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Romanian Commercial Banks' Systemic Risk and Its Determinants: A CoVAR Approach

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Abstract *This paper aims to estimate the effects of contagion on the Romanian commercial banks during period 2008 – 2015, by using the CoVaR methodology. The motivation in choosing this topic is represented by the fact there is little research on systemic risk and contagion in the Romanian banking sector. The results of this paper highlight that the largest contribution to the daily losses of Romanian banking system is given by BCR, while the lowest contribution is given by BCC. Moreover, we analysed the impact of the main financial indicators on systemic risk contribution. Based on this, we saw that financial leverage, size, risk and market to book value have a significant impact on systemic risk contribution of commercial banks.*

Key words Correlation, financial crisis, Romanian banking sector, systemic risk, CoVaR, Value at Risk

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1. Introduction

The world in which we live is changing daily, and these changes are affecting especially the financial environment. The crisis from 2008 had a huge impact on financial markets volatility, when big financial institutions were affected and recorded significant losses. Lehman Brothers had bankruptcy, even if the bank was considered to be infallible, and this event released high risk on financial market, risk which is known as systemic risk. This was a signal for financial regulators such that Basel III regulated the capital requirements from 2013. Regarding Romania, the lending went down, unemployment increased, the Government cut the wages of peoples who works in public sector, and Romania borrowed money from International Monetary Fund.

This paper aims to estimate the effects of contagion on the Romanian commercial banks by using the CoVaR methodology, there is little research on systemic risk and contagion in the Romanian banking sector. In Romania, there are only four banks which are listed on stock exchange: Romanian Commercial Bank (used a proxy for Erste Group), Carpatica Commercial Bank, Transilvania Commercial Bank and BRD Commercial Bank.

2. Literature review

The importance of measuring the systemic risk of financial institutions was highlighted by researchers as Huang *et al.* (2009), who developed a measurement of insurance price against systemic distress. Going further, Acharya *et al.* (2010) proposed systemic expected shortfall (SES). An indicator made by Brownlees and Engle (2012) is SRISK index, which present the expected capital shortage of a firm during on a substantial market meltdown.

In this paper, the systemic risk is measured through methodology proposed by Adrian and Brunnermeier (2008): CoVaR. This methodology is able to identify the contribution of each bank to systemic risk. According to Adrian and Brunnermeier, CoVaR focuses on tail distribution. In the same time is an equilibrium and directional measure, because CoVaR of a bank to the banking system is not equal to the CoVaR of banking system to the same bank.

This methodology is used a lot in the economic literature. Roengpitya and Rungcharoenkitkul (2011) showed that the bank size is not influencing the systemic risk. Going further, Lopez-Espinosa *et al.* (2012) pointed out the fact that short-term wholesale funding is a key determinant for systemic risk. Moreover, Bernardi *et al.* (2013) based on Bayesian inference for CoVaR highlightsthe fact that the model is able to sharply calculate conditional quintile.

Several authors (Borri *et al*., 2012 and Mutu, 2012) applied this methodology to estimate systemic risk for European banking system. Mutu (2012) applied the methodology for 53 European banks, and pointed out that the highest contribution to the systemic risk come from Belgium, Germany, Greece, Ireland and Spain.

3. Methodology of research

The contribution to the systemic risk is computed based on the methodology proposed by Adrian and Brunnermeier (2008, 2011), namely CoVaR. The first step in applying this methodology is the calculation of market value of banks total assets, based on (1):

$$A_t^i = \left(N_t^i \cdot P_t^i\right) \cdot \frac{Asset^i{}_t}{E^i{}_t} \tag{1}$$

Where
N_t – number of shares in the moment *t*;
P_t – market price of the share in the moment *t*;
$Asset_t$ – accountant value of asset in moment *t* and
E_t – accountant value of capital in moment *t*.

Based on formula (1) we will calculate the percentage changes in the asset value for each bank, based on formula (2):

$$R_t^i = \frac{A^i{}_t - A^i{}_{t-1}}{A^i{}_{t-1}} \tag{2}$$

Further, we will calculate VaR for each ban and for the banking system, using a confidence level of α based on formula (3):

$$\Pr(R^i{}_t < VaR^i{}_{1-\alpha}) = 1-\alpha \tag{3}$$

CoVaR estimation means to find the 1–α quartile for the distribution R_t, based on (4):

$$\Pr(X_t^{sys} \le CoVaR_{1-\alpha,t}^{sys\left|R_t^i = VaR_{1-\alpha,t}^i\right.} \left| R_t^i = VaR_{1-\alpha,t}^i \right.) = 1-\alpha \tag{4}$$

Where
sys – is the banking system, and*i* – values for each bank.

For each bank we will estimate the parameters of the following quartile regression:

$$R_t^i = \beta^i{}_0 + \beta^i{}_1 \cdot BET_{t-1} + \beta^i{}_2 \cdot ROBOR3M_{t-1} + \beta^i{}_3 \cdot StDev(BET)_{t-1} + \varepsilon^i{}_t \tag{5}$$

Based on the parameters estimated in regression (5), we will calculate the VaR for each bank as follows:

$$\hat{VaR}_t^i = \hat{\beta}_0^i + \hat{\beta}_1^i \cdot BET_{t-1} + \hat{\beta}_2^i \cdot ROBOR3M_{t-1} + \hat{\beta}_3^i \cdot StDev(BET)_{t-1} \quad (6)$$

Going further the CoVaR for the entire banking system is calculated based on the estimated parameters of the quartile equation (7):

$$R_t^{sys|i} = \beta_0^{sys|i} + \beta_1^{sys|i} \cdot BET_{t-1} + \beta_2^{sys|i} \cdot ROBOR3M_{t-1} + \\ + \beta_3^{sys|i} \cdot StDev(BET)_{t-1} + \beta_4^{sys|i} \times R_t^i + \varepsilon_t^{sys|i} \quad (7)$$

Based on the parameters estimated in regression (7), we will calculate the CoVaR as follows:

$$\hat{CoVaR}_{AP,t}^{sys|i} = \hat{\beta}_0^{sys|i} + \hat{\beta}_1^{sys|i} \cdot BET_{t-1} + \hat{\beta}_2^{sys|i} \cdot ROBOR3M_{t-1} + \\ + \hat{\beta}_3^{sys|i} \cdot StDev(BET)_{t-1} + \hat{\beta}_4^{sys|i} \times \hat{VaR}_t^i \quad (8)$$

Finally the risk that a bank is spreading on the market is calculated based on equation (9):

$$\Delta CoVaR_{1\%/5\%}^{sys|i} = CoVaR_{1\%/5\%}^{sys|i(1\%/5\%)} - CoVaR_{1\%/5\%}^{sys|i(50\%)} \quad (9)$$

In order to test our results, we will apply also the Basel test. According to this test we can classify the banks in 3 categories of risk using 250 observations (for each year):

- If $\sum I_t \le 4$, then the bank is in low risk category;
- If $5 \le \sum I_t \le 9$, then bank is in medium risk category;
- If $\sum I_t \ge 10$, then bank is in high risk category;

Where variable I_t is defined as:

$$I_t = \begin{cases} 1 & r_t < VaR_t \\ 0 & r_t \ge -VaR_t \end{cases} \quad (10)$$

4. Descriptive statistics

This methodology, CoVaR, can be applied only if the banks are listed on capital market. Unfortunately this means that we had to decrease the sample to 4 commercial banks: Transilvania Bank (TLV), Carpatica Bank (BCC), Romanian Bank for Development (BRD) and Romanian Commercial Bank (BCR).

Even if BCR is not listed on stock exchange, Erste Group Bank (EBS), the bank which holds Romanian Commercial Bank, is listed on Bucharest Stock Exchange and we used the market date for EBS as a proxy for BCR. Regarding this, because the assets of BCR are 7% from the total assets of Erste Group Bank (Erste Group Bank, 2014), we estimated the BCR stock price to be 7% from market price of EBS's shares.

According to National Bank of Romania, on 31 December 2015, the Romanian banking system was formed by 36 banks. Despite this, the 4selected banks have 40% from market share, which means that our analyses will be significant.

All the date regarding the asset value, capital value and debt value for the 4 selected banks were obtained from the quarter reports available on each bank's website. Based on the interpolation we transform the quarter data in daily data.

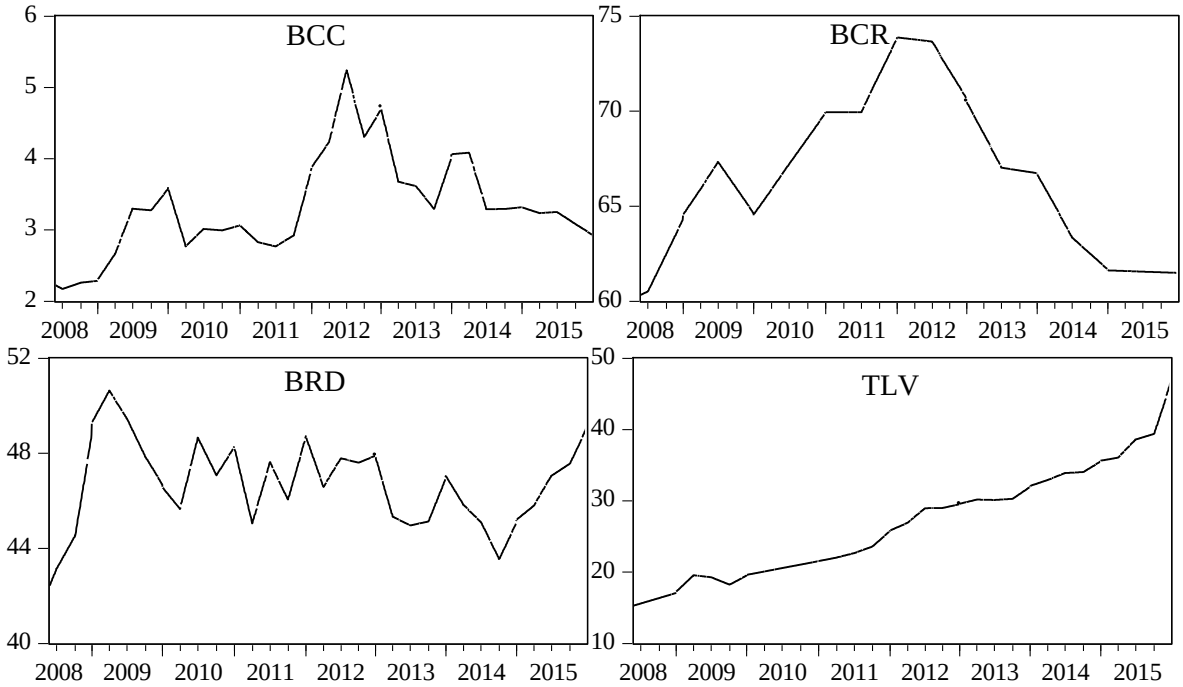


Figure 1. Evolution of total assets for period 2008 – 2015 (billion RON)

Based on the methodology used by Mutu (2012), we selected for CoVaR calculation three macroeconomics variables, namely:

- Return of BET –shows the capital market evolution;
- Volatility of BET – shows the risk of capital market;
- The degree of modification of interbank lending rate – ROBOR for 3 months.

Table 1. Descriptive statistics for period 2008 – 2015

Variable	Mean	Median	Max.	Min.	Std. Dev.	Skewness	Kurtosis
Carpatica Bank							
Total assets	3.34	3.28	5.24	2.17	0.65	0.60	3.21
Total capital	0.30	0.30	0.43	0.19	0.07	0.12	1.77
Total debts	3.04	2.97	4.90	1.86	0.68	0.75	3.41
Adjusted assets	2.34	2.21	5.02	1.45	0.62	1.26	4.94
Financial leverage	11.55	11.44	17.11	7.66	2.43	0.51	2.20
Changing rate of adjusted assets	-0.01%	-0.07%	22.30%	-15.06%	2.73%	0.83	13.49
Size	19.49	19.51	19.88	19.05	0.23	-0.15	1.84
Volatility	2.83%	2.31%	15.13%	0.92%	2.34%	4.35	23.05
Value M/B	0.75	0.70	2.26	0.33	0.34	1.85	6.78
Return	-0.05%	0.00%	118.39%	-16.25%	3.77%	16.29	515.89
Romanian Commercial Bank							
Total assets	66.80	66.70	73.90	60.30	3.92	0.21	1.98
Total capital	6.88	7.20	8.26	4.91	0.92	-0.59	2.08
Total debts	59.50	59.00	66.00	54.70	3.51	0.28	1.86
Adjusted assets	979.00	994.00	1,580.00	229.00	301.00	-0.19	2.59
Financial leverage	9.82	9.53	12.55	8.40	0.98	0.91	2.81
Changing rate of adjusted assets	0.05%	0.03%	47.15%	-15.09%	3.11%	1.72	34.68
Size	22.64	22.70	22.83	22.31	0.14	-0.74	2.28
Volatility	2.63%	2.11%	6.52%	0.97%	1.27%	1.45	4.18
Value M/B	14.86	14.81	26.22	3.50	5.14	0.13	2.53
Return	-0.01%	0.00%	14.16%	-16.25%	2.93%	-0.43	9.56

BRD							
Total assets	46.70	46.80	50.60	42.40	1.61	-0.02	2.88
Total capital	4.95	5.30	6.05	3.04	0.86	-0.82	2.58
Total debts	40.70	40.80	43.30	37.50	1.30	-0.17	2.24
Adjusted assets	74.10	62.60	218.00	33.60	32.30	1.97	7.82
Financial leverage	9.81	8.79	16.18	7.69	2.11	1.21	3.36
Changing rate of adjusted assets	-0.03%	0.00%	15.26%	-14.56%	2.25%	-0.10	11.50
Size	22.30	22.39	22.52	21.84	0.19	-1.10	3.26
Volatility	1.97%	1.55%	5.91%	0.80%	1.09%	1.89	6.05
Value M/B	1.59	1.31	5.11	0.67	0.74	2.32	9.61
Return	-0.03%	0.00%	13.98%	-15.85%	2.25%	-0.46	11.56
Transilvania Bank							
Total assets	26.70	26.60	47.20	15.30	7.29	0.36	2.19
Total capital	2.56	2.45	6.02	1.43	0.83	0.91	3.81
Total debts	24.10	24.20	41.20	13.90	6.55	0.29	2.06
Adjusted assets	48.40	29.30	273.00	14.40	47.60	2.47	8.88
Financial leverage	10.58	10.58	11.59	7.85	0.58	-1.08	5.63
Changing rate of adjusted assets	0.24%	-0.02%	320.37%	-89.56%	8.18%	31.13	1,244.26
Size	21.61	21.62	22.52	21.08	0.31	0.27	2.18
Volatility	2.76%	1.88%	18.64%	0.00%	3.14%	4.09	20.19
Value M/B	2.07	1.16	14.05	0.61	2.60	2.72	9.58
Return	0.09%	0.00%	143.47%	-23.60%	4.03%	23.38	840.28
ROBOR							
ROBOR – 3mo	-0.08%	0.00%	65.90%	-34.80%	3.05%	10.11	231.91
SYST							
Adjusted assets	1,100.00	1,130.00	1,840.00	345.00	305.00	-0.11	2.64
Changing rate of adjusted assets	0.04%	0.05%	38.94%	-17.34%	2.84%	1.21	26.50
BET							
Return	0.00%	0.04%	10.56%	-13.12%	1.66%	-0.65	13.17
Volatility	1.40%	1.03%	4.18%	0.50%	0.89%	1.40	4.03

Note: SYST – banking system (formed by BCC, BCR, BRD and TLV)

We can see that the highest value of assets is recorded by BCR (66.8 billion RON), followed by BRD (46.7 billion RON), TLV (26.7 billion RON) and BCC with 3.3 billion RON. In the same time, according with the evolution presented in figure 1, we can see an increase in the assets of Transilvania Bank during the period 2008 – 2015. Regarding this, the asset value tripled, from 15 billion RON in 2008 to 47 billion RON in 2015.

Table 2. Correlation coeficient for period 2008 – 2015

Variable	BCC	BCR	BRD	SYST	BET	ROBO3M
BCC	1.0000					
BCR	0.2461	1.0000				
BRD	0.3043	0.4450	1.0000			
SYST	0.2724	0.9739	0.4999	1.0000		
BET	0.3807	0.5045	0.8074	0.5410	1.0000	
ROBO3M	-0.0165	-0.1016	-0.0262	-0.0993	-0.0469	1.0000

Moreover, the changes in the assets value for each bank highlight the fact that BCC and BRD recorded a decrease in the market value during this period, while the other 2 banks recorded an increase.

Evolution of all financial variables can be seen in the Figures A1-A7, where we can see also the capital increase for each bank. Regarding the last aspect we see that Transilvania Bank and Carpatica Bank have increased the capital many times, while BRC and BCR have not increase the capital or increased it only once or twice. In the same time we are able to see that the only reduction in capital was made by BCC in October 2015.

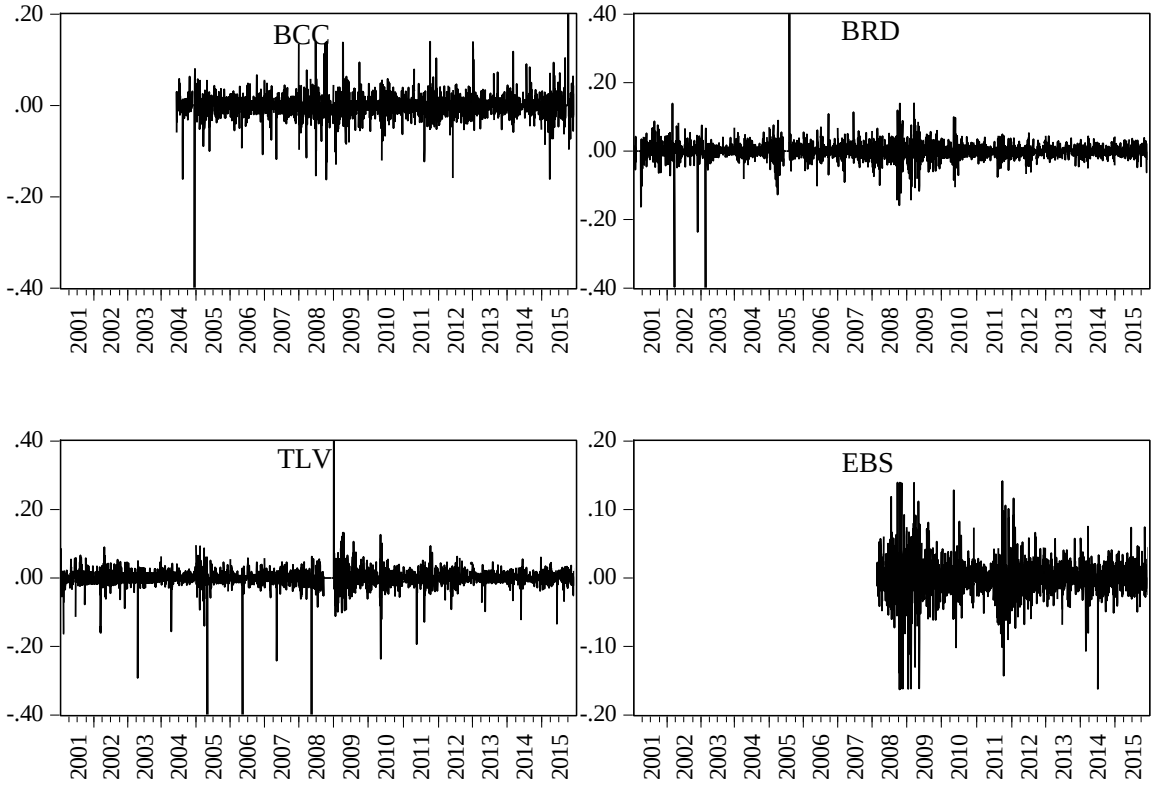
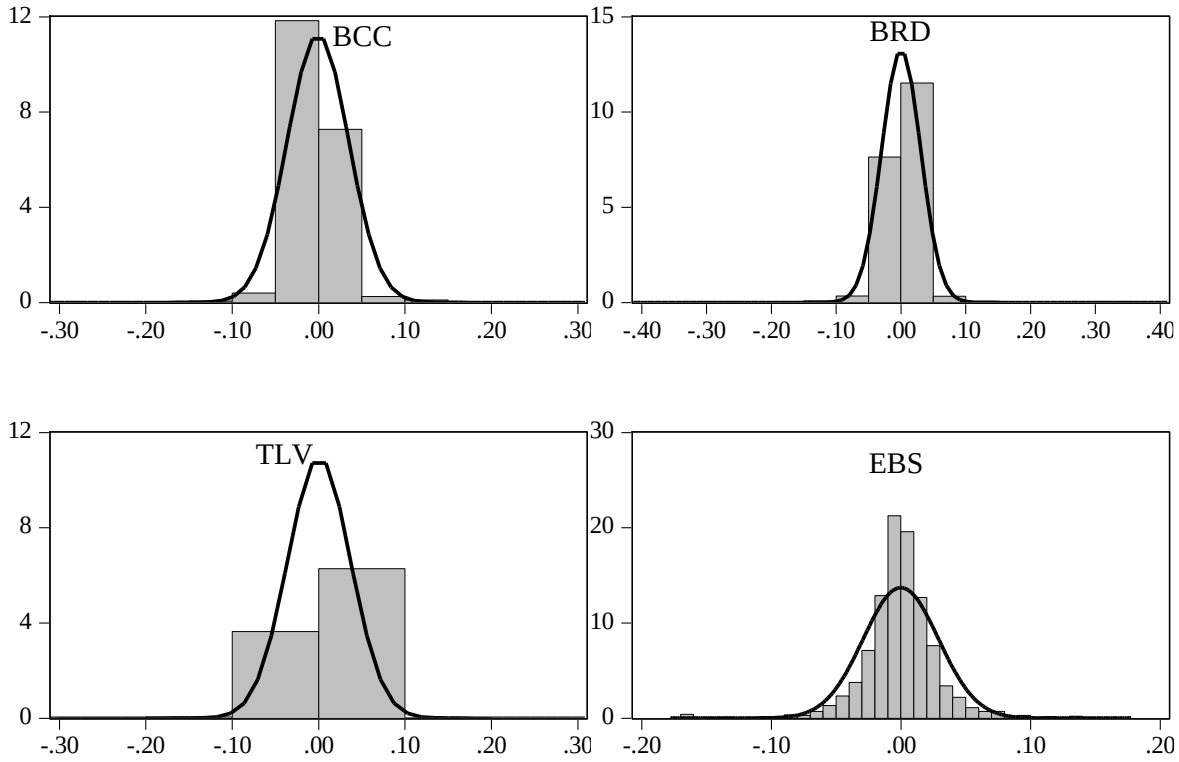


Figure A1. Evolution of daily returns



FigureA2. Distribution of daily returns versus normal distribution

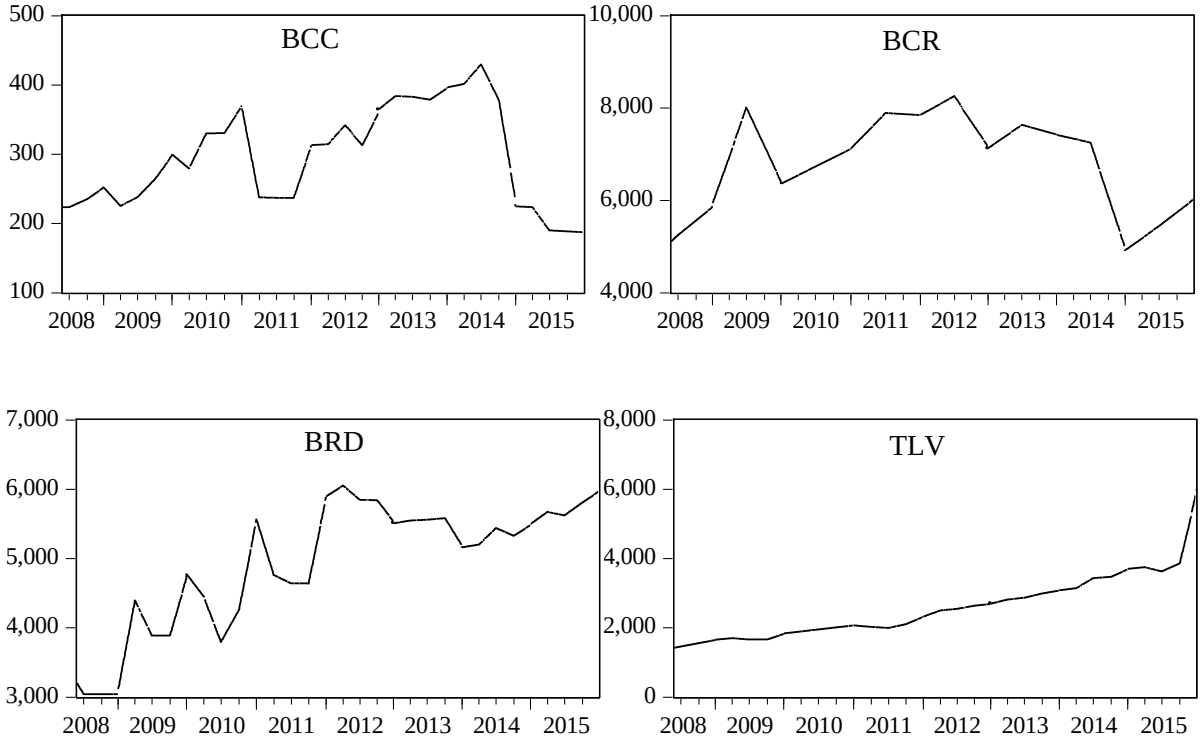


Figure A3. Evolution of total assets for period 2008 – 2015 (million RON)

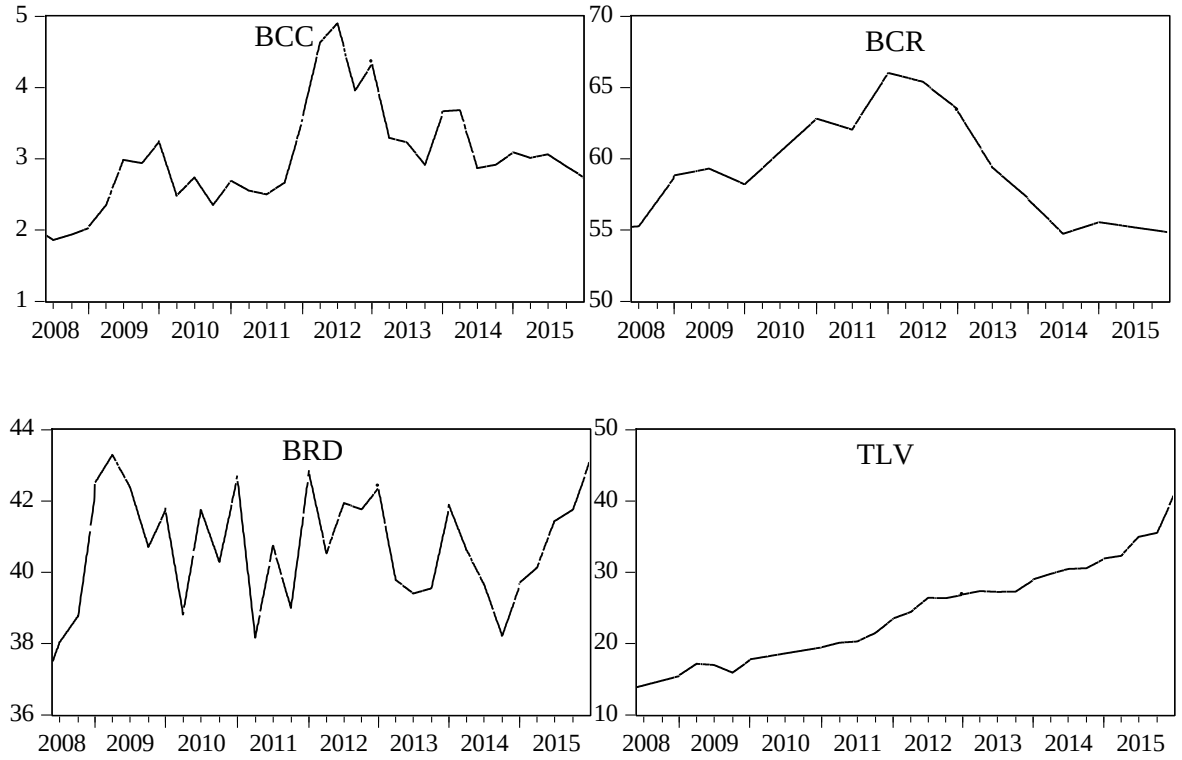


Figure A4. Evolution of total debt for period 2008 – 2015 (billion RON)

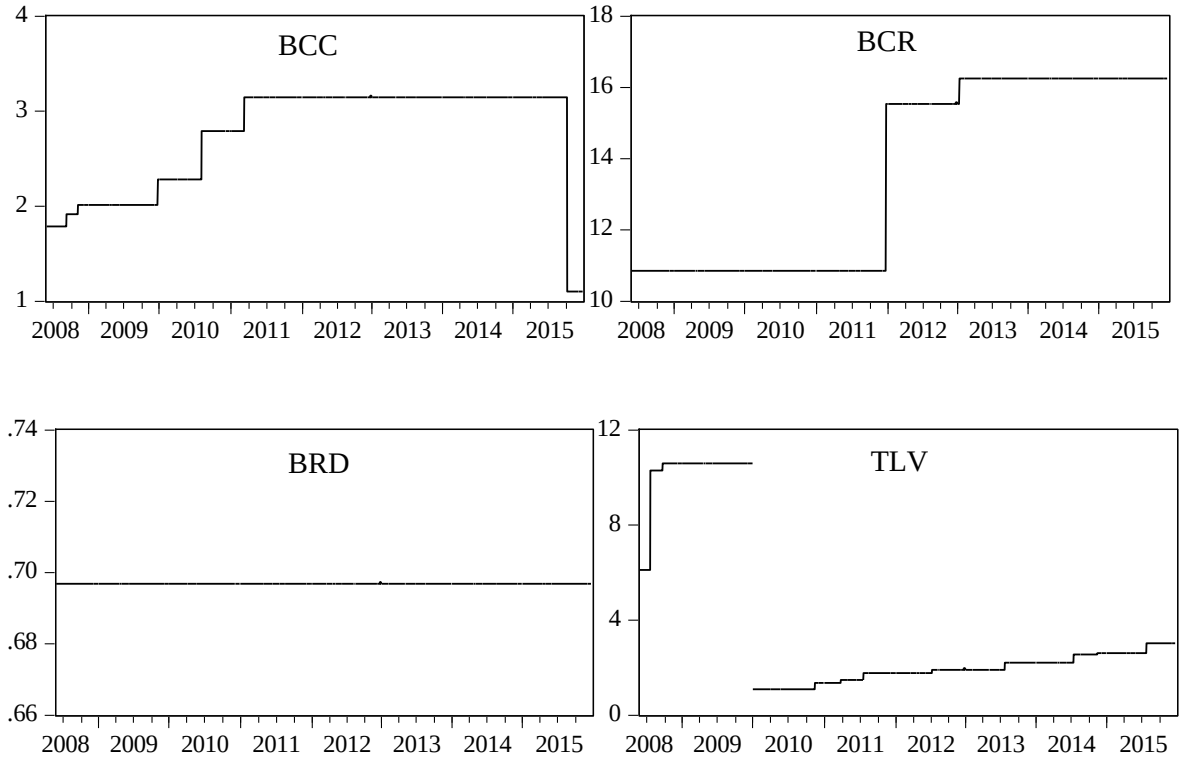


Figure A5. Evolution of shares' number for period 2008 – 2015 (billion shares)

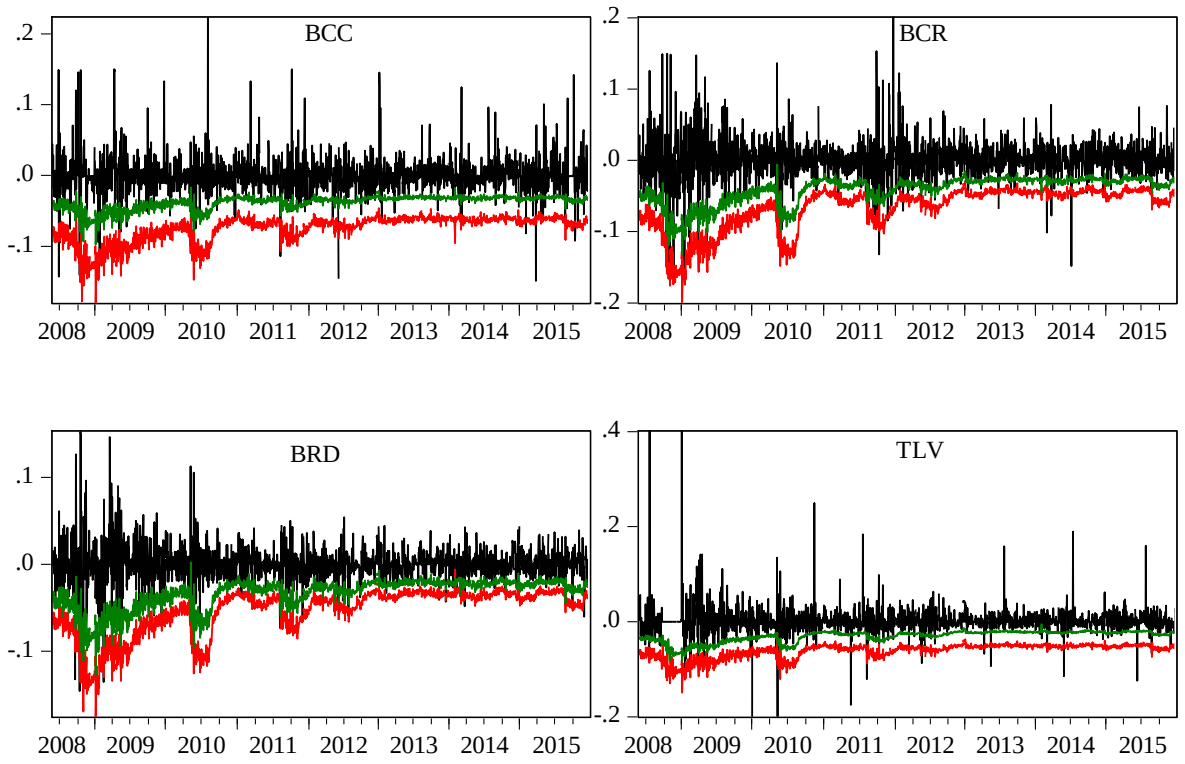


Figure A6. VaR estimation based on quartile regression (VaR(5%) –**green line**; VaR(1%) –**red line)**

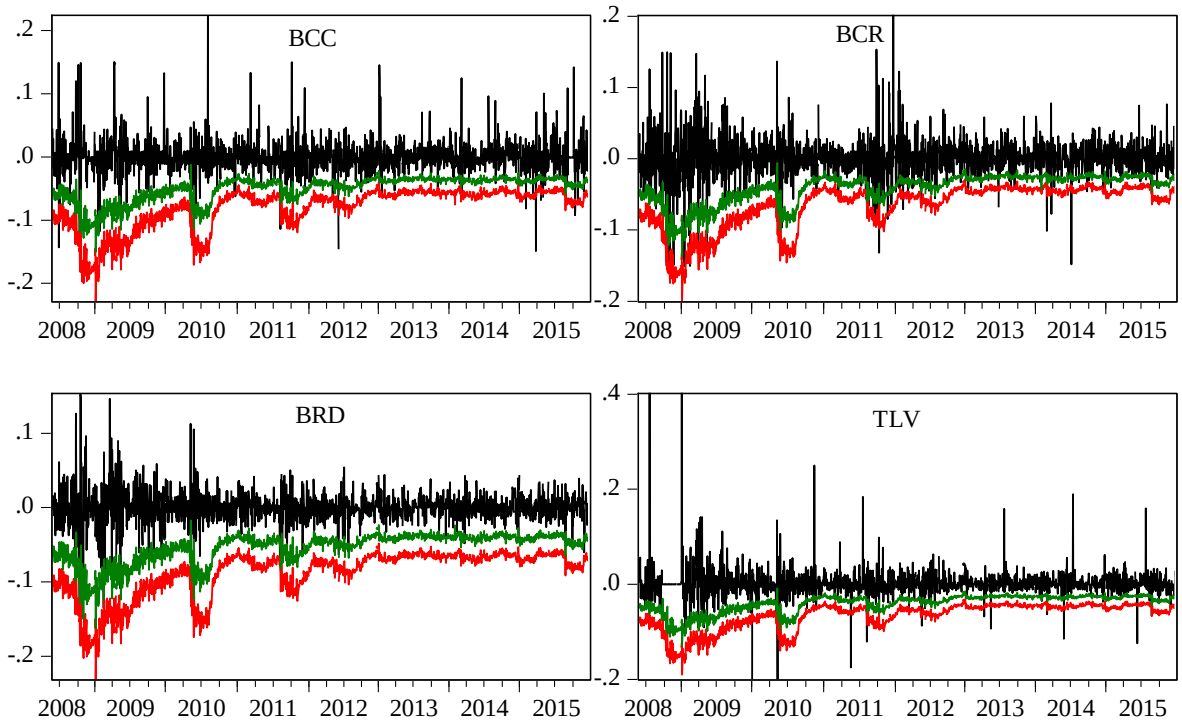


Figure A7. CoVaR estimation based on quartile regression (CoVaR(5%) –**green line**; CoVaR(1%) –**red line)**

The biggest correlation of 0.9649 is recorded between the changes in market value of assets of BCR and banking system. In the same time the smallest correlation is between banking system and BCC (0.2724). In the same time, based on the Augmented Dickey Fuller test, where can see that the most variable are stationary.

Table 3. Augmented Dickey Fuller stationarity test for analysed variables

Variable	BCC	BCR	BRD	TLV	SYST	BET	ROBOR 3m
Financial leverage	-2.62*	-3.16**	-2.95**	-1.15			
Changing rate of adjusted assets	-44.45***	-39.08***	-39.92***	-43.42***	-39.62***		
Size	-2.05	-2.73*	-3.06**	1.68			
Volatility	-0.34	-1.48	-1.90	-3.79***		-1.56	
Value M/B	-4.43***	-1.68	-5.14***	-2.49			
ROBOR – 3month							-18.11***
Return						-40.63***	

****,**,*- stationary test ADF (Augmented Dickey-Fuller) is significant at 1%, 5%, or 10%.*

5. Results

The second objective followed in this paper is to quantify the systemic risk contribution of each bank.

Table 4. VaR estimation for period 2008 – 2015

Model	constant	BET(-1)	Volatility BET (-1)	ROBO3M	Pseudo R^2
VaR (1%)					
BCC	-4.0481*** (0.0065)	0.4438 (0.3342)	-1.9099*** (0.5009)	-0.0692 (0.2472)	0.0830
BCR	-0.0208*** (0.0045)	0.4089*** (0.0666)	-3.3088*** (0.3806)	-0.0208*** (0.0066)	0.2866
BRD	-0.0131** (0.0063)	0.3832 (0.2664)	-2.8936*** (0.6184)	0.0667*** (0.0128)	0.2822
TLV	-0.0396**	0.3778	-1.5557*	0.0035	0.0529

	(0.0163)	(0.3065)	(0.9402)	(2.1898)	
VaR (5%)					
BCC	-0.0242*** (0.0051)	0.2668** (0.1036)	-0.9859** (0.4324)	0.0348 (0.0799)	0.0381
BCR	-0.0125*** (0.0024)	0.3071*** (0.0842)	-2.0581*** (0.2287)	-0.0354 (0.0585)	0.1351
BRD	-0.0084*** (0.0017)	0.3878*** (0.0623)	-1.7887*** (0.1627)	0.0182 (0.0238)	0.1652
TLV	-0.0120*** (0.0023)	0.1453 (0.0917)	-1.3203*** (0.1800)	0.0382 (0.0507)	0.0651
VaR (50%)					
BCC	-0.0005 (0.0007)	-0.0114 (0.0284)	-0.0022 (0.0434)	0.0016 (0.0063)	0.0001
BCR	0.0005 (0.0010)	0.0111 (0.0609)	-0.0167 (0.0858)	-0.0042 (0.0138)	0.0001
BRD	0.0001 (0.0709)	0.0893** (0.0436)	-0.0392 (0.0650)	-0.0164 (0.0709)	0.0033
TLV	-0.0001 (0.0005)	0.0004 (0.0161)	-0.0026 (0.0251)	-0.0001 (0.0041)	0.0001

****,**,*- coefficients are significant at 1%, 5%, or 10%.*

() – standard deviation; (-1) – lag value (one day).

For variables BET and ROBOR 3 months, we used a lag(1), because the effects of these variables have impact in time.

Table 5. CoVaR estimation for period 2008 – 2015

Model	constant	BET(-1)	Volatility BET (-1)	ROBO3M	Return	Pseudo R^2
CoVaR (1%)						
BCC	-0.0179*** (0.0042)	0.3350*** (0.0823)	-3.0133*** (0.3889)	-0.0170** (0.0067)	0.2788*** (0.0417)	0.2904
BCR	-0.0002 (0.0008)	0.0157 (0.0141)	-0.6520*** (0.0807)	0.0052 (0.0037)	0.8468*** (0.0021)	0.8203
BRD	-0.0318*** (0.0065)	0.1938 (0.2841)	-1.5316*** (0.3519)	-0.0446*** (0.0065)	0.6548*** (0.2096)	0.3448
TLV	-0.0196*** (0.0039)	0.3342*** (0.0608)	-2.9637*** (0.3316)	-0.0125** (0.0059)	0.0827*** (0.0034)	0.2951
CoVaR (5%)						
BCC	-0.0128*** (0.0020)	0.2839*** (0.1040)	-1.7983*** (0.1935)	-0.0210 (0.0682)	0.3165*** (0.0158)	0.1807
BCR	0.0010** (0.0004)	0.0366** (0.0160)	-0.3744*** (0.0440)	-0.0011 (0.0037)	0.8978*** (0.0088)	0.8660
BRD	-0.0189*** (0.0018)	0.1930*** (0.0412)	-1.0281*** (0.1405)	0.0292*** (0.0091)	0.6140*** (0.0252)	0.2615
TLV	-0.0107*** (0.0035)	0.2915*** (0.0702)	-1.9390*** (0.3813)	-0.0156 (0.0347)	0.0683*** (0.0035)	0.1511
CoVaR (50%)						
BCC	-0.0001 (0.0009)	0.0276 (0.0570)	0.0332 (0.0662)	-0.0116 (0.0124)	0.2237*** (0.0264)	0.0338
BCR	0.0001 (0.0001)	0.0045 (0.0057)	-0.0157 (0.0109)	-0.0039 (0.0037)	0.9178*** (0.0031)	0.8875
BRD	0.0006 (0.0009)	0.0001 (0.0426)	-0.0508 (0.0702)	-0.0093 (0.0400)	0.5028*** (0.0372)	0.1090
TLV	0.0002 (0.0009)	-0.0080 (0.0538)	-0.0255 (0.0698)	-0.0116 (0.0112)	0.2634** (0.1221)	0.0601

****,**,*- coefficients are significant at 1%, 5%, or 10%.*

() – standard deviation; (-1) – lag value (one day).

Descriptive statistics for VaR and CoVaR for period 2008 – 2015, for a confident level of 1% and 5% are presented in table 6. The highest VaR is recorded byBCC, at 1% confidence level (7.49%), while for a confident level of 5%, the highest value for VaR is recorded by BCR (4.14%). For CoVaR, the situation is different and it seems that the highest risk is recorded for BRD.

Table 6. Descriptive statistics for VaR and CoVaRfor period 2008 – 2015

Risk indicator		**Mean**	**Median**	**Max.**	**Min.**	**Dev. St.**	**Skewness**	**Kurtosis**
BCC	VaR 1%	-7.49%	-6.76%	-1.94%	-17.99%	1.89%	-1.61	5.69
BCR		-6.72%	-5.48%	-2.49%	-20.21%	3.04%	-1.46	4.46
BRD		-5.38%	-4.31%	-0.59%	-17.52%	2.67%	-1.49	4.68
TLV		-6.15%	-5.57%	-2.41%	-14.92%	1.53%	-1.61	5.56
BCC	VaR 5%	-3.82%	-3.46%	-1.67%	-9.74%	0.99%	-1.69	6.23
BCR		-4.14%	-3.36%	-0.59%	-13.21%	1.92%	-1.49	4.68
BRD		-3.36%	-2.69%	0.22%	-12.84%	1.73%	-1.58	5.33
TLV		-3.06%	-2.56%	-0.50%	-8.29%	1.21%	-1.47	4.57
BCC	CoVaR 1%	-8.11%	-6.77%	-3.13%	-22.82%	3.27%	-1.47	4.51
BCR		-6.64%	-5.35%	-2.87%	-19.86%	3.15%	-1.44	4.35
BRD		-8.86%	-7.58%	-4.57%	-23.10%	3.15%	-1.47	4.51
TLV		-6.63%	-5.47%	-2.96%	-19.01%	2.83%	-1.46	4.43
BCC	CoVaR 5%	-5.02%	-4.22%	-1.23%	-15.03%	1.99%	-1.52	4.85
BCR		-4.13%	-3.29%	-0.59%	-13.68%	2.06%	-1.48	4.60
BRD		-5.40%	-4.62%	-1.76%	-16.28%	2.04%	-1.58	5.27
TLV		-4.00%	-3.24%	-0.86%	-12.94%	1.89%	-1.49	4.64

Note: BCC – Carpatica Bank, BCR – Romanian Commercial Bank, BRD – Romanian Bank of Development, TLV – Transilvania Bank

For both levels of confident we obtain that the highest CoVaR belongs to BRD and it is 8.86% (at 1% confidence level), and 5.4% (at 5% confidence level).

Table 7. Average systemic risk contribution for each bank for period 2008-2015
(Million RON)

Connection	**ΔCoVaR**			
	Mean	**Maxim**	**Minim**	**Dev. St.**
1 % confidence level				
BCC → system	-199	-67	-775	123
BCR → system	-59,606	-23,911	-151,655	21,613
BRD → system	-6,871	-2,486	-23,725	4,434
TLV → system	-3,596	-617	-24,059	4,751
5 % confidence level				
BCC → system	-123	-37	-494	76
BCR → system	-37,096	-8,773	-99,032	14,116
BRD → system	-4,184	-870	-15,287	2,751
TLV → system	-2,185	-214	-16,382	2,959

Note: BCC – Carpatica Bank, BCR – Romanian Commercial Bank, BRD – Romanian Bank of Development, TLV – Transilvania Bank

Table 8. Basel test for VaR and CoVaR for each year

Bank	**VaR (1%)**		**VaR (5%)**		**CoVaR (1%)**		**CoVaR (5%)**	
	Exceptions	*Risk*	*Exceptions*	*Risk*	*Exceptions*	*Risk*	*Exceptions*	*Risk*
BCC								
2008	5	***Medium***	10	**High**	4	**Low**	6	***Medium***
2009	2	**Low**	12	**High**	0	**Low**	2	**Low**
2010	1	**Low**	8	***Medium***	1	**Low**	5	***Medium***
2011	1	**Low**	11	**High**	1	**Low**	3	**Low**

2012	2	**Low**	12	**High**	2	**Low**	6	***Medium***
2013	1	**Low**	8	***Medium***	1	**Low**	6	***Medium***
2014	2	**Low**	11	**High**	2	**Low**	7	***Medium***
2015	8	***Medium***	22	**High**	10	**High**	19	**High**
BCR								
2008	2	**Low**	9	***Medium***	3	**Low**	9	***Medium***
2009	2	**Low**	7	***Medium***	2	**Low**	7	***Medium***
2010	1	**Low**	7	***Medium***	0	**Low**	7	***Medium***
2011	4	**Low**	19	**High**	5	***Medium***	20	**High**
2012	2	**Low**	16	**High**	2	**Low**	16	**High**
2013	1	**Low**	10	**High**	3	**Low**	11	**High**
2014	5	***Medium***	14	**High**	5	***Medium***	17	**High**
2015	1	**Low**	11	**High**	2	**Low**	12	**High**
BRD								
2008	3	**Low**	9	***Medium***	1	**Low**	5	***Medium***
2009	2	**Low**	20	**High**	0	**Low**	4	**Low**
2010	2	**Low**	9	***Medium***	1	**Low**	2	**Low**
2011	2	**Low**	12	**High**	0	**Low**	3	**Low**
2012	1	**Low**	8	***Medium***	0	**Low**	1	**Low**
2013	2	**Low**	7	***Medium***	0	**Low**	2	**Low**
2014	2	**Low**	15	**High**	0	**Low**	2	**Low**
2015	3	**Low**	15	**High**	0	**Low**	2	**Low**
BT								
2008	1	**Low**	8	***Medium***	1	**Low**	2	**Low**
2009	3	**Low**	14	**High**	0	**Low**	8	***Medium***
2010	5	***Medium***	17	**High**	6	***Medium***	13	**High**
2011	2	**Low**	14	**High**	2	**Low**	7	***Medium***
2012	2	**Low**	13	**High**	2	**Low**	7	***Medium***
2013	2	**Low**	5	***Medium***	2	**Low**	3	**Low**
2014	2	**Low**	10	**High**	2	**Low**	9	***Medium***
2015	2	**Low**	12	**High**	4	**Low**	8	***Medium***

Regarding the contribution to the systemic risk for period 2008 – 2015 we highlight that BCR has the highest impact on both confidence level. Regarding this the average contribution is 59 billion at 1% confidence level and 37 billion at 5% confidence level. In the same time the smallest impact on systemic risk is done by BCC, namely 199 million RON at 1% and 123 million RON at 5%. Of course, if we are restrictive for the confidence level the systemic risk contribution is increasing.

Applying the Basel test we were able to see that the risk is capture in a big proportion by both models for a confidence level of 1%. In the same time for 5% confidence level the VaR model is not capturing anymore the risk, while CoVaR is capturing better the risk especially for BRD.

Table 9. Regresion models estimation

1. Depended variable: ΔCoVaR (1%)				
	Model 1.1	**Model 1.2**	**Model 1.3**	**Model 1.4**
constant	-0.1275***	-0.1404***	-0.0839***	-0.0881***
	(0.0008)	(0.0021)	(0.0010)	(0.0019)
Ln(TA)	0.0022***	0.0026***	0.0001*	0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
StDev	0.1333***	0.1239***	0.1047***	0.1020***
	(0.0076)	(0.0081)	(0.0088)	(0.0092)
LVG		0.0005***		0.0002**
		(0.0001)		(0.0001)

M / B			0.0008***	0.0008***
			(0.0001)	(0.0001)
R^2	*0.9197*	*0.9203*	*0.385*	*0.9385*
Adj. R^2	*0.8929*	*0.8937*	*0.9179*	*0.9180*
Alkaike criterion	*-6.0561*	*-6.0630*	*-6.3223*	*-6.3228*
2. Dependent variable: ΔCoVaR (5%)				
	Model 2.1	**Model 2.2**	**Model 2.3**	**Model 2.4**
constant	-0.0802***	-0.0898***	-0.0575***	-0.0628***
	(0.0004)	(0.0012)	(0.0006)	(0.0012)
Ln(TA)	0.0014***	0.0017***	0.0003***	0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
StDev	0.0704***	0.0634***	0.0555***	0.0521***
	(0.0049)	(0.0053)	(0.0056)	(0.0059)
LVG		0.0004***		0.0002***
		(0.0001)		(0.0001)
M / B			0.0004***	0.0004***
			(0.0001)	(0.0001)
R^2	*0.9252*	*0.9260*	*0.9377*	*0.9379*
Adj. R^2	*0.9003*	*0.9013*	*0.9170*	*0.9172*
Alkaike criterion	*-7.0329*	*-7.0432*	*-7.2161*	*-7.2191*

****,**,*- coefficients are significant at 1%, 5%, or 10%. () – standard deviation;*

Further we want to analyse the main determinant of the systemic risk contribution for each bank. The regression used to capture this is the following:

$$\Delta CoVaR_{i,t} = \alpha_0 + \alpha_1 LVG_{i,t} + \alpha_3 \ln(TA)_{i,t} + \alpha_4 StDev_{i,t} + \alpha_5 M/B_{i,t} + \varepsilon_{i,t} \quad (11)$$

Where

$\Delta CoVaR_{i,t}$ is the systemic risk contribution of bank *i* in moment *t*,

$LVG_{i,t}$ is the ration between total assets and total capitals of bank *i* in moment *t*,

$\ln(TA)_{i,t}$ is the logarithm of total assets of bank *i* in moment *t*,

$StDev_{i,t}$ is the volatility of share price of bank*i* in moment *t*, computed as standard deviation for each quarter,

$M/B_{i,t}$ is the ration between market price and book price of capital for bank *i* in moment *t*, $\alpha_0, \alpha_1, \alpha_3, \alpha_4, \alpha_5$ are the parameters of regression model, and

$\varepsilon_{i,t}$ is the error term.

Results for estimating the models are presented in table 9. We took as dependent variable, both ΔCoVaR (1%), and ΔCoVaR (5%), in order to see if the confidence level has an impact on the regression estimation. Based on the model estimation we see that the confident level choose for ΔCoVaR, is not influencing the results. In the same time we see that all four selected variables have a significant impact on the systemic risk contribution of each bank.

6. Conclusions

Our paper brings a significant contribution to the existing literature by extending the systemic risk estimation for Romanian banking system. In the same time the results are important for banks, because they can see the most important factors which affect them to contribute to the systemic risk.

The results of this paper highlights that the largest contribution to the daily losses of Romanian banking system is given by BCR (59 billion at 1% confidence level and 37 billion at 5% confidence level), while the lowest contribution is given by BCC, namely 199 million RON at 1% and 123 million RON at 5%. In the same time we was able to see, that by choosing a more restrictive confidence level, the estimated

contribution of each bank to the whole system is increasing. That's why, when we select 1% confidence level, the contribution to banking system loses is largest compared with 5% confidence level.

Moreover, the Regulators who are supervising the financial markets and also the banking system, can see the most important indicators which they must measure in order topoint the predisposition of a bank to increase the systemic risk.

Systemic risk contribution of each bank is increasing in the same time with the increase in financial leverage (ration between total assets and total capitals of bank), size of the bank *(*used proxy in this paper is logarithm fromtotal assets of bank), volatility of share price of bank and also the ration between market price and book price of capital. Based on this finding, the Regulators can group the banks in more several categories, based on some ranges for the identified indicators, in order to differentiate the banks which are most likely to spread systemic risk on the banking system.

The main limitation of the analyse is the small number of commercial banks, only 4, but this limitation due to the fact that only these banks are listed on stock exchange.

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