The Impact of the ECB Monetary Policy on Systemic Risk Changes in Eurozone

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Abstract
This study examines the impact of ECB's monetary policy decisions on the state of financial stability in Eurozone countries in the form of systemic risk in the banking sector. We argue that the environment of low interest rates encourages bank risk taking and increases systemic risk. We employ time-varying parameter structural vector autoregressive model to test the response of systemic risk measured by the market-based SRISK indicator to changes in monetary policy based on official ECB statistics. Our results indicate that unconventional monetary policy in form of quantitative easing further escalates financial instability in Eurozone countries.

Keywords: monetary policy, systemic risk, low interest rates
JEL codes: E52, E58, G20

1. Introduction

The latest global financial crisis has put the mainstream view about monetary policy mechanisms of controlling interest rates to counteract financial exuberance (such as asset price bubbles) into question. Before the crisis, active interest rate regulation was considered a costly and inefficient measure (Bernanke and Gertler, 2001 or Gilchrist and Leahy, 2002), or in other words, central bank should intervene against market bubbles only to prevent price instability. Nowadays, the widely held belief that the current financial architecture is inherently fragile, and that widespread externalities stemming from some form of asset price corrections can have a systemic impact on the financial sector, disrupting financial intermediation and, in turn, jeopardizing the normal functioning of the real economy (Adrian et al., 2014). In theory, researchers argue that there is a new, so-called risk-taking channel of monetary policy through which low interest rates could lead to higher risk in the financial sector. Some studies (such as Allen and Gale, 2000) highlight the potential connection between central banks' monetary policy and the systemic risk present in the financial market. The standard monetary policy interacts with important drivers of financial imbalances, such as credit, liquidity and risk taking. Loose monetary policies drive up asset prices, which would eventually fall and cause financial instability. Moreover, extensive microeconomic evidence by Jiménez et al. (2014), based on the study of loan applications and contracts, demonstrate that low interest rates lead to increased bank risk taking.

In this brief paper, we aim to examine the effect of European Central Bank (ECB) monetary policy on the systemic risk present within the Eurozone's financial sector. This issue was recently addressed in the IMF study by Laseen et al. (2015) for the United States, for which a surprise in the tightening monetary policy does not necessarily reduce systemic risk, particularly when the state of the financial sector is fragile. Our paper extends the analysis of the impact of monetary policy on systemic risk changes to Eurozone countries and ECB policies. This is an important ex-post analysis aimed to answer the question about what drives the risk-taking channel, whether it was influenced solely by the volatility in the global financial markets or if the common monetary policy has also contributed. Our paper serves as a preliminary analysis of the systemic risk and monetary policy interconnectedness within the Eurozone, while contributing to the ever-going debate on, as formulated by White (2009), whether monetary policy should "lean or clean".

2. Methodology

To study the impact of ECB monetary policy on the European financial system stability, we employ the vector autoregressive modelling framework, but first we have to determine how the systemic risk should be measured.

2.1 Measuring the Systemic Risk in Europe's Financial Sector

According to Acharya et al. (2012), a financial firm faces severe default probability when the value of its equity falls under sufficiently small portion of its liabilities. In the short run, the firm may be able to raise new capital or to face a controlled bankruptcy. In bad times, however, acquiring any new capital is rather difficult, which might eventually lead to a situation, when government has to decide whether to save firm (using taxpayer money) or to let it go bankrupt. Such decision is especially troubling, when the financial firm can be described as systematically important (SIFI). In that case, the capital shortage is damaging to the real economy as the failure of this firm will have repercussions throughout the financial and real sectors. Financial Stability Board (2010) defines the SIFIs as financial institutions whose disorderly failure, because of their size, complexity and systemic interconnectedness, would cause significant disruption to the wider financial system and economic activity.

To measure the marginal contribution of a financial institution to the systemic risk of the financial sector, Acharya at el. (2012) proposes the Marginal Expected Shortfall (MES) indicator that reflects the sensitivity of the risk of the system to a unit change in a firm's weight in the financial system. Since this indicator does not account for the level of the firm's characteristics, such as size and leverage, a small unleveraged firm can appear more systematically risky than a big, leveraged one. According to Banulescu and Dumitrescu (2013), the MES privileges the too-interconnected-to-fail logic rather than the too-big-to-fail hypothesis.

Brownlees and Engle (2012) extended the MES methodology into the SRISK indicator by taking into account the firm's size and its existing leverage. SRISK measures the capital shortfall of the financial institution if there is another crisis in the the financial system. Simply put, it estimates the amount of capital needed by a financial firm in the event of a crisis. The SRISK equation is calculated as follows:

$$SRISK = k.DEBT - (1-k).EQUITY.(1-LRMES) \tag{1}$$

where k is the capital requirement and $LRMES$ is the long-run marginal expected shortfall. By multiplying the components in (1), we obtain the total differential of SRISK:

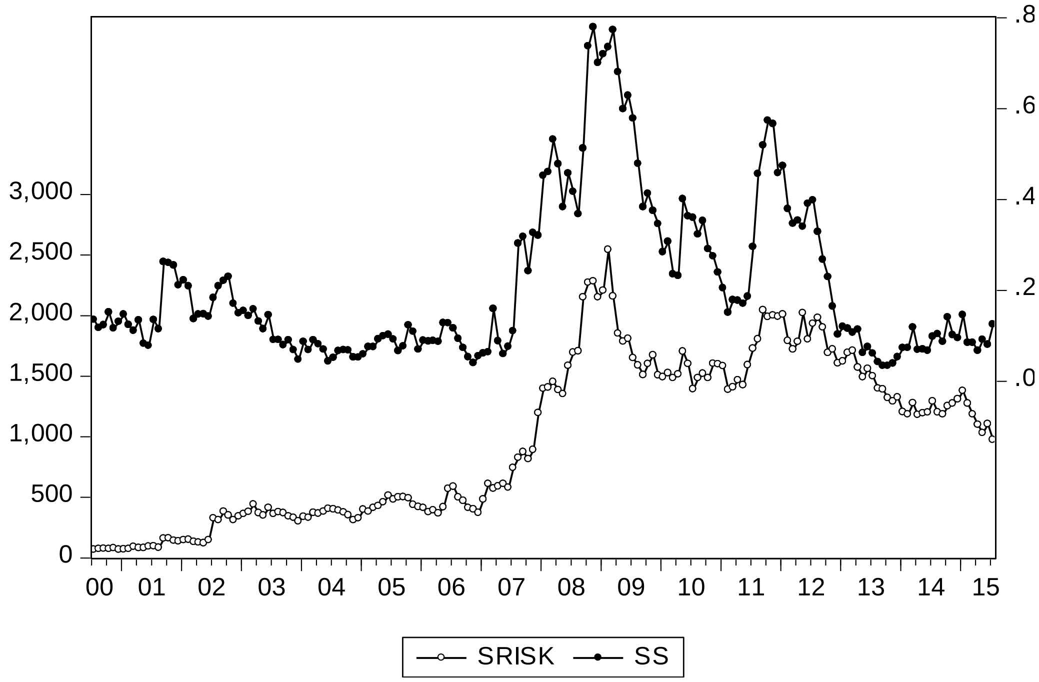
$$\Delta SRISK = k.dDEBT - (1-k).(1-LRMES).dEQUITY + (1-k).EQUITY.dLRMES \tag{2}$$

The change in SRISK can be hence decomposed into three parts:

- $\Delta(DEBT) = k.dDEBT$ - the contribution of firm's debt to SRISK: as the company takes on more debt, it increases its leverage and the contribution to the systemic risk will be positive;
- $\Delta(EQUITY) = -(1-k).(1-LRMES).dEQUITY$ can be described as firm's equity position: as firm's market capitalization declines, the SRISK contribution rises;
- $\Delta(RISK) = (1-k).EQUITY.dLRMES$ shows a potential increase in firm's risk attributes, such as increased correlation or volatility.

The SRISK indicator for Eurozone is depicted in Figure 1. We can clearly see the build-up phase shortly since 2007, while reaching its peak during volatile third and fourth quarters of 2008. After the beginning of the Eurozone sovereign debt crisis, in the end of 2009, the level of systemic instability increased (especially after intensified concerns during few first months of 2010) and it started to fall only after ECB offered free and unlimited support for all Eurozone countries involved in a sovereign state bailout/precautionary program from European Financial Stability Facility on September 6, 2012.

Figure 1: SRISK (left scale, billions USD) and Systemic Stress Index (right scale) for Eurozone



Source: NYU V-Lab database and Bloomberg

To check the robustness of our results, we also consider the official ECB financial stability indicator - Eurozone's systemic stress index (SS), also depicted in Figure 1. This index is the composite indicator which aims to represent the level of systemic stress in the Eurozone's financial system based on 15 mainly market-based financial stress measures from the financial intermediaries sector, money markets, equity markets, bond markets and foreign exchange markets. All components carry equal weightings, thereby allowing the stress index to place relatively more weight on situations in which stress prevails simultaneously in several market segments. The stress index falls within 0 and 1, where higher stress levels are closer to one. While both ECB's systemic stress index and SRISK indicator have the same trend and similar development, the SRISK remains comparatively high, when the SS index shows that the level of financial stability is on its pre-crisis values.

2.2 Econometric Model Settings and Data

To study the effect of the set monetary policy on systemic risk in Eurozone, we make use of a three equation structural vector autoregressive model (SVAR) containing: systemic risk indicator $srisk$, inflation π_r and set monetary policy instruments i_t, M_t. This composition appears to be appropriate as frequently used DSGE models of monetary policy transmission channels usually take similar form. We decided to cut the output gap variable as it caused too much interferences within the defined system and because of the ill-defined short-term relationship between systemic risk and output.

To allow for stochastic volatility, which was an important driver of the business cycle in both the US (Christiano et al., 2014 or Justiniano and Primiceri, 2008) and Europe (Gambetti and Musso, 2012), we use time-varying parameter SVAR model (TVP-SVAR) as in Primiceri (2005). Since the global economy was undergoing a financial crisis during the studied period (2000-2015), we cannot assume that the size of shocks will remain unchanged. The TVP-SVAR not only allows the sizes of the shocks to change over time, but also allows the VAR coefficients to be time varying. The time variation in the VAR coefficients can help us capture the potential structural changes caused by ECB's ongoing economic reforms. Let us consider a time-varying parameter VAR model specified as follows:

$$y_t = X_t \beta_t + A_t^{-1} \sum_t \varepsilon_t \,, \; t = s+1,...,n \tag{3}$$

where the β_t coefficients, and the A_t, and $\sum_t$ are all time varying. As suggested in Primiceri (2005), we assume the parameter in (3) to follow a random walk process:

$$\begin{aligned} \beta_{t+1} &= \beta_t + u_{\beta t}, \\ a_{t+1} &= a_t + u_{at}, \;, \\ h_{t+1} &= h_t + u_{ht}, \end{aligned} \quad \begin{pmatrix} \varepsilon_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim N\left(0, \begin{pmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{pmatrix} \right), \tag{4}$$

where a_t is the vector of non-zero and non-one elements of the matrix A_t and h_t is the vector of the diagonal elements of the matrix $\sum_t$. I_n denotes an n-dimensional identity matrix, Q, S, W are positive definite matrices. It should be noted that none of the restrictions made here are essential to the outcome.

The estimation procedure in TVP-VAR can be constructed using the Markov chain Monte Carlo (MCMC) methods. Since the TVP-SVAR has a larger number of parameters than the conventional SVAR and our sample size is small, we estimate the model using the Bayesian method. We use uninformative priors for estimation. Details on the priors are available in Primiceri (2005, p. 831). The posterior distribution is simulated using Gibbs sampling.

When using structural analysis, the identification of structural shocks is the most crucial part. Consider the following structural VAR:

$$y_t = X'_t \beta_t + \Theta_t \varepsilon_t \tag{5}$$

It differs from (3) because the $n \times n$ matrices $\Theta_t, t = 1,...,T$ are not necessarily lower triangular. To be able to compute our SVAR, we must assume that for any t, Ξ_t contains at least $\frac{n(n-1)}{2}$ restrictions. In our case, we consider following structure for Ξ_t:

$$\Xi_t = \begin{bmatrix} x & 0 & 0 \\ x & x & 0 \\ x & x & x \end{bmatrix} \tag{6}$$

We use recursive scheme and order systemic risk indicator first as it takes some time to accumulate the risk that eventually leads to a financial crisis. Also as pointed by Taylor (2009), an over-expansionary period of monetary policy was one of the causes of the US subprime mortgage crisis. Similar period can be observed in the Eurozone as well. We order inflation indicator second and monetary policy instrument last. Therefore, the monetary policy influences inflation with delay. We decided to simulate two monetary policy shocks. First, we use 3M-EURIBOR as a proxy for ECB main refinancing operations rate. Second, as the ECB launched its quantitative easing program in 2015, we use monetary aggregate M2 as a source of the second monetary policy shock.

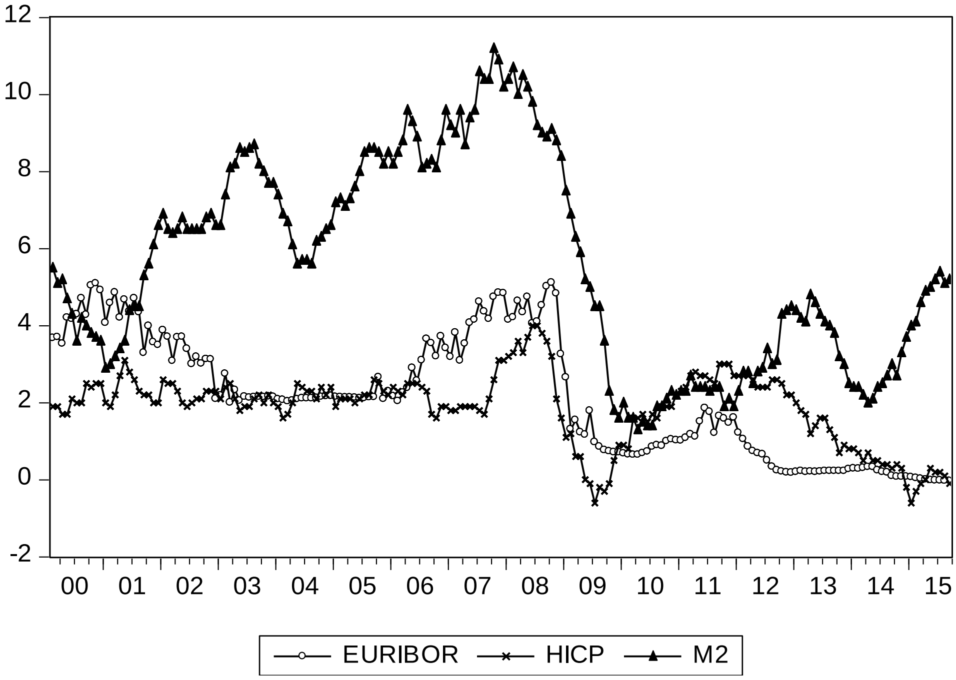
To draw meaningful results, we estimate the reduced form VAR following Primiceri (2005) methodology. We estimate the posterior of the β_t and the Ω_t at every point in time. In order to obtain the posterior of the Ξ, it suffices to solve the system of equations given by:

$$\Xi_t \Xi_t^{'} = \Omega_t \, , \; t = 1,\ldots,T \tag{7}$$

The fact that the elements of Ξ_t are time-varying is the crucial difference between modelling time variation in a structural SVAR as opposed to standard VAR.

We obtain historical data on macroeconomic variables from ECB database. SRISK indicator was generously provided us by the Volatility Institute (V-Lab) and the systemic stress index was drawn from Bloomberg. We use monthly data and use aggregate indicators for the whole Eurozone. Our sample ranges from February, 2000 to August 2015 and contains 188 observations. Used macroeconomic variables are represented in Figure 2.

Figure 2: 3M-EURIBOR, Eurozone HICP and M2 aggregate



Source: ECB Statistical Data Warehouse

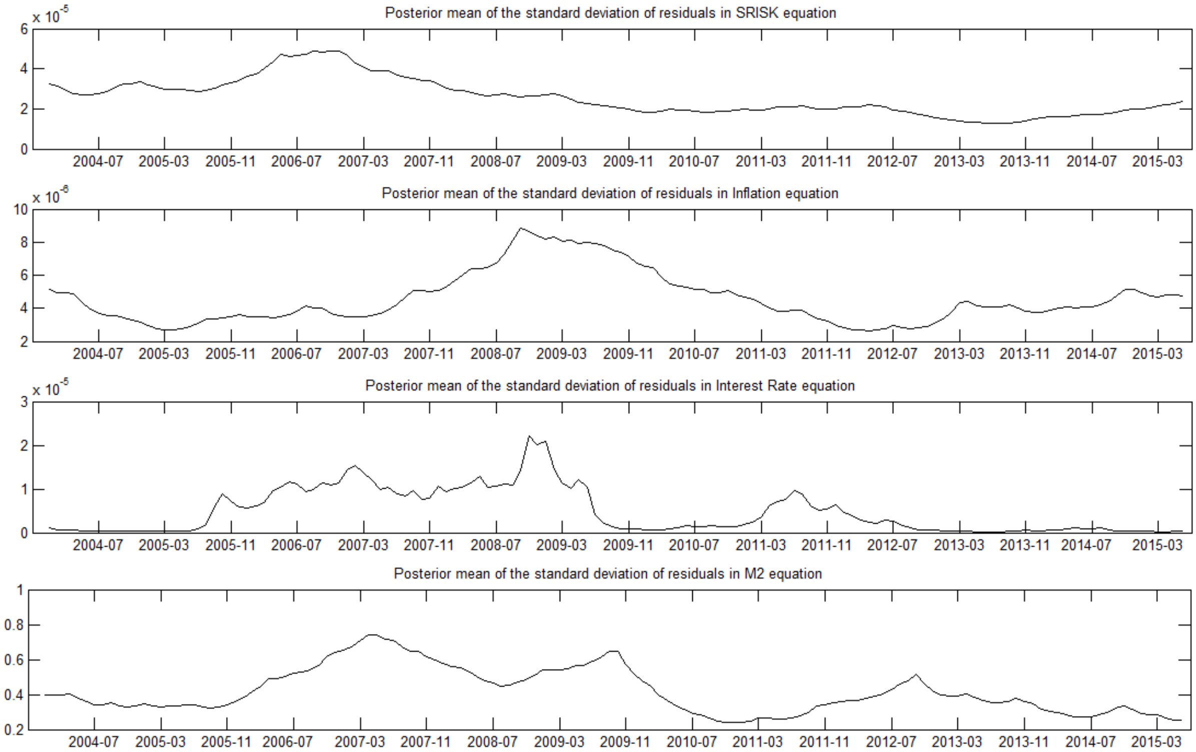
Figure 2 depicts the considered microeconomic variables. For the purposes of our study, changes in the ECB monetary policy are interpreted as shocks. From examining the changes in the 3M-EURIBOR, we can easily identify the mostly unvarying phase prior to the financial crisis from the 3rd quarter of 2002 to the 3rd quarter of 2005, when the official ECB interest rates remained quite low. This loose monetary policy fed the risk-taking behavior of economic agents, so when it stopped, the market was just a short step from collapsing. The collapse came in the 3rd quarter of 2008, when the banking sector failed to overcome the US sub-prime mortgage crisis. The Federal Reserve and ECB coordinated reaction was to lower the interest rate at impact in order to stop the up-coming recession. After seven years, the interest rates are still at near-zero values and now longer available to ECB to use as a monetary policy tool in the situation, when the inflation is extremely low (see the Harmonized Index of Consumer Prices - HICP). Since the 2% inflation rate was generally considered the natural display of growing economies, the European Central Bank seems to manage its primary goal of price stability without any difficulties until the crisis. The prolonged crisis period brought deflationary fears and pressures within the Eurozone. The loose monetary policy before the crises also explains the growing money supply in the Eurozone countries (represented by M2 aggregate), where the multiplicative money effect was feeding the economic growth. The money supply declined significantly during the crisis. The recent levels of money supply are influenced by quantitative easing programs.

3. Empirical Results

We estimate two specifications of TVP-SVAR model with stochastic volatility. In our first model setting, we estimate the systemic risk, inflation and 3M-EURIBOR response on restrictive monetary policy shock which is described as 1% increase in the official ECB interest rate. Second model setting simulates the systemic risk, inflation and money supply response to expansionary monetary policy shock denoted as 1% increase in the money supply (drawn from M2 aggregate). We estimate the TVP-SVAR models by 50,000 replications with 20,000 burn-in draws.

Since the simulated monetary policy shocks are measure of the non-systematic policy actions, we can estimate the relative importance and changes of non-systematic monetary policy by the time varying standard deviation of the identified monetary policy shocks. Figure 3 plots posterior means of the time-varying deviation in SRISK, inflation, interest rate and M2 equation. First graph presents the stochastic volatility of SRISK indicator driven by monetary policy. We can see the build-up phase in systemic risk during 3rd quarter of 2005 to 3rd quarter of 2007 where the monetary policy volatility played an important role in systemic risk. Clearly, the initially free monetary policy period and cheap loans has fed the mortgage crisis resulted in the widespread financial crisis. The variance declines after the ECB decided to drop official interest rates to near-zero values. Second graph shows variance in the inflation equation where we can expect strong effects of the taken monetary policy, since the primary goal of ECB is to maintain price stability. Third and fourth graph outlines the variance in monetary policy variables. The period from the end of 2005 to 2009 exhibits a substantially higher variance of monetary policy shocks. However, after the crisis volatility declines. The observed changes in the variance of monetary policy variables suggest that Taylor-type rules are good approximations of ECB monetary policy before and during the crisis, but insufficient after the crisis.

Figure 3: Posterior means of the standard deviation of residuals in SRISK, inflation, interest rate and M2 equation



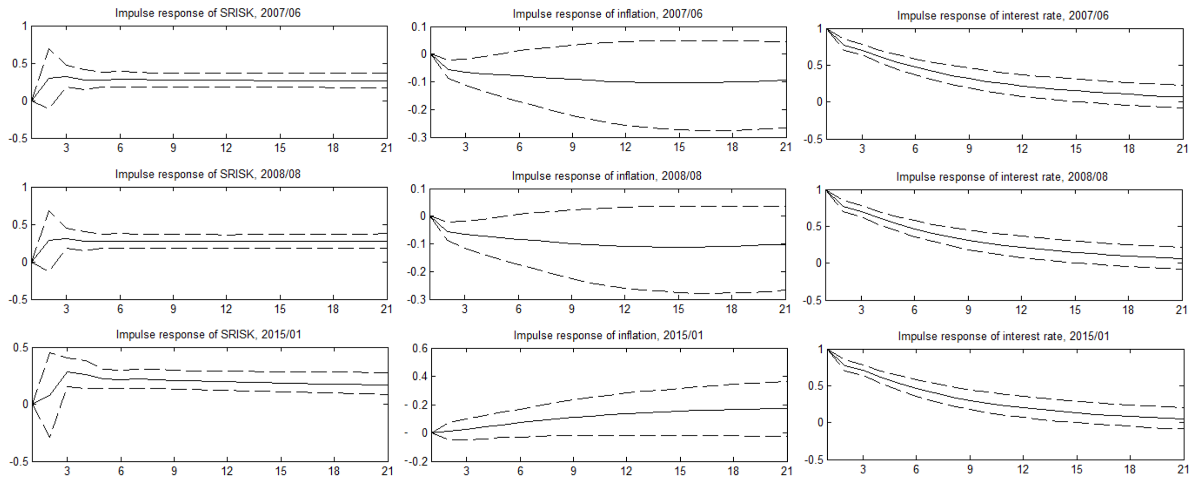
Source: authors' illustration

As it was mentioned previously, our methodological approach allows the coefficients to vary over time, so we can investigate the effect of monetary policy on the systemic risk in different periods. First, we consider systemic risk response during June 2007 which can be characterized as the build-up phase before the financial crisis. We would expect this to be the highest response to monetary policy shock. Indeed, in the euro area the first signs of the crisis were felt in the end of July 2007, when the German government rescued the Deutsche Industriebank (IKB) due to its exposure to mortgage/baked securities. Second, we consider August 2008 shock. When in mid-September 2008 the crisis intensified and the interbank trading came to a virtual halt, the ECB engaged in a new mode of liquidity provisioning, as it has started to provide refinancing well above the levels that banks could have absorbed to fulfill their reserve requirements in normal times. Third, we analyze systemic response in January 2015, when ECB launched the next wave of quantitative easing of one trillion euros.

We summarize the impulse responses of the variables to an unexpected restrictive and expansionary monetary policy in Figure 4 and 5. Although the impulse responses differ quantitatively, the qualitative results have similar patterns. Important measures of the performance of the systematic monetary policy are the responses of inflation, output (or unemployment) and, for some central banks, even systemic risk, as they incorporate financial stability into their framework.

A restrictive monetary policy shock (1% increase in official interest rate) reduces inflation within first 3 months in both analyzed periods of June 2007 and August 2008 (Figure 4). The response of inflation to monetary shock in January 2015 is not significant. We can argue that the inflation expectations are to blame. As the official interest rates are now close to zero, an unexpected increase might not have any effect on the inflation level in Eurozone. Restrictive monetary policy shock also increases the systemic risk measured by SRISK indicator, although with a lag of up to 3 months. Hence, a 1% interest rate increase causes the amount of capital needed by a financial firm in the event of a crisis to increase as well up to 0,25%. Judging from the response functions, the SRISK increase is quite persistent in all of studied periods.

Figure 4: Impulse responses to restrictive monetary policy shock
(1% increase in official interest rate)

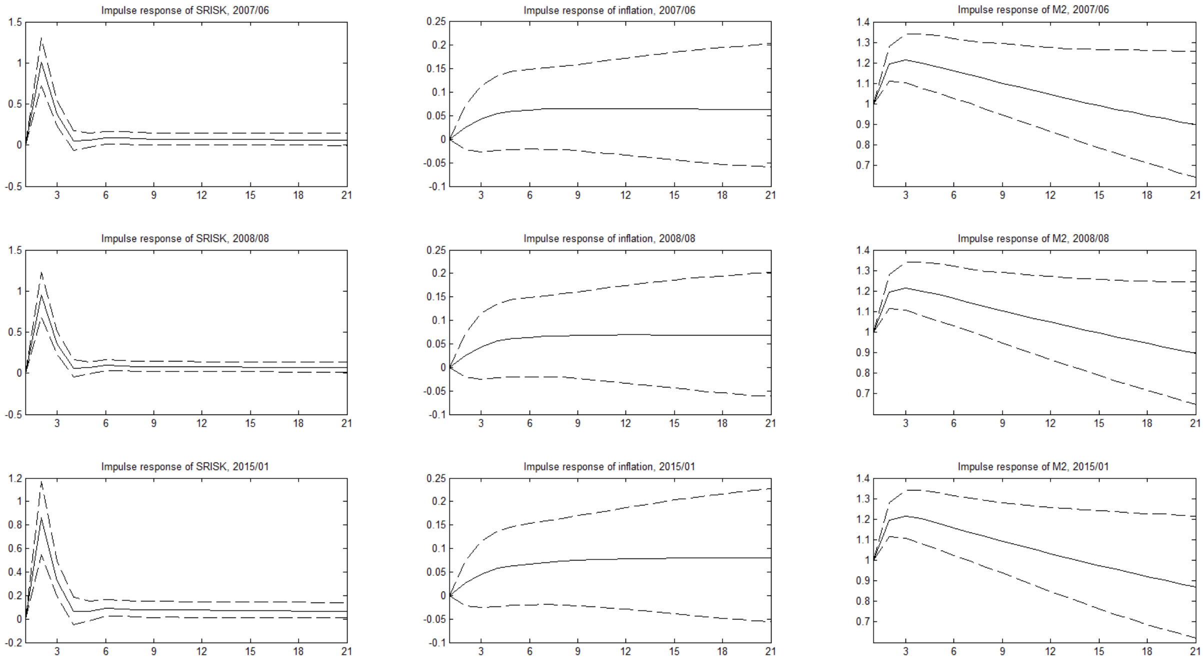


Note: The solid line represents the posterior median responses; the dashed lines are the 0.025 and 0.975 quantiles (based on 50,000 simulations with 20,000 burn-in draws). Numbers on the horizontal axis denote months.

Source: authors' illustration

In our second model setting, we drawn from the expansionary monetary policy shock to M2 aggregate (Figure 5). Since ECB cannot effort to reduce official interest rates any lower, the central bank committed to quantitative easing. The response in M2 aggregate shows a multiplicative effect of an unexpected increase in money supply as the response functions increases after the shock. It then slowly approximate to zero as the shock fades. Inflation is, however, not responding significantly. The first possible explanation in virtually no changes in inflation levels is that there is in general an excess supply of goods and services in the integrated economy, but profitable business opportunities are limited. The other possible explanation builds on recent studies from the US quantitative easing experience (see Fawley and Neely, 2013 for literature review). Several studies argue that the commercial banks might be to blame as they are hoarding the money provided by the FED to regain liquidity and that there is very little financial intermediation taking place. That also might be the reason, why the systemic risk is responding by a sharp surge within 3 to 4 months after the shock. The shock is, however, not persistent as in our first model. In this setting, excessive money supply does not help finance the real sector of the economy, but just encourages speculation. Quite possibly, the combination of speculation and households' increasing dependence on leverage to finance accommodation needs pose a sizable threat to financial stability in the form of the housing bubble.

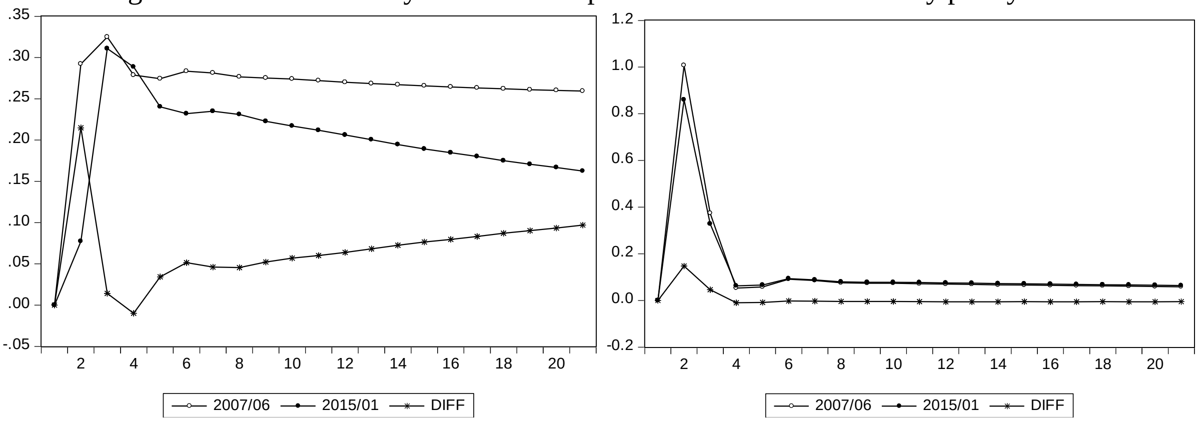
Figure 5: Impulse responses to expansionary monetary policy shock
(1% increase in M2 aggregate)



Note: The solid line represents the posterior median responses; the dashed lines are the 0.025 and 0.975 quantiles (based on 50,000 simulations with 20,000 burn-in draws). Numbers on the horizontal axis denote months.
Source: authors' illustration

Next, we study differences in response functions for both models (Figure 6). Left-sided graph shows the difference between calculated systemic risk responses for June 2007 and January 2015. This comparison is useful as it shows higher SRISK response to restrictive monetary policy shock in pre-crisis period, when the interest rates were rather high. The difference is then becoming minimal after 4 months. Still, unexpected rise in interest rates cannot be recommended even in the post-crisis period, as the system remains fragile. Similar difference (close to 0.2%) in response to shocks is observed between calculated systemic risk responses for June 2007 and January 2015 in our second model settings (the right-sided graph).

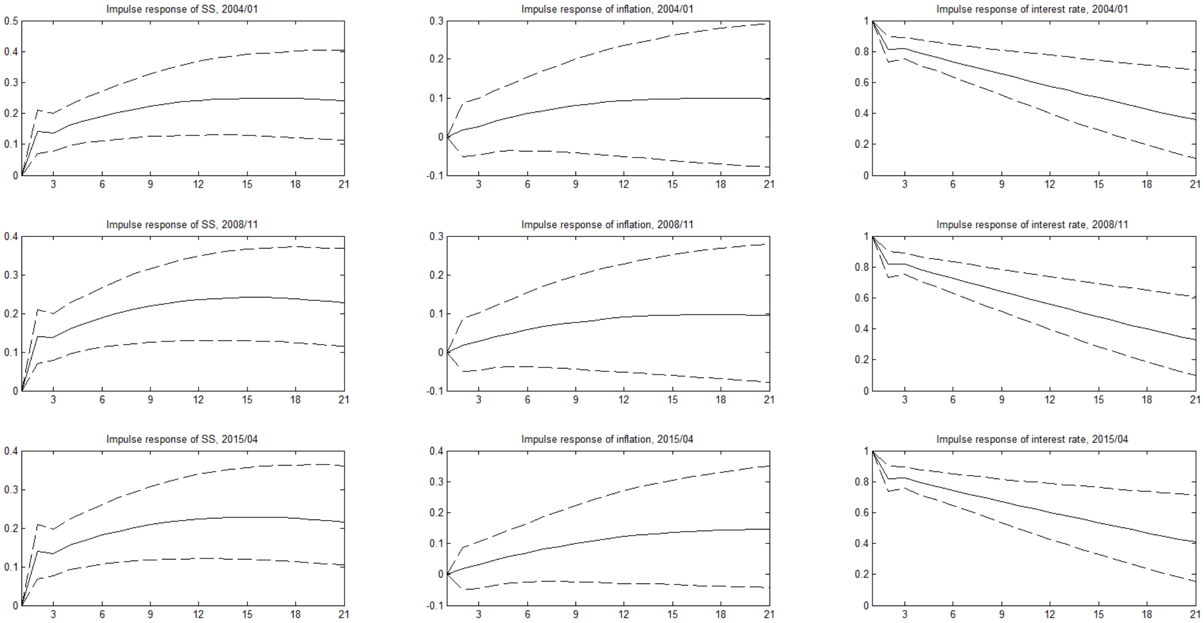
Figure 6: Differences in systemic risk responses to restrictive monetary policy shock



Note: Numbers on the horizontal axis denote months.
Source: authors' illustration

To check the robustness of our results, we consider the official ECB financial stability indicator - systemic stress index (SS) as a financial stability indicator. The results are displayed in Figure 7. We test only systemic stress response to restrictive monetary policy shock as in previous settings. To add time-changing factor, we also changed the analyzed periods to January 2004, November 2008 and April 2015 but we are still aiming to capture the response in the pre-crisis, crisis and post-crisis periods. As seen from Figure 6, shapes of response are non-changing; however, the TVP-SVAR model is less stable. We cannot recommend using the SS index for such analysis.

Figure 6: Impulse responses to restrictive monetary policy shock based on Systemic Stress Index



Note: The solid line represents the posterior median responses; the dashed lines are the 0.025 and 0.975 quantiles (based on 50,000 simulations with 20,000 burn-in draws). Numbers on the horizontal axis denote months.

Source: authors' illustration

4. Conclusion and Future Research

The findings of our analysis can be summarized as follows: we found that a restrictive monetary policy does not necessarily reduce the level of systemic risk, which applies to both the pre-crisis and post-crisis periods. On the contrary, the lowering of interest rates increased the systemic risk measured by SRISK indicator with a lag of up to 3 months. Hence, a 1% interest rate increase causes the amount of capital needed by a financial firm in the event of a crisis to increase up to 0,25%. The increase in systemic risk due to lower interest rates is persistent during the whole studied period. The ECB policy on managing interest rates reduced inflation before and during the crisis, but has zero effect on inflation in near deflation times (after the crisis). We also found that the recent monetary expansion in the form of quantitative easing did not raise inflation, but increased the level of systemic risk. Therefore, excessive money supply does not help finance the real sector of the economy, but presumably encourages speculation. Our analysis suggests that unconventional monetary policy brings unwanted results and further escalates financial instability in Eurozone countries.

Our future analysis will address the effects of common monetary policy on individual systemic risk of Eurozone-member countries. Since there are still some asymmetries remaining in Euro Area states in terms of differences in the transmission mechanisms (Berben et al., 2004), the level of unemployment and prices (Barigozzi et al., 2014) or the sovereign debt, the effect of common monetary policy could have asymmetrical impact on financial stability.

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