2. SPILLOVERS IN THE PRESENCE OF FINANCIAL STRESS – AN APPLICATION TO ROMANIA

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Abstract

The study investigates the behavior of macroeconomic variables for Romania using a Threshold Bayesian VAR model with the Country-Level Index of Financial Stress as a threshold variable. Over the 2002-2021 period, a number of ten periods of high financial stress are identified, with an average duration of 3.5 months related to either domestic, externally driven or global events. No significant assymmetries are found across regimes. However, the impact of shocks is larger, but less persistent, under the high stress regime. Interest rates should be used to stabilize output in recessions and inflation during normal times. Negative shocks on financial conditions lead to higher, less persistent, fall in output during high stress periods and increases in inflation with a resulting tradeoff in stabilizing them.

Keywords: systemic financial stress, Threshold Bayesian VAR, monetary policy, exchange rate, output

JEL Classification: C11, E44, E52

1. Introduction

The global financial crisis showed once again that periods of extreme stress on the financial sector could have significant and long-lasting negative effects on economies, both developed and emerging ones. The behavior of the economies throughout the crisis and the subsequent recoveries, while different from ones in place during the low financial stress periods, were also dependent on the policies put forward by the authorities to cushion the negative effects of the economic turmoil. The crisis led also to a revival of the academic interest in the relation between financial stress and macroeconomy. Previously, the research focused mostly on financial markets segments and their effects on economy, and much less on the relevance and impact of systemic financial stress. Moreover, structural models used for policy analysis discarded, with some notable exceptions (e.g., Bernanke *et al*., 1999,

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Kiyotaki and Moore, 1997), the relevance of financial factors in shaping business cycle fluctuations.

Financial stress indices were developed and adopted to expand the analysis on the magnitude and impact of financial stress on the economy. One common feature of most of these indices is that they consider, besides the evolutions associated with the investigated market segments, the co-movements among the latter in order to better capture systemic financial stress episodes. The different behavior of the economy during high financial stress periods relative to the low stress ones makes the use of single regime models potentially inappropriate. For example, using the financial stress index of Carlson *et al*. (2012) for the US in a Markov-switching BVAR model, Hubrich and Tetlow (2015) find periodic shifts both in the dynamics of the economy (*i.e.,* coefficients) as well as in the size of the shocks impacting the economy.

Significant focus of this strand of research is on the impact of monetary policy shocks in the presence of financial systemic stress. Fry-McKibbin and Zheng (2016), using a TVAR model estimated for the US, show that output reacts stronger to monetary policy shocks when stress is high relative to low stress periods. Similar results for the euro area are reported by Martins (2020), using ECB's Composite Indicator of Systemic Stress (CISS) of Kremer *et al*. (2012) as threshold variable. Implicitly, easing monetary policy in the high stress periods helps. On the other hand, Hubrich and Tetlow (2015) find that monetary policy behavior is different across regimes, being much less effective in times of high financial stress when higher level of stress results following policy intervention, diminishing its effect. The impact of financial shocks on macroeconomic variables received similar attention. The most common finding is that the impact of financial stress on real economy/output is extremely strong during episodes of high stress, while no significant/lower impact is found when the economy functions in low financial stress regime (Hubrich and Tetlow, 2015, for the US; Aboura and van Roye, 2017, for France; Afonso *et al*., 2011, for US, UK, Germany and Italy)[1].

Similar research for Romania is rather limited. Nalban (2016) uses a TBVAR with Economic Sentiment Indicator (ESI) as a threshold variable. The results point towards a more efficient policy in affecting output during low confidence periods and inflation when confidence is high, with the results being driven by changes in both the reaction function of the monetary authority and the overall macroeconomic framework. Saman (2016) finds that shocks on external systemic stress indices for the euro area have a stronger impact on the domestic economy relative to those originated in the US. Moreover, higher stress leads to lower inflation and lower output[2]. Similar impact of a shock on CISS for the euro area during the financial crisis on inflation and output of Central and Eastern European economies, Romania included, is found by Kubinschi and Barnea (2016).

The current paper investigates in a non-linear, two-regime framework, the behavior of macroeconomic variables conditional on the level of domestic systemic financial stress, as the behavior of the economy during high stress periods might be different relative to the low ones. A Threshold Bayesian VAR model (TBVAR) with seven variables is employed, using

[1] *In addition, a negative impact of higher stress on macro variables, especially output, is also found when a linear framework is used (van Roye, 2011, for Germany and euro area; Mallick and Sousa, 2013, for the euro area and Cevik et al., 2016, for a group of Asian economies).*

[2] *While the results are similar over longer periods, it should be mentioned that identification is obtained by imposing sign restrictions on the reaction of output and inflation to a negative external financial stress shock (i.e., decrease in output and inflation).*

the Country-Level Index of Financial Stress (CLIFS) for Romania as a threshold variable. Similar with other financial stress indices, CLIFS, as developed by Peltonen *et al*. (2015) for each EU country, takes into account, besides developments on three segments of the financial markets (*i.e*., equity, bonds, foreign exchange), the co-movements across them. This enhances the capacity of the resulting index to capture systemic financial stress episodes.

Given the posterior median value of the threshold, ten periods of high systemic financial stress are identified, with duration ranging from 1 to 8 months and an average value of 3.5 months. They are associated with either domestic, external driven or global events. For most of the shocks, the posterior standard deviation is larger in the high stress regime relative to the low stress one. No significant asymmetries are found when investigating regime specific impulse response functions (IRFs). However, the magnitude/persistence of the responses is usually higher/lower under the high stress regime even after we control for the size of the shocks. These results are similar with the ones of Mendieta-Munoz and Sundal (2020), using a TBVAR for the US economy.

Following a monetary policy shock, easing monetary policy in recessions should help: output and credit should increase, without a negative effect on inflation, although the currency depreciates after appreciating on impact. Confidence would increase, while financial stress should decrease. These effects are reminiscent of the financial accelerator mechanism of Bernanke *et al*. (1999). During low stress periods, monetary policy could aim at stabilizing inflation without affecting output, being helped by the response of the exchange rate and that of credit. Confidence would slightly decrease, while financial stress would slightly increase. The impact on output is in line with the literature that finds a stronger impact of monetary policy shocks when stress is high (Fry-McKibbin and Zheng, 2016; Martins, 2020).

Irrespective of the stress regime, the exchange rate shock has no significant impact on output, potentially reflecting the balancing effects of net exports and balance sheet channels. Nalban (2016), using confidence as threshold for Romania, finds a negative/positive impact on output in the low/high confidence regime. However, if the simple BVAR approach is used there is a persistent decrease in output also in our case.

Although the shock on financial stress is significantly different from 0 only on impact under the high stress regime, it leads to a higher drop, but less persistent, in output and confidence, increasing inflation (relative to no impact under low stress), depreciating currency (relative to appreciating one) and substantially lower, but less persistent interest rates. With the effects of the shock similar to those of a negative supply shock (*i.e*., lower output and higher prices), monetary policy lowers interest rates to dampen the effect of the financial stress shock on output and credit, while allowing for higher inflation. The impact on output conditional on the financial stress regime is in line with the ones found in the above-mentioned literature.

To our knowledge, this is the first attempt to quantify the impact of domestic rather than external systemic financial stress on macroeconomic variables in a non-linear fashion for Romania, adding also to the relatively scarce literature on the Central and Eastern European countries. In our case, it is risk rather than confidence (*i.e*., as in Nalban, 2016) that leads to a potential asymmetric behavior of macroeconomic variables and different monetary policy responses. In doing so, we employed a two-regime threshold Bayesian VAR for Romania, an emerging economy with an inflation targeting monetary policy regime and a relatively volatile business cycle. Relative to other studies on Romania, the methodology adopted is better equipped to deal with a relatively short sample. Using CLIFS as transition variable, we captured ten periods of high stress, a substantially lower number when compared with those identified when using each of the three segments of the financial market included in the index, suggesting its relevance in accounting for correlation when identifying systemic stress events. Moreover, we found evidence of different prescriptions for monetary policy conduct conditional on the regime and the shock hitting the economy. Thus, through monetary policy shocks, central bank should aim to stabilize output in recessions and inflation during normal times. Negative shocks on financial conditions lead to higher, less persistent, fall in output during high stress periods and an increase in inflation, with a resulting tradeoff between output and inflation in the high stress regime.

The rest of the paper is organized as follows. The next section presents the methodology and the data used in estimation. The results and conclusions follow.

2. Methodology and Data

This section presents the TBVAR methodology used to capture the potential non-linear effects of systemic stress and the data used in its estimation. We closely follow Blake and Mumtaz (2015) and Nalban (2016) in describing the TBVAR model. The following two-regime model *(i.e.*, High and Low) is employed:

$$Y_t = \begin{cases} B^L X_t + \Gamma^L Z_t + (\Omega^L)^{1/2} e_t \; if \; S_{t-d} \leq S^* \\ B^H X_t + \Gamma^H Z_t + (\Omega^H)^{1/2} e_t \; if \; S_{t-d} > S^* \end{cases}$$

for t=1,2,...T, where: Y_t is a vector of *n* endogenous variables, X_t is a vector of *p* lagged endogenous variables, Z_t is a vector of exogenous variables and e_t is a vector of N(0,1) distributed structural shocks. The endogenous variables used (*i.e.*, the Y_t vector) are: monthly volume of real GDP, volume of credit to the non-governmental sector in real terms, inflation rate as proxied by the change in the Harmonized Index of Consumer Prices (HICP), 3-month money market interest rate, the nominal exchange rate of leu against the euro, the Economic Sentiment Indicator (ESI) and the CLIFS. The X_t is a vector of the lagged, above-mentioned, endogenous variables. As for the exogenous variables (*i.e.*, the Z_t vector), we use the (first lag of the) annual euro area HICP inflation rate, a time trend and two dummy variables (one controlling for the inflation targeting regime and one identifying the COVID-19 period). More details on the data used is provided further below.

S_{t-d}, (the lag of) one endogenous variable, is the threshold variable and S^* is the threshold level. The coefficients and the variance covariance matrices of the reduced form residuals are regime specific (B^z, Γ^z and Ω^z for z={H,L}). The economy is in a state of high/low stress if the threshold variable S_{t-d}, potentially lagged *d* periods is above/below an estimated threshold S^*. Conditional on *d*, the delay parameter, and S^*, the threshold level, being known, one may think of the above model as being a set of two VARs models depending on the threshold variable being above or below the threshold level. Similar to Blake and Mumtaz (2015) and Nalban (2016), we estimate the threshold level S^*, while we assume that the delay parameter, *d* is known[1].

We set a Minnesota type prior for the TBVAR using dummy observations as in Banbura, Giannone and Reichlin (2010). Thus, the priors for the coefficients of the endogenous variable *j* on the equation of the variable *i* and their covariance matrix are set according to the scheme below, where *l=1,...,p* is the lag. The values we set for (common) hyper

[1] *See Chen and Lee (1995) for the case with the delay parameter also estimated.*

parameters controlling the priors are similar with the ones usually used in the literature as reported by Canova (2007): λ_1=0.2, controls for own lags tightness; λ_2=1, other lags tightness, with the assumed value implying equal treatment for own and foreign lags, resulting in conjugacy and known analytical forms for the posterior distributions; λ_3 =2, controls for lag decay; λ_4 =10^4 the tightness of the prior variance for the constant and the exogenous variables; σ_i and σ_j represent variances of the AR(1) error terms on OLS regressions for the used variables, with their ratio introduced to control for the potentially different measurement units of the variables.

$$E\left[(B_l)_{ij}\right] = \begin{cases} 1 \text{ or AR(1) coeff. if l = 1 and i = j} \\ 0 \text{ otherwise} \end{cases}$$

$$Var\left[(B_l)_{ij}\right] = \begin{cases} \left(\frac{\lambda_1}{l^{\lambda_3}}\right)^2 \text{ if i = j} \\ \left(\frac{\sigma_i}{\sigma_j}\frac{\lambda_1\lambda_2}{l^{\lambda_3}}\right)^2 \text{ if i} \neq \text{j} \\ (\sigma_i\lambda_4)^2 \text{ for the constant} \end{cases}$$

The prior for the covariance matrix of the residual is improper, $\Omega^z \sim |\Omega^z|^{-\frac{n+3}{2}}$, while the one for the threshold parameter, S^*, is assumed normal, with a mean fixed at the historical average value (i.e., 0.14) and variance of 0.025.

Conditional on the regime and the value of the threshold, the posterior distribution is Normal Inverse Wishart. Assuming no delay (*i.e.*, d=0), the Gibbs algorithm (with a MH step), with a scale parameter fixed to ensure an acceptance rate between 20% and 30%, is fully explained in Blake and Mumtaz (2015). Similar with Nalban (2016), the number of lags, *p*, is set to 4. A number of 500,000 draws are taken, with the first 200,000 dropped, while to avoid any autocorrelation, only each 100th draw is saved[1].

As for the data used in estimation, aggregate demand in the economy is proxied by the monthly volume of real GDP. However, the real GDP measure is available only at quarterly frequency. To obtain the monthly measure, we use GDP data for the 2000Q1-2021Q3 period provided by the National Institute of Statistics (NSI), and the method proposed by Chow and Lin (1971) to distribute the low-frequency observations over higher-frequency periods. While usually only the industrial production index is used as high frequency indicator, we use multiple monthly frequency indicators to provide a better picture of the fluctuations of the economy at monthly frequency and map the cover of the GDP on the supply side. These are: (i) the volume index of production for mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; construction; (ii) the index of deflated turnover for retail trade, except of motor vehicles and motorcycles; (iii) the index of turnover for services, except retail trade and repair. We proxy the financial sector variable, by the volume of credit to the non-governmental sector, as provided by the National Bank of Romania (NBR), deflated by the price level. As for the latter, the HICP for Romania is used, as provided by Eurostat. The stance of the monetary policy is proxied by the 3-month money market interest rate, a relevant measure given the inflation targeting monetary policy regime in place since August 2005. To account for both the open dimension of the economy and the relevance of

[1] *For detailed info on the estimation steps and the derivation of posterior distribution please consult Blake and Mumtaz (2015).*

the balance sheet channel, given the relatively high level of loan euroization over the analyzed period[1], the nominal exchange rate of leu against the euro is used. The monthly average values for the last two series are available from the NBR. The monthly values for the ESI were collected from the European Commission (EC). Last but not least, the series for CLIFS were extracted from the ECB's database. When used in estimation, we take the 12-months period log-difference for real GDP, non-governmental credit in real terms, HICP index and nominal exchange rate, while for the rest of the variables (*i.e.*, interest rate, ESI and CLIFS) the level is used.

Given the availability of CLIFS for Romania and the last GDP data available at the time of the estimation, the sample covers the March 2002-September 2021 period. When estimating the model, the following exogenous variables were added to address the potential lack of sample homogeneity, different monetary regimes in place and the COVID-19 pandemics: the first lag of the annual euro area HICP inflation rate to approximate external price pressures, a time trend and two dummy variables: one controlling for the inflation targeting regime (taking the value of 0 before August 2005 and 1 thereafter) and one identifying the COVID-19 period (taking values of 0 before March 2020 and 1 afterwards). Given that we are using a Bayesian framework, we are not concerned by the eventual presence of unit roots, even in the transformed series, as the form of the posterior distributions is the same, regardless of their presence.

The CLIFS, as developed by Peltonen *et al*. (2015), is a country specific, coincident measure of financial stress developed for each EU country. Three segments of the financial market are investigated: equity markets (*i.e*., stock price index – real terms); bond markets (*i.e*., 10-year government yields-real terms); foreign exchange markets (*i.e*., real effective exchange rate). For each segment, two measures, one capturing volatility and one capturing large losses are developed. Individual financial stress sub-indices for each segment are computed as average of the previous, standardized, measures. Similar with the approach developed by Kremer *et al.* (2012) in constructing the CISS[2], Peltonen *et al.* (2015) relies on capturing co-movements across the three financial market segments investigated when aggregating the sub-indices, by weighting each sub-index by its cross-correlation with the others. Thus, the resulting aggregate index can capture systemic financial stress episodes. By construction, the aggregate index is bounded between 0 and 1. The choice of CLIFS as transition variable is justified by its construction, as it is meant to capture episodes of systemic financial stress. During these episodes of high stress, the behavior of the economy, and implicitly the adjustment of the macro variables, are expected to be different relative to periods of low financial stress, when *business as usual* is in place. One potential limitation of the paper is that we allow only for a single threshold value. This can be justified by the relatively short time span covered by the analysis and the construction of CLIFS, aimed at capturing episodes of systemic financial stress, being hard to identify intermediate episodes, additional to the "high" and "low" ones.

When employing the TBVAR, a Cholesky factorization is used to recover the structural shocks, being the approach mostly used in the literature (*e.g*., Nalban, 2016; Hubrich and Tetlow, 2015; Martins, 2020; Mendieta-Munoz and Sundal, 2020). Output is ordered first, its shocks having contemporaneous effects on all variables, while responding in the first period

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[1] *For example, the share of foreign currency loans to the private sector it stood at 48.3% at the end of 2007, a maximum of 64.4% in May 2012, entering afterwards a declining trend and reaching 28.4% in September 2021.*

[2] *The CISS indicator is not available for Romania.*

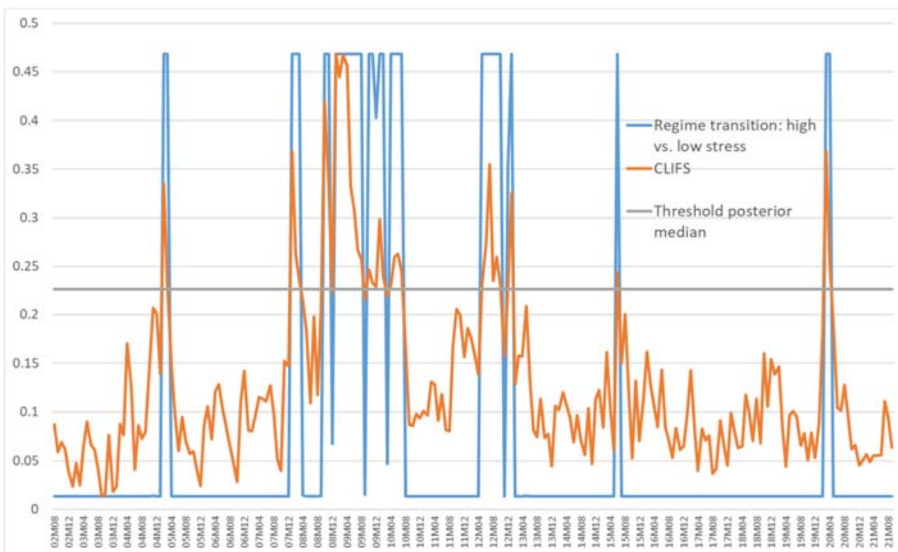
only to its own shocks. Non-governmental credit is second, being contemporaneously affected only by demand and its own shocks. Inflation follows, with a simultaneous impact from output, credit and its own shock. We order the interest rate before the exchange rate, allowing for monetary policy shocks to impact the exchange rate in the same month, while a shock on the exchange rate leads to a monetary policy reaction only on the following month. Switching the ordering of the last two variables resulted in broadly similar results. ESI is ordered second to last, while CLIFS is ordered last. Thus, following a shock on CLIFS, all other variables respond with a one-month period lag[1].

3. Results

In analyzing the behavior of the economy to shocks, we follow the approach of Ehrmann *et al.* (2003) by using regime dependent IRFs as they have the advantage of letting the researcher analyze the different patterns in the economy according to the regime. The estimated posterior regime transitions and the posterior median value of the threshold are reported in Figure 1.

Figure 1

CLIFS and Estimated Regime Transitions



Source: Authors' calculations.

The threshold posterior median value is estimated at 0.23, substantially higher than the prior value of 0.14. Ten periods of high systemic financial stress are identified, with duration ranging from 1 to 8 months, and an average value of 3.5 months. The number of systemic high stress events identified using CLIFS is substantially lower when compared with the ones

[1] *This is justified given that CLIFS values are reported as end-of-month values.*

identified when using each of the three segments of the financial market[1], suggesting its relevance in accounting for correlation when identifying systemic stress events. Thus, when using CLIFS, 15.2% of the observations are placed in the systemic high stress category[2], while when the individual components of CLIFS are used the percentage is 38.3 for bond markets, 45.7 for equity markets and 48.7 for exchange rate markets.

The high financial stress periods are associated with either domestic (*e.g.*, political turmoil, elections, economic measures following the effects of the international financial crisis), external specific (*e.g.*, the Greek government-debt crisis), or global events (*e.g.*, direct effects of the international financial crisis, the COVID-19 pandemic). Table 1 bellow lists the high stress periods and offers anecdotal information on the potential events driving the stress[3].

Table 1

Systemic Stress Periods and Associated Events

Period	Events
February-March 2005	Political turmoil following end-2004 general elections.
January-March 2008	Unfolding of the international financial crisis, with global stock markets tumbling, FED and other major banks aggressively cutting interest rates; Northern Rock nationalized, Bear Stearns bought by J.P. Morgan Chase.
October-November 2008	Effects of the crisis, following its escalation starting September 2008, economies dip into recession, first recovery plans unveiled.
January-August 2009	The highest impact of the crisis on both international and domestic levels. Balance of payments assistance program with international financial institutions reached in April 2009.
October 2009-February 2010	Agreement of the parent banks to keep their exposure to Romania; Domestic political crisis, presidential elections and referendum for impeachment of the president; Supplemental Memorandum between Romania and international financial institutions; First signs of the Greek crisis.
April-July 2010	Request of an international bailout for Greece, new austerity packages announced; Domestic austerity measures and tax increases starting July 1st.
May-October 2012	Domestic political crisis, president suspended, referendum. Volatile financial markets, euro-zone crisis and measures.
December 2012-January 2013	Parliamentary elections in Romania.
June 2015	Prospect of Greece leaving the Eurozone, referendum announced.
March-April 2020	Debut of the COVID-19 pandemic, lock-down measures in place.

Source: Authors' calculations.

[1] *Similar TBVARs were run for each of the components of CLIFS, with the prior mean for the threshold set at the historical average. While the posterior distribution of the threshold is also tighter for each of the sub-components, posterior median values were close to the prior mean.*

[2] *This is similar with the standard level of trimming often used in the existing non-bayesian literature (i.e., between 15% and 20%).*

[3] *Moreover, the individual components of CLIFS were not necessarily identified, when similar TBVARs were run for each of them, as being simultaneously with CLIFS in a high stress regime for some of the months.*

As shown in Table 2 below, the median posterior standard deviation of the shocks is larger in the high stress regime relative to the low stress one, except for the shock on inflation, which is marginally higher under the latter regime. However, if one looks at the associated 68% confidence bands, the difference is statistically significant only for four out of seven shocks: on credit, interest rate, confidence and financial stress. Moreover, the median posterior value for the standard deviation of the monetary policy shock is 2.4 times higher under the high stress regime relative to the low stress one.

Table 2

Median Posterior Standard Deviation of Shocks

Shock on:	Median value [68% confidence band]	
	Low stress regime	*High stress regime*
Output growth	2.02 [1.92-2.12]	2.23 [2.00-2.54]
Non-governmental credit growth	1.42 [1.35-1.49]	1.75 [1.56-1.97]
Inflation	0.49 [0.46-0.51]	0.47 [0.42-0.53]
Interest rate	0.38 [0.36-0.40]	0.91 [0.82-1.02]
Exchange rate variation	1.39 [1.32-1.46]	1.48 [1.34-1.67]
ESI	2.72 [2.58-2.87]	3.70 [3.34-4.16]
CLIFS	0.032 [0.030-0.033]	0.040 [0.036-0.045]

Source: Authors' calculations.

Once we accounted for the size of the shocks, employing regime dependent IRFs is done by normalizing the size of the shocks across regimes (and simple BVAR). This is one way to account for different transmission mechanisms across specifications (*i.e.*, different coefficients in this case). While, due to the lack of space, not all responses are shown[1]. Two general conclusions emerge. First, no significant asymmetries are found. However, there are important differences regarding the magnitude of variables' responses even after we control for the size of the shocks, with the magnitude of the response being usually higher under the high stress regime. Second, the effect of shocks on the variables they belong to is less persistent under the high stress regime (similar with the findings of Mendieta-Munoz and Sundal, 2020). This induces less persistence also on the answers of the remaining affected variables. Thus, during the high stress periods the shocks to the economy are usually larger, while their effects are less lasting relative to the low stress periods.

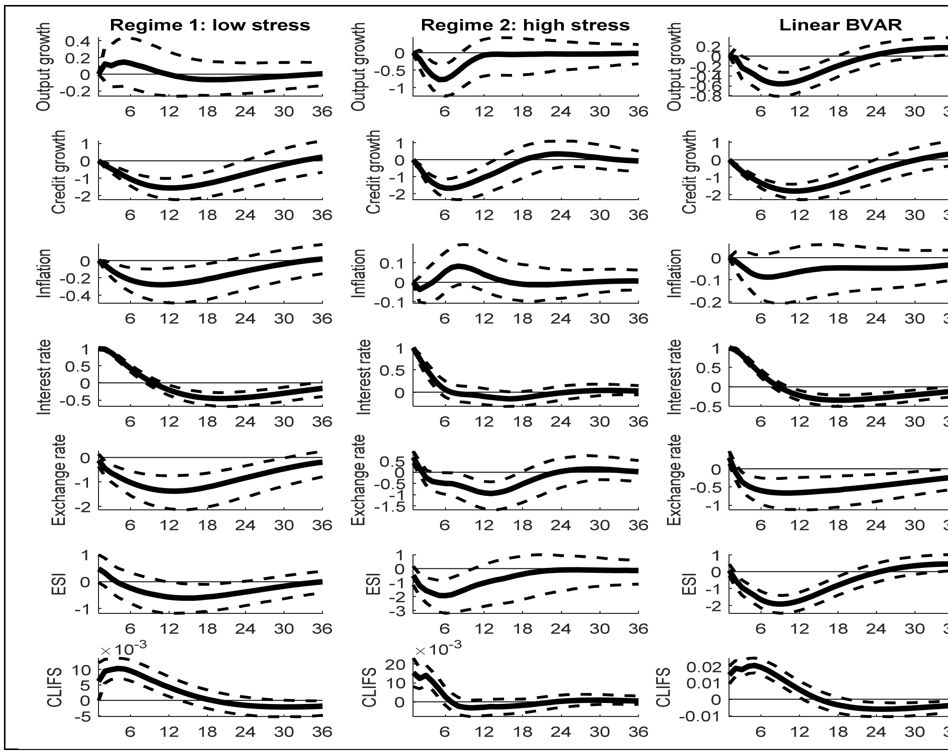
Figure 2 displays the IRFs to an unexpected 1-percentage point negative monetary policy shock (*i.e.*, increase in interest rate), with the dotted lines indicating the 68% posterior confidence interval. Output drops the most in the high stress regime with the maximum impact reached after half a year, while no significant impact is detected in the low stress regime.

It drops less under the simple BVAR framework, with the maximum impact reached after around 9 months, but the drop is more persistent. This is in line with the literature that finds there is a stronger impact of monetary policy shocks on output when stress is high (Fry-McKibbin and Zheng, 2016; Martins, 2020).

[1] *The IRFs not shown are available upon request.*

Figure 2

Monetary Policy Shock Impact on Macroeconomic Variables



Source: Authors' calculations.

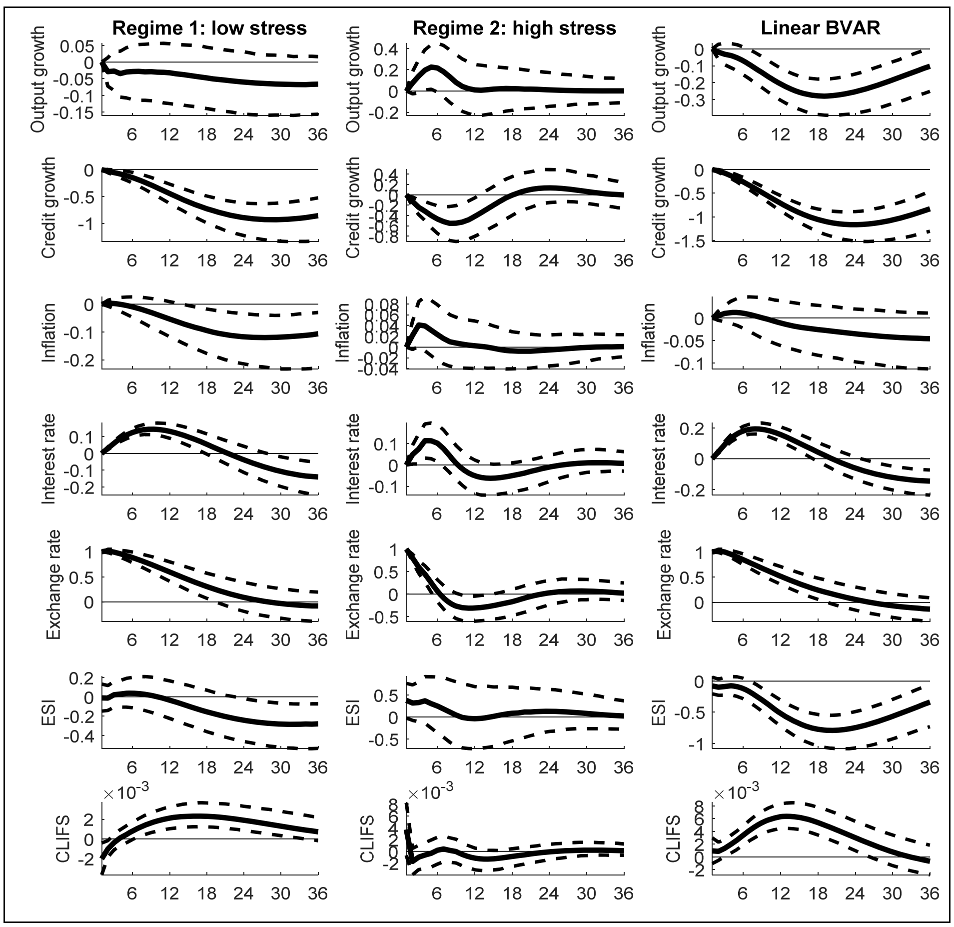
As for inflation, there is a statistically significant drop only in the low stress regime. Nalban (2016) reaches similar conclusions in terms of output, inflation and implicitly monetary policy efficacy for Romania when confidence is used as a threshold variable. Credit drops across all specifications, with the maximum impact marginally higher under the high stress regime, but with less persistence relative to the low one and the simple BVAR. The domestic currency appreciates the most under the low stress regime with an accompanying high and statistically significant persistence, the latter similar with the BVAR case. It depreciates on impact (*i.e.*, short term exchange rate puzzle) and then appreciates less under the high stress regime, staying statistically significant for around one year and a half. Nalban (2016) finds a significantly more persistent exchange rate puzzle when confidence is low. The drop in confidence is similar in magnitude for the simple BVAR approach and the high stress regime, but less persistent for the latter case. Only a small medium term negative impact is detected under the low stress regime. As for financial stress, CLIFS increases under both stress regimes, more on impact but less persistent under high stress, the latter similar with the findings of Hubrich and Tetlow (2015). In the simple BVAR, the magnitude on impact is similar with the high stress regime, but more persistent. A similar result in a linear framework is documented by Mallick and Sousa (2013) for the euro area.

According to these results, the effects of the monetary policy actions on the economy are different conditional on being on the high or low stress periods. Monetary policy authority could help in dampening recessions associated with high stress periods by reducing interest rates. Following such a shock, output and credit will increase, while there will be no negative effect on inflation. Moreover, confidence will rebound, while financial stress will decrease. During periods of low financial stress, monetary policy should aim at stabilizing inflation, without significantly affecting output. In doing so, the appreciation of the currency and the drop in credit help.

The IRFs following a 1% (depreciation) shock on the exchange rate of leu against the euro are depicted in Figure 3.

Figure 3

Exchange Rate Shock Impact on Macroeconomic Variables



Source: Authors' calculations.

No substantial impact on output is found either under the low or high stress regimes, reflecting potential balancing effects of the net exports and balance sheet channels. However, if the simple BVAR approach is implemented there is a persistent decrease in output, similar with the findings of Copaciu *et al*. (2015), in a linearized DSGE framework. The results in the regime dependent IRFs are different from the results of Nalban (2016) for Romania, who finds a negative impact on output in the low confidence regime and a positive one in high confidence one. Moreover, in our case there is no statistical difference in the size of the shocks across regimes, while Nalban (2016) finds higher magnitude of the shocks in the low confidence regime. These differences may stem from different threshold used (*i.e*., confidence versus risk), lower loan euroization in our sample, relatively richer set of variables used in our TBVAR.

Given the higher persistence of the exchange rate's response to its own shock in the low stress regime and linear BVAR, the increase in the interest rate and the subsequent decrease in credit are higher in magnitude and more persistent relative to the high stress regime. The response of the credit also reflects the still relatively high degree of credit dollarization of the domestic economy. As for inflation rate, there is no significant impact, except a slight decrease over medium term in the low stress regime. While in the simple BVAR confidence drops persistently following an exchange rate depreciation shock, no significant impact is found in the high stress regime and a medium-term decrease is found in the low stress one. Last, but not least, there is a gradual buildup of stress under the simple BVAR and (to a lesser extent) low stress regime, and, somehow unexpected no impact under the high stress regime.

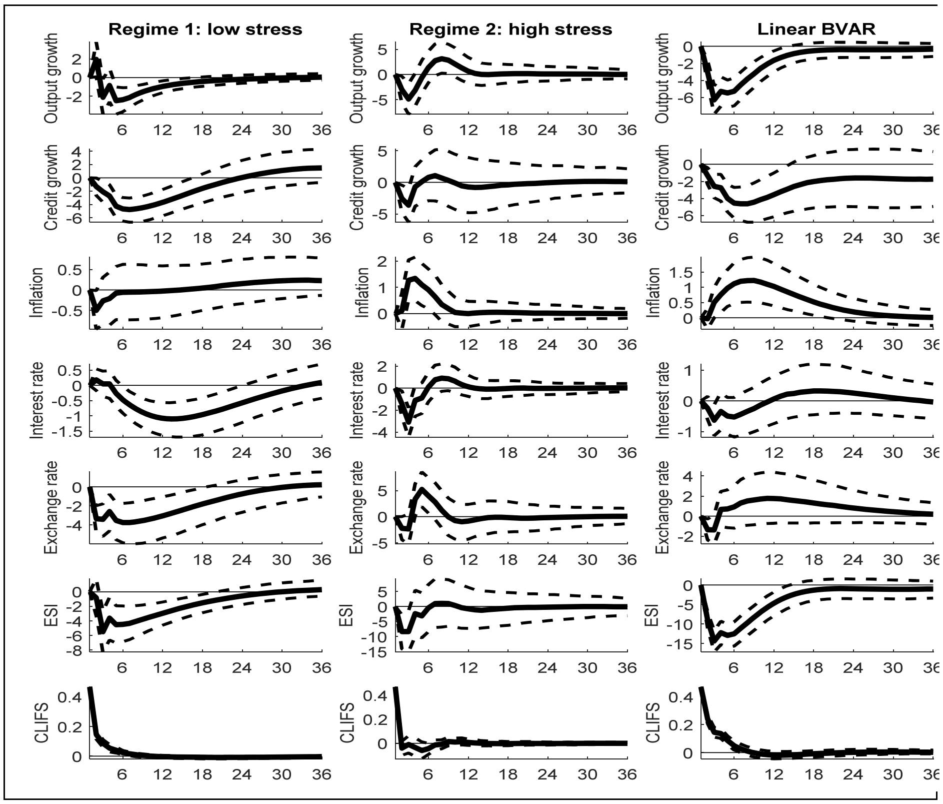
Finally, the IRFs following an increase in the financial stress are shown in Figure 4. Different from the other shocks, we scale the shock on CLIFS to its maximum historical value, that is 0.47, reached in January 2009, during the peak of the financial crisis. Also in this case, the persistence of the shock is lower in the high stress regime. More specifically, the CLIFS is statistically different from 0 only in the month of impact for the high stress regime, as compared to 7 months for the low stress regime and simple BVAR cases. Across stress regimes, at the maximum impact, output drops around twice as much under the high stress regime, while it increases initially and drops afterwards more persistently under the low stress one. The drop in output is even larger in the simple BVAR framework. These patterns for output are similar with the ones most found in the literature[1]. Confidence evolves in a similar manner with output.

Credit drops across specifications, but less persistent under the high stress regime. Inflation increases only in the high stress regimes and this shapes the answer for the linear case, a result in contradiction with the lower inflation found by van Roye (2011) for Germany and the Euro Area. The leu appreciates against the euro under the low stress regime and less persistent under the linear BVAR. In the high stress regime, it appreciates in the first two periods after the shock, but then it depreciates much more.

[1] *See the literature review section for a list of references.*

Figure 4

Financial Stress Shock Impact on Macroeconomic Variables



Source: Authors' calculations.

As for interest rates, they drop across each regime, but around three times more at the maximum impact, although less persistent, in the high stress regime. The high stress regime behavior of interest rates is similar with the one found by Vašíček (2012) for Poland and the Czech Republic, when the financial stress index as developed by Balakrishnan *et al.* (2011) is used as a threshold variable.

According to the above results, there is an output-inflation tradeoff in the high stress regime. The financial stress shock has effects similar to those of a negative supply shock (*i.e.*, lower output and higher prices). Therefore, monetary policy lowers interest rates to dampen the effect of the financial stress shock on output and credit, while allowing for higher inflation. This is the norm for the reaction to supply side shocks, while no second-round effects on inflation are in place.

4. Conclusions

We investigated the behavior of macroeconomic variables for the Romanian economy conditional on the level of domestic systemic financial stress, using a threshold Bayesian VAR model with seven variables. The Country-Level Index of Financial Stress for Romania was used as a threshold variable. Given the endogenously determined posterior median value of the threshold, ten periods of high systemic financial stress were identified, with an average duration of 3.5 months and a min-max interval of 1 to 8 months. The episodes can be associated with either domestic, external driven or global events.

While no significant asymmetries are found when investigating regime specific IRFs, most of the shocks are larger in magnitude, but less persistent, under the high stress regime. However, the magnitude of the responses is usually higher under the high stress regime even after we control for the size of the shocks. Interest rates should be used to stabilize output in recessions and inflation during normal times. Negative shocks on financial conditions lead to higher, less persistent, fall in output during high stress periods and an increase in inflation with a resulting monetary policy tradeoff in stabilizing them.

This paper tried to shed some light on the potential non-linear behavior of macroeconomic variables when a domestic financial stress index was used as a threshold variable. While an empirical, time series, approach was implemented, further research should focus on a structural model analysis to assess the impact of systemic financial stress on the economy. Also, the contribution of spillovers from the financial stress originating in the external sector, other than the ones already reflected in the domestic counterpart, should be investigated.

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