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Identifying loan supply shocks behind credit developments in Romania

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Topics

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Motivation

- The economic crisis was accompanied by intensified financial stress on the financial markets.
- Central Bank has made several attempts at reviving the credit markets. However, the real developments in non-government loans reveal a strong decline over the period 2009-present.

⇨ Instructive for policy-makers to:

derive a precise distinction between supply- and demand-side determinants of credit developments.

identify drivers of loan supply dynamics.

- The deleveraging process has amplified in Europe, triggering an alarm signal for CEE countries, especially Romania.

⇨ Important to asses the implications of loan supply shocks on the economic activity.

Objectives

- Explore the role of the banking sector in macroeconomic fluctuations.
- Draw robust insights for macroprudential regulation.

⇨ Obtain answers to the following questions:

- To what extent do shocks originating in the credit market drive output fluctuations?
- What is the main constraint on the "supply-side" of the credit market?
- Did loan supply shocks had a paramount effect on loan growth during the financial crisis?

Literature Review

Recent research has made progress in developing empirical tools for disentangling supply and demand effects on loan markets.

- **Cointegration methodology** – does not allow decomposing the aggregate volume of loans into structural shocks

Gambacorta and Rossi (2007): asymmetric broad credit channel in the Euro Area.

- **BLS data –based VAR methodology** – serious limitation in terms of sample period

Ciccarelli et al. (2010) : "credit crunch with real effects " in the Euro Area.

- **Sign restrictions VAR methodology**

• Meeks (2009): shocks in the US corporate credit market play an important role during financial crises, but a less important one during "normal" business cycles.

• Busch et al (2010): in Germany, since autumn 2008, there was a sequence of negative loan supply shocks of extraordinary magnitude.

• Tamasi and Világi (2011): credit supply shocks did not have a dominant role in the decline of the Hungarian economy over the crisis period.

• Hristov et al (2012): in the Euro Area a significant share of the decline in lending and real GDP growth can be attributed to loan supply shocks.

Methodology - Sign Restriction Bayesian SVAR (1)

- **Bayesian VAR model with flat priors** - Uhlig (2005).

$$Y_t = B_1 Y_{t-1} + B_2 Y_{t-2} + \cdots B_p Y_{t-p} + u_t \qquad u_t \sim N(0, \Sigma)$$
$$Y = X\,\mathbf{B} + \mathbf{u}$$

- Prior for (**B**,**Σ**) follow an $n-$dimensional Normal-Inverse Wishart distribution, the natural conjugate prior for the multivariate normal distribution:

$$\mathrm{vec}(B) \setminus \Sigma \sim N(\mathrm{vec}(\bar{B}_0), \Sigma \otimes N_0^{-1})$$
$$\Sigma \sim IW((v_0 S_0)^{-1}, v_0)$$

- Flat prior - Uhlig (2005:30) → $N_0 = 0, v_0 = 0$; S_0 and $\bar{B}_0$ arbitrary

- The normal likelihood function and the flat prior also yield the Normal-Inverse Wishart posteriors:

$$\mathrm{vec}(B) \setminus \Sigma \sim N(\mathrm{vec}(\hat{B}), \Sigma \otimes X'X^{-1})$$
$$\Sigma \sim IW((T\hat{\Sigma})^{-1}, T)$$

Weak prior ⟺ posterior depends only on the MLE estimates of the model

- We can sample directly from the posterior. MC methods are easily implementable.

- Same form of posterior if using Jeffreys (diffuse) prior –WinRATS for drawing error bands for impulse responses.

$^{q}QQ'=$

Methodology - Sign Restriction Bayesian SVAR (2)

- **Identification: pure sign restriction approach (Uhlig, 2005), complemented with zero restrictions**

Consider the *n* *n* matrix *A*, which relates reduced-form residuals to the orthogonal structural shocks : $u_t = Av_t \quad \Sigma = \mathrm{E}(u_t u_t') = AE(v_t v_t')A' = AA'$

The *pure sign-restriction approach* is implemented as follows:

1. Draw d = 1, . . . , n1 models ($\Sigma^{(d)}$, $B^{(d)}$) from the posterior distribution of the VAR.
2. For j = 1, 2, . . ., n2 draw randomly from the models.
3. Choose $A := \tilde{A}^j$ where $\tilde{A}^j$ is the Cholesky decomposition of Σ^j.
4. For each j, draw a n x s matrix Q, containing s orthonormal vectors q^s . Search for Q , column by column recursively, drawing from a uniform distribution over the unit sphere.
5. Use Q to compute matrix of candidate impulse vectors $\tilde{A}Q=[a^{(1)} \quad a^{(s)}]$
6. Verify if the impulse responses satisfy all sign restrictions imposed – over the period k.

We call the combination of model *j* and identification scheme an *accepted model* if the sign restrictions are fulfilled.

Repeat steps from 2-6, taking as many draws of $B^{(d)}$, $\Sigma^{(d)}$ and q^s as needed to obtain a collection of 3000 accepted models.

- *Zero restriction* on impact : draw q 's uniformly on the unit sphere from the restricted subspace.

Data description (1)

Monthly data covering the period 2003M06-2011M12:

- **Real GDP:** gross domestic product at market prices, chain-linked volumes, 2000=100, calendar and seasonally adjusted, in national currency (Eurostat).

The monthly data was obtained by interpolation (*distribution*) through Chow-Lin method, using as indicator variable the industrial production.

- **Consumer Price Index**: seasonally adjusted, 2000=100 (National Institute of Statistics).
- **Money market rate**: monthly average 3-month ROBOR (NBR).
- **Nominal effective exchange rat**e: determined as a basket of two exchange rates, one against the EUR (70%) and the other against the USD (30%) (NBR).
- **Loan volume**: outstanding amount of loans (all maturities) from MFIs to non-financial corporations, all currencies combined (NBR).
- **Loan rate**: interest rate charged by MFIs for loans to non-financial corporations (outstanding amounts) in percent, weighted average by currency (own calculation, based on NBR statistics).

Data description (2)

- **Credit spread** : weighted average of the difference between the interest rate of RON denominated corporate loans and the 3-month ROBOR and the difference between the interest rate of foreign currency denominated loans and the 3-month EURIBOR. (own calculation, based on NBR statistics).
- **Share of past-due debts in total due:** proxy for credit risk (NBR)

Related literature uses corporate bond spreads and corporate default rate, but data availability constraints restrict us to using the above mentioned series.

❑ We use the logarithmic transformation of the levels of the time series expressing quantities (real GDP, credit) and prices (CPI, exchange rate) and the levels expressed in percentage points of the spread, interest rate variables and the proxy for risk.

❑ Following Busch et al. (2010), Tamasi and Vilagi (2011), Franta et al. (2011) we estimate the models in levels.

Note that in Bayesian estimation nonstationarity is not an issue, since the presence of unit roots in the data does not affect the likelihood function.

Baseline Model

Baseline Model – Identification and Structural Interpretation

$$Y = X\,\mathbf{B} + \mathbf{u}$$

$$Y = [lRGDP_t\ lNEER_t\ lCPI_t\ MMIR_t\ lLOAN_t\ IR_t]'$$

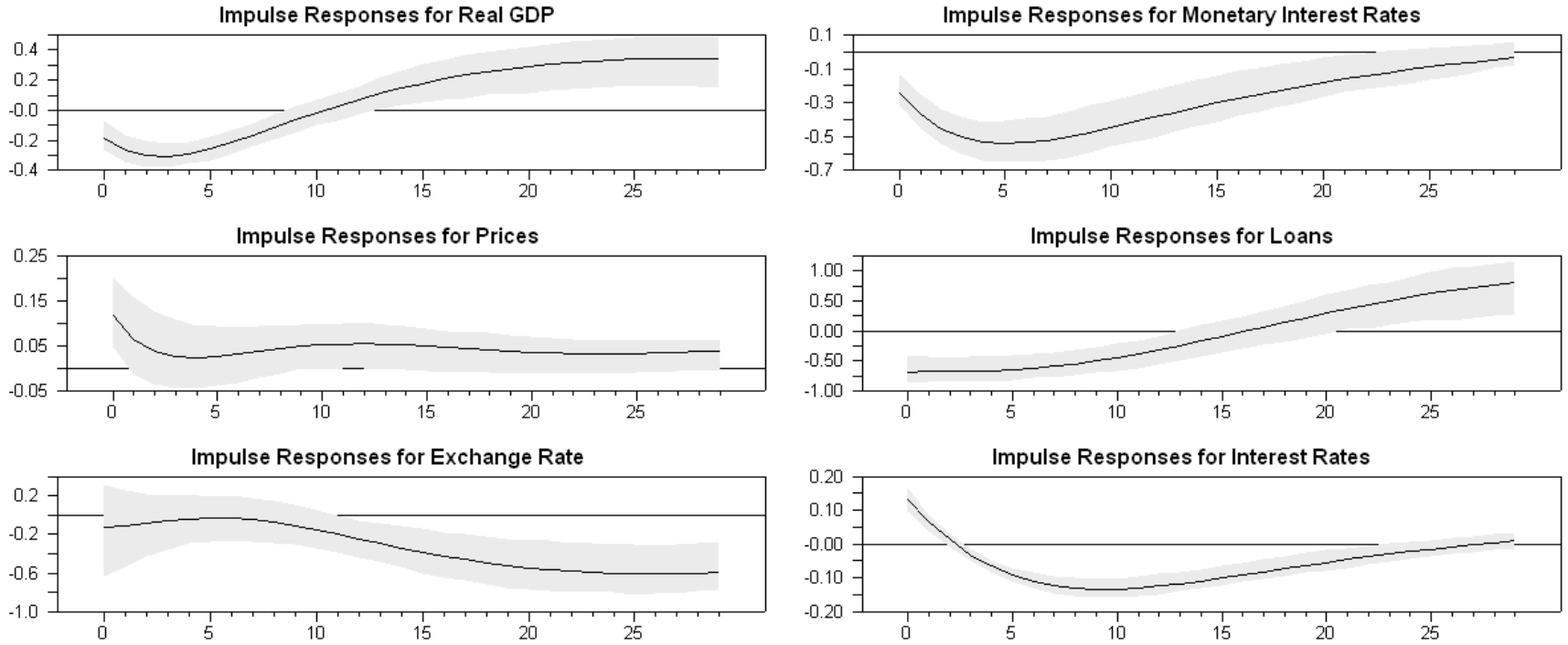
- **X** augmented by a constant and deterministic trend
- VAR(1) model as indicated by Schwarz and Hannan -Quinn criteria
- In addition to **loan supply shocks,** we also account for **monetary policy shocks** and **aggregate demand shocks**. Restrictions are imposed following literature and evidence from DSGE models .

Table 1 - Sign restrictions in the baseline model

	Aggregate Demand Shock			Monetary Policy Shock			Loan Supply Shock		
Date	T=0	T=1	T=2	T=0	T=1	T=2	T=0	T=1	T=2
RGDP	-	-	-		-			-	-
NEER				-					
CPI	-	-	-		-				
MMIR	-	-	-	+	+	+	-	-	-
LOAN							-	-	-
IR		-					+	+	

Results - Impulse Responses (1)

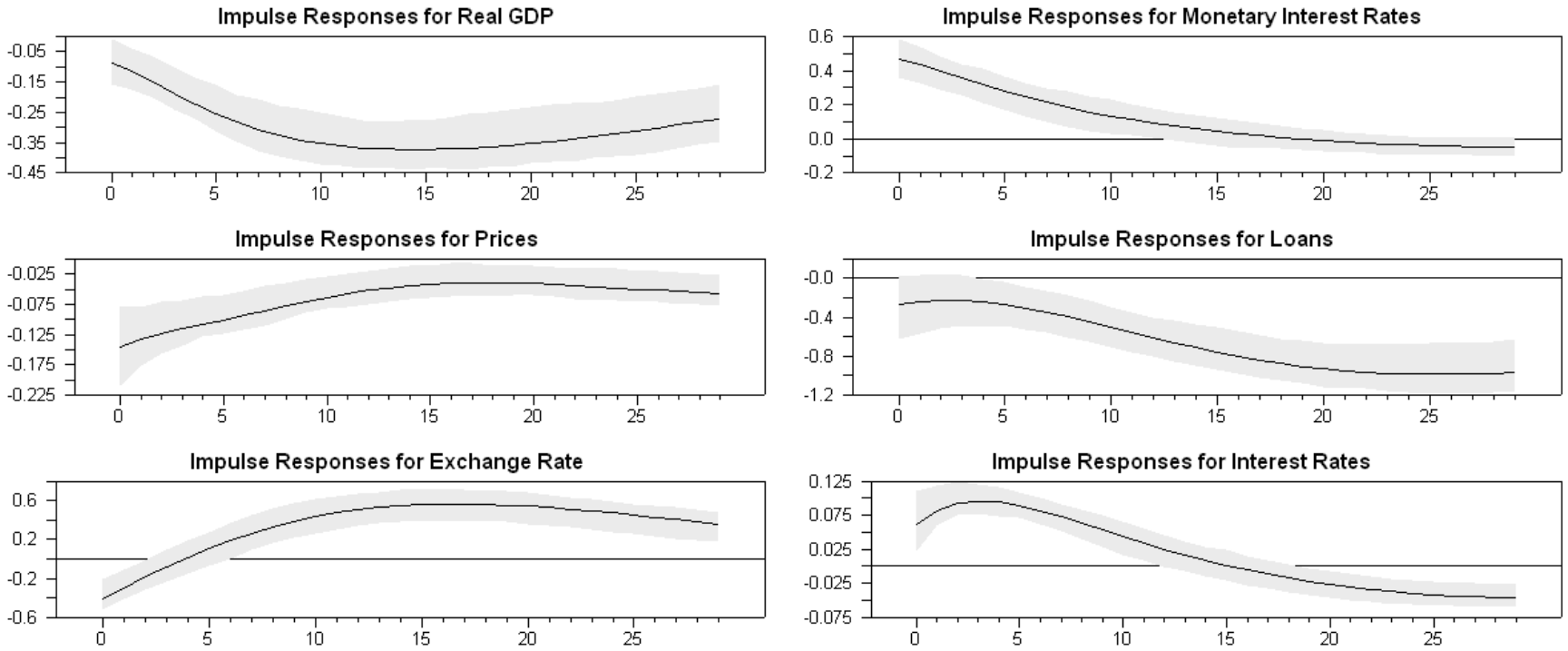
Figure 1 – Impulse responses to a (one standard deviation) loan supply shock



- Consistent with the fall in loan volume and thus, in the available funds for investments, real GDP declines.
- The money market response: plausible reaction of monetary policy to the decline in lending.
- Loan rate falls below its steady state outside the horizon in which it was restricted, following closely the movement of the money market rate.
- The increase in prices: firms borrow funds in order to pay for intermediate good inputs, which implies that marginal costs are directly affected by the loan rate.

Results - Impulse Responses (2)

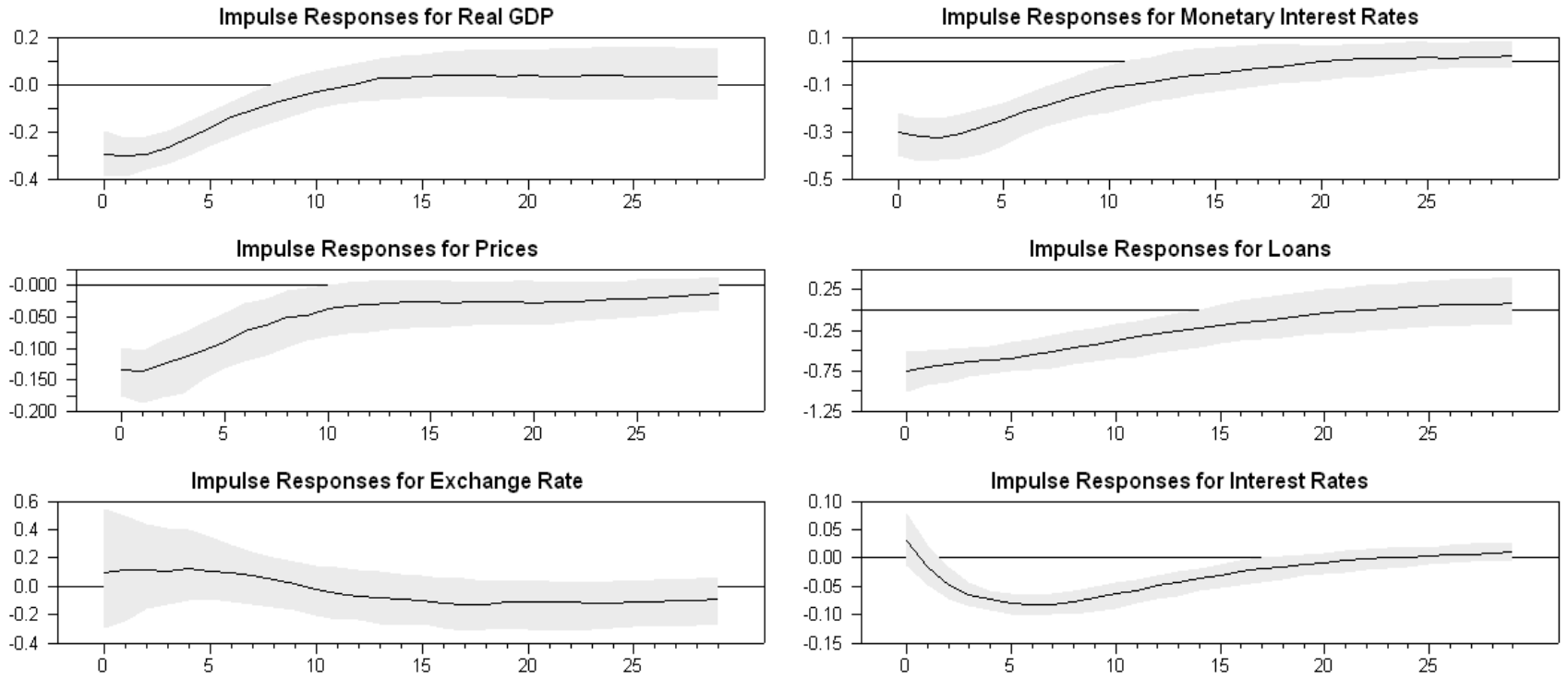
Figure 2 – Impulse responses to a (one standard deviation) monetary policy shock



- The non-positive effect on real GDP is highly persistent.
- Results free of <price puzzle>. However, exchange rate response is merely enforced by the restrictions imposed.
- Following the inflationary pressures, monetary interest rate is shifted below its trend after 4 quarters.
- Pass-through of monetary policy to the interest rates, although limited in amplitude.
- Besides interest rate channel, credit channel is also important in the transmission of monetary policy.

Results - Impulse Responses (3)

Figure 3 – Impulse responses to a (one standard deviation) aggregate demand shock



- Central Bank reacts to a negative aggregate demand shock by lowering the nominal interest rate.
- The median response of exchange rate has the expected sign on short term, but the response is not statistically significant.
- Given the decrease in aggregate income, the demand for loans falls, triggering a decrease of their price.
- The response of the loan interest rates is significant. Informal robustness checks showed that the pattern of the response is robust across alternative variants of the algorithm.

Results – Variance decomposition

Table 2 - Identified shocks' contribution to the forecast errors of endogenous variables (per cent)

Horizon	Real GDP	Inflation	Exchange Rate	Monetary Interest Rates	Loans	Interest Rates
impact	31.90	29.95	29.85	40.00	28.08	37.65
1 quarter	34.22	32.12	30.89	40.40	31.28	41.92
3 quarters	40.45	38.01	38.82	45.64	41.59	49.93
5 quarters	44.71	40.96	45.25	47.70	44.73	50.09
10 quarters	47.70	43.45	47.71	47.74	47.18	49.54

- In the short run identified structural shocks are responsible for less than 40% of the forecast errors.
- In the longer run their contribution increases above 45%.

Table 3 - Individual shocks' relative contribution to the forecast errors of endogenous variables explained by the identified structural shocks (per cent)

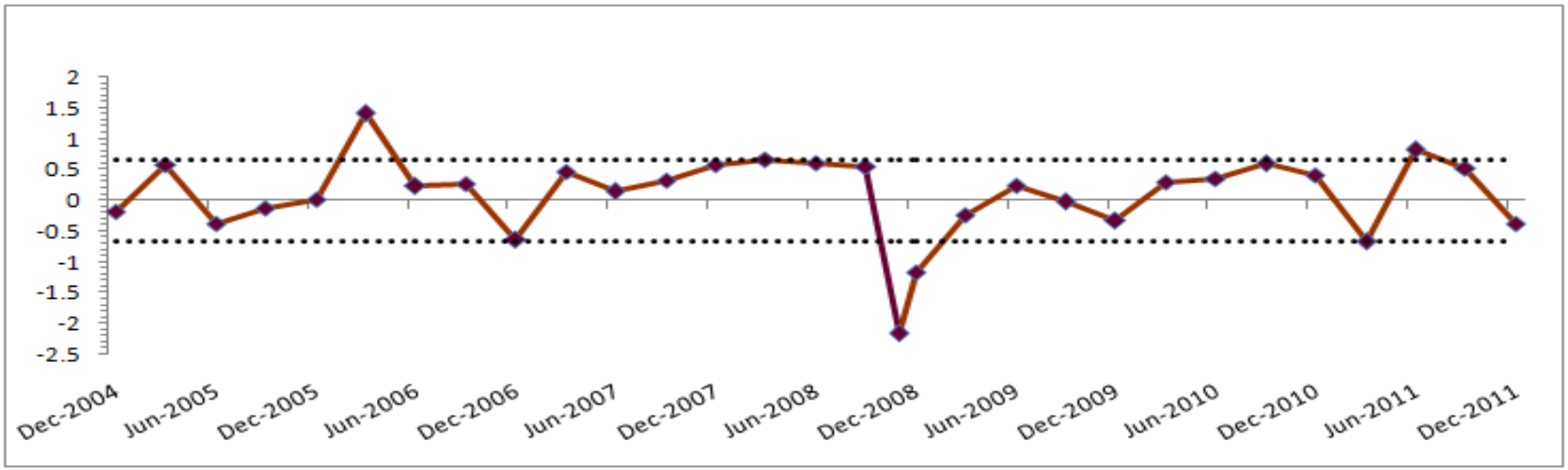
	AGGREGATE DEMAND SHOCK				MONETARY POLICY SHOCK				LOAN SUPPLY SHOCKS			
Horizon	Real GDP	Monetary Interest Rates	Loans	Interest Rates	Real GDP	Monetary Interest Rates	Loans	Interest Rates	Real GDP	Monetary Interest Rates	Loans	Interest Rates
impact	62.63	19.50	43.55	23.40	12.82	68.55	30.98	32.62	24.55	11.95	25.46	43.98
1 quarter	56.66	20.94	43.45	23.85	16.69	64.90	29.99	37.36	26.65	14.16	26.57	38.79
3 quarters	43.24	26.21	41.64	27.80	27.19	48.60	28.25	44.06	29.57	25.20	30.10	28.14
5 quarters	36.35	29.08	40.13	30.84	36.30	41.43	32.75	37.83	27.35	29.50	27.12	31.32
10 quarters	32.33	29.83	33.57	31.81	38.22	39.04	38.75	35.45	29.45	31.13	27.68	32.74

- Significant impact of loan supply shock on economic activity. Explanation ("credit view"): lack of competitiveness of the financial intermediary sector.
- Loan supply shocks have a higher importance in the case of interest rates, as compared to loan volumes

⇨ the main driving force of the latter is in fact the demand-side of the market.

Evolution and Variability of Loan Supply Shock

Figure 4 - Identified loan supply structural shock

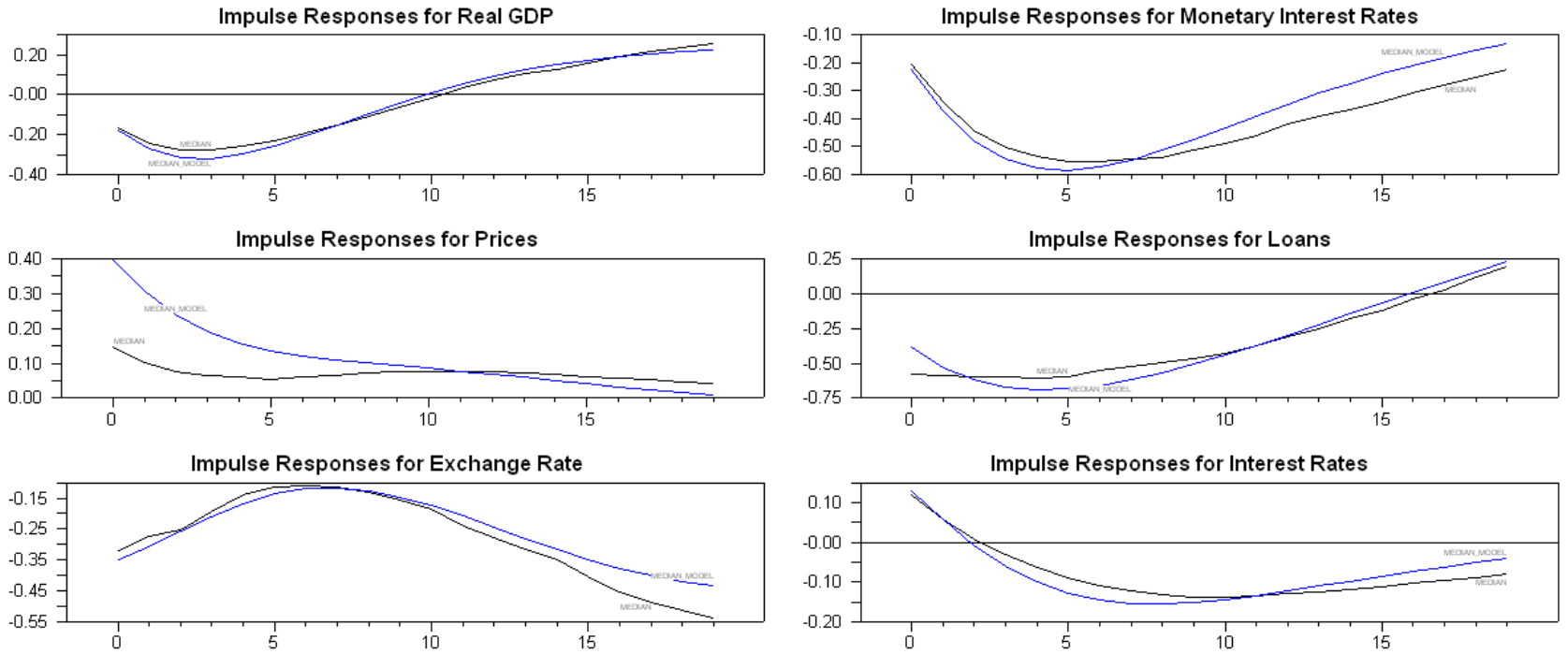


- Rather constant variance ⇨ impact of the banking sector on the economy is significant even in normal times, is not an exclusive feature of the recent financial crisis.
- Positive shocks prevailed in 2006−2008 H1: growing appetite for risk of the banks that took advantage of the excess liquidity on the market to expand loan supply further.
- A negative loan supply shock of large magnitude is observed in 2008Q4 following the Lehman Brothers' collapse.
- A series of positive loan supply shocks in 2010 probably triggered by the lowered interest rates and relatively stable lending standards.

Robustness Checks (1)

- Median Model - Implementation along the lines of the algorithm proposed in Fry and Pagan (2010)

Figure 5 - Median model impulse responses to a (one standard deviation) loan supply shock

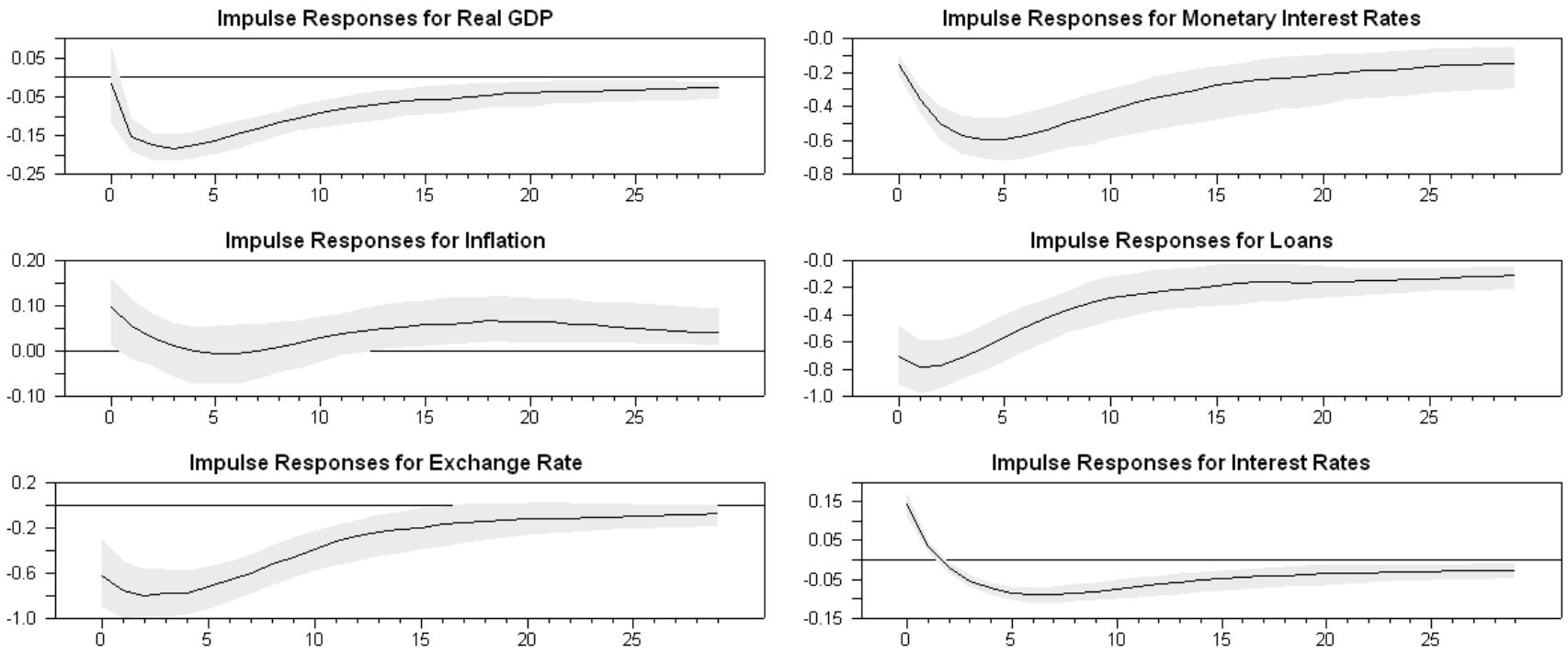


Notes: The black line denotes the median of the impulse responses, computed based on the collection of accepted models. The solid blue lines denotes the impulse responses of the median model, i.e. the model whose impulse responses are as close to the median.

Robustness Checks (2a)

- Alternative sample period excluding the financial crisis

Figure 6 - Impulse responses to a (one std deviation) loan supply shock .Short sample up to 2008:06



- The shortening of the sample period does not invalidate previous conclusions: the reactions to the shock overall display the same sign and the same pattern as the baseline impulse responses.
- More persistent response of GDP and Loans.
- Exception: exchange rate response.

Robustness Checks (2b)

- Alternative sample period excluding the financial crisis

Table 4 - Loan suppply shock relative contribution to the forecast errors of variables explained by the identified structural shocks (per cent) - Alternative sample period

	Real GDP		Loans		Monetary Interest Rate		Interest Rates	
Horizon	Full sample	Alternative sample	Full sample	Alternative sample	Full sample	Alternative sample	Full sample	Alternative sample
impact	24.55	25.54	25.46	36.03	11.95	12.53	43.98	54.15
1 quarter	26.65	36.55	26.57	36.70	14.16	29.97	38.79	39.32
3 quarters	29.57	36.92	30.10	36.92	25.20	35.35	28.14	38.52
5 quarters	27.35	37.46	27.12	37.23	29.50	35.96	31.32	38.60
10 quarters	29.45	37.14	27.68	36.70	31.13	35.38	32.74	37.98

- Excluding the financial crisis from the sample increases the relative importance of the loan supply shock in explaining the variance of our variables of interest.
- For both output and the loan volume this measure increases by more than 7 percentage points in the long run.

⇨ Following the financial turmoil period, both loan and economic dynamics were most likely driven by large aggregate demand shocks.

Augmented Model

Augmented Model – Identification and Structural Interpretation

$$Y = X\,\mathbf{B} + \mathbf{u}$$

$$Y = [lRGDP_t\ lNEER_t\ lCPI_t\ MMIR_t\ lLOAN_t\ SPREAD_t\ RISK_t]'$$

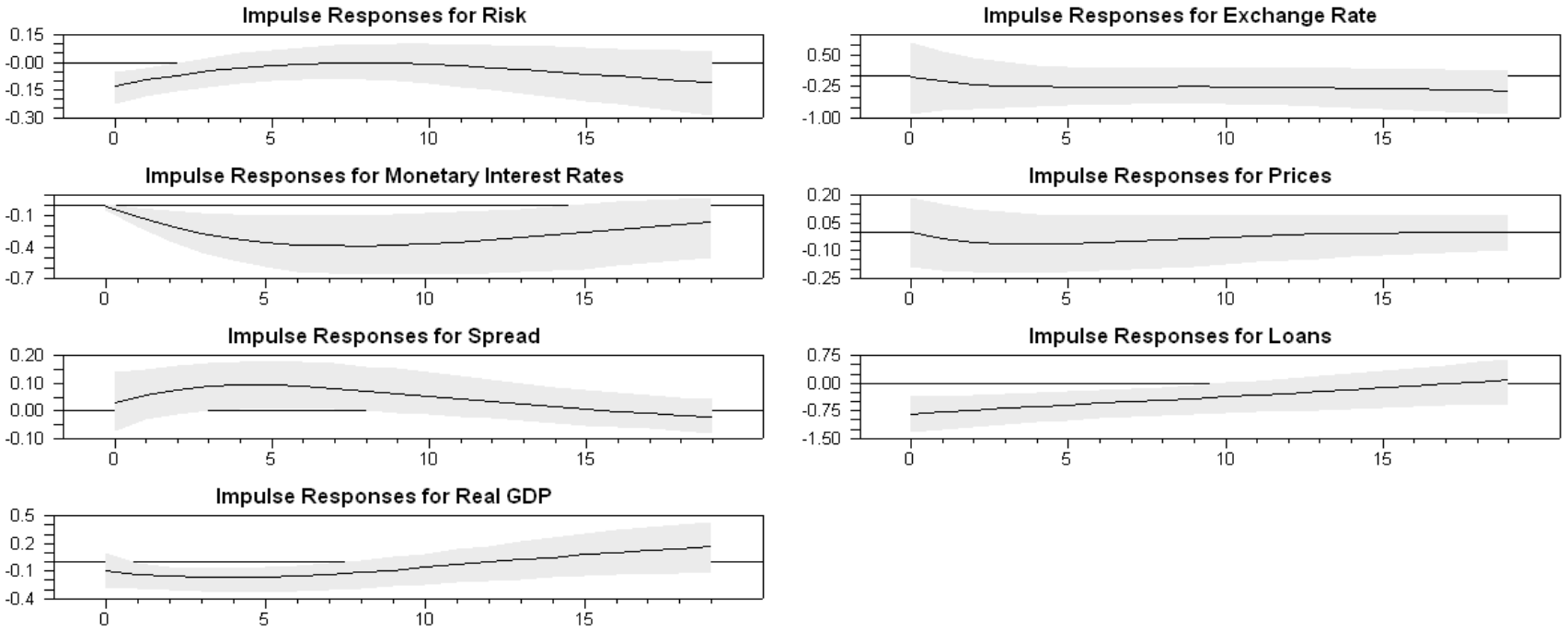
- **X** augmented by a constant and deterministic trend
- VAR(1) model as indicated by Schwarz and Hannan -Quinn criteria
- In addition to **monetary policy shocks** we disentangle loan supply shocks into**:** **spread shock** and **risk assessment shock**.

Table 5 - Sign and zero restrictions in the augmented model

	Credit Spread Shock			Risk Assessment Shock			Monetary Policy Shock		
Date	T=0	T=1	T=2	T=0	T=1	T=2	T=0	T=1	T=2
RGDP		-	-		-	-		-	
NEER							-		
CPI								-	
MMIR	0			0			+	+	+
LOAN	-	-	-	-	-	-			
SPREAD	+	+	+						
RISK	0			-					

Results - Impulse Responses (1)

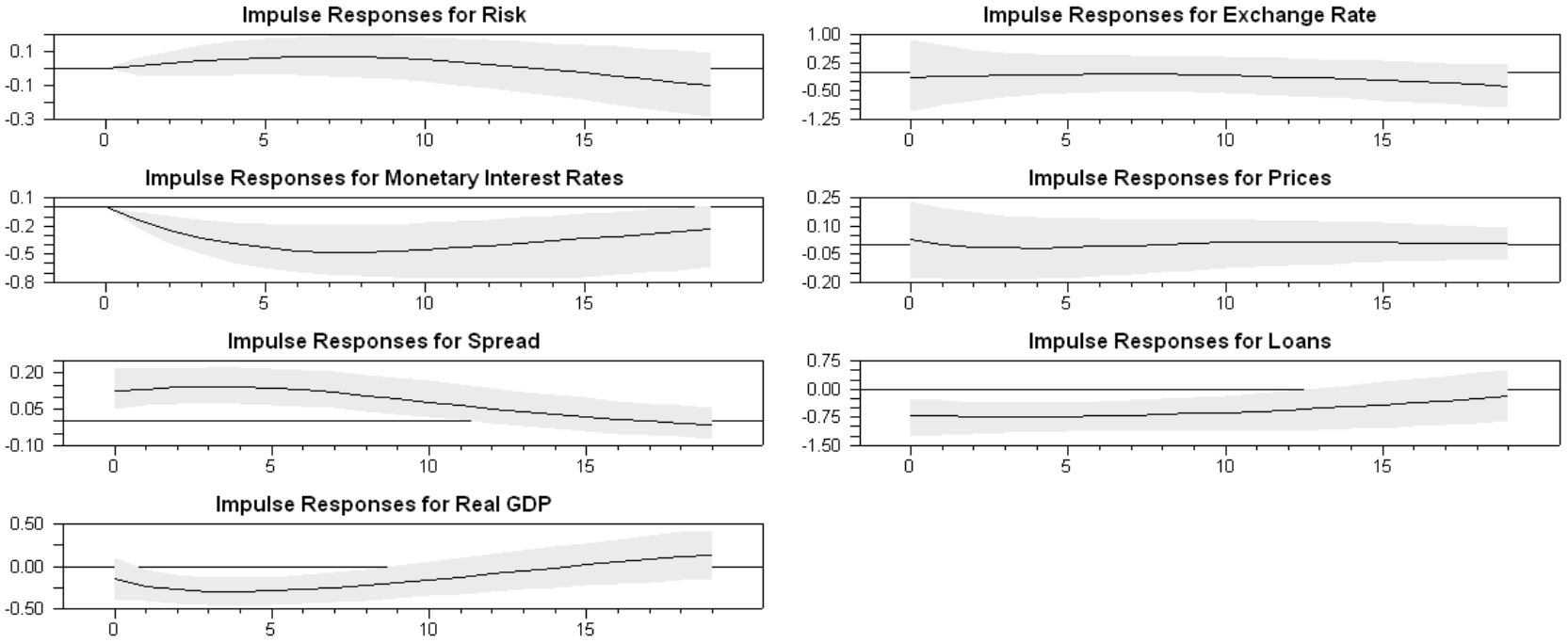
Figure 7 – Impulse responses to a (one standard deviation) risk assessment shock



- Although restricted on impact, ROBOR decreases significantly: the contraction in loan supply is accompanied by a lowering demand for loanable funds ⇨ a drop in the prices of these funds.
- The credit contraction is accompanied by a decrease in real GDP.
- The effect of the shock on the median responses of CPI and exchange rates is rather neutral.

Results - Impulse Responses (2)

Figure 8 – Impulse responses to a (one standard deviation) credit spread shock



- The shape of the response of real GDP is comparable to that of the risk assessment shock.
- While with a lower magnitude on impact, the credit spread shock has a more persistent effect on loans.
- The responses of Spread is both more strong and persistent than in the previous case .

⇨ The main difference in interpreting the two types of loan supply shocks: a shock triggered by changing risk perception of banks is not necessarily reflected by an increase in the interest rates, but by tightened credit standards.

Results – Variance decomposition

Table 6 - Individual shocks' relative contribution to the forecast errors of endogenous variables explained by the identified structural shocks (per cent)

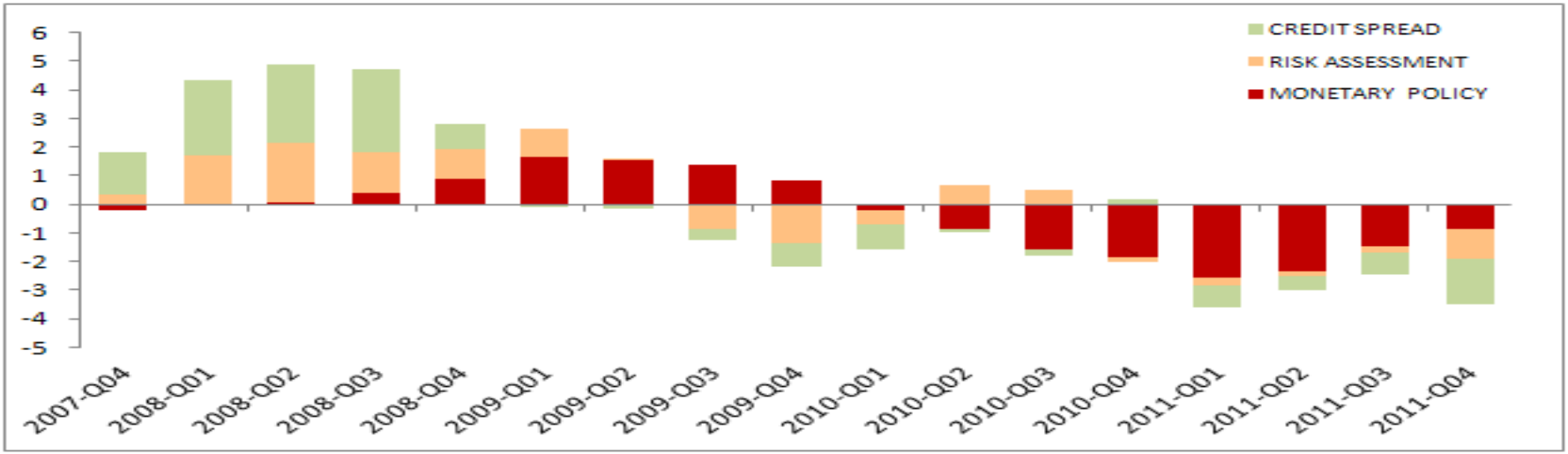
	CREDIT SPREAD SHOCK				RISK ASSESSMENT SHOCK				MONETARY POLICY SHOCK			
Horizon	Real GDP	Monetary Interest Rates	Loans	Credit Spread	Real GDP	Monetary Interest Rates	Loans	Credit Spread	Real GDP	Monetary Interest Rates	Loans	Credit Spread
impact	33.78	0.00	34.46	58.93	41.90	0.06	49.03	20.54	24.32	99.94	16.52	20.54
1 quarter	39.15	19.79	35.68	50.84	34.68	18.76	46.24	29.64	26.16	61.45	18.08	19.51
3 quarters	34.77	33.62	38.13	44.72	27.44	29.79	40.89	30.45	37.79	36.59	20.98	24.82
5 quarters	32.19	36.10	36.45	36.10	27.35	30.81	37.43	27.29	40.46	33.10	26.13	36.62
10 quarters	31.78	36.91	35.45	36.91	27.55	31.34	33.81	27.74	40.67	31.76	30.74	35.35

- The shift in credit risk perception - more important impact on the supply of loans.
  - In contrast to evidence from developed economies, where the main supply-side constraints have been related to capital and liquidity (Hristov et al., 2012).
  - Possible explanation: NBR has closely supervised the developments in capital adequacy ratio of credit institutions (i.e. European Bank Coordination Initiative).
  - Important policy implication: even if Central Bank lowers interest rates, it does not entirely brings expected relief to the credit-constraint agents of the nonfinancial sector.

- Credit spread shocks, explain a larger part of the volatility of the real GDP in the long run.
  - Possible explanation: altered spreads not only influence the flow of new loans to businesses, but also affect the cash flow and the liquidity of firms, triggering an increasing number of insolvencies.

Contribution of identified shocks to the dynamics of Loans to Non-financial corporations

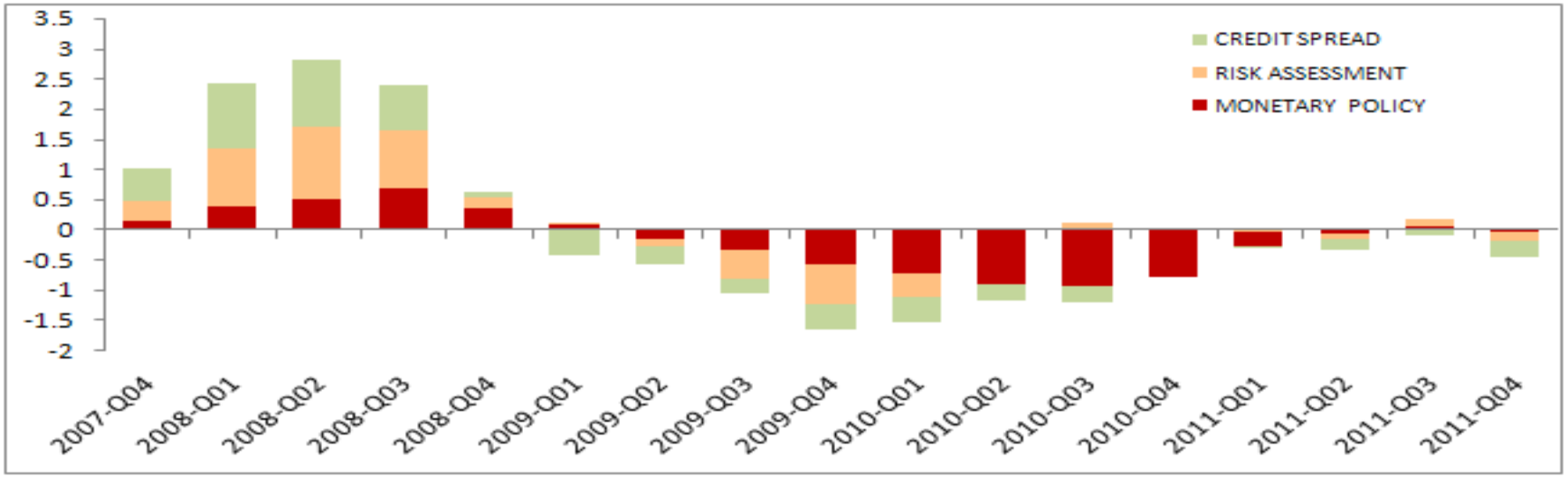
Figure 9 - Historical decomposition of Loans



- The evolution of lending standards and conditions throughout 2008 - favorable to credit developments; decoupled from that of the credit markets in the Euro Area.
- From 2008Q3 onwards, given the rising tension on the interbank money market and increasing volume of non-performing loans, the cumulated positive impact of loan supply shocks started to decline; ending up in a marked negative impact towards the end of 2009.
- The lagged cumulated impact of expansionary monetary policy shocks counteracted the subdued development of loans until 2010, when NBR stopped easing monetary conditions.

Contribution of identified shocks to the dynamics of Real GDP

Figure 10 – Historical decomposition of Real GDP



- A significant share of economic growth in the period preceding the burst of crisis was fuelled by the "credit boom".
- Starting with 2009, both loan supply shocks had a significant contribution to real GDP decline.
- High persistence of the credit spread shocks caused lasting effects on real GDP, that cumulated over time and resulted in a considerably slower pace of the expansion of the real GDP than implied by the model baseline.

Conclusions (1)

- The **banking system** is not a "passive player", only conveying aggregate demand and monetary shocks, but rather acts as a **source of additional economic disturbances.**

  ⇨ Necessity of incorporating financial intermediaries into macroeconomic models for better describing macroeconomic dynamics.

- Risk perception appears to be the main constraint on the supply side of the credit market.

  - Interest rate channel in the Romanian economy was proven to be rather weak;
  - Banks are not severely constrained by liquidity and capital standing.

  ⇨ Should decision-makers intend to **stimulate bank lending**, they must at **reducing uncertainty in the economy and increasing the risk appetite of banks.**

  ⇨ Potential channel of **financial contagion**, as risk policies and lending practices of foreign-owned banks are usually set at the parent company level.

Conclusions (2)

- High persistence of the credit spread shocks, causing lasting effects on GDP. Assuming an excessive **deleveraging** of the subsidiaries of foreign banks in Romania, the economic recovery will be once again put at risk.
- Lending and real GDP evolution in the course of the **financial crisis** were significantly influenced by the **changes in the behavior of the banks** in the altered macroeconomic environment; loan supply shocks was particularly relevant from 2009 onwards.
- For future work, it would be desirable to:

✓ explore the robustness of the results in more detail, should the data availability constraints be overcome (new credit risk measure, BLS data).

✓ explain and understand better the factors behind the unidentified innovations.

✓ investigating the economic mechanisms underlying the dynamics of foreign-currency household loans.

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