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The Contagion Effect on the Romanian Capital Market in the Context of the COVID-19 Pandemic

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Abstract

The capital markets' activity is often disturbed by turbulences that quickly extend worldwide due to complex links existing between countries. Even though the COVID-19 crisis first broke out in the healthcare sector, the negative effects extended rapidly to the financial sector, capital markets being one of the major affected activities due to lockdowns, shutdown of non-essential activities, decrease in capital flows, and changes in investors' behavior. The scientific literature in the field proposes different methodologies in order to study volatility and the contagion effects, in recent times focusing on GARCH models' application to study the contagion during the global financial crisis (2007-2009), at the same time developing research papers for the coronavirus pandemic period. This paper investigates the contagion effect between the Romanian stock market and the stock markets of other twelve countries worldwide during the COVID-19 pandemic crisis. The study applies the Dynamic Conditional Correlation GARCH model to daily stock returns of market indexes from selected countries for the period January 2016 - April 2021. The breakpoint due to crisis is identified using the Chow test for structural breaks by testing possible dates that mark changes in the Romanian capital market. The results show a significant increase in the mean of dynamic conditional correlation coefficients between Romania and most of the other selected stock markets in the crisis period compared to the pre-crisis period, especially in relation with Italy, Hungary and United Kingdom. The findings prove the existence of contagion between Romania and most of the selected stock markets. The paper contributes to the field of study by investigating the effects of the recent global health crisis on stock markets' movements and by studying the contagion effects on the emerging Romanian capital market in these turbulent times.

Keywords: Financial crisis; contagion; COVID-19; Romania; GARCH-DCC model.

JEL Classification: E44, G15, N2.

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1. Introduction

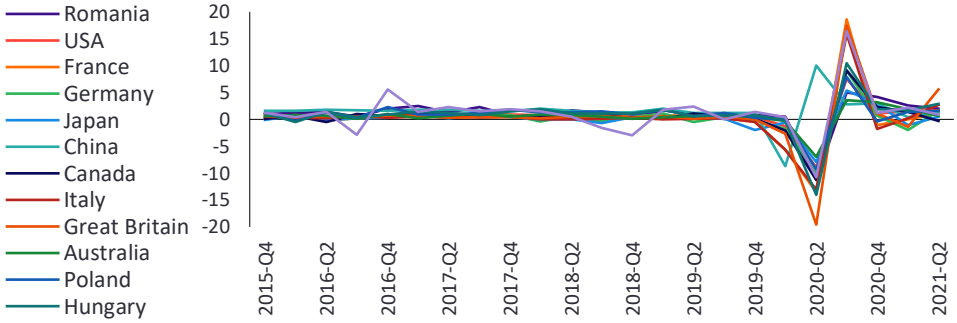
Prolonged periods of economic development are often disturbed by economic, political, or other types of turbulence that expand at a rapid pace across countries due to the complex links existing between them. The COVID-19 pandemic crisis broke out at the regional level in China's health sector and escalated rapidly, leading to the infection and death of millions of people. To contain the negative effects of the virus, it was necessary to impose generalized protection measures, but the adverse effects of the pandemic were not limited to the health sector alone, affecting also the commercial and financial sectors, global supply chains, and stock markets.

The financial systems have adopted measures to counter the pandemic negative effects and to encourage consumption and investment, measures such as: decreasing the monetary policy interest rate and the minimum reserves and supporting access to financing sources for households, SMEs, and corporations. Capital markets are one of the main activities affected due to lockdowns, the shutdown of non-essential activities, and the decrease in capital flows and changes in investors' behaviour.

Figure 1 shows the evolution of the economic growth rate from the end of 2015 to mid-2021 in the selected countries. Historically, a similar trend has been observed up to the emergence of the COVID-19 pandemic.

The economic growth rate's evolution for the period between the first and the third quarter of 2020 is correlated with the COVID-19 cases expansion worldwide. China is the first to experience an economic decline in the first quarter of 2020, while the other selected countries are lagging in terms of economic response, with GDP decreasing in the second quarter of 2020 as the COVID-19 infection spread across Asia and other continents. After the first pandemic wave, the economies are slightly increasing, their recovery depending on the epidemiological situation of each country, its ability to manage the crisis and to respond to shocks.

Figure 1. Evolution of quarterly economic growth in selected countries (%)



Source: OECD database.

Further on, the paper details in chapter 2 the current state of the scientific literature regarding the contagion in international financial markets, followed by the research statement (chapter 3), the study's research methods (chapter 4) and the empirical results (chapter 5).

2. Problem Statement

Capital markets influence economic growth and are considered a barometer of the health of the economy (Kazi, 2011). The relationship between capital markets was analysed in the early period by Granger and Morgenstern (1970), their study focusing on the interdependence between markets. Further on, research papers studying stock markets correlations were developed, such as Ripley (1973) and Panton et al. (1976), where simultaneous movements in the share price were the result of factors such as geographical proximity, currency relations, and trade partnerships, cultural and economic elements.

Bekaert, Garcia and Harvey (1995) indicate that capital markets have a crucial role in the economic development of emerging markets because properly functioning markets ensure that the right prices are obtained for securities. The links established between financial markets and economic growth relate mainly to the diversification of risks' exposure, companies being able to choose riskier projects with higher returns, and households being able to invest at a higher level than their economies.

The concept of contagion was introduced around the 1990s to distinguish between the classic transmission of a crisis that occurs through links to the real sector and the one transmitted through the financial markets. Contagion is defined as a significant increase in the links between financial markets after a shock has been applied to a particular country, as measured by the extent to which asset prices or financial flows move simultaneously across financial markets relative to the same simultaneous dynamics in calm periods (without crisis). (Dornbusch, Park, Claessens; 2000). A crisis can be identified by a sudden and acute fall in stock prices that persists for a relatively long period of time, with stock index values providing the most concise information on the capital market (Burzala, 2016).

Moreover, the need to achieve results on the transmission of financial market disturbances in order to identify and implement public policy measures to increase market resilience is imperative in recent years as the financial sector is developing and crises are more frequent (The Great Economic Crisis of 1929-1933, Black Monday in 1987, Dot-Com crisis of 2000-2002, Financial crisis of 2007-2010, Sovereign debt crisis in Europe in 2009-2019, COVID-19 pandemic crisis).

Alper and Yilmaz (2004) analyse the contagion of share returns' volatility from emerging markets and financial centres to the Turkish capital market since 1992. The methodology involves simple rolling regressions that identify periods of persistent volatility on the Istanbul Stock Exchange and the contagion of volatility to this capital market, while also applying a GARCH model to obtain solid estimates. The results show an increase in volatility and its persistence in the Turkish capital market around prominent economic events such as the economic crisis of 1994, the Russian crisis of 1998, the Marmara earthquake of 1999, and the crisis of 2001.

Kazi et al. (2011) investigate the spillover effect between the US stock market and 16 OECD member countries in the context of the global financial crisis of 2007-2009. The methodology is based on the GARCH model of dynamic conditional correlation developed by Engle (2002), applied to daily share price data for the period 2002-2009. An upward trend of the DCC coefficients between the US capital

market and those in the OECD countries is identified from October 2007 onward. Finally, the simultaneous movement of major capital markets in times of crisis highlights the contagion between the US capital market and those of the selected OECD member countries, a relationship confirmed by several previous studies.

Burzala (2016) tested whether the approach developed by Orlov (2009) is relevant to capital markets and whether high-frequency fluctuations are the result of lagged reactions or are caused by simultaneous reactions. The research carried out indicates that the return rates on the European markets studied react simultaneously to a much greater extent as a result of interdependencies between them or as a response to the situation observed on third-country markets, than as a result of mutual contagion.

Da Silva et al. (2016) investigate the impact of the 2008 financial crisis and the contagion effect by studying the cross-correlations between the closing price of indexes in G7 countries. The methodology involves computation of the DCCA cross-correlation coefficient and construction of an index, defined as the share between the post and pre-crisis coefficient value. The results show a positive cross-correlation of the index, the financial crisis of 2008 leading to a greater grouping of capital markets in G7 countries, and the effects of the crisis spreading to most countries. Thus, a movement in a particular stock market leads to similar changes in other markets.

The scientific literature on the economic effects of the COVID-19 pandemic crisis recently began to develop as Baker et al. (2020) and Zhang et al. (2020) explore the effects of the pandemic on aggregated markets, and McKibbin and Fernando, (2021) show the effect of COVID-19 outbreak on the global economy.

In this context, Akhtaruzzaman et al. (2021) are investigating the effects of the COVID-19 pandemic on firms' profitability, the financial contagion generated by them and the implications for portfolio composition. The results show that dynamic conditional correlations between the securities' return in China and those in the G7 countries have increased significantly in the pandemic period. The results also show that China and Japan are net transmitters of spillover effects during the outbreak, the financial contagion effect following a similar pattern to that of virus contagion.

The scientific literature regarding the effects of the coronavirus pandemic on financial markets, and, more specifically, on stock exchange movements and contagion, is still scarce even after two years of the global health crisis. The difficulty in studying this topic arises from the ongoing pandemic situation, the data being limited and uncertain, while the crisis consequences, both short and long-term, and are not fully revealed. At the same time, the emerging capital market of Romania attracts investors rather on a regional level, not having the power to influence more developed markets. The research papers studying its connection with other capital markets have expanded in recent years, but are still limited and slow to incorporate recent changes in international stock exchanges.

Thus, the present paper contributes to the field of study by investigating the effects of the recent global health crisis on stock markets' movements and by studying the contagion effects on the emerging Romanian capital market in these turbulent times.

3. Aims of the Research

The research aims to study the effects of the contagion on the Romanian stock market of other twelve international capital markets in the context of the COVID-19 pandemic by using a DCC-GARCH model.

4. Research Methods

The database includes information on the daily closing prices for thirteen stock indexes, for the period from 1st of January 2016 to 30th of April 2021:

Table 1. The countries and stock indexes selected

Country	Stock exchange index
Romania	BET
United States of America	Nasdaq 100
France	CAC 40
Germany	DAX 30
Japan	Nikkei
China	Shanghai Composite Index
Canada	TSX 60
Italy	MIB
Australia	AII Australian 50
United Kingdom	FTSE 100
Poland	MSCI Poland
Hungary	MSCI Hungary
Turkey	BIST 100

Source: Author's analysis.

The stock index return $R_{i,t}$ is computed as the logarithmic difference of the closing price of each stock index $P_{i,t}$ using the formula: $R_{i,t} = \log(P_{i,t}/P_{i,t-1}) \times 100$ and subtracting the mean of each series' values. The data sources mainly consist of the financial platform Investing.com and the stock exchanges' websites.

The methodology applied refers to a Dynamic Conditional Correlation GARCH (DCC-GARCH) model applied to the daily price return of the stock indexes from the thirteen countries selected. For this, the structural break within the data series has to be identified. The applied model is based on the research conducted by Kazi et al. (2011), where the empirical study refers to the methodology of Engle (2002).

To identify the structural breaks, a Bai-Perron test is performed on the BET index data series, this approach allowing for the estimation of several structural breaks of a linear model estimated using the least-squares method.

Following the application of the Bai-Perron test on the BET index closing price series between January 2016 and April 2021, three structural breaks were identified, as can be seen in the table below. Analysing the SARS-CoV-2 infection cases, as well as authorities' announcements and the news, there is no link between the evolution of the financial market and the epidemiological situation, the identified structural breaks being caused by other factors. At the same time, applying the Bai-Perron test on the BET index return data series, no structural breaks were identified.

Table 2. Bai-Perron test results

	BET closing price	BET return
Break test	0 vs 1 * *(1373.907)* 1 vs 2 * *(1030.438)* 2 vs 3 * *(115.4271)* 3 vs 4 *(10.86373)*	0 vs 1 *(5.691192)*
Break dates	17.02.2017 28.06.2019 17.07.2020	-

Note: The numbers in parentheses show the Bai-Perron F-statistic for each hypothesis testing. *Significant at 0.05 level

Source: EViews output, Author's analysis.

Further on, the date from the pandemic period that could be a structural break in the BET index data series was identified based on news, press releases, and regulations passed by the authorities. The selected dates were checked using the Chow test to identify if they prove to be a structural break or not.

Thus, the Romanian capital market experienced a structural break for both the BET closing price and the BET return on 17th of March 2020, the day following the establishment of the state of emergency in Romania due to the global pandemic situation. Therefore, because of the global spread of the coronavirus, an immediate reaction of investors is observed based on the increased uncertainty of macroeconomic conditions and global markets. The table below shows the Chow test F-statistic when the date of 17th of March 2020 is tested as a structural break:

Table 3. Chow test F-statistic when testing 17th of March 2020

	BET closing price	BET return
F-statistic	347.1240***	5.1958**

*Significant at 0.10 level; **Significant at 0.05 level; ***Significant at 0.01 level.

Source: EViews output, Author's analysis.

Therefore, the data series was divided into two periods, the pre-pandemic time (respectively the period 04.01.2016 – 16.03.2020), and the period during the COVID-19 crisis (respectively the period 17.03.2020 – 30.04.2021).

To measure the degree of simultaneous movement between time-varying correlation coefficients, a DCC-GARCH model is applied on pairs of capital markets indexes, each being considered together with the BET index, following the steps:

First, the return series y_{1t} and y_{2t} are defined:

$$\sigma_t^2 = Var(y_t/y_{t-1}) = c + \alpha u_{t-1} + \beta\sigma_{t-1}^2 \quad (1)$$

Furthermore, the GARCH(1,1) model is fitted to each of the return series. The standardized residual series is extracted from the GARCH fit. Let $z_{i,t}$ be the standardized $u_{i,t}$, where $i \in (1;2)$, indicating each pair of stock indexes analysed.

For every $z_{i,t}$, the sample variance and covariance are calculated, as well as the conditional correlation coefficient is computed for each pair of stock indexes, respectively between $z_{1,t}$ and $z_{2,t}$.

The log-likelihood method is used to estimate the parameters, allowing for the conditional variance and covariance to be estimated for each variable. The log likelihood function is defined by the following formula:

$$Logl = -\frac{1}{2}(2\log(2\pi) + log|R_t| + (z_1^2 + z_2^2 - 2\rho_{12}z_1z_2)/|R_t| \quad (2)$$

Where $|R_t|$ is the determinant of the correlation matrix, computed as follows:

$$|R_t| = (1 - \rho_{1,2}^2) \quad (3)$$

The contagion effect is identified if there is a positive change between the co-movements of stock indexes returns, meaning if the mean of DCC coefficients in the crisis period is higher than their mean for the pre-pandemic period.

5. Findings

The GARCH(1,1) coefficients, estimated for each stock exchange index for the period between January 2016 and April 2021, are significant and positive, indicating that the volatility of the capital market indexes is captured by the estimated GARCH model. The table below shows the estimated coefficients of the GARCH(1,1) model of each stock index return series:

Table 4. GARCH(1,1) coefficients and standard errors

Stock index	C	Resid(-1)^2	GARCH(-1)
BET	0.000001*	0.352332*	0.654324*
	(0.000000)	*(0.012128)*	*(0.015500)*
CAC 40	0.000001*	0.192705*	0.776889*
	(0.000000)	*(0.017583)*	*(0.019573)*
Nasdaq-100	0.000001*	0.182315*	0.783815*
	(0.000000)	*(0.01795)*	*(0.019191)*
DAX 30	0.000000*	0.096176*	0.880105*
	(0.000000)	*(0.009846)*	*(0.012768)*
Nikkei	0.000000*	0.111903*	0.861736*
	(0.000000)	*(0.010315)*	*(0.012974)*
SSE Composite Index	0.000000*	0.074979*	0.915600*
	(0.000000)	*(0.006071)*	*(0.005773)*
TSX Canada	0.000000*	0.252961*	0.698035*
	(0.000000)	*(0.023404)*	*(0.03077)*
MIB Italy	0.000001*	0.156714*	0.812531*
	(0.000000)	*(0.012722)*	*(0.016896)*
FTSE 100 UK	0.000000*	0.144946*	0.813103*
	(0.000000)	*(0.016611)*	*(0.020767)*
AII Australia	0.000000*	0.131462*	0.834187*
	(0.000000)	*(0.013103)*	*(0.018174)*
MSCI Poland	0.000000*	0.059368*	0.909745*
	(0.000000)	*(0.006360)*	*(0.013237)*

Stock index	C	Resid(-1)^2	GARCH(-1)
MSCI Hungary	0.000001*	0.097603*	0.86519*
	(0.000000)	*(0.010356)*	*(0.014725)*
BIST Turkey	0.000003*	0.071970*	0.836539*
	(0.000000)	*(0.013231)*	*(0.037527)*

Note: The numbers in parentheses represent the associated standard errors. *Indicates that the coefficients are significant at the level of 5%.

Source: EViews output, Author's analysis.

The GARCH error parameter measures the reaction of conditional volatility to market shocks, a relatively high value (e.g., above 0.1) meaning that the volatility is very sensitive to market events (Alexander, 2008). Based on the empirical results, the error parameter is greater than 0.1 for most countries except Germany, China, Poland, Hungary, and Turkey. Therefore, the capital markets in most of the selected countries show immediate movements due to changing macroeconomic and financial circumstances, as was the case of the COVID-19 pandemic crisis, when health issues affected the commercial and financial sectors, increasing, in turn, the volatility in the capital markets of selected countries.

The GARCH lag parameter measures the persistence of conditional volatility, and when its value is relatively high (for example, over 0.9), it takes a long time for the volatility to disappear after a financial crisis (Alexander, 2008). Based on the above results, the lag parameter is well below 0.9 for stock indexes in Romania, France, the US, Canada, Italy, Great Britain, Australia, and Turkey, while being over 0.9 or close to it in specific cases, including Germany, Japan, China, Poland, and Hungary. Based on the results, for most of the selected countries, the pandemic's negative effects will not impact the stock markets in the long term. As the global epidemiologic situation improves and countries' economies fall back on track, the stock markets are expected to no longer be affected by the previous pandemic condition.

Based on the bivariate GARCH-DCC model estimated for the period between January 2016 and April 2021, the mean of the DCC coefficients between Romanian capital market and each of the other selected capital markets is shown below:

Table 5. Mean of DCC coefficients

	Before crisis	In time of crisis	% Difference
CAC 40	0.306	0.483	58.0%
Nasdaq-100	0.206	0.153	-25.6%
DAX 30	0.313	0.496	58.5%
Nikkei	0.230	0.374	62.5%
SSE Composite Index	0.160	0.147	-7.6%
TSX Canada	0.215	0.261	21.5%
MIB Italy	0.263	0.480	82.5%
FTSE 100 UK	0.248	0.483	94.6%
AII Australia	0.219	0.256	16.9%
MSCI Poland	0.255	0.339	33.2%
MSCI Hungary	0.237	0.439	84.9%
BIST Turkey	0.131	0.251	91.3%

Source: EViews output, Author's analysis.

The results indicate, for almost all the stock indexes selected in pair with the BET index, that the dynamic conditional correlation coefficients have higher values during the pandemic crisis compared to the pre-pandemic period. Therefore, the phenomenon of contagion in the context of the global pandemic crisis is present in most of the selected capital markets to the Romanian stock index.

The largest conditional correlation for the pre-crisis period is observed between the BET index in Romania and DAX 30 index in Germany (0.313), followed by the correlation between the BET index and the CAC 40 index in France (0.306). The overall economic activity of Romania is strongly linked with the German and French markets through capital flows, related especially to trade and investments, therefore their capital markets are also greatly connected.

For the pandemic period, the strongest correlation is with the DAX 30 index and the CAC 40 index, after the correlation coefficient increases by approx. 58%. The stock market relation between Romania and Germany or France grows stronger in pandemic times, showing that financial disturbances are transmitted faster in crisis periods than the movements in calm periods.

At the same time, the lowest conditional correlation before the pandemic crisis is registered between the Romanian stock market and the Turkish stock market, which increases by approx. 91% during the pandemic. For the crisis time, the lowest correlation coefficient is noticed between the BET and SSE composite index, the Romanian and Chinese markets not being directly linked in the financial sector.

6. Conclusions

The GARCH(1,1) model estimated for each of the thirteen stock indexes significantly captures the real movements of the stock markets analyzed. For most of the selected countries, their capital market is sensitive to market events and shocks, while the expected volatility persistence is rather low for the global pandemic period.

An upward trend is identified in the dynamic conditional correlations starting with March 2020 for most of the sample markets, from the moment when the coronavirus pandemic outbroke worldwide onward. Thus, the mean of the DCC coefficients is higher in the pandemic period than the mean of the DCC coefficient for the pre-pandemic period in most of the selected markets. The results of the empirical analysis indicating the existence of simultaneous movements between the Romanian stock index and the other twelve selected indexes prove the contagion on the Bucharest Stock Exchange from the other capital markets in the context of the COVID-19 pandemic.

Following on, the policy implications of the study refer to the urgency to increase stock markets' resilience in times of generalized crises, the authorities needing to ensure mechanisms that make markets able to cope with increased volatility. As it can be seen from the results, in crisis periods, the correlation between stock markets is increasing, which makes them more vulnerable to shocks transmitted across countries.

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