Romania's Journey of Integration into the European Monetary Union: a Quantitative Analysis

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Abstract. *Nobody can doubt that in most countries from Western Europe, it is almost unanimously observed the advantage of using the EUR currency as single currency. Thus, we may suppose that adopting the single currency could be beneficial for Romania as well. For Romania to become a member of the European Monetary Union, our country would have to build itself a reference system in the center of which it should place the single European currency. This currency should be a stability factor, which will lead to the achievement of important savings from many national economic agents, especially due to the elimination of the exchange rate risk or lower transaction costs. Considering that our country would become a member of the Eurozone and adopt the EUR currency, it was noted that local banks have manifested their interest in building a system in which EUR would play an important role. Thus, they accepted deposits in EUR, they granted loans in EUR, thus contributing to the large-scale use of the single currency on Romanian territory. Therefore, the adaptation of the Romanian banking system for this move has already started.*

Keywords: Eurozone, financial markets, single currency, stock market, bond market, foreign exchange market

JEL classification: G14, G21

1. Foreword

The adoption of EUR as a single currency for our country would have a major positive effect, considering that 2/3 of exports are oriented towards the European Member States. Before Romania's accession to the European Union, most commercial contracts of companies from Romania were expressed in US dollars (USD), the most known being those concluded with mobile phone companies, where all costs were expressed in USD. After January 1, 2007, namely after EU accession, all commercial transactions were performed using EUR. Therefore, the influence of the exchange rate on trading costs was significantly reduced.

Romanian companies had much to lose since, until recently, were chosen as contract currencies either USD or other currencies of European countries, for which the exchange rate fluctuated. The introduction of EUR is a stability factor, which shall significantly reduce the losses of economic agents that have been caused especially by the exchange rate risk. Also, the introduction of this currency has contributed to the reduction of trading fees, and all of these have been transformed into improved financial results of companies and prosperity for them, once with the new trading conditions.

As the monetary barriers of the European Union have been eliminated, the country's exporters which adhered to the Eurozone have much easier access to the markets of any member country. Therefore, the number of intermediaries that might appear on the commercial chain is reduced and enterprises increase their revenues due to direct exports.

An additional advantage offered by the single European currency is transparency. The expression of all prices in EUR for a country like Romania will help Romanian companies better choose the suppliers they need, and optimize costs to a better extent. Together with the single European currency, of special importance for our country is the

European Central Bank, which started its activity in Frankfurt, taking over, in the end, a series of duties from the International Monetary Fund regarding the financing and tracking of strong and consistent price stability policies.

Financial integration, for the case of countries that accessed the European Union in the last decades, is one of the most pressing and topical issues, but it is also a problem that is difficult to capture through mathematical and economic models. Financial integration, in correlation with the contagion effect, must be analyzed in different market contexts and must be analyzed differently according to the type of market to which we refer. The degree to which financial integration has been achieved is crucial for a country's accession to the European Union and the Eurozone, and it is necessary to correlate economic cycles. Nor should it be overlooked that as the level of integration increases, the risk of contagion may increase in the context of negative shocks in international or regional financial markets and, consequently, the transmission in the event of economic and financial crises becomes higher between the member states of the community which it accedes to.

2. Romania's integration in the Eurozone: impact on the financial markets

■ Methodological considerations

The commercial and financial connections have always been the most important determinants of the level of integration for the international financial markets, as they have become more interconnected in time. we remind you that the term **integration of financial markets** refers to a scope of research from the field of the financial economy which includes several aspects of the interdependencies between the mentioned entities. we also bring back into the discussion the fact that Walti[1] has an extremely useful description of market integration using terms like "comovement", "synchronization", or "correlation".

As financial markets have become increasingly unified, it has also been observed that shocks are transmitted much faster from one market to another, with the contagion effect becoming much stronger. An example that supports this allegation is precisely the economic and financial crisis of 2007-2009, which started in a sector of the American economy. Then it extended and influenced the entire economy of the United States, and subsequently the global economy. Being defined as an evolutionary process concerning transnational economies, the term contagion has followed a gradual measurement and improvement process in recent years. At first, a simple measure of the statistical correlation between stock returns was considered, and later new techniques were addressed that consider autoregressive models, co-integration of returns, or various aspects that could be included in econometric models.

Research on crises and their impact on economic activity can be very helpful in finding out how a particular shock in a country is transmitted to markets in the region or even to global markets. A financial crisis can be specific to a certain country, because most of the time it starts in one country, in most cases a developed one, and then it extends through the contagion effect in the region or at the international level, affecting a much higher number of economies of different countries.

[1]Wälti, S. (2011). Stock market synchronization and monetary integration. *Journal of International Money and Finance*, *30*(1), 96-110.

To supplement these researches comes the one published by Babecky and others[2], through which the authors made an analysis concerning integration on financial markets, namely the sigma-convergence and beta-convergence in the stock market, the foreign exchange market, the money market, or the bond market. Using the results obtained following the application of the model, the authors managed to bring to the discussion a topic and a problem that are very important in the European Union and at the global academic level.

The transmission of volatility during crisis periods is analyzed through the spillover index introduced by Diebold and Yilmaz[3] which helps to measure the directional transmission by a generalized auto-regressive vector (ARV) which excludes the possible dependence of the results on the ordering driven by the Cholesky factor. Let the process of stationary covariance N - VAR variables (p) be specified as follows:

$$x_t = \sum_{i=1}^{p} \Pi_i x_{t-1} + \varepsilon_t,$$

ε_t ~ i.i.d. (0, Σ), and Σ is the error variation matrix.

Then, the ARV process mentioned above is represented as a moving average process, as follows:

$$x_t = \sum_{i=0}^{\infty} \mathrm{A}_i \mathfrak{E}_{t-i},$$

where A_i is NxN matrix of coefficients fulfilling the recursion process: $A_i = \sum_{k=1}^{p} \Pi_k A_{i-k}$, with A_0 being the NxN identity matrix for $A_i = 0, i < 0$. The variance breakdown allows the analysis of the predicted error variances of each variable, in parts that are attributed to different system shocks. When this system produces correlated innovations simultaneously, orthogonal innovations are needed for the decomposition of variation. Orthogonality can be achieved by Cholesky factorization. However, in this case, the variance decomposition becomes extremely sensitive to the ordering of the variables. The general ARV approach introduced by Koop and others[4], respectively by Pesaran and Shin[5] solves this problem.

The decomposition of the predicted error variance H H – step – ahead is the following:

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \sum e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \sum e_j\right)},$$

where σ_{jj} is the standard deviation of the error term for equation j and e_i is the selection error with values 1 for the element we and 0 for the remainder. The sum of the elements on every row of the variance decomposition matrix is not equal to 1, namely $\sum_{j=1}^{N} \theta_{ij}^{g}(H) \neq 1$.

Each element of the variance decomposition matrix is normalized so that each row in the variance decomposition table is equal to 1, and the new equation becomes:

$$\tilde{\theta}_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)}$$

[2]Babecký, J., Havránek, T., Matějů, J., Rusnák, M., Šmídková, K. and Vašíček, B. (2013). Leading indicators of crisis incidence: Evidence from developed countries. Journal of International Money and Finance, 35, 1-19.
[3]Diebold F. X. and Yilmaz K. (2010). Better to Give than Receive: Predictive Directional Measurement of Volatility Spillovers, Working Paper, No. 1001, March.
[4]Koop, G., Pesaran, M. H. and Potter, S. M. (1996). Impulse response analysis in nonlinear multivariate models. Journal of econometrics, 74(1), 119-147.
[5]Pesaran, H. H. and Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. Economics letters, 58(1), 17-29.

The total contagion effect index shows the contribution of volatility shocks over all variables to the total variance of forecast errors. This is calculated as follows:

$$S^g(H) = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)} x100 = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{N} x100$$

The advantage of the ARV model in calculating this index is that it allows the directional calculation of the *spillover* index. The directional volatility emissions received by the market we from all other markets j are measured as follows:

$$S_{i \to j}^g(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)} x100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^g(H)}{N} x100$$

and similarly, the directional volatility emissions sent by market we to all other markets is measured as follows:

$$S_{j \to i}^g(H) = \frac{\sum_{i=1}^{N} \tilde{\theta}_{ji}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ji}^g(H)} x100 = \frac{\sum_{i=1}^{N} \tilde{\theta}_{ji}^g(H)}{N} x100$$

■ Developments in the stock, bond, and foreign exchange markets in the context of Romania's integration into the Eurozone

Using the methodology presented in the previous paragraph and the existing statistical data in the field, we constructed a new analysis that takes into account the decomposition explained by Diebold and Yilmaz[6] and we applied it to three financial markets.

The first of the markets for which we performed the analysis is the **stock market**, where we considered the stock market in the Eurozone, the stock market in Poland, Hungary, the Czech Republic, and Romania, the evolution of each being captured by the representative index for that market: Euro Stoxx 50, WIG20, BET, BUX, and PX. Using these data, we made calculations and managed to obtain a series of results that could be used in practice and academia to make economic interpretations.

We shall present below the results for the stock market, using the model proposed by Diebold and Yilmaz[7] which we have previously explained using the mathematic formulas. All these results shall be presented with the help of a summary table, as we have done for other materials. It is presented an analysis of the spread of conditional volatility. This analysis was calculated with the help of an ARV (auto-regressive vector) model, based on the methodology proposed and described by Diebold and Yilmaz[8]. The results are presented in the table below. For a better illustration, they were divided into three sub-periods to capture the pre-crisis period, the period associated with the

[6]Diebold F. X. and Yilmaz K. (2009). Measuring Financial Assets Return and Volatility Spillovers, with application to Global Equity Markets, The Economic Journal, No. 119, 158-171, January.
[7]Diebold F. X. and Yilmaz K. (2010). Better to Give than Receive: Predictive Directional Measurement of Volatility Spillovers, Working Paper, No. 1001, March.
[8]Diebold F. X. and Yilmaz K. (2009). Measuring Financial Assets Return and Volatility Spillovers, with application to Global Equity Markets, The Economic Journal, No. 119, 158-171, January.

economic and financial crisis of 2008-2009, and the post-crisis economic recovery period.

Thus, in **Table no. 1** we presented the changes of volatility for different asset markets, the variance of forecast errors, as well as the index of the total contagion effect, which is calculated based on the ARV model. In this table, entry j represents the estimated contribution to the variance of forecast errors for market i, which is owed especially to innovation j. If the main diagonal (contribution to others) is excluded, and if the amounts are excluded one at a time (own contributions), we reach a conclusion that shows us the total variance on market j due to all the other variances. All these calculations lead to obtaining the total contagion (spread) index, which is approximately the sum of all contributions. Therefore, an approximate decomposition of the spread index is presented in the previous table in percentages.

Table no. 1: Contagion effect for the stock markets in Romania, Hungary, the Czech Republic, Poland, and the Eurozone

Dec.1999 – Jul 2007		From					
		EUROSTOXX50	WIG20	BET	BUX	PX	Contribution from others
To	EUROSTOXX50	**98.6**	0.0	0.0	0.6	0.7	1.4
	WIG20	4.8	**95.0**	0.0	0.1	0.1	5.0
	BET	0.0	0.0	**99.2**	0.4	0.3	0.8
	BUX	6.3	7.6	0.0	**85.4**	0.7	14.6
	PX	4.8	7.7	0.1	6.7	**80.7**	19.3
Contribution to others		15.9	15.3	0.2	7.8	1.9	41.1
Contribution including own		114.5	110.3	99.4	93.2	82.6	**Spillover index = 8.2%**

Aug.2007 – Dec 2012		From					
		EUROSTOXX50	WIG20	BET	BUX	PX	Contribution from others
To	EUROSTOXX50	**97.6**	0.1	1.9	0.0	0.4	2.4
	WIG20	31.3	**65.1**	3.0	0.0	0.6	34.9
	BET	9.7	4.9	**84.6**	0.2	0.7	15.4
	BUX	29.7	6.8	9.8	**49.0**	4.7	51.0
	PX	29.3	8.9	14.6	0.5	**46.7**	53.3
Contribution to others		100.0	20.8	29.3	0.7	6.4	157.0
Contribution including own		197.5	85.9	113.9	49.7	53.1	**Spillover index = 31.4%**

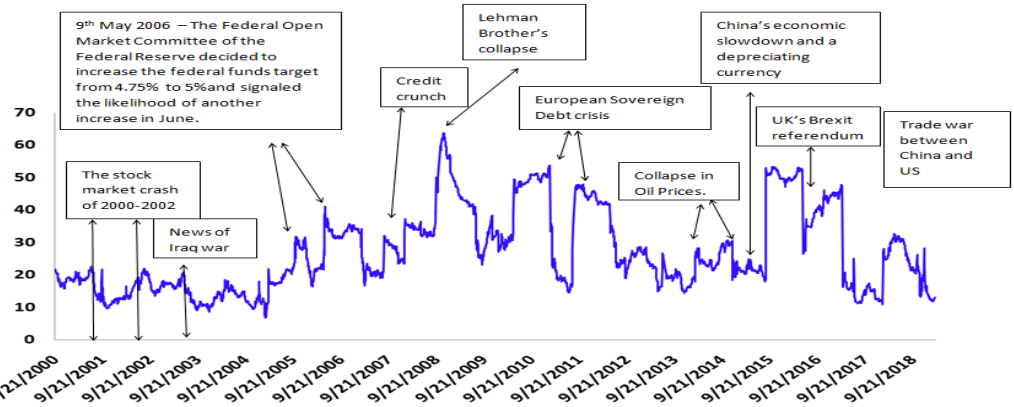
Jan.2013 – Oct 2019		From					
		EUROSTOXX50	WIG20	BET	BUX	PX	Contribution from others
To	EUROSTOXX50	**98.3**	0.0	0.4	0.0	1.3	1.7
	WIG20	19.2	**80.6**	0.0	0.1	0.0	19.4
	BET	5.0	3.8	**90.8**	0.3	0.0	9.2
	BUX	13.1	8.3	1.8	**76.5**	0.3	23.5
	PX	28.7	3.8	2.9	0.9	**63.6**	36.4
Contribution to others		66.1	16.0	5.1	1.4	1.6	90.1
Contribution including own		164.3	96.6	95.9	77.9	65.2	**Spillover index =18.0%**

Source: The results from this table were obtained using the Eviews program, and the size of the lag for the model was chosen using the Schwartz criterion

The results which were obtained emphasize the fact that during tensed periods the spread of volatility is, on average, higher than during the periods before the crisis or after the crisis. Thus, 31.4% of the volatility variation of the forecast error is determined by all 5 markets and comes from the spread of volatility during times of crisis. On the other hand, before the crisis appears an explanation only for 8.2% and after the crisis of 18%. As it can very easily be noted in the previous table, the main diagonal presents significantly higher values than those outside the main diagonal, which shows that the impact of internal factors is much higher than that of external factors. Also, the results show that the Romanian market is much more correlated with the European stock markets, which shows that the losses on external markets can be extended much faster towards the local market, given the interconnection thereof of recent years.

As the period chosen for the analysis includes several phases of turbulence in the financial markets, it seems unrealistic for a single model with a fixed parameter to lead to a relevant result. This could be a vulnerability of what has been built so far and what we have worked on so far. Nevertheless, there are works in the specialty literature that approach this issue and contribute to the resolution thereof. Thus, for resolution purposes, we could use the running method for 200 days proposed by Diebold and Yilmaz in 2009[9], where it is assessed the nature and size of the propagation of the contagion phenomenon[10]. The result can be synthesized in a single graph:

Graph no. 1: Total contagion effect for the stock market



Source: Own processing, based on the results obtained following the estimation of the model and based on Bloomberg data

Note: An international stock index (Euro Stoxx 50) and four regional indices from Central and Eastern Europe were used, such as Romania, Poland, the Czech Republic, and Hungary. The values of these indices were included in the model and resulted in the figures behind the previous index.

As it can be noted in the previous graph, volatility has an ample variance and is spread when extreme economic episodes occur, as they were marked on the graph above. Of them, we could mention the Sovereign debt crisis, the Sub-prime credit crisis in the United States, and so on. Therefore, we have marked a series of events that have led to the increase of volatility and, implicitly, to the increase of the index used to measure contagion, namely a certain form of instability on the financial markets of these countries from Central and Eastern Europe in correlation with what is happening for the Eurozone market.

Then, as we mentioned, the same type of approach was applied to the **bond market.** The table below presents the analysis regarding the spread of conditioned volatility, as it was previously done for the stock market case. Thus, the procedure is used exactly the same for the case of the bond markets, with the same methodology proposed by Diebold and Yilmaz[11], which is based on the conditioned volatilities obtained through the DCC-Garch model. The results that were reached were synthesized and presented below, with the help of **Table no. 2**:

[9]The same as 8.
[10]The English term is ***spillover*** and can be translated as a contagion effect for financial markets.
[11]The same as 8.

Table no. 2 Contagion index for the bond markets

Jan.2010 – Oct 2019		From					
		Germany	Hungary	Romania	Czech Republic	Poland	Contribution from others
To	Germany	**99.7**	0	0	0.2	0	0.3
	Hungary	3.7	**95.5**	0	0.4	0.4	4.5
	Romania	0.5	5.9	**92.9**	0	0.7	7.1
	Czech Republic	5.1	2.1	0.1	**92**	0.7	8
	Poland	1.9	4.3	0.5	1.5	**91.8**	8.2
Contribution to others		11.2	12.3	0.7	2.2	1.8	28.1
Contribution including own		110.9	107.8	93.5	94.1	93.6	**Spillover index = 5.6%**

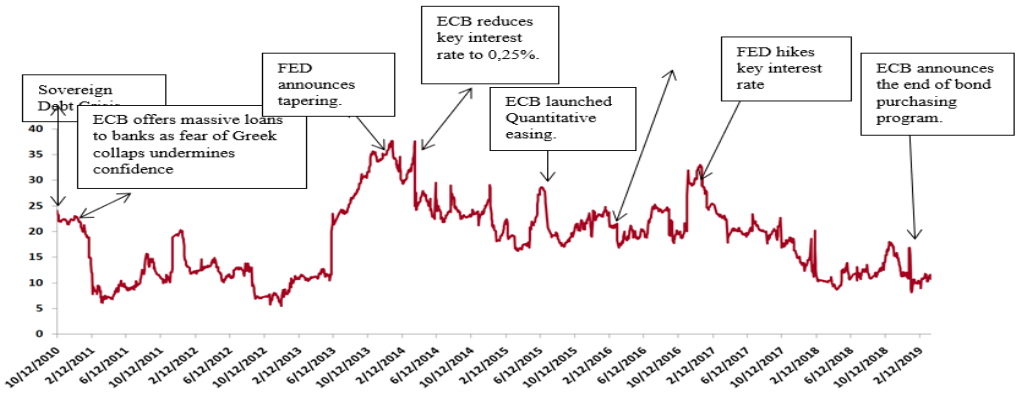
Source: The results from this table were obtained using the Eviews program, and the size of the lag for the model was chosen using the Schwartz criterion

The table above presents the changes in volatility for the bonds traded on the bond markets chosen for analysis, the variation of forecast errors, as well as the index of the total contagion effect, which is calculated on the basis of the ARV model using the generalized decomposition of the variance. we remind you of the fact that a 10 day lag was chosen, according to the Schwartz criterion used, as presented above. In this table, entry j represents the estimated contribution to the variance of forecast errors for market i, which is owed especially to innovation j. If the main diagonal (contribution to others) is excluded, and if the amounts are excluded one at a time (own contributions), we reach a conclusion that shows us the total variance on market j as a result of all the other variances. All these calculations lead to the obtaining of the total contagion (spread) index, which is approximately the sum of all contributions. Therefore, an approximate decomposition of the spread index is presented in the previous table in percentages.

As seen in the previous table, most of the forecast error variation comes from shocks from the domestic market, and this is emphasized by the fact that the elements on the main diagonal have the highest values. Therefore, we can say that the economic fundamentals of those countries largely influence the sovereign obligations of the states chosen for the analysis, the fiscal-budget policy strategies adopted (budget deficit, public debt level), and political stability (e.g. the fall of the government, unexpected results in the presidential or parliamentary elections). It can be noted that only 7.1% of the fluctuation on the bond markets in Romania is explained by the other bond markets taken into account: the Eurozone market, the one in Poland, the Czech Republic, and Hungary. However, the Romanian market is in second place in terms of the size of the influence, after the Polish market, where there was an influence of 8.2% from the other bond markets compared to the Polish bond market. Conversely, 91.8% of the volatility on Polish bond markets is explained by events related to the domestic market, just as it happened in Romania's case.

On the other hand, it is noted that in the case of other markets considered, the external influence is much lower, and to establish the volatility thereof, it is much more important to consider the domestic evolution and the events which occur on the domestic market of those countries or of the Eurozone. As we have presented for the previous case, we built the cumulated volatility index for these markets as well and it is presented below under the form of a line type graph:

Graph no. 2 Volatility index for the bond markets in the countries chosen for analysis



Source: Own processing, based on Bloomberg data

Note: The estimated model presented in the previous graph uses data related to an aggregated index for the Eurozone and four indices specific to the countries from Central and Eastern Europe: Romania, Poland, Hungary, and the Czech Republic.

Graph no. 2 presents the main events that had a decisive role in generating spreads of volatility on the financial markets from the countries included in the analysis for the period 2010-2019. It can be noted this time that volatility and the level of contagion on the bond markets have increased when there have been important events leading to the increase of stress and tensions. The graph presented above marked the events that generated the increase of this index, and the results are according to the expectations initially formulated, when we confirmed that a negative event leads to an increase of the level of contagion. The level of contagion is higher when we are talking about a higher integration on financial markets.

The third financial market for which we decided it is opportune to analyze is the **foreign exchange market**. In this case, the exchange rates for the currencies of the countries of Central and Eastern Europe against the EUR will be chosen, and the reference exchange rate (Benchmark) will be the EUR / USD exchange rate, i.e. the single European currency against the US dollar, these being the two most important currencies internationally. As was the case for the other financial markets and the foreign exchange market, the results obtained using the methodology of Diebold and Yilmaz to obtain correlations and indications on the relationships between variables for all countries for which the analysis was considered are taken into account. The foreign exchange market case was also divided into three sub-periods: the pre-financial crisis period, the financial crisis period, and the post-crisis period of 2008-2009. This division was made in order to notice certain patterns with respect to the behavior of foreign exchange markets in different market scenarios and in different periods, being also assessed the contagion according to the level of integration between these markets, since it is known that we are talking about countries which joined the European Union in different periods, as well as the fact that we are talking about countries with more or less similar economies from several perspectives.

Table no. 3: Contagion effect for the foreign exchange markets in Romania, Poland, Hungary, the Czech Republic, and the Eurozone

Jan. 2000 - July 2007		From					
		EUR/USD	EUR/HUF	EUR/RON	EUR/CZK	EUR/PLN	Contribution from others
To	EUR/USD	**99.9**	0	0	0	0.1	0.1
	EUR/HUF	0	**99.9**	0	0	0	0.1
	EUR/RON	18.1	0.1	**81.9**	0	0	18.1
	EUR/CZK	2.1	2.5	0.1	**94.9**	0.5	5.1
	EUR/PLN	9.6	3.9	0.2	0.6	**85.7**	14.3
Contribution to others		29.7	6.6	0.3	0.6	0.6	37.8
Contribution including own		129.6	106.5	82.2	95.5	86.3	**Spillover index = 7.6%**

Aug. 2007 – Dec. 2012		From					
		EUR/USD	EUR/HUF	EUR/RON	EUR/CZK	EUR/PLN	Contribution from others
To	EUR/USD	**98.4**	0.3	0.5	0.1	0.6	1.6
	EUR/HUF	1.3	**98.5**	0.2	0	0	1.5
	EUR/RON	0.8	2	**97.1**	0	0.1	2.9
	EUR/CZK	2.6	12.4	1.3	**82.4**	1.3	17.6
	EUR/PLN	5.5	23.8	0.5	4.9	**65.2**	34.8
Contribution to others		10.2	38.6	2.6	5	2.1	58.5
Contribution including own		108.5	137.1	99.7	87.4	67.3	**Spillover index = 11.7%**

Jan. 2013 – Oct. 2019		From					
		EUR/USD	EUR/HUF	EUR/RON	EUR/CZK	EUR/PLN	Contribution from others
To	EUR/USD	**99.3**	0.5	0	0	0.2	0.7
	EUR/HUF	4.2	**95.7**	0	0	0	4.3
	EUR/RON	0.4	5.1	**94.4**	0	0.1	5.6
	EUR/CZK	0	0.1	0.1	**99.7**	0	0.3
	EUR/PLN	6.9	10.9	1.3	0.1	**80.8**	19.2
Contribution to others		11.5	16.7	1.5	0.2	0.3	30.1

Contribution including own	110.7	112.4	95.9	99.9	81.1	**Spillover index = 6%**

Source: The calculations were obtained using the Eviews 8 program, and the size of the lag was selected with the help of the Schwartz criterion.

Table no. 3 presents the changes in volatility for the currency pairs from the countries chosen for analysis, the variation of forecast errors, as well as the index of the total contagion effect, which is calculated on the basis of the ARV model using the generalized decomposition of the variance. we remind you of the fact that a 10 day lag was chosen, according to the Schwartz criterion used, as presented above. In this table, entry j represents the estimated contribution to the variance of forecast errors for market i, which is owed especially to innovation j. If the main diagonal (contribution to others) is excluded, and if the amounts are excluded one at a time (own contributions), we reach a conclusion that shows us the total variance on market j as a result of all the other variances. All these calculations lead to obtaining the total contagion (spread) index, which is approximately the sum of all contributions. Therefore, an approximate decomposition of the spread index is presented in the previous table in the form of percentages.

As in the case of the other two markets (the stock market and the bond market), we will also interpret the results obtained in the context of the level of integration in order to conclude the impact of integration on the level of contagion, and all these will be thought of keeping in mind the three sub-periods in which the entire analysis period was divided. It can be seen that during the crisis, the volatility index (i.e., spillover index) was higher, which shows that it was a tense period and a higher contagion effect for these markets. On the other hand, the same index decreased during the post-crisis period, being at a level even lower than during the pre-economic and financial crisis period of 2008-2009. This shows that, as the integration was made in these countries, foreign exchange markets have become increasingly correlated and this led to higher stability and lower fluctuation of local currencies compared to the European single currency. The observation is in line with economic theory and with one of the criteria for joining the Eurozone, according to which the currency of the country wishing to join must be more and more stable against the EURO, i.e. volatility must be lower and lower.

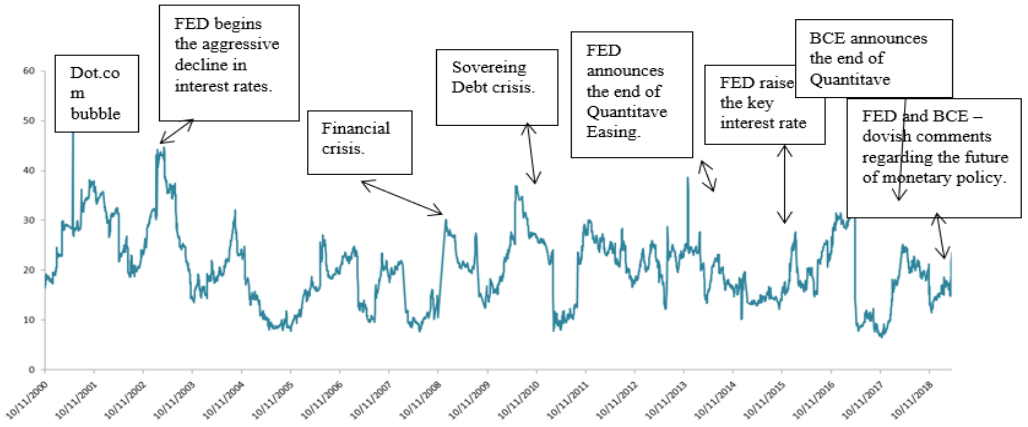
The above observations regarding the foreign exchange market for the general case are also applicable for the case of Romania, where it was observed that a much larger part of the EUR / RON exchange rate variation is explained by external factors in the pre-financial crisis period of 2008-2009, than in the post-financial crisis period.

Another aspect that is worth mentioning is the one related to the EUR/PLN exchange rate and the foreign exchange market in Poland. After we applied the methodology, we noticed that this exchange rate registered the highest influences from the other markets, the EUR/USD exchange rate being decisive for all the other three sub-periods.

As we have done for the case of the other two financial markets (the stock market and the bond market), this time also, for the foreign exchange market, we shall present below the evolution of the contagion index calculated for Romania, Hungary, Poland, the Czech Republic, and the Eurozone. This index will be presented under the form of a line type graph, being registered the most important events on the financial markets we considered relevant for determining volatility and for the influence they might have had on the foreign exchange markets from the countries we considered and taking into account the objective of this chapter. This index must be interpreted every time in

correlation with the events and it must be considered the level of integration made for the countries from the region considered for analysis.

Graph no. 3: Contagion index calculated for the foreign exchange markets in Romania, Hungary, the Czech Republic, Poland, and the Eurozone



Source: Own processing, based on the data downloaded from Bloomberg and using the Eviews software to obtain the index

Note: The constructed model uses a reference exchange rate (considered to be the Benchmark - EUR/USD) and four exchange rates for the countries in Central and Eastern Europe that were chosen (Romania, Poland, the Czech Republic, and Hungary). The contagion effects are measured with the help of the decomposition of the forecast error variance, so as to be able to identify the impact of internal, as well as external variances on every foreign exchange market, according to the countries chosen for analysis.

The previous graph emphasizes the evolution of the contagion index calculated for Romania, Hungary, Poland, the Czech Republic (countries from Central and Eastern Europe) and the Eurozone. This index was calculated to emphasize how the contagion risk has evolved in these countries as the level of integration has increased and as different events have occurred that might cause shocks on the financial markets, but especially for foreign exchange markets. In line with the things noted in the analysis for the stock market and the bond market, we have noted for the case of foreign exchange markets from these countries that the level of contagion increased significantly when important events for the economies of these countries occurred and this level of contagion has also increased in time, as the integration was made for the countries under analysis from Central and Eastern Europe, once with their joining the European Union and, as they have tried to fulfill more and more criteria for accession to the Eurozone.

Therefore, it is noted that the level of contagion has increased as problems have arisen in the Eurozone, especially during the Sovereign Debt Crisis, but also when the Central European Bank took important monetary policy decisions. All of these things show that once with the increase of the level of integration and once with a higher correlation of financial markets from the countries which recently joined the European Union comes a higher risk of contagion which can manifest itself under different forms. We have also shown that this contagion risk increases, especially when important monetary policy events occur in the Eurozone or events that lead to a change in the investors' confidence regarding the perspective of financial markets or the solidity of the European construction.

3. Conclusions

We believe that the most relevant conclusions drawn from this research are the following:

✓ Financial integration of the countries part of the European Union has always represented a topic intensely debated in the specialty literature and a topic on which a series of specialty papers have been written. Such a topic was the starting point for economists like Baele and others[12] or Agenor and El Aynaoui[13], who introduce different qualitative aspects apart from quantitative models to capture the level of financial integration and the level of convergence. Of these measures and methodologies, we would mention: price-based measures[14], quantity-based measures or news-based measure[15]. Moreover, a very important paper in this direction is that of Babetskii and others[16], where it is analyzed exactly the issue of financial integration of the countries from Central and Eastern Europe;

✓ The most recent economic and financial crisis managed to show us that financial markets can be atypical in times of tension. This is why the level of integration can be different from one period to another, according to the general economic situation and other variables. Thus, the level of integration and stability of financial markets depends mainly on the economic situation, but there is also a possibility for this relationship to be reversed.

✓ The most important events from the global economies, as well as from the European economies, have had a significant impact on stock markets and have been reflected into an increase of contagion, namely of the risk on these markets;

✓ once with the increase of the level of financial integration appear new risks and they are mostly related to the potential level of contagion on these markets;

✓ After the accession to the European Union, the EUR / RON exchange rate became more and more stable, being about integration and a higher correlation of the foreign exchange market in Romania with that of the Eurozone. Therefore, it can be stated that the level of volatility has been lower, that there is talk of better integration of the Romanian foreign exchange market, but also of a higher vulnerability of the Romanian financial markets to the shocks on the financial markets from the Eurozone;

✓ EUR/PLN volatility has been dependent on EUR/USD volatility, with **high integration for this market with what is happening in the Eurozone**, but at the same time, such integration has also led to a much higher contagion risk in the event of such shocks for the Polish foreign exchange market. Moreover, we believe it should be noted that it is as interesting the evolution from the post-crisis period compared to the pre-crisis period of the contagion index for Poland's case, where there was an increase of the level of contagion explained by the external factors compared to the period prior to the crisis and an increase of the dependence on what is happening in the Eurozone. Therefore, we can affirm that the foreign exchange market in Poland has become more volatile,

[12]Baele, L., Ferrando, A., Hördahl, P., Krylova, E., and Monnet, C. (2004). Measuring financial integration in the euro area (No. 14). ECB occasional paper.
[13]Agénor, P. R., and El Aynaoui, K. (2003). Labor market policies and unemployment in Morocco: A quantitative analysis (Vol. 3091). World Bank Publications.
[14]Bekaert G., Harvey C. R. (1995). Time-Varying World Market Integration, The Journal of Finance, Vol. L, No. 2, iunie.
[15]Calero J. A. U. (2013). Essays of Financial Contagion, Doctoral Thesis, Universitat Rovira we Virgili.
[16]Babetskii, I., Komárek, L. and Komárková, Z. (2007). Financial integration of stock markets among new EU member states and the euro area. Czech National Bank, Economic Research Department.

more sensitive to external factors, but much more correlated, **integrated** with, and dependent on what is happening in the Eurozone.

- ✓ integration could bring about beneficial effects, but it could also lead to higher risks, and one of the most important risks is the one related to the increase of the level of correlation of financial markets, of economies and, implicitly, the increase of the contagion risk in case of a crisis or certain shocks.

With the help of the aggregated volatility index and of the effect of contagion we analyzed financial stability and the tension in the chosen markets for that period. Based on this index, it was noted that financial stability decreased during periods with tensed events, and the risk of contagion increased, while in situations with no negative events the situation was reversed. The methodology which formed the basis of these conclusions was a complex one, based on what was proposed by Diebold and Yilmaz in 2009[17], since they were among the first to apply this procedure of measurement of contagion and the level of integration on financial markets, the end purpose was to correlate all conclusions with the level of stability a country represents.

These indicators can be very useful in quantifying financial stability and they can form the basis of taking extremely concrete and concise measures when the situation so requires. Thus, we have tried through this research to add, once again, a plus of applicability and originality and to emphasize the importance of research for the academia and the business environment from Romania and from abroad, being able to make an important contribution to different fields. As we mentioned, we set out to make the paper both theoretical and applied, in a balanced way.

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