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The impact of the US Stock Market on the Romanian Stock Market in the context of the Financial Crisis

Costel Nistor[1] *– Razvan Stefanescu*[2] *- Ramona Dumitriu*[3]

Abstract: *This paper explores the stock market interlinkages between the United States and Romania during the actual financial crisis. For this purpose we analyze, in a Vector Autoregressive framework, daily values of Dow Jones and BET, being two reference indexes for the US and the Romanian Stock markets. By comparing with the results for a more tranquil period of time, we conclude that in the context of the financial crisis the Romanian stock market became more sensitive to the US stock market evolution.*

Keywords: *Financial Linkages, Romanian Stock Market, Crisis, Vector Autoregressive Model*

JEL Classification: G01, G10, G15

1. Introduction

It is widely admitted that in the recent years stock markets from around the world became more integrated. Several circumstances led to this evolution: the practices of international portfolio diversification, the international financial markets deregulation, the abandon of Bretton Woods Monetary System, the financial innovations proliferation, the new technologies in communication and information, the European integration a.s.o. (for example Sharpe 1964, Lintner 1965, King 1994, Kasa 1990, Roca 2000, Kaminsky et. al. 2001, Forbes and Chinn 2004). The financial linkages between the stock markets are materialized not only in the changes of returns, but also in the transfer of volatilities (Kyle 1985).

Some studies approached the particularities of the financial linkages between the stock markets due to specific circumstances. There were revealed the considerable influences of the US stock market on the financial markets from other countries (for example Janakiramanan and Lamba 1998, Hsiao et. al. 2003, Gilmore 2002). The linkages between the emerging markets and the financial markets from the developed countries depend on the role of the foreign investors (Enn and Shim 1989, Ferson and Harvey 1995, Masih and Masih 1998, Login and Solnik 2001). In the Eastern European emerging markets case the perspective to become members of the European Union raised the international investors' interest. In this context they became more sensitive to the foreign stock markets evolutions (Rockinger and Urga 2000). Some researches approached the impact of the crises on the linkages between the international stock markets. Lin et al. (1994) found that during the periods of high volatility the international stock markets were more cointegrated than in the tranquil periods. Yang et al (2005) found that dynamic linkages between US, Germany and four East European (Russia, Poland, Hungary and Czech) stock markets were strengthen after 1998 Russian financial crisis. Zhang (2009) found that effects of the US stock market on the major Asian stock markets were greater after the Asian financial crisis.

In the last years the stock market from Romania experienced significant changes. The perspective of adhesion to the European Union attracted foreign investors and the Bucharest Stock Exchange (BSE) became more integrated with the international financial markets. Between 2006 and 2008 the Romanian stock market experienced an ascendant trend. However, since 2008, in the context of the global crisis, the stocks prices have fallen.

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Figure 1. Evolution of DOW JONES and BET from January 2006 to September 2009

In this paper we study the linkages between the Romanian and the US stock markets in the financial crisis context. We use two main indexes of these stock markets: the well known DOW JONES index from the New York Sock Exchange (NYSE) and BET, a reference index from BSE. The quite similar trends followed by the two indexes in the recent years suggest significant between them (Figure 1). We investigate these linkages in the period of crisis and in a more tranquil period using a VAR framework.

The rest of this paper is organized as follows. In the second part we describe the data and the methodology used in our analysis. In the third part we present the empirical results and in the fourth part we conclude.

2. Data and Methodology

In our analysis we employ daily close values of DOW JONES, provided by Yahoo Finance, and BET, provided by BSE. Because of the time differences between the two countries we study the relationship between the two indexes in two forms: in the first we take the values from the same day for the two variables while in the second we use one day lagged values for DOW JONES. The time period of the data is from the 3rd January 2006 to the 30th of September 2009. For both indexes we compute returns as:

$$R_t = (\ln P_t - \ln P_{t-1}) * 100 \quad (1)$$

where:

- R_t is the return of an index in the day t;
- P_t, P_{t-1} are the values of an index in the day t, respectively t-1.

We use the following variables:

- RBET – the return of BET;
- RDOWJ – the return of DOW JONES;
- LRDOWJ – the one day lagged return of DOW JONES;
- VRBET – the conditional variance of RBET;
- VRDOWJ – the conditional variance of RDOWJ;
- LVRDOWJ – the one day lagged conditional variance of RDOWJ;
- d_VRBET – the first differences of VRBET;
- d_LVRBET – the first differences of LVRBET.

We separate our sample of data in two sub-samples:

- a sub-sample from the 3rd January 2006 to the 11th of April 2008, corresponding to a tranquil period of time;
- a sub-sample from the 12th of April 2008 to the 30th of September 2009, corresponding to a period of time when the stock markets were affected by the financial crisis.

Table 1. Descriptive statistics of RBET and RDOWJ for the two sub-samples

	RBET		**RDOWJ**	
Indicator	**Sub-sample 1**	**Sub-sample 2**	**Sub-sample 1**	**Sub-sample 2**
Mean	0.0262048	-0.181497	0.0242919	-0.0774979
Median	0.00744916	-0.116589	0.0651782	-0.0824473
Minimum	-9.57338	-13.5461	-3.34876	-8.20051
Maximum	4.83962	10.0907	3.48749	10.5083
Std. Dev.	1.58528	3.05046	0.896141	2.32671
C.V.	60.4958	16.8072	36.8904	30.0228
Skewness	-0.640705	-0.529297	-0.298019	0.302038
Ex. kurtosis	3.45954	2.50959	2.01457	3.08540
Jarque - Bera test for normality	331.754	100.77	107.585	134.266
p-value for Jarque - Bera test	0.00001	0.00001	0.00001	0.00001

In the Table 1 there are presented the descriptive statistics of the two indexes returns for both sub-samples. There are significant differences between the means and the standard deviations for the two sub-samples.

We investigate the stationarity of the variables using two tests: the classical Augmented Dickey – Fuller Test and a test proposed by Saikkonen and Lutkepohl (2002) and Lanne et al. (2001) which allow us to take into account the eventual structural breaks. We employ a VAR model to analyze the transmission of the shocks from NYSE to BSE. This model allows the test of the Granger causality between DOW JONES and BET.

In order to analyze the linkages between the volatilities of RBET and RDOWJ we compute, using ARCH - GARCH models, the conditional variances of these variables. Then we study the interactions between them by a VAR model.

3. Empirical Results

3.1. Results for the first sub-sample

Based on the graphical representation we used in the analysis of stationarity for both variables only intercept as deterministic term. In the Table 2 there are presented the results of the Augmented Dickey – Fuller Tests which indicate that both variables are stationary.

Table 2. Augmented Dickey-Fuller Test for the observations from the first sub-sample

Variable	Lagged differences	Test statistics	Asymptotic p-value
RBET	4	-11.0712	0.00001***
RDOWJ	1	-17.9529	0.00001***

Note: The number of the lagged differences was chosen based on Akaike Information Criteria.

The results of unit root tests with structural breaks are presented in the Table 3. They also indicate the stationarity of RBET and RDOWJ.

Table 3. Unit root tests with structural breaks for the observations from the first sub-sample

Variable	Shift Function	Break Date	Lagged differences	Test statistics
RBET	Impulse dummy	498	4	-11.5958***
	Shift dummy	97	4	-4.8832***
RDOWJ	Impulse dummy	532	2	-13.6438***
	Shift dummy	486	1	-6.0759***

Note: The number of the lagged differences was chosen based on Akaike Information Criteria.

The two equations of a VAR model with RBET and RDOWJ as dependent variables are presented in the Table 4. It shows a low interaction between the variables and an insignificant influence of RBET to RDOWJ.

Table 4. VAR system for the first sub-sample

Equation 1: RBET

Variable	Coefficient	Std. Error	t-ratio	p-value
const	0.00535269	0.0624756	0.0857	0.93175
RBET_1	0.0282291	0.0453859	0.6220	0.53420
RDOWJ_1	0.557409	0.0769292	7.2457	<0.00001***

Mean dependent var	0.020592	S.D. dependent var	1.580809
Sum squared resid	1309.626	S.E. of regression	1.501362
R-squared	0.101083	Adjusted R-squared	0.097988
F(2, 581)	26.27619	P-value(F)	1.19e-11
rho	-0.005273	Durbin-Watson	2.008053

Equation 2: RDOWJ

Variable	Coefficient	Std. Error	t-ratio	p-value
const	0.0262874	0.0372152	0.7064	0.48025
RBET_1	-0.0104802	0.0312211	-0.3357	0.73724
RDOWJ_1	-0.0851081	0.0470438	-1.8091	0.07095*

Mean dependent var	0.023817	S.D. dependent var	0.896835
Sum squared resid	465.3228	S.E. of regression	0.894930
R-squared	0.007660	Adjusted R-squared	0.004244
F(2, 581)	1.686554	P-value(F)	0.186062
rho	-0.000112	Durbin-Watson	1.997710

Tests of the residual values

Type of Test	Test Statistic	P-value
Test for multivariate normality of residuals Doornik-Hansen Chi-square(4)	155.563	0.0001
ARCH-LM Test for residual values of first equation	76.5021	0.0001
ARCH-LM Test for residual values of second equation	40.3567	0.0007

Decomposition of variance for RBET

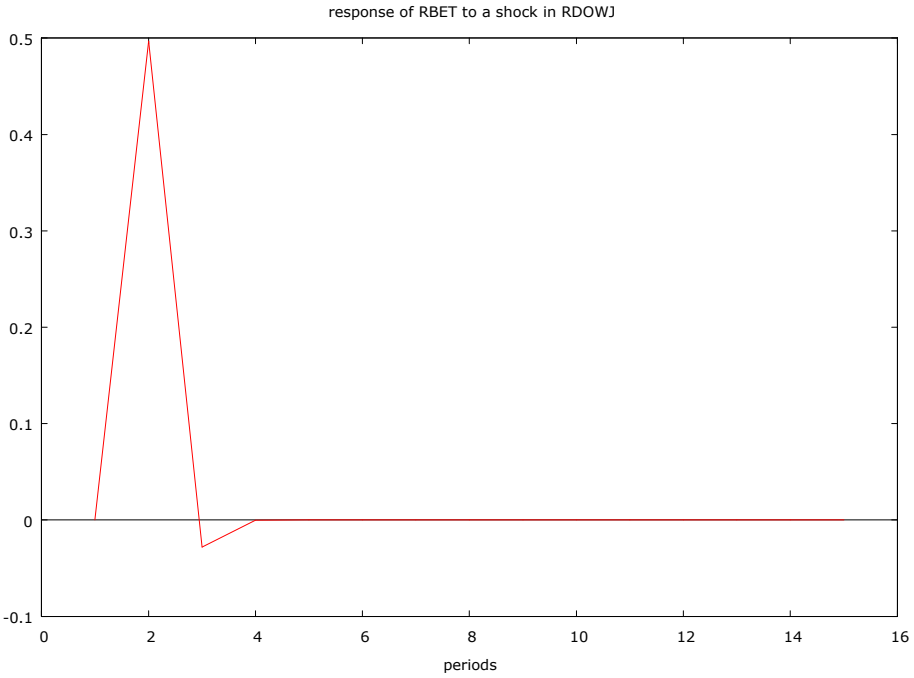
Period	Std. error	RBET	RDOWJ
1	1.4975	100.0000	0.0000
2	1.57931	90.1059	9.8941
3	1.57959	90.0774	9.9226
4	1.57959	90.0774	9.9226
5	1.57959	90.0774	9.9226
6	1.57959	90.0774	9.9226
7	1.57959	90.0774	9.9226
8	1.57959	90.0774	9.9226
9	1.57959	90.0774	9.9226
10	1.57959	90.0774	9.9226
11	1.57959	90.0774	9.9226
12	1.57959	90.0774	9.9226
13	1.57959	90.0774	9.9226
14	1.57959	90.0774	9.9226
15	1.57959	90.0774	9.9226

Decomposition of variance for RDOWJ

Period	Std. error	RBET	RDOWJ
1	0.892628	0.3169	99.6831
2	0.896068	0.3642	99.6358
3	0.896069	0.3643	99.6357
4	0.896069	0.3643	99.6357
5	0.896069	0.3643	99.6357
6	0.896069	0.3643	99.6357
7	0.896069	0.3643	99.6357
8	0.896069	0.3643	99.6357
9	0.896069	0.3643	99.6357
10	0.896069	0.3643	99.6357
11	0.896069	0.3643	99.6357
12	0.896069	0.3643	99.6357
13	0.896069	0.3643	99.6357
14	0.896069	0.3643	99.6357
15	0.896069	0.3643	99.6357

The impulse-response analyses indicate that a shock in RDOWJ leads to a raise of BET and the effects are persistent for some days (Figure 2).

Figure 2. Impact of a shock in RDOWJ on RBET for the first sample



The Granger causality test indicates a unidirectional causality from RDOWJ to RBET (Table 5).

Table 5. Tests of Granger causality between the variables for the first sub-sample

Null hypothesis	**F-statistic**	**P-value**	**Causal inference**
H0: "RBET" do not Granger-cause "RDOWJ"	0.2390	0.6251	"RBET" do not Granger-cause "RDOWJ"
H0: "RDOWJ" do not Granger-cause "RBET"	63.9889	0.00001***	"RDOWJ" Granger-cause "RBET"

We analyzed, in the same VAR framework, the relation between RBET and the lagged values of RDOWJ. The results indicated insignificant interactions between RBET and LRDOWJ.

We compute the conditional variances of the two variables based on the GARCH models (Table 6 and Table 7).

Table 6. GARCH model with RBET as dependent variable for the first sub-sample

Variable	**Coefficient**	**Std. Error**	**z-stat**	**p-value**
const	0.0474254	0.0522473	0.9077	0.36403
alpha(0)	0.285152	0.113702	2.5079	0.01215**
alpha(1)	0.277888	0.0764693	3.6340	0.00028***
beta(1)	0.641435	0.0687922	9.3242	0.00001***

Mean dependent var	0.026205	S.D. dependent var	1.585278
Log-likelihood	-1064.137	Akaike criterion	2138.274
Schwarz criterion	2160.132	Hannan-Quinn	2146.792

Table 7. GARCH model with RDOWJ as dependent variable for the first sub-sample

Variable	**Coefficient**	**Std. Error**	**z-stat**	**p-value**
const	0.0592195	0.0304368	1.9457	0.05170*
alpha(0)	0.0120848	0.00914273	1.3218	0.18624
alpha(1)	0.0596406	0.0147079	4.0550	0.00005***
beta(1)	0.92541	0.0187985	49.2280	<0.00001***

Mean dependent var	0.024292	S.D. dependent var	0.896141
Log-likelihood	-710.5048	Akaike criterion	1431.010
Schwarz criterion	1452.868	Hannan-Quinn	1439.528

We studied, in a VAR framework, the interactions between the conditional variances of RBET and RDOWJ. Because VRDOWJ proved to be not stationary we use the first differences of the two variables. However, we found no significant relation between d_VRBET and d_VRDOWJ.

3.2. *Results for the second sub-sample*

The graphical representation suggests, for both variables, the use of one intercept as deterministic term in the analysis of stationarity. In the Table 8 there are presented the results of the Augmented Dickey – Fuller Tests which indicate that both variables are stationary.

Table 8. Augmented Dickey-Fuller Test for the observations from the second sub-sample

Variable	**Lagged differences**	**Test statistics**	**Asymptotic p-value**
RBET	1	-12.5798	0.00001***
RDOWJ	1	-15.9689	0.00001***

Note: The number of the lagged differences was chosen based on the Akaike Information Criteria.

The results of the unit root tests with structural breaks are presented in the Table 9. They also indicate the stationarity of RBET and RDOWJ.

Table 9. Unit root tests with structural breaks for the observations from the second sub-sample

Variable	**Shift Function**	**Break Date**	**Lagged differences**	**Test statistics**
RBET	Impulse dummy	145	1	-12.2033***
	Shift dummy	93	1	-3.3664**
RDOWJ	Impulse dummy	93	1	-10.1078***
	Shift dummy	122	1	-3.4619**

Note: The number of the lagged differences was chosen based on the Akaike Information Criteria.

In the Table 10 there is presented a VAR model with RBET and RDOWJ as dependent variables. It results again a low interaction between the two variables and an insignificant influence of RBET on RDOWJ.

Table 10. VAR system for the second sub-sample

Equation 1: RBET

Variable	**Coefficient**	**Std. Error**	**t-ratio**	**p-value**
const	-0.150854	0.160168	-0.9418	0.34698
RBET_1	-0.0267816	0.0767321	-0.3490	0.72730
RDOWJ_1	0.416605	0.0853175	4.8830	0.00001***

Mean dependent var.	-0.177951	S.D. dependent var	3.054489
Sum squared resid.	2734.002	S.E. of regression	2.913879
R-squared	0.095566	Adjusted R-squared	0.089949
F(2, 322)	12.49621	P-value(F)	5.93e-06
rho	0.016311	Durbin-Watson	1.965388

Equation 2: RDOWJ

Variable	Coefficient	Std. Error	t-ratio	p-value
const	-0.0883392	0.12495	-0.7070	0.48008
RBET_1	-0.0151269	0.073738	-0.2051	0.83759
RDOWJ_1	-0.134569	0.0694478	-1.9377	0.05353*

Mean dependent var.	-0.075242	S.D. dependent var.	2.329937
Sum squared resid.	1722.917	S.E. of regression	2.313152
R-squared	0.020440	Adjusted R-squared	0.014356
F(2, 322)	2.391524	P-value(F)	0.093114
rho	-0.022570	Durbin-Watson	2.045078

Tests of the residual values

Type of Test	Test Statistic	P-value
Test for multivariate normality of residuals Doornik-Hansen Chi-square(4)	96.6272	0.00001
ARCH-LM Test for residual values of first equation	67.801	0.00001
ARCH-LM Test for residual values of second equation	13.5091	0.0190478

Decomposition of variance for RBET

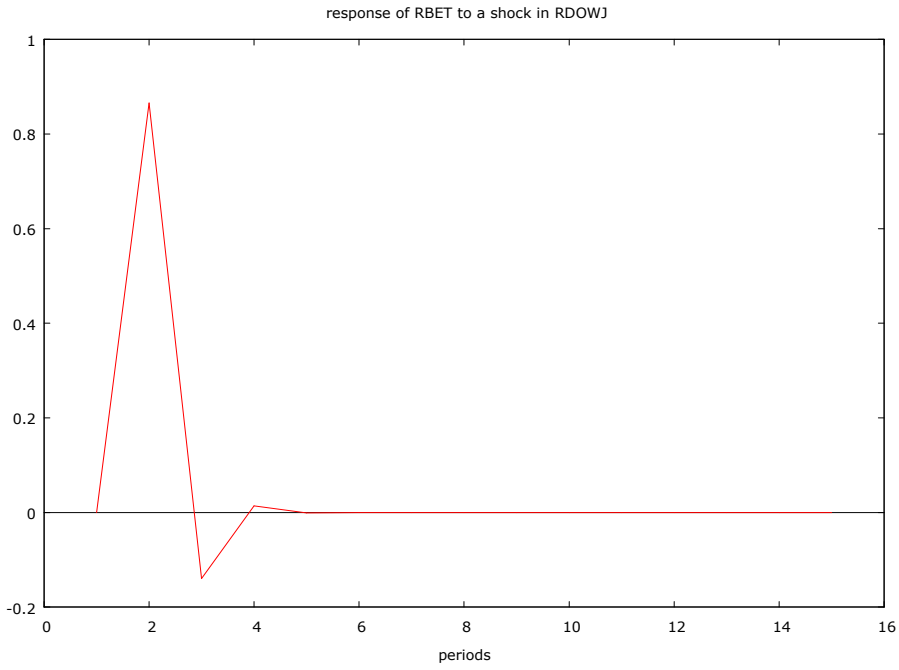
Period	Std. error	RBET	RDOWJ
1	2.9004	100.0000	0.0000
2	3.04538	91.9159	8.0841
3	3.0497	91.7290	8.2710
4	3.04975	91.7272	8.2728
5	3.04975	91.7271	8.2729
6	3.04975	91.7271	8.2729
7	3.04975	91.7271	8.2729
8	3.04975	91.7271	8.2729
9	3.04975	91.7271	8.2729
10	3.04975	91.7271	8.2729
11	3.04975	91.7271	8.2729
12	3.04975	91.7271	8.2729
13	3.04975	91.7271	8.2729
14	3.04975	91.7271	8.2729
15	3.04975	91.7271	8.2729

Decomposition of variance for RDOWJ

Period	Std. error	RBET	RDOWJ
1	2.30245	18.5140	81.4860
2	2.32614	18.7192	81.2808
3	2.32634	18.7224	81.2776
4	2.32634	18.7224	81.2776
5	2.32634	18.7224	81.2776
6	2.32634	18.7224	81.2776
7	2.32634	18.7224	81.2776
8	2.32634	18.7224	81.2776
9	2.32634	18.7224	81.2776
10	2.32634	18.7224	81.2776
11	2.32634	18.7224	81.2776
12	2.32634	18.7224	81.2776
13	2.32634	18.7224	81.2776
14	2.32634	18.7224	81.2776
15	2.32634	18.7224	81.2776

The impulse-response analyses indicate again that a shock in RDOWJ leads to a raise of BET and the effects are persistent for some days (Figure 3).

Figure 3. Impact of a shock in RDOWJ on RBET for the second sample



The Granger causality tests indicate again a unidirectional causality from RDOWJ to RBET (Table 11).

Table 11. Tests of Granger causality between the variables for the second sub-sample

Null hypothesis	**F-statistic**	**P-value**	**Causal inference**
H_0: "RBET" do not Granger-cause "RDOWJ"	0.3563	0.5508	"RBET" do not Granger-cause "RDOWJ"
H_0: "RDOWJ" do not Granger-cause "RBET"	31.1231	0.00001***	"RDOWJ" Granger-cause "RBET"

The VAR analysis indicates an insignificant interaction between RBET and LRDOWJ. We compute the conditional variances of the two variables using the GARCH models (Table 12 and Table 13).

Table 12. GARCH model with RBET as dependent variable for the second sub-sample

Variable	**Coefficient**	**Std. Error**	**z-stat**	**p-value**
const	-0.0851979	0.155268	-0.5487	0.58320
alpha(0)	5.44242	0.895769	6.0757	0.00001***
alpha(1)	0.489471	0.1764	2.7748	0.00552***

Mean dependent var.	-0.181497	S.D. dependent var	3.050458
Log-likelihood	-807.7566	Akaike criterion	1623.513
Schwarz criterion	1638.661	Hannan-Quinn	1629.558

Table 13. GARCH model with RDOWJ as dependent variable for the second sub-sample

Variable	**Coefficient**	**Std. Error**	**z-stat**	**p-value**
const	0.0566057	0.0822904	0.6879	0.49153
alpha(0)	0.00390167	0.0219536	0.1777	0.85894
alpha(1)	0.0956819	0.0200921	4.7622	0.00001***
beta(1)	0.904318	0.0180734	50.0359	0.00001***

Mean dependent var.	-0.077498	S.D. dependent var	2.326707
Log-likelihood	-670.2819	Akaike criterion	1350.564
Schwarz criterion	1369.498	Hannan-Quinn	1358.120

The interactions between the conditional variances were studied in a VAR framework. The two equations presented in the Table 14 indicate a unidirectional influence from d_VRDOWJ to d_VRBET.

Table 14. VAR system on conditional variances for the second sub-sample

Equation 1: d_VRBET

Variable	Coefficient	Std. Error	t-ratio	p-value
const	-0.0217447	0.585055	-0.0372	0.97038
d_VRBET_1	-0.615212	0.123923	-4.9644	0.00001***
d_VRBET_2	-0.262329	0.106925	-2.4534	0.01469**
d_VRDOWJ_1	0.168472	0.956014	0.1762	0.86023
d_VRDOWJ_2	-0.567585	1.00297	-0.5659	0.57186

Mean dependent var	-0.0105011	S.D. dependent var	12.275
Sum squared resid	34301.3	S.E. of regression	10.3858
R-squared	0.293014	Adjusted R-squared	0.25114
F(4, 318)	6.17334	P-value(F)	0.00001***
rho	-0.0482122	Durbin-Watson	2.09618

Equation 2: d_VRDOWJ

Variable	Coefficient	Std. Error	t-ratio	p-value
const	-0.0113635	0.0577988	-0.1966	0.84426
d_VRBET_1	0.0179907	0.0103024	1.7463	0.08173*
d_VRBET_2	0.00947066	0.00829925	1.1411	0.25467
d_VRDOWJ_1	-0.13762	0.0669609	-2.0552	0.04067**
d_VRDOWJ_2	0.164727	0.144604	1.1392	0.25550

Mean dependent var.	-0.012173	S.D. dependent var.	1.06932
Sum squared resid.	335.48	S.E. of regression	1.02712
R-squared	0.088839	Adjusted R-squared	0.068241
F(6, 315)	2.11513	P-value(F)	0.0787*
rho	0.0011	Durbin-Watson	1.99764

Tests of the residual values

Type of Test	Test Statistic	P-value
Test for multivariate normality of residuals Doornik-Hansen Chi-square(4)	507.446	0.00001
ARCH-LM Test for residual values of first equation	5.02361	0.00002
ARCH-LM Test for residual values of second equation	2.10824	0.087371

Decomposition of variance for d_VRBET

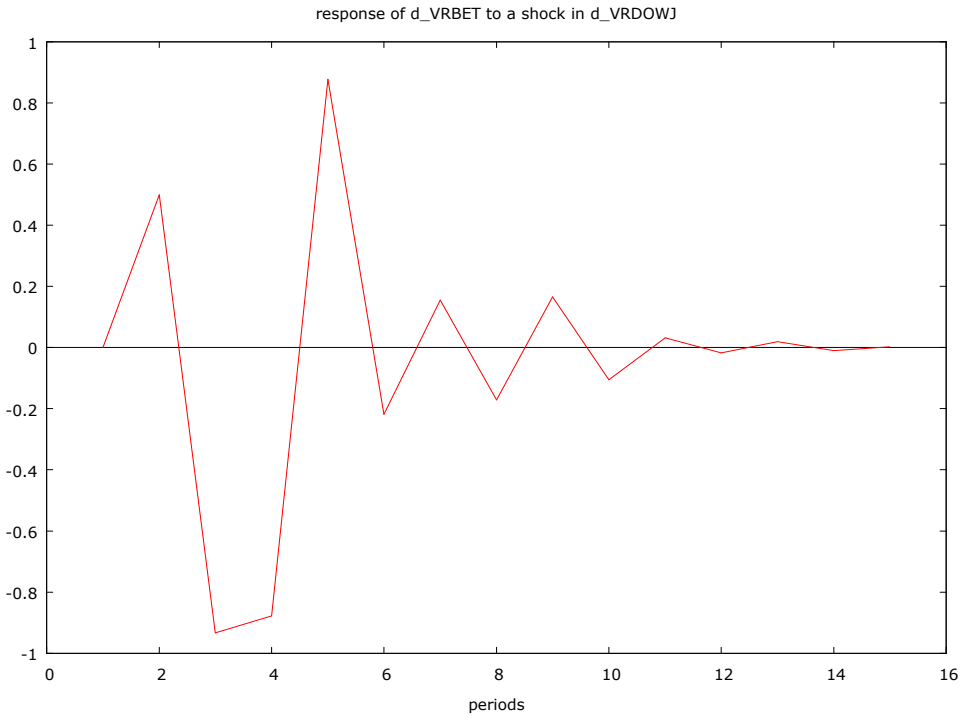
Period	Std. error	d_VRBET	d_VRDOWJ
1	10.3051	100.0000	0.0000
2	12.1046	99.9799	0.0201
3	12.1906	99.6439	0.3561
4	12.2253	99.4777	0.5223
5	12.2523	99.4413	0.5587
6	12.2556	99.4393	0.5607
7	12.2556	99.4393	0.5607
8	12.2559	99.4393	0.5607
9	12.256	99.4393	0.5607
10	12.256	99.4393	0.5607
11	12.256	99.4393	0.5607
12	12.256	99.4393	0.5607
13	12.256	99.4393	0.5607
14	12.256	99.4393	0.5607
15	12.256	99.4393	0.5607

Decomposition of variance for d_VRDOWJ

Period	Std. error	d_VRBET	d_VRDOWJ
1	1.01914	0.2161	99.7839
2	1.04647	3.5683	96.4317
3	1.0648	3.6743	96.3257
4	1.06651	3.6626	96.3374
5	1.06748	3.6823	96.3177
6	1.06762	3.6881	96.3119
7	1.06765	3.6882	96.3118
8	1.06766	3.6883	96.3117
9	1.06766	3.6884	96.3116
10	1.06766	3.6884	96.3116
11	1.06766	3.6884	96.3116
12	1.06766	3.6884	96.3116
13	1.06766	3.6884	96.3116
14	1.06766	3.6884	96.3116
15	1.06766	3.6884	96.3116

The impulse response analysis indicates that a shock in d_VRDOWJ has a persistent impact on d_VRBET (Figure 4).

Figure 4. Impact of a shock in d_VRDOWJ on d_VRBET for the second sub-sample



4. Conclusions

In this paper we studied the impact of the US stock market on the Romanian stock market in the financial crisis context. Our analysis covered a period of time from the 12th of April 2008 to the 30th of September 2009, when the stock markets were affected by the global crisis. For comparison we perform a similar analysis in a more tranquil period of time, from the 3rd January 2006 to the 11th of April 2008.

We approached the NYSE evolution impact on the stock prices and on the volatility from BSE. Regarding the stock prices we found for both periods of time a unidirectional causality from the US stock market to the Romanian stock market. However, the VAR impulse – response analysis suggests the impact of NYSE evolution on BSE was more consistent during the crisis period than during the tranquil period. We also found the volatility of the US stock market had a significant influence on the Romanian stock market only in the financial crisis context.

The results indicate that Romanian stock market became quite integrated with the US stock market. They also confirm the theory that during the financial crisis the emerging markets are more sensitive to the financial markets evolution from the developed countries.

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