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Forecasting Romanian Financial System Stability Using a Stochastic Simulation Model

by

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Abstract

The aim of this paper is to develop an aggregate stability index for the Romanian financial system, which is meant to enhance the set of analysis used by authorities to assess the financial system stability. The index takes into consideration indicators related to financial system development, vulnerability, soundness and also indicators which characterise the international economic climate. Another purpose of our study is to forecast the financial stability level, using a stochastic simulation model. The outcome of the study shows an improvement of the Romanian financial system stability during the period 1999-2007. The constructed aggregate index captures the financial turbulences periods like 1998-1999 Romanian banking crisis and 2007 subprime crisis. The forecasted values of the index show a deterioration of financial stability in 2009, influenced by the estimated decline of the financial and economic activity.

Key words: financial stability, aggregate financial stability index, forecasting systemic stability, stochastic simulation model.

JEL classification: C43, C51, C53, G01, G17.

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1. Introduction

Over the last two decades, addressing financial stability has become an important subject of the national and international policy agendas. Policymakers in general and central bankers in particular, have allocated increasing resources to monitor the potential threats to financial stability and to elaborate a framework to achieve this goal. Systemic financial stability became one of the authorities' major concerns after the 2007 subprime crisis.

Measurement of the financial stability has two quite distinct roles. One is to help ensuring the accountability of the authorities responsible for performing the task. The other is to support the implementation of the chosen strategy to achieve the goal in real time (Borio and Drehmann, 2008).

There are several techniques used to assess systemic stability, each of them presenting both advantages and inconveniences related to the capacity to provide accurate information in respect of the stability level. The early warning systems (EWS) enable the forecasts related to the probability of financial crisis appearance, but they neither offer the possibility to include in the calculations all the risks to which the system is exposed, nor do they provide information related to the shocks response capacity. The stress-tests techniques allow the identification of potential shocks and estimate the financial system resistance, but give no possibility to compare the stability level during different periods or the stability level of two or more financial systems.

The construction of an aggregate financial stability index (AFSI) represents, beside the early warning systems and the stress-tests, one of the quantitative methods for measuring the stability of a financial system. Even if some specialists (Hanschel and Monnin, 2005; Borio and Drehmann, 2008) state that this method is auxiliary to other more complex techniques, we consider there are several reasons for which the AFSI method must be regarded as an independent technique, complementary to the others. On the one hand, the index offers the possibility to make comparisons between different periods, different financial systems and enabling also the observation of the stability level dynamics. On the other hand, it presents numerous advantages such as high transparency, easier access to statistic data, simplicity of calculations and possibility to forecast financial stability level.

The financial stability represents a dynamic process and therefore the stress must fall on the evolution of the aggregate index in time. Consequently, in our study we use quarterly data, which allow a more accurate analysis as compared to annual data. At the same time, we take into account different categories of individual indicators connected with the financial stability.

Because we analyse the financial stability of an emerging country, we focus on the balance sheet data and not on the market data – which are more volatile and enable a short run forecast of financial stability. Another reason for choosing the balance sheet approach is the large presence of the banking sector within the Romanian financial system. The index allows for a good identification of the turbulence periods crossed by the financial system as for example: the 1998-1999 banking crisis, the 2001 capital markets crunch and the 2007 subprime crisis.

The econometric validation of the IASF supposes highlighting the relation between the financial stability and macroeconomic environment. The stability is largely influenced by the economic activity trend, by the variables which facilitate the investments like the interest rate, and by the evolution of the confidence on the capital markets, reflected by the stock exchange index. Other factors which can influence the stability level and consequently represent the forecast basis are the credit activity or the interest rate spread on the interbank market.

The reminder of the paper is organised as follows. Section 2, describes different methods used in the construction of the financial stability or financial stress index. The next section presents the calculation of an aggregate stability index for Romania's financial system. Section 4 is dedicated to the econometric exercise for the validation of the AFSI and section 5 presents a forecast method based on a stochastic simulation model. The last section points out the findings of this study.

2. Financial stability aggregate index: literature overview

An indicator represents an observable variable used to describe a phenomenon which is difficultly seized. Nevertheless, a multidimensional economic phenomenon like financial stability[1] can only be analyzed by means of a synthetic index which aggregates different so-called "basic" indicators. These indicators reflect the dimensions of the financial stability. They highlight the stock market and banks performance, the credit quality, the consumer confidence or the macroeconomic context.

To be included into a synthetic index, the individual indicators have to be quantified. They do not always have the same accuracy or the same measurement unit, situation which complicates their aggregation. The indicators' values have thus to be normalized.

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[1] The financial stability can be defined as the financial system capacity to carry out appropriately its functions during an undetermined period, by correcting the imbalances frequently occurring in its operational mechanisms.

Several normalization methods can be taken into account, as none of them is satisfactory enough. The most common normalization methods are:

- *Statistical normalization* consists in expressing all values in standard deviation, so that the variables average is equal to zero.

- *Empirical normalization* supposes different techniques. Usually, the benchmark is represented by the value of the indicator in a reference year. Another method gives the 0 value (Min) to the most unfavourable observed value and 1 or 10 (Max) to the best recorded value. All intermediary values are calculated based on the formula: Y = X – Min/(Max – Min).

- *Axiological normalization*, resembling to the empirical approach with *min* and *max* limits, is characterized by the fact that the limits are not statistically identified, being chosen based on the undesirable situation, which receives the "0" value, and on the ideal situation, which can or can not correspond to a strategic objective and which receives the value "1".

- *Mathematical normalization* consists in transforming data by means of a mathematic function in order for the values to range between an upper and a lower limit (e.g. -1 and +1 or 0 and 1).

The empirical normalisation method, gives either the possibility to calculate a stress index (if the analysis is based on the volatility of the variables) or a stability index (if the normalisation procedure takes into consideration the worst and the best values recorded by the indicators in the analyzed time horizon). In our study we have chosen the second approach.

The next step in the index construction is the aggregation of individual values. We can choose either to give the same importance to all the variables or to apply different weights based on decision making criteria or on statistical calculations.

The standard procedure consists in giving the same weight to all the variables which are included in the aggregate index. Another possibility is to transform the variables in percentiles, using their sample cumulative distribution function – CDFs (Illing and Liu, 2006; Rouabah, 2008). In this case, the last percentile corresponds to a high instability period, while the value of the first percentile characterises a low stress level. The other values around the median reflect an average risk level. Before building the aggregate index, the normalised variables are aggregated in a chain index and the connection between them can be established using the arithmetic mean as well as the geometric mean, according to the formulas:

$$AFSI = \frac{\sum_i (X_{it} w_{it}) + \sum_i (X_{it} w_{it-1})}{2} \tag{1}$$

$$AFSI = \sqrt{\sum_i (X_{it} w_{it}) * \sum_i (X_{it} w_{it-1})} \qquad (2)$$

where: (X_{it}) represents the transformed individual variables and (w_{it}) stands for their weight within the index in the (t) period. The weight is calculated based on the ratio between the normalised variable and the sum of all the variables at the (t) moment.

A third weighting technique identified in the literature is the factor analysis. The principal components approach represents a reliable method used as a tool in exploratory data analysis. The method resides in identifying some axes to explain most of the variables' inertness. After the identification of the main components, the aggregate index will be calculated by means of the standard method. Finally, the credit weights approach considers the variables by the relative size of each market to which they pertain. The larger the market as a share of total credit in the economy, the higher the weight assigned to the variable which represents a stress proxy in that market (Illing and Liu, 2006).

We can thus discover various techniques used to build a financial stability index. One simple method is that enabling a mechanic comparison between the individual stability indicators characterizing different financial systems and it consists of a hierarchy of individual indicators values (the aggregate index components). The inconvenience of this non-parametric method comes from the minimum differences between the values of the indicators having the same weight within the aggregate index.

The aggregate index can also be built as a weighted average of individual indicators (see Călin (2004) and Rouabah (2008)). In a recent study about the Romanian financial system stability, made in order to asses the opportunity of Romania's accession to the eurozone, we have also used an individual indicators weighted average (Albulescu, 2008).

An ample presentation of the literature on this subject is carried out by Gersl and Hermanek (2006) who calculate an aggregate index for the Czech banking sector, using again the normalization and aggregation procedures. This index is called "banking stability aggregate index". The indicators were selected based on current international practice, and their weights were established based on the authors' experience and judgements.

A third method consists in the construction of an aggregate index, based on daily financial markets data (share prices or prices of other banking assets). Nelson and Perli (2005) describe such an index, called "financial fragility index". Their study concentrated on the United States financial system, and the authors demonstrated that this aggregate fragility index can bring its contribution to forecasting the probability according to which a turbulent

period may occur. The index construction follows a two-step process: a) the information included in 12 individual variables was grouped in three indicators which took into account their level, volatility and correlation; b) a *logit* model was estimated to obtain the probability that the behaviour of financial markets is analogous to that of previous financial crisis.

$$P_t = L \left(\beta_O + \beta_1 \lambda_t + \beta_2 \delta_t + \beta_3 \gamma_t \right) \tag{3}$$

where: λ - level indicator, δ - rate-of-change indicator, and ρ - co-movement indicator.

Illing and Liu (2003) constructed a "financial stress index" using market data too. A more complex method consists in combining market data and balance sheet data into a "stress index" for the banking sector (Hanschel and Monnin, 2005). Schweizerische Nationalbank (2006) has built a stress index for the Switzerland's banking system using this technique.

Experts from the Netherlands Central Bank had an original approach to the construction of the index (Van den End, 2006). The "financial stability conditions index" was built based on indicators characterising monetary conditions, namely: interest rates, effective exchange rate, real estate prices, stock prices, solvency of financial institutions and volatility of financial institutions stock index. The innovation of this index resides in the introduction of some upper and lower critical limits to take into account the potential non-linear effects. A low value of the indicators means increased instability, whereas too high values may result in the accumulation of financial imbalances. Therefore, the ideal evolution of the index is the one within a particular financial stability band.

The last method consists in the construction of an AFSI by calculating the default rate for the entire financial system using the Merton approach (Van den End and Tabbae, 2005). A similar index assessing the systemic risk, based on the stochastic distribution of individual financial institutions default, was also proposed by Čihák (2007). The advantage of this method is the interconnection between financial perturbations and business cycle. However, the application of this method supposes liquid capital markets with active banks, which represents an inconvenient for the stability analysis of a less developed financial system.

In the following section we will describe the construction method of an AFSI for the Romanian financial system, using the standard procedure. We take into consideration individual variable which characterise not only the vulnerability of the economy and the banking sector soundness, but also the development of the financial sector (very important for an emerging country) and the international economic climate (imperious to be included in the index in the context of globalisation and increased international financial dependencies).

3. The construction of the stability index for the Romanian financial system

In order to build an AFSI we used quarterly data. The benchmark for the normalisation procedure was represented by the worst and the best indicators' values in the analyzed period (this method allows to focus on stability and not on financial stress). Another solution could be to choose as benchmark the indicators' values during crisis periods (e.g. the indicators' values during the 1998-1999 Romanian banking crisis). Because the second approach would have led us directly to the results, we preferred the first method.

The normalized indicators values range between [0;1], facilitating their aggregation and analysis. The value "1" indicates a stability situation and is equal to the best recorded value of each indicator and the value "0" reflects the opposite case. The formula used for the normalization process is:

$$I_{it}n = \frac{I_{it} - Min(I_i)}{Max(I_i) - Min(I_i)} \tag{4}$$

where: I_{it} represents the value of type i indicator during the t period; $Min(I_i)$ and $Max(I_i)$ is the minimum respectively the maximum value registered for type i indicator in the analyzed period; $I_{it}n$ is the indicator's normalized value.

The individual indicators, grouped into the composite (or partial) stability indexes which reflect the dimension of the financial stability, are presented in Table 1. Another possibility is to formulate the financial stability index based on different business activity blocks, namely the stock market, bonds market and banking sector (Hadad et al., 2007).

Table 1: Individual indicators for financial stability analysis

Market capitalisation / GDP	I_{d1}	*Financial Development Index (FDI)*
Total credit in "lei" / GDP	I_{d2}	
Interest spread	I_{d3}	
Banking reform & interest rate liberalisation	I_{d4}	
Inflation rate	I_{v1}	*Financial Vulnerability Index (FVI)*
General budget deficit (% GDP)	I_{v2}	
Current account deficit (% GDP)	I_{v3}	
REER excessive depreciation or appreciation	I_{v4}	
Non governmental credit / Total credit	I_{v5}	
Loans as a percentage of deposits	I_{v6}	
Deposits / M2 (variation %)	I_{v7}	
(Reserves / Deposits) / (Note & coins / M2)	I_{v8}	
Non-performing loans / Total loans	I_{s1}	*Financial Soundness Index (FSI)*
Regulatory capital / Risk weighted assets	I_{s2}	
Own capital ratio (Own capital / Total assets)	I_{s3}	
Liquidity Ratio (Effective liquidity / Required liquidity)	I_{s4}	
General risk ratio	I_{s5}	
Economic Climate Index - CESifo	I_{w1}	*World Economic Climate Index (WECI)*
World Inflation	I_{w2}	
World Economic Growth Rate	I_{w3}	

The selected indicators (a total of 20) are often used in financial stability literature. Due to the fact that banking sector stands as the sector with the most significant importance within the financial system, most indicators refer to credit institutions. We also took into consideration the indicator "market capitalisation to GDP", indicator reflecting the development of the capital market, because this market knew a continuous ascending trend during the last years in Romania. We left aside from our analysis the indicators related to the insurance sector, still poorly developed in Romania, as this sector does not represent at present a potential systemic risk source.

In order to analyze the *financial system development* level, many studies appeal to indicators such as "banking assets to GDP" and "total credit to GDP". In this case we preferred the second indicator which provides information related to the financial intermediation level. The highest this level is, more developed and more mature the banking system is considered. We have taken into consideration the private credit in domestic

currency instead of the foreign currency credit, because the latter may represent a possible source of currency risk.

The "interest spread", calculated as the difference between the average lending rate and the average borrowing rate, represents another indicator which reflects the system's development. In the context of increased competition and penetration of important financial groups on Romanian banking market, the interest spread shows a decreasing trend, even if a few years ago its level was quite high. An increased real interest spread characterizes a high profitability of the banking sector necessary to guarantee its stability, offering at the same time signals that this sector is immature and poorly developed. An increased interest spread can point out financial instability periods when the credit institutions undertake additional protection measures against potential risks.

The last indicator in this category reflecting the financial system development is an indicator calculated by the European Bank for Reconstruction and Development (EBRD), indicator which shows the status of banking reforms and the interest rate liberalisation.

The starting-point in assessing *financial vulnerability* is represented by the analysis of the indicators that the International Monetary Fund (IMF) presents in its country reports. In this set of indicators we can distinguish a group which characterizes the macroeconomic stability and another group which describes the funding structure. These indicators are more accessible to the public and therefore are often analyzed by the investors. The sustainable values of the vulnerability indicators show that the financial system is sound and capable to respond to potential shocks.

The first indicator retained in this category is the "inflation rate" which represents a macroeconomic vulnerability indicator. The central banks' main objective is price stability. A sustainable level of this indicator increases the investors' confidence and it is very important for the financial stability. Another macroeconomic indicator which describes the government performance is the "general budget deficit to GDP". If the budget deficit is high, the investors lose their confidence in the government's capacity to ensure a future sustainable economic growth.

The third vulnerability indicator is the ratio "current account deficit to GDP". An important current account deficit shows a macroeconomic imbalance which supposes a future correction, affecting the financial stability. An economy with a large current account deficit consumes more than it can produce, and it needs borrows or external funds, like foreign direct investments, in order to sustain this consumption. If the flow of these foreign investments decreases due to different causes, the financial system becomes vulnerable.

The next indicator is the excessive appreciation or depreciation of the real effective exchange rate (REER). A considerable volatility of the REER shows that the economy undergoes major corrections by means of the exchange rate, which can affect the stability of the financial system.

Another indicator is represented by the "private credit to total credit ratio". In our study, the private credit is represented by the non governmental credit. After 1990, many banks financed public companies in Romania and an important part of these loans became non performing loans. That is why a decline of the indicator's value reflects a favourable situation.

The banks reserves represent a guarantee related to the bank's capacity to respond to severe money withdrawals. In Romania, the minimum reserve requirements have been used as an important monetary policy instrument. The reserves to deposits ratio is above the level registered in other financial systems. At the same time, the liquidity preference is important because the stronger the cash payments preference manifests, more significant the increase of withdrawals probability is. To highlight these assumptions, we have retained as indicator the ratio between "reserves to deposits" and "note & coins to M2".

The last two vulnerability indicators retained in our analysis have the capacity to issue signals about an eventual financial crisis. The credit boom which is not accompanied by a deposits' expansion shows a potential imbalance within the financial system (the confidence in the national currency diminishes). The "deposits to money supply - M2" ratio reflects the relation between savings and consumption. A deterioration of this indicator's value shows at the same time, the currency depreciation, the savings reduction and the consumption increase.

The third category of selected indicators is related to *financial system soundness*. These indicators are proposed and used by the international financial institutions in assessing financial system soundness exercises. The access to these data is difficult, especially when we need quarterly data. That is why we have used several databases, including the IMF country reports.

The first soundness indicator is represented by the "NPL to total loans ratio" and reflects the loans quality. Even if the indicator shows an improvement in the last years, we have to signal the fact that the volume of non-performing loans considerably increased once the credit boom occurred. The values of the indicators deteriorated furthermore after the start of the 2007 subprime crisis.

The second indicator in this category – "own capital to total assets" – reveals the banking system capitalization level. The Romanian banking system is well capitalized and the National Bank of Romania (NBR) had an important role in this direction.

The third indicator, "regulatory capital to risk weighted assets ratio", also characterizes the banking sector capitalization, but the most important information offered by this indicator is related to banking institutions' solvability.

The "return on assets" (ROA) is the next soundness indicator retained in our analysis. Its value is relatively high for the Romania's banking institutions, but this situation can be considered normal for a transition country. The profit obtained by the credit institutions must remunerate the existing risk on the market. A higher level of the ROA reflects a more profitable and sounder banking system.

The last financial soundness indicator is represented by a "general risk indicator" calculated by the NBR in its monthly bulletins. The choice of these indicators was made in order to include in the analysis some important aspects of banking institutions soundness such as: lending activity performance, capital adequacy, profitability and solvability.

The last category of individual stability indicators characterizes the *world economic climate*, such as "world inflation", "world economic growth", and an index calculated by the Center for Economic Studies & Institute for Economic Research (CESifo) using the business climate perception about investment opportunities – the "economic climate index". All financial systems are interconnected and a deterioration of these indicators has a negative impact at national level, both for economic and financial stability.

The data used in our analysis were extracted from several databases. Most of the indicators were collected from the NBR monthly bulletins. Due to the lack of quarterly data for the financial soundness indicator – "NPL to total loans ratio" – we had to use linear interpolation to transform the annual data found in the IMF country reports, into quarterly data. Another indicator, calculated by means of linear interpolation and extracted from the EBRD database, was the "banking reform & interest rate liberalisation". All the other individual indicators were extracted on a quarterly basis from the Eurostat database, International Financial Statistics database (IMF) and CESifo database.

The individual indicators were grouped into four composite indexes, presented in Table 1 above: *a financial development index* (with four individual indicators), a *financial vulnerability index* (with eight individual indicators), a *financial soundness index* (with five indicators) and a *world economic climate index* (with three indicators).

After the indicators' value normalisation, we have assigned the same weight to all indicators in order to calculate the composite indexes (in the case of unavailable data, this method makes possible the calculation of the composite index based on available

observations). Taking into account the fact that we retained 20 individual indicators, the formula used to calculate the aggregate index is:

$$AFSI = \frac{\sum_{i=1}^{4} I_{ij}}{20} \tag{5}$$

thus, we have:

$$\sum_{i=1}^{4} I_{ij} = \sum_{j=1}^{4} I_{dj} + \sum_{j=1}^{8} I_{vj} + \sum_{j=1}^{5} I_{sj} + \sum_{j=1}^{3} I_{wj} \tag{6}$$

and we reach the following formula:

$$IASF = \frac{4\,\overline{I_{dj}}}{20} + \frac{8\,\overline{I_{vj}}}{20} + \frac{5\,\overline{I_{sj}}}{20} + \frac{3\,\overline{I_{wj}}}{20} \tag{7}$$

where: I_{ij} are the composite indexes (I_{dj} represents the financial development index – FDI; I_{vj} represents the financial vulnerability index – FVI and I_{sj} represents the financial soundness index – FSI).

The AFSI was built, as we have already said, by giving the same importance to the individual financial stability indicators and not to the composite indexes.

A general positive evolution of the AFSI can be observed starting with 1999 (Figure 1). The deterioration of the AFSI occurs before and during the 1998 Romanian banking crisis, during the second half of 2001 and especially after the start of the 2007 subprime crisis. It is also important to observe the WECI trend, which ameliorates before the turbulence periods and decreases during the crisis. In the third quarter of 2008, this index drops to the lowest level recorded in the analyzed period. The financial soundness index substantially declines before the crisis because the banks take additional risks during economic growth periods. The FSI level improves continuously after the Romanian banking sector reform, in 1999-2000.

Figure 1: The trend of the aggregate financial stability index and of the composites indexes
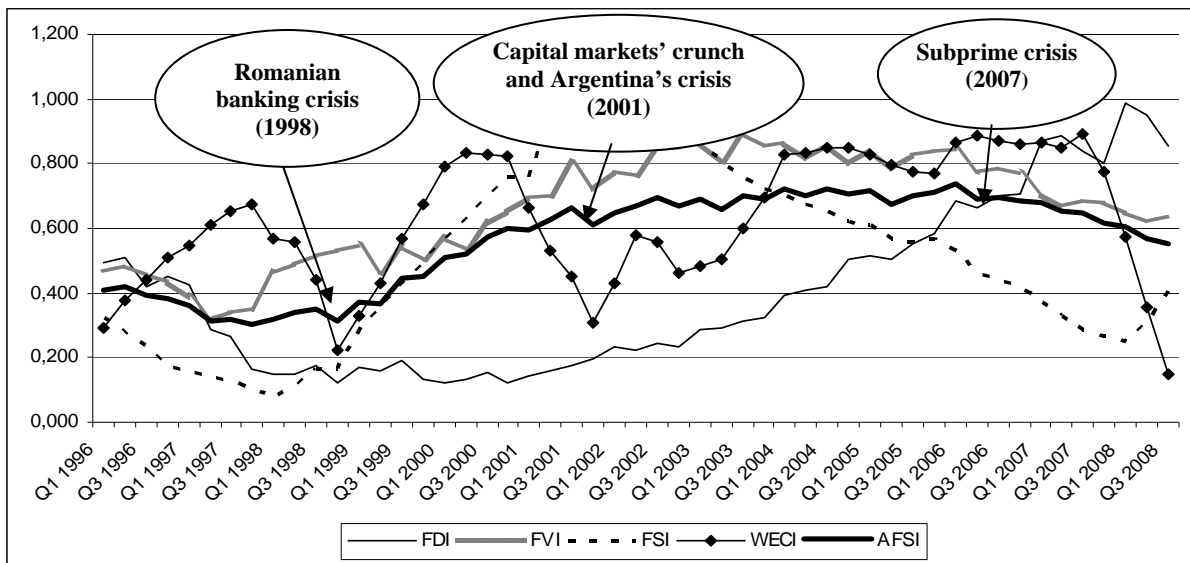
As a conclusion, the improvement of the Romanian financial system stability level occurred after 1999, in the context of financial system development, macroeconomic indicators' improvement and world economic climate amelioration. At the same time, the banking system soundness indicators values declined beginning with 2002.

Another possibility to calculate the financial stability aggregate index is the use of a chain index, based on the arithmetic and geometric mean of the variables. The results of these methodologies, compared to the standard procedure, are presented in Figure 2.

Figure 2: The AFSI trend based on different calculation methods
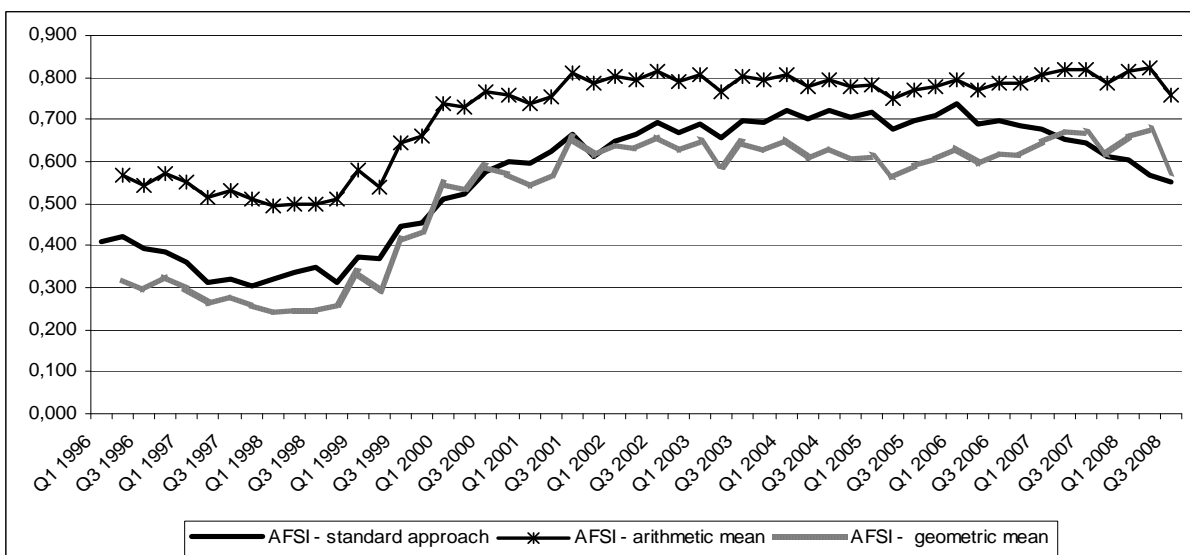
As it can be observed, the results of the three calculation methods are similar. However, the standard procedure seems more adequate because the AFSI captures all the financial turbulences experienced by the system and highlights not only the present economic crisis

started at the end of 2008, but also the financial imbalances which affected the financial system stability in the second half of 2007. Consequently, we prefer this method for further researches related to the econometric validation of the aggregate index and to the forecast exercise.

4. AFSI econometric validation

The AFSI dynamics analysis shows that the index successfully identifies the crisis periods crossed by the Romanian financial system during the last decade. For the econometric validation of the AFSI we have chosen several macroeconomic variables which behave differently during crisis periods as compared to normal periods. These variables are: the economic growth rate, the interbank interest rate – ROBOR at three months (*Romanian Interbank Offer Rate*), the Bucharest stock exchange index – BET and the ratio foreign currency loans to GDP, the last variable being extremely high in the periods preceding the crisis and representing thus a turbulences amplifier factor[2].

The economic growth rate is an indicator which reflects at the same time the business cycle volatility and the volatility of the economic environment where the financial institutions activate. The deterioration of the economic activity affects the banks' activity and, consequently, the stability of the financial system. The financial crises also slow down the economic activity.

The interbank market interest rate tends to increase during instability periods since the financial institutions make efforts to ensure the liquidity necessary in difficult situations. The liquidity demand on the interbank market entails an interest rate increase. That is why we expect to find a negative correlation between the interest rate and the AFSI.

The third explanatory variable retained in our analysis is the Bucharest stock exchange index – BET. Even if the capital market is poorly developed in Romania, the BET index reflects the companies' economic situation as well as the status of the entire economy. A

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[2] In the construction of the AFSI, we have inserted, as variables reflecting the system's vulnerability, some macroeconomic indicators such as the inflation rate and the public deficit. We consider that these variables have an important and immediate influence on the investors' perception in respect of financial system stability. In fact, the above mentioned indicators stand for imbalances which suppose a correction with negative effects on stability. We have also considered some macroeconomic variables for the AFSI econometric validation. In this case, we focussed on variables characterizing rather the stability's macroeconomic context than the external vulnerability (the system can be stable even if the economic growth rate is quite modest). This choice can appear limited, but it has already been used in literature (see Rouabah, 2008). Moreover, the choice of the economic growth rate and the interest rate as explanatory variables offers the possibility to make a forecast in respect of the stability level, because the values estimated for these variables are provided by several financial or governmental institutions (see the next section).

decrease of the BET index value can be associated with a profitability reduction and with the deterioration of the investors' confidence in the financial and economic system.

The last variable retained is the foreign currency credit to GDP ratio. As we have previously seen, the ratio between non-governmental credit in domestic currency and the GDP represents an indicator which describes the financial system development, a higher financial intermediation level and a stable financial system. On the other side, the foreign currency credit represents a vulnerability indicator. If its growth rate exceeds the economic growth rate, the situation may amplify the financial crisis. An excessive credit activity demonstrates that the banks assume higher risks without analyzing in detail their implications.

At a first glimpse, the econometric exercise can appear limited because, as we mentioned before, the financial stability represents a multidimensional concept, which depends not only on the macroeconomic context, but also on the institutions' soundness, on the system's reformation or on the prudential surveillance quality. That is the reason for which we included, in the initially tested equation, some variables whose role is to point out these aspects. The tested variables which proved insignificant, reason for which they were left out from the final equation, were: the interest rate EURIBOR at three months, the *spread* between ROBOR at three months and ROBID at three months (*Romanian Interbank Bid Rate*), the growth rate of the foreign currency nongovernmental credit, a *dummy* variable to underline the financial system's reform starting with 2000 and another *dummy* variable to highlight the impact of adopting the inflation targeting strategy and of the managed floating exchange rate starting with 2005.

Before the estimation of the equation, we present the results of the tests which look for the stationarity of the variables. To obtain more precise information, we have used three different tests: *Augmented Dickey-Fuller* (ADF), *Phillips-Perron* and *KPSS*. As it can be observed in Table 2, the AFSI is stationary in difference – the ADF test indicate a unit root, fact also confirmed by the KPSS test. All the other variables present a unit root. Consequently, in order to obtain a valid and precise relation, we express these variables in difference.

Table 2: Unit root tests and stationarity tests

Variables	ADF level	ADF difference	PP level	PP difference	KPSS level	KPSS difference
Null hypothesis	Unit root		Unit root		Stationarity	
AFSI	0.53497	-1.41333	-0.01855	-8.04883***	0.19018***	0.21822
robor3	-4.7833***	-6.3722***	-5.5277***	-17.923***	0.17878***	0.50000**
gdpgr	-2.7715	-4.8991***	-3.1703***	-12.453***	0.12663**	0.13044**
fccgdp	0.11952	-4.60741***	-2.85180	-9.63376***	0.22232	0.11954**
bet	-0.26241	-5.78957***	-0.39351	-5.91846***	0.15650***	0.16703***
(*) (**) and (***) indicate the rejection of the null hypothesis at 10%, 5%, respectively 1% *(t-statistic).*						

The final equation became:

$$\Delta afsi_t = c + \alpha * afsi_{t-1} + \beta * \Delta fccgdp_{t-1} + \delta * \Delta gdpgr_t + \gamma * \Delta robor3_t + \lambda * \Delta bet_t + \varepsilon_t \qquad (8)$$

where: *afsi* is the stability aggregate index, *fccgdp* is the foreign currency credit to GDP ratio, *gdpgr* is the GDP growth rate, *robor3* represents the interbank market interest rate at three months and *bet* is the Bucharest stock exchange index.

An autocorrelation problem can arise because we retained among the explanatory variables the GDP growth rate, as well as the foreign currency credits to GDP ratio. Consequently, we chose to insert, as explanatory variable, the endogenous variable's first lag to remedy this autocorrelation problem.

The results of the econometric estimation are presented in the following table.

Table 3: Econometric results

Dependent variable: $\Delta afsi_t$		
Explanatory variables	*Coefficient*	*Standard deviation*
c	0.046571***	0.017105
$afsi_{t-1}$	-0.071210**	0.028526
$\Delta fccgdp_{t-1}$	-0.090959***	0.031621
$\Delta gdpgr_t$	0.001455*	0.000862
$\Delta robor3_t$	-0.000546**	0.000244
Δbet_t	0.009649**	4.67E-06
R^2	0.412450	
DW	2.459714	
Observations	44	
*, ** and ***, mean statistic relationship significant at 10%, 5%, respectively 1%		

Most of the estimated coefficients are significant. The economic growth rate coefficient is significant only at 10%. This situation can be explained by the fact that the GDP

volatility was high at the beginning of the analyzed period. In addition, the last observations indicate at the same time a drop of the AFSI values and a relatively high economic activity.

The coefficients' signs are those expected and the model's explanatory power is good ($R^2 = 0,41$) taking into account the small number of observations. At the same time, it is obvious that other factors influence the financial stability. The coefficient's sign of the AFSI first lag shows that the stability's trend is not "explosive"; in other words, the aggregate index growth (decrease) follows after the AFSI growth (decrease), but of smaller amplitude.

Having in mind the stationarity tests ambiguity, we analyzed the model's errors' behaviour in order to check the tests validity. The residuals have a normal distribution and they are independent according to the Durbin-Watson and Breusch-Godfrey test results. The White test certifies the fact that the model's errors check the homoscedasticity hypothesis. On the other hand, Phillips (1986) demonstrated that, for the residuals which are not stationary, the common testing techniques can not be used because they lead to results and interpretations which are not relevant. The results of the stationarity tests we performed on the model's errors show however that the econometric test is correct (Table 4).

Table 4: Unit root and stationarity tests for the equation residuals

Variables	ADF level	ADF difference	PP level	PP difference	KPSS level	KPSS difference
Null hypothesis	Unit root		Unit root		Stationarity	
residus	-4.8643***	-8.4575***	-8.5243***	-40.871***	0.10985***	0.126743**
(*) (**) and (***) indicate the rejection of the null hypothesis at 10%, 5%, respectively 1% *(t-statistic)*.						

5. Financial stability level forecasts

Finding a valid econometric relation between the AFSI and a group of macroeconomic variable gives us the possibility to perform a forecasting exercise in order to assess the future stability level of the Romanian financial system. If we know the forecasted values for a part of the independent variables, it is possible to forecast the dependent variables values (AFSI in our case), for the same period. In this context, the data advanced by the European Commission represent the basis of the forecast exercise in respect to the GDP growth rate and to the interest rate on short term (the data related to the interest rate were obtained on an annual basis and were transformed into quarterly data using the linear interpolation). We have applied a specific equation for each of the other series – foreign currency private credit to

GDP ratio and BET – in order to extend them. We have expressed their values based on a constant, on the first lag of endogenous variables and on a series of explanatory variables (the foreign currency deposits to GDP ratio for the credits and the potential GDP calculated with the HP filter for the BET index). An error correction model was used for the credits and a GARCH (1,1) model for the stock market index.

Finally, we have used a stochastic simulation model[3] (50.000 iterations) to forecast the AFSI values, based on three equations[4]:

$$
\begin{cases}
afsi_t = c + \alpha * afsi_{t-1} + \beta * \Delta fccgdp_{t-1} + \delta * \Delta gdpgr_t + \gamma * \Delta robor3_t + \lambda * \Delta bet_t + \varepsilon_t & (9) \\
fccgdp_t = fccgdp_{t-1} + \varepsilon_t & (10) \\
bet_t = bet_{t-1} + rcpibhp_t + \varepsilon_t & (11)
\end{cases}
$$

A stochastic simulation relies on repeated random sampling to compute the results (it is generally known as a Monte-Carlo simulation). In contrast to the deterministic simulation, where the inputs to the model are fixed at known values and a single path is calculated for the output variables, in the stochastic environment uncertainty is incorporated into the model by adding a random element to the coefficients. A temporary series is created for every endogenous variable in the model which is solved repeatedly for different draws of the stochastic components of the model.

Furthermore, for models which contain lagged endogenous variables (our case), these variables can be bind to either the actual historical data – a static forecast, or to the values solved for in previous periods – a dynamic forecast. A static solution is typically used to produce a set of one-step ahead forecasts over the historical data so as to examine the historical fit of the model. A static solution cannot be used to predict more than one observation in the future. A dynamic solution is typically the correct method to use when forecasting values for several periods in the future (a multi-step forecast). This last solution was chosen in our study.

So as not to limit our analysis to the macroeconomic data forecasted by the European Commission (the base case scenario), we have built two other scenarios. In the worst case scenario, we have used the EBRD data for the GDP and the ING forecasts for the interest rate. The best case scenario was constructed based on the IMF statistics - *World*

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[3] A stochastic simulation model was also used by Hostland and Karam (2006) for the assessment of external and public debt sustainability and by the Rouabah (2008) for the forecast of the Belgian banking sector vulnerability.
[4] We have eliminated from the equation (11) the variable "foreign currency deposits / GDP" because its coefficient was not significant. The constant for the equation (11) and (12) was also non-significant.

Economic Outlook Database. All these data were transformed in quarterly data by means of linear interpolation. The data were extracted in October 2008, when the pessimistic forecasts were not so sever. At the beginning of 2009, the economic climate deteriorated furthermore and these scenarios can be considered as optimistic at present.

The results of the model are presented in Figure 3. According to the three different scenarios (base case, worst case and best case scenario) and to the international financial institutions forecasts, the AFSI values will have the following tendency:

Figure 3: The AFSI forecasted values – different scenarios
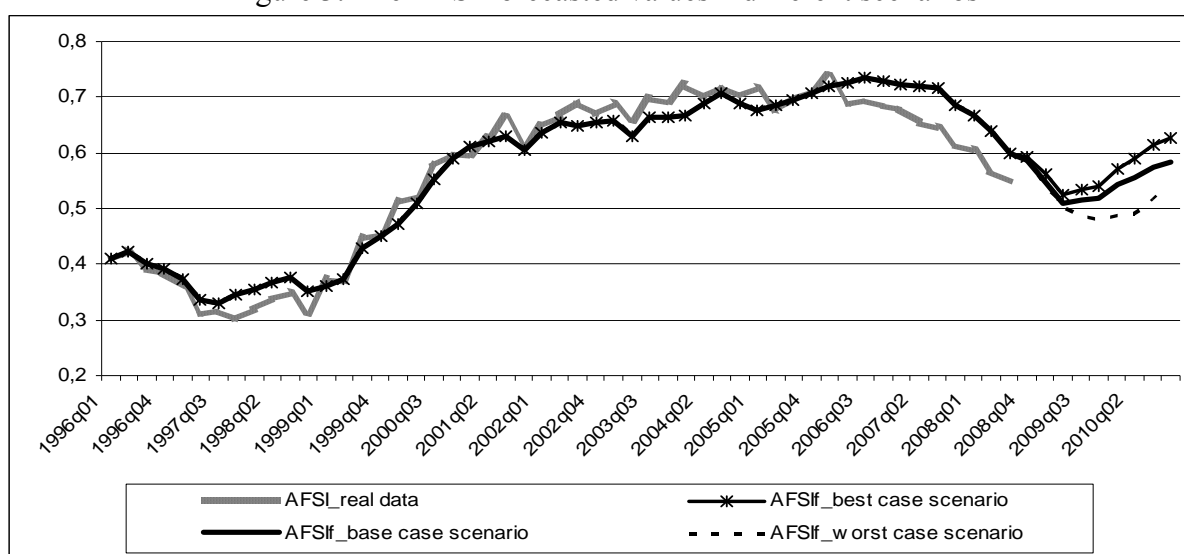
The previous figure highlights two main conclusions. First, the forecasting model is accurate, reflecting the historical data trend. However, in the second half of 2007 – first half of 2008, the forecasted values no longer reflect with the same preciseness the real data. This can be explained by the fact that the economic growth in Romania remained relatively high, despite the crisis appearance.

The second conclusion is related to the sharp reduction of the AFSI in 2009. Practically, these values are as small as those registered in 2000, when the Romanian financial system was in the middle of a reforming process. This finding reflects the severity of the actual financial crisis. According to the forecasts obtained in the fall of 2008, an amelioration of the AFSI is possible in 2010, but we must remind the fact that, in the meantime, a deepening of the crisis occurred and our forecasts can be thus considered as optimistic. Romania recently concluded a borrowing agreement with the IMF, European Commission, EBRD and European Investment Bank.

5. Conclusions

The construction of an aggregate financial stability index represents one of the methods which can be used to measure the systemic financial stability. The AFSI is meant to supplement the early warning systems which allow to evaluate the probability of financial crisis appearance, but also to supplement the stress-tests, that show the system's resistance to possible destabilizing shocks.

The AFSI advantages reside in the calculations' simplicity, data's accessibility and appropriate transparency level. This index provides the analysts with the possibility to compare different financial systems in terms of stability and also allows them to observe the financial stability dynamics. The inconveniences, or rather the deficiencies, of this method are of a similar importance. It is difficult to exactly predict the probability of a crisis appearance or to measure the system's capacity to withstand potential shocks.

The technique which is based on the calculation of an aggregate financial stability index, even if simple at a first view, is not arbitrary. Several steps need to be followed: selection of individual indicators, selection of the method for their normalization and identification of a weighting method (which relies on the retained criteria and on the established weights). The individual indicators' selection depends on the system features, but also on the data availability. The weights are given by the importance assigned to each individual indicator within the structure of the aggregate index.

We have built in our study an AFSI for the Romanian financial system, a system where the banking sector prevails. The individual indicators refer to the system's development level, to its vulnerability, to banks' soundness and to world economic climate – different financial stability dimensions. The major contribution of the paper consists in the identification of Romanian financial system turmoil by means of an aggregate stability index. Another contribution of the study is the introduction within the aggregate index of some indicators such as world economic growth ratio or perceptions of the business climate at international level. The last important contribution of the study is a forecast exercise based on the aggregate index, using a stochastic simulation model.

The achieved results show an improvement of the stability level of the Romanian financial sector, starting with 2000. A clear degradation of this index during the crisis period (mainly in 1998, but also in 2001 and 2007) can be observed in the analysis of the AFSI evolution. The econometric validation of the AFSI shows the influence of the macroeconomic variables upon the financial stability level. In this context, a further deterioration of these

variables in the context of the crisis will lead to a sharp reduction of the financial stability level.

The following analyses will focus on a more accurate identification of variables which provide the most significant information about the stability level and will test the index capacity to detect the financial turmoil in other financial systems. A slight adjustment of the index components must be performed, depending on each financial system structure or on the available data.

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