Conceptual dimensions regarding the financial contagion and the correlation with the stock market in Romania

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Abstract. *The economy, defined as a set of economic activities, can be described as a network, having as links companies (banking, non-banking), public entities, non-governmental organizations. Of late years, bank accidents have led to a significant disruption of the financial system worldwide. One of the objectives of this paper is to analyze the stock market by measuring the stock indices to evaluate the extent to which events such as the crisis of 2008 or the explosion of the Swiss franc have impacted the stock market and whether a systemic event with impact on the stock market has formed. The stock market in Romania will also be analyzed through the BET-FI stock index to observe the impact of events in other countries and to demonstrate how a shock can spread from one market to other markets such as the domino effect. Another objective is to explain the concept of financial contagion from a theoretical point of view, how it can be transmitted and how we can quantify it. The analysis will be performed in R software. The presented results will be focused around the theme of systemic events with an impact on banking networks.*

Keywords: capital market, financial contagion, systemic risk, financial network, R 3.5.1.

JEL Classification: C00, C10, C58, F36, G01, G15, G32.

1. Introduction

Financial stability is one of the most important means of reducing the economic uncertainty that influences the decision makers in establishing them and the investors regarding the long-term investment funds. Financial resilience needs to be evaluated in terms of its ability to absorb shocks, protecting countries from making costly short-term adjustments in the real economy by employing labor or adjusting inflation. Finding a balance between financial stability and the resilience of the financial system, two competing goals, is a critical path for decision makers.

The world we live in and where we operate is very complex and constantly changing. We face complex agricultural, biological, aquatic, environmental, technological and socio-economic problems that we must understand and manage for sustainable development. In the context of globalization, on the one hand, global warming and its impact on agriculture, energy and the environment are increasingly debated, and on the other hand, it analyzes reports on the economic cycles that cause financial panic, and on a regional level (Chiriță and Nica, 2019). In addition, we often find price fluctuations and food insecurity in poorly developed countries.

The concept of contagion was used for the first time in 1797, by David Ricardo[1], who attributed this concept to the feeling of panic that led to the suspension of the convertibility, i.e. the unfounded fears of the timid part of the community. In 1895, the French sociologist Le Bon wrote that the ideas, emotions and opinions that feed the crowd have as much influence as germs.

The term contagion has been used quite rarely before 1995, after which it occasionally appeared in articles that presented the impact of the Mexican crisis on other Latin American countries.

2. Literature review

Taken from medicine as a concept, contagion means the manifestation or transmission of viruses throughout the body, and subsequently, by passing from virus to disease, transmitting it to other people. Only after the crisis in Thailand occurred when the currency was devalued and other Asian countries affected, affecting global financial markets. These events aroused the interest of the researchers so that in the early 2000s, academic papers began to appear in order to try to study to measure, understand, predict and prevent international financial contagion.

The specialized literature allows us to distinguish two basic approaches for understanding the term of contagion: the spread of financial crises and the limitation of their behavior. As part of the interpretative framework of such phenomena are viral marketing, purchasing decisions or behavior within the supply chain, the concept of contagion being used in the context of limiting behavior. The financial markets approach focuses on the spread of crises, negative shocks or disruptions. However, both cognitive perspectives are sometimes complementary, for example analyzes describing the spread of financial crises take into account the limitation of actual behavior.

Kolb (2010) recommends that we should consider, first of all, the very nature of the metaphor used to describe the contagion phenomenon. We need to be aware that the concepts of epidemic and contagion used in the context of financial crises are very different. Not all crises or epidemics can be due to contagion. The main reason for contagion is the mechanism for transmitting contagion from one financial institution to another.

Allen Franklin and Douglas Gale (2000), in the paper "Financial Contagion", assert that this concept of contagion is defined by the small shocks that affect several institutions or sectors and are then spread throughout the financial sector of the contagion economy.

Caramazza et al. (2004) stated that the spread of problems in the financial sphere from one economy to another, in one region or globally, can be called contagion phenomenon.

Complexity science develops especially since the late 1920s, but became more visible in 1968, when von Bertalanffy published his famous book on general systems theory. Complexity scientists seek to examine patterns and trends in complex systems. In recent decades, this theory has been present in the social sciences as well. Regarding the moment, the achievements obtained within the system approach can be perceived as next steps in explaining the phenomenon of complexity. Therefore, three stages of system theory development can be identified. The first wave, immediately after the Second World War, is connected to the development of computers and the application of feedback. The second phase is associated with the development of cybernetics and system dynamics, and the last phase is based on a new understanding of balance in discontinuity theories.

3. BASEL Agreements

The role of capital in the banking system is crucial because it contributes to maintaining a secure and solid financial environment. When banks retain a sufficient amount of capital, they will be able to fulfill their obligations. In this regard, the banking industry introduced a mechanism for setting minimum capital standards for all international banks in the 1990s under the name Basel Agreement (Balthazar, 2006). The risk-based capital standards called Basel capital agreements have been issued by the Banking Supervisory Committee in Basel (BCBS, 2011).

To establish the financial balance and to predict, prevent or mitigate the effects of bank contagion, the following are necessary (Nica et al., 2018):
A) Applying effective models for systemic risk detection.
B) Early identification of institutions of systemic importance.
C) Formulation of micro-prudential and macro-prudential regulations for systemic risk prevention.

A) These models closely analyze the level of systemic risk and contagion. The focus is on risk estimation models that take into account the aggregate evolution of financial markets, the measurement of the degree of contagion between banking institutions, the establishment of a level of bank capitalization and the maintenance of an adequate degree of liquidity.

The well-known Diamond-Dybvig model (Diamond and Dybvig, 1983) is the foundation of studies that wanted to highlight the connection between the bank's liquidity and its

vulnerability, in the face of considerable withdrawals of deposits prior to maturity. It is based on 3 principles:

- From a probabilistic point of view, the situation of withdrawals of concomitant deposits is reduced because the needs of the clients do not manifest at the same time.
- The liquidity's need for a client is limited by the information it has at a certain moment.
- They primary objective of banks is to obtain as much profit as possible by redirecting liquidity to economic agents in the form of credits because the retention of liquidity is equivalent to obtaining low revenues.

Starting from the Diamond-Dybvig model, a number of researchers have developed a series of optimizations of this model, which have expanded from an individual bank to the entire banking system.

With the collapse of Lehman Brothers (2008) and the increase in contagion in financial and banking systems as a result of the global economic crisis, various financial supervisory authorities have begun to analyze and develop the core principles of the Diamond-Dybvig model.

B) An important aspect is that not all banks can give rise to an economic crisis or financial contagion, but only banks of systemic importance.

An institution is considered to be of systemic importance if a malfunction causes a widespread problem. From the point of view of Federal Reserve Bank, financial institutions are of systemic importance if „their failure to honor obligations to customers and creditors has significant adverse effects on the financial system and the economy as a whole".

The Basel Banking Supervision Committee has developed a document that is characterized by an attempt to develop a methodology for identifying systemically important banks.

They are defined as „dangerous financial institutions because of the size, complexity and systemic interconnections that cannot leave the financial market without causing a major catastrophe".

Although at international level a universally accepted definition of systemically important banks has not yet been developed, several features have been identified that are found in all the documents prepared by the supervisory authorities (Nica et al., 2018):

- Size – the banks are too big to accept their collapse – Too Big to Fail.
- Connections – the banks are too interconnected to accept their collapse – Too Interconnected to Fail.
- Importance – the banks are too important to allow their bankruptcy – Too Important to Be Allowed to Fail.

C) Of the aim of identifying, monitoring and predicting systemic risk, have established international approaches to the prudential regulation of systemic banking risk and the need for continuous optimization of banking supervision.

Liquidity injections and various ways to decrease the effects of bank contagion are not the most effective measures against systemic risk given their ex-post nature. This has raised the issue of measures of an ex-ante nature.

The need for supervision stems from the need for rules to set up a monitoring framework appropriate to the effective operation of each bank and the entire banking system.

The Banking Supervision Committee of Basel is the international banking supervision organization. Its purpose is to strengthen credibility and increase the international banking system's sustainability, striving to provide customers with security against systemic risk.

**Figure 1.** *The chronological evolution of Basel's regulations*
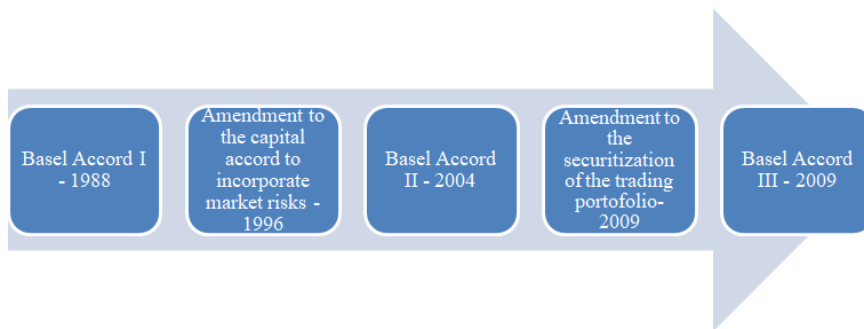
Source: Authors computation.

The first agreement issued was the Basel I agreement, which was conceived in 1988. It deals with the first level of capital adequacy on an international scale. The agreement focused on regulating the adequacy of capital, both off-balance sheet assets and on balance sheets. These are subsequently weighted at risk. More than 100 countries have implemented this regulation, and the results have been as expected. Nevertheless, the economy grew rapidly, as did the commercial bank and the agreement began to show some flaws. One of these was related to credit risk, which he used most in any analysis and the rest of the identified risk categories were then ignored. Another situation identified as a problem was the way in which the risk weights were assigned to the monetary instruments. These were the same for all instruments, whether long-term or short-term.

The Basel II agreement is based on three components called pillars: minimum capital requirements, supervisory actions and market discipline. It was published in June 2006 and aims to promote the adaptation of stricter practices in risk management.

Figure 2. *Three Pillar of Basel II*
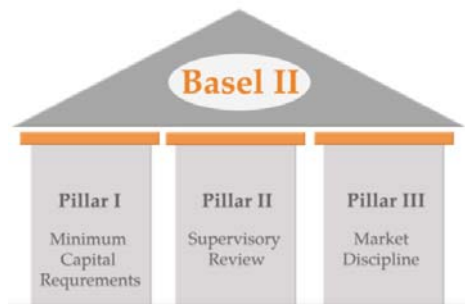
Source: https://www.semanticscholar.org/paper/The-impact-of-the-Basel-(2.-3.)-accords-on-SME-a-Piroli/19cdea1cb1b9ed98b65c3bdf9aca2bbaacd2361e

The Basel III capital agreement introduces extensive quantitative and qualitative capital requirements, new liquidity requirements, a review of the counterparty credit risk and a debt indicator for banks in the member countries of the Basel Committee (BCBS, 2011).

4. BET-FI Analysis

For the analysis proposed in this article, we will consider the evolution of the BET-FI index, to see the impact on the financial network.

The BET-FI index is also launched by BVB, which appeared first, as a sectoral index. It shows the evolution of financial investment companies and other similar companies with their profile.

For the analysis of this case study, we used 3508 observations for the BET-FI index, the period analyzed 03.01.2006 - 30.12.2019 (Bucharest Stock Exchange, 2019).

Figure 3. *The evolution of the BET-FI index*
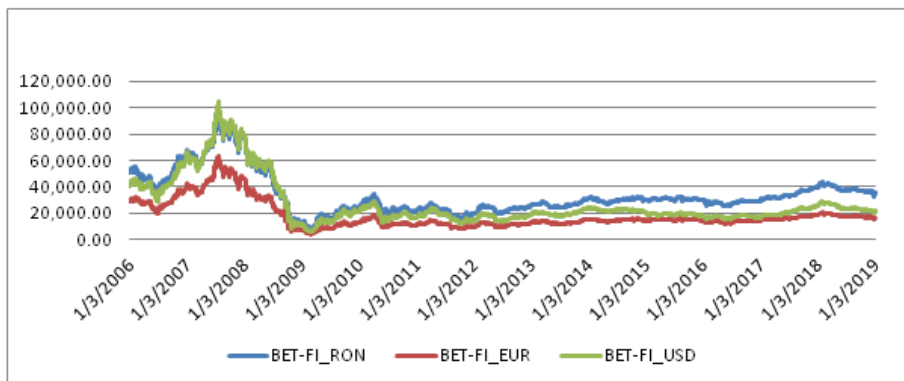
Source: Authors computation.

The first step of the analysis is to perform statistical analyzes using the R Programming software solution. The data used are obtained from the official website of the Bucharest Stock Exchange. The daily values of the BET-FI index in RON, EUR and USD currency will be analyzed.

Figure 4. *Summary statistic in R for BET-FI index*

```
   #---------------------#
> summary(doc$BET.FI_RON)
   Min. 1st Qu.  Median   Mean 3rd Qu.    Max.
   7862   24400   30295  33962   38317   95111
> #---------------------#
> summary(doc$BET.FI_EUR)
   Min. 1st Qu.  Median   Mean 3rd Qu.    Max.
   3995   12197   14859  17895   18290   63788
> #---------------------#
> summary(doc$BET.FI_USD)
   Min. 1st Qu.  Median   Mean 3rd Qu.    Max.
   5949   17917   20649  26771   24578  104864
   #---------------------#
```
Source: Authors computation.

From the above output, we have the following information about the evolution of the BET-FI index. For the national currency RON, the minimum value of the index registered between 03.01.2006 - 30.12.2019 is 7862 registered on 24.02.2009 and the maximum of 95111 on 24.07.2007.

In the case of the BET-FI index for the EURO currency, the minimum value was recorded on the same date, with a value of 3995 and the maximum value registered is 63788. For the USD currency, the minimum is 5949 and the maximum is 104864. For the two extremes, we will analyze these points in the chronological axis to see what influenced them.

Table 1. *Skewness, Kurtosis and standard deviation for BET_FI index*

	Index	Skewness	Kurtosis	Std. deviation
1	BET.FI_RON	1.50514993366243	5.40270095307087	14981.4627926349
2	BET.FI_EUR	2.00256510795469	6.86547271046906	10041.1632428416
3	BET.FI_USD	2.1553325873465	7.14484992316297	17197.0700559707

Source: Authors computation.

Even if our data series is not expected to be normally distributed, we will test this to identify how the variables are distributed. We calculated the Skewness and Kurtosis coefficients, their values being in the above table, output from R. The flattening or arching coefficient, calculated by the Kurtosis test, has the value of 5.40 for the BET-FI index in RON, the value of 6.87 for EURO and for the USD currency the value of the coefficient is 7.14.

Skewness is the asymmetry coefficient and together with the values of the Kurtosis coefficient, we will analyze the shape of the distribution represented graphically by histograms. Skewness coefficient values are given in the tables.

The way in which the variables are scattered in the analyzed sample is given by the standard deviation value, calculated values and found in the table above. Before representing the histograms for each currency analyzed, we will also calculate the coefficient of variation that evaluates the standard deviation from the average value to see the homogeneity of our sample. If the coefficient of variation is less than 10% then the sample is homogeneous, if its value is between 10% and 20% then it is relatively homogeneous, between 20-30% is relatively heterogeneous and greater than 30% the analyzed sample is heterogeneous. We do not expect our data series to be homogeneous so, by analyzing in R, we obtained the following data for the coefficient of variation, noted with CV:

$CV_{BET-FI\_RON} = 44,11\%;$

$CV_{BET-FI\_EUR} = 56,11\%;$

$CV_{BET-FI\_USD} = 64,23\%.$

The values of the coefficient of variation are very high, the series being heterogeneous, ie it reflects large changes in the values of the data series.

Figure 5. *BET-FI_RON, BET-FI EUR, BET-FI USD index histogram*
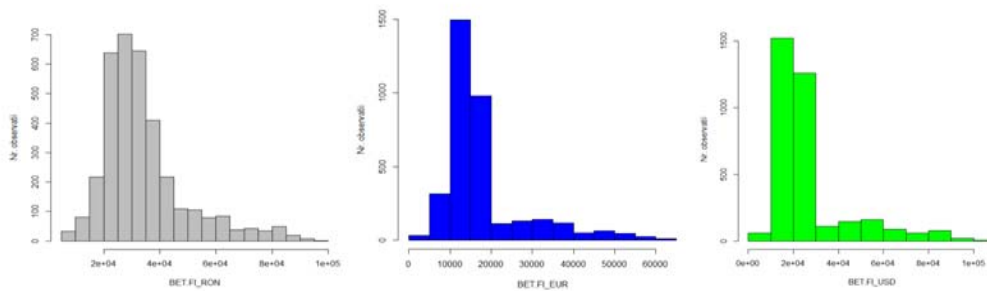
Source: Authors computation.

From the representation of the 3 histograms, but also from the values of the mean, median, standard deviation and coefficient of variation, it follows that the series is not homogeneous, the distribution is not represented by the Gaussian curve, being leptokurtic or asymmetric to the right.

Figure 6. *Boxplot for each currency of the BET-FI index*
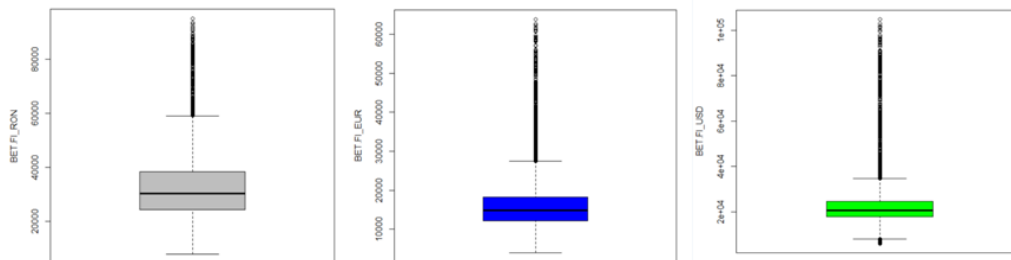
Source: Authors computation.

From the representation of the boxplots, we observe the existence of the outliers being evident for the evolution during the analyzed period, recording the extreme values during the economic crisis of 2007-2008.

The capital market is very complex being made up of several markets such as stocks and bonds, the gold or derivatives market, the futures contract market and the stock market. The most important links are with the money market, the foreign exchange market, the real economy and with the National Securities Commission, which has the role of overseeing securities transactions.

Being closely connected the capital market with the foreign exchange market and because a major event such as the crisis of 2007-2008 took place due to the collapse of Lehman Brothers in the USA and because of the mortgage crisis we will analyze the evolution of the Romanian currency market.

I will consider the most important currencies in terms of the occurrence of contagious events in certain economic markets such as the Swiss franc explosion or the Brexit. We will evaluate the following currencies: USD, EURO, GBP and CHF relative to the national

currency of Romania, RON. The analyzed data series consists of 3542 daily series observations for the exchange rate of the 4 currencies above reported in RON.

Figure 7. *The evolution of the exchange rate for CHF, EUR, GBP and USD*
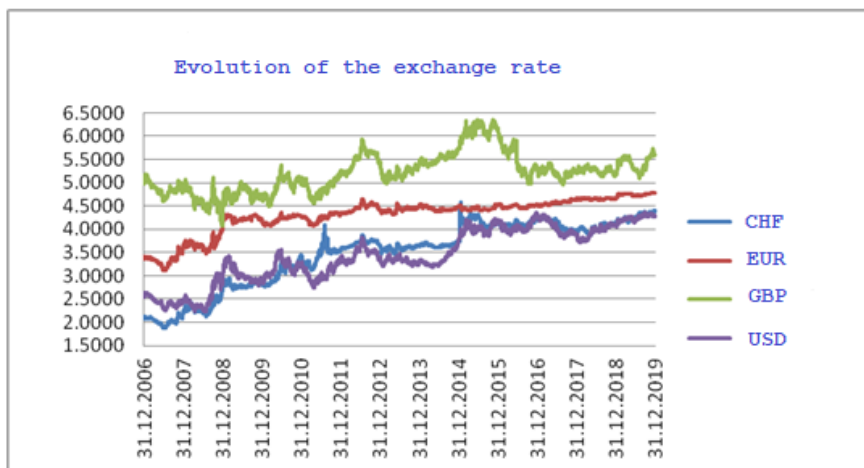
Source: Authors computation.

With the R programming computer solution, we have represented the matrix diagram of the correlations between all pairs of currencies with existing values for the analyzed period.

Figure 8. *Matrix of correlations of currency pairs in Romania existing for the analyzed period*
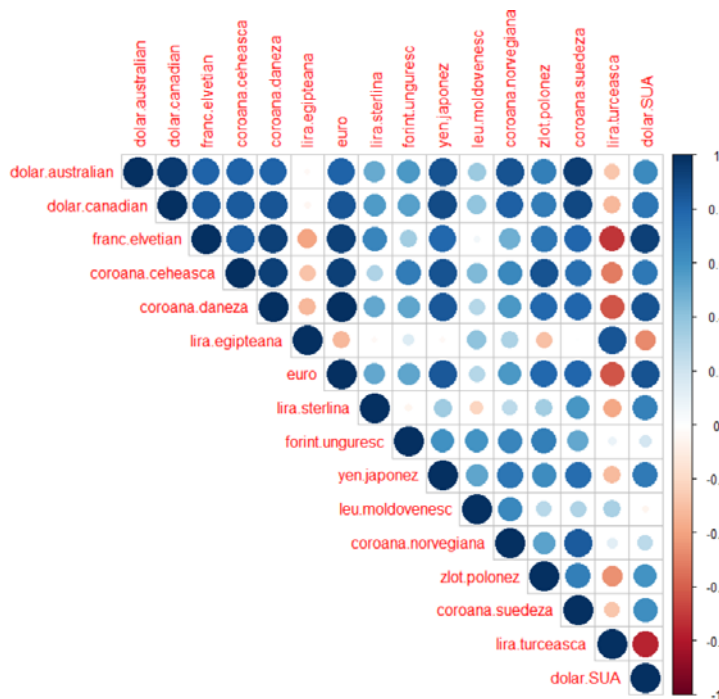
Source: Authors computation.

The darker the shades in the above representation, the stronger the correlation between the represented currencies. At the opposite end, the tighter the shades, the more the currencies tend to manifest independently of the other currencies. We see a strong correlation between the Australian dollar and the Swedish krone or the Danish krone with the euro.

During the analyzed period, we will specify the following impact event:

▪ On January 15, 2015, the National Bank of Switzerland announced that it would waive the threshold of the CHF/EUR exchange rate set in 2011, that 1 EUR was worth the equivalent of 1.2 CHF. The exchange rate for this parity has exploded, forming a systemic shock on the foreign exchange market, affecting several countries including Romania. The situation was quite severe for that period for some banks in Romania that had granted loans in CHF currency. The actors affected by this contagious bubble were the banking institutions, but also the clients who contracted a credit in this currency. In that, both sides were guilty because on the one hand, the banks did not properly present the clients with the variant of mortgage lending in this currency, did not emphasize a potential currency risk and were not prepared for such events. On the other hand, the clients, perhaps due to the fact that Romania is still on the last places regarding the financial education, were caught by the fever of money and contracted amounts as large as possible, without reading the contractual conditions completely, for the purchase of real estate. On January 14, 2015 the value of the CHF / RON exchange rate was 3.7415 and on the following day it came to 1 CHF worth 4.3287 RON.

Figure 9. *Summary Statistics for pair CHF/RON*

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> summary(valute$franc.elvetian)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  1.874   2.795   3.619   3.392   4.078   4.582
```

Source: Authors computation.

The minimum value for the period analyzed according to the output of the R software was registered on 24.07.2007, 1 CHF = 1,874 RON and maximum registered on 23.01.2015, immediately after the explosion of the Swiss franc exchange rate reaching the value of 4.5817. According to the correlation matrix represented above, we observe the putative correlations of the Swiss franc with the following currencies: Danish krone, euro, US dollar.

The event generated by an appreciation of the Swiss franc, as we said, generated effects in Romania. The bank, viewed as a complex adaptive system, had to find immediate solutions for the loans granted in CHF. Clients were unable to pay and the portfolio of mortgages in CHF went into default. Banks came up with the solution of converting the loans from CHF to RON, under certain conditions.

5. Conclusions

The failure to regard the banking institution as an individual-independent system, and not as a dependent component of the entire financial-banking system, was caused by the satisfaction of the commercial banks with regard to poor regulation at the banking level

that allowed them to obtain considerable profits. With the fall of Lehman Brothers bank and the start of the domino effect of bank failures, efforts to recover the international economy of international supervisory authorities, along with central banks, government institutions and other financial institutions have been the synergy needed to develop the Basel III Agreement.

The prudential regulations related to Basel III represented a tightening of the conditions related to the level of capital adequacy and the mode of operation specific to the commercial banks, also including an element of novelty compared to the previous agreements, namely, the banks of systemic importance to which they had imposed additional capital requirements, due to the potential impact on the international economy in the event of a bankruptcy.

Starting from the premise that the best treatment for the phenomenon of financial contagion is to prevent its triggering, the financial supervisory authorities have regulated the obligation to use the risk measurement models in order to closely monitor the activity of commercial banks.

In the last period, there have been many events that have had an impact on the Romanian capital market. Starting with Romania's accession to the European Union in 2007, the financial crisis or the CHF explosion are just some of the aspects that have influenced the stock market.

All these events with an impact on the evolution of stock exchange indices have been studied in this paper to analyze whether the stock market can be considered a starting point for the emergence of a contagious event that can influence the financial system, respectively to turn into a financial contagion in Romania.

Considering that the structure of the Romanian stock offering is based on important volumes of the transactions made by banks and financial services, we can say that it is a sensitive point to analyze regarding the forecast of a potential financial contagion. In the analyses carried out on the BET-FI index, we observed the influences of the currencies and the correlations between them. In the following research, it is interesting to apply a Value at Risk methodology to measure the market risk and to correlate if there is a significant connection between it and the stock market.

Note

[1] Was a British political economist, one of the most influential of the classical economists along with Thomas Malthus, Adam Smith and James Mill Source: https://en.wikipedia.org/wiki/David_Ricardo

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