Academy of Economic Studies
Doctoral School of Finance and Banking

Identifying the effects of monetary policy shocks using Factor Augmented VAR

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Aims of the thesis

- To asses the effects of monetary policy shocks on the wide range of Romanian macroeconomic variables
- To compare FAVAR results to those obtained by using a small scale VAR
- Model robustness to changes in the number of unobservable factors and VAR variables.
- Conclusions , possible drawbacks and improvements

Literature review

- Stock and Watson (1999) – showed that dynamic factors explain much of the predictable variation in major macroeconomic variables and outperform forecasting accuracy of the standard autoregression approach

- Bernanke, Boivin, Eliasz (2005) – combined VAR models with factor analysis to measure the effects of monetary policy in a „ data-rich" environment.

- Francesco Belviso and Fabio Milani (2005)– tried to asign a clear economic interpretation of the factors

- Mumtaz and Surico 2009 – extended FAVAR model to an open economy using both recursive and sign restriction (Uhlig 2005) identification methods.

ECONOMETRIC FRAMEWORK

Factor Augmented Vector Autoregressive model

$$\begin{bmatrix} f_t \\ y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} f_{t-1} \\ y_{t-1} \end{bmatrix} + v_t \qquad v_t \sim (0, Q)$$ – VAR part of the model

$$x_t = \lambda^f f_t + \lambda^y y_t + e_t \qquad e_t \sim (0, R)$$ – DFM part of the model

x_t – macroeconomic time series

f_t – unobservable factors

y_t – VAR variables (unobservable factors)

λ^f – factor loading associated to unobservable factors

λ^y – factor loading associated to observable factors

e_t, v_t – error terms

ECONOMETRIC MODEL

State space representation

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \lambda^f & \lambda^y \\ 0 & I \end{bmatrix} \begin{bmatrix} f_t \\ y_t \end{bmatrix} + \begin{bmatrix} e_t \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} f_t \\ y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} f_{t-1} \\ y_{t-1} \end{bmatrix} + v_t$$

$$X_t = \Lambda F_t + s_t \quad - \quad \text{measurement equation}$$

$$F_t = \Phi(L) F_{t-1} + u_t \quad - \quad \text{transition equation}$$

$$X_t = \begin{bmatrix} x_t \\ y_t \end{bmatrix} \quad F_t = \begin{bmatrix} f_t \\ y_t \end{bmatrix} \quad \Lambda = \begin{bmatrix} \lambda^f & \lambda^y \\ 0 & I \end{bmatrix} \quad s_t = \begin{bmatrix} e_t \\ 0 \end{bmatrix} \quad R = \begin{bmatrix} R_{ii} & 0 \\ 0 & 0 \end{bmatrix}$$

Data

- **Series:**
  - computed as the change from the corresponding month of the previous year
- **Sample length**
  - 138 observations
- **Frequency**
  - Monthly
- **Period**
  - 06.2003 – 12.2013
- **Variables**
  - 112 disaggregated macroeconomic variables
  - real activity , prices, interest rates, external trade.
- **Sources**
  - Eurostat , National Bank of Romania.

Estimation

The model was estimated under a **Bayesian framework** using **Gibbs Sampling** algorithm to approximate the marginal posterior distribution by sampling from conditional distributions.

- **Starting values:**

  - parameter estimates obtained from PCA estimation of DFM and VAR

- **Identification of shocks**

  - recursive method

- **Factor estimation**

  - Kalman filter

- **Number of lags used in estimation**

  - three

- **Number of iterations**

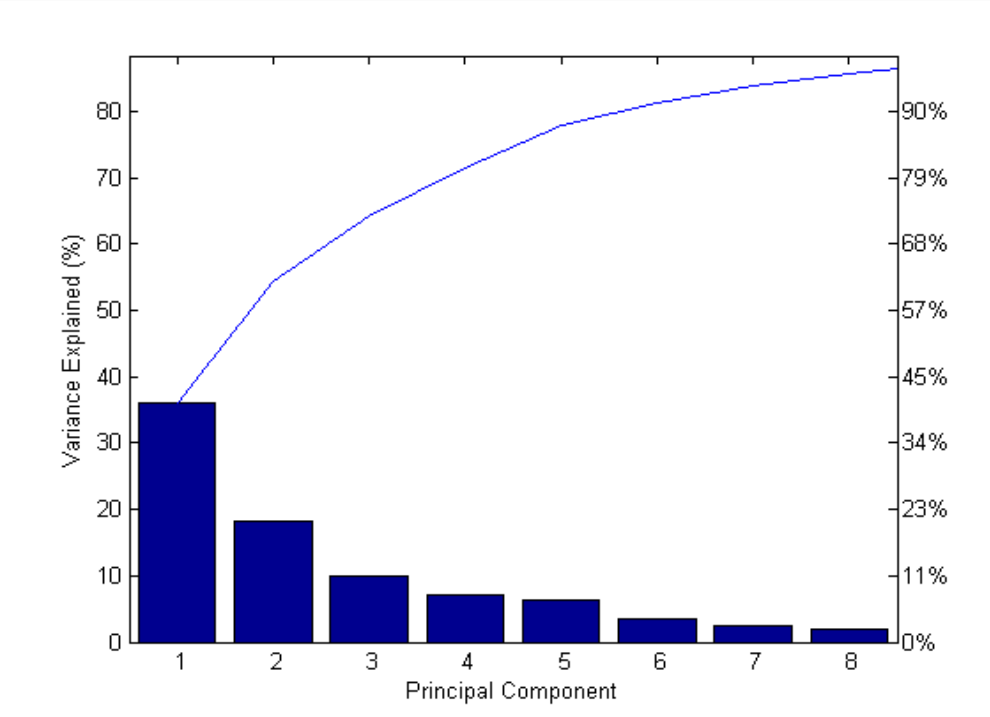
  - 10000 (discarding 5000)

- **Convergence test**

  - Geweke

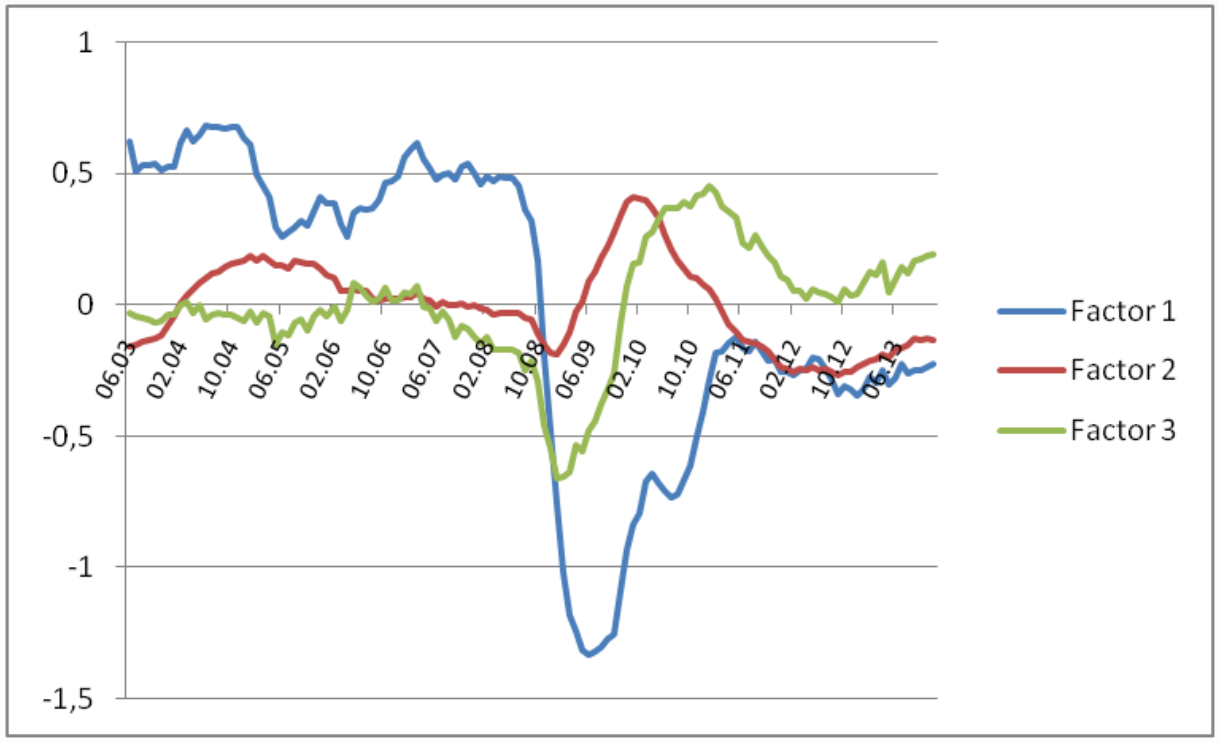
Empirical results

Figure 1. Cumulated share of variance explained by the first eight factors



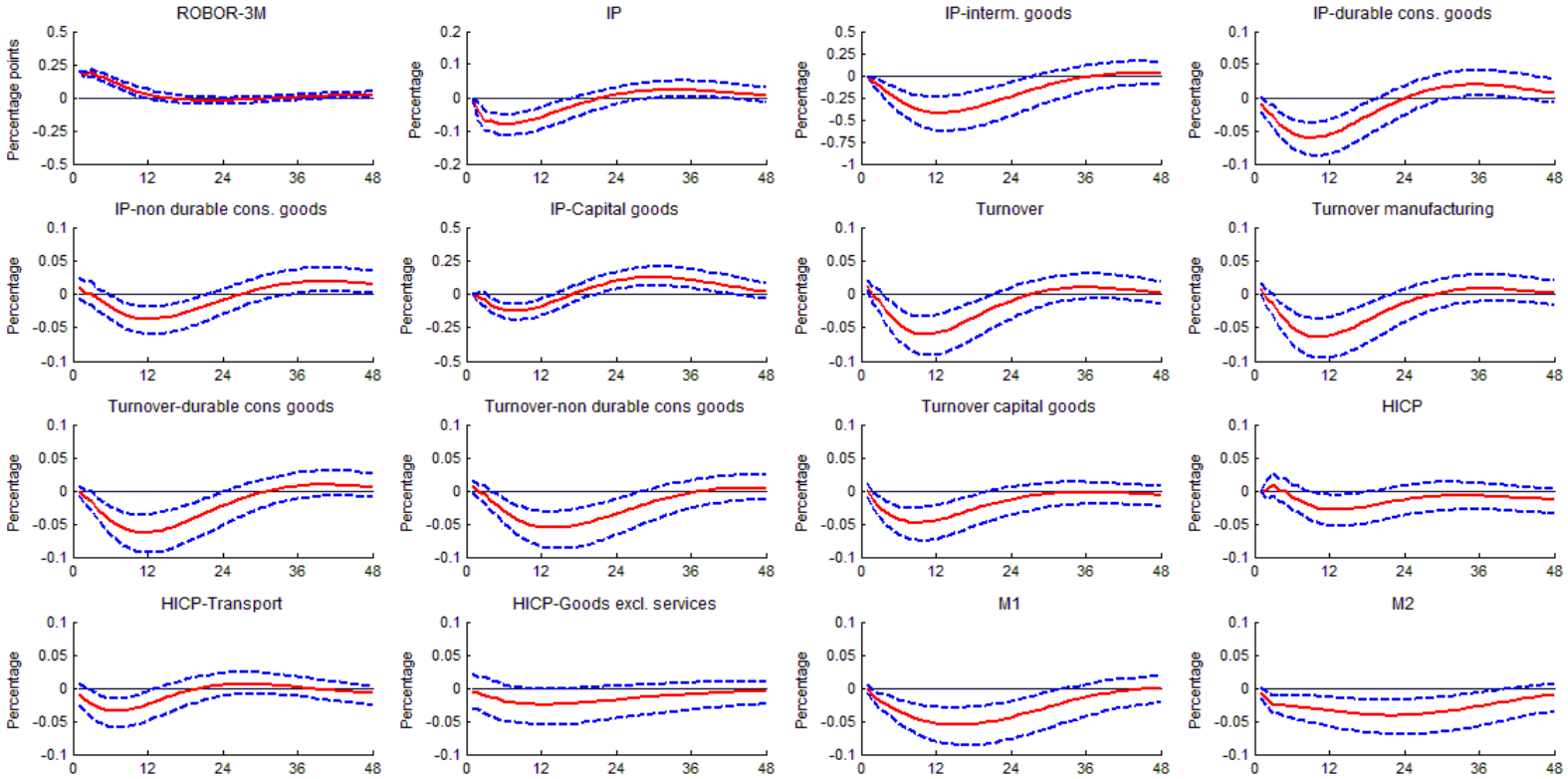
Empirical results

Figure 2. Gibbs sampling estimated factors



Empirical results 1

IRF to a positive monetary policy shock
K=3 , Y = (IP,HICP, ROBOR3M)

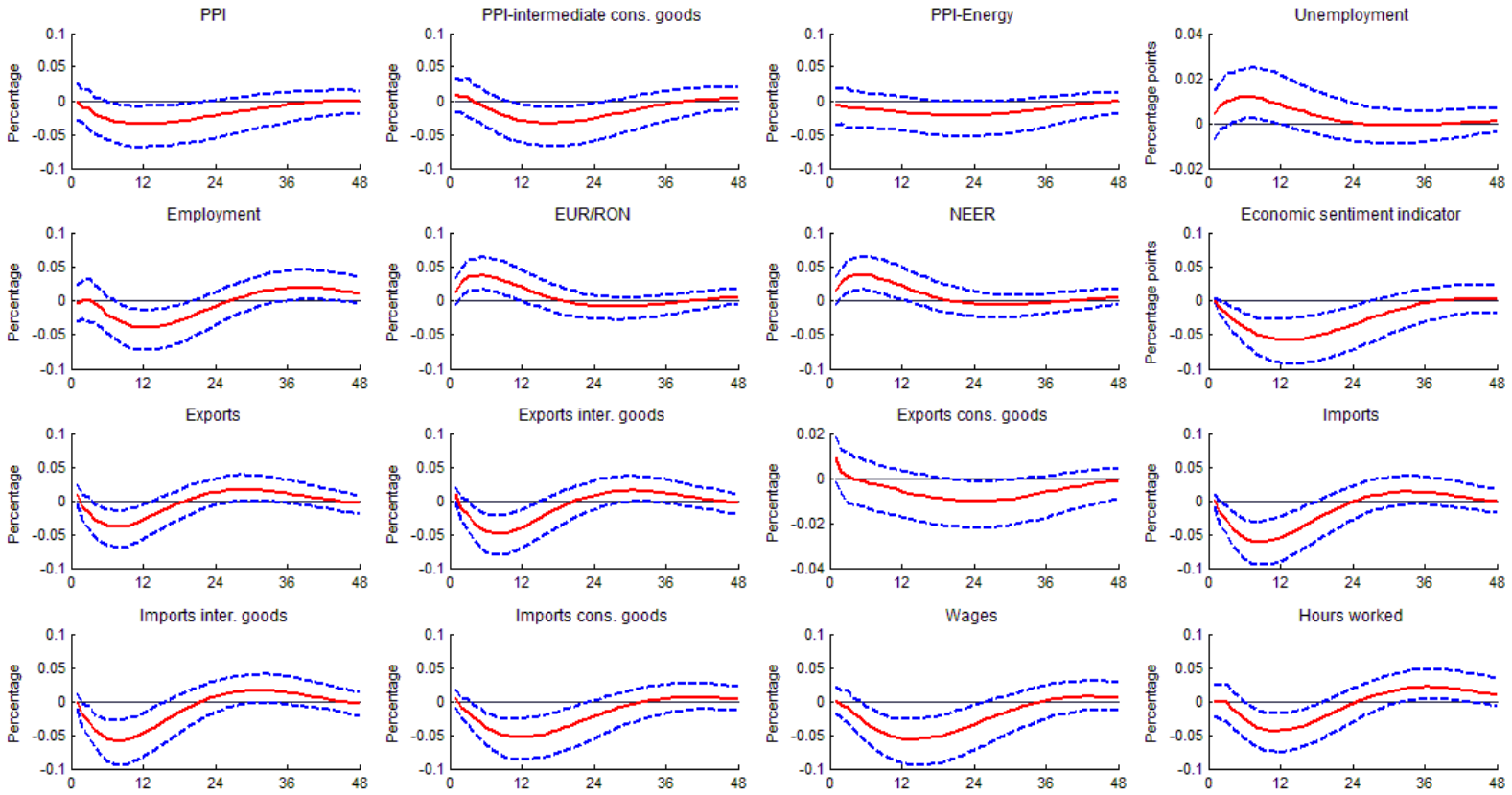


- The responses of the Industrial production, turnover, HICP decrease for all the sectors included in the model.
- The behavior of the industrial production is leaded by IP from Capital Goods sector.
- Monetary aggregates respond intuitively with a higher impact on the „narrow" money (M1)

Empirical results 2

IRF to a positive monetary policy shock

K=3 , Y = (IP,HICP, ROBOR3M)

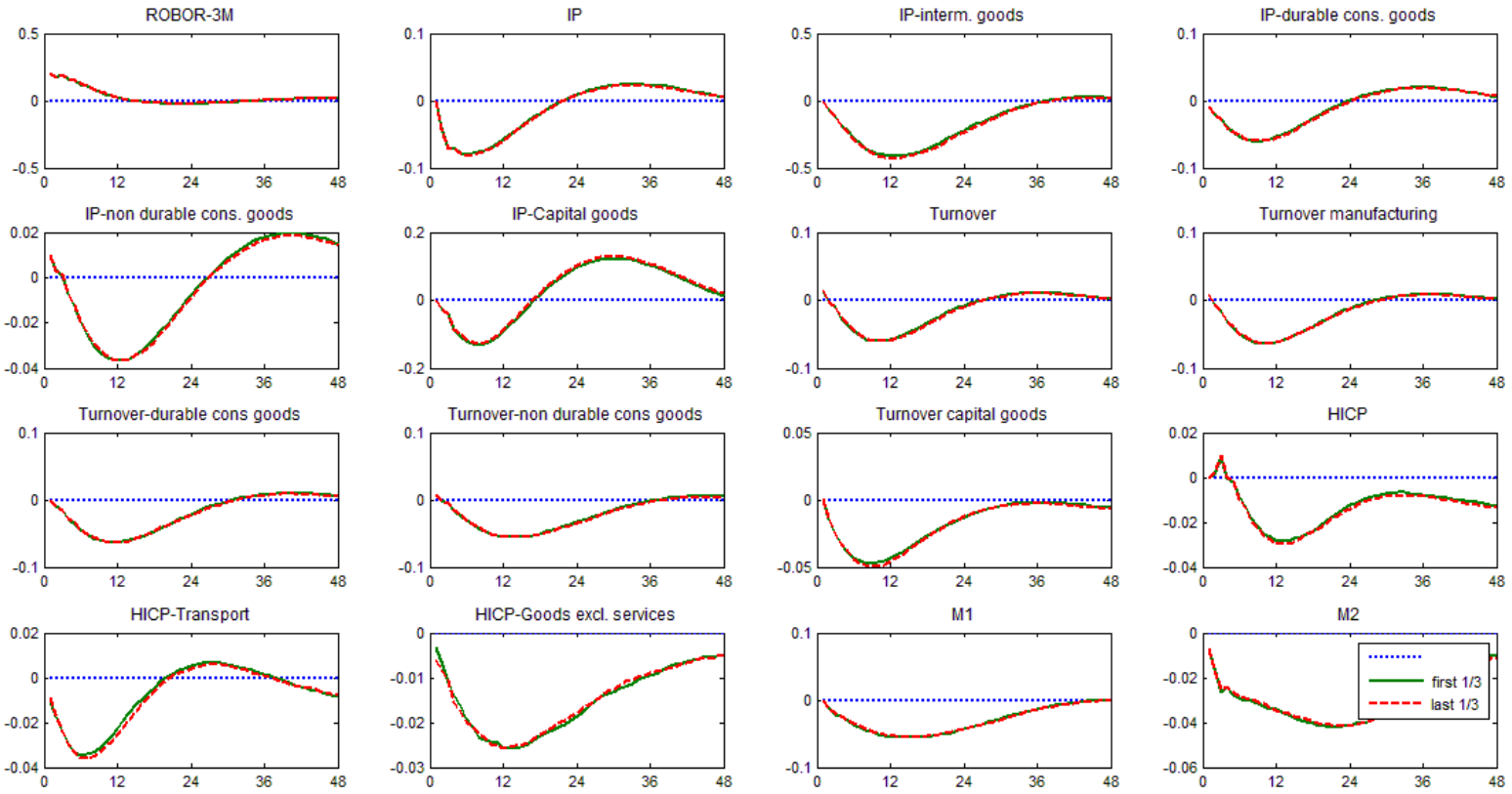


- The producer prices, employment, ESI, exports, employment decrease through all the sectors.
- The smallest impact on the PPI is occurred in energy sector.
- The exchange rate and imports response is not in line with the theory.

Empirical results 3

Convergence test

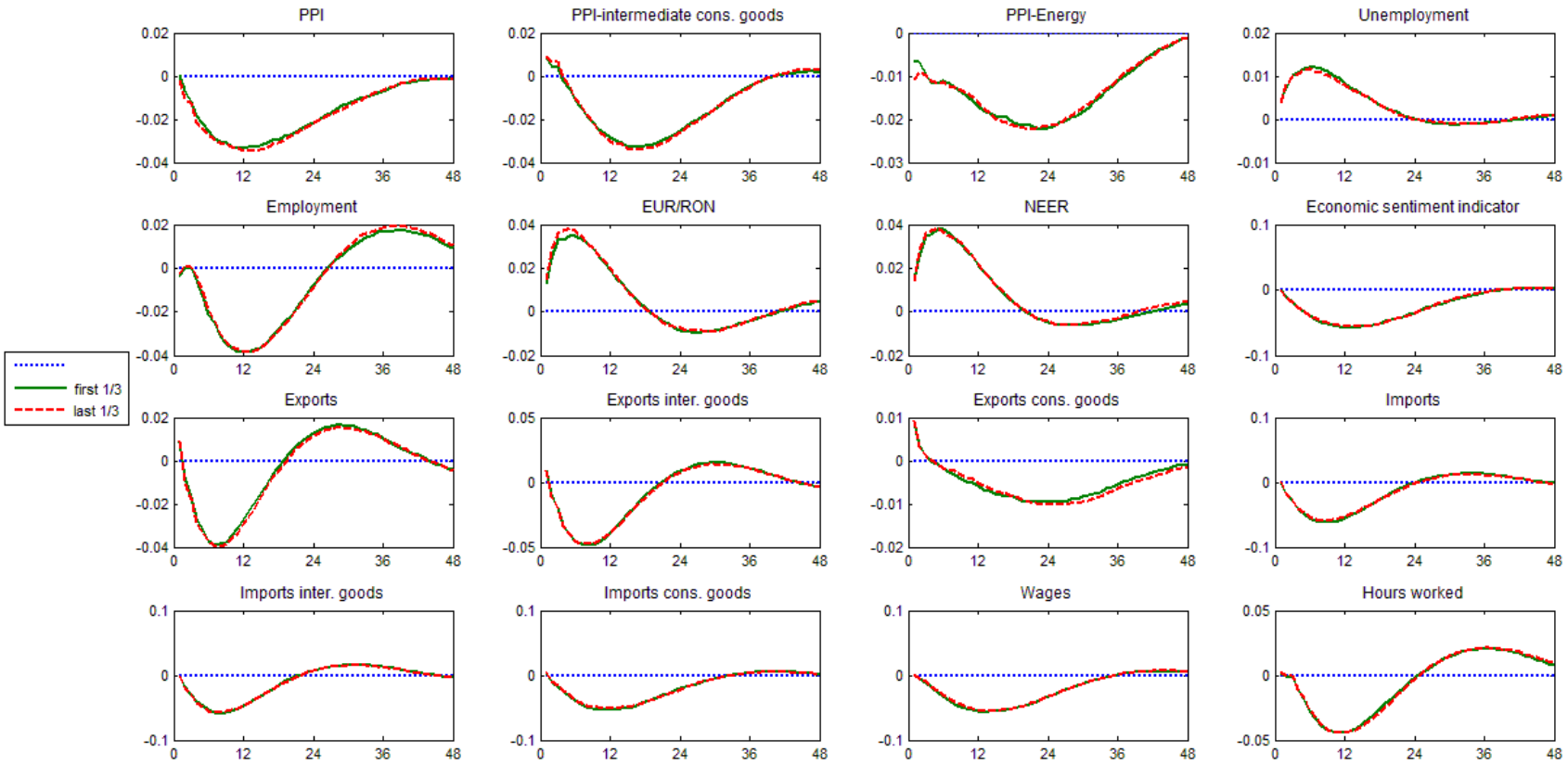
K=3 , Y = (IP,HICP, ROBOR3M)



Empirical results 4

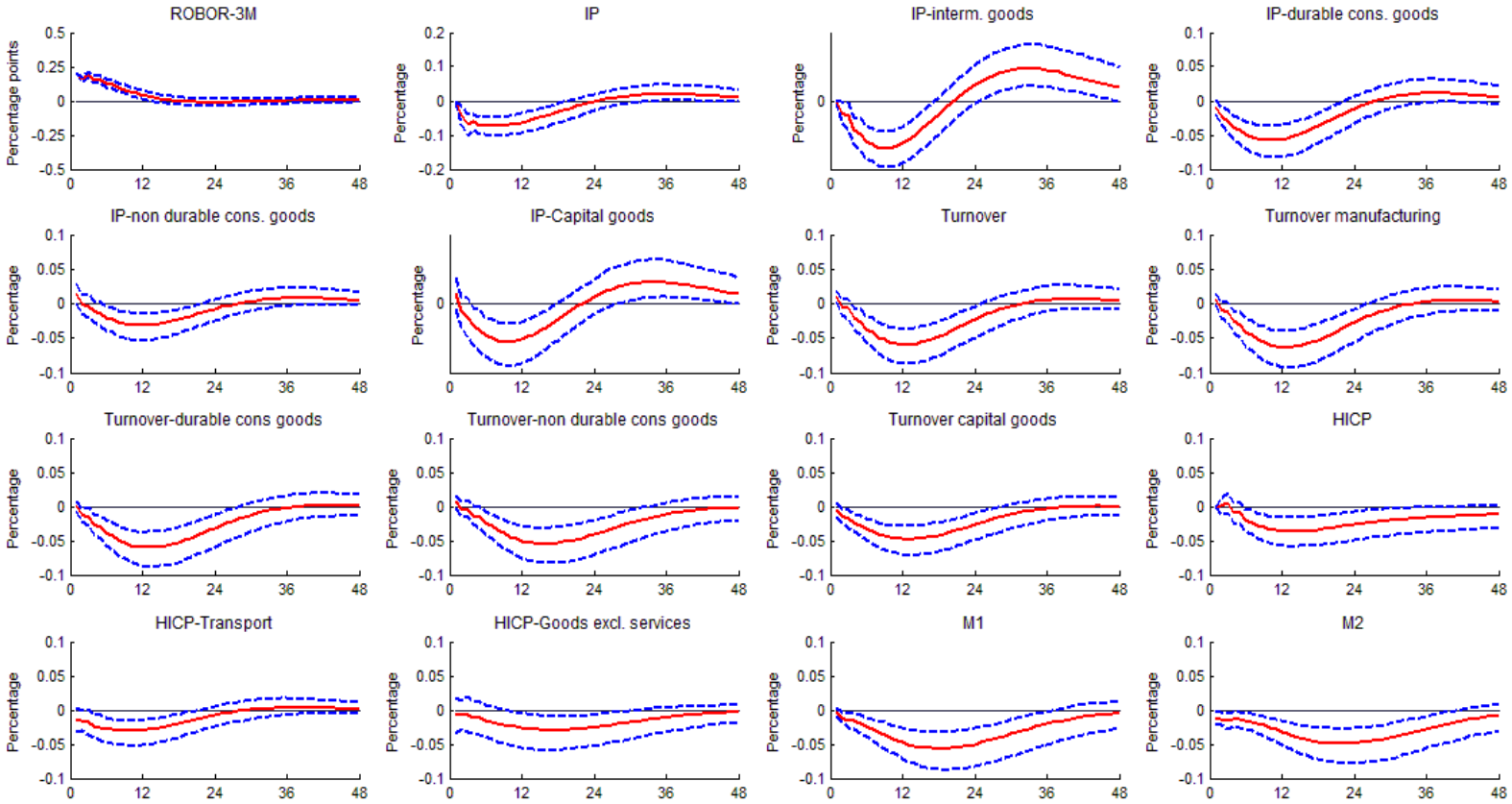
Convergence test

K=3 , Y = (IP,HICP, ROBOR3M)



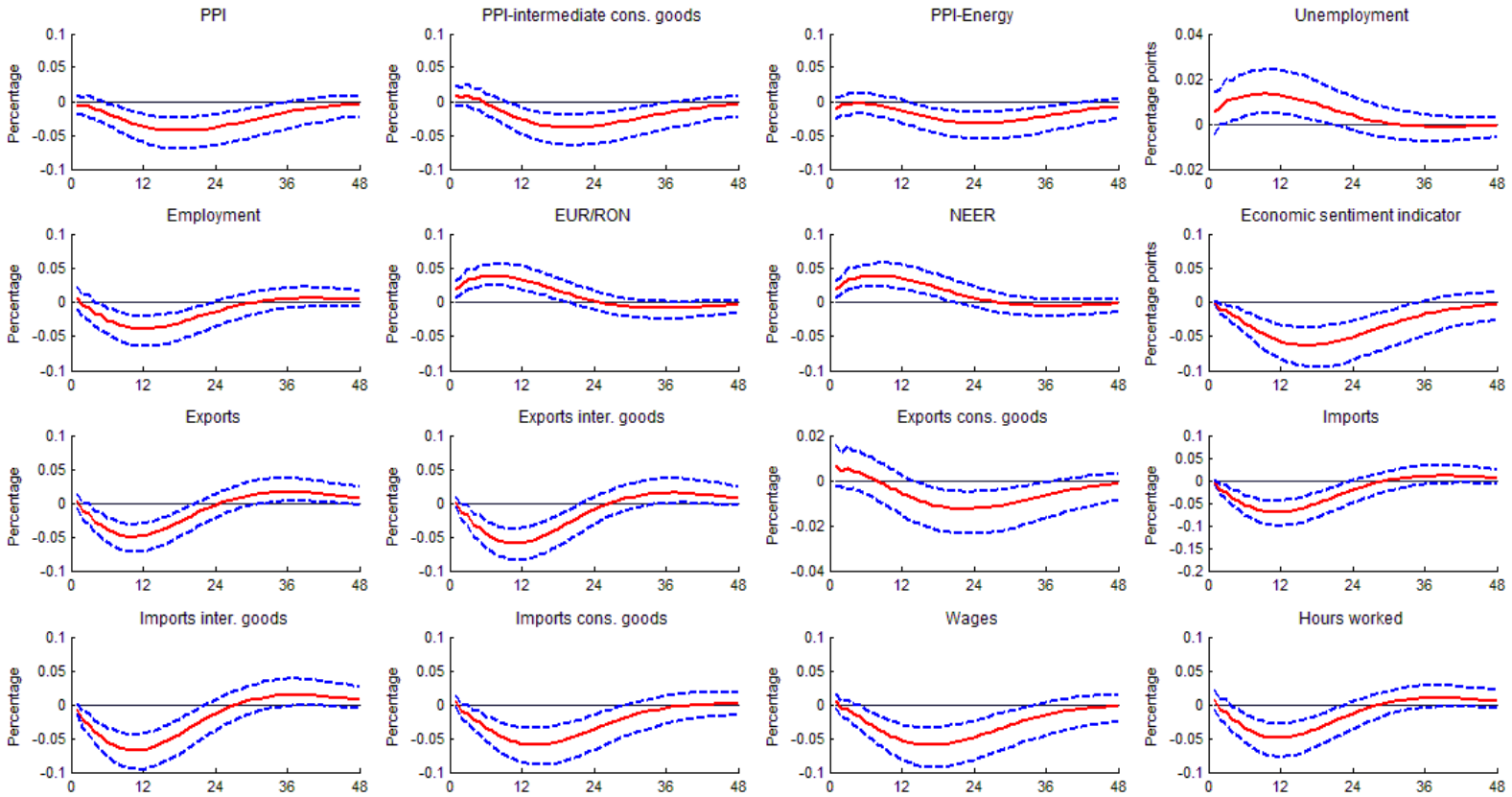
Robustness check

IRF to a positive monetary policy shock
K=2 , Y = (IP,HICP, ROBOR3M)



Robustness check

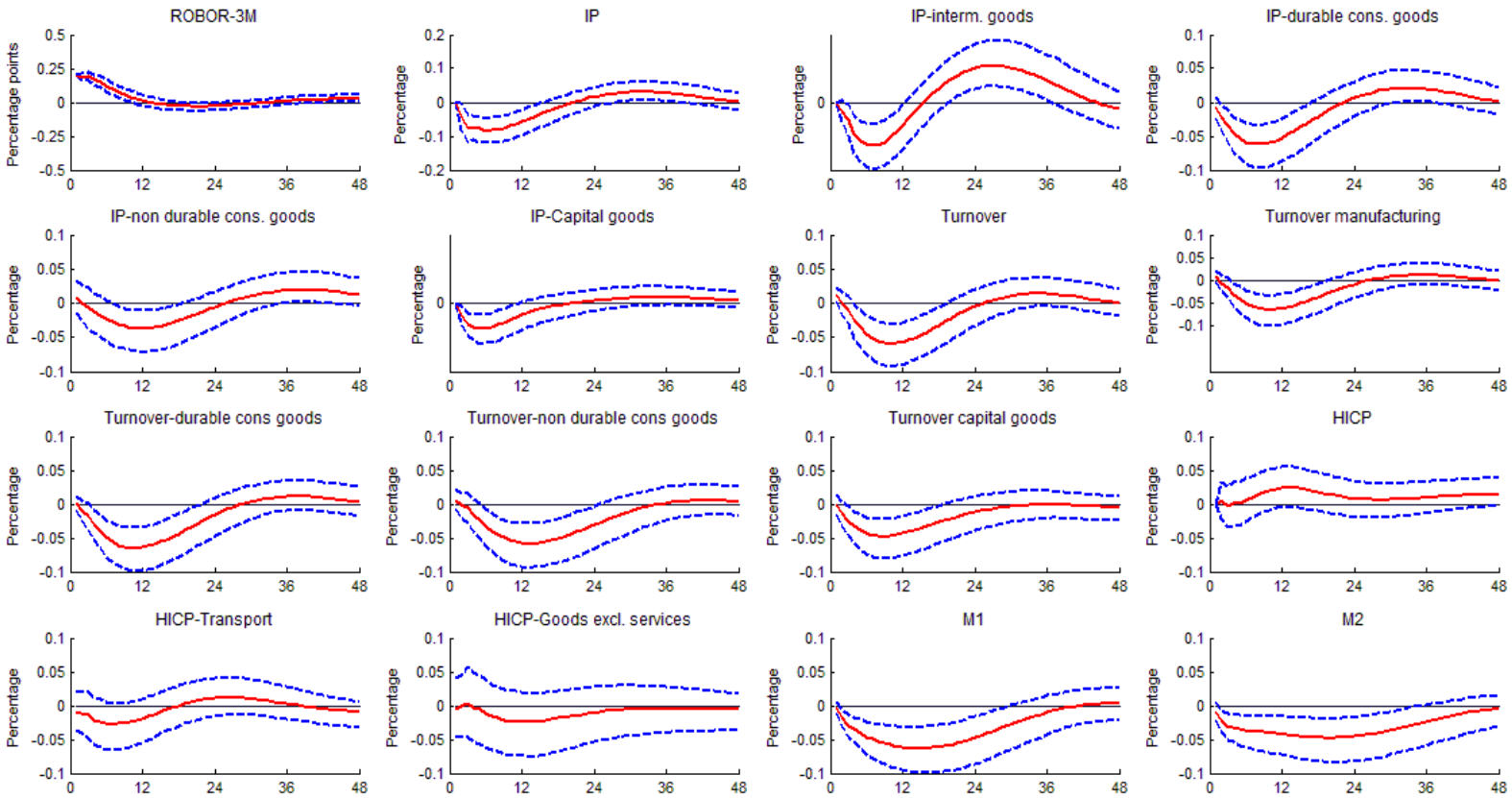
IRF to a positive monetary policy shock
K=2 , Y = (IP,HICP, ROBOR3M)



Robustness check

Impulse response to a positive monetary policy shock

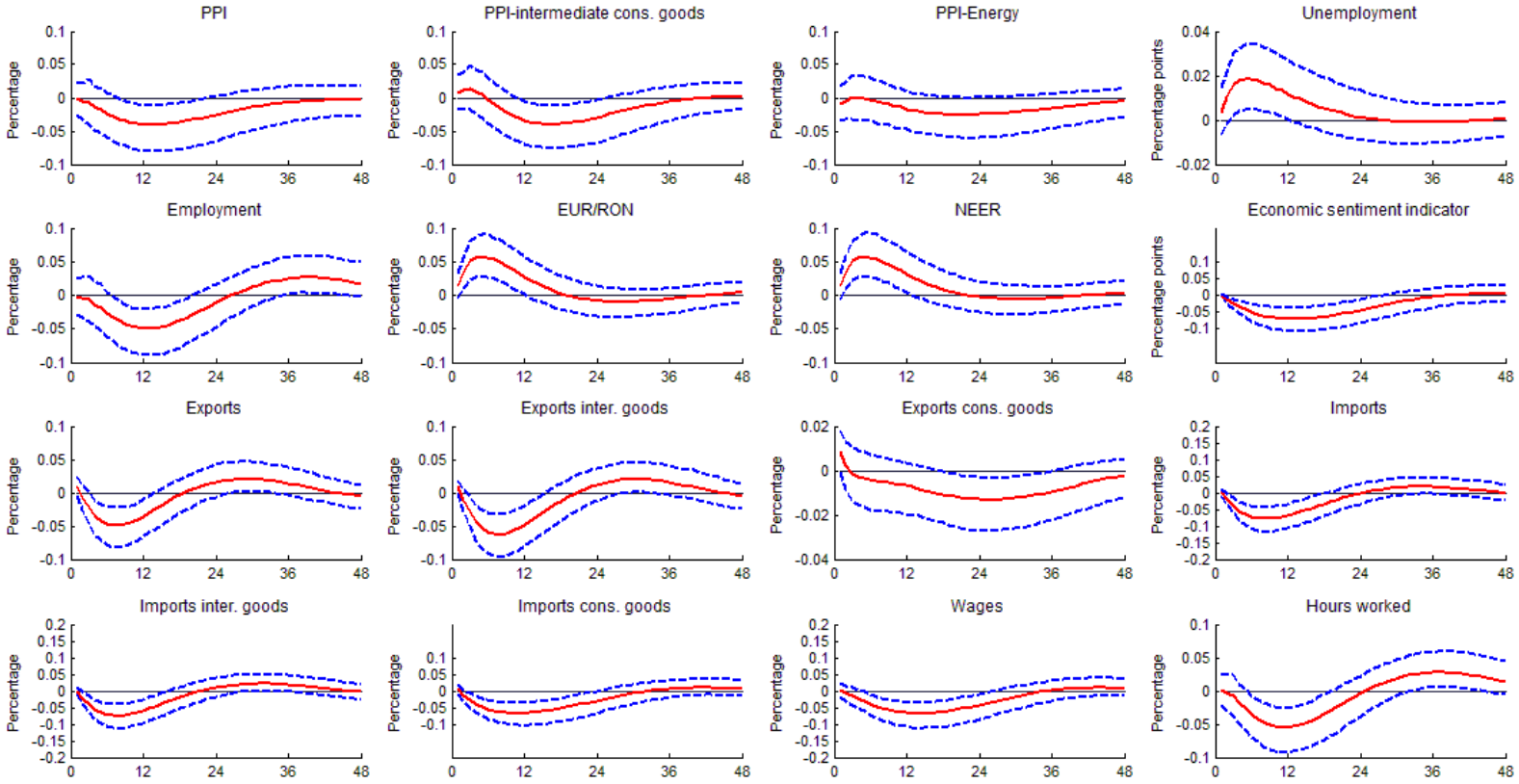
K=4 , Y = (IP,HICP, ROBOR3M)



Robustness check

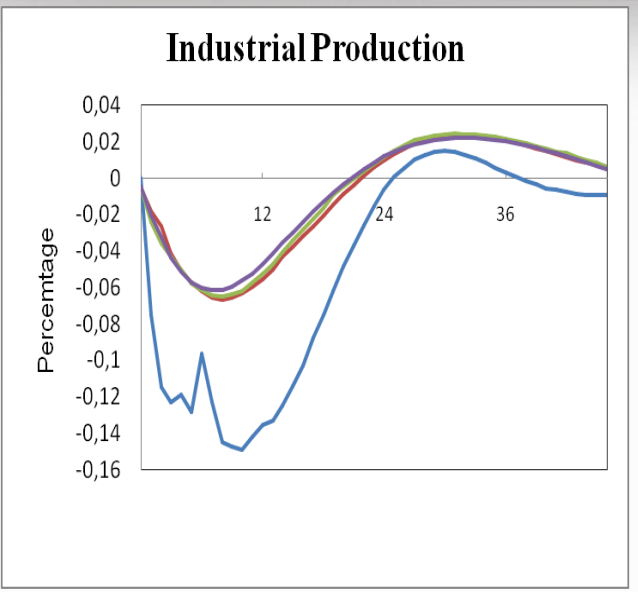
IRF to a positive monetary policy shock

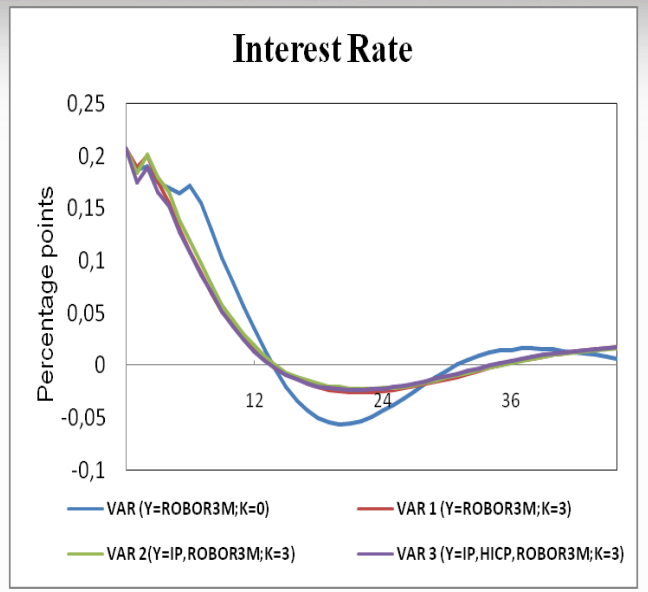
K=4 , Y = (IP,HICP, ROBOR3M)

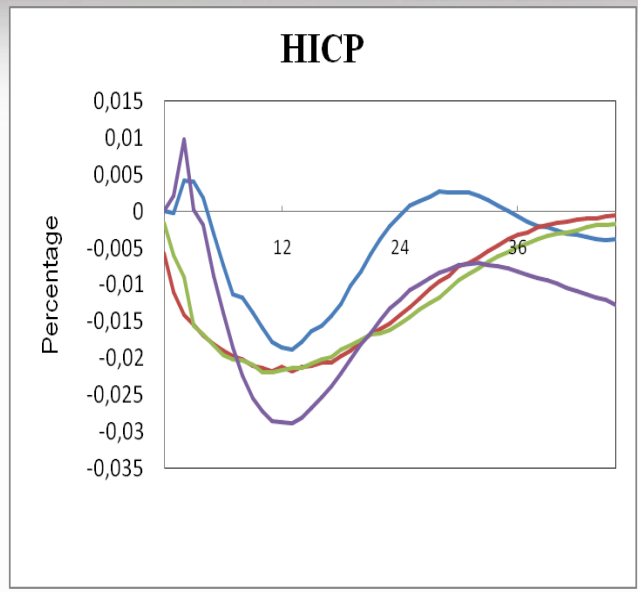


- Changing the number of factors and the magnitude of the impulse responses did not change significantly
- Increasing the number of factors the return of the median line to the initial state becomes more slowly

VAR – FAVAR comparison







- The response of the industrial production in the standard VAR is more persistent than those from FAVAR
- The price puzzle tends to disappear once less observable factors are chosen
- The marginal contribution of the included factors in the VAR is high.

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Conclusions and further improvements

Conclusion

- The impulse response functions obtained are generally in line with available literature across economic subsectors and seem to make sense from economic point of view.
- The standard VAR indicates a different behavior of the industrial production and prices after the shock.
- In general the results are robust given the different structure of the VAR structure and the number of factors. In particular the response of HICP tends to create a puzzle as more number of factors are chosen.

Drawbacks

- The impossibility to assign any sort of the economic interpretation of the factors
- Lack of tests to discriminate the model

Improvements

- To identify the monetary policy shocks using different identification methods
- To measure the international monetary policy shocks transmission with a focus on Romanian economy.

References

- Bai, J. and Ng, S. (2002), Determining the Number of Factors in Approximate Factor Models. Econometrica 70 (1), 191-221.
- Belviso, F. &F. Milani (2006). Structural Factor-Augmented VARs (SFAVARs) and the Effect of Monetary Policy , *Topics in Macroeconomics*: 6(3)3, pp. 1443-1443.
- Bernanke, B., Boivin, J. and Eliasz, P. (2005), Measuring the Effects of Monetary Policy: a Factor-Augmented Vector Autoregressive (FAVAR) Approach. The Quarterly Journal of Economics 120 (1), 387-422.
- Bernanke, B. and Boivin, J. (2003), Monetary Policy in a Data-Rich Environment. Journal of Monetary Economics 50 (3), 525-546.
- Blake, A. and Mumtaz, H. (2012), "Applied Bayesian Econometrics for Central Bankers", Centre for Central Banking Studies, Technical Handbook No 4
- Boivin, Jean, and Marc Giannoni, "Has Monetary Policy Become More Effective?" NBER Working Paper No. 9459, 2003
- Brooks, S., and A. Gelman (1998): .General Methods for Monitoring Convergence of Iterative Simulations,. Journal of Computational and Graphical Statistics, 7(4), 434.455.

References

- Hamilton, J. (1994), "Time Series Analysis", Princeton University Press
- Geweke, J. (1977), The Dynamic Factor Analysis of Economic Time Series. In:
- Aigner, D. and Goldberger, A. (Eds.), Latent Variables in Socio-Economic Models, Amsterdam: North-Holland.
- Geweke, J. (1992), "Evaluating the Accuracy of Sampling-Based Approaches to the Calculation of Posterior Moments" In: Bayesian Statistics, ed. José M. Bernardo, James O. Berger, Alexander P. Dawid and A.F.M. Smith, 169-193. Oxford University Press, Oxford
- Gelman, A., and D. B. Rubin, "A Single Sequence from the Gibbs Sampler Givesa False Sense of Security," in J. M. Bernardo, J. O. Berger, A. P. Dawid, andA. F. M. Smith, eds., *Bayesian Statistics* (Oxford, UK: Oxford UniversityPress, 1992).
- Laganà, G. and Mountford, A. (2005), Measuring Monetary Policy in the UK: A Factor-Augmented Vector Autoregression Model Approach. The Manchester School 73 (1), 77-98.

References

- Scholl, A. and H. Uhlig, 2005, New Evidence on the Puzzles — Results from Agnostic Identification on Monetary Policy and Exchange Rates, SFB 649 Discussion Paper 2005-037, Humboldt University.
- Sims, C. (1992). Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy, *European Economic Review* (June) pp. 975 - 1000.
- Sims, C.A., and T. Zha, 1998, Bayesian Methods for Dynamic Multivariate Models, International
- Economic Review, 39, pp. 949-968.
- Stock, J. and Watson, M. (2002b), Macroeconomic Forecasting using Diffusion Indexes. Journal of Business and Economic Statistics 20 (2), 147-162.
- Stock, J. and Watson, M. (2005), Implications of Dynamic Factor Models for VAR Analysis. Working Paper 11467, June, NBER.
- Uhlig, H., 2005, What are the effects of monetary policy on output? Results from an agnostic identification procedure, Journal of Monetary Economics, 52, pp.381-419.