Modelling the dynamics of sovereign risk premium in Romania*

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Abstract

This paper investigates the main determinants of the market-assessed sovereign risk premium in Romania, measured by the Option-Adjusted Spreads, from 2003 to 2013. The results show that the dynamics of sovereign spreads can be explained by both risk aversion indicators and macroeconomic fundamentals. Domestic fundamentals are found to be significant in explaining the spreads prior to and after the crisis. However, due to a regime switching for the Eurozone market volatility, sovereign spreads started to respond to changes in the volatility only post crisis, thus Romania experienced a re-pricing in its market-assessed risk premium. Furthermore, risk-premium shocks appear to have important macroeconomic effects. With respect to the risk premium management by the monetary authority, the NBR monetary policy does not appear to respond contemporaneously to a risk premium shock.

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1. **Introduction and Motivation**

The international financial crisis and the European sovereign debt crisis revealed the increasing importance of sovereign risk premium management, as they resulted in substantial rise in both government yields and sovereign risk premium. These crises also revealed that financial stability deserves much more attention, indicating that "there must be a role for monetary policy to address financial stability considerations" (Constâncio, 2012)[1]. Hence, both financial stability concerns and monetary policy decisions have emphasized the importance of understanding what drives the dynamics of sovereign risk premium in Romania and its consequences on the key macroeconomic variables.

Prior literature that analyzes the dynamics of sovereign risk premium in the European Emerging Markets proxies the risk premium to the 10 year yield spreads relative to Germany, due to the role of German Bunds as benchmark bonds. The spreads of Romanian sovereign debt over German Bunds have also widened substantially during the financial crisis. In this respect, I will make an attempt to identify the significant drivers of sovereign risk premium dynamics in Romania, focusing on two main categories of determinants. On the one hand, I will try to explain at which extent changes in risk premium occur due to improvements or deteriorations in country specific fundamentals. On the other hand, I will focus on the vulnerability of sovereign risk premium to changes in external financial conditions.

Recent developments of Romania's economy make the analysis of these determinants even more interesting: Romania is a small open economy that experienced a period of high annual growth rates (2002-2008) mostly driven by a strong domestic demand which resulted in high external imbalances. Furthermore, Romania tended to have, a rising fiscal deficit, both before and during the crisis, although, it has been significantly reduced during the last three years. It is not only the magnitude of these deficits and imbalances that require a deeper insight into the risk premium dynamics, but also the global financial crisis contagion that render it more vulnerable to external conditions. Hence, I will take a closer look at the importance of Eurozone financial

[1] Constâncio, V. (2012), Vice-President of the ECB, Conference of Financial Stability: Methodological Advances and Policy Issues, Frankfurt am Main, 14 June 2012.
http://www.ecb.europa.eu/press/key/date/2012/html/sp120614_1.en.html

conditions for risk premium dynamics. Understanding sovereign risk premium dynamics is also essential for the macroeconomic outcomes and the implications they may have in the monetary policy transmission. In this light, the paper also focuses on the macroeconomic effects of risk premium shocks such as currency depreciation, a deterioration in real GDP growth or an outbreak in inflation.

The remainder of this paper is structured as follows: In Section 2, I begin with a summary of the literature regarding the main drivers of sovereign risk premium. Section 3 describes the methodology, the data used and the estimation results. In the fourth section I will take a look at the consequences of the dynamics of risk premium on the main macroeconomic variables. I conclude and draw some policy implications of risk premium management in the fifth section.

1. The dynamics of sovereign risk premium in Romania

2.1. Literature Review

Several contributions have pointed out the role of macroeconomic fundamentals as explanatory variables of sovereign spreads and found a statistically and economically significant relationship between sovereign risk premium and country specific fundamentals. For instance, Codogno et al. (2003), Attinasi et al. (2009), Barrios et al. (2009), Haugh et al. (2009), Moody (2009), Sgherri and Zoli (2009), Gerlach et al. (2010) and Schuknecht et al. (2010) included fiscal variables such as Debt to GDP and Fiscal Balance to GDP ratios in their empirical analyses.

Other studies couple government finance variables with external liquidity indicators and financial market variables in order to reveal the main drivers of sovereign risk premium. For instance, Eichengreen and Mody (1998) investigated how much of the spread variation was influenced by fundamental factors in comparison to the market sentiment. They found that the rise in sovereign spreads cannot be fully explained by changes in macroeconomic fundamentals, suggesting that spreads were also driven by changes in global financial conditions. Özatay et al. (2009) investigated the impact of US macroeconomic news and macroeconomic indicators on sovereign spread movements in emerging markets and concluded that spreads were mainly determined by global financial conditions.

Other cross-country studies emphasized the existence of nonlinearities in the behavior of macroeconomic and financial variables that explain the sovereign spreads' dynamics. For instance, Barrios et al., (2009), Haugh et al., (2009), Gerlach et al., (2010) found that global risk may increase the cost of detaining a higher Public Debt to GDP ratio. Moreover, Dumičić and Tomislav (2010) showed that macroeconomic fundamentals such as the Current Account Balance, General Government Debt and External Debt to GDP ratios were not significant drivers of sovereign spreads in European emerging economies prior to the crisis, but became significant due to the financial turmoil.

Moreover, time-switching regimes in parameters are also used in modelling risk premium dynamics showing that the structural breaks in financial markets volatility strengthened the role of fiscal variables as drivers of sovereign risk premium. For instance, Attinasi et al. (2009) showed that coefficients for many macroeconomic fundamental determinants increased rapidly during the financial crisis. Furthermore, Caggiano and Greco (2011) showed that a structural break in financial markets volatility caused by the financial turmoil strengthened the role of fiscal variables as determinants of sovereign spreads in the Eurozone.

In contrast to the above studies, I show that in Romania's case, domestic and external imbalances were fundamental drivers of sovereign risk premium before and during the crisis. Similar to these studies, I address the problem of stability of parameters. My analysis reveals a structural break in the Eurozone volatility, associated with the financial crisis outbreak. Due to this regime switching for the volatility, Romania experienced a re-pricing in its market-assessed risk premium.

2.2. The empirical model

Starting from a model widely used in the literature on sovereign spreads, that separates risk premium determinants in country specific fundamentals and global specific factors, I estimate the following equation in order to model the dynamics of sovereign risk premium in Romania:

$$\Delta spread_t = \sum_i \beta_i CSF_{i,t} + \sum_j \beta_j GSF_{j,t} + u_t$$

where Δspread is the spread differential, CSF is a country-specific set of macroeconomic solvency and debt-related variables, GSF is a vector with global specific variables mostly capturing liquidity conditions, financial stress, or investors' degree of risk aversion and u is the error term. I use both macroeconomic and financial quarterly series[2] from 2002Q4 to 2013Q1 from NBR Database and other official sources such as those provided by National Institute of Statistics, Eurostat and Bloomberg. A detailed description of the variables is provided in the Appendix, Table A1. The spread used as a proxy for sovereign risk premium is the Option-Adjusted Spread (OAS) for Romanian bonds. The OAS is the yield spread between a bond and a government benchmark bond[3] . The OAS proxies the risk premium, as it measures the compensation an investor receives for a variety of risks net of the cost of embedded options. Descriptive statistics for this variable are provided in Table 1.

Table 1 – Descriptive statistics- Dependent Variable

Quarterly Change in OAS (basis points)	
Mean	-6.58
Median	-8.39
Maximum	580.98
Minimum	-211.076
Std. Dev.	107.15
Skewness	3.15
Kurtosis	18.68
Observations	52

Source: Own calculations

The data set of macroeconomic fundamental variables contains: the Quarterly GDP growth rate, the Quarterly CPI inflation, the Current Account Balance (%GDP), the Government Balance (%GDP), the Government Debt (%GDP), the External Debt (%GDP) and the Foreign Official Reserves (%GDP). As global specific variables[4] I use

[2] Two tests were used in order to examine macroeconomic and financial series for stationarity - a test with the null hypothesis a unit root in the series (augmented Dickey-Fuller) and a test with the null hypothesis the series is stationary (KPSS). According to KPSS test, most of the series used in further estimations are assessed to be stationary.

[3] German bonds with similar coupon and duration values.

[4] In the original work, the block of global specific variables also included a a Eurozone representative interest rate capturing the liquidity degree in the market (Euribor3M or ECB Rate) and Zew Eurozone Expectation of Economic Growth as an indicator of the economic sentiment. Since they were found to be insignificant, I excluded them from this analysis. In my opinion, they are already reflected in the Euro area's

only an implied volatility index, the VSTOXX Index[5], as a proxy of investors' risk aversion and the level of financial stress. Similar studies use the VIX or VDAX Index. I, however, find more relevant for Romania's case the VSTOXX Index, since it measures the volatility in the Eurozone. Descriptive statistics for these variables are provided in Table 2.

Table 2 – Descriptive statistics- Country and Global Specific Variables

	Quarterly GDP Growth Rate (%)	Quarterly CPI Inflation (%)	Current Account Balance (%GDP)	Government Balance (%GDP)	Government Debt (%GDP)	External Debt (%GDP)	Foreign Official Reserves (%GDP)	Quarterly Change in VSTOXX Index (percentage points)
Mean	3.61	10.78	-6.90	-3.55	22.04	7.67	4.16	-0.83
Median	4.12	8.05	-5.26	-2.87	22.30	8.15	4.71	-5.14
Maximum	13.04	35.16	-3.00	4.71	37.80	14.23	7.11	127.12
Minimum	-13.26	-3.11	-14.03	-12.32	11.40	0.19	-1.52	-53.93
Std. Dev.	5.04	9.02	3.26	3.82	7.59	3.92	2.16	31.19
Skewness	-0.82	1.37	-0.82	-0.47	0.44	-0.25	-0.65	1.72
Kurtosis	4.22	4.16	2.40	2.73	2.41	2.11	2.67	8.11
Observations	52	52	50	52	52	42	49	52

Source: Own calculations

The model is estimated using OLS. A GMM technique using instrumental variables is not necessary as I assume that there is no endogenous relationship between the contemporaneous values of the explanatory variables and those of the spread dynamics[6].

2.3. Estimation Results

Two analyses are presented in this section, similar with previous studies on both emerging and Eurozone debt markets. The first analysis investigates the effect of domestic fundamentals and global conditions on Romanian spreads as well as the potential interaction between the macroeconomic and the financial variables during

volatility, provided that financial markets and especially stock markets of developed economies act as advanced indicators of the macroeconomic outlook.

[5] Developed by Deutsche Borse and Goldman Sachs, it is based on the Dow Jones EURO STOXX 50 Index options traded on Eurex. It measures implied volatillity on options with a rolling 30 day expiry.

[6] I assume that changes in risk premium are contemporaneously influenced by both quarterly GDP growth rate and CPI inflation and not the opposite. As one will observe in the third section of this paper, I show that risk premium has explanatory power only for the future values of economic growth and inflation. However, the risk premium dynamics is found to have a contemporaneous effect only on the exchange rate dynamics. This explains why the exchange rate depreciation was not employed as a determinant for sovereign spreads dynamics when adopting the OLS technique.

2002Q4 to 2013Q1. The estimation results of this approach are presented in Table 3 (Equation Specifications 1-4). The second approach includes a time-switching regime in parameters induced by the onset of the financial crisis. The estimation results are presented in Table 4 (Specification 5-8).

Applying the OLS in the estimation requires correcting the errors for autocorrelation and heteroskedasticity in order to obtain efficient and unbiased estimators[7]. Therefore, the estimation of the standard errors is corrected for the presence of heteroskedasticity and autocorrelation of error terms in every equation specification using HAC covariance estimator proposed by Newey-West and West (1978). The Jarque-Bera test suggests that the residuals are normally-distributed.

Another methodology that can be used in order to account for serial correlation of residuals is including autoregressive terms. Following Caggiano and Greco (2011), in some specifications I ignore the lagged dependent variable terms, since for a variable like sovereign spread, the relevance of autoregressive terms decreases when observations have lower frequency (Attinasi et al., 2009). However, I will also consider for each specification an extended model including two autoregressive terms for both robustness checks and errors' serial correlation considerations.

The first analysis (Table 3) is motivated by the studies conducted by Ebner (2009) and Dumičić and Tomislav (2010). Ebner (2009) showed that a high market volatility is the most important factor influencing spreads of euro-dominated sovereign bonds in the CEE region during 1999 to 2007 and that market variables are more significant than fundamentals. In addition, Dumičić and Tomislav (2010) analyzed determinants of the changes in sovereign bond spreads in emerging European markets before and during the recent global financial crisis. According to their results, changes in spreads are driven by both changes in market sentiment and in domestic macroeconomic fundamentals. Furthermore, they showed that external imbalances were not significant determinants of spreads dynamics prior to the crisis, but became the most significant factors when the crisis broke out.

[7] Breusch-Godfrey Serial Correlation LM Tests and Breusch-Pagan-Godfrey Heteroskedasticity Tests were conducted on every specification and detected the presence of autocorrelation and heteroskedatsicity of error terms.

Table 3 – Equation Specifications

Equation Specification	1	2	3	4
Dependent Variable: **Quarterly Change in OAS** (basis points)				
Intercept	-113.04 [137.83] (0.42)	-112.22 [101.46] (0.28)	-32.54 [26.26] (0.22)	-11.55 [19.78] (0.56)
Quarterly Change in GDP Growth Rate (%)	**-3.96** **[1.96]** **(0.05)**	**-4.35** **[2.18]** **(0.06)**	**-2.71** **[1.13]]** **(0.02)**	-0.53 [0.96] (0.58)
Quarterly CPI Inflation (%)	2.83 [2.93] (0.34)	3.16 [2.33] (0.18)	-0.91 [2.10] (0.67)	**-2.74** **[1.36]** **(0.05)**
Current Account Balance (% GDP)	**-13.96** **[5.87]** **(0.02)**	**-9.82** **[4.99]** **(0.06)**	**-7.09** **[1.71]** **(0.002)**	**-4.68** **[1.74]** **(0.01)**
Government Balance (%GDP)	-1.78 [2.65] (0.51)	2.91 [1.90] (0.14)		
Government Debt (%GDP)	2.13 [2.96] (0.48)	2.61 [2.38] (0.28)		
External Debt(%GDP)	-5.27 [4.09] (0.21)	-1.81 [4.76] (0.71)		
Foreign Official Reserves(%GDP)	-0.67 [5.78] (0.91)	1.91 [5.86] (0.75)		
Quarterly Change in VSTOXX Index (percentage points)	**2.93** **[0.73]** **(0.0003)**	**2.95** **[0.65]** **(0.0001)**	0.32 [0.91] (0.73)	0.90 [0.55] (0.11)
Government Balance (%GDP) x Change in VSTOXX			**-0.41** **[0.04]** **(0.0000)**	**-0.40** **[0.02]** **(0.0000)**
Government Debt(%GDP) x Change in VSTOXX			-3.31 x 10^{-5} [0.03] (0.99)	-0.005 [0.02] (0.74)
External Debt(%GDP) x Change in VSTOXX			-0.19 [0.13] (0.16)	-0.13 [0.08] (0.12)
Foreign Official Reserves(GDP) x Change in VSTOXX			0.34 [0.29] (0.25)	0.10 [0.17] (0.56)
Quarterly Change in OAS (-1)		0.13 [0.09] (0.16)		**0.21** **[0.05]** **(0.0001)**
Quarterly Change in OAS (-2)		**-0.19** **[0.07]** **(0.01)**		**-0.09** **[0.03]** **(0.0014)**
Observations	41	41	41	41
R-squared	0.73	0.78	0.89	0.92
Adjusted R-squared	0.66	0.71	0.86	0.90

t-Statistic probabilities are in parentheses, Standard Errors are in brackets

Source: Own calculations

In the first specification all country specific variables are included. According to the first specification, country fundamentals do not account for the OAS variation, except for the quarterly growth in GDP and the Current Account Balance to GDP ratio (at a 10% significance level), which makes it very difficult to interpret the model from a macroeconomic perspective. However, the coefficients of the other country specific variables have the expected sign (except for the External Debt to GDP Ratio). As for the global specific variable, one can notice that risk premium movements seem to mostly occur due to changes in the volatility index. This model, however, remains difficult to interpret in terms of his statistical adequacy. The second equation corresponds to the extended model, where two autoregressive terms are included. The first lag of the dependent variables is not found to be significant.

Following Dumičić and Tomislav (2010), I will now investigate whether the domestic variables that were not found statistically significant in the first model, may become significant during periods associated with high volatility. Hence, in the third specification I include some interaction terms between these variables and the changes in volatility. These interaction terms may point out non-linear relationships between some of the macro specific fundamentals and the market uncertainty captured by the VSTOXX Index.

The same country specific variables were found to be significant in Specifications 3. Moreover, in crisis time and other periods associated with high volatility, the fiscal balance has a significant impact in changes on spreads and moreover, it appears to have the expected sign. The value of the adjusted R^2, of 85%, seems high indicating that the model is able to capture enough variability of the changes in spreads. This is however, a specification difficult to interpret, as the change in the Eurostoxx 50 volatility is not significant anymore. Specification 4 includes, apart from the interaction terms, two lags of the changes in Romanian spreads. They are found to be highly significant, indicating a prolonged persistence in the Romanian risk premium dynamics as well as a backward-looking pricing of sovereign spreads. Nevertheless, the specification remains difficult to interpret form an economic perspective because the CPI inflation appears statistically significant but does not have the expected sign. The changes in volatility are also statistically insignificant.

The poor statistical and, in particular, economical validity of the results found in this approach drives my interest for introducing another empirical approach for analyzing the dynamics of risk premium in Romania. I come back to the first specification, and following Sgherri and Zoli (2009), Bernoth and Erdogan (2010) and Schuknecht et al. (2010) I test whether time-switching regimes in parameters occurred due to the systemic distress caused by the financial crisis. I first run a Chow breakpoint test that verifies whether all regressors vary across the breakpoint 2008Q3. This breakpoint is associated with the financial crisis outbreak in Romania indicated by the first negative quarterly economic growth rate, that is -0.43%. The results (untabulated) suggest that there was a structural break in the third quarter of 2008 and therefore, some coefficients are not stable and may change at the beginning of the crisis. Further, I run similar stability tests on the parameters of each explanatory variable in order to find those that potentially changed after the crisis. All coefficients of macroeconomic factors were found to be stable. I now verify whether the financial series used for the changes in Eurozone volatility contains a structural break. In this case, the Chow breakpoint test suggests that in the earlier specifications of the equation, the coefficient for the change in VSTOXX Index was not stable; therefore, it had different magnitudes before and after the crisis.

In the following specifications I include the stability test result using a slope time dummy variable, the Crisis Dummy (which takes the value 0 before the crisis and 1 starting from 2008Q3). In this second approach, the estimation results are, in part, consistent with the literature documenting parameters' instability in sovereign-spreads econometric models. As indicated earlier, Bernoth and Erdogan (2010) show that coefficients of global risk and deficit-to-GDP ratios changed after the crisis. In contrast to these results, the following specifications indicate only an unstable coefficient for the changes in volatility used as a proxy for the global risk.

These specifications are presented in Table 4. Some macroeconomic fundamental variables such as the Current Account Balance (%GDP), Government Balance (%GDP), Government Debt (%GDP), External Debt (%GDP) and Foreign Official Reserves (%GDP) are lagged one period, as most of the macroeconomic shocks are not rapidly transmitted.

Table 4 – Equation Specifications

Equation Specification (with Structural Break)	5	6	7	8
Dependent Variable: **Quarterly Change in OAS** (basis points)				
Intercept	**-216.00** **[89.33]** **(0.02)**	**-174.81** **[92.75]** **(0.07)**	**-222.99** **[91.70]** **(0.02)**	**-175.46** **[91.58]** **(0.06)**
Quarterly Change in GDP Growth Rate (%)	**-4.45** **[1.63]** **(0.01)**	**-3.08** **[1.63]** **(0.07)**	**-3.93** **[1.43]** **(0.01)**	**-3.01** **[1.44]** **(0.05)**
Quarterly CPI Inflation (%)	**4.16** **[2.46]** **(0.10)**	2.35 [2.21] (0.30)	3.99 [2.54] (0.12)	2.31 [2.20] (0.30)
Current Account Balance (%GDP) (-1)	**-10.50** **[4.75]** **(0.03)**	**-10.44** **[5.60]** **(0.07)**	**-11.28** **[4.64]** **(0.02)**	**-10.54** **[5.47]** **(0.06)**
Government Balance (%GDP) (-1)	1.37 [1.85] (0.46)	0.19 [1.50] (0.90)		
Government Debt (%GDP) (-1)	**4.53** **[2.19]** **(0.05)**	**3.72** **[2.12]** **(0.09)**	**4.56** **[2.23]** **(0.05)**	**3.72** **[2.09]** **(0.09)**
External Debt(%GDP)(-1)	5.32 [4.10] (0.20)	2.07 [3.26] (0.53)	4.52 [3.68] (0.23)	1.95 [3.09] (0.53)
Foreign Official Reserves (%GDP)(-1)	-2.47 [4.30] (0.57)	-0.73 [4.04] (0.86)	-2.12 [4.34] (0.63)	-0.67 [4.06] (0.87)
Quarterly Change in VSTOXX Index (percentage points)	-0.06 [0.82] (0.94)	0.13 [0.63] (0.85)	-0.13 [0.79] (0.88)	0.11 [0.61] (0.85)
Quarterly Change in VSTOXX Index x Crisis Dummy (percentage points)	**3.40** **[0.78]** **(0.0001)**	**3.32** **[0.65]** **(0.0000)**	**3.51** **[0.76]** **(0.0001)**	**3.33** **[0.65]** **(0.0000)**
Quarterly Change in OAS (-1) (basis points)		**0.16** **[0.08]** **(0.05)**		**0.17** **[0.08]** **(0.04)**
Quarterly Change in OAS (-2) (basis points)		**-0.14** **[0.04]** **(-0.001)**		**-0.15** **[0.04]** **(0.0007)**
Observations	41	41	41	41
R-squared	0.83	0.87	0.83	0.87
Adjusted R-squared	0.78	0.82	0.79	0.83

t-Statistic probabilities are in parentheses, Standard Errors are in brackets
Source: own calculations

According to the above figures, prior to the crisis, not only changes in VSTOXX Index appear to have had a different impact on spread movements, but they also appear statistically insignificant. The intuition behind this result is the following: prior to the global crisis, investors' perception of Romanian sovereign bonds risk was probably independent of the level of volatility from European stock markets, as changes in volatility were

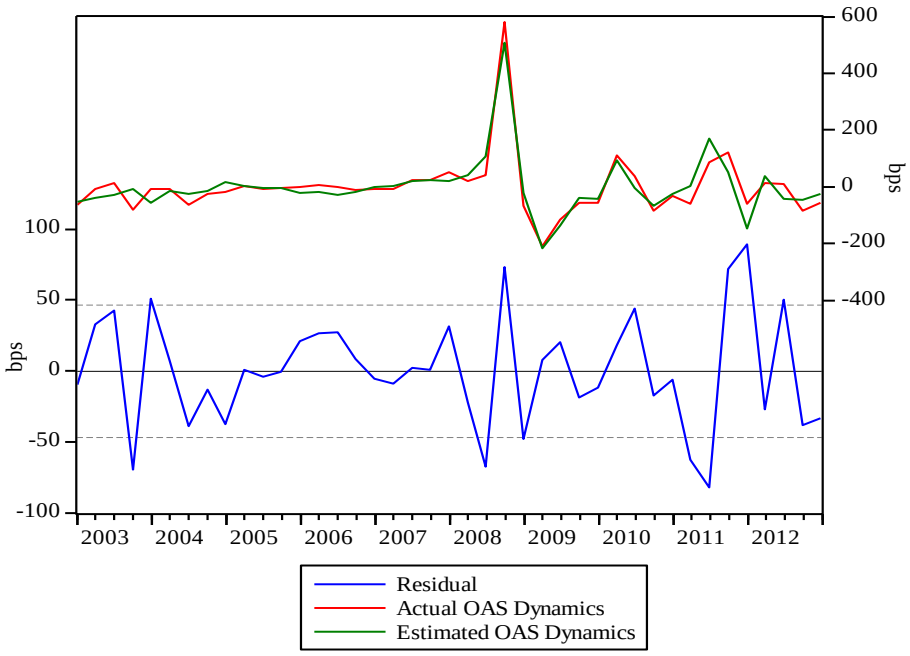
relatively low. For this reason, markets might have ignored this level of uncertainty from financial markets before 2008, giving more weight to domestic fundamentals. However, as the crisis broke out, asset classes became more and more correlated and markets have started paying attention to this level of uncertainty and financial stress. The global crisis has probably changed the pricing of Romanian sovereign spreads as well. Hence, changes in volatility appear to be priced in risk premium dynamics since the financial crisis outbreak and probably continued to have a major impact due to the sovereign debt crisis in Europe.

As indicated in the estimations' results from Specification 5, changes in volatility became indeed statistically significant after the financial turmoil. All things being equal, an increase of 1 percentage point in the VSTOXX stresses in average the Romanian sovereign spread by 3.34 basis points. Moreover, using the specifications with the regime switching for the volatility, several macro-fundamental factors are found to have a significant impact on the market-assessed risk premium dynamics. Apart from the Quarterly GDP Growth Rate and Current Account Balance to GDP Ratio, whose coefficients continue to appear significant and with the expected signs (they relax the spreads), quarterly CPI Inflation and Government Debt to GDP Ratio are also found to be fundamental drivers of sovereign risk premium in Romania (at 10% level of significance). Their coefficients can be interpreted as the average tension in the risk premium that would result from a unit change in these variables.

Even if it is found statistically significant, the government balance is worth some further discussion. The fact that it does not appear with the sign suggested in the literature is not very surprising in Romania's case, as the fiscal policy was pro-cyclical in most of the reference period. Romania tended to have a rising fiscal deficit even when it experienced high economic growth rates. For these considerations and since the model also employs another measure of public finance, in Specification 7, the fiscal balance as a percentage of GDP is eliminated. As for the External Debt and Foreign Official Reserves to GDP Ratios, even if they are found statistically insignificant, they are kept in the model, because their elimination reduced significantly the Adjusted R squared. Hence, they seem to explain somehow the variation of the dependent variable. CPI inflation appears now to be only very marginally significant with a p-value of the t-Statistic of 12%.

The extended form of equation 5 and 7 containing two lags of the depended variable are specified in Equation 6 and 8. Both autoregressive terms are found significant as in the previous analysis suggesting a quite persistent risk premium. Despite an improvement in both R and Adjusted R squared, the quarterly CPI inflation does not account anymore for the risk premium dynamics. Figure 1 provides an illustration of the Equation Specification 8.

Figure 1 – Equation Specification 8



Despite periods of volatility and high tensions in the Eurozone, country-specific fundamental factors such as the Quarterly GDP Growth Rate, Quarterly CPI Growth Inflation, Current Account Balance and Public Debt to GDP Ratios remain relevant drivers of the dynamics of sovereign risk premium. However, prior to the crisis, markets seem to have ignored the changes in external financial conditions extracted from the VSTOXX index, but due to a structural adjustment in investors' perception of sovereign risk, they have started to price them in sovereign spreads since the financial outburst.

3. Macroeconomic effects of risk premium shocks

This part of the analysis looks into the effects of a risk-premium shock on the main macroeconomic variables: GDP, inflation and the exchange rate. The empirical part of this section is similar to the research done by Carare and Popescu (2011), as their study focuses on monetary policy and risk premium shocks in Hungary, an emerging small open economy as Romania.

3.1. The VAR Model

In order to estimate the dynamic interaction between the risk premium and the macroeconomic variables of interest, I adopt a Vector Autoregression approach. As in the case of monetary policy shocks, the VAR approach is very appropriate to understand the transmission mechanism of a risk premium shock to other endogenous variables. In addition, the VAR framework not only captures the evidence in the data, but it also allows a shock identification scheme in order to impose theoretical assumptions. I identify the shock as an unexpected rise in Romania's sovereign risk premium dynamics, measured by the Option-Adjusted Spread differential.

A reduced form VAR is employed and each equation is estimated using OLS from 2000Q4 to 2013Q1. I include only stationary endogenous variables in order to obtain a stable VAR. To be consistent with the first part of this paper, I include as a measure of the real activity the quarterly GDP growth rate. For the same reason, in order to measure the price dynamics, I use the quarterly CPI inflation rate. The exchange rate dynamics is captured by the nominal exchange rate depreciation/appreciation. I also investigate the reaction of the NBR monetary policy to a risk premium disturbance and its monetary policy implications, thus the NBR policy rate is also included.

Concerning the new variables introduced in this section, I use nominal exchange rate series (EUR/RON) in order to obtain the stationary series for the currency depreciation used in the VAR estimation. The NBR policy rate is used in level. A more detailed description of the data and their sources can be found in the Appendix in Table A1. An intercept is included in the VAR.

Because of the measure of Real GDP growth rate, data is used at quarterly frequency as in the previous analysis. Descriptive statistics of the VAR's endogenous variables are provided in Table 5.

Table 5 - Descriptive Statistics- VAR Variables
Sample 2000Q4:2013Q1

	Quarterly Change In OAS (basis points)	Quarterly Exchange Rate Depreciation (%)	NBR Policy Rate (%)	Quarterly CPI Inflation rate (%)	Quarterly GDP Growth Rate (%)
Mean	-4.47	6.13	14.59	9.81	3.67
Median	-8.39	3.19	8.72	7.97	4.21
Maximum	580.98	49.98	49.06	33.31	13.04
Minimum	-211.08	-29.05	5.25	-3.11	-13.26
Std. Dev.	108.09	16.14	11.69	7.73	5.13
Skewness	3.16	0.60	1.57	1.38	-0.84
Kurtosis	18.51	3.12	4.56	4.61	4.12
Observations	50	50	50	50	50

Source: Own calculations

In order to determine the appropriate lag lengths, I use several LAG Length criteria[8]. All criteria indicate only one lag for the endogenous variables. The estimated VAR is stable, as all roots lie inside the unit circle.

3.2. Identification of risk premium shocks

Christiano et al. (1999) provide a review of the literature on how to identify monetary policy shocks. For instance, the Cholesky decomposition of the variance-covariance matrix has been widely used to identify monetary policy shocks. The Cholesky (recursive) identification scheme implies that there is an ordering of the variables so that the shock to one variable affects contemporaneously only the variables after.

Using a SVAR, Vonnák (2005) imposes sign restrictions for four quarters so that monetary policy shocks result in an exchange rate appreciation and higher policy rate for four quarters. Vonnák (2007) and Vonnak (2010) identify all shocks that lead to a positive correlation between the exchange rate and the interest rate as monetary policy shocks, and those that lead to a negative correlation are identified as risk-premium shocks. These restrictions are imposed for one year as well. In addition, Vonnák (2010) identifies monetary policy and exchange rate risk premium shocks by imposing both contemporaneous and sign restrictions on impulse responses.

Following Carare and Popescu (2011), I also employ the Cholesky approach for the identification of risk-premium shocks. In this light, I assume that a risk premium shock

[8] Akaike, Schwarz and Hannan-Quinn Information Criterion.

does not have a contemporaneous impact on economic growth, price dynamics and policy rate. In other words, it takes time until shocks originated in financial markets spread onto the real economy. Therefore, I assume the fact that only the exchange rate depreciation/appreciation is a contemporaneously responsive variable to a risk-premium shock, as it is a financial, "fast-moving" variable[9]. Thus, I order the variables as follows. First I place the GDP growth rate and the CPI inflation rate, then the NBR Policy rate. The OAS differential is next. Finally, I place the exchange rate depreciation. This ordering is also consistent with the first part of the paper. Whereas similar studies include the exchange rate as a determinant of risk premium dynamics in models estimated with OLS, in Romania's case, currency depreciation was not considered a determinant due to endogeneity considerations. Only the GDP growth rate and CPI inflation were included in the estimation, because, according to my assumptions, they do not respond contemporaneously to risk premium dynamics, thus the endogeneity issue disappears.

In order to trace the effects of a risk premium dynamics shock to the variables of interest, I use impulse response functions. The Cholesky approach defines the risk premium dynamics impulse as one standard deviation innovation that is an unexpected increase of around 102 basis points in the Option-Adjusted Spread differential.

3.3. Estimation Results

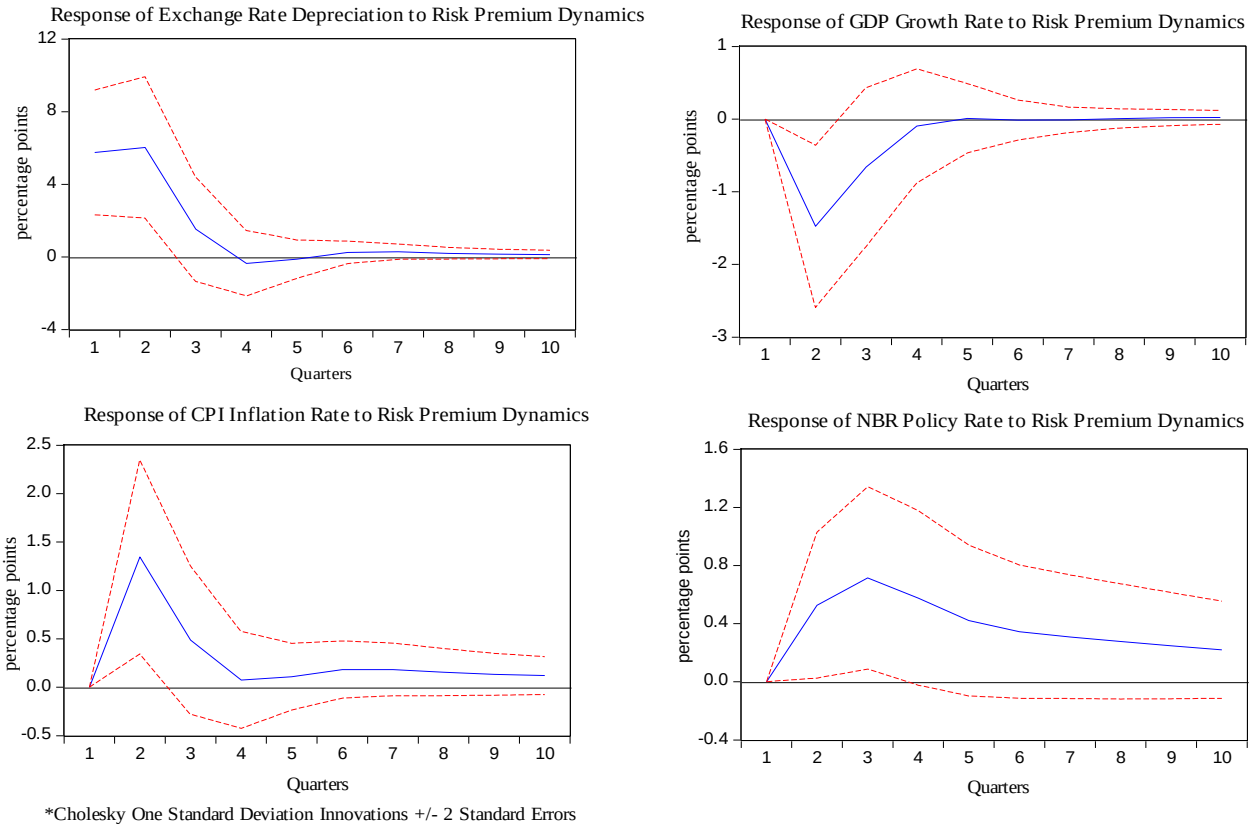
3.3.1. Impulse Responses Functions

Despite the reduced amount of information of the reduced form VAR, the results of Impulse Responses Functions are significant and confirm both the economic theory and the assumptions from the Cholesky ordering[10]. These results are shown in Figure 2, where responses of every variable of interest to a risk premium dynamics shock are illustrated with the standard error bands.

[9] According to Bernanke et al. (2005), the fast-moving variables are those variables highly sensitive to policy shocks or news, such as the stock market prices and financial assets. The term is also employed by Carare and Popescu (2011).

[10] The signs of the IRFs are in accordance with the ones suggested by the literature therefore, there is no necessity of imposing any additional restrictions.

Figure 2 – Impulse Responses to a Shock in Risk Premium Dynamics*



*Cholesky One Standard Deviation Innovations +/- 2 Standard Errors

As expected, the exchange rate depreciation is the most sensitive variable to shocks in risk premium dynamics. The Impulses Responses Functions indicate that an unexpected increase in the spread differential depreciates significantly the national currency. Such a shock leads to an immediate deterioration in the currency depreciation by 5.8 percentage points. This is a both large and persistent effect, as it lasts and even worsens in the quarter following the shock, but it diminishes during the third quarter and seems to disappear later.

The risk premium is followed by the exchange rate pass-through to consumer prices. The depreciation of the exchange rate leads to a significant increase in both import and volatile prices and hence in the overall consumer prices in the quarter following the risk premium disturbance. This result can be illustrated in the effect of risk premium shock on the price dynamics: the immediate depreciation is followed by a rise in the CPI inflation rate by 1.35 percentage points by the end of the first quarter after the shock.

With respect to the monetary policy, the response of the NBR policy rate seems to be significant and persistent. After a negative risk premium shock causing the

depreciation of the currency, the NBR increases its policy rate within one quarter by 0.58 percentage points in order to stabilize the exchange rate. Even though this disturbance results in a rise in the policy stance after one quarter, the peak occurs around two quarters following the shock, when the pass through in the inflation rate is realized. The shock was very persistent during two quarters because the policy makers strongly react to the shock in CPI inflation rate by a significant interest rate hike (0.71 percentage points). The intuition behind this result is that the monetary policy responds with a greater magnitude to price stability purposes than financial stability concerns.

The shock to the risk premium is also transmitted to the Quarterly GDP Growth Rate. Real activity contracts significantly: the response of the real economy to the risk premium shock is a contraction of the GDP growth rate by 1.48 percentage points within the quarter following the disturbance.

On the one hand, the shock is transmitted to the real economic activity due to the NBR's reaction via the policy stance. Of course, real economy is affected by medium and long term deposit and lending rates, whose levels are affected, although with a lag, by the policy rate. Higher interest rates stimulate savings, and decelerate lending, restraining consumption and investments in the short run. As a result, aggregate demand in the economy is affected.

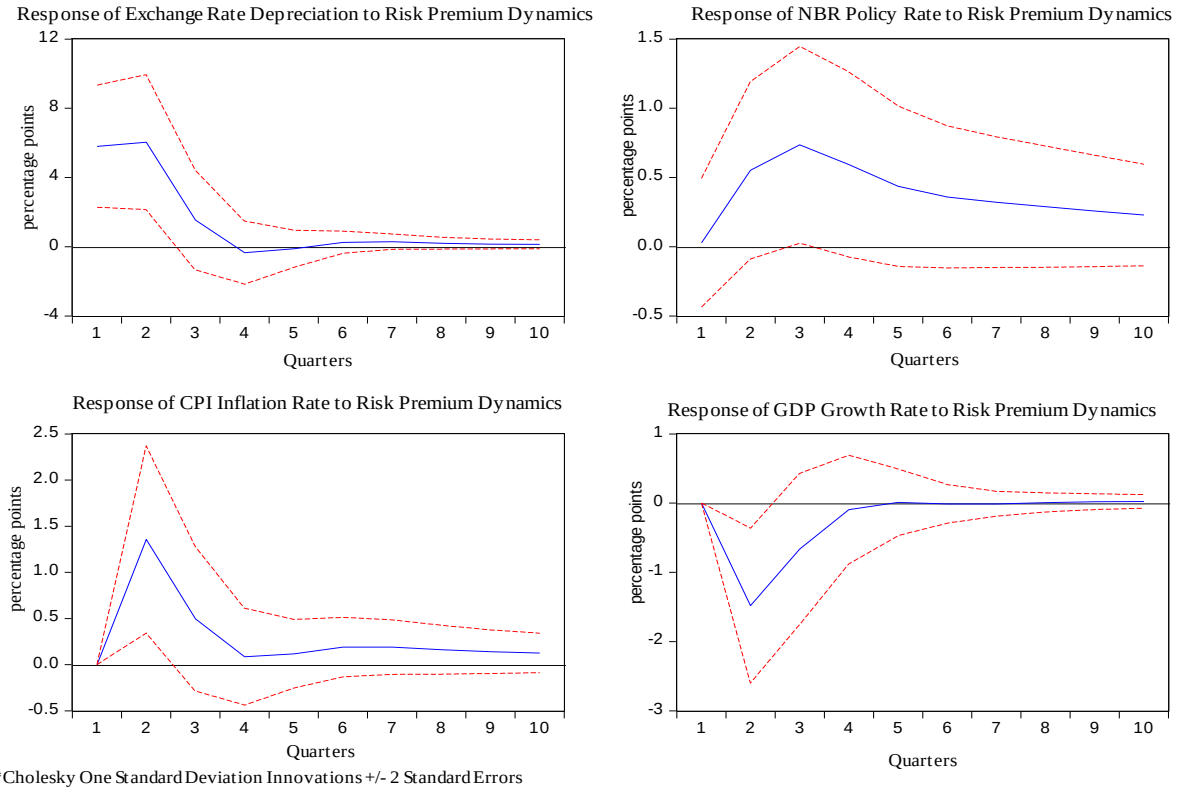
On the other hand, real economic activity is influenced through the combined effects of interest rates and exchange rate, via the wealth and balance sheet channel. Higher exchange rate depreciation increases the relative value of foreign-denominated assets and liabilities, which affects the demand and leads to a decrease in the economic growth rate. Moreover, the economic growth response is also explained by the negative effect of net exports. Even though the currency depreciation should stimulate exports, Romania's exports are highly influenced by imports. This renders exports more demand than price sensitive. A similar result was observed in the case of Hungary too[11].

These results indicate that risk-premium shocks appear to have important macroeconomic effects. For this particular reason, the case of monetary policy's response is worth some further discussion, in order to draw some conclusions concerning the monetary policy implications. The results above show, a priori, that the monetary policy

[11] See Carare and Popescu (2011)

does not respond quickly to a risk premium disturbance as the policy makers react only after the disturbance spreads in the currency dynamics and afterwards, in the CPI inflation. I, however, also test for robustness by using an alternative ordering that places the monetary policy rate after the risk-premium, assuming that the NBR may respond rapidly to shocks in financial markets. The results (Figure 3) show no significant differences on the exchange rate dynamics, CPI inflation and GDP growth rate responses.

Figure 3 - Impulse Responses to a Shock in Risk Premium Dynamics*



*Cholesky One Standard Deviation Innovations +/- 2 Standard Errors

In contrast to other studies on small open economies with inflation targeting framework (Vonnák (2010), Carare and Popescu (2011)), the NBR policy rate does not appear to respond contemporaneously to a risk-premium shock. These results may reveal a very important implication for the policy makers and renders the analysis of risk premium determinants even more necessary. The NBR policy rate appears to respond with a quarter lag to a risk premium shock as the NBR needs to allow the flexibility of exchange rate movements caused by financial markets. However, a monetary policy that responds

rapidly to a contemporaneous an unexpected increase in sovereign risk premium dynamics could prevent the economic activity from being affected by that disturbance[12].

A quick response of the monetary policy would stabilize the exchange rate in the same period of the disturbance and would probably reduce the inflationary effect as well. Lower and less persistent exchange rate depreciation would not affect the demand at the same extent. Furthermore, the decrease in imports would not be that significant anymore and would result in a positive effect of the net export on the real economy. Therefore, this might strengthen the financial and price stability and it may also have a positive effect on the economic growth. However, these effects on prices and output are difficult to anticipate, since an increase in interest rates may lead instead to a more pronounced economic contraction via a decrease in lending and confidence.

3.3.2. Variance Decomposition

I also verify whether the lagged values of the changes in spreads have explanatory power for the other macroeconomic variables in the system using the variance decomposition. The variables are ordered as in the risk premium dynamics shock identification and the horizon is 12 quarters. The variance decomposition (untabulated) reveals that risk-premium shocks play a relatively large role in explaining fluctuations in exchange rate in the short and medium run (around 30%). However, these changes in spread dynamics appear to help in explaining a relatively small part of the variation of the other macroeconomic variables (GDP Growth Rate, CPI Inflation and NBR Policy Rate) on the medium run (around10%).

3.3.3. Historical Decomposition

Using historical decompositions, I will now analyze the contributions of structural shocks to the movements of the key macroeconomic variables over the sample period. In order to estimate the historical decomposition of each macroeconomic variable on contributions of shocks, the VAR is specified as follows:

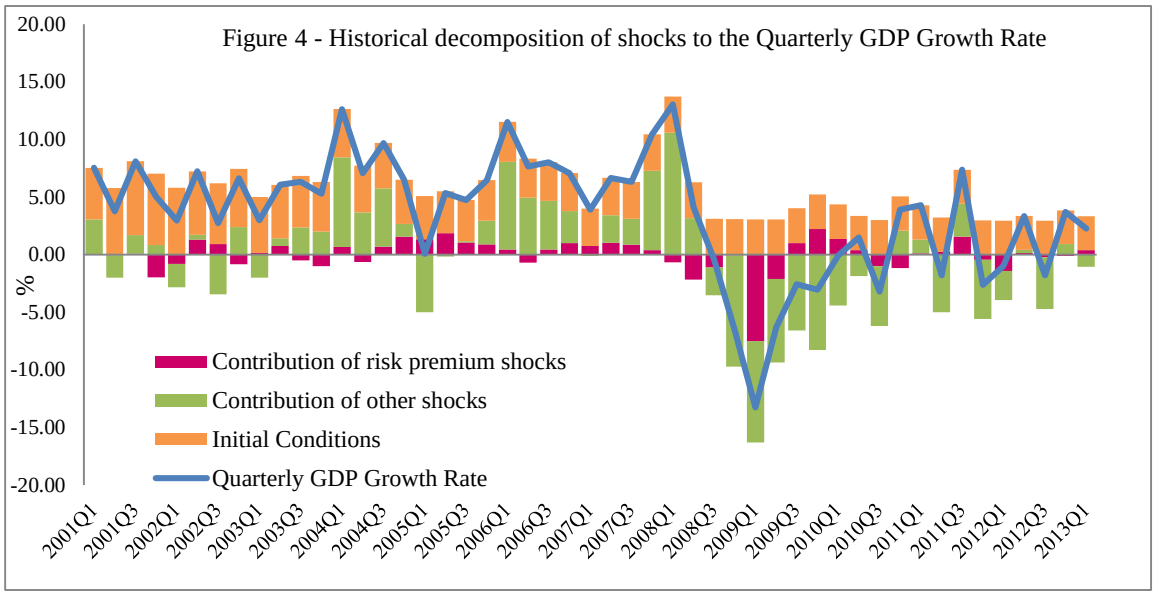
[12] Vonnák (2007) argues that several times the Hungarian monetary policy has been able to prevent the real economy from being affected by risk premium shocks.

$$Y_t = A_0 + A_1 Y_{t-1} + u_t$$

Next, using backward substitution, the variables at each point in time, (for simplicity Y_t) can be represented as a function of initial values (Y_0) plus the sum of all the structural shocks of the model:

$$Y_t = \sum_{i=0}^{t-1} A_1^i A_0 + A_1^t Y_0 + \sum_{i=0}^{t-1} A_1^i u_{t-1}$$

Hence, I identify the first two terms (the constant and the initial values) as the initial conditions of the variables and the third one as the sum of the shocks. However, I will only focus on the individual contribution of risk premium shocks. For this reason, the shocks from the other variables will be aggregated. The historical decomposition of the shocks to the GDP growth rate is shown in Figure 4.

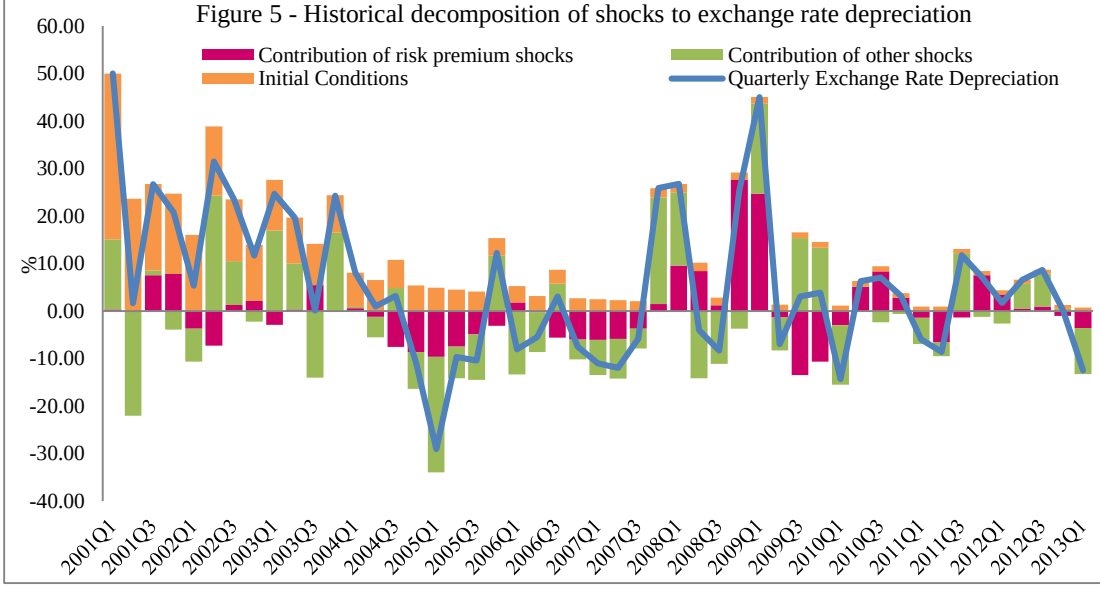


One can remark that risk premium shocks had a large negative contribution to the real GDP contraction during the financial crisis. Moreover, these shocks have also negatively contributed just before 2008Q3, when financial markets were already anticipating that Romania was becoming more and more risky. In addition, one can see that from 2009Q3 to 2010Q1, as the sovereign risk premium reduced, risk premium shocks had a positive contribution on the GDP growth rate.

With respect to the CPI inflation and the NBR policy rate, risk premium shocks' contributions do not seem to be very significant for the movement of these variables, as initial conditions are very important. However, a large positive contribution of a risk premium shock of 6.61 percentage points at the quarterly CPI inflation rate can be remarked in the first quarter of 2009, 6 months after the financial crisis outbreak in Romania. In the same quarter, risk premium shocks also had a positive large contribution for the NBR's decision of policy rate of 2.62 percentage points.

The historical decomposition of the shocks to the exchange rate depreciation is shown in Figure 5. The contribution of risk premium shocks has been the most important on exchange rate movements over the sample period. Shocks in risk premium dynamics appear to be highly correlated with the exchange rate depreciation, as they accentuate both periods of appreciation and depreciation of the national currency with relatively large contributions. The greatest positive contribution to the national currency depreciation (27.67 percentage points) is associated with the financial turmoil and occurred in 2008Q4.

Figure 5 - Historical decomposition of shocks to exchange rate depreciation



4. Conclusions

The paper analyzes the main determinants of the Romanian sovereign risk premium. The results indicate that the dynamics of risk premium can be explained by both investors' risk aversion and macroeconomic fundamentals. Domestic variables such as the Quarterly GDP Growth Rate, Current Account Balance, Public Debt to GDP Ratios

and Quarterly CPI Growth Rate are found to be relevant drivers of the risk premium dynamics prior to and during the crisis. Moreover, due to a regime switching for the Eurozone market volatility, risk premium in Romania has been subject to a re-pricing triggered by significant adjustments in investors' risk aversion. The Eurozone market volatility appears to not have exerted any significant effect on sovereign spreads prior to the crisis, but investors have started paying attention to fluctuations in VSTOXX Index and price them in Romanian sovereign spreads as the crisis broke out.

The paper also focuses on the macroeconomic outcomes triggered by a risk premium shock. The shock leads immediately to a progressive depreciation of the currency for about two quarters, followed by an inflationary effect. The disturbance resulted in a rise in the policy stance after one quarter but the peak occurred around two quarters following the shock when policy makers responded to the rise in CPI inflation. The shock also resulted in a strong contraction of the real economy. With respect to the risk premium management by the NBR, my analysis framework shows that the monetary policy does not respond contemporaneously to a risk premium shock. In this light, I argue that maybe a quick response of the policy stance would strengthen the financial and price stability and would also be beneficial for the domestic real activity. On the other hand, this may have opposite effects on the output, due to a deceleration of lending and confidence, therefore it may lead to a more pronounced economic contraction instead.

The variance decomposition indicates that risk-premium shocks explain around 30 per cent of the fluctuations in exchange rate in the short and medium run, whereas explanatory power for the other macroeconomic variables is much lower. Moreover, the historical decompositions of these variables indicate strong contributions of risk premium shocks to the movements of Quarterly GDP growth rate and Exchange rate depreciation. However, when the crisis broke out, these shocks had large contributions on the dynamics of the other variables as well, highlighting the financial spillovers of the high risk-premium into the real economy and the increased co-movement of economic variables after the crisis.

5. References

Attinasi, M.G., Checherita, C., and C. Nickel (2009). “What Explains the Surge in Euro Area Sovereign Spreads during the Financial Crisis of 2007-09?” *ECB Working Paper Series,* No.1131.

Barrios, S., Iversen, P., Lewandowska, M., and R. Setzer (2009). “Determinants of Intra-Euro Area Government Bond Spreads during the Financial Crisis.” *EC Economic Papers*, No.388.

Bernoth, K. and B. Erdogan (2010). “Sovereign bond yield spreads: A time-varying coefficient approach.” European University Viadrina Frankfurt (Oder), Department of Business Administration and Economics, Discussion Paper 289.

Caggiano, G. and L. Greco (2011). “Sovereign Risk in the Euro Area: Is it Mostly Fiscal or Financial?” The Rimini Centre for Economic Analysis in Canada.

Caggiano, G. and L. Greco (2012). "Fiscal and financial determinants of Eurozone sovereign spreads" Dipartimento di Scienze Economiche "Marco Fanno", *"Marco Fanno" Working Papers 0148.*

Carare, A. and A. Popescu (2011). “Monetary Policy and Risk Premium Shocks in Hungary. Results from a large Bayesian VAR” *IMF Working Paper 11/259.*

Christiano, L. J., M. Eichenbaum, and C. L. Evans (1999). “Monetary Policy Shocks: What Have We Learned and to What End?” *Handbook of Macroeconomics*, Volume 1, Elsevier, pp. 65–148.

Ciarlone, A., Piselli, P and G. Trebeschi (2007). “Emerging markets spreads and global financial conditions”. Bank of Italy*, Termi di discussion*, No. 637.

Ciarlone, A., Piselli, P and G. Trebeschi (2008). “Emerging markets spreads in the recent financial turmoil”. Bank of Italy*, Questioni di Economia e Finanza*, No. 35.

Codogno, L., Favero, C. and A. Missale (2003). “Yield spreads on EMU government bonds.” *Economic Policy*, Volume 18, issue 37, pages 503-532.

Dötz, N. and C. Fischer (2010). “What can EMU countries’ sovereign bond spreads tell us about market perceptions of default probabilities during the recent financial crisis?” Deutsche Bundesbank, *Discussion Paper Series 1: Economic Studies,* No.11/2010.

Di Cesare, A., Grande, G., Manna, M. and M. Taboga (2012). “Recent estimates of sovereign risk premia for euro-area countries” Bank of Italy*, Questioni di Economia e Finanza*, No. 128.

Dumičić, M. and R. Tomislav (2010). “Determinants of sovereign risk premia for European emerging markets” Financial Theory and Practice, Volume 35, Issue 3, pages 278-299.

Ebner A. (2009). “An empirical analysis on the determinants of CEE government bond spreads” *Emerging Markets Review*, Volume 10, Issue 2, pages 97-12.

Eichengreen, B. and A. Mody (1989). “What explains changing spreads on emerging market debt: fundamentals or market sentiment?” *NBER Working Paper*, No.6408.

Enders, W. (2010). “Applied Econometric Time Series”, Third Edition, John Willey and Sons.

Fracasso, A. (2004). “The Role of Foreign and domestic factors in the evolution of the Brazilian EMBI spread and debt dynamics.” *HEI Working Paper No. 22/2007.*

Gerlach, S., Schulz, A., and G.B. Wolff (2010). “Banking and Sovereign Risk in the Euro Area.” Deutsche Bundesbank Research Centre, *Discussion Paper Series 1: Economic Studies,* No. 2010*.*

Haugh, D., Ollivaud, P and D. Turner (2009). “What drives sovereign risk premiums?: An analysis of recent evidence from Euro Area”, *OECD Economic Department Working Papers*, No. 205.

Hochstein, M. (2013) “Fundamental drivers of Euro sovereign risk premia” Allianz Global Investors, Understand. Act.

Manganelli, S. and G. Wolswijk (2009). “What Drives Spreads in the Euro Area Government Bond Market?” *Economic Policy*, Volume 24, Issue 58, pages 191-240.

McGuire, P. and M. Schrijvers (2006). “Common Factors in Euro-denominated Emerging Market Bond Spreads” *International Finance Review*, Volume 6, pages 261-280.

Moody, A. (2009). “From Bear Stearns to Anglo Irish: How Eurozone Sovereign Spreads Related to Financial Sector Vulnerability.” *IMF Working Paper 09/108*.

Özatay, F., Özmen, E and G. Şahinbeyoğlu (2008). “Emerging Market Sovereign Spreads, Global Financial Conditions and US Macroeconomic News” Economic Research Forum Working Paper No. 400.

Peracchi, F. (2001). “Econometrics”, First Edition, John Willey and Sons.

Remolona, E., Scatinga. M. and E. Wu (2007). "Interpreting Sovereign Spreads” *BIS Quarterly Review, March 2007*.

Remolona, E., Scatinga. M. and E. Wu (2008). "The dynamic pricing of sovereign risk in emerging markets: fundamentals and risk aversion” *Journal of Fixed Income*, Vol. Spring, 2008.

Schuknecht, L., von Hagen, J. and G. Wolswijk (2008). “Government risk premiums in the bond market, EMU and Canada.” *ECB Working Paper Series*, No.879.

Sgherri, S. and E. Zoli. 2009. “Euro Area Sovereign Risk During the Crisis.” *IMF Working Paper 09/222*.

Vonnák, B. (2005). “Estimating the Effect of Hungarian Monetary Policy within a Structural VAR Framework”, Magyar Nemzeti Bank, *MNB Working Papers 2005/1.*

Vonnák, B. (2007). “The Hungarian Monetary Transmission Mechanism: an Assessment” Magyar Nemzeti Bank, *MNB Working Papers 2007/3*.

Vonnák, B. (2010), “Risk Premium Shocks, Monetary Policy and Exchange Rate Pass-Through in the Czech Republic, Hungary and Poland” Magyar Nemzeti Bank, *MNB Working Papers 2010/1.*

6. Appendix

Table A1 – Data description and Source

Variable	Description	Source
Dependent Variable		
Change in Romanian bond OAS (Option- Adjusted Spreads)	The OAS series used to reflect Romanian sovereign risk premium is an average of OAS quotes provided by Bloomberg of three different representative Romanian bonds.	Bloomberg, Own calculations.
Country Specific Variables		
Quarterly GDP Growth Rate	The quarterly (annualized) GDP growth rate is obtained as the difference of the Real GDP logarithms multiplied by 4. The Real GDP is extracted from NBR Database.	National Institute of Statistics
Quarterly CPI Inflation	The quarterly (annualized) CPI growth rate is computed as the difference of the index logarithms multiplied by 4. The CPI is extracted from NBR Database.	National Institute of Statistics
Current Account Balance to GDP Ratio	The flows of the Current Account Balance are expressed as a percentage of GDP, based on four-quarter rolling sums. The Current Account balance is provided in millions of euro. The GDP was converted in millions of euro at a quarterly average exchange rate.	NBR Database, own claculations
Government Balance to GDP Ratio	The Government net lending/borrowing as a percentage of GDP.	Eurostat
Government Debt to GDP Ratio	The Government consolidated gross debt as a percentage of GDP.	Eurostat
External debt to GDP Ratio	External debt stock is provided by NBR Database in millions of euro at the end of the period. Flows are expressed as a percentage of GDP, based on four-quarter rolling sums. The GDP was converted in millions of euro at a quarterly average exchange rate.	NBR Database, own calculations
Foreign Official Reserves to GDP Ratio	Data for the Foreign Official Reserves (including Gold) is extracted in millions of national currency at the end of period. An observation was missing in 2012 Q3 and was added from the NBR Interactive Database. The NBR also provided these data at the end of the period in millions of euro. The value was converted in national currency with the exchange rate at the end of September 2012. Foreign Reserves Flows are expressed as a percentage of GDP, based on four-quarter rolling sums.	Eurostat, NBR Database and own calculations
NBR Policy Rate	The National Bank of Romania's key monetary policy interest rate.	NBR Database
Quarterly Exchange Rate Depreciation	I use nominal exchange rate series (EUR/RON) in order to obtain the stationary series for the currency depreciation used in the VAR estimation. The quarterly (annualized) depreciation is computed as the difference of the exchange rate logarithms multiplied by 4.	NBR Database, own calculations
Global Specific Variables		
Change in VSTOXX Index	The index is provided on a daily basis and it was thus converted in quarterly data using an average of observations through the period. To be consistent with the other series, quarterly changes in volatility are multiplied by 4 in order to be annualized	Bloomberg
Crisis Dummy	A dummy variable for the financial crisis and post crisis period: it has a value of 1 after 2008Q2 and 0 otherwise.	