Tokmakcioglu, Kaya; Ozcelebi, Oguzhan

Article

Impacts of the shadow short rates on the Ted spread and stock returns : empirical evidence from developed markets

Reference: Tokmakcioglu, Kaya/Ozcelebi, Oguzhan (2020). Impacts of the shadow short rates on the Ted spread and stock returns : empirical evidence from developed markets. In: Ekonomický časopis 68 (3), S. 269 - 288.
https://www.sav.sk/journals/uploads/0325160403%2020%20Tokmakcioglu%20+%20RS.pdf.

Impacts of the Shadow Short Rates on the Ted Spread and Stock Returns: Empirical Evidence from Developed Markets

*Kaya TOKMAKCIOGLU** – *Oguzhan OZCELEBI***

Abstract

This study employs Bayesian Vector Autoregression (BVAR) and Time-Varying Structural VAR (TVP-VAR) models for the Euro area, and the US to analyze the impacts of the shadow short rates (SSRs) on the Treasury-EuroDollar rate (TED spread) and stock returns. Forecast error variance decompositions (FEVDs) of the BVAR indicated that the volatility in stock markets and the bubbles in financial assets can be mitigated by the SSR in the Euro area. However, the results of FEVDs showed that the credit risk cannot be explained substantially by monetary policy. According to our results, the contractionary monetary policy will decrease the stock returns; thus, it can be revealed that asset price bubbles and financial crisis risk can be controlled. It was also indicated that the contractionary monetary policy led to an increase in the TED spread, which in turn raised the probability of credit risk after the 2008 – 2009 global financial crisis (GFC).

Keywords: *shadow short rate, TED spread, stock returns, BVAR, TVP-VAR*

JEL Classification: E43, E44, E47

Introduction

As a result of the 2008 – 2009 global financial crisis (GFC), the central banks of major economies implemented a quantitative easing (QE) policy, and the relevant process significantly altered the macroeconomic and financial variables. Together with the QE policy, theoretical assumptions regarding the relationship between macroeconomic and financial variables showed considerable variations,

* Kaya TOKMAKCIOGLU, corresponding author, Istanbul Technical University, Faculty of Management, Department of Management Engineering, Macka-Besiktas, Istanbul, Turkey; e-mail: tokmakcioglu@itu.edu.tr

** Oguzhan OZCELEBI, Istanbul University, Faculty of Economics, Department of Economics, Beyazit-Fatih, Istanbul, Turkey; e-mail: ogozc@istanbul.edu.tr

and the role of unconventional monetary policy instruments gained importance in the scientific literature (Conti, 2017; Eksi and Tas, 2017; Potjagailo, 2017; Aastveit, Natvik and Sola, 2017; Brana, Campmas and Lapteacru, 2018; Ganelli and Tawk, 2019). Within this framework, the shadow short rate (SSR), which can be recognized as an important indicator of unconventional monetary policy, is the shortest maturity rate, which is derived from the estimated shadow yield curve. The SSR can also have negative values in zero-lower bound/unconventional environments, and thus negative values of the SSR may affect the economy in a different way than that of positive values (Krippner, 2014).[1] Additionally, following the recent crisis, the decline in the policy rate was not reflected in bank loan rates.

A study by Illes, Lomabardi and Mizen (2015) can be recognized as a pioneering approach in terms of the differentiation of bank loan rates from policy rates. According to Illes, Lomabardi and Mizen (2015), the reason for the relevant differentiation is that the policy rate is short-term, whereas bank loan rates are regarded mostly as long-term. The spread between bank loan rates and the policy rate can be corrected by using an appropriately adjusted swap rate, whereas banks also provide financial sources from deposits and other money market instruments. Depending on the level of the credit interest rate, the credit risk in an economy is under the influence of many economic factors, and these effects may have a time-varying nature. In this context, it is important to use empirical models that involve time-varying effects in the determination of the relationship between the credit risk and conventional and unconventional monetary policy. It is important to determine which credit risk indicators should be included in the related models, whereupon the Treasury-EuroDollar rate (TED) is one of the main indicators showing the difference between the three-month Treasury bill and the three-month London Inter-bank Offered Rate (LIBOR) based on US dollars. The TED spread also reflects liquidity conditions of the market, and thus it is under the influence of the monetary policy stance. In this study, we employ Time-Varying Structural VAR (TVP-VAR) and Bayesian Vector Autoregression (BVAR) models to investigate the interplay among financial performance, credit risk, and monetary policy (conventional and unconventional) in developed countries, namely the US, and the Euro area, with monthly data from 2005:11 to 2018:07. Considering the drastic effects of the GFC, we use a sub-period of 2010:01 – 2018:07 to analyze the interactions among the stock returns, the TED spread, and the SSR in our BVAR approach. Along with BVAR modeling, the TVP-VAR methodology of Primiceri (2005) is also performed because the credit risk, monetary policy stance, and stock market dynamics may change over time

[1] For the details, please see <https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-ofinternational-monetary-policy-measures>.

and have influence on the propagation mechanism of innovations and the transmission mechanism. Thus, we take the advantage of non-constant parameters by modeling time-varying parameters in terms of the interactions among the stock returns, the TED spread, and the SSR. In this respect, the aims of our study are (1) to show the weight of the movements in the forecast errors of dependent variables that are due to their own shocks and shocks to the other variables by estimating forecast error variance decompositions (FEVDs) of BVAR models and (2) to detect the reactions of the dependent variables both in the TVP-VARs and BVARs to shocks to each of the variables by estimating impulse response functions (IRFs). Thus, we analyze whether changes in conventional and unconventional monetary policy stance have had a significant effect on the credit risk and the variations in stock markets in the US, and the Euro area. The main hypothesis of this paper is to test whether monetary policy in those countries can be designed to lower the credit risk and provide the necessary liquidity to boost the economic activity and financial markets for maintaining financial stability. The major contribution of our study is that we employ TVP-VAR models, following the methodology of Primiceri (2005), and trace out whether SSRs may have different influences on the TED spread and stock returns due to changes in macroeconomic conditions. Another contribution of our study is that we compare the differences in the effects of changes in the SSRs on the TED spread and stock returns between the full-sample and the post-crisis period. For this purpose, stock price index (2010 = 100) that is in logarithms, is obtained from the statistical database of the OECD. Accordingly, stock returns refer to the growth rate of the relevant stock price index from a month ago.[2] The Reuters database is used as a source to take the TED spread, while we extract the SSR from the statistical database of the Reserve Bank of New Zealand.[3] All series are seasonally adjusted using the x-13-arima-seats system developed by the US Census Bureau, and Rats 9.10, EViews 10.0, and MATLAB routines are employed for the empirical exercise.

1. Literature Review

Economic developments before and after the GFC revealed the necessity to reconsider the transmission mechanism of monetary policy. In this context, the banking sector became the core of the analysis in assessing the effects of conventional

[2] The share price index covers all listed companies on the New York Stock Exchange, while data are collected from the stock exchanges and trading systems of the Euro zone participating countries by the OECD.

[3] For the details please see <https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-ofinternational-monetary-policy-measures>.

and unconventional monetary policy (Cetorelli and Goldberg, 2012; Neuenkirch and Nöckel, 2018; Brana, Campmas and Lapteacru, 2018). Decisions in the banking sector may affect the credit volume significantly and determine the credit risk that economic agents are exposed to. On the other hand, banks do not always respond to a decline in policy rates by lowering their loan rates, and thus the difference between policy rates and loan rates may have significant effects on financial variables due to the crucial role of the banking sector. According to Alessandri and Nelson (2015), this process can be amplified by flattening the yield curve as a result of the QE, and an upward-sloping yield curve is also a factor in the change of financial conditions.

On the other hand, the implementation of expansionary monetary policies following the

GFC led to excessive liquidity of the banks, which can cause banks to give loans to risky projects. Because financial stability may be impaired, unconventional monetary policy has been developed in this context to ensure financial stability (Lengnick and Wohltmann, 2016; Brana, Campmas and Lapteacru, 2018). In terms of the effects of unconventional monetary policies, the determination of time-varying impacts on macroeconomic and financial conditions, regime shifts, and possible asymmetric effects are essential to determine the interactions among the monetary policy and other indicators of the banking sector and the financial sector. For instance, Brana, Campmas and Lapteacru, (2018) showed that loosening monetary policy (lowering interest rates and increasing central banks' liquidity) had negative impacts on banks' risk channel in Europe by adopting bank risk indicators, namely the distance to default and the asymmetric Z-score. The results of Brana, Campmas and Lapteacru, (2018) also verified the existence of the risk-taking channel, and it was indicated that unconventional monetary policies had stronger impacts below a certain threshold level with the Panel Threshold Model (PTR). In the context of the monetary transmission mechanism, which is subject to change in crisis conditions, and in order to understand the credit channel, the policy implementation of the US Federal Reserve System (the Fed) has also an important weight in the scientific literature (Kim, 2001; Canova, 2005; Cetorelli and Goldberg, 2012). More specifically, it can be inferred that a healthy structure of the financial sector, especially the banking sector, will increase the control of the monetary policy on macroeconomic and financial variables through the credit channel. At this point, the TED spread is considered an important indicator that reflects credit conditions and the credit risk. The fact that the TED spread – as a credit risk indicator – is in line with macroeconomic developments and monetary policy indicates coherence between policy rates and banks' loan rates. Potential incoherencies may be caused by many factors, whereas the determination of the loan interest rate in accordance with the monetary policies of the banks is carried out within the framework of their liquidity management.

Along with the indicators concerning credit, other macroeconomic and financial indicators can also be used to explain the effects of conventional and unconventional monetary policy. Within the scope of unconventional monetary policy, the SSR approach developed by Wu and Xia (2014) has been used in many studies (Potjagailo, 2017; Conti, 2017; Eksi and Tas, 2017; Aastveit, Natvik and Sola, 2017; Caraiani and Călin, 2018; Ganelli and Tawk, 2019). In terms of the effects of unconventional monetary policy on domestic macroeconomic variables, the study by Conti (2017) is one of the leading investigations. By using SSR data, Conti (2017) employed a medium-scale BVAR model and assessed the role of US monetary policy in inflation and economic activity. As a result of the historical decomposition and a conditional forecast scenario, it was found that the Fed's stance was in line with GDP and inflation dynamics. Potjagailo (2017) examined the effects of unconventional monetary policy in Europe's peripheral countries. The study scrutinized the ECB's monetary policy by employing a Factor-Augmented VAR model. Accordingly, the effects of expansionary monetary policies in the non-Euro economies with high foreign trade deficits were observed on the industrial sector, while interest rates were affected more in countries with a high level of financial integration. In terms of the international spillover effects of the variations in SSR, Ganelli and Tawk (2019) employed a Global VAR model to identify Japan's unconventional monetary policy. They found that Japan's monetary easing policy tended to have positive impacts on the emerging countries in Asia, whereas the SSR did not totally reflect the spillover effects. The effects of unconventional monetary policies may vary depending on the level of macroeconomic uncertainties as well as on the indicators of the credit risk. This assertion was supported by Aastveit, Natvik and Sola (2017), who found that US monetary policy shocks affect economic activity less when the uncertainty is high.

While unconventional monetary policies may have impacts on macroeconomic expectations and uncertainties, the determination of the effects on the economic uncertainty and financial variables may increase the policy's effectiveness. In this context, Caraiani and Călin (2018) incorporated the role of time-varying impacts in their BVAR model to show the effects of SSRs on stock returns. They found that the effect of monetary policy shocks on asset prices can be negative. More specifically, there was also a much lower positive effect of monetary policy shocks on bubbles. The results of Caraiani and Călin (2018) were in contrast to those of Gali and Gambetti (2015), who found that a positive monetary policy shock has a positive impact on asset prices. A study by Eksi and Tas (2017) focused on the impacts of unconventional monetary policy of the Fed on stock returns. Eksi and Tas (2017) constructed a theoretical model on the basis of Fama and French (2015) and the Taylor-rule framework. More precisely, they enhanced the model by the inclusion of inflation, the output gap, and the SSR. Along with macroeconomic variables, their model contained small (market capitalization) minus big (SMB) and high (book-to-market ratio) minus low (HML) variables to control for changes in market returns due to firm-specific risks, whereas other control variables of the model were the lagged values of changes in the CBOE Volatility Index on the S&P 500 (VIX), changes in the 10-year US T-bond yield, and the S&P 500 returns. Eksi and Tas (2017) also conducted additional analysis using the Chow test to determine the break point in the data set and modified their model accordingly. They found that the response of stock returns to monetary policy decisions were higher after the federal funds rate hit the zero-lower bound.

The SSRs' effect on the stock return is not direct but is exhibited through variables. In other words, the effect of the SSR on the stock return can be realized through some transmission channels, and it can be said that the financial conditions of the country mediate the effect of the SSR on stock return. At this point, VAR-type models can be used as an effective tool in explaining this relationship. In addition, the effects of the stock return on the SSR can be analyzed by VAR models within the time dimension that have a simultaneous equation system structure. The effects of conventional and unconventional monetary policy on stock returns may vary depending on investor behavior and the financial conditions of the country. In this study, a crucial role in the determination of the relationship between the SSR and stock return is given within the TVP-VAR model. Thus, unlike Eksi and Tas (2017), we discuss the effects of changes in credit conditions and credit risk on stock return. More specifically, the effect of the SSR on stock return is examined through a financial variable, and therefore our study differentiates itself from Eksi and Tas (2017), who evaluated macroeconomic variables on the basis of monetary policy reaction function. Because identification of the time series model depends on SVAR framework in our study, unlike Eksi and Tas (2017), theoretical assumptions are included in our SVAR model by imposing restrictions. Additionally, variations in time series are not studied on a single variable basis, as in the case of Eksi and Tas (2017) using SMB and HML, and the time-related effects that may exist between the variables of the model are demonstrated by the methodology of Primiceri (2005). Because the credit-based indicators are predominant in explaining unconventional monetary policies in the scientific literature (Brana, Campmas and Lapteacru, 2018;

Neuenkirch and Nöckel, 2018; Ganelli and Tawk, 2019), we use the TED spread as a variable and discuss the possible effects of the risks in the credit market.

In this study, we employ Bai (1997) and Bai and Perron (1998; 2003) tests in order to capture the number of structural breaks in the series. In this respect, we found multiple structural breaks in stock returns, the TED spread, and the SSR series for the cases of the US, and the Euro area. Thus, we use the Lumsdaine--Papell unit root test considering multiple structural breaks to specify the empirical models used in our study. Due to the unit root properties of the data under investigation, a possible cointegration relationship was tested; however, the variables in our models are not found as cointegrated, and we are not able to extend the TVP-VAR model to long-memory models. Accordingly, we divide the full-sample (2005:11 to 2018:07) according to the GFC and employ two BVAR models to examine whether the changes in both conventional and unconventional monetary policies of the US, and the Euro area had influence on the TED spread and stock returns in a different way. We cannot estimate the FEVDs based on TVP-VAR when the empirical methodology of Primiceri (2005) is followed; accordingly, we estimate the BVAR model's FEVDs to analyze the factors influencing the variations in the TED spread and stock returns. Our empirical approach differs from Eksi and Tas (2017), Brana, Campmas and Lapteacru, (2018) and Iacoviello and Navarro (2019) in that we do not classify variables as dependent and independent. Although theoretical considerations can be used to make this classification, the adaptation of models incorporating simultaneous interactions among variables – the estimation TVP-VAR models – is more suitable for analyzing the interest rate pass-through and transmission mechanism. Along with time-varying impacts, possible asymmetric effects of SSRs can be studied by the Asymmetric VAR model.

2. Methodology of Analysis

In this study, BVAR models with Minnesota prior are estimated to take the advantage of releasing the assumption of constant parameters unlike traditional VAR models. In this respect, the following variables are included in the vectors of empirical models, such as: $(sto_t^{eu}, ted_t^{eu}, ssr_t^{eu})'$, $(sto_t^{us}, ted_t^{us}, ssr_t^{us})'$. In the relevant vectors, the percentage change in stock market index from the previous month, the TED spread and the SSR are included, respectively. More precisely, an increase/decrease in the stock market index reflects better/worse stock market performance, whereas an increase/decrease in the TED spread signifies higher/lower credit risk for the economy. Finally, an increase/decrease in the SSR corresponds to contractionary/expansionary monetary policy implementation. In this study, we focus on the SSR which is the shortest maturity rate from the estimated shadow yield curve in line with Krippner (2014). The SSR is a crucial indicator of both conventional and unconventional monetary policy having impacts on the dynamics of macroeconomic and financial variables, especially after the GFC. Thus, we also used TVP-VARs models to consider policy shifts and implied shifts in terms of the relationship between the SSR, the TED spread and the stock market return. Monetary policy stance of the central bank and the decisions of the banking sector are also incorporated in the model via the TED spread which is defined as the difference between the inter-bank offered rate (LIBOR) and the T-bill rate. Here, the LIBOR reflects the macroeconomic situation and country risk. Following the approach by Shirakawa (2010), we also derive the TED spread for the Euro area.

In order to analyze the relationship between the SSR, the TED spread and stock returns, we estimate our IRFs for three different dates in the sample to demonstrate the possible differences between the impulse responses on different dates in the 16^{th} and 84^{th} percentiles. The dates are arbitrarily chosen as 2009:11, 2012:05 and 2014:03 to show the changes in economic conditions and the economic crisis. More precisely, 2009:11 corresponds to the recent financial crisis period, while 2012:12 coincides with the year that the FED ended its QE policies. 2014:03 is chosen taking into account that the negative impacts on the global economy due to the annexation of Crimea by Russia which resulted in sanctions on Russia imposed by the US. Because the methodology of Primiceri (2005) is used in this study, the FEVDs based on the TVP-VAR cannot be calculated; herein, we take advantage of the BVAR model's FEVDs to specify the sources of the variations in stock returns and the TED spread.

2.1. Identification of the Models

The point of departure of our empirical analysis depends on a VAR model that can be specified as in (1). On the other hand, Bayesian techniques can be used in the estimation process of VAR models which in turn constitutes a base for a BVAR model;

$$y_t = a_0 + \sum_{j=1}^{p} A_j y_{t-j} + \varepsilon_t \tag{1}$$

where Equation 1 specifies a VAR model with intercept terms. Thus, y_t represents a $Kx1$ vector with $t = 1, \ldots T$. The vectors of errors and intercepts are denoted by ε_t and a_0 and A_j refers to a MxM matrix including coefficients (Koop and Korobilis, 2009, p. 4). If it is assumed that, $\alpha = vec(A)$ this corresponds to a $KMx1$ vector stacking all the VAR coefficients (and the intercepts) into a vector $A = \left(\alpha_0, A_1, \ldots, A_p\right)'$. Accordingly, the model in (1) can be rewritten as; $y = (I_K \otimes X)\alpha + \varepsilon$, where $\varepsilon \sim N\left(0, \Sigma \otimes I_K\right)$ (Koop and Korobilis, 2009, p. 4). The identification of the BVAR model in (1) is critically important, while forecast of time series, impulse responses and variance decompositions can be imprecisely computed without imposing prior information into the estimation process. In this respect, the Minnesota priors proposed can be incorporated in the estimation process of BVAR models. When Σ is replaced with an estimate, a prior for α is to be set and the Minnesota prior assumes that $\alpha \in N\left(\alpha_{min}, V_{min}\right)$ (Koop and Korobilis, 2009, p. 6).

VAR specification can be enhanced by allowing restrictions in the estimation process and thus, SVAR models can be obtained. Moreover, the derivation of TVP-VAR model as specified in (3) can be made on the basis of SVAR model. Within this framework, time varying coefficients and time varying variance covariance matrix of the additive innovations are contained in the TVP-VAR model.

$$Ay_t = F_1 y_{t-1} + \ldots + F_s y_{t-s} + u_t \tag{2}$$

where y_t denotes a ($Kx1$) vector of observed variables, A and $F_{1, \ldots} F_s$ correspond to (KxK) matrices of coefficients. More specifically, it can be specified that;

$A = \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix}$ and u_t refers to a ($Kx1$) structural shock that can be defined as; $\Sigma = \begin{pmatrix} \sigma_1 & 0 & 0 & 0 \\ 0 & \sigma_2 & 0 & 0 \\ 0 & 0 & \sigma_3 & 0 \\ 0 & 0 & 0 & \sigma_4 \end{pmatrix}$ (Jebabli, Arouri and Teulon, 2014, p. 69).

More specifically, the model in (3) is a Blanchard-Quah-type of an SVAR model with short-term restrictions. The restrictions in a Blanchard-Quah-type of a SVAR model can be put in line with the assumptions from economic theory and it is acknowledged as a useful tool for the analysis of transmission mechanism.

Nonlinearities or time variation in the lag structure of the model can be studied in terms of the drifting coefficients; moreover, the multivariate stochastic volatility signifies the possible heteroscedasticity of the shocks and nonlinearities in the simultaneous relations among the variables of the model. Because time variation both in the coefficients and the variance covariance matrix is allowed, the data identifies whether the time variation of the linear structure stems from changes in the size of the shocks (impulse) or from changes in the propagation mechanism (response) (Primiceri, 2005, p. 823). Consequently, the TVP-VAR model can be given as below;

$$y_t = c_t + B_{1,t} y_{t-1} + \ldots + B_{k,t} y_{t-k} + \mu_t \tag{3}$$

In Equation (4), the observed endogenous variables are contained in a $(Kx1)$ y_t vector and c_t is a $(Kx1)$ vector of time varying coefficients that multiply constant terms. Additionally, the time varying coefficients are included in $(nxn) B_{i,t}$ matrix in Equation (5), and μ_t has heteroscedastic unobservable shocks with variance covariance matrix Ω_t (Primiceri, 2005, pp. 823 − 824). The SSR is ordered at last in our model, while we select the order of the TED spread and stock returns arbitrary. Within the Blanchard-Quah-type SVAR modeling framework and also parallel to Primiceri (2005), we identify our model by the assumption that the TED spread and stock returns do not instantaneously respond to the changes in the SSR. It is assumed that the TED spread and stock returns react to the SSR with at least one period of lag. Accordingly, the time-series vectors used in our empirical analysis can be given as; $(sto_t , ted_t , ssr_t)'$.[4]

3. Empirical Data and Analysis

3.1. Empirical Data

In order to have robust estimation results, we followed Bai (1997) and Bai and Perron (1998; 2003) to determine the structural break dates. Bai-Perron tests of l + 1 vs. l globally determined breaks were used to test the null hypothesis of l break versus the alternative of l + 1 breaks, until it was no longer possible to reject the null hypothesis.[5] Those test results are also in line with the UDmax and WDmax statistics of Bai-Perron tests of 1 to M globally determined breaks. In this respect, it was indicated that there are multiple structural breaks in the variables under investigation due to the macroeconomic and financial developments for

[4] Equations (1) – (4) provide the basis for the BVAR and TVP-VAR models; in this context, the coefficients of the models' variables are presented in vectors A_j and $B_{i,t}$, respectively. Considering the related equations, the IRFs and FEVDs of both models can also be performed for the following periods. However, when the scientific literature is examined in terms of the journals covered in SSCI, it can be inferred that almost all the studies do not interpret the estimated parameter values of VAR-type models. In this respect, we do not analyze the relationships between variables over the calculated coefficients of BVAR and TVP-VAR models and thus the value of estimated parameters are not given.

[5] The relevant test allows error distributions to differ across breaks, while the intercept term was employed as a regressor to vary across breakpoints.

the period from 2005:11 to 2018:07. Thus, the Lumsdaine-Papell unit root test was employed to determine the unit root properties of the series under investigation.[6] The stock returns, the TED spread, and the SSR variables for the period 2005:11 to 2018:07, corresponding to the full-sample, were derived and unit root testing was performed. Considering the 1% level of significance, we found that all variables are not stationary at levels. However, the Johansen cointegration test results at the 1% significance level stresses that the relationship between those variables cannot be investigated within the Vector Error Correction (VEC) framework. Because multiple break dates were obtained, we suggest that it seems to be meaningful to divide the sample according to the GFC. Accordingly, we determined the recent financial crisis as a factor to specify a sub-sample (2010:01 to 2018:07) and also conducted an empirical exercise in that framework. More specifically, we estimated two BVAR modeling frameworks: Model 1 covers the period from 2005:11 to 2018:07, while Model 2 considers the financial crisis period from 2008:01 to 2018:07. Similar to the Lumsdaine-Papell unit root test results for the variables from 2005:11 to 2018:07, we found that the variables derived for the period from 2010:01 to 2018:07 are integrated of order one at levels at the 1% significance level; however, no cointegration relationship was found as a result of the Johansen Cointegration test. Therefore, it can be inferred that our methodology is supported.[7]

3.2. Empirical Analysis

In this study, we employ BVAR models for the Euro area, and the US to determine the future dynamics of the TED spread, stock returns and the SSR by computing their forecasts and thus exhibiting the interactions between them. The Akaike Information Criterion (AIC) is used to determine the lag length of the models and a lag length of 2 for BVAR models $1-2$ with the time-series vectors; $(sto_t^{eu}, ted_t^{eu}, ssr_t^{eu})'$, $(sto_t^{us}, ted_t^{us}, ssr_t^{us})'$. Our BVAR models are identified by the most commonly used prior in the literature, namely the Minnesota prior. The Lumsdaine-Papell unit root tests show that the variables for the Euro area, and the US have no unit root when they are first differenced, but, they can still have long memory, and thus, have a high degree of persistence. The robustness of the BVAR model estimations using the Minnesota prior are also confirmed by the

[6] None of the series contain deterministic trends; thus, we select the type of break as intercept. On the other hand, it has been acknowledged by many researchers that allowing for breaks may have the consequence for the series to be classified as stationary, as the most significant deviations from stationarity can be masked by an incorporation of a regime switch.

[7] The Lumsdaine-Papell, Bai-Perron, Johansen Cointegration test results can be given upon request.

alternative BVAR models with the Diffuse and Normal-Wishart priors. On the other hand, our TVP-VAR models have the full-sample running from 2005:11 to 2018:07, where 2 lags are used for the estimation. Following to Primiceri (2005), the simulations realize 10,000 iterations of the Gibbs sampler, discarding the first 2000 for convergence. Additionally, the prior distributions are incorporated using the first 40 months (from 2005:11 to 2009:02).

3.2.1. Results of FEVD Analysis

To analyze the variations in stock returns, we use BVAR models' FEVDs to determine the contribution of the shocks in the model variables for the following 36 periods. As shown in Table 1, most of the variations in stock returns are related to their past values for all cases. According to the FEVDs of BVAR 1, the past values of shocks in stock returns explain at least 50% of its own variation as of the following 36^{th} forecast periods. This finding shows that the technical dynamics of the stock market will affect supply and demand in the market in the future periods, while similar implications can be made for the FEVDs of BVAR 2. Past values of stock returns also mainly account for the changes in stock returns in the Euro area after the GFC, whereas the role of the past value of the relevant variable is found to be below 50%. Thus, it is indicated that the ability of the ECB to influence the stock market by using the SSR is relatively effective, in line with Eksi and Tas (2017). According to the FEVD results of the BVAR 2 model, the share of SSR in explaining the stock return is 61% and 54% in the Euro area and less than 10% in the US, respectively. In other words, it can be put forward that the volatility in stock markets and the bubbles in financial assets cannot be mitigated by the SSR in the US. However, the BVAR 2 model, which covers the post-crisis period, implies that the monetary policy of the ECB may have a high impact on financial variables. Accordingly, we can infer that the QE policy implemented by these central banks has a limited impact on the decisions of financial investors. On the other hand, FEVD results show that the unconventional monetary policy in the US does not have a high impact on financial variables due to the developed financial markets. In this regard, it can be said that the effects of financial securities in both countries are more than that of the Euro area.

Within the scope of the BVAR 1 and 2 models, we also examine the share of the TED spread, which is an indicator of the credit condition, in the disclosure of changes in stock returns. The FEVD analysis covering the period of 2005:11 – 2018:07 reveals that the weight of the TED spread on stock returns is high in the Euro area, and the US; however, FEVDs of the BVAR 2 model shows that the relevant weight is relatively low. These findings indicate that the relationship between stock returns and credit risk in those economies is weakening. Thus, it can be interpreted that the QE policy in the Euro area, and the US increases enterprises' and other economic agents' access to credit. Because the TED spread is also related to the 3-month Treasury bill, it can be implied that the relationship between financial securities based on short-term interest rates and stocks in terms of investment alternatives decreases after the GFC. More specifically, it can be claimed that investment decisions in the Euro area, and the US are evaluated on the basis of long-term interest rates.

T a b l e 1

FEVDs of Stock Returns

Full-sample				**Sub-sample**			
Forecast horizon	Δsto_t^{eu}	Δted_t^{eu}	Δssr_t^{eu}	Forecast horizon	Δsto_t^{eu}	Δted_t^{eu}	Δssr_t^{eu}
1	100.0000	0.000000	0.000000	1	100.0000	0.000000	0.000000
12	81.28178	17.44249	1.275731	12	81.70764	0.539384	17.75297
24	72.77470	20.70137	6.523926	24	48.74261	1.754244	49.50315
36	67.44629	19.38388	13.16983	36	36.20521	2.658883	61.13591
Forecast horizon	Δsto_t^{us}	Δted_t^{us}	Δssr_t^{us}	Forecast horizon	Δsto_t^{us}	Δted_t^{us}	Δssr_t^{us}
1	100.0000	0.000000	0.000000	1	100.0000	0.000000	0.000000
12	83.99450	15.98183	0.023673	12	97.67717	1.820572	0.502256
24	77.80969	21.67277	0.517539	24	95.23231	3.602550	1.165143
36	75.47624	22.81992	1.703835	36	93.95845	4.410658	1.630894

Source: Authors' own calculations.

The FEVD analysis based on the BVAR 1 and 2 models investigates which factors may be the source of variations in the TED spread in the Euro area, and the US in the following periods. The FEVD results of the BVAR 1 model show that the past values of the TED spread have a weight of at least 70% in explaining the variations as of the following 36 forecast periods, which is parallel to the findings of Cetorelli and Goldberg (2012), Neuenkirch and Nöckel (2018), Brana, Campmas and Lapteacru, (2018) and Ganelli and Tawk (2019). In this respect, it is seen that the relationship between the dynamics of the credit market and the stock market is weak. Additionally, the FEVD analysis of the BVAR 1 model reveals that the power of conventional and unconventional monetary policy determining the credit risk is weak but notable. Because the TED spread is related to the 3-month Treasury bill, it can be claimed that changes in the stock market and monetary policy in the short run may have consequences in the money market. The FEVD analysis of the BVAR 2 model gives similar results compared to the BVAR 1 model; more specifically, it is revealed that there is no substantial difference between the two models in terms of the explanation of the variations in the TED spread by the other variables. In addition, the credit risk and the country risk reflected in LIBOR have proven to be dominant factors in the US.

Accordingly, it is revealed that the US money markets, and especially the credit market dynamics of the country, may vary depending on the macroeconomic performance. On the other hand, the absence of significant changes within the scope of both BVAR model results in the Euro area can be explained by the fact that the region consists of a large number of countries and that each country does not have country-specific characteristics that may affect credit conditions of the whole area. However, the weight of conventional and unconventional monetary policies in the Euro area, and the US countries on the TED spread does not differ significantly between the BVAR 1 and BVAR 2 models. This finding points out that the TED spread may not follow the monetary policy stance, and moreover, the credit interest rates may not correspond to the credit market dynamics. In other words, the 3-month Treasury bill and the interbank interest rates may not be substantially under the influence of the policy interest rates.

Table 2

FEVDs of the TED spread

Full-sample				Sub-sample			
Forecast horizon	Δsto_t^{eu}	Δted_t^{eu}	Δssr_t^{eu}	Forecast horizon	Δsto_t^{eu}	Δted_t^{eu}	Δssr_t^{eu}
1	8.250773	91.74923	0.000000	1	6.879574	93.12043	0.000000
12	6.530357	91.93502	1.534622	12	8.109830	89.62730	2.262870
24	8.024975	88.60446	3.370568	24	7.631756	87.93843	4.429810
36	9.406948	86.49706	4.095996	36	7.653934	87.06872	5.277343
Forecast horizon	Δsto_t^{us}	Δted_t^{us}	Δssr_t^{us}	Forecast horizon	Δsto_t^{us}	Δted_t^{us}	Δssr_t^{us}
1	15.99129	84.00871	0.000000	1	3.032985	96.96701	0.000000
12	14.39756	83.46340	2.139040	12	3.255261	94.06430	2.680441
24	17.12881	77.20328	5.667917	24	6.154518	89.91968	3.925803
36	20.72557	72.34734	6.927085	36	10.54672	85.59698	3.856308

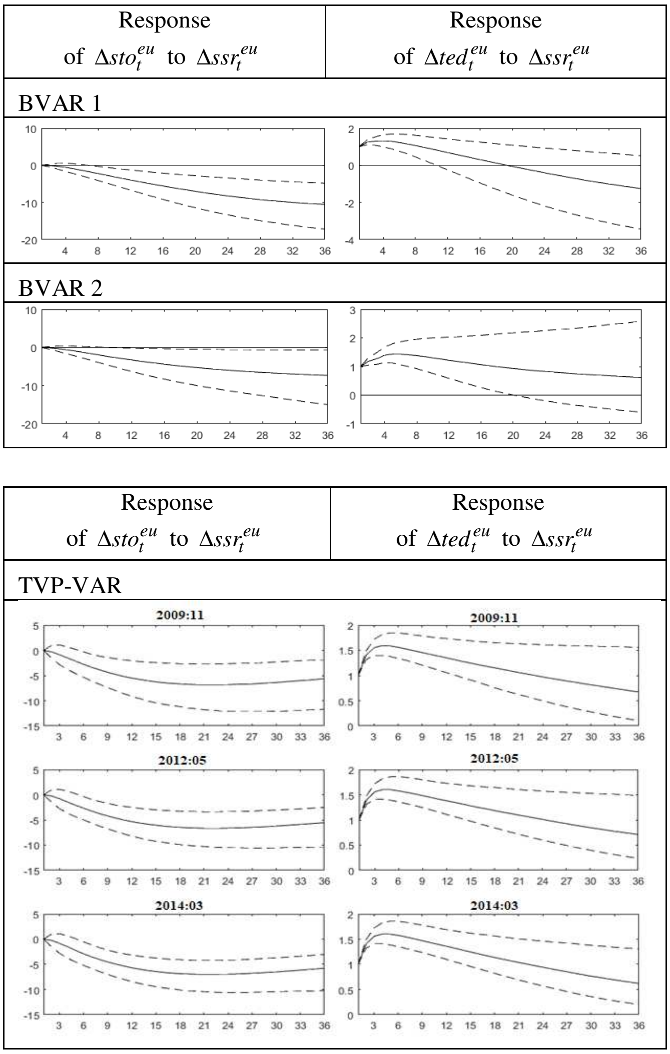
Source: Authors' own calculations.

3.2.2. The Results of the Impulse Response Analysis

In this study, the IRFs are estimated, whereupon the effects of the shocks in the SSR on the TED spread and stock returns are determined for the following 36 periods. Within the scope of the BVAR 1 model, the positive shocks in the SSR lead to a decrease in stock returns in the Euro area, which is in line with Caraiani and Călin (2018), but in contrast to Gali and Gambetti (2015). Accordingly, it can be asserted that the contractionary conventional and unconventional monetary policy implementation will reduce the investor's interest in the stock market. However, this negative effect becomes especially evident from the 8th period onwards and is persistent up to the 36th period. Unlike the Euro area, the impulse response analysis of the BVAR 1 and 2 models for the US does not detect a statistically significant impact of the contractionary monetary policy on stock returns. In other words, it is revealed that the contractionary monetary policy in the US does not have any effect on reducing the stock prices. For the case of the Euro area, it can be inferred that the rise in interest rates decreases the stock returns associated with the real sector by creating the expectation that economic growth will slow down. Because the BVAR models do not incorporate the role of asymmetry in the estimation process, it can be inferred that unlike the US, the contractionary/expansionary monetary policy in the Euro area may prevent/trigger the formation of financial asset bubbles, and the risk of financial crisis will be changed.

Figure 1

Responses to the SSR Shocks in BVAR and TVP-VAR Models (The Euro Area)



Source: Authors' own compilations.

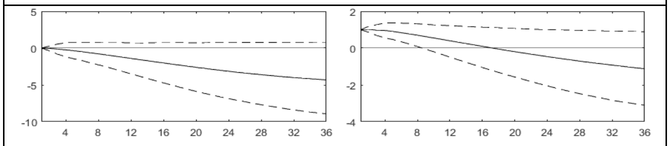
On the other hand, the effects of the expansionary conventional and unconventional monetary policy can be examined in terms of the models incorporating the asymmetric effects and the IRFs estimated in this framework. According to Kilian and Vigfusson (2011), asymmetric effects can be examined in the model based on VAR structure. In this framework, the examination of the asymmetric effects will not be carried by imposing restrictions in the estimation process on the basis of the transmission mechanism because there are two variables in the model. Another model used in our study is the TVP-VAR model, which is based on the SVAR structure in line with Primiceri (2005), whereupon the effects of the SSR increase are investigated. Additionally, the TVP-VAR model's IRFs can be reestimated according to specific dates. Therefore, the effects of the contractionary monetary policy on stock returns are analyzed by taking into account the regime changes and structural breaks. In contrast to the IRFs of BVAR models, the TVP--VAR model's IRFs show that the positive shock of the SSR in the stock returns can occur in the earlier periods for the case of the Euro area. Thus, it is implied that the impact of the contractionary monetary policy on the decrease in stock returns is observed in a short period of time as a result of regime changes and other similar factors. Because the TVP-VAR model considers the nonlinear relationships among variables by incorporating the regime changes, whereas the role of asymmetry is not taken into account in the model, we can assert that the reduction of the SSR (expansionary monetary policy) will have opposite effects on stock returns. Similar to the results of the impulse response analysis of both BVAR models, the TVP-VAR model's IRFs show that the SSR in the US has no significant effect on stock returns. Consequently, the developed US stock market is influenced by its own dynamics and is not affected directly by monetary policy implementation.

In terms of macroeconomic and financial stability, stock market bubbles are important, and the effects of the changes in the monetary policy stance on the interest rates of credit given by the banking sector are also crucial. Additionally, central banks may influence the credit risk and liquidity conditions of a country by their conventional and unconventional monetary policy implementations. More precisely, it can be assumed that the contractionary monetary policy implementations will be reflected in interest rates of other financial securities with different maturities, and the increase in the SSR will increase commercial loan rates and short-term bond interest rates. In this context, IRFs estimated on the basis of the BVAR 1 and 2 models show that the contractionary monetary policy increases simultaneously with the TED spread. This finding can be regarded as parallel to Neuenkirch and Nöckel (2018), whereas it is in contrast to Choi and Lee (2016) and Brana, Campmas and Lapteacru, (2018). On the other hand, it is detected that the effects of the increase in the SSR become insignificant after a certain period of time. In other words, the relevant situation in the Euro area, and the US has not changed after the GFC.

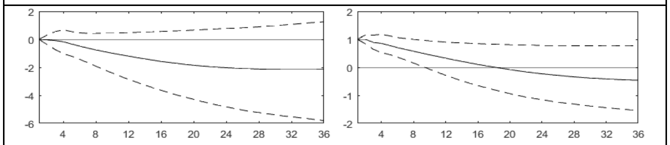
Figure 2

Responses to the SSR Shocks in BVAR and TVP-VAR Models (The US)

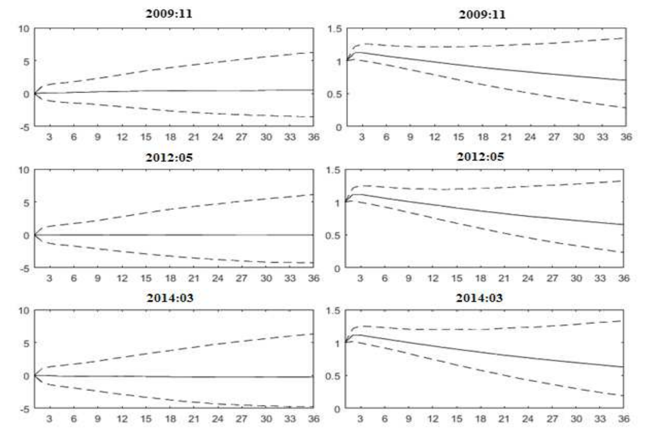
Response of Δsto_t^{us} to Δssr_t^{us}	Response of Δted_t^{us} to Δssr_t^{us}
BVAR 1	



BVAR 2



Response of Δsto_t^{us} to Δssr_t^{us}	Response of Δted_t^{us} to Δssr_t^{us}
TVP-VAR	



Source: Authors' own compilations.

When the effects of regime changes and macroeconomic developments are taken into account in the estimation process, it is found that an increase in the SSR will raise the country's LIBOR compared to the 3-month Treasury bill rates, and thus the TED spread of the country and its credit risk will rise. The TVP-VAR model's IRFs show that this effect is persistent over longer horizons compared to BVAR models, but the magnitude of the impact is descending. Therefore, it is implied that the ECB and the FED do not achieve absolute control over the interbank interest rate and the interest rates of commercial and consumer credit by increasing the SSR. Similarly, it can be inferred that an expansionary conventional and unconventional monetary policy will not lower the loan rates with respect to the 3-month Treasury bill rates or decrease the TED spread when regime changes and other factors are taken into account.

Conclusion

In this study, a FEVD analysis is implemented to determine the role of the SSR in explaining the variation of stock returns and the TED spread. In this framework, the FEVD results of the BVAR 1 model show that the past values of the stock returns are of primary importance to explain its own variations in the upcoming periods. In other words, in the Euro area, and the US, the stock returns have at least 50% weight up to the 36th period. The results of the BVAR 2 model, which focuses on the post-GFC period, reveal significant changes in the role of stock returns. While the values of stock returns in the Euro area have decreased compared to past values, they have reached high levels in the case of the US. The results of the FEVD analysis of the BVAR 2 model show that the conventional and unconventional monetary policy decisions of the ECB would have a high impact on stock prices. Therefore, it can be put forward that the monetary policy authorities of the Euro area may have the power to prevent the formation of financial asset bubbles by using the SSR as a tool. Similarly, it can be said that the depth of the stock market and the wide range of financial securities in the US reduce the efficiency of the Fed in that respect.

Despite the fact that the IRFs estimated in this study do not incorporate the role asymmetry, the IRFs of the BVAR 1, 2, and TVP-VAR models reflect the effect of the SSR on the direction of stock returns. In this respect, our results show that contractionary/expansionary monetary policy implementations in the Euro area would decrease/increase the stock returns. More specifically, an increase in the SSR of the Euro area can generate an obstacle to the formation of financial asset bubbles according to our IRFs. Therefore, it can be said that the relevant finding obtained for the Euro area supports the hypothesis of our study. However, it can be suggested that contractionary monetary policy in the US will not prevent the formation of financial asset bubbles because the results of the IRFs are not statistically significant. Similarly, it can be claimed that expansionary monetary policy implementations, which can be associated with the reduction of the SSR, will create opposite effects and may lead to financial asset bubbles in the Euro area.

In our study, the possible role of the SSR in the credit risk and liquidity of the market reflected in the TED spread was also analyzed with the help of FEVDs. Within this framework, significant differences are observed between the results of the FEVD analysis performed under the BVAR 1 and 2 models. The FEVD results of the BVAR 2 model show that the share of past values of the relevant variables is at least 85% in explaining the change of the TED spreads in the US. This result suggests that the changes in the interbank interest rates and thus the credit risk and the liquidity conditions in the US are not mainly affected by conventional and unconventional monetary policy implementations. In other words, we argue that macroeconomic performance and economic expectations in the US will have a major impact on the dynamics of the money and credit market.

In this paper, the effects of contractionary monetary policy were examined in terms of the increase in the SSR by using IRFs, and we found that the credit risk might increase and liquidity in the money market may decrease due to this policy in the following periods. Nevertheless, the effects of contractionary monetary policy are gradually decreasing for the BVAR 1, 2, and TVP-VAR models in the Euro area and the US, and our results imply that the SSR will not fully influence the difference between loan rates and the 3-month Treasury bill rates. Because BVAR and TVP-VAR models do not deal with asymmetry in their estimation process, we reveal that the hypothesis of our study is supported by our findings in terms of the TED spread. On the other hand, the effects of contractionary and expansionary monetary policy on stock returns and the TED spread can be transmitted through different channels, and there may be an asymmetric impact direction of each channel. Moreover, because the outcomes of the SSR on these two variables can be under the influence of microeconomic-based variables, the clarification of relevant channels by TVP-VAR and asymmetric VAR approaches becomes difficult. Control of the credit risk through monetary policy instruments and reduction of the possibility of financial asset bubbles are important for financial stability, and thus we suggest the adaptation of macroprudential policies to develop a more effective monetary policy framework.

References

AASTVEIT, K. A. – NATVIK, G. J. – SOLA, S. (2017): Economic Uncertainty and the Influence of Monetary Policy. Journal of International Money and Finance, *76*, No. 7, pp. 50 – 67.

ALESSANDRI, P. – NELSON, B. D. (2015): Simple Banking: Profitability and the Yield Curve. Journal of Money, Credit and Banking, *47*, No. 1, pp. 143 – 175.

BAI, J. (1997): Estimating Multiple Breaks One-at-a-Time. Econometric Theory, *13*, No. 3, pp. 315 – 352.

BAI, J. – PERRON, P. (1998): Estimating and Testing Linear Models with Multiple Structural Changes. Econometrica, *66*, No. 1, pp. 47 – 78.

BAI, J. – PERRON, P. (2003): Computation and Analysis of Multiple Structural Change Models. Journal of Applied Econometrics, *18*, No. 1, pp. 1 – 22.

BRANA, S. – CAMPMAS, A. – LAPTEACRU, I. (2018): (Un)Conventional Monetary Policy and Bank Risk-taking: A Nonlinear Relationship. Economic Modelling. Available at: <https://doi.org/10.1016/j.econmod.2018.07.005>.

CANOVA, F. (2005): The Transmission of U.S. Shocks to Latin America. Journal of Applied Economics, *20*, No. 2, pp. 229 – 251.

CARAIANI, P. – CĂLIN, A. C. (2018): The Effects of Monetary Policy on Stock Market Bubbles at Zero Lower Bound: Revisiting the Evidence. Economic Letters, *169*, No. 8, pp. 55 – 58.

CETORELLI, N. – GOLDBERG, L. (2012): Bank Globalization and Monetary Transmission. Journal of Finance, *67*, No. 5, pp. 1811 – 1843.

CHOI, H. S. – LEE, M. (2016): Credit, Banking, Liquidity Shortfall, and Monetary Policy. International Review of Economics and Finance, *46*, No. 6, pp. 87 – 99.

CONTI, A. M. (2017): Has the FED Fallen behind the Curve? Evidence from VAR Models. Economic Letters, *159*, No. 10, pp. 164 – 168.

EKSI, O. – TAS, B. K. O. (2017): Unconventional Monetary Policy and the Stock Market's Reaction to Federal Reserve Policy Actions. North American Journal of Economics and Finance, *40,* No. 2, pp. 136 – 147.

FAMA, E. F. – FRENCH, K. R. (2015): A Five-factor asset Pricing Model. Journal of Financial Economics, *116*, No. 1, pp. 1 – 22.

GALI, J. – GAMBETTI, L. (2015): The Effects of Monetary Policy on Stock Market Bubbles: Some Evidence. American Economic Journal: Macroeconomics, *7*, No. 1, pp. 233 – 257.

GANELLI, G. – TAWK, N. (2019): Spillovers from Japan's Unconventional Monetary Policy: A Global VAR Approach. Economic Modelling, *77*, No. 2, pp. 147 – 163.

IACOVIELLO, M. – NAVARRO, G. (2019): Foreign Effects of Higher U.S. Interest Rates. Journal of International Money and Finance, *95*, No. 6, pp. 232 – 250.

ILLES, A. – LOMBARDI, M. – MIZEN, P. (2015): Why did Bank Lending Rates Diverge from Policy Rates after the Financial Crisis? [Working Papers, 486.] Basel: BIS.

JEBABLI, I. – AROURI, M. – TEULON, F. (2014): On the Effects of World Stock Market and Oil Price Shocks on Food Prices: An Empirical Investigation Based on TVP-VAR Models with Stochastic Volatility. Energy Economics, *45*, No. 5, pp. 66 – 98.

KILIAN, L. – VIGFUSSON, R. J. (2011): Are the Responses of the U.S. Economy Asymmetric in Energy Price Increases and Decreases? Quantitative Economics, *2*, No. 3, pp. 419 – 453.

KIM, S. (2001): International Transmission of U.S. Monetary Policy Shocks: Evidence from VAR's. Journal of Monetary Economics, *48*, No. 2, pp. 339 – 372.

KOOP, G. – KOROBILIS, D. (2009): Bayesian Multivariate Time Series Methods for Empirical Macroeconomics. [MPRA Paper, 20125.] Munich: MPRA.

KRIPPNER, L. (2014): Documentation for United States Measures of Monetary Policy. Available at: <https://rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Research/Additional%20research/Leo%20Krippner/2014Documentation_20140930.pdf?la=en>. [Accessed September 27, 2018.]

LENGNICK, M. – WOHLTMANN, H. W. (2016): Optimal Monetary Policy in a New Keynesian Model with Animal Spirits and Financial Markets. Journal of Economic Dynamics and Control, *64*, No. 3, pp. 148 – 165.

NEUENKIRCH, M. – NÖCKEL, M. (2018): The Risk-taking Channel of Monetary Policy Transmission in the Euro Area. Journal of Banking and Finance, *93*, No. 8, pp. 71 – 91.

POTJAGAILO, G. (2017): Spillover Effects from Euro Area Monetary Policy across Europe: A Factor-augmented VAR Approach. Journal of International Money and Finance, *72*, No. 3, pp. 127 – 147.

PRIMICERI, G. E. (2005): Time Varying Structural Vector Autoregressions and Monetary Policy. Review of Economic Studies, *72*, No. 3, pp. 821 – 852.

SHIRAKAWA, M. (2010): Uniqueness or Similarity? Japan's Post-Bubble Experience in Monetary Policy Studies. Available at: <http://www.boj.or.jp/en/announcements/press/koen_2010/data/ko1009c.pdf>. [Accessed October 24, 2018.]

WU, J. C. – XIA, F. D. (2014): Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound. [NBER Working Papers, 20117.] Washington, DC: NBER.