THE BUCHAREST UNIVERSITY OF ECONOMIC STUDIES
DOCTORAL SCHOOL OF FINANCE AND BANKING

Financial Frictions and Business Cycle Fluctuations – the Case of Romania

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Motivation:

- The recent economic recession highlighted the importance of financial factors for the business cycle dynamics;
- Because of this new developments, we've decided to analyse the Romanian **business cycle fluctuations** from the perspective of a Dynamic Stochastic General Equilibrium (DSGE) model with financial frictions;
- The model that we've chosen was developed by Brzezina and Makarsky (2011) and incorporates **financial frictions** like collateral constrains and interest rate spread between the interbank interest rate and the interest rate on loans or deposits;
- The **purpose** of this thesis is to asses:
  - The impact of financial shocks and external shocks on the business cycle fluctuations;
  - The role played by the **financial factors** in the last economic recession;

I. Brief Literature Review

- **Smets and Woters (2002)** were among the first to estimate a DSGE model using Bayesian approach;
- The most common approach to introduce financial frictions into DSGE models is the financial accelerator **(Bernake, Gertler and Gilchrist 1999)** - endogenous developments in credit markets amplify and propagate shocks to the economy;
- Another way to introduce financial frictions into DSGE models is with collateral constrains, framework developed by **Iacovello (2005)** to asses the interactions between housing prices and economic activity;
- **Brezina and Makarsky (2011)** developed a open economy DSGE model with collateral constrains and interest rate spread between loans/deposits and the interbank interest rate to asses the recent credit crunch on Polish economy.

Model Fit for Romanian Economy

- In this framework the financial disturbances enter in the model **exogenously**: LTV shocks and interest rate spreads shocks have a AR(1) representation, in the financial accelerator framework financial disturbances are **endogenously –** the idiosyncratic risk determines a cost for banks which gives rise risk premium above the risk free interest rate;

- In this framework banks are allowed to borrow form the **external interbank market**, subject to a risk premium, in the financial accelerator framework banks finance their loans from **household deposits**;

- Also, we've introduced **time varying inflation objective** – which has an AR(1) representation, and a **tertiary monetary policy objective** – real exchange rate.

II. The Model - Households

- The economy is populated by **patient, impatient households and entrepreneurs;**
- **Patient and impatient households** have the following utility function:

$$E_0 \sum_{t=0}^{\infty} \beta_U^t \, \varepsilon_{u,t} \left[\frac{\left(c_t^U(i) - \xi c_t^U\right)^{1-\sigma_c}}{1-\sigma_c} + \varepsilon_{\chi,t} \frac{\chi_t^U(i)^{1-\sigma_\chi}}{1-\sigma_\chi} - \varepsilon_{n,t} \frac{n_t^U(i)^{1+\sigma_n}}{1+\sigma_n} \right]$$

Where U = I,P

- The budget constrain for **patient households**:

$$P_t c_t^P(i) + P_{\chi,t}\left(\chi_t^P(i) - (1-\delta_\chi)\chi_{t-1}^P(i)\right) + D_t^H \leq W_t n_t^P(i) + R_{D,t-1}^H D_{t-1}^H(i) - T_t(i) + \Pi_t^P$$

- The budget constrain for **impatient households**:

$$P_t c_t^I(i) + P_{\chi,t}\left(\chi_t^I(i) - (1-\delta_\chi)\chi_{t-1}^I(i)\right) + R_{L,t-1}^H L_{t-1}^H \leq W_t n_t^I(i) + L_t^H(i) - T_t(i)$$

- Impatient households face the following **borrowing constrain**:

$$R_{L,t-1}^H L_{t-1}^H(i) \leq m_t^H E_t\left[P_{\chi,t+1}(1-\delta_\chi)\chi_t^I(i)\right]$$

II. The Model - Entrepreneurs

- **Entrepreneurs** draw utility only from **consumption**:

$$E_0 \sum_{t=0}^{\infty} (\beta_E)^t \left[\varepsilon_{u,t} \frac{(c_t^E(i) - \xi c_{t-1}^E)^{1-\sigma_c}}{1-\sigma_c} \right]$$

- They run **firms** which are producing homogeneous intermediate goods

$$y_{W,t}(i) = A_t [u_t(i) k_{t-1}(i)]^{\alpha} n_t(i)^{1-\alpha}$$

- The **budget constrain** is:

$$P_t c_t^E(i) + W_t n_t(i) + P_{k,t}(k_t(i) - (1-\delta_k) k_{t-1}(i)) + P_t \psi(u_t(i)) k_{t-1}(i) + R_{L,t-1}^F L_{t-1}^F$$
$$= P_{W,t}\, y_{W,t}(i) + L_t^F(i) - T_t(i)$$

- The **borrowing constrain** is:

$$R_{L,t}^H L_t^H(i) \leq m_t^F E_t [P_{k,t+1}(1-\delta_k) k_t(i)]$$

II. The Model - Producers

- **Capital** (k) and **Housing** (χ) Goods Producers**:**

$$k,\chi_{\ t} = \left(1 - \delta_{k,\chi}\right) k,\chi_{\ t-1} + \left(1 - S_{k,\chi}\left(\frac{i_{k,\chi\ ,t}}{i_{k,\chi\ ,t-1}}\right)\right) i_{k,\chi\ ,t}$$

- **Domestic retailers** (j_H) and **importing retailers** (j_F) - they purchase undifferentiated goods from entrepreneurs/abroad - differentiate the goods – and sells them to the final good producers.

  They operate in **monopolistically environment** and sets the prices accordingly to a Calvo scheme. For those that aren't allowed to re-optimize the prices, the indexation scheme is:

$$P_{H,F,t+1}(j_{H,F}) = P_{H,F,t}(j_H)\left((1 - \xi_{H,F})\bar{\pi}_t + \xi_{H,F}\pi_{t-1}\right)$$

- **Final Good** Producers:

$$y_t = \left[\eta^{\frac{\mu}{1+\mu}} y_{H,t}^{\frac{1}{1+\mu}} + (1-\eta)^{\frac{\mu}{1+\mu}} + y_{F,t}^{\frac{1}{1+\mu}}\right]^{1+\mu}$$

- **Exporting retailers** act like domestic retailers, only they sell their differentiated goods abroad.

II. The Model - Financial Sector (1)

- The financial sector is composed by **financial intermediaries and banks**.
- Financial intermediaries are operating in a **competitive environment**;
- A **financial saving intermediary** collects deposits from household and deposits them into a savings bank, they maximize profits given by:

$$\frac{1}{R_{D,t}^{H}} D_t^H - \int_0^1 \frac{1}{R_{D,t}^{i}(i_D^H)} D_t^H(i_D^H) di_D^H$$

subject to the aggregation technology

- A **financial lending intermediary** maximize profits given by:

$$R_{L,t}^{H} L_t^H - \int_0^1 R_{L,t}^{H}(i_L^H)\, L_t^H(i_L^H) di_L^H$$

subject to the aggregation technology

II. The Model - Financial Sector (2)

- **Savings banks** collects deposits from the savings intermediary and deposits them in the interbank market at the interbank interest rate - it is assumed that banks can deposit only a part of their deposits:

$$D^H_{IB,t}(i^H_D) = z^H_{D,t} D^H_t(i^H_D)$$

- There are two types of **lending banks,** one that lends to households and one that lends to firms, both of them are taking loans from the interbank market at the policy interest rate and only $z^H_{L,t}$ units of loans can be made:

$$L^H_t(i^H_L) = z^H_{L,t}\,(L^H_{IB,t}(i^H_L) + e_t L^{H*}_{IB,t}(i^H_L))$$

- Lending banks have also access to the **foreign interbank market** subject to a risk premium defined as:

$$\rho_t = exp\left(-\varrho \frac{e_t L^*_t}{P_t \tilde{y}_t}\right)\varepsilon_{p,t}$$

- It is assumed that banks are operating in a **monopolistically environment** and are setting their interest rate accordingly to a Calvo mechanism.

The Government and the Central Bank

- At every period the government sheet is balanced and expenditure are driven by an AR(1) process with normal innovations;
- The **monetary policy** is conducted accordingly to a Taylor rule (in linear form):

$$\hat{r}_t = \gamma_r \hat{r}_{t-1} + (1-\gamma_r)(\gamma_\pi(\hat{\pi}_t - \overline{\pi}_t) + \gamma_y \hat{y}_t + \gamma_q \hat{q}_t)$$

Where:

- $\hat{r}_t$ is monetary policy rate
- γ_r is the interest rate smoothing
- γ_π is the inflation feedback
- γ_y is the output gap feedback
- γ_q is the real exchange rate feedback
- $\overline{\pi}_t$ is time varying inflation objective

Market clearing conditions

- In the final goods market we have:

$$c_t + i_{k,t} + i_{\chi,t} + g_t + \psi(u_t)k_{t-1} = y_t$$

- For homogeneous goods market:

$$\int_0^1 y_{H,t}(j)dj + \int_0^1 y^*_{H,t}(j)dj = y_{W,t}$$

- The balance of Payments (home currency):

$$\int_0^1 P_{F,t}(j_F)y_{F,t}(j_F)dj_F + e_t R^*_{t-1}\rho_{t-1}L^*_{t-1} = \int_0^1 e_t P^*_{H,t}(j^*_H)y^*_{H,t}(j^*_H)dj^*_H + e_t L^*_t$$

- GDP is defined as:

$$P_t\tilde{y}_t = P_t y_t + \int_0^1 e_t P^*_{H,t}(j^*_H)y^*_{H,t}(j^*_H)dj^*_H - \int_0^1 P_{F,t}(j_F)y_{F,t}(j_f)dj_F$$

Estimation procedure

- The model was estimated* with the **Bayesian technique**, which has the following steps:
  - Specification of the prior distribution - $\boldsymbol{p(\theta)}$;
  - Computation of the conditional likelihood function using Kalman Filter - $\boldsymbol{p(y|\theta)}$;
  - Computation of the posteriori distribution using Bayes theorem;

$$\boldsymbol{p(\theta|y)} = \frac{\boldsymbol{p(y|\theta)p(\theta)}}{\boldsymbol{p(y)}}$$

  - Maximization of the log posteriori kernel;
  - Simulation of the posteriori distribution with Metropolis Hastings;
  - Computation of the marginal density.

* the estimation was performed in Dynare

Data and Shocks

- The model is estimated using **thirteen** macroeconomic time series:
- **Domestic economy:**
  - Real GDP, real government expenditure, the real exchange rate, consumer price inflation (HIPC);
  - Money market interest rate (ROBOR 3M) and the interest rate for households deposits and loans and firms loans;
  - New credits to households and firms.

- **Foreign economy (Euro Area 16):**
  - Real GDP;
  - Money market interest rate (EURIBOR 3M);
  - Consumer price inflation (HIPC).

Source: Eurostat, NBR, NIS and EURIBOR

- In the model there are **16 structural shocks**, three of them enter exogenously through the VAR model for the foreign economy.

Calibration

Parameter	Calibrated Value
Discount factor for Patient Households	**0.9952**
Discount factor for Impatient Households	**0.9752**
Home Bias	**0.61**
Loan to Value Households	**0.7**
Loan to Value Entrepreneurs	**0.6**
Foreign Debt*	**2.1**
New loans to Households*	**0.014**
New loans to firms*	**0.038**
Interest rate on Households Loans**	**3.29%**
Interest rate on Firms Loans**	**3.11%**
Monetary Policy Interest Rate**	**1.93%**

* share in GDP
** are expressed in quarterly terms

Prior distributions

Parameters	Distribution	Mean	Std. err.
Capital utilization cost	Gamma	0.2	0.05
Inve. Capital adjustment costs	Beta	0.2	0.05
Inve. Housing adjustment costs	Beta	0.02	0.005
Calvo probabilities - θ	Beta	0.6	0.1
Indexation - ξ	Beta	0.5	0.1
Interest rate smoothing - γ_R	Beta	0.7	0.1
Response to inflation - γ_π	Normal	1.5	0.1
Response to GDP - γ_y	Normal	0.5	0.05
Response to real exchange rate - γ_Q	Normal	0.2	0.05
Autoregressive parameters - ρ	Beta	0.7	0.1
Standard deviations of shocks - σ	Inv. Gamma	0.05, 0.01	inf

Estimation results

- A small degree of habit in consumption - **0.27**;
- The duration of the wage contract is around **one quarter**;
- **Two quarters** stickiness in domestic price sector;
- The indexation parameter for the past inflation is around **0.5**;
- The Calvo parameter for interest rate on deposits and loans is estimated at **0.5 –** a **two quarter** period between interest rate adjustments;
- A small degree of interest rate smoothing – **0.44;**
- Response to inflation and response to output gap are in line with Taylor principle – **1.49** for inflation response and **0.52** for output gap response;
- Response to real exchange rate is estimated at **0.21**;
- A small persistence of financial shocks (generally between **0.3 and 0.5** – exception is households LTV shock which is around **0.7**).

Different specifications

Model	Marginal Likelihood*
0. Baseline	**1864**
1. No Loan to Value Shocks	**1803**
2. No Interest Rate Spreads Shocks on Loans	**1538**
3. No External Shocks	**1210**

1. - The absence of loan to values shocks doubles the **capital investment adjustment costs** – affects the level of loans;

2. - The absence of interest rate spreads on loans determines an increase of the **capital utilization costs** with more than 0.1 points – affects the cost of loans;

3. - The absence of external shock determines the **grates fall** of the marginal likelihood.

*Modified Harmonic Mean Estimator

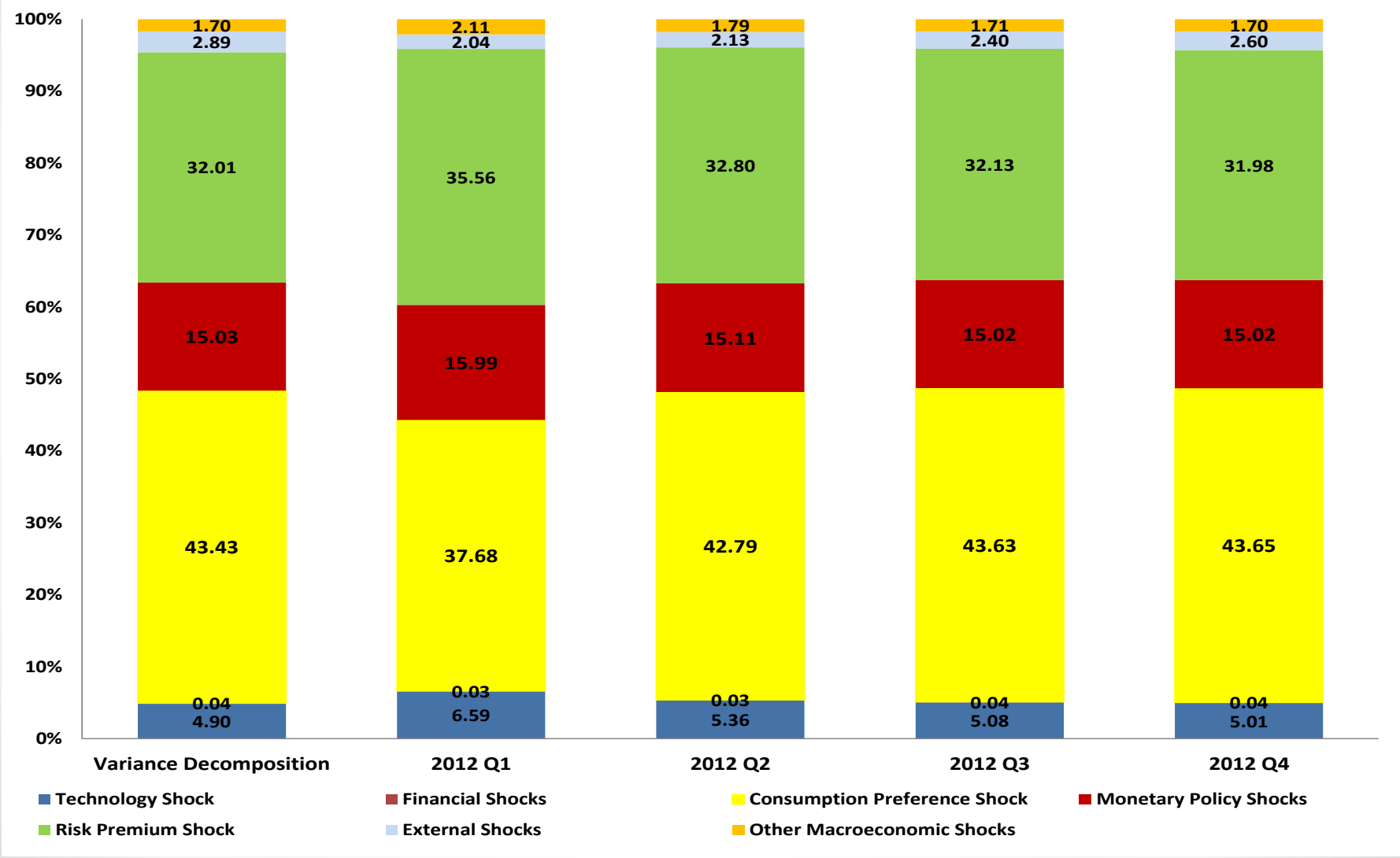
Impulse response analysis

- An **increase of the risk premium** determines exchange rate depreciation due to the UIP, a rise of the interest rates fallowed by a decline in consumption and loans to households. Because of the exchange rate depreciation the export are rising leading to a rise in GDP;

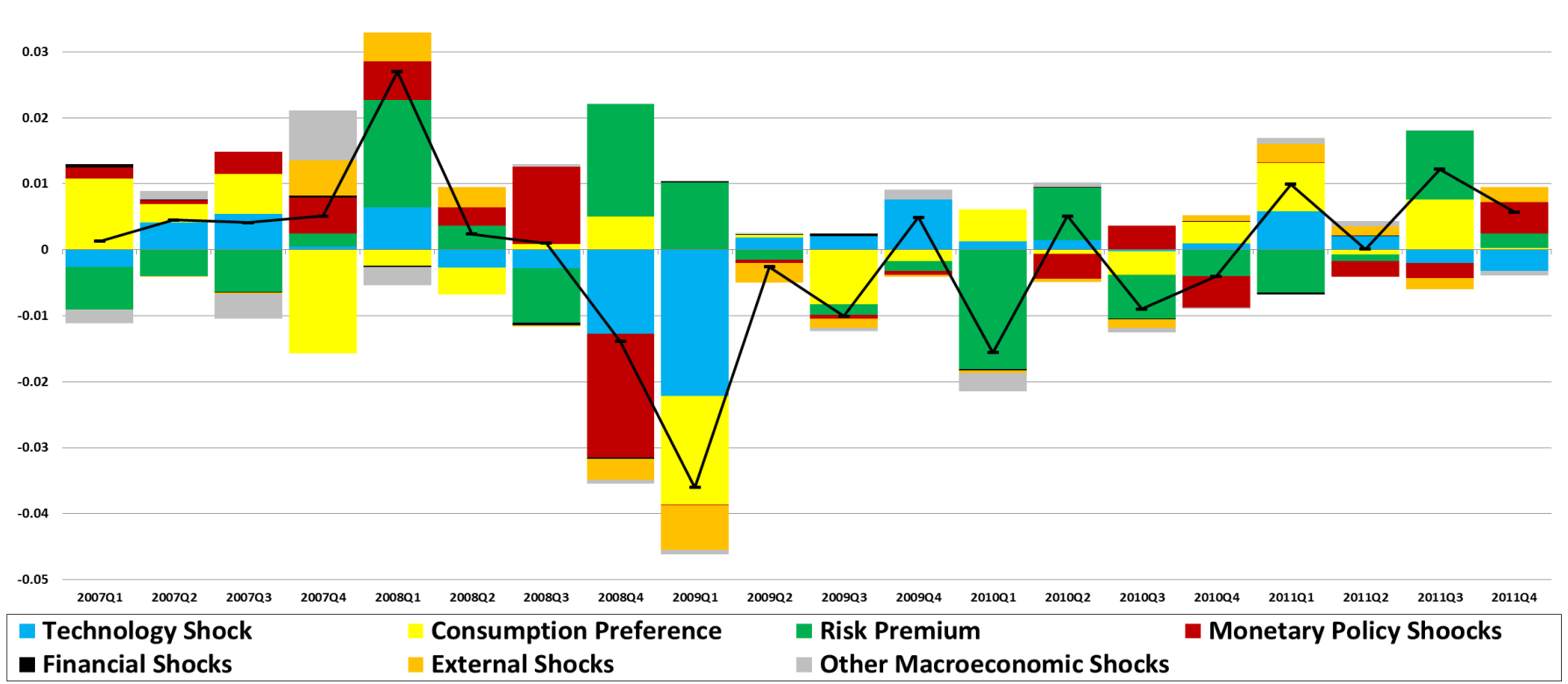
- A **rise of the Loan to Value for entrepreneurs** (equivalent to reduction of down payment) determines increase in loans for entrepreneurs, but they increase only the level of consumption because this shock is perceived as temporary.

- An **increase in the interest rate for deposits** determines the patient households to save more, determining a drop in consumption. Loans for impatient households are rising but they cannot compensate for the drop in consumption.

Variance Decomposition and Conditional Variance Decomposition

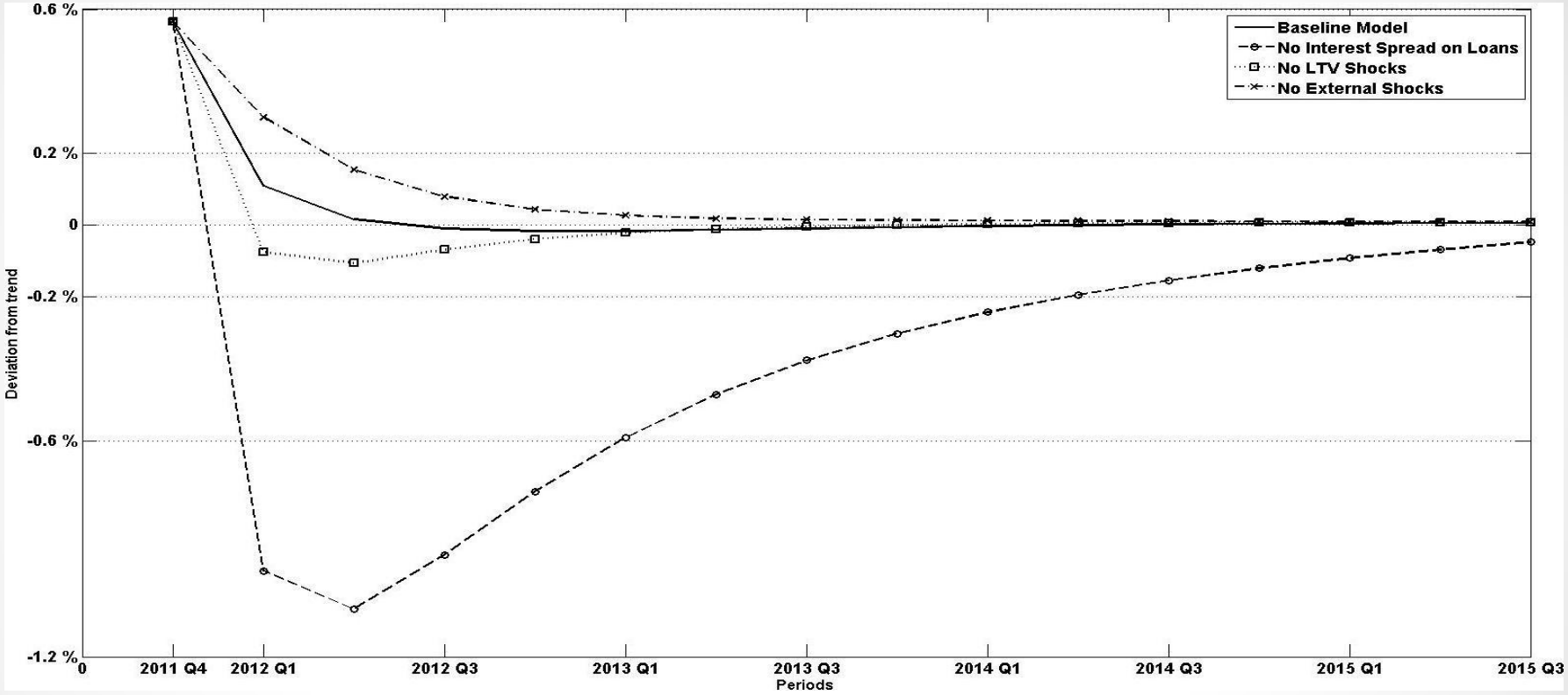


Historical Decomposition - GDP



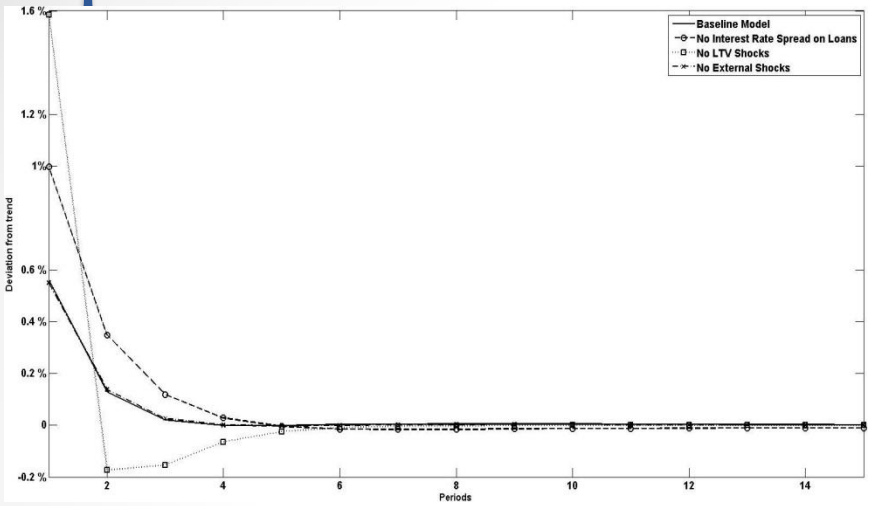
- Financial shocks had **no contribution** in the economic slowdown;
- The external shocks were responsible of **0.68%** reduction in the GDP;
- The remaining value can be attributed to the consumption preference shock and to the technology shock.

Forecasting GDP with Different Specifications

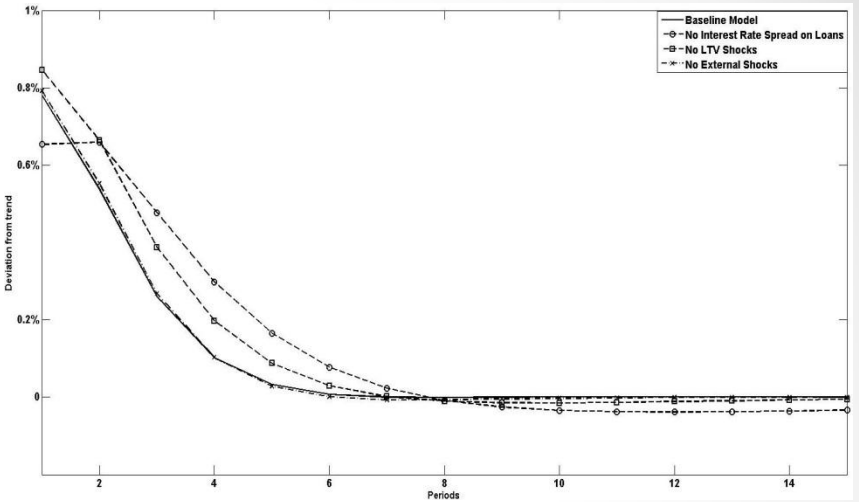


- The absence of interest rate spreads for loans drives GDP under the steady state, the GDP is recovering after 16 quarters;
- In absence of LTV shock determines a smaller fall in GDP, then the GDP is recovering after 4 quarters.

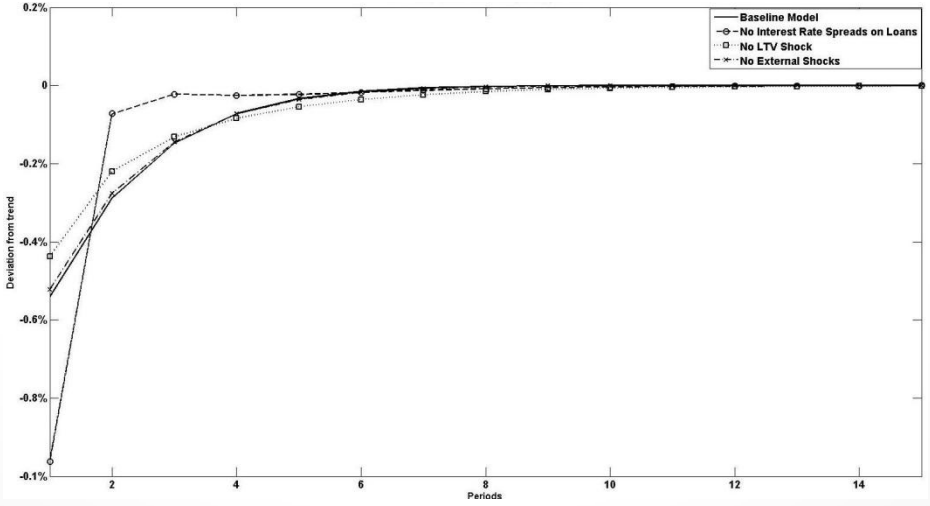
Impulse Response with Different Specifications - GDP



Technology Shock



Consumption Preference Shock



Monetary Policy Shock

Conclusions

- There is a low **level of stickiness in wages, domestic prices, export prices** and a **high level of indexation**, also the habit formation is very low;
- The absence of external shocks determines the **greatest fall** in the marginal likelihood density and the absence of LTV and interest rate spreads shocks determines modifications in the level of **adjustment costs**;
- A increase of the risk premium determines a rise of the GDP – **thought the export channel**;
- The **variance of the GDP** is mainly due to the risk premium shock, monetary policy shocks and consumption preference shock;
- The external shocks had a non-negligible impact on the GDP, being responsible for **0.68%** reduction of the GDP (3.6%) in the recent economic slowdown;
- The financial shocks had a almost **zero impact on the GDP during** the last economic recession;
- Financial shocks are acting in a **pro-cyclical way** – in the absence of interest rate spreads shock on loans the GDP falls below the SS for 16 quarters.

Directions for Further Work

- The model doesn't take into account **loans in foreign currency** and, thus, the exchange rate depreciation has a positive impact on the GDP;
- The **level of external funds** isn`t stochastically perturbed and, thus, the model can`t mimic the reduction of the external credit lines;
- **The government** is modeled very simplistic – during the latest recession the government has borrowed larger amounts of funds form the banking system, causing even a larger fall of the private borrowing.
- A further investigation of how the **adjustment cost** are acting in periods of economic expansion and economic recession.

Thank you!

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