

**BUCHAREST UNIVERSITY OF ECONOMIC STUDIES** 

DOCTORAL SCHOOL OF FINANCE AND BANKING



Dissertation paper

# Measuring Systemic Risk in a CCA Global VAR

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## Aims of the Paper

Determine the extent to which the banking, sovereign and corporate sectors, along with economic growth and household credit growth, have been inter-dependent during the recent global financial crisis.

Analyze the spillover effects among Central and Eastern European countries by determining whether a shock in one sector of a country would have a significant effect on the other sectors and countries analyzed.

Determine which sector's distress has a higher impact on the contraction of economic growth. Compare the effects generated by shocks in the banking and sovereign sectors.



Literature review
 Methodology
 Data description
 Results
 Conclusions
 Selected References

# 1. Literature Review



# 2. Methodology

#### **5** variables:

- Corporate Risk
- Banking Risk
- Sovereign Risk
- Economic growth
  Household credit growth

4 Central and Eastern European Countries:

- Romania
- Bulgaria
- Hungary
- Poland

For the period 2006-2013, using quarterly data.

## For the Corporate, Banking and Sovereign Risk, the Contingent Claims Analysis Methodology is used:

Merton Model:  

$$\begin{cases}
E = A N(d_1) - Be^{-rT} N(d_2) \\
E \sigma_E = A \sigma_A N(d_1)
\end{cases}$$

- **E** = Market capitalization;
- $\sigma_E$  = the volatility of the traded equity (measured as historic volatility on a rolling window on 125 trading days);
- **B** = Distress Barrier;

**B**<sub>CORPORATE\_SECTOR</sub> = Short Term Debt + 0.5 Long Term Debt

(Moody's/KMV Methodology);

**B**<sub>BANKING\_SECTOR</sub> = 0.7 Total Liabilities;

B<sub>SOVEREIGN\_SECTOR</sub> = Short Term FCD + 0.5 Long Term FCD, where FCD = Foreign Currency Debt;

# **Measuring Sovereign Risk using CCA**

#### 2 conditions have to be met:

- all the elements encountered on the liabilities side could be traced to observable data;
- all the elements shall be denominated in a common currency.

#### **Additional steps:**

- construct the Consolidated Balance sheet of the Government and the National Bank:

Sovereign Sector Consolidated Balance Sheet					
Assets	Liabilities				
International Reserves	Domestic Currency Liabilities (DCL): <ul> <li>Base Money (M0);</li> </ul>				
Domestic currency assets: Other assets – Financial Guarantees	<ul> <li>Domestic Currency Debt (DCD).</li> <li>Foreign Currency Debt (FCD)</li> </ul>				

- use the volatility of the main index of the stock exchange as proxy for equity volatility;

# **Risk indicators analyzed**



The above risk indicators are calculated separately for each company and bank and for the sovereign sector as a whole.

## 3. Data description

Sector/ Country		Romania	Bulgaria	Hungary	Poland
Corporate Sector	(average percent of total market capitalization)	35%	23%	60%	22%
	number of companies	7	5	5	9
Banking Sector	(average percent of total banking system assets)	41%	27%	44%	<b>49</b> %
	number of banks	4	4	3	8

## **Unlisted banks**

Some assumptions were made in order to include in the analysis 3 banks that were not listed on a stock exchange:

$$E = \frac{\text{Group market capitalisation + Bank balance sheet equity}}{2}$$
$$\sigma_E = \frac{\text{Group}_{\sigma_E} + \text{weighted average of the local banks}_{\sigma_E}}{2}$$

Therefore, proxies have been used for the market capitalization and price volatility using information from the affiliated Banking Groups (Erste Group for Romania and Hungary, Unicredit Group for Bulgaria).

# 4. Results

4.1. CCA Results for the Corporate, Banking and Sovereign Sectors

4.1.1. Corporate sector



## 4.1.1. Corporate sector



### 4.1.2. Banking sector



## 4.1.2. Banking sector



#### 4.1.3. Sovereign sector





#### 4.2. Households and Economic Growth

### 4.2.1. Households



## 4.2.2. Economic growth



#### 4.3. Results aggregated by country



## 4.4. Distances to distress







## 4.5. Series included in the GVAR



# 4.6. Common Weight matrices for the foreign variables vectors

	RO	BG	HU	РО
RO	0.00	0.26	0.27	0.18
BG	0.48	0.00	0.22	0.59
ни	0.28	0 17	0.00	0.23
PO	0.24	0.57	0.51	0.00

The weight matrix was computed by minimizing the sum squared residuals from a local model, subject to the constrains that its set of weights are non-negative and sum to unity (iterative numerical optimization using sequential quadratic programing).

$$min_{\tau_{i}, w_{ijk}} \sum_{t=1}^{T} \varepsilon_{it}^{2}$$
$$w_{ijk} \geq 0, j = 0, \dots, N, k = 1, \dots, K$$
$$\sum_{j=0}^{N} w_{ijk} = 1, \ k = 1, \dots, K,$$

## 4.7. Model's stability



## 4.8. Shock transmission analysis using GVAR's IIRFs

#### **Scenario 1:** A shock of 1 STD to all the countries banking sectors



#### Scenario 2: A shock of 1 STD to all the countries sovereign sectors



#### The impact of shocks in the banking and corporate sectors upon Economic Growth



#### The impact of shocks in the banking and corporate sectors upon Romanian Economic Growth





- The banks with a smaller value of assets faced financial distress earlier than the rest of the banks included in the analysis;
- The probabilities of default for the sovereign and corporate sectors ware significantly different from zero only during periods of distress;
- \* A more suitable CCA risk indicator proved to be the distance to distress;
- The results obtained identified two periods of increased financial distress: the most severe episode of distress caused by the global financial crisis that affected the European countries in 2008-2009 and second episode of distress as a result of the euro area debt crisis that impacted the countries included in the analysis in 2011-2012.
- The estimated weights for the foreign variables vectors illustrated that the countries with the highest influence among the rest of the countries included in the analysis are Poland and Bulgaria.
- The result sustain the fact that the impact of a sovereign crisis is transmitted easier to economic growth than the impact of a banking crisis, the monetary policy mechanism having a delayed effect as compared to the fiscal policy mechanism. As it was expected, the cumulative impulse response functions are more pronounced when a shock affects both the banking and sovereign sectors.

## Selected References

- Altăr, M., Samuel, J., Altăr-Samuel, A.N., (2012), "A Study Of Sovereign Risk, Using Contingent Claims Analysis", World Finance & Banking Symposium - "Asian Finance & Banking", Shanghai, China
- Bisias D., M. Flood, A. W. Lo, and S. Valavanis. (2012),. "A Survey of Systemic Risk Analytics", Working Paper 0001, Office of Financial Research;
- Gapen M. T., D. Gray, C. H. Lim, Y. Xiao (2008), "Measuring and Analyzing Sovereign Risk with Contingent Claims," IMF Staff Papers Volume 55.
- Gray D., M. Gross, J. Paredes, and M. Sydow (2013), "Modeling Banking, Sovereign, and Macro Risk in a CCA Global VAR", IMF Working Paper, WP/13/218;
- Gray, D. and A. A. Jobst (2011), "Systemic CCA A Model Approach to Systemic Risk", Conference "Beyond the Financial Crisis: Systemic Risk, Spillovers and Regulation";
- Gray, D., Merton, R. and Bodie, Z., (2008) "New Framework For Measuring And Managing Macrofinancial Risk And Financial Stability", Central Bank of Chile, Working Papers No. 541;
- Gray, Dale F. and Andreas A. Jobst. (2011) "Modelling Systemic Financial Sector Risk and Sovereign Risk". Economic Review 2:68,106.
- Gross M. (2013), "Estimating GVAR weight matrices", ECB, Working Paper Series No. 1523;
- Gross M. and C. Kok (2013), "Measuring contagion potential among sovereigns and banks
- using a mixed-cross-section GVAR", ECB, Working Paper Series No. 1570;
- Jobst A. A. and D. Gray (2013), "Systemic Contingent Claims Analysis Estimating Market-Implied Systemic Risk", IMF Working Paper, WP/13/54;
- Merton, R.C., (1973), "Theory of Rational Option Pricing," Bell Journal of Economics and Management Science, 4 (Spring), pp. 141-83 (Chapter 8 in Continuous-Time Finance).