Bucharest Academy of Economic Studies
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DOFIN

Evaluating Changes in the Monetary Policy Transmission Mechanism in CEE Countries

A Time-Varying Parameter VAR Approach

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- June 26, 2012 -

Outline of the paper

- Motivation and importance of the theme in question
- Brief literature review
- Objectives
- The econometric model
- Data and estimation strategy
- Results
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- References

Motivation and importance of the theme in question

- The study of the monetary policy transmission mechanism (MPTM) is essential in establishing the ***timing and efficiency of monetary policy***
- On the one hand, the need to explain the sources of "***The Great Moderation***" for the US, and on the other hand the ***creation of the euro area*** for Europe, have ***boosted the research*** on the MPTM and its evolution over time.
- All ***CEE countries*** have the characteristics of small open economies and have faced similar monetary policy regime changes. Comparisons have been made under the perspective of joining the euro area, due to the fact that differences would imply a disproportionate burden of the disinflationary process under a common monetary policy.
- Studying the CEE countries with standard techniques raises the problem of regime changes, likely to affect the MPTM. Only a few years have passed since the last change and also sub-regime changes are in order as well ⇒ ***the use of fixed parameter models is questionable***

Brief literature review

In order to evaluate changes in the MPTM existing VAR studies have employed one of the following strategies:

1. Estimate an empirical model over different ***subsamples*** : Boivin and Giannoni (2002)

… or address time-variation within the model using one of the following methods:

1. Treat parameters as ***latent variables that follow a random walk***; The Kalman filter is used for estimation as in Colgely and Sargent (2005), Primiceri (2005), Franta *et al* (2011,2012), Nakajima (2011), Darvas (2009)
2. Use parameters that ***switch (back and forth) between regimes*** driven by latent state variables which follow a Markow switching process.: Rubio-Ramirez (2005)
3. Use parameters that ***change from one regime to another smoothly*** (and permanently) in time; the specification is the multivariate extension of STAR model: He, Terasvirta and Gonzalez (2005)
4. Use ***mixture innovations models***, that allow us to estimate whether, where, when and how parameters have changed Koop *et al* (2008)

Objectives

- Asses the characteristics of the MPTM in Romania and compare them to the Czech Republic, Hungary and Poland
- Identify and explain differences between the countries analysed, as far as the MPTM is concerned
- Asses possible structural changes in the macroeconomic framework and the impact of these changes on the MPTM
- Assert whether the MPTM has indeed changed, or whether apparent changes are due to changes in the volatility of shocks

Drawbacks of the analysis:

Limited data availability and short time data samples →

mitigated by using monthly data for the range **2000M01 – 2012M02** and ultimately by using Bayesian estimation methods

The econometric model

Based on Primiceri (2005), I consider following model:

$$y_t = c_t + B_{1,t} y_{t-1} + \ldots + B_{1,p} y_{t-p} + u_t \qquad t = 1, \ldots, T \quad (1)$$

where:

y_t - is a $M \times 1$ vector of observed endogenous variables

c_t - is a $M \times 1$ vector of time-varying coefficients

$B_{i,t}$ $i = 1, \ldots, p$ - are the $M \times M$ matrices of VAR time-varying coefficients

u_t - are unobservable shocks with time-varying variance covariance matrix Ω_t for $t = 1, \ldots, T$ ⇨

up **to the data to determine** whether time variation derives from

- changes in the ***size of shocks*** (impulses)
- changes in the ***propagation mechanism*** (responses)

The econometric model

- A triangular reduction for Ω_t will be used such that:

$$A_t \Omega_t A_t' = \Sigma_t \Sigma_t' \quad (2) \qquad \Leftrightarrow \qquad \Omega_t = A_t^{-1} \Sigma_t \Sigma_t^{-1} \left(A_t^{-1}\right)' \quad (3)$$

Where A_t is a triangular matrix and Ω_t is a diagonal matrix:

$$A_t = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ \alpha_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ \alpha_{M1,t} & \cdots & \alpha_{MM-1,t} & 1 \end{pmatrix} \quad (4) \qquad \Sigma_t = \begin{pmatrix} \sigma_{1,t} & 0 & \cdots & 0 \\ 0 & \sigma_{2,t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_{M,t} \end{pmatrix} \quad (5)$$

Therefore we have:

$$y_t = c_t + B_{1,t} y_{t-1} + \ldots + B_{1,p} y_{t-p} + A_t^{-1} \Sigma_t \varepsilon_t \qquad (6)$$

Stacking all the RHS coefficients (6) can be rewritten as:

$$y_t = X_t' B_t + A_t^{-1} \Sigma_t \varepsilon_t \qquad \text{where} \qquad X_t' = I_M \otimes \left[1, y_{t-1}', \ldots, y_{t-p}'\right] \quad (7)$$

The econometric model

- Next by specifying the laws of motion for the time-varying parameters we obtain the following ***state-space model***:

- The ***measurement*** equation:

$$y_t = X_t^{'} B_t + A_t^{-1} \Sigma_t \varepsilon_t \qquad (7)$$

- The ***transition*** equations:

$$B_t = B_{t-1} + v_t \qquad (8)$$

$$\alpha_t = \alpha_{t-1} + \zeta_t \qquad (9)$$

$$\log \sigma_t = \log \sigma_{t-1} + \eta_t \qquad (10)$$

Where the innovations have following variance covariance matrix

$$V = \operatorname{var}\left(\begin{bmatrix} \varepsilon_t \\ v_t \\ \zeta_t \\ \eta_t \end{bmatrix} \right) = \begin{bmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix}$$

The econometric model

- **Priors** are set to be …

$$B_0 \sim N\left(\hat{B}_{OLS}, 4 \cdot \mathrm{var}\left(\hat{B}_{OLS}\right)\right)$$

$$A_0 \sim N\left(\hat{A}_{OLS}, 4 \cdot \mathrm{var}\left(\hat{A}_{OLS}\right)\right)$$

… diffuse and uninformative …

$$\log \sigma_0 \sim N\left(\log \hat{\sigma}_{OLS}, 4 \cdot \mathrm{var}\, I_M\right)$$

$$Q \sim IW\left(k_Q^2 \cdot \tau \cdot \mathrm{var}\left(\hat{B}_{OLS}\right), \tau\right)$$

, where τ is the size of the training sample

$$W \sim IW\left(k_W^2 \cdot (1+\dim(W)) \cdot I_M, (1+\dim(W))\right)$$

$$S_l \sim IW\left(k_S^2 \cdot (1+\dim(S_l)) \cdot \mathrm{var}(\hat{A}_{OLS}), (1+\dim(S_l))\right)$$

and S_t denote the blocks of S, while $\hat{A}_{l,OLS}$ correspond to the blocks of $\hat{A}_{OLS}$ … and in **line with the literature on TVP-VAR**

Data and estimation strategy

- Estimation – simulate the distribution of the parameters of interest, given the data => ***Gibbs sampling***, carried out in steps:

1. Initialize B^T, A^T, Σ^T, V
2. Draw the time-varying VAR coefficients B^T
3. Draw the simultaneous relations A^T
4. Draw the volatilities Σ^T
5. Draw the hyperparameters of V
6. Go back to step 2

Conditional ***on the data*** and ***the rest of the parameters***.

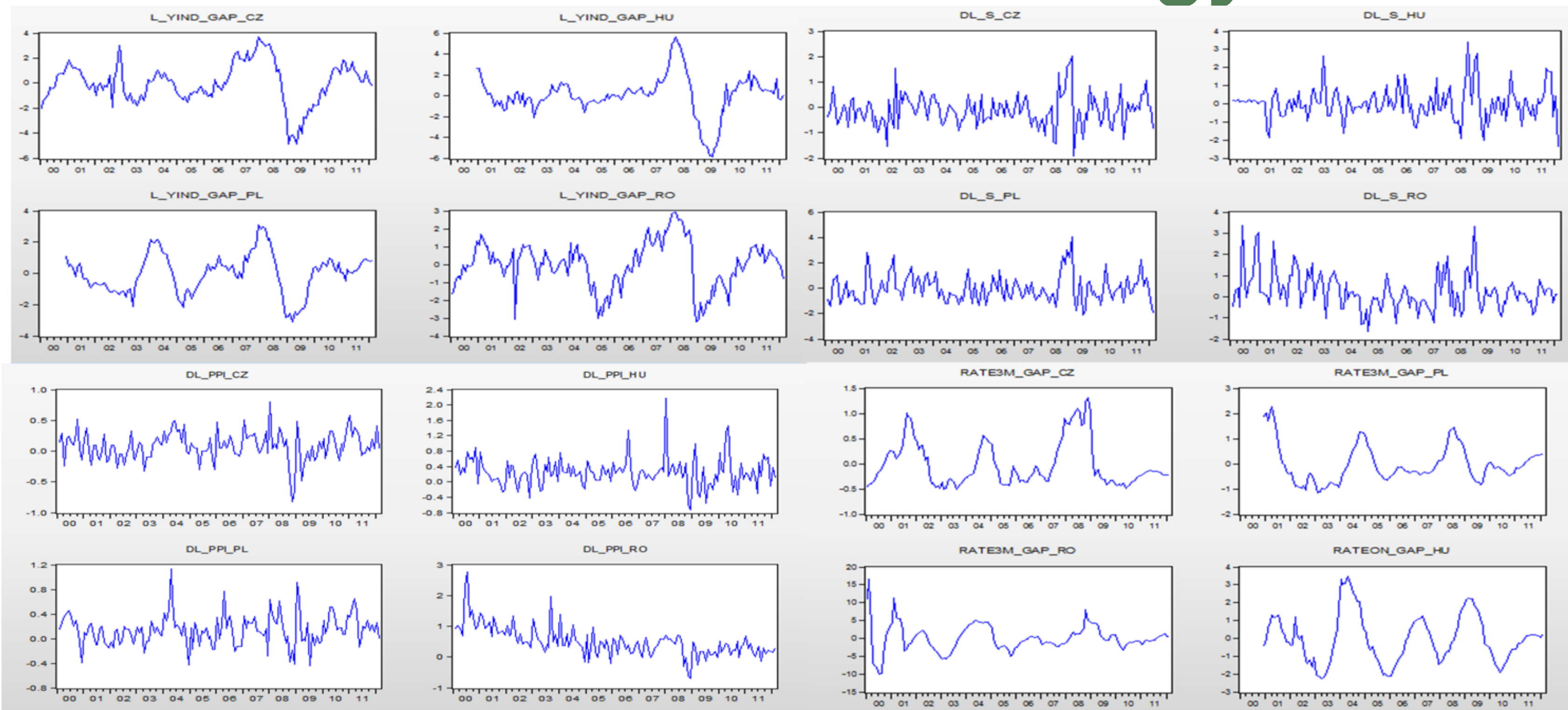
Matlab code used in the estimation is the one adapted after Koop and Korobilis:
http://personal.strath.ac.uk/gary.koop/bayes_matlab_code_by_koop_and_korobilis.html

Data and estimation strategy

- Monthly data used on the range 2000M01-2012M02; All data, except for interest rates, were transformed into logarithms and multiplied by 100 (so that detrended variables and first differences are expressed in percentage points);
- For the industrial production and short-term interest rate, filtered data was used – stationarity assumption implied by construction
- Data source: Eurostat

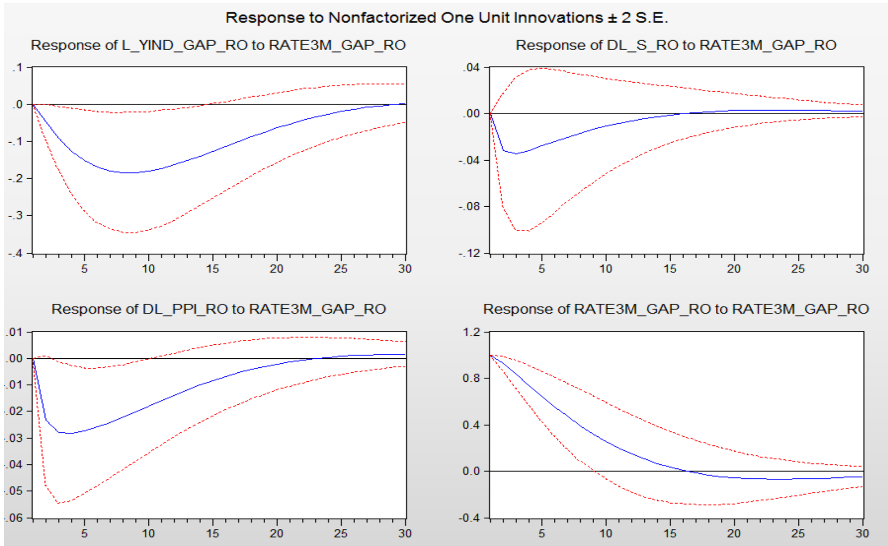
Variables	Data handling
Industrial production	Re-fixed base 2000M01; data transformed in logarithms and filtered – I(0)
PPI index	Re-fixed base 2000M01; data transformed in logarithms; the first difference was used – I(0)
3M Rate (RO,CZ,PL)	Filtered data – I (0)
ON Rate (HU)	Filtered data – I (0)
Bilateral exchange in relation to the euro	Data transformed in logarithms; the first difference was used – I(0) (- shows an appreciation / + shows a depreciation of the national currency)

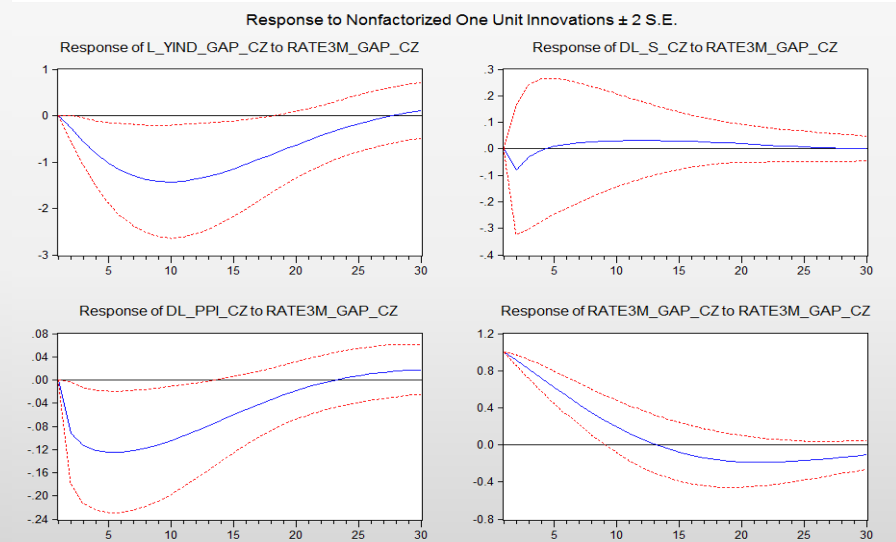
Data and estimation strategy

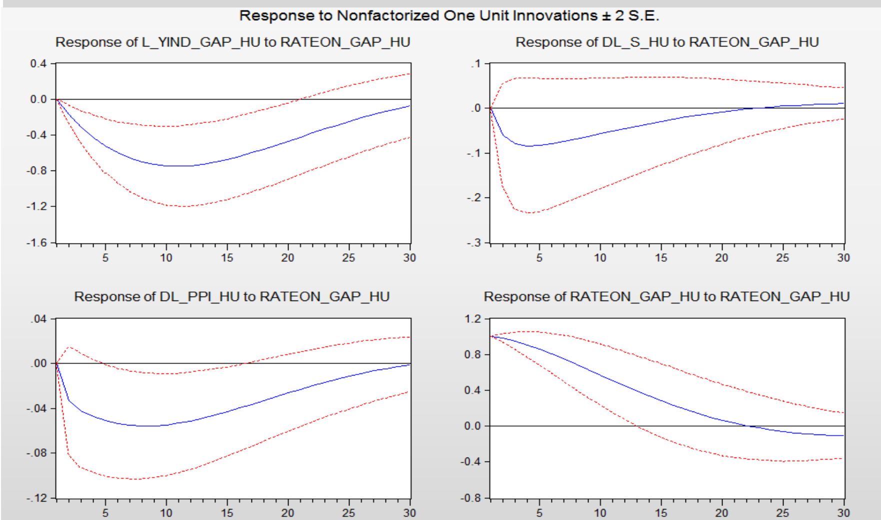


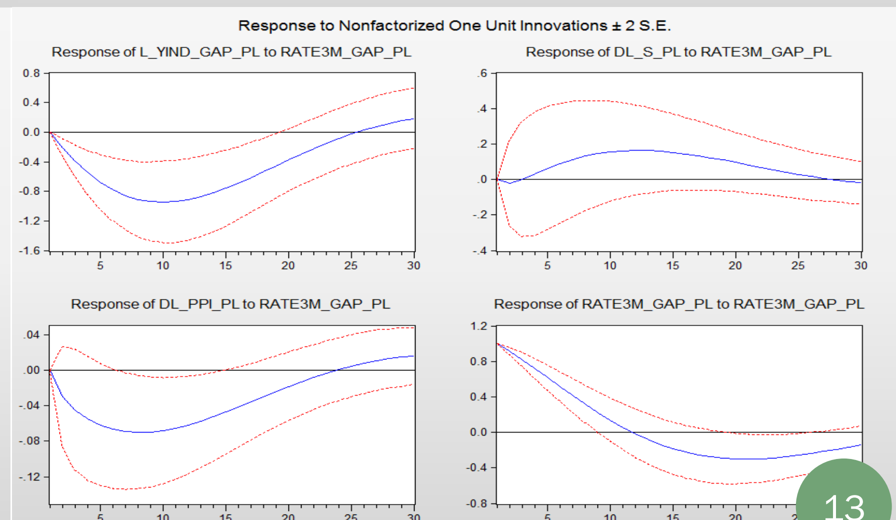
1. Time invariant-framework – OLS VAR
2. Rolling window estimation – OLS VAR, subsamples of 86 obs. each
3. Time-varying framework – Gibbs sampling for state-space models; 140 000 draws for RO and 70 000 draws for CZ,HU,PL

Results – Responses to a one unit monetary policy shock









Results – Responses to a one unit monetary policy shock

- VAR estimated with OLS - time invariant framework

Country	Variable	Maximum Impact	Horizon	Estimation Range	MP shock
Romania	l_yind_gap_ro dl_ppi_ro dl_s_ro	-0,18 – 8M-9M -0,028 – 4M - Not significant	1M-14M 2M-10M	2003M01-2012M02	Fades out in about 9M
Czech Republic	l_yind_gap_cz dl_ppi_cz dl_s_cz	-1,4 -10M -0,125 -5-6M - Not significant	1M-18M 2M-13M	2000M01-2012M02	Fades out in about 9M
Hungary	l_yind_gap_hu dl_ppi_hu dl_s_hu	-0,75 – 10-11M -0,056 – 7-8M -Not significant	1M-21M 4M-17M	2000M12-2012M02	Fades out in about 13M
Poland	l_yind_gap_pl dl_ppi_pl dl_s_pl	-0,95 –10M -0,07– 8-9M -Not significant	1M-19M 5M-16M	2000M12-2012M02	Fades out in about 9M

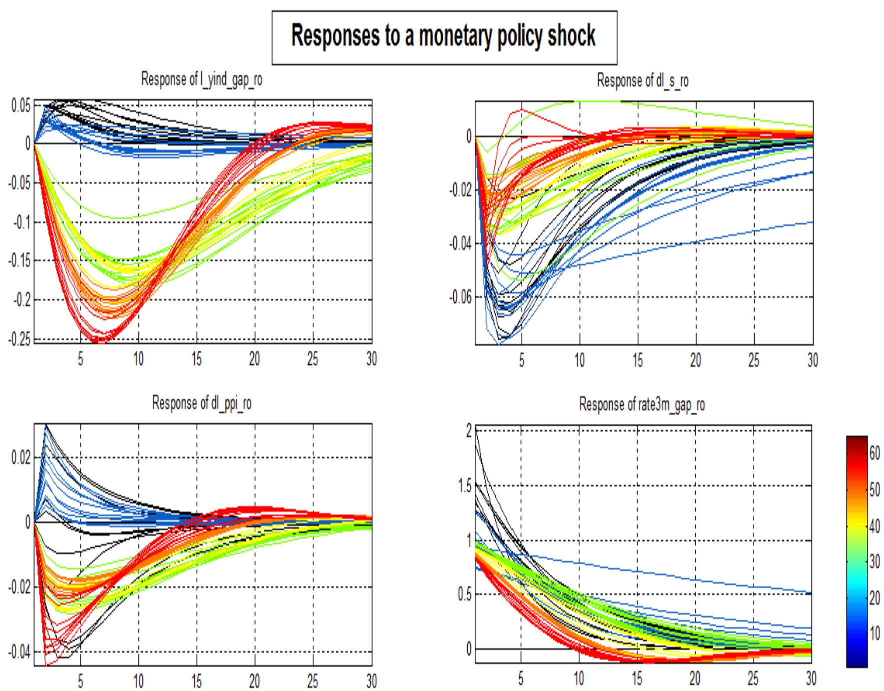
Results – Rolling window estimations

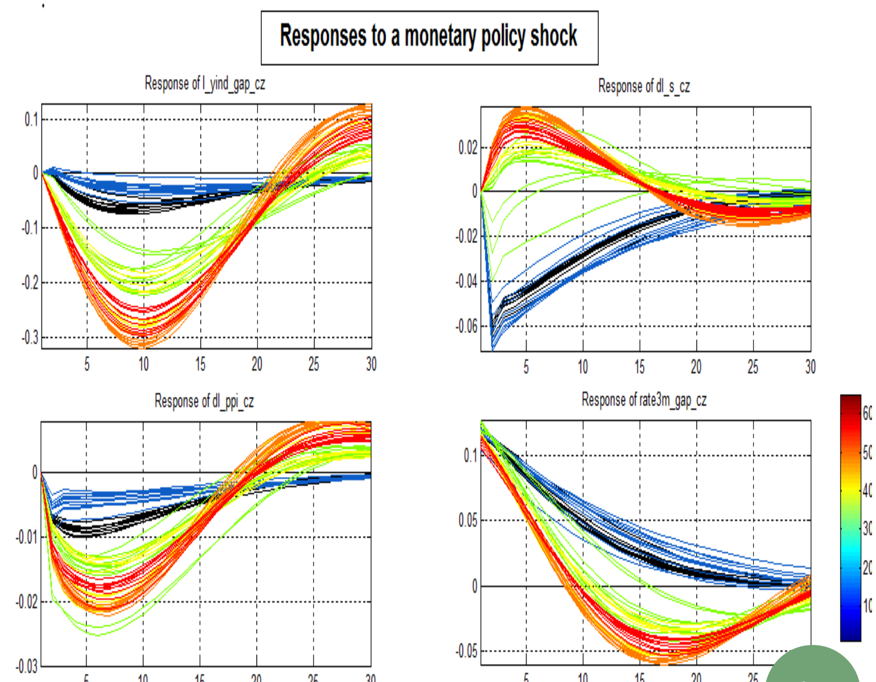
Romania ***Czech Republic***

60 rolling windows (86 observations each)

2000M02-2007M03 …

… 2005M01-2012M02





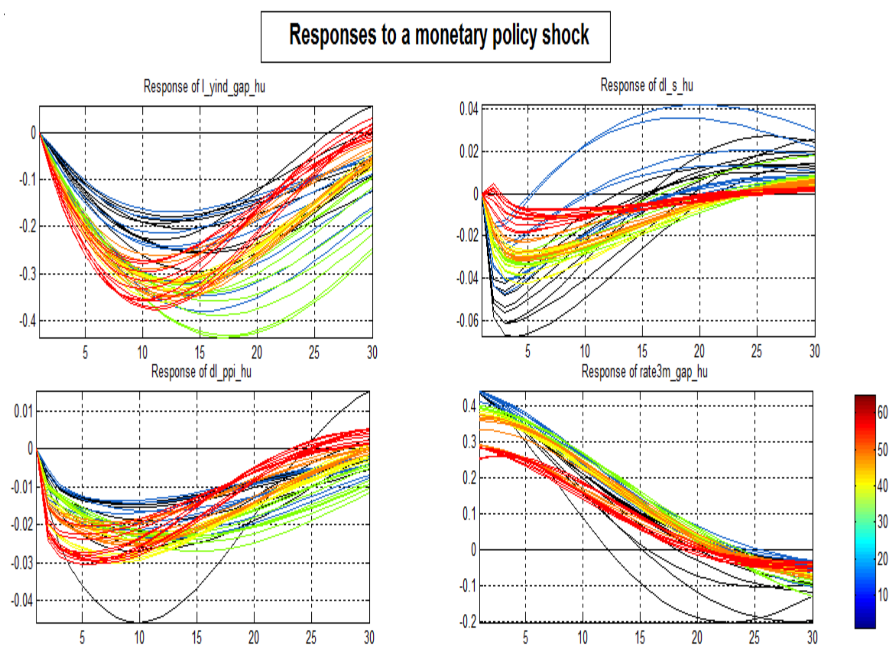
Results – Rolling window estimations

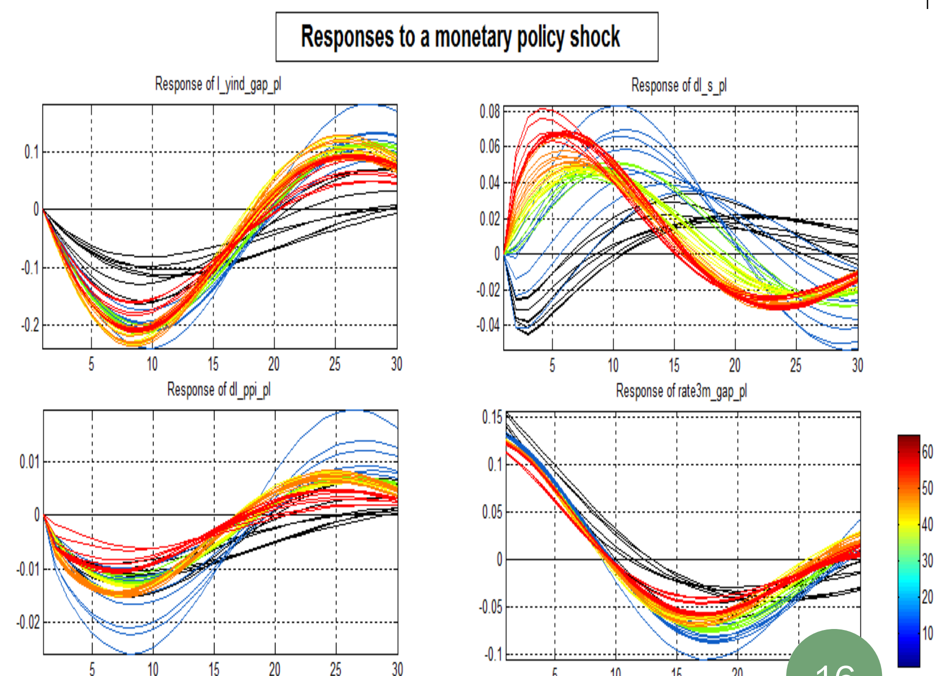
Hungary ***Poland***

50 rolling windows (86 observations each)

2000M12-2008M01 …

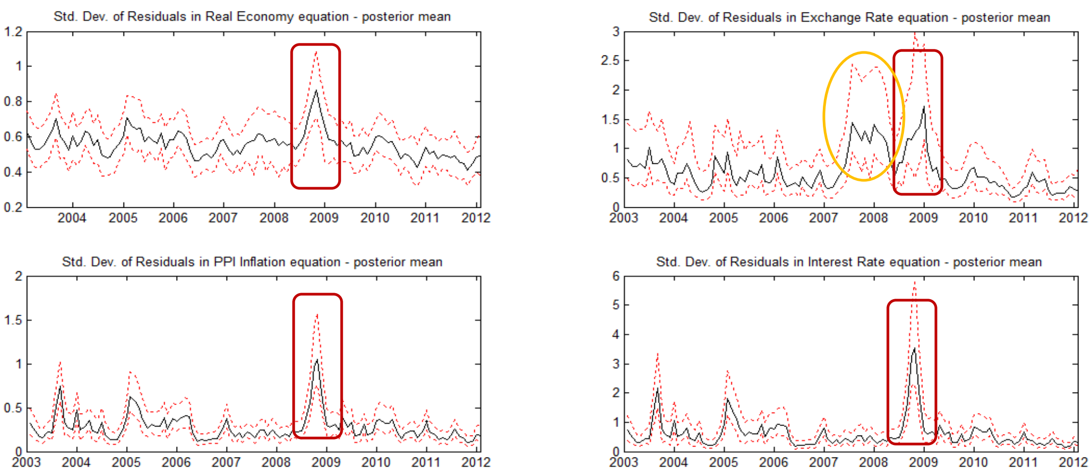
… 2005M01-2012M02

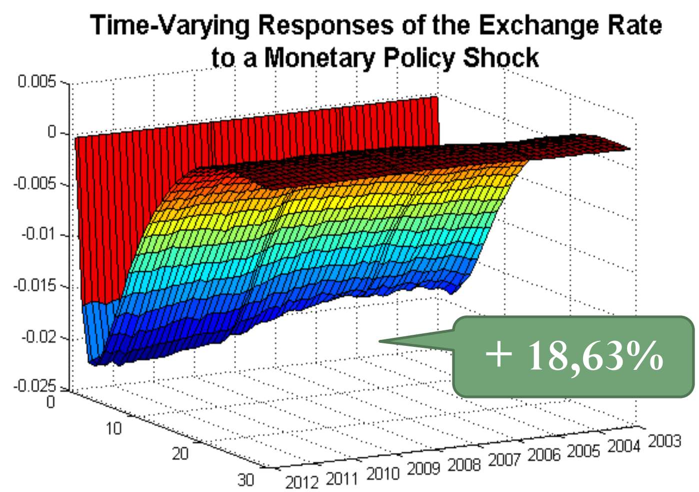


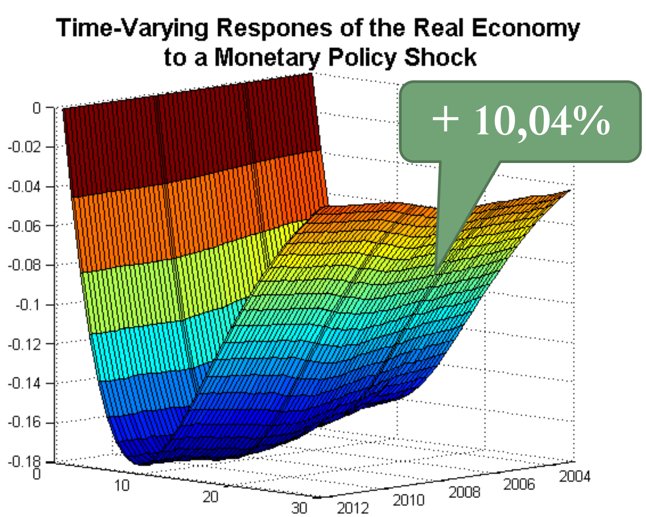


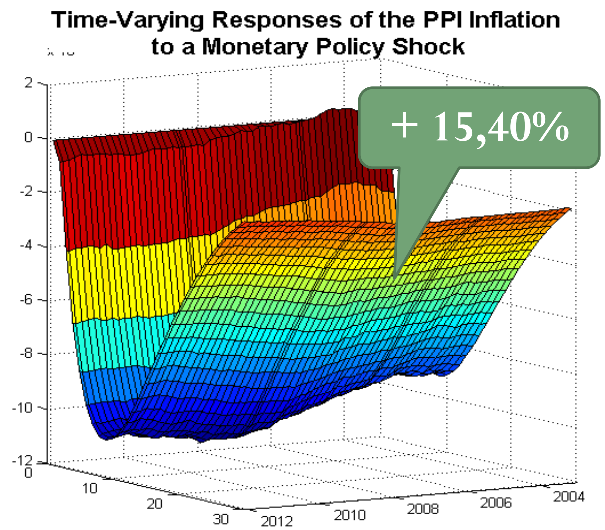
Results – Time varying-parameter VAR

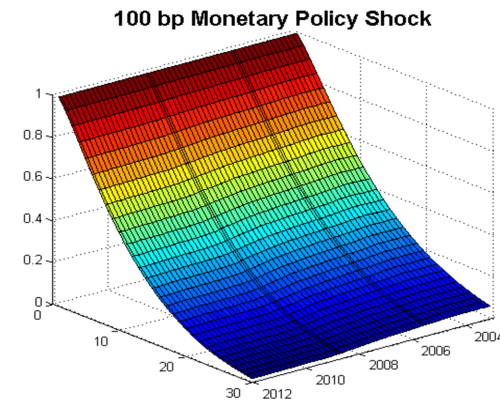
- **Romania** – 140 000 draws (K_Q=0.05, K_S=0.025, K_W=0.01)





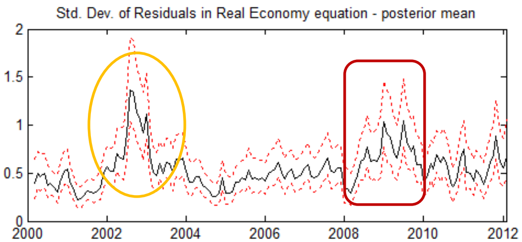


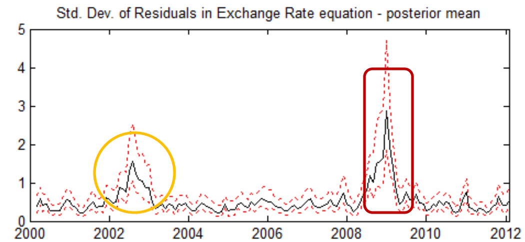


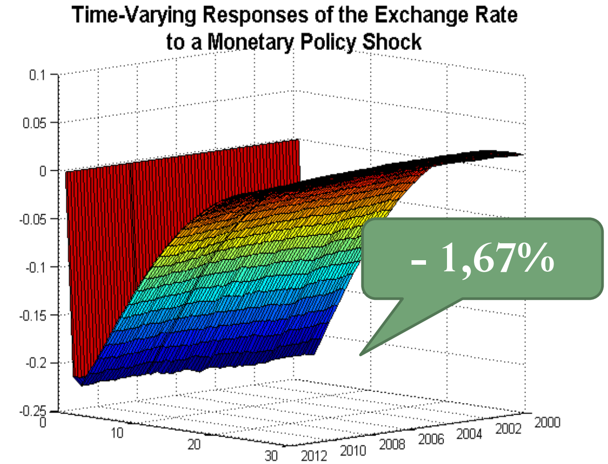


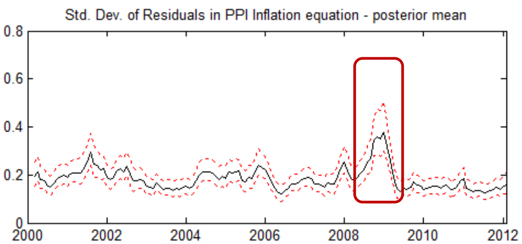
Results – Time varying-parameter VAR

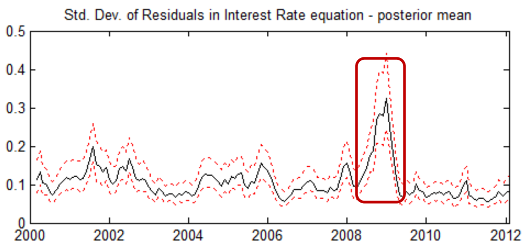
- **Czech Republic –** 70 000 draws (K_Q=0.05, K_S=0.025, K_W=0.01)

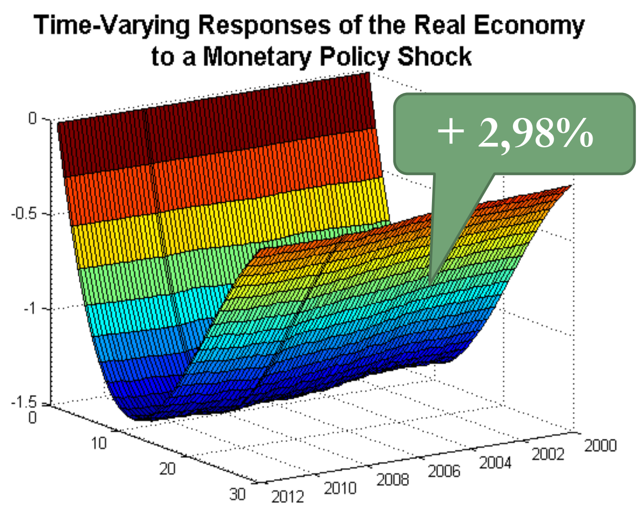


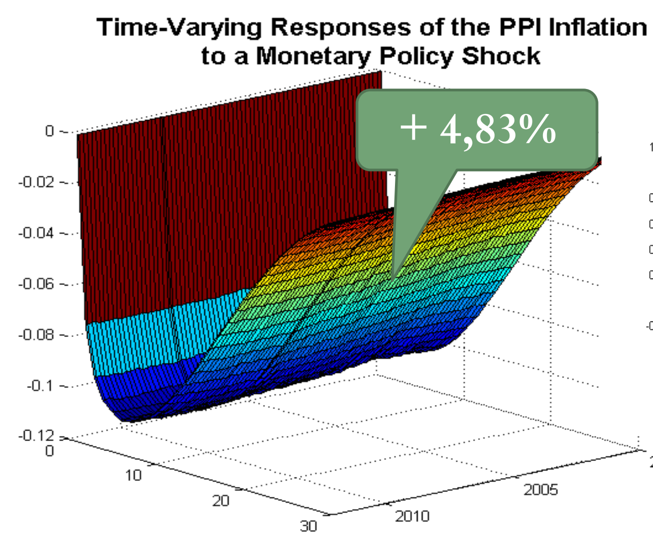


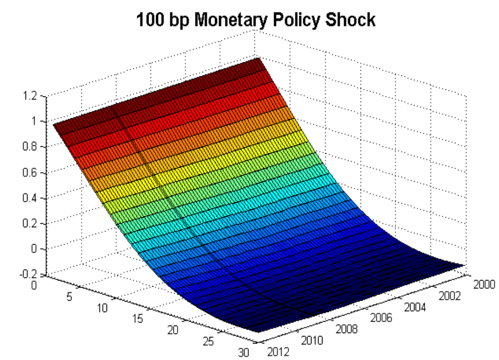






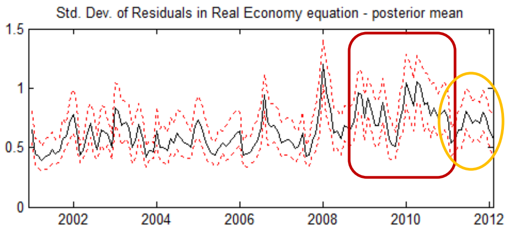


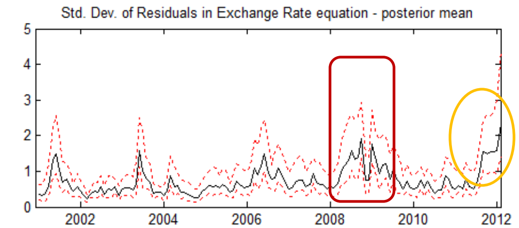


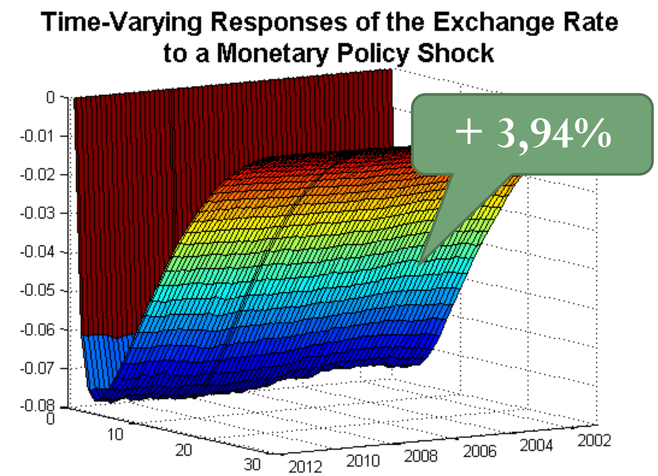


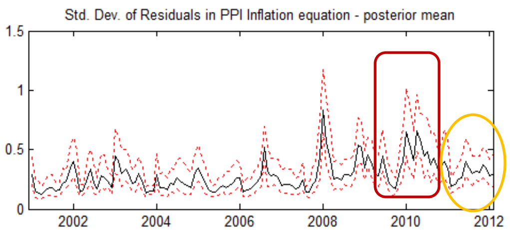
Results – Time varying-parameter VAR

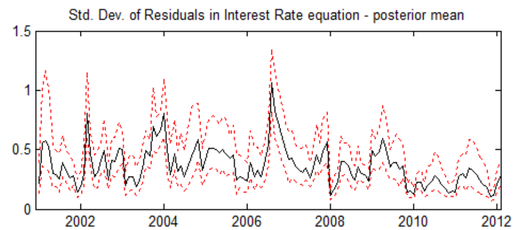
- **Hungary** - 70 000 draws (K_Q=0.05, K_S=0.025, K_W=0.01)

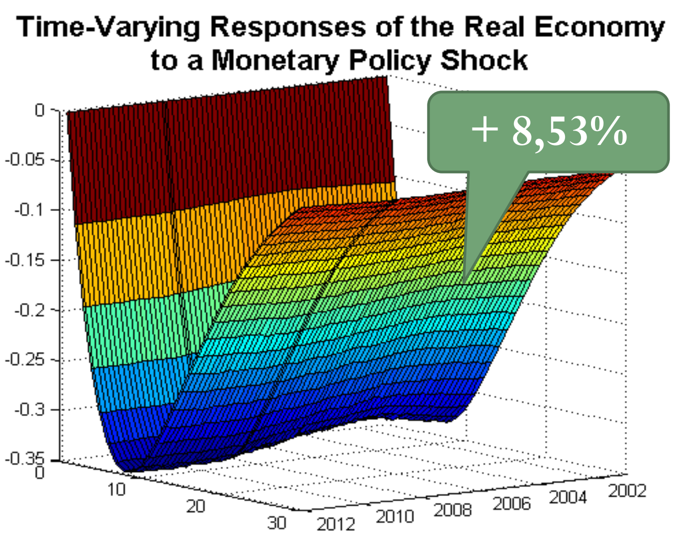


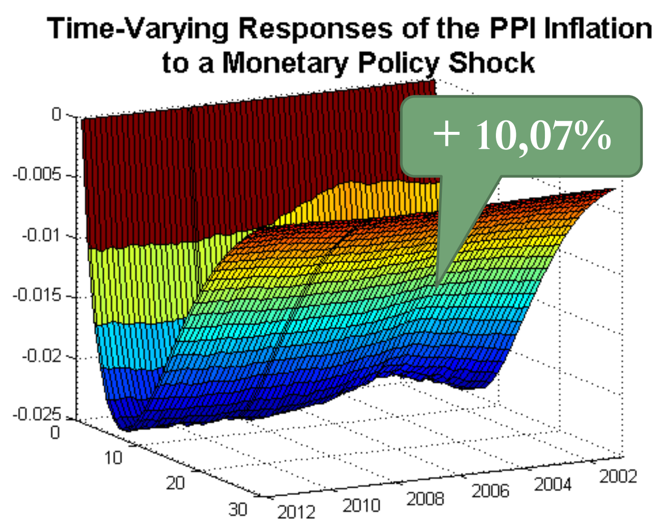


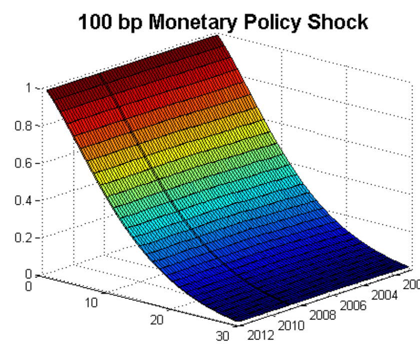






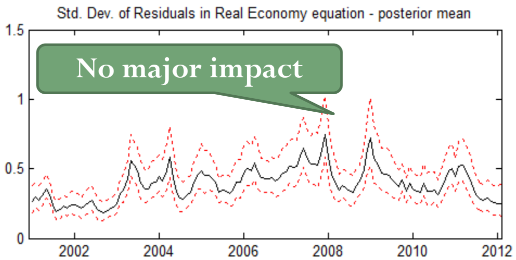


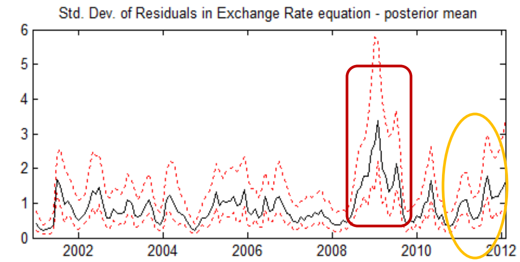


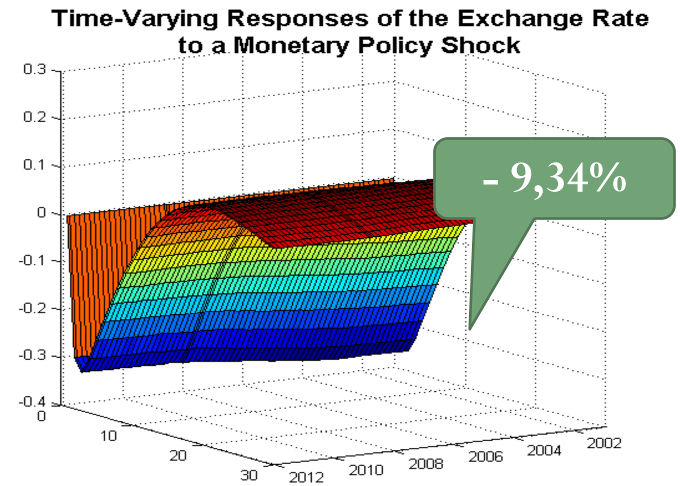


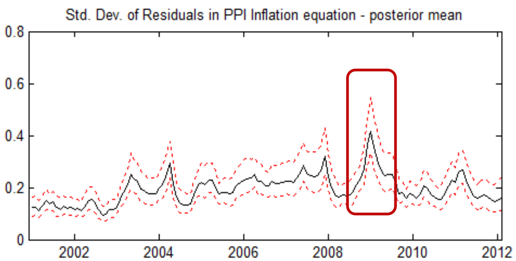
Results – Time varying-parameter VAR

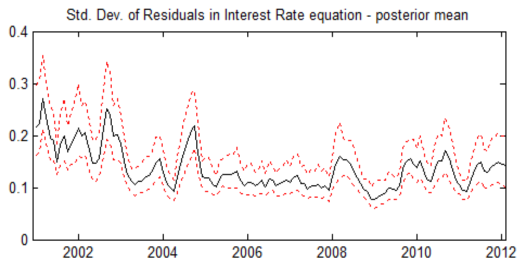
- **Poland** - 70 000 draws (K_Q=0.05, K_S=0.025, K_W=0.01)

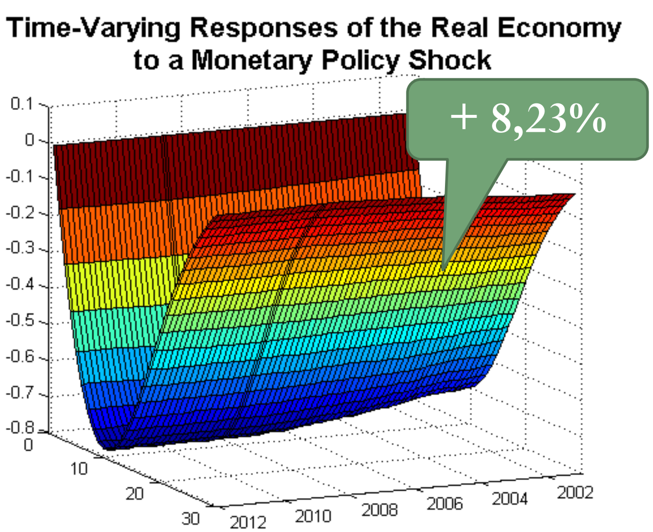


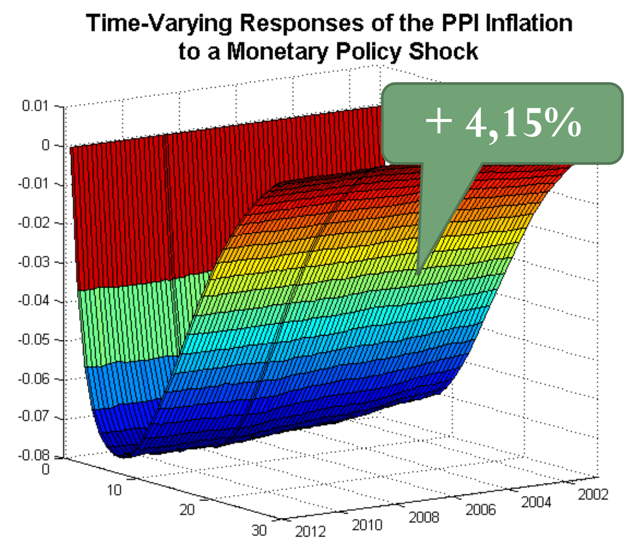


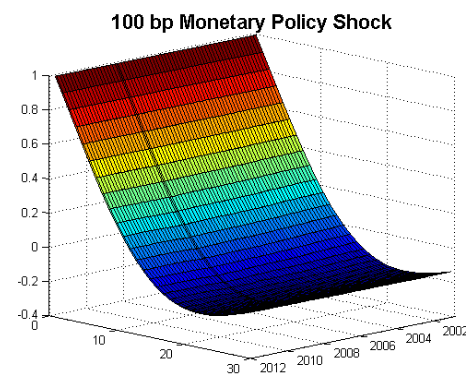












Results – Other empirical studies

	Country	Methodo-logy	TV MPTM	TV volatility	Cross-country results
Boivin and Giannoni (2002) Boivin *et.al* (2010)	US	Subsamples	Yes; $\downarrow$ responsiveness Since the 1980s	Not so much	-
Cogley and Sargent (2003)	US	TVP-VAR	Yes, but lower than in homosced. fr.	Yes	-
Primiceri (2005)	US	TVP-VAR	Not so much	Yes	-
Canova and Gambetti (2009)	US	TVP-VAR	Quite stable after 1980	Yes	-
Rubio-Ramirez *et.al.* (2005)	euro area	MS VAR	No. Stable since 1993	Yes	Area-wide model
Ciccarelli and Rebucci (2006)	euro area	two-stage: TR, TVP-VAR	$\downarrow$ with 10-20% after 1991	Homosced. shock	Country diff. have not changed
Darvas (2009)	NMS	TVP-VAR	Yes; $\uparrow$ responsiveness	Yes	MPTM is similar Price puzzle
Franta *et.al* (2011, 2012)	Czech Republic	TVP-VAR	Yes; $\uparrow$ responsive-ness until the crisis	Yes	-
Nakajima (2011)	Japan	TVP-VAR	Yes; $\downarrow$ responsiveness	Yes	-

Conclusions

- ***Impulse-response functions are similar when it comes to signs and shapes.*** However, there are ***differences in the magnitudes and in the timing*** of the responses, probably related to the transparency and credibility of the monetary policy authority, as well as the overall development of the economy.
- The responses of prices are in line with the economic theory of price stickiness
- The length of the responses of the real economy and inflation to a monetary policy shock are in line with targeting horizon assumed by the monetary authorities (CZ -12-18M, Medium term for the others)
- ***Rolling window estimations indicate an increasing responsiveness of the real economy and prices*** due to a monetary policy shock, as we come closer to present times
- As pointed out by Cogley and Sargent (2003), Primiceri (2005) and Nakajima (2011), overlooking heteroscedasticity of shocks might generate false dynamics of the VAR coefficients…

… thus, here also the time-varying parameter analysis shows a gradual increase in the responsiveness of prices and industrial production, but not as much as the one indicated by the rolling window estimation.

Conclusions

- ***The volatility of residuals from the VAR equations exhibit quite high time variation.*** Regarding the evolution of the volatilities of innovations we can identify both regional (the economic and financial crisis that started at the end of 2008) and national spikes (internal economic drivers).
- ***Regarding the changes in the MPTM,*** the Czech Republic shows only slightly increased responsiveness, while bigger changes have affected the Polish and Hungarian economy.
- The biggest changes in the MPTM have been observed in the Romanian economy, facing the transition between two monetary policy regimes during the analysed period
- ***Another important finding is that the crisis, does not seem to have reduced the effectiveness of the monetary policy transmission mechanism*** by causing a decrease in the responsiveness of the variables under study, but has rather stopped increased responsiveness where it was manifested.

Thank you for your attention!

Selective References

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