# National Bank of the Republic of Macedonia
# Working Paper

# Loan supply shocks in Macedonia: a Bayesian SVAR approach with sign restrictions

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**Abstract**

This paper analyses the effects of loan supply, as well as aggregate demand, aggregate supply and monetary policy shocks between 1998 and 2014 in Macedonia using a structural Vector Auto Regression with sign restrictions and Bayesian estimation. The main results indicate that loan supply shocks have no significant effect on loan volumes and lending rates, as well as on economic activity and prices. The effects of monetary policy on lending activity are fairly limited, although there is some evidence that it affects lending rates more than loan volumes. Monetary policy shocks have strong effects on inflation, while the central bank reacts strongly to adverse shocks hitting the economy. Baseline results are fairly robust to several extensions and robustness checks. According to historical decomposition, the lending activity was supporting economic growth before and during the crisis, but its contribution became negative during the recovery and it was a drag on growth until the end of the period. Pre-crisis GDP growth is mostly explained by the supportive interest rate of the main monetary policy instrument. However, the restrictive policy during the crisis for the purposes of maintaining monetary policy goals was associated with a fall in GDP, while the policy became supportive again during the early stages of the recovery. Policy rates in the recent years mostly reflect subdued lending activity and aggregate supply factors, which the central bank tries to counteract with a more accommodative policy.

**JEL classification:** C11, C32, E51, E52

**Keywords:** loan supply, monetary policy, Bayesian VAR, sign restrictions, Macedonia

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## 1. Introduction

Lending activity in Macedonia was fairly subdued in the first half of the transition process, thus contributing to a lower level of financial intermediation than its peer countries, as well as slower economic growth. However, a period of expansion of bank lending started in the mid-2000s. Combined with the stable macroeconomic environment and the absence of external shocks, the higher lending was associated with acceleration in economic growth rates. With no significant pressures on the price level and the current account, the central bank was able to maintain the exchange rate peg to the euro, while at the same time relaxing the monetary policy in this period by reducing interest rates. However, the global economic and financial crisis put an end to this process. Post-crisis economic growth has been lower or slightly negative (in 2009 and 2012), while lending growth rates are continuously lower than in the pre-crisis period and remain at a moderate level. In addition, the central bank had to fight pressures on foreign reserves by raising policy rates and implementing more restrictive policy during the first wave of the crisis. Nevertheless, as the pressure subsided, the central bank was able to relax its policy in order to support economic activity.

This paper aims to analyse the effects of loan supply shocks in Macedonia between 1998 and 2014 as well as the effects of other key macroeconomic shocks, i.e. monetary policy, aggregate demand and aggregate supply shocks. In order to do so, it applies a Structural VAR (SVAR) with sign restrictions and Bayesian estimation. Restrictions are imposed in a manner that enables proper identification of shocks and is in line with the recent theory and empirical studies. The paper focuses on an important economic and policy issue in Macedonia, which has not been previously empirically investigated, and tries to analyse it with an estimation method that is dominant in the relevant recent literature in this area. In particular, by using Bayesian SVAR with sign restrictions, the empirical investigation in this paper avoids some of the drawbacks of using classical econometric methods arising from the relatively short data series with numerous structural and methodological breaks, which is common for transition countries. Finally, to the best of our knowledge, this is the first paper that tries to apply this technique to economic data on Macedonia.

The paper starts with stylised facts on bank lending and economic growth in Macedonia. Data and methodology are discussed in Section 3. Section 4 presents the baseline results and Section 5 provides extensions and robustness checks. Section 6 concludes.

## 2. Stylised facts

Bank lending in Macedonia has undergone several distinct stages during the last two decades. From the beginning of the transition process until mid-2000s, the banking sector was quite shallow and undeveloped, and went through a process of deep structural reforms. During that period, the country was also hit by several large internal and external shocks. Consequently, the central bank

(National Bank of the Republic of Macedonia, NBRM) was mostly implementing a restrictive monetary policy in attempts to eliminate external pressures on foreign reserves and to maintain the fixed exchange rate. Economic growth was fairly volatile and lending was lower than in the more advanced transition countries.

Major reforms of the banking system during the 2000s and subsequent changes in bank ownership, the transfer of know-how from the new foreign owners, changes in the legal environment for banking operations[1] and the introduction of international governance and banking practices contributed towards a reformed and stable banking sector, which was capable of supporting economic growth. On the policy side, despite various external and internal shocks, the stable macroeconomic environment and the maintenance of the fixed exchange rate were additional supportive factors for an acceleration of economic growth. Movements during the period (Figure 1) indicate that the expansionary stage of lending activity began around 2004 and lasted until the beginning of the global economic and financial crisis. Annual growth of loans was in the double digits during this period, reaching the maximum of almost 40% in 2007. This contributed to a faster process of financial deepening, which finally started to accelerate after several years of a loan-to-GDP ratio lower than 20%, far below most other transition countries. This period of strong credit growth was both reflecting and supporting stronger GDP growth, averaging 5.4% between 2006 and 2008, which is the highest growth rate for Macedonia in the transition period. However, the expansion of credit and the acceleration of growth did not result in more significant price pressures, as average inflation was fairly low and stable before the global economic crisis (1.4% between 2003 and 2007), although it did reach a high of 8.3% in 2008, mostly as a result of global price rises. While stronger economic growth in a small open economy with a fixed exchange rate such as Macedonia did create additional pressures regarding the trade deficit, continuous stable inflows of foreign currency (private transfers and capital inflows) prevented a more serious pressure on foreign reserves. Therefore, monetary policy during the latter part of this period was fairly relaxed, with policy rates reaching a then historical low of 4.7% in November of 2007.

[1] During this period banks started with the usage of foreign exchange clauses in their approved loans, as well as adjustable interest rates on their loan contracts and deposit products. In addition, several other institutional and legal reforms contributed towards improving the overall environment for banking operations (reforms in the judiciary, streamlining of procedures for bankruptcy, collateral enforcement and payment collections).

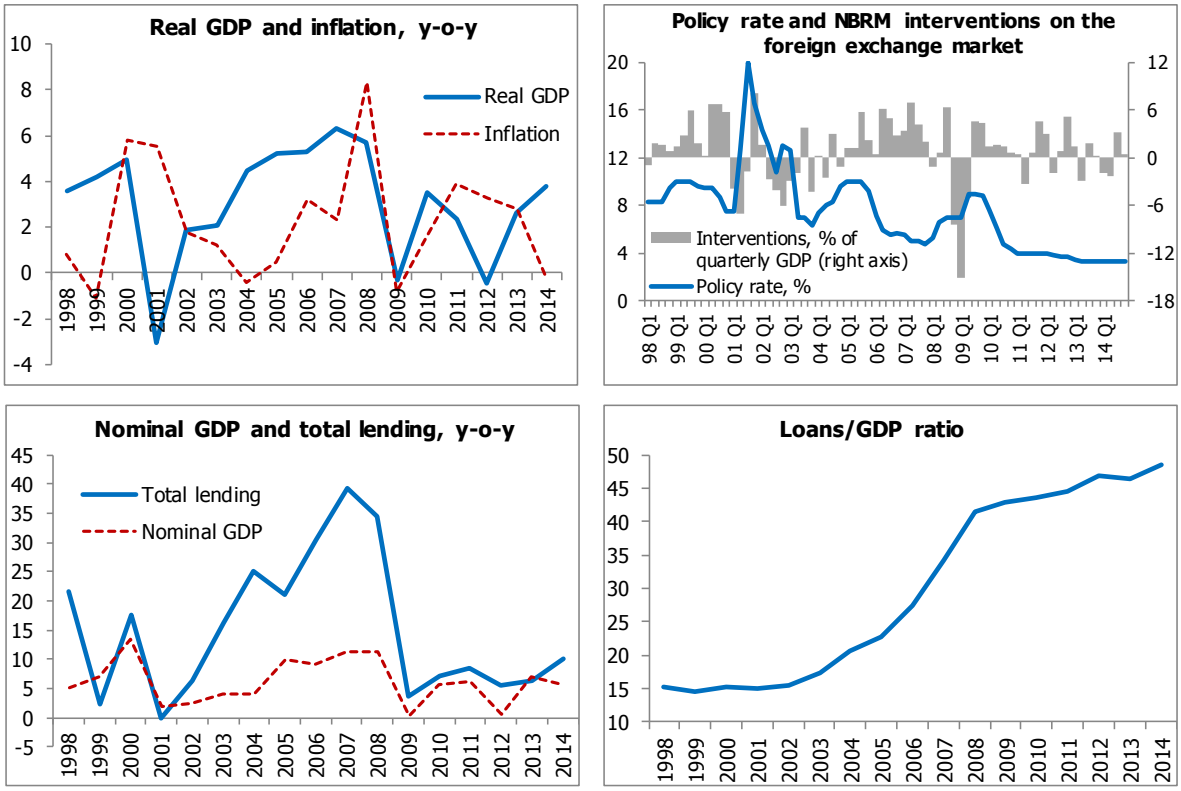



Figure 1. Stylised facts, annual data (quarterly data for policy rates and NBRM interventions)
Source: NBRM and State Statistical Office (SSO)

The spill-over of the financial crisis to Macedonia in late 2008 ended the expansionary credit cycle that started around 2004. The first effects from the crisis were transmitted through the weakened external demand and the reduction of capital inflows, and within a couple of months the negative impact was felt in the deposit and credit markets as well. There was a sharp decline in credit growth, which signalled the contraction phase of the credit cycle accompanying the economic slowdown, with lending growth rates mostly in single digits after 2008. The lower lending was initially also a reflection of measures implemented by NBRM between mid-2008 and end-2009 aimed at slowing down lending to households. In addition, towards the end of 2008, global uncertainty and growing negative expectations resulted in an elevated demand for foreign currency. Under such circumstances, monetary policy was facing serious challenges of preserving the confidence in domestic currency and maintaining the fixed exchange rate. NBRM managed to restore confidence and maintain the exchange rate stability with large interventions in the foreign exchange market. Interventions on the foreign exchange market soared to around 10% of GDP in the first half of 2009. At the same time, NBRM increased the policy rate to 9%, which was the highest level since the end of 2005. In order to discourage the demand for foreign currency, additional contractionary measures were adopted in May 2009 by increasing the reserve requirement rate for bank liabilities in foreign

currency and liabilities with a foreign exchange clause (foreign currency-linked liabilities). During 2009 the central bank also adopted prudential measures for liquidity management.

The period after 2009 could best be described as a period of high uncertainty and volatility arising from the external environment, with mixed signals from both global and domestic developments, and corresponding policy responses. The overall effect from the crisis for the Macedonian economy was inevitably negative in 2009; but unlike many other countries, it returned to positive growth relatively quickly. Since the external sector is a key factor for the economic growth in Macedonia, the improved situation on the global markets and of the terms of trade, as well as inflows of foreign investments all had an important role in this regard. Since end-2009, NBRM made several cuts to the policy rate, thus relaxing monetary policy in order to support the ongoing economic recovery. Monetary policy was further relaxed in the following years, with the policy rate reaching a historical low of 3.25% in middle of 2013. NBRM also introduced prudential measures which further strengthened the stability of the financial system. In the wake of the global crisis, and also of the sovereign debt crisis at the end of 2011, growth of bank lending was slower than before 2009, reflecting higher perceptions of credit risk and more conservative lending activity, and also volatile credit demand and apparent pressures on the credit portfolio quality. Although there were some signs of private sector deleveraging in the post-crisis years, it was smaller than in most other countries (IMF, 2015), which means that banks in this period supported domestic demand through lending activity. Overall, despite the serious challenges, the stability of the exchange rate was preserved, while foreign reserves continued to grow and the banking sector remained stable and fully functional. In addition, the uncertainty and volatility after the crisis notwithstanding, in the recent years there are signs that the recovery is more sustainable, with relatively stable positive GDP growth rates, and moderate and rising credit growth.

## 3. Data and methodology

### 3.1. Data

As discussed in more details below, our analysis is carried out using Structural Vector Auto Regression (Structural VAR, SVAR) with sign restrictions. We use Bayesian estimation, which has some advantages over classical estimation when using a small sample such as ours, e.g. in overcoming problems of over-parametrisation in the VAR and problems arising from structural breaks in the data. The choice of variables in the VAR reflects a mix of theoretical foundations and casual considerations. Indeed, we include standard macroeconomic variables that are expected to capture well the loan supply factors, as well as other key macroeconomic factors. While details vary among studies, these variables are similar to the ones used by the literature on loan supply shocks.

The variables included in our baseline VAR are: the seasonally adjusted quarter-on-quarter real GDP growth, the seasonally adjusted quarter-on-quarter CPI inflation rate, the policy rate (rate

on central bank bills), the quarter-on-quarter change in total outstanding volume of local currency (denar) loans and the corresponding average weighted lending rate, i.e. the rate on the total outstanding volume of local currency loans. We also include a constant term in the VAR. Although most studies use the GDP deflator as an indicator of price movements, we decided to use consumer price inflation because it is the indicator monetary policymakers usually focus on when making policy decisions (Halvorsen and Jacobsen (2014)), which is also the case in Macedonia. Further, by using the policy rate, we deviate from most of the literature, which tends to use interbank rates as an indicator of the monetary policy stance. However, in circumstances of continuous surplus liquidity in the banking system, the role of the interbank market in Macedonia in helping banks to address temporary liquidity shocks by borrowing or lending is fairly limited. Indeed, the interbank money market in Macedonia is relatively shallow, as indicated by the relatively low number of transactions. In this context it should also be noted that the correlation between policy rates and money market rates is very high, and that policy rates are fully transmitted to money market rates (Veličkovski (2006) and Bogoev and Petrevski (2012)). Related to this, while our use of the policy rate as a representative of monetary policy is in line with the relevant literature, this also implies that we abstract from additional instruments and measures that NBRM has occasionally used to convey the policy stance, particularly in the post-crisis period. Finally, we use the outstanding volume of total local currency loans and the corresponding interest rate as market variables. In a fixed exchange rate regime, monetary policy can only influence local currency loans, so we use the total outstanding volume of denar loans in our analysis, including denar loans with a foreign exchange clause (and lending rates on total outstanding denar loans). However, below we also check the robustness of our results to replacing denar loans with total loans, which enables an indirect inference on the reaction of foreign currency loans to shocks. We also check the robustness by splitting denar loans into loans with and without a foreign exchange clause (with respective lending rates in all cases). In addition, it should be noted that most studies focus on loans to non-financial corporations and respective lending rates. However, this is unfeasible in our case due to data limitations, as the series on corporate lending rates only starts in 2005, so we use total denar loans. Finally, since the series on newly approved loans in Macedonia starts in the end of 2005, we decided to use total outstanding loan volumes and respective lending rates in all specifications, which is in line with most other studies.

There is little agreement in the literature on loan supply shocks regarding the way the data should enter the VAR (except for interest rates, which generally enter untransformed, i.e. as percentage points). Empirical studies in this area employ various approaches, often with little or no explicit arguments for doing so. Busch et al. (2010), Musso (2009) and Deryugina and Ponomarenko (2011) all use seasonally adjusted log-levels. Hristov et al. (2012) use linear de-trending of all variables, including interest rates. Halvorsen and Jacobsen (2014) use a mix of detrended GDP, the inflation rate and the level of house prices. On the other hand, other studies use differenced data (e.g. Peersman (2005) or Mumtaz et al. (2012)). Bearing all this on mind, we decided to follow the

latter studies and use quarter-on-quarter percent changes of GDP and loans and the quarter-on-quarter inflation rate, while interest rates enter as percentages.

We use quarterly data between 1998Q1 and 2014Q4 in our estimation (Figure 2), which is the maximum sample available at the time of writing. The beginning of our sample is entirely determined by the availability of data on loan volumes and lending rates. As for the end of the period, there is a risk of parameter instability arising from the inclusion of the crisis period, which implies a structural break (Busch et al., 2010). However, leaving out several of the recent years would result in a fairly short sample, consisted of an early period with various internal and external shocks and a latter period that includes only the expansionary stage of the business cycle in Macedonia. Indeed, the use of the maximum sample available is the approach taken by most papers in this area (e.g. Hristov et al. (2012) and Deryugina and Ponomarenko (2011)). Nevertheless, after using the entire period as baseline, we also carry out some sub-sample analysis in order to check for possible differences across time periods. Standard information criteria and autocorrelation tests indicate that a VAR of two lags is appropriate, and below we also check for robustness to alternative lag lengths.

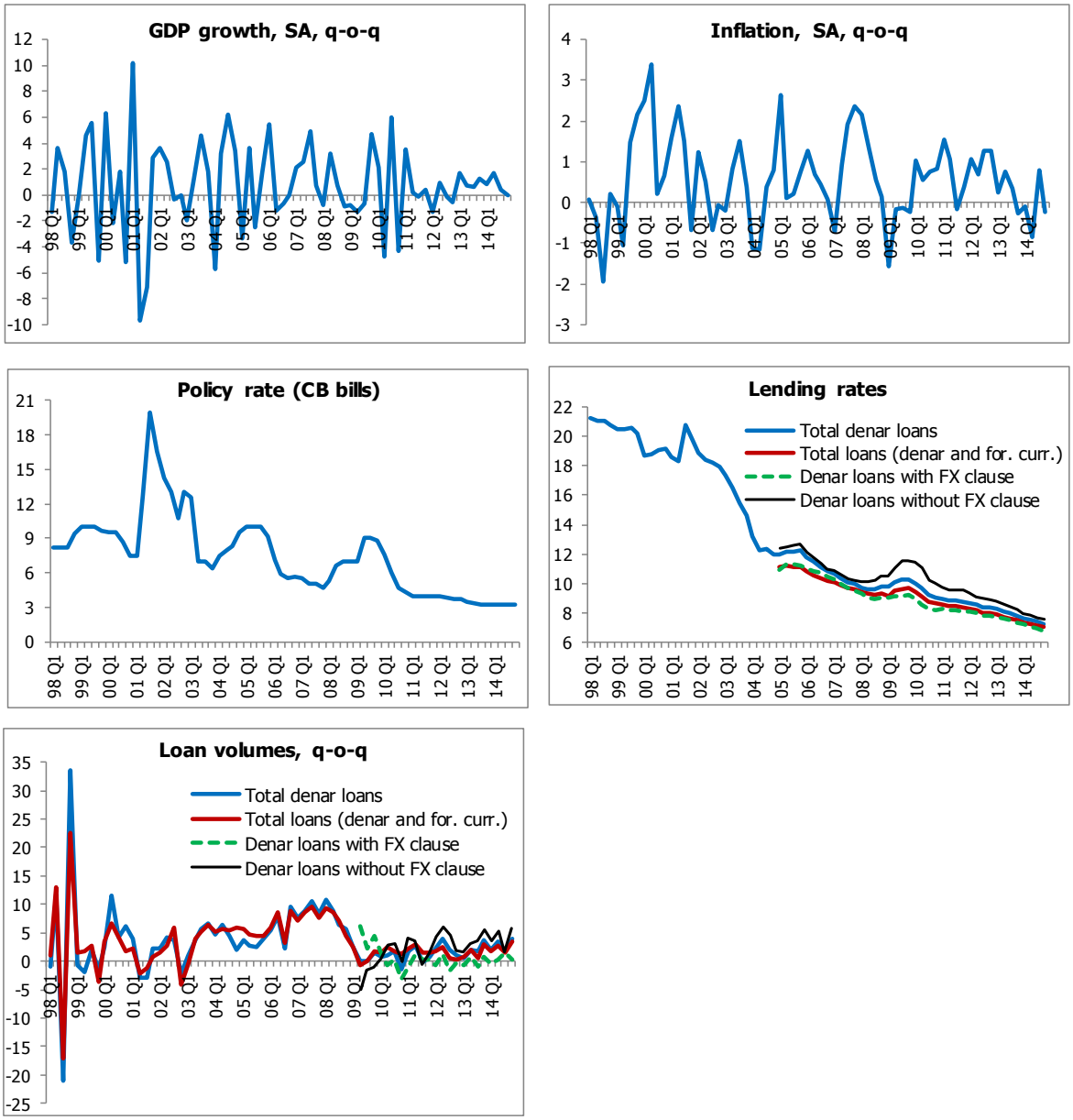



Figure 2. Data used in the empirical analysis
Source: NBRM and State Statistical Office (SSO)

### 3.2. Methodology

Our empirical investigation is based on Structural Vector Auto Regression. VAR models describe the evolution of the endogenous variables as a function of their past values (and possibly additional exogenous and deterministic terms). A general, reduced form VAR can be represented as:

$$X_t = B(L)X_{t-1} + u_t \qquad \text{Eq. 1}$$

where $X$ is a vector of $k$ endogenous variables, $B(L)$ is a matrix polynomial in the lag operator $L$, and $u_t$ represents a $k$-length vector of reduced form residuals, which is normally distributed with zero mean and covariance matrix $E[u_t u_t']=\Sigma$.

The problem with the reduced-form VAR in Eq. 1 above is that residuals $u_t$ will in general be correlated. As a consequence, reduced-form VARs do not have a structural, economic interpretation. Therefore, the reduced-form should be transformed into a structural model, which is done by pre-multiplying the reduced-form VAR with an $A_0$ matrix to compute the structural form of the VAR:

$$A_0 X_t = A_0 B(L) X_{t-1} + \varepsilon_t \qquad \text{Eq. 2}$$

In Eq. 2, $\varepsilon_t$ is a $k \times 1$ vector of structural shocks, which are assumed to be independent, with $E(\varepsilon_t \varepsilon_t')=I$, i.e. identity matrix. Further, the matrix $A_0$ in Eq. 2 describes contemporaneous reactions of the endogenous variables in $X$ to the structural shocks $\varepsilon_t$. However, without further restrictions, the structural form of the VAR in Eq. 2 is not identified and hence the VAR still lacks an economic interpretation.

In order to distinguish the structural shocks and to identify the VAR, the empirical literature uses two main approaches to impose restrictions based on economic theory or casual considerations[2]. The first approach imposes zero restrictions[3] on elements of the $A_0$ matrix by using a recursive structure on the contemporaneous responses of endogenous variables to shocks. It was originally proposed in a seminal article by Sims (1980), and has since become one of the most used empirical approaches in macroeconomics, particularly in monetary policy studies. The recursive approach restricts $A_0$ to a lower triangular matrix with diagonal elements equal to one. This implies that the decomposition of the variance-covariance matrix $\Sigma$ is achieved via the Cholesky decomposition. However, the Cholesky decomposition implies causal ordering of variables, meaning that variables that are ordered first are allowed to have a contemporaneous effect on later variables, but later variables do not contemporaneously affect the variables ordered before them. Therefore, in the recursive identification, the ordering of variables can have an important effect on results, so the restrictions implied by that ordering must rely on particular theoretical guidance or institutional information. Related to this, an additional drawback of the recursive approach is that it requires a large number of zero restrictions in order to fully identify the model and analyse all structural shocks.

The second approach to imposing identifying restrictions is to use sign restrictions. It was first proposed in the context of monetary policy studies by Uhlig (2005), Canova and de Nicolo (2002) and Faust (1998), and was later extended to other areas as well. This approach, typically using Bayesian estimation, is dominant in the recent literature on loan supply shocks and is consequently

[2] This part provides a non-technical description of the two approaches. For technical details, see e.g. Enders (2010) for recursive VARs and Uhlig (2005) for sign restrictions.

[3] Zero restrictions are also used in other approaches to the identification problem in VARs, for instance by imposing long-run restrictions (Blanchard and Quah (1989) for aggregate demand and supply shocks) or restrictions that are derived by casual considerations or structural relations (e.g. Blanchard and Perotti (2002) for fiscal policy).

also used in this study. In particular, we use Bayesian estimation with a Normal Inverted Wishart prior for the SVAR coefficients and the covariance matrix, with 10.000 Gibbs iterations and 1.000 retained draws. Our estimations were carried out using the codes by Haroon Mumtaz as well as the handbook by Blake and Mumtaz (2012)[4].

Unlike the recursive VAR, the sign restrictions approach does not impose size (zero) restrictions on contemporaneous relations between variables. Instead, it imposes restrictions on the signs of contemporaneous and/or future responses of variables to particular shocks, i.e. restrictions are based on the expected co-movement of variables following a structural shock. Identification is achieved by assuming that various variables react in a different manner to various shocks, and this information is then used within the SVAR to distinguish between structural shocks. In technical terms, the sign restrictions approach consists of drawing a candidate $A_0$ matrix, repeatedly rotating it and keeping the draws that meet all the sign restrictions. Further, unlike the recursive approach, the sign restrictions approach does not prescribe the number of restrictions in order to reach identification, and it is possible to identify shocks with few restrictions. Instead, the necessary restrictions depend on the number and nature of shocks one aims to identify and in particular on the successful discrimination between the reactions to the identified shocks and to other shocks affecting the variables. In addition, the sign restrictions approach is relatively flexible on the number and manner in which shocks are identified. Related to this, the restrictions to identify structural shocks can be imposed in a relatively "atheoretical" or "agnostic" manner, thus avoiding the imposition of potentially contentious identification restrictions based on variable ordering or institutional information.

### 3.3. Identification

Our main interest is related to the identification of exogenous shifts of particular factors, most notably the credit supply. Exogenous shifts are the ones which reflect factors other than the endogenous reactions to the factors already incorporated in the model. Since we have five endogenous variables, we could identify at most five structural shocks. However, proceeding in this manner is generally not recommended, as it requires complicated identification restrictions and increases the computational burden (Busch et al., 2010). On the other hand, identifying only a few shocks can result with a large amount of unexplained movements. Bearing on mind this trade off, studies usually choose the number of shocks to identify in accordance with their main point of interest. For instance, in his seminal paper on SVARs with sign restrictions, Uhlig (2005) only identifies the monetary policy shock, noting that he is only interested in that shock. However, numerous studies identify several shocks, thus enabling a richer economic analysis and also facilitating the identification of structural shocks (Paustian, 2007).

[4] We also rely on correspondence with Haroon Mumtaz. The code can be downloaded from https://sites.google.com/site/hmumtaz77/code.

Studies on credit supply that use SVAR with sign restrictions identify two shocks at the least: the loan supply shock and the monetary policy shock. Busch et al. (2010) explain this decision with the difficulties in disentangling the two shocks, which means that identifying only one of them would make its interpretation more complicated. On the other hand, they also note that they do not identify loan demand shocks because it is difficult to separate them from aggregate demand shocks; if those two shocks were also identified, then computation in a six-variable VAR would become difficult. Deryugina and Ponomarenko (2011) follow Busch et al. (2010) in imposing their sign restrictions by identifying the same two shocks in a five-variable VAR. In their study of Norway and the UK, Halvorsen and Jacobsen (2014) also identify only lending and monetary policy shocks within a six-variable VAR. On the other hand, several studies of credit supply identify more than two shocks. For instance, besides the loan supply and monetary policy shocks, Musso (2009) also identifies the effects of money demand and loan demand shocks to key macroeconomic variables in the euro-area and the US. Tamási and Világi (2011) also identify four shocks in a seven-variable VAR in their analysis of the Hungarian economy. Finally, in their analysis of loan supply shocks in the euro-area with a five-variable panel VAR with sign restrictions, Hristov et al. (2012) identify four shocks: loan supply, monetary policy, aggregate demand and aggregate supply shocks.

We decided to closely follow Hristov et al. (2012) and the literature surveyed therein in the identification of shocks and sign restrictions in our study for two main reasons. First, we are interested in a richer economic analysis. Imposing several shocks will thus enable us to disentangle their separate effects on key macroeconomic variables and to explain a bigger share of the latter. Second, Hristov et al. (2012) impose sign restrictions based on a careful survey of other studies and their findings, particularly DSGE studies that we also follow. Therefore, we identify the following four shocks (Table 1): aggregate supply, monetary policy, aggregate demand and loan supply shocks, while there is also a fifth, unidentified shock that picks up the effect of other factors. Shocks are defined as adverse shocks, but results are unchanged if all shocks are defined in an opposite manner. In the baseline specification, we only impose contemporaneous restrictions on impulse responses, whereas Hristov et al. (2012) impose restrictions for two quarters. Most studies also impose restrictions over several quarters, including more elaborate restrictions such as delayed reactions of some variables (e.g. Busch et al. (2010)). In contrast, other studies impose contemporaneous restrictions only (e.g. Halvorsen and Jacobsen (2014)). Canova and Paustian (2011) recommend against imposing restrictions beyond the contemporaneous period, since they seldom have a clear theoretical underpinning. Bearing this on mind, we decided to only impose contemporaneous restrictions, which is also consistent with the original idea of the sign restrictions approach to only impose minimal restrictions and then let the data speak. Last but not least, the imposition of shocks for longer periods proved to be technically difficult, since the computational burden increases considerably in our case with four shocks. However, when checking the robustness of our baseline results in Section 5, we also try a specification where restrictions are imposed in two quarters.

Restrictions for the identification[5] of aggregate supply, aggregate demand and monetary policy shocks draw on the VAR studies by Peersman (2005) and Fratzscher et al., (2009), as well as standard DSGE studies by Straub and Peersman (2006) and Canova and Paustian (2011). The aggregate supply shock is identified by imposing restrictions so that GDP growth and inflation move in opposite directions, i.e. an adverse supply shock leads to a contemporaneous rise of prices and fall of GDP. As a reaction to these movements, the central bank reacts with a more restrictive monetary policy. Aggregate supply shocks can be of various nature: shocks to the production function or production factors, shocks to labour or non-labour costs of production, shocks to the price-setting behaviour, technology shocks or oil shocks (Musso, 2009). The policy shock is identified via tighter monetary policy (higher interest rates), which causes a contemporaneous fall of GDP and prices. This restriction on prices is important as it separates the monetary policy from the aggregate supply shock; otherwise the two would be indistinguishable. In addition, other studies also identify monetary policy shocks in a similar manner (Busch et al. 2010). Finally, in order to identify an aggregate demand shock, we restrict GDP growth and inflation to move in the same direction (i.e. they both fall for the adverse shock). In such a case, the policy rate also falls as the central bank reacts to the negative aggregate demand shock by an expansionary monetary policy. In addition, the negative aggregate demand shock is also accompanied by a contemporaneous fall of lending rates, for two main reasons. First, lower aggregate demand probably causes lower demand for loans, which is generally accompanied by lower lending rates. Second, the lower policy rate in the wake of the negative demand shock will also cause lower lending rates, even with incomplete transmission of monetary policy. It should also be noted that this restriction on the movement of lending rates serves to distinguish the aggregate demand shock from the loan supply shock. Aggregate demand shocks may also be quite diverse, and may reflect changes in consumption or preference, investment demand shocks or fiscal policy shocks (Gambetti and Musso, 2012).

The identification of loan supply shocks also relies on the relevant VAR and DSGE literature. Loan supply shocks may reflect some fundamental changes in banking sector, i.e. they go beyond the endogenous reaction of banks to macroeconomic movements. They may reflect a combination of factors from the financial sector, such as changes in financing conditions, changes in competition, changes in the quality of borrowers (Hristov et al. 2012) or confidence effects. Further, when summarising the relevant literature on loan supply shocks, Barnett and Thomas (2014) note that they could reflect a wide array of factors, such as worsening of bank assets, a decline in bank capital, an increase in the default risk or higher risk aversion by investors unrelated to credit default. There is general agreement in the theoretical and empirical literature that loan supply shocks move the loan volume and the lending rate in different directions, and this is the approach taken by all the SVAR studies mentioned above. That is, in the case of adverse loan supply shocks, the volume of outstanding loans falls, whereas the lending rate rises contemporaneously. This ensures that loan supply shocks can be distinguished from aggregate demand shocks, since in the latter the lending

[5] This and the following paragraph draw heavily on Hristov et al. (2012).

rate also falls. Further, based on DSGE models with financial frictions and credit markets[6], GDP growth also falls in the wake of loan supply shocks. On the other hand, there is some disagreement regarding the reaction of monetary policy and prices. Most studies find that the central bank also relaxes its policy and prices fall in cases of loan supply shocks. Therefore, we also impose a restriction for the monetary policy to react to loan supply shocks and the accompanying economic slowdown by lowering the policy rate. Besides being in line with the theoretical findings, this also enables an identification of loan supply shocks, i.e. their distinction from aggregate supply and monetary policy shocks (which are accompanied by rising policy rates). No restrictions are imposed on price movements since other restrictions are sufficient for shock identification, and the relevant literature is ambiguous about the reaction of prices.

| | GDP growth | inflation | policy rate | lending rate | loan volume change |
|---|---|---|---|---|---|
| Aggregate supply shock | − | + | + | | |
| Monetary policy shock | − | − | + | | |
| Aggregate demand shock | − | − | − | − | |
| Loan supply shock | − | | − | + | − |

Table 1: Contemporaneous sign restrictions imposed to identify (adverse) structural shocks (empty cells imply no restrictions are imposed for the response of the respective variable to the respective shock)

## 4. Baseline results

In this section we discuss the baseline results of our analysis: the impulse responses of the variables to the four identified shocks by imposing contemporaneous restrictions, as well the accompanying forecast error variance decomposition (FEVD) and the historical decomposition. In all cases we present median impulse responses for each of the four shocks over a horizon of 16 quarters. Following Sims and Zha (1999) and the relevant literature using sign restrictions, we also present confidence bands of 16% and 84% percentiles of the responses.

Figure 3 shows impulse responses to an adverse aggregate supply shock. In line with the restrictions imposed, an adverse aggregate supply shock initially causes higher prices and lower GDP, with the central bank contemporaneously reacting to the shock by increasing the policy rate. The reaction of GDP and prices is quite short-lived, as their response quickly becomes insignificant and remains so throughout the horizon. The restrictive monetary policy is however more persistent and lasts for around a year. This indicates that the central bank responds rather strongly to adverse

[6] See the survey in Hristov et al. (2012).

aggregate supply shocks, despite the usual recommendations that monetary policy should not do so unless the supply shock threatens to have second-round effects on inflation and inflationary expectations. As a result of the more restrictive monetary policy, lending rates increase on impact, and remain higher for a considerable period following an aggregate supply shock, while the reaction of loan volumes is quite weak. However, the reaction of both lending rates and loan volumes in the wake of aggregate supply shocks is insignificant during the entire horizon.

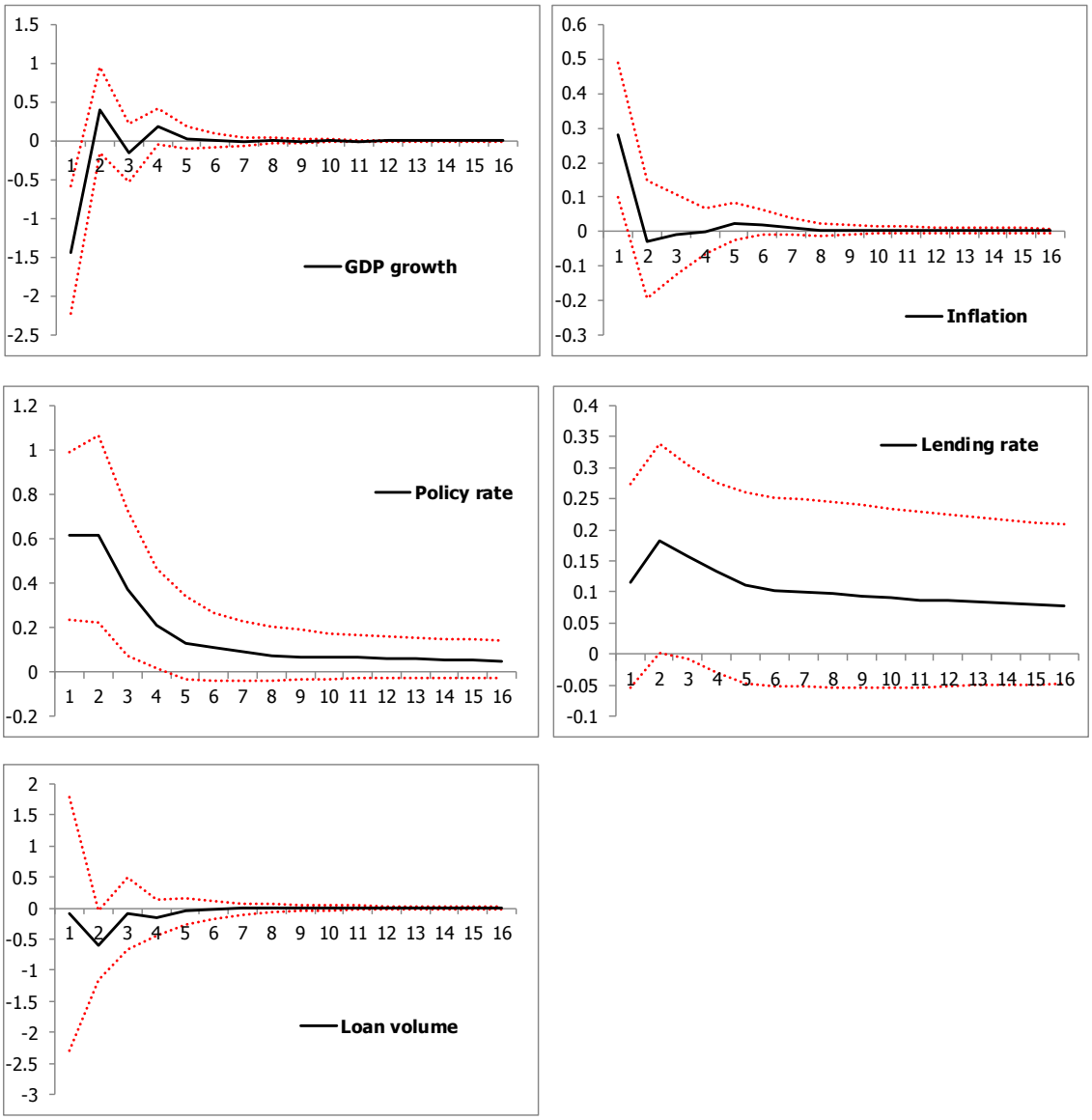



Figure 3. Impulse responses to an aggregate supply shock

Next we analyse the response to a restrictive monetary policy shock (Figure 4). The policy rate rises on impact, in line with the sign restrictions, and this reaction is maintained for several quarters. This protracted reaction indicates some inertia in monetary policy decisions, which is to be expected. The restrictive monetary policy shock has a relatively strong effect on prices, which fall on impact, and remain significantly lower for about a year. On the other hand, the reaction of GDP is

insignificant beyond the period of the restriction. This indicates that monetary policy does not affect inflation via economic activity, but its effect on prices is direct. One possible explanation for this would be the effects on monetary policy on inflationary expectations first and then on inflation due to the strong credibility of the central bank, which might be related to the relatively long and successful maintenance of the pegged exchange rate regime. Finally, the reaction of lending variables, which are left unrestricted, is very weak. Indeed, in the wake of the restrictive policy shock, lending rates rise and lending activity falls, which is in line with *a priori* expectations, but these reactions are insignificant throughout the period.

The insignificant reaction of lending rates (and volumes) indicates a relatively weak monetary policy transmission mechanism, which is broadly in line with findings from other studies regarding the transmission of policy rates to other interest rates in Macedonia such as Veličkovski (2006) and Bogoev and Petrevski (2012). Further, our finding of an insignificant effect of monetary policy shocks on GDP is similar with the one by Jovanovic et al. (2015), who use a smaller VAR with recursive identification over a similar period in Macedonia, although they do find some evidence of weak effects of monetary policy when using regime-switching VARs and other monetary policy instruments. On the other hand, unlike their finding of insignificant response of inflation (when using a smaller VAR with recursive identification), we find that monetary policy shocks do have a direct effect on price movements.

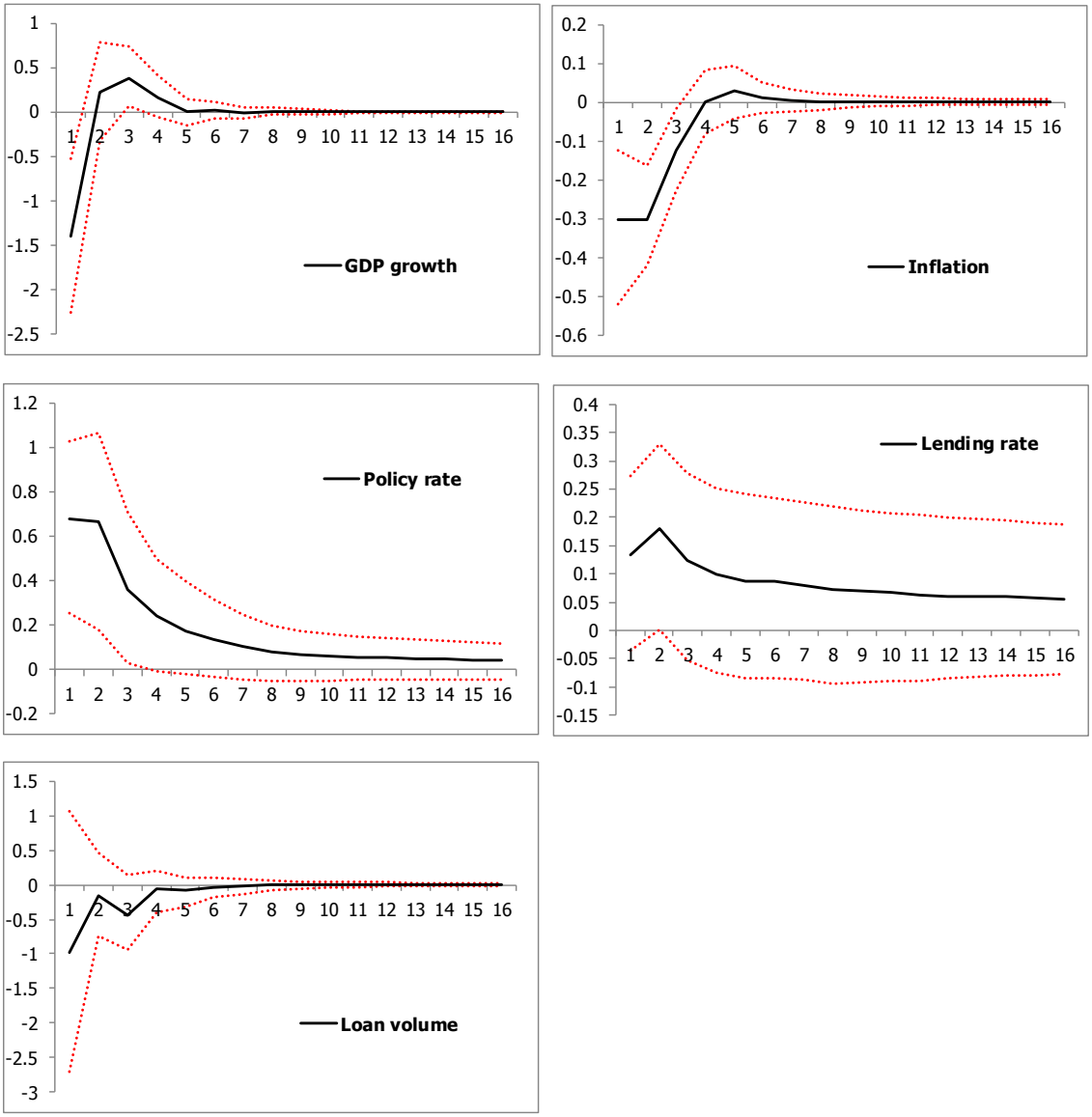



Figure 4. Impulse responses to a monetary policy shock

Figure 5 shows impulse responses to an adverse aggregate demand shock. GDP falls on impact, in line with the restrictions imposed, but immediately jumps back the following quarter (probably reflecting base effects) before becoming insignificant. Also in line with the restrictions imposed, both prices and the policy rate fall on impact. The reaction of prices becomes insignificant soon thereinafter, while the policy rate remains significantly lower for a relatively long period, which indicates that adverse demand shocks are met with a relatively long-lived reaction by the central bank with a more relaxed policy. The lending rate falls on impact, and this reaction is quite persistent, as it remains significant for over four years, thus mirroring the lower policy rates. On the other hand, the

response of the loan volume is insignificant, which is somewhat surprising given the lower lending rates. One explanation for this result may be that the unchanged economic activity is reflected in an unchanged demand for loans. If that is the case, the unchanged demand for loans is dominating over lower lending rates to yield unchanged loan volumes.

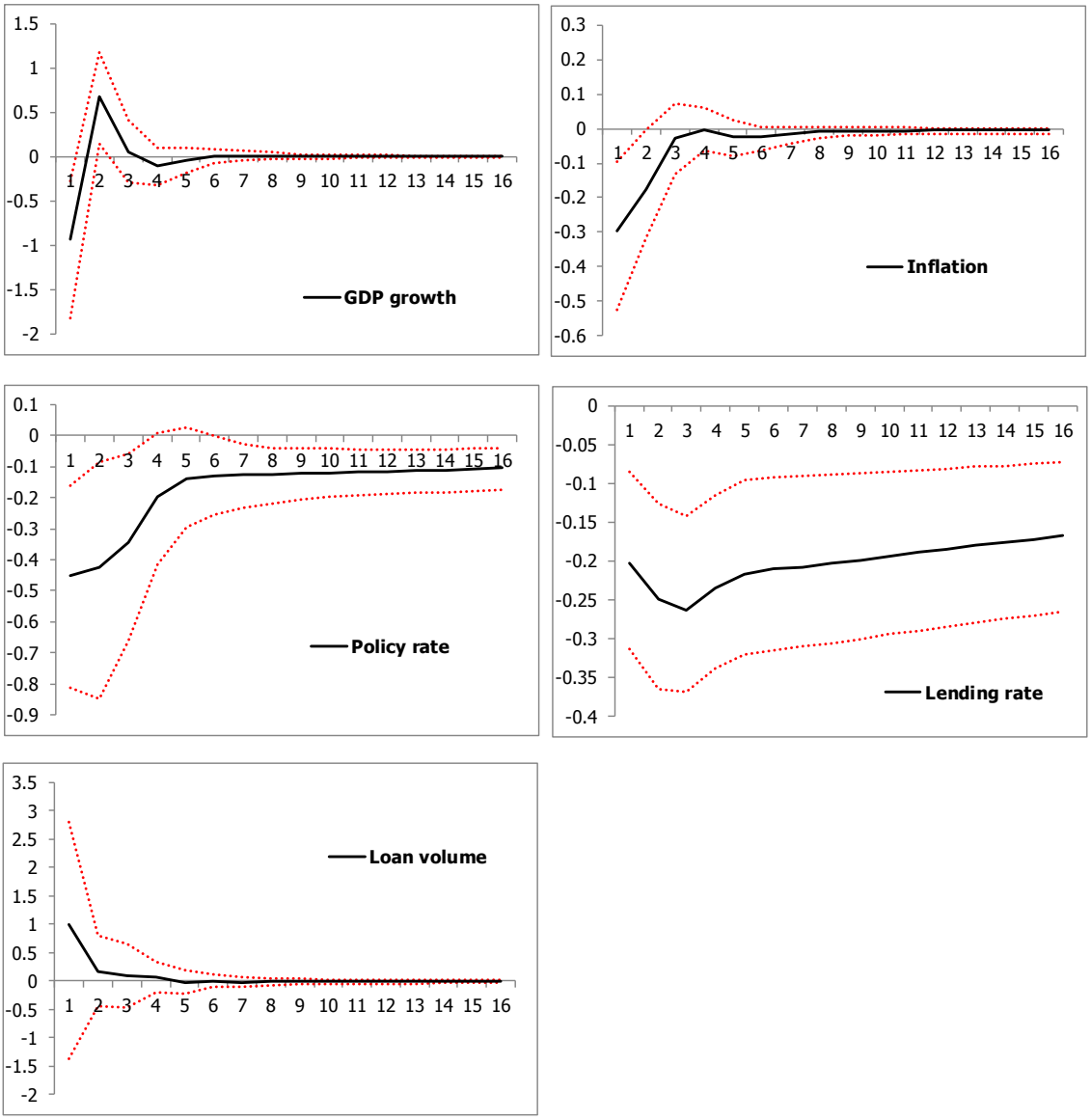



Figure 5. Impulse responses to an aggregate demand shock

Finally, Figure 6 shows the reaction to an adverse loan supply shock, which is one of the key issues of interest. In line with the sign restrictions, the loan supply shock initially causes opposite movements of loan volumes and rates. This effect on lending rates is quite prolonged, as they are

higher for quite a long period, although both lending rates and volumes become insignificant fairly quickly. The impact on other variables is quite limited. GDP falls on impact due to the restriction, but is insignificant thereinafter. The response of inflation, which is left unrestricted, is insignificant throughout the period. The only reaction that is significant for a longer period is the one by monetary policy, which reacts with lower rates on impact due to the sign restrictions, and is more relaxed for about a year after the adverse loan supply shock. Overall, this implies that, if the supply of loans falls, the central bank tries to counteract by relaxing its policy, which is usually successful, since loan supply shocks do not result in a significant decline in loan volumes, and they also do not cause a contraction in GDP and a fall in prices.

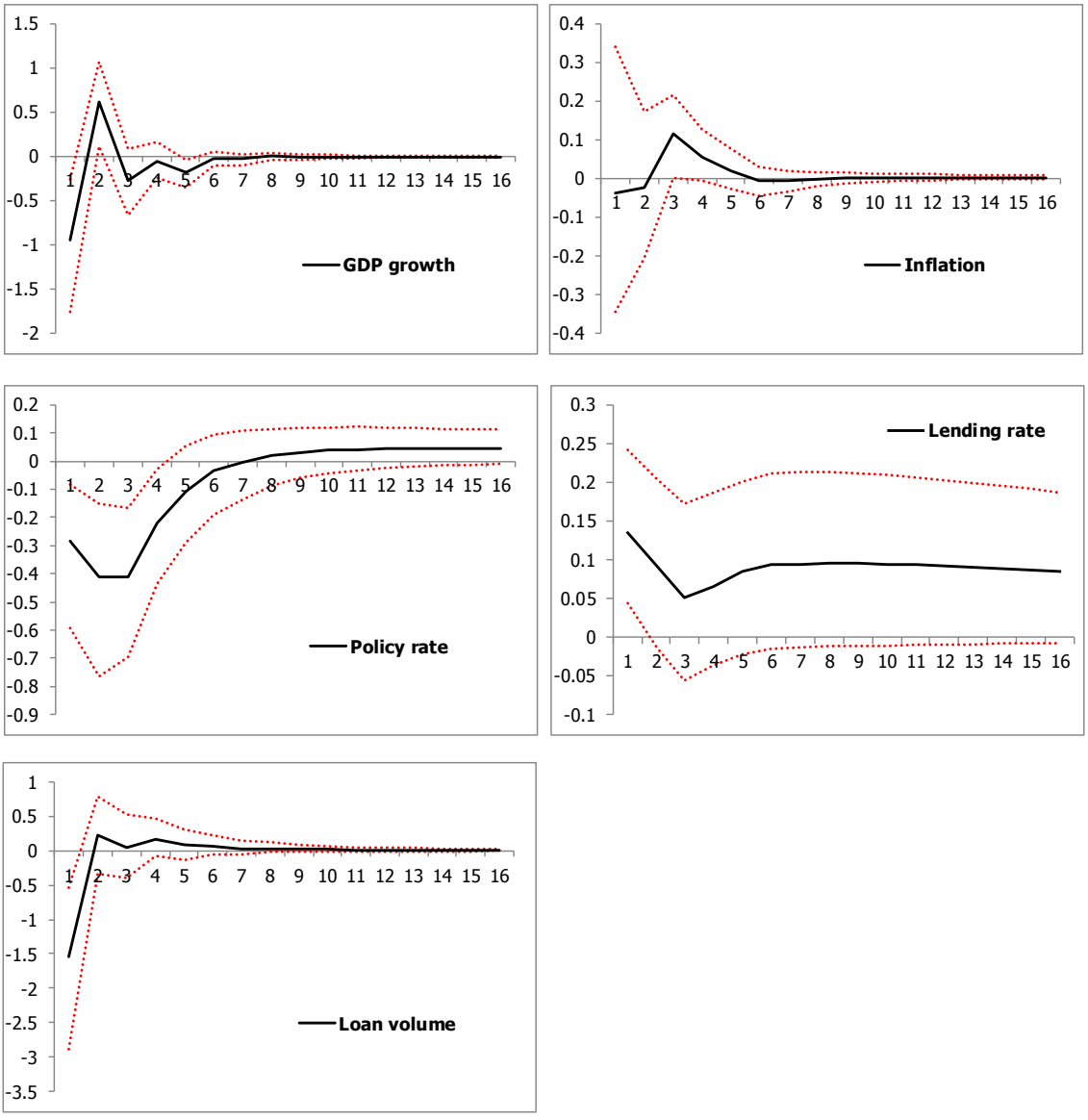



Figure 6. Impulse responses to a loan supply shock

Next we present results of the forecast error variance decomposition (FEVD), which is complementary to impulse responses, but also takes into account the magnitude of the shocks. FEVD decomposes the forecast error variance of each variable into contributions by separate structural shocks. In line with our points of interest, in Table 2 we focus on the contribution of various shocks to the forecast error variance of quarter-on-quarter de-trended GDP growth and the contribution of the loan supply shock to the forecast error variance of various variables. The left panel indicates that aggregate supply and monetary policy are the main drivers of economic activity, as their shocks each explain around a fifth of the forecast error variance of GDP. Loan supply shocks explain around 10% of the variance of GDP on impact, and this share rises to around 13% for the variance after a year. The right panel shows the contribution of loan supply to the FEVD of all variables. Besides the noted effect on GDP, loan supply shocks also explain between 10% and 13% of the variance of prices, policy rates and loan volumes, while their effect on lending rates is somewhat lower.

**FEVD of q-o-q detrended GDP**

| | At impact | After 1 year | After 3 years | After 5 years |
|---|---|---|---|---|
| **Contributions of:** | | | | |
| Unidentified shocks | 39.1 | 35.2 | 34.7 | 34.7 |
| Agg. supply shocks | 22.3 | 20.2 | 20.4 | 20.4 |
| Mon. policy shocks | 20.1 | 19.1 | 19.2 | 19.2 |
| Agg. demand shocks | 9.2 | 12.9 | 12.9 | 12.9 |
| Loan supply shocks | 9.4 | 12.6 | 12.8 | 12.8 |

**Contributions of the loan supply shock**

| | At impact | After 1 year | After 3 years | After 5 years |
|---|---|---|---|---|
| **To the FEVD of:** | | | | |
| GDP growth | 9.4 | 12.6 | 12.8 | 12.8 |
| Inflation | 9.6 | 11.6 | 11.8 | 11.8 |
| Policy rate | 4.4 | 9.5 | 10.0 | 10.4 |
| Lending rate | 9.7 | 5.2 | 6.5 | 6.9 |
| Loan volume | 11.8 | 12.1 | 12.5 | 12.5 |

Table 2. Forecast error variance decomposition (FEVD) - baseline specification
(Note: The table on the left shows the contribution in percent of each shock to the forecast error variance of q-o-q detrended GDP at various horizons. The table on the right shows the contribution in percent of the loan supply shock to the FEVD of each variable at various horizons.)

In order to better analyse the developments during the latest crisis, including the boom preceding it and the post-crisis recovery, we also present the historical decomposition of the variables into contributions of past and current shocks over the period 2007Q1-2014Q4 (with complete decompositions for the entire period presented in Appendix 1). Technically, historical decomposition consists of presenting each actual data series as a sum of a deterministic component (trend) and of the contributions of past and current shocks. It should be noted that, in line with the practice in other studies (e.g. Barnett and Thomas (2014) or Finlay and Jääskelä (2014)), we focus on the deviations of variables from their trend values, so the figures below show the decomposition of deviations from trend instead of actual variables, whereas complete decompositions for the entire period are shown in Appendix 1. In addition, for ease of exposition, here we present year-on-year changes of GDP, inflation and loan volumes, whereas Appendix 1 contains decompositions of actual data used in the estimation (i.e. quarter-on-quarter changes of GDP, prices and loan volumes).

Results of historical decomposition in Figure 7 below lend additional support to our decision to identify several structural shocks, since they display a rich and plausible economic interpretation, with only a relatively small role left for unidentified shocks. The decomposition of (the deviation of) year-on-year GDP growth indicates that, in the period immediately preceding the crisis, above-trend GDP growth was supported by accommodative monetary policy, with additional contributions by loan supply and buoyant aggregate demand. As the crisis hit, growth slowed down markedly during the second half of 2008 and particularly during 2009. At the same time there was also a relatively large shift in the stance of monetary policy (and consequently its contribution to GDP), which during this period was mostly focused on stopping the loss of foreign exchange reserves and stabilising expectations. Negative aggregate supply shocks in the wake of rising uncertainty and volatility in global financial markets had an additional effect on the fall of GDP. The post-crisis recovery shows changing contribution of factors. For instance, in the immediate aftermath of the crisis and in circumstances of stabilised movements of foreign exchange reserves, recovery was supported by monetary policy, whose contribution to growth was positive until the middle of 2011. Thereinafter, with a few exceptions, the contribution of monetary policy to GDP growth until the end of 2014 is mostly negative, but relatively low[7]. The supply of loans has a relatively strong supportive role in GDP growth before and during the crisis, but its effect becomes negative in the second half of 2010 and remains so throughout the period, thus reflecting effects of continued uncertainty and heightened risk aversion by banks. Although comparatively smaller, the contribution of aggregate demand follows a similar pattern. On the other hand, while aggregate supply shocks were dragging down GDP growth in the period immediately preceding and during the crisis, their effect in the last two years is positive, which probably reflects the lack of global and domestic inflationary pressures and the positive role that these movements have on private consumption and investment (including the effects of lower oil and commodity prices on imports).

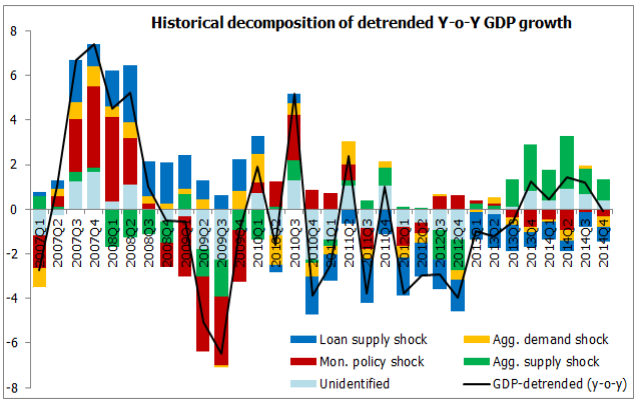
The second panel of Figure 7 indicates a relatively strong contribution of monetary policy shocks towards inflation, which is in line with impulse responses analysed previously. In particular, monetary policy contributed considerably towards the high inflation before the crisis and the falling inflation during the crisis, while its effect becomes weaker during the recovery. The contribution of other factors is relatively smaller but in line with expectations. Aggregate supply, aggregate demand and loan supply shocks all contributed towards higher inflation before the crisis and lower inflation during the crisis, and they also largely explain price movements during the recovery.

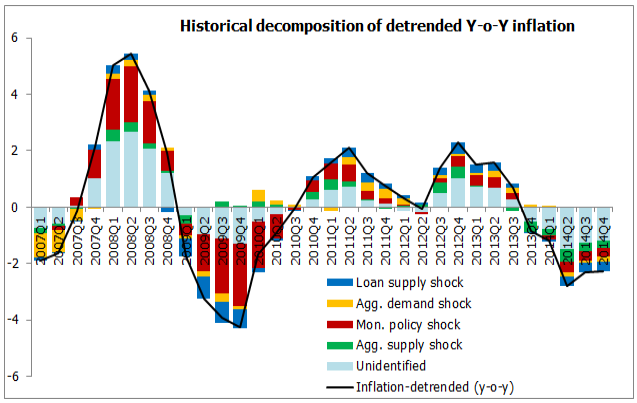
Further, determinants of the policy rate vary across the sample. For instance, accommodative policy rates during the pre-crisis boom are mostly due to policy shocks (and unidentified factors). As the crisis hit, policy rates were tightened mostly as a result of monetary policy shocks, with an additional contribution by aggregate supply shocks and unidentified factors. On the other hand, during the recovery, the below-trend movement of policy rates is mostly explained by loan supply

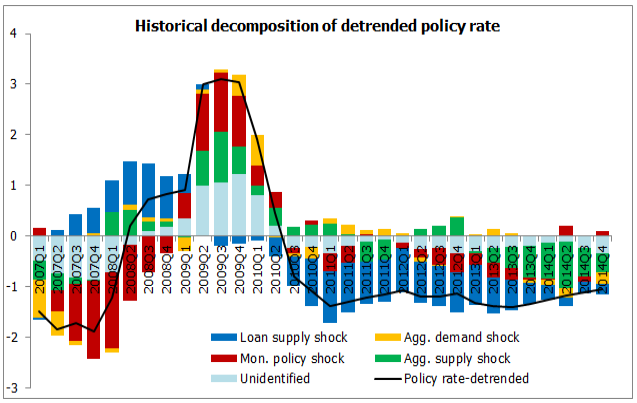
[7] This result should be qualified since the post-crisis monetary policy also relies on additional instruments which are not captured by the policy rate that is used in our analysis to represent monetary policy, as noted above. For empirical evidence on effects of additional instruments used by the NBRM, see Jovanovic et al. (2015).

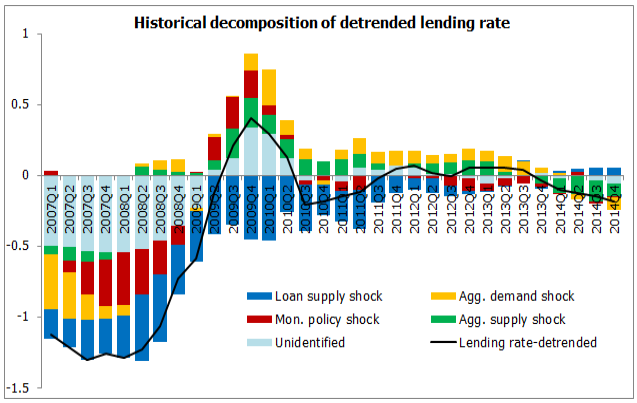
shocks, thus confirming the previous finding that monetary policy tries to counteract negative loan supply shocks (within an environment of low inflation and stable foreign exchange market movements). In the last several quarters aggregate supply shocks have an additional effect towards the accommodative stance of monetary policy.

The last two panels show the decomposition of lending rates and loan volumes, thus providing additional insights on the most important factors of lending activity. Loan supply shocks have a stronger impact on lending rates than on loan volumes. In particular, they contribute to downward movements of lending rates almost throughout the period analysed. Further, during the crisis, above-trend lending rates are partially explained by more restrictive policy rates, whereas before and after the crisis monetary policy has contributed towards lower lending rates. On the other hand, all the shocks contribute positively to the above-trend loan volume changes before the crisis, with monetary policy shocks exerting the strongest influence. As the crisis hit, the combined effect of factors becomes negative, thus driving and keeping loan volumes below trend until the end of the sample. Related to this, it should also be noted that a considerable part of loan volume changes are related to unidentified factors, i.e. to shocks that are not explicitly identified in this analysis.



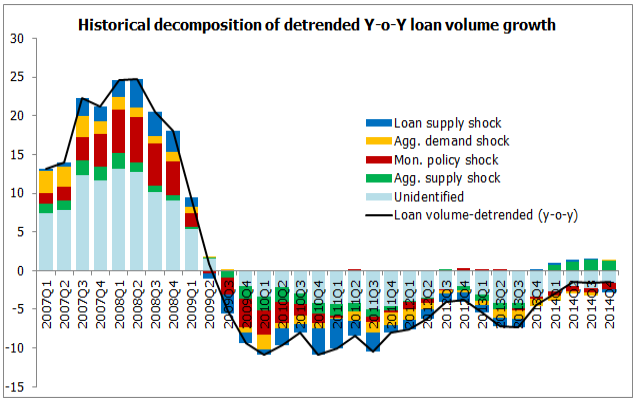



Figure 7. Historical decomposition

## 5. Robustness checks and extensions

In this section we present results from several extensions to the baseline specification and to the sample. These modifications are used as checks on the robustness of the baseline results, but they also provide additional insights related to the issues being investigated. In order to facilitate the analysis, the comparisons are presented via graphs of impulse responses and the corresponding 68% confidence intervals.

As noted above, in line with standard VAR selection criteria, we include two lags of endogenous variables in our baseline VAR. However, we are also interested whether our results are robust to alternative VAR lengths. Therefore, Figure 8 below compares baseline impulse responses[8] to the ones obtained when other lag lengths are used in the VAR (one and four lags). In all cases, results are fairly similar if the VAR contains four instead of two lags, with only minimal differences in the magnitude of some responses. On the other hand, several responses have a different magnitude and sometimes even a different sign if only one lag is included in the VAR. In this case, it should be taken into account that residuals in the first order VAR indicate severe autocorrelation and hence point towards biased results, which could explain some of the counterintuitive responses. For instance, in the wake of both adverse aggregate supply and of monetary policy shocks, the response of monetary policy and of lending rates is much stronger than in the baseline. However, in both cases the loan volume rises considerably, which is implausible in light of the nature of the shocks and the considerably more restrictive policy and lending rates. Responses to an aggregate demand shock are similar to the baseline ones, with differences only in magnitude. However, results for the loan supply shock are also implausible. With a VAR of one lag, it appears that, in the wake of an adverse loan supply shock, monetary policy first relaxes and immediately tightens interest rates and loan volumes first fall and then rise, which is counterintuitive.

[8] For ease of exposition, for the lag length comparison we do not present accompanying confidence bands, which are available from authors on request.

Overall, the results of the alternative lag length support our decision to use two lags in our VAR. On the one hand, results are very robust to using four instead of two lags, but in such a case the VAR would have fewer degrees of freedom. On the other hand, the first order VAR would be problematic due to auto-correlation, and would also yield some implausible results that are difficult to explain.

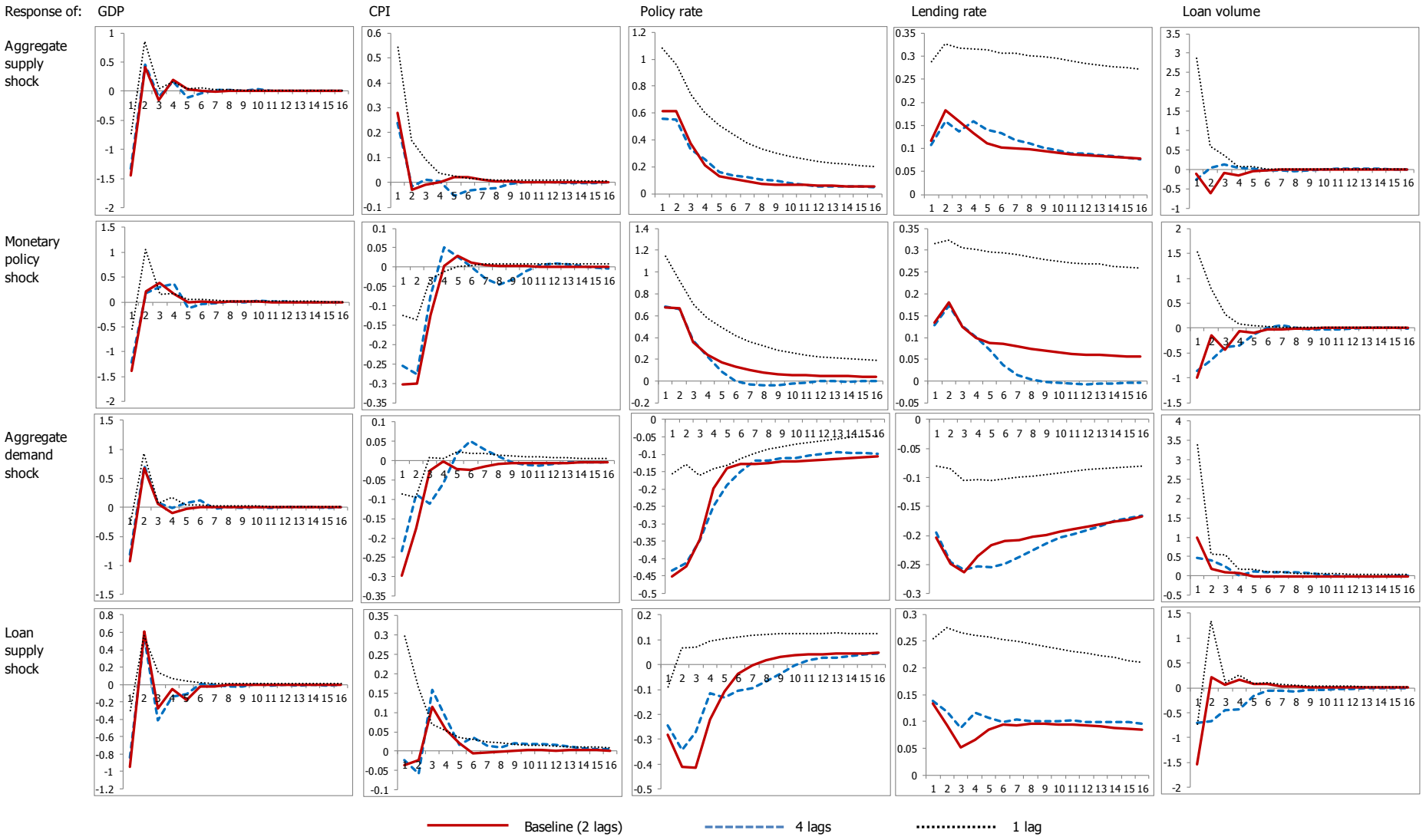



Figure 8. Results with alternative lag length

Another important issue of interest is whether baseline results are an artefact of the particular duration of the sign restrictions imposed to identify the four shocks. In the baseline specification, restrictions are imposed only contemporaneously, i.e. when the shocks appear, whereas the responses are left unrestricted thereinafter. In the alternative specification, we try to capture the delay that might be characteristic for some of the relations analysed, since some of these variables may be more inertial and not react immediately to shocks. Therefore, we impose the same restrictions not only contemporaneously, but also for an additional period, i.e. restrictions are imposed in two quarters. Figure 9 below shows that responses with this alternative specification are fairly similar to baseline results, and this applies to the magnitude, the sign and the significance of responses. The only difference appears in the significance of responses of lending rates to monetary policy and loan supply shocks. In particular, unlike the insignificant responses in the baseline specification, it appears that the lending rate responds significantly to these shocks when the alternative restrictions are used, thus yielding results that are more plausible. More precisely, the rise of lending rates in the wake of an adverse monetary policy shock is now significant for more than a year, thus strengthening the previous tentative finding from the baseline analysis that monetary policy is transmitted via lending rates (and not lending volumes). The alternative restrictions also strengthen the finding that loan supply shocks are mostly manifested through higher lending rates, despite a more accommodative monetary policy in this case. However, this reaction of lending rates to loan supply shocks is now significant, whereas we confirm the insignificant response of loan volumes.

Related to this issue, it might be interesting to analyse results with sign restrictions imposed for even longer periods. However, this is often unfeasible due to the computational burden when restrictions are imposed for longer periods. The burden is particularly severe with higher number of shocks identified, as is our case. Bearing this on mind, as well as the broad robustness of our baseline results, we proceed using our baseline specification (i.e. the contemporaneous imposition of sign restrictions).

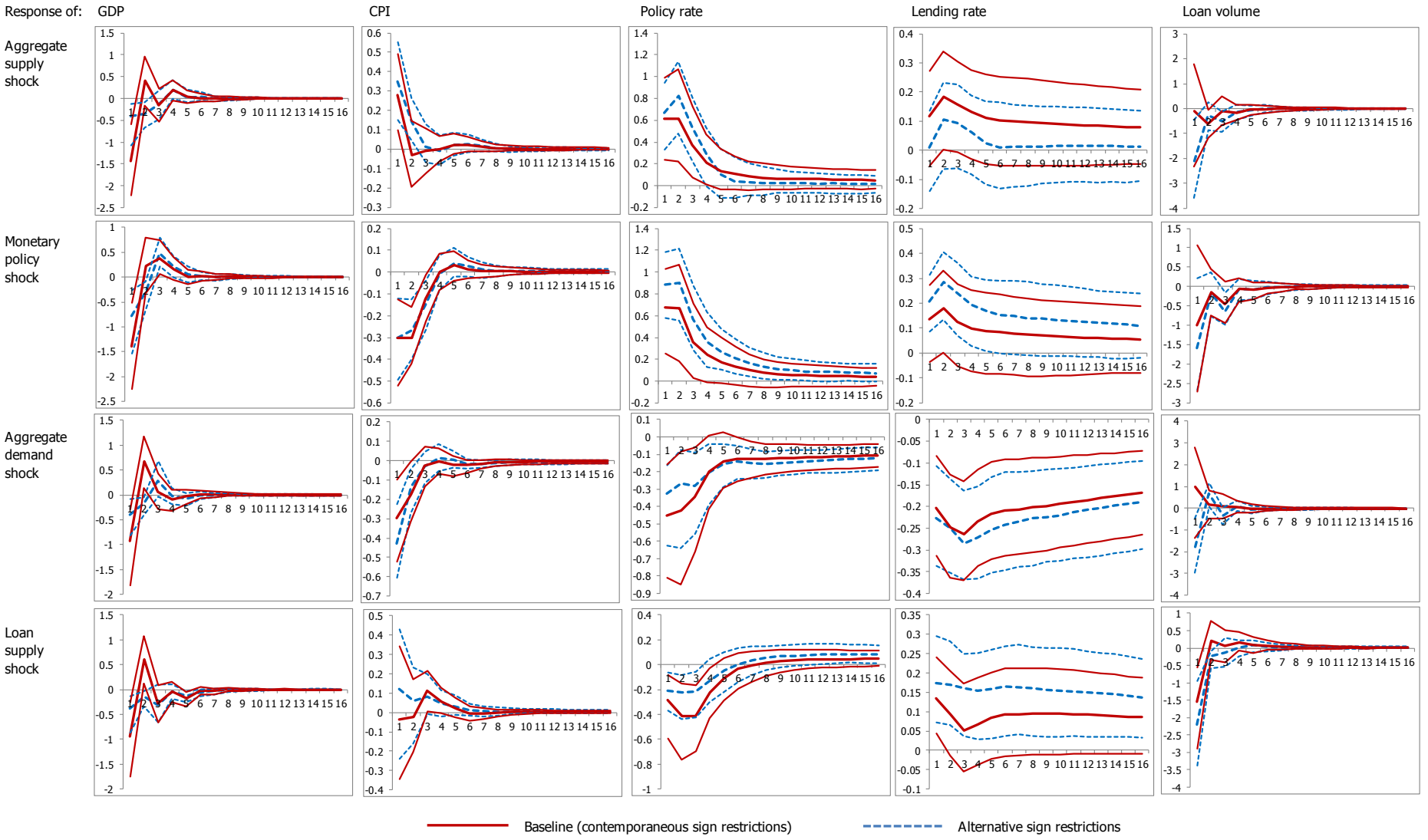



Figure 9. Results with alternative duration of restrictions imposed

We also wanted to check whether our results hold across the entire period, or are there any structural breaks or differences in the response of variables to shocks. Such an analysis could be performed by using Time Varying Parameter VAR, which is however unfeasible in our case due to the length of available data series. Therefore, we carry out the stability analysis by splitting the sample in two in the end of 2004, thus analysing two sub-samples: 1998-2004 and 2005-2014. This split broadly corresponds to the earlier period of relatively low credit activity, and to the latter period that includes the intensification of lending, the crisis and the post-crisis recovery (Figure 1).

Before a more detailed analysis, it must be noted that this split considerably shortens the sample and consequently yields less precise results than previously. Figure 10 shows that the response of GDP, prices and loan volumes to shocks is qualitatively similar in the two periods, with only minimal differences in significance in some cases. On the other hand, differences in the response of policy rates and lending rates are notable. In particular, monetary policy was reacting much more strongly to all kinds of shocks before 2004, and this reaction was lasting for longer. On the other hand, the response of monetary policy to shocks after 2004 is much weaker. This difference probably reflects differences in the size and the nature of shocks in the two periods, as well as the use of additional instruments and measures in the latter period. Shocks before 2004 were larger and different in nature, e.g. the war in Kosovo in 1999 and the internal conflict in 2001. Since the central bank weathered this period relatively successfully, thus establishing and maintaining monetary policy credibility, there was increased space for a more moderate policy response to shocks after 2004. The response of lending rates is also much stronger and lasts for longer in the first than in the second period, thus mirroring differences in the response of policy rates. Indeed, this reflection of differences from policy rates to lending rates again indirectly indicates that the latter are considerably affected by monetary policy, as well as potentially by other factors (e.g. structural reforms or competition, as discussed in Section 2).

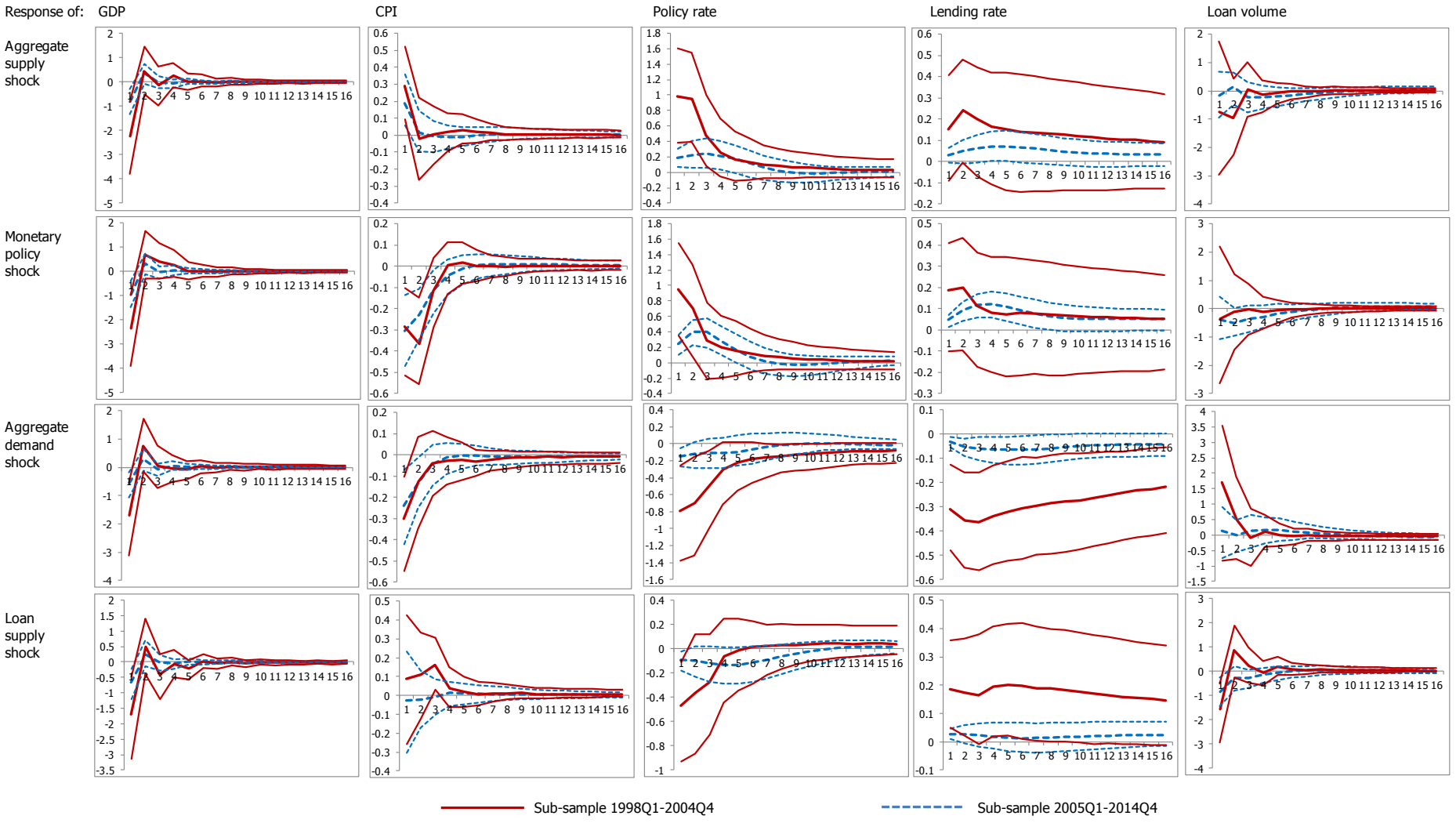



Figure 10. Sub-sample analysis

In another sensitivity check we replaced local currency with total loan volumes and accompanying total lending rates. While such a definition is not typical in most studies (as surveyed above), in the case of Macedonia it might be more appropriate due to the sizeable (although during the crisis period declining) euroisation in the economy (albeit declining during the crisis period) and the fact that monetary policy decisions also affect the portfolio mix between local and foreign currency holdings and loans. This change means we are only able to analyse the period between 2005 and 2014, since data on lending rates for foreign currency loans are not available for the preceding period. The shorter time period and the accompanying imprecision notwithstanding, Figure 11 shows that there are only small differences between the two specifications, mostly in the significance of some responses, e.g. the response of the policy rate to loan supply shocks or the response of lending rates to aggregate supply or demand shocks. This similarity of results reflects the broadly similar movements of data on denar and total loans and the accompanying lending rates (Figure 2 above). Overall, this analysis confirms that these results hold regardless if total or local currency loans are used, thus indirectly pointing out that the previous results on denar loans also hold for foreign currency loans.

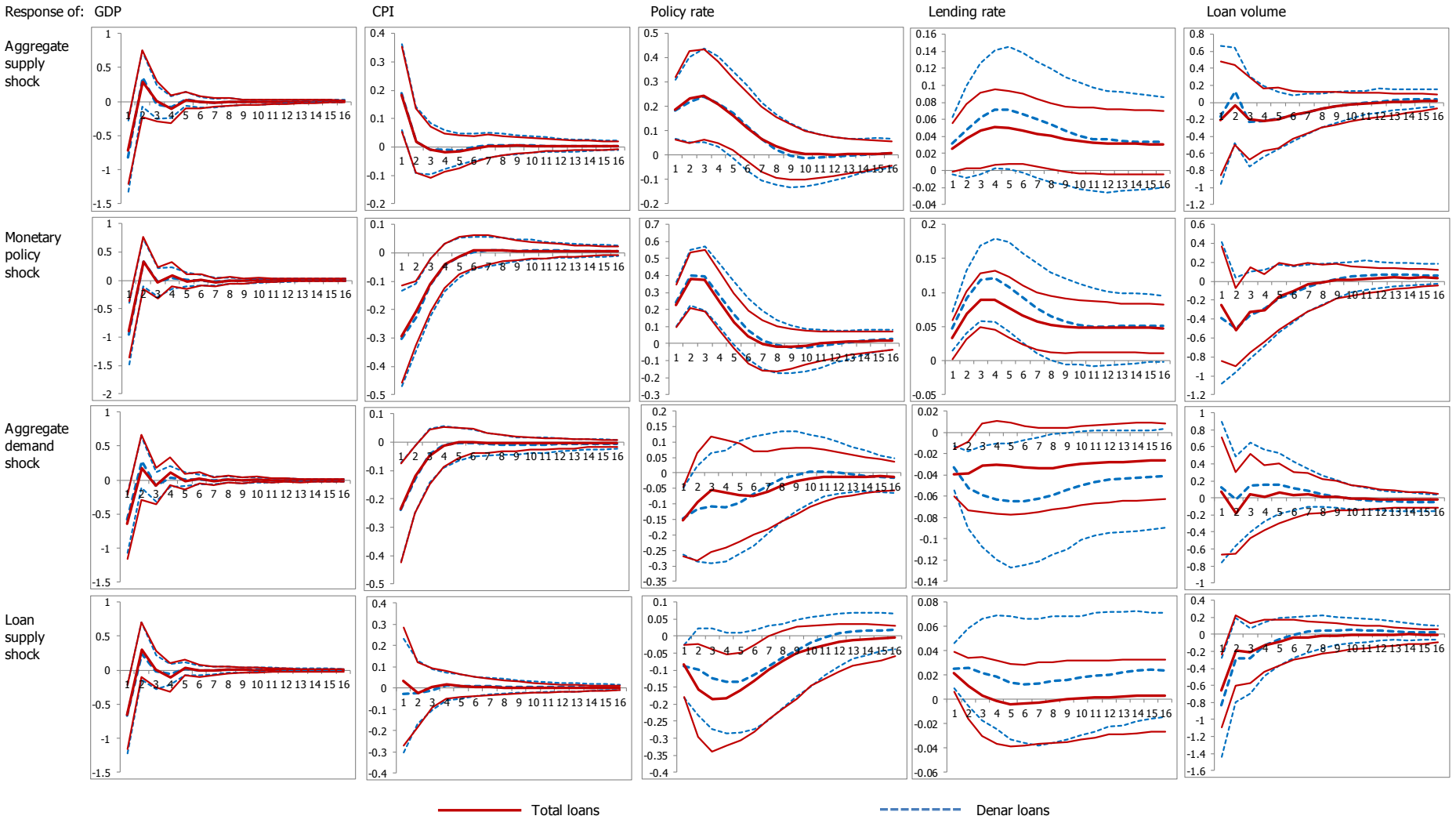



Figure 11. Differences between total and denar loans and accompanying interest rates (2005 - 2014)

In the final part of the empirical analysis we come back to local currency loans, and investigate whether there is any difference between loans with and without a foreign exchange clause (and corresponding rates). Due to data availability, this forces us to use a considerably shorter period that only covers the global crisis and the post-crisis recovery (2009-2014), thus greatly magnifying potential small sample problems and implying the need for additional caution when interpreting the results.

Nevertheless, impulse responses presented in Figure 12 show only limited differences between samples using loans with and without a foreign exchange clause and corresponding lending rates, which probably again reflects similar historical movements of these series (Figure 2 above). For instance, in Figure 12, lending rates respond more strongly to monetary policy shocks and to aggregate demand shocks when using the specification without a foreign exchange clause. One possible reason for this might be that, during the crisis and the recovery, banks were considering the exchange rate risk to be higher. Consequently, in this period of high uncertainty, in the wake of adverse demand and policy shocks they were requiring higher lending rates for loans that do not cover the possibility of exchange rate changes (i.e. denar loans without a foreign exchange clause). There is also a slight difference in the reaction of lending rates to adverse loan supply shocks - they increase more and the reaction is significant for loans with a foreign exchange clause (unlike the insignificant reaction of the loans without a clause). However, we do not have a possible explanation for this difference, and suspect it might reflect the imprecision due to the short sample in this case.

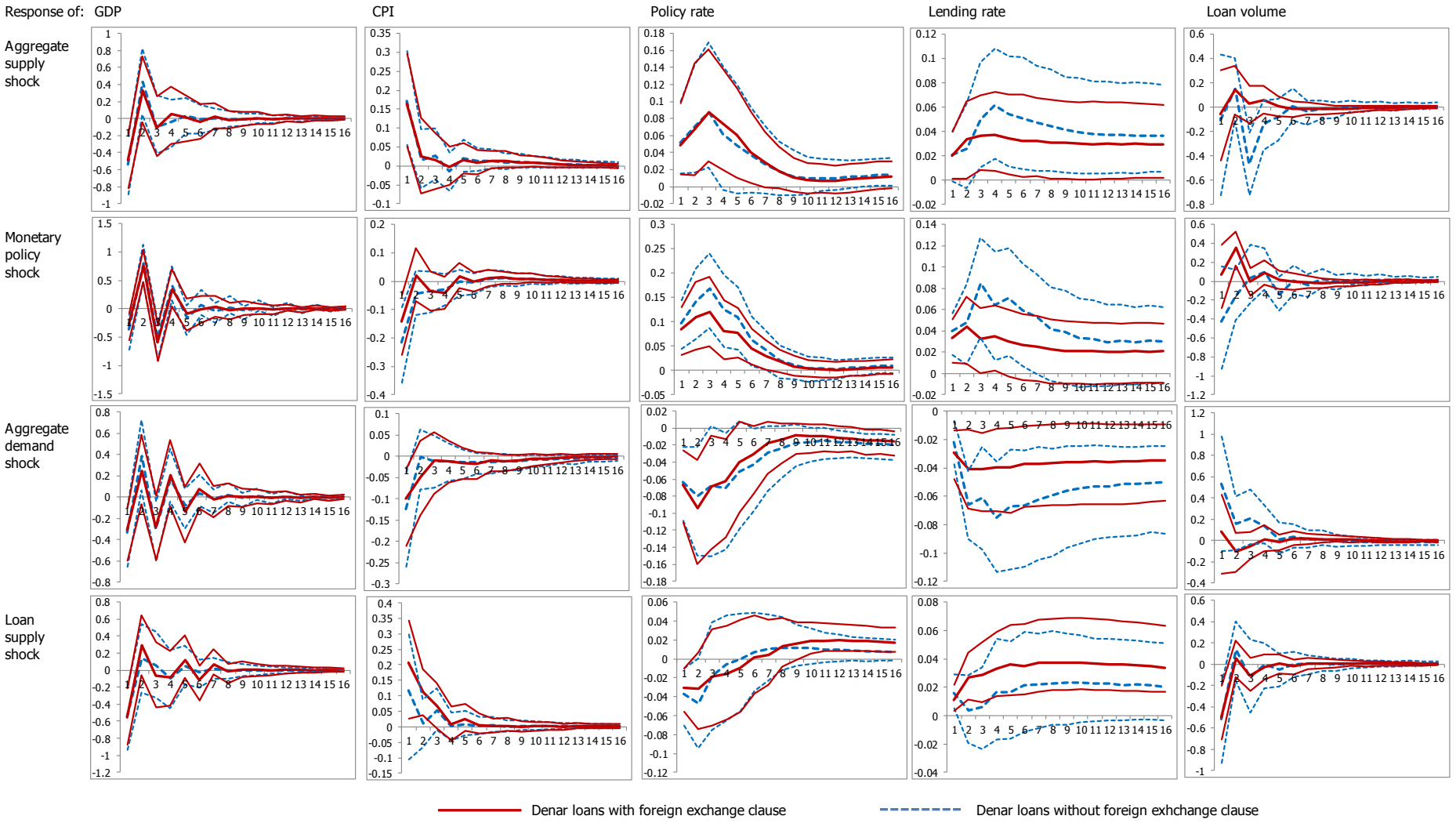



Figure 12. Differences between denar loans with and without a foreign exchange clause (2009-2015)

## 6. Conclusion

This study examines the dynamics of loan supply and relations to macroeconomic and policy factors in Macedonia between 1998 and 2014 by using a Bayesian SVAR with sign restrictions. The paper relies on the available theoretical and empirical literature to identify four structural shocks and their effects on key macroeconomic, policy and lending variables. To the best of our knowledge, it is the first paper to investigate lending and monetary policy in Macedonia using this relatively novel technique.

Our main findings for the entire period are as follows. Somewhat surprisingly, loan supply shocks have no significant effect on either loan volumes or lending rates, and their effects on economic activity and prices are also limited. Baseline results indicate that monetary policy shocks have a relatively limited effect on lending, as their effects on both loan volumes and lending rates are quite weak. Further, policy shocks have relatively strong effects on inflation, which indicates that monetary policy is effective in achieving its main aim. On the other hand, the response of monetary policy to adverse shocks hitting the economy such as aggregate demand and loan supply shocks is quite strong and in line with expectations. Monetary policy also reacts quite strongly to adverse aggregate supply shocks, thus indicating the importance attached by the central bank to maintaining low and stable inflation.

The analysis also yields some interesting insights regarding particular policy episodes. Loan supply was supporting economic growth before and during the crisis, but its contribution became negative during the recovery and it continues to act as a drag on growth by the end of 2014. In the period preceding the global crisis, monetary policy was one of the key factors driving above-trend GDP growth. When the crisis hit in late 2008 and in 2009, the effect of the interest rate of the main monetary policy instrument on GDP growth turned to negative, as it was trying to stop the loss of foreign exchange reserves and stabilise expectations. Once this was achieved and monetary policy was relaxed, its contribution to the recovery became positive, although the effect in the recent years is again mildly negative. Further, policy rates in the recent years are mostly explained by subdued lending activity and aggregate supply factors, which the central bank tries to counteract with a more accommodative policy.

Extensions to our baseline specification confirm our main findings and provide some additional insights. Baseline results are robust to different lag lengths and to imposing restrictions for a longer period, although in the latter case we find a more plausible result of stronger and significant reaction of lending rates to monetary policy and loan supply shocks. Further, in the first half of the sample, monetary policy was reacting more strongly to shocks hitting the economy. As the nature of the shocks changed, the central bank enhanced its credibility and also started using additional instruments, the policy reaction to shocks became more subdued, and the reaction of lending rates also changed accordingly. Finally, baseline results when using local currency loans are broadly robust

to alternative definitions of lending aggregates such as total loans or loans with and without a foreign exchange clause.

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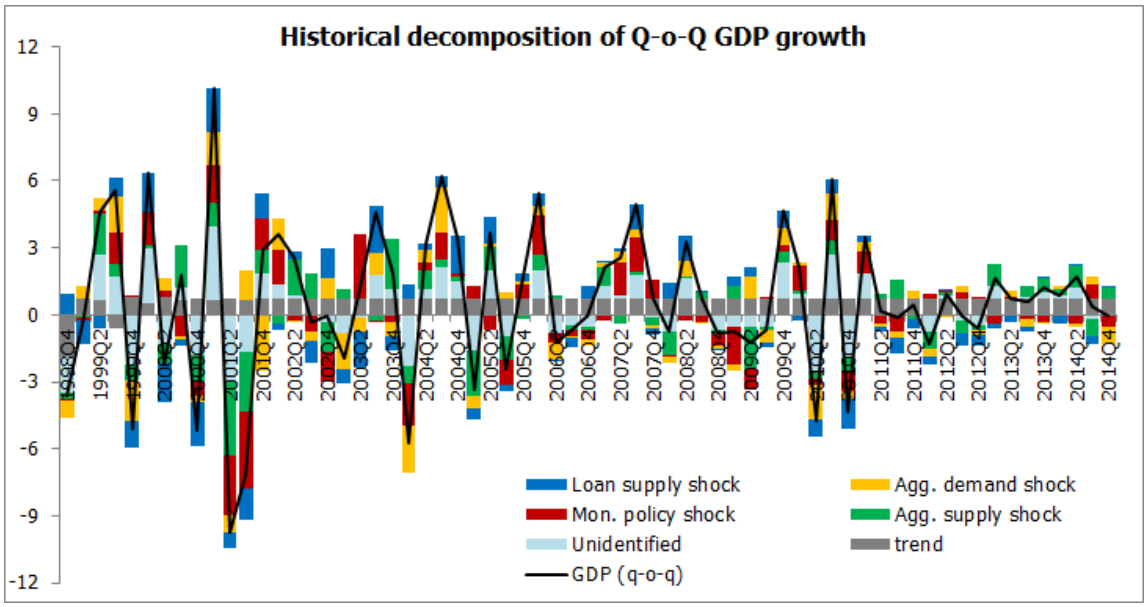
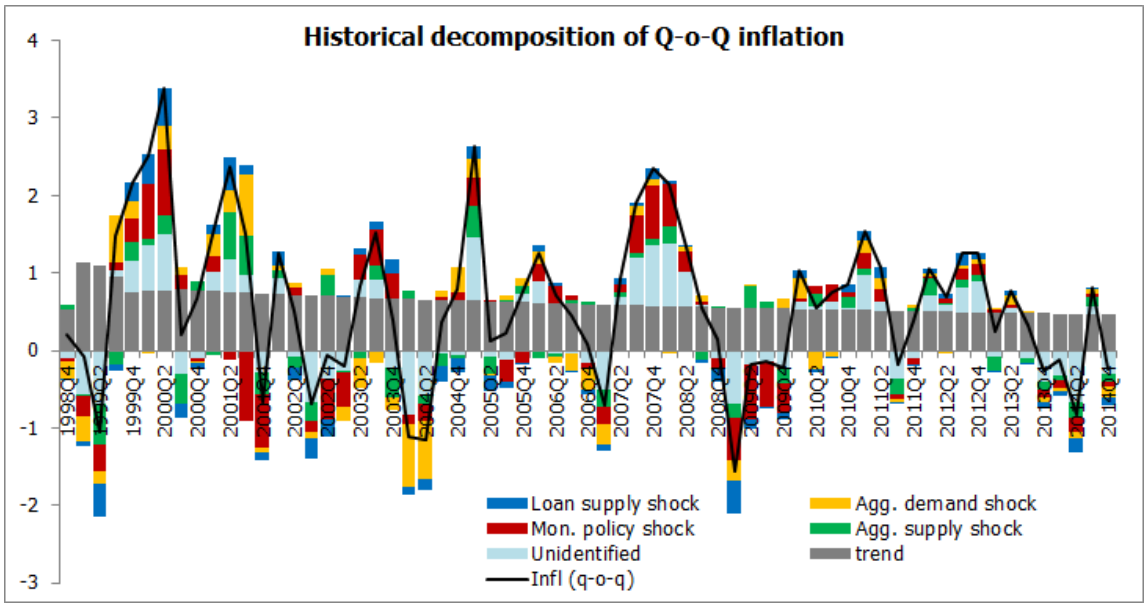
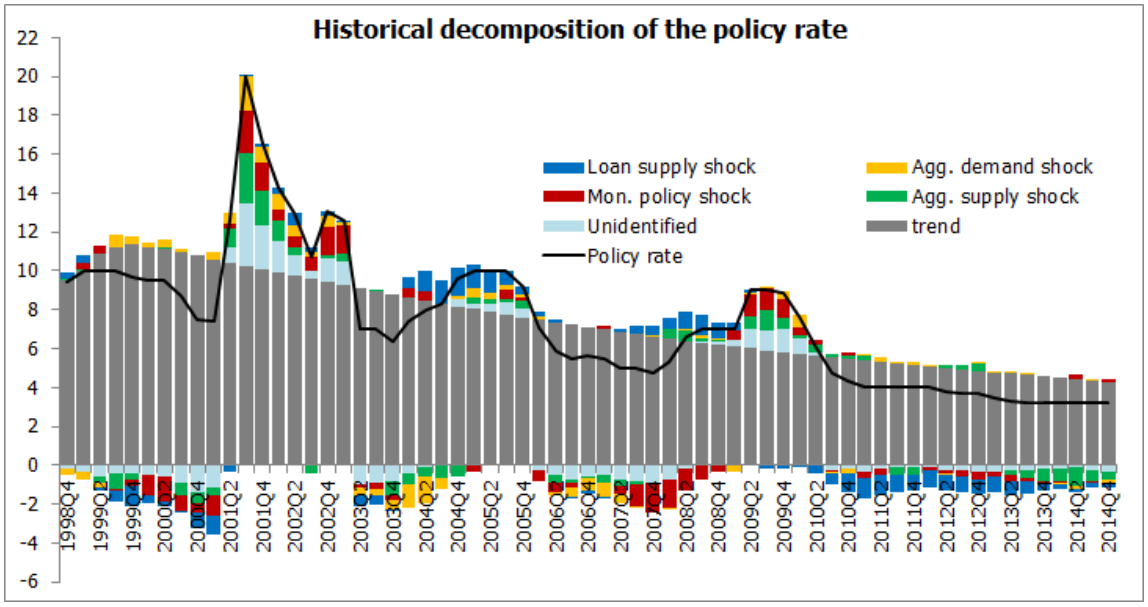
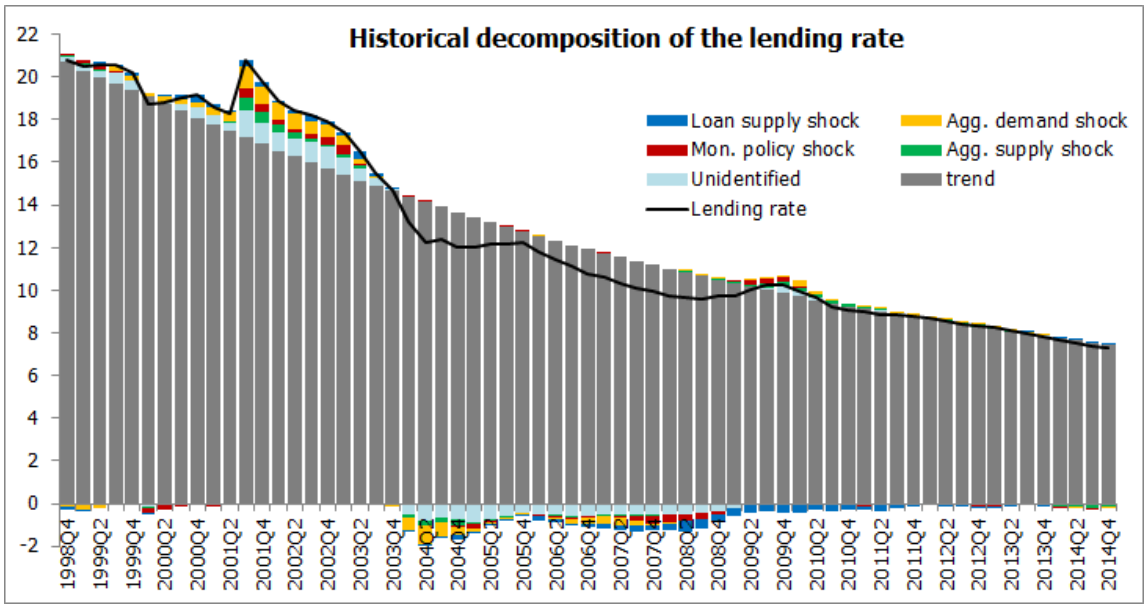
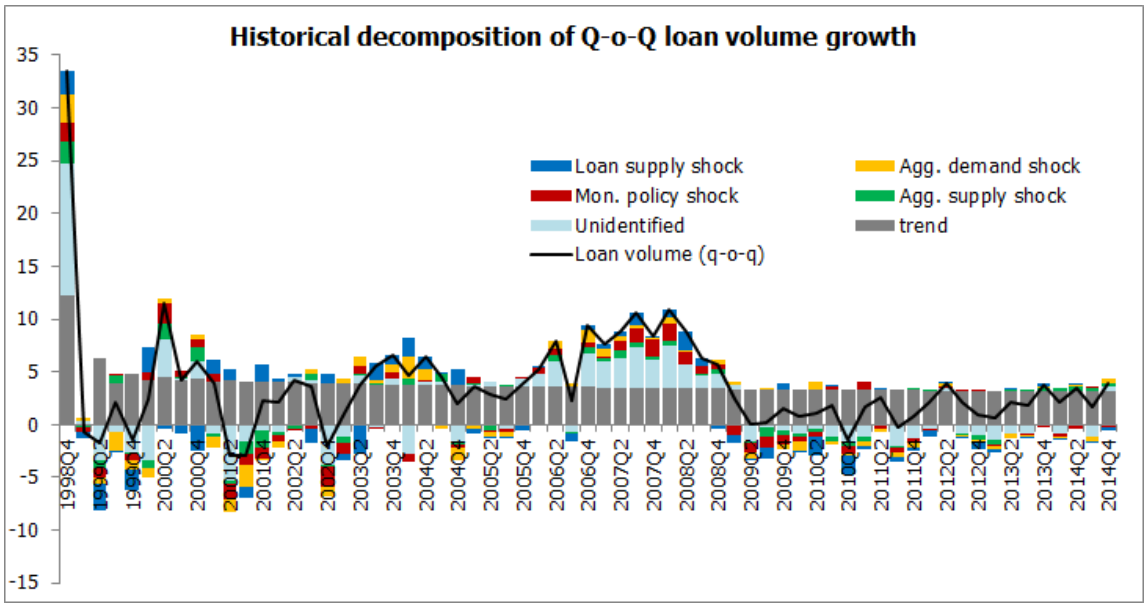
**Appendix 1 - Complete results on historical decomposition (baseline specification)**




Historical decomposition of the policy rate
Loan supply shock
Agg. demand shock
Mon. policy shock
Agg. supply shock
Unidentified
trend
Policy rate


Historical decomposition of the lending rate
Loan supply shock
Agg. demand shock
Mon. policy shock
Agg. supply shock
Unidentified
trend
Lending rate


Historical decomposition of Q-o-Q loan volume growth
Loan supply shock
Agg. demand shock
Mon. policy shock
Agg. supply shock
Unidentified
trend
Loan volume (q-o-q)