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MULTI CRITERIA FORECASTING FINANCIAL BUBBLES BY NEURONAL APPROACH

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Abstract
Over the recent decades the complexity of financial decisions has increased rapidly, highlighting the importance of developing and implementing sophisticated and effective quantitative analysis techniques to support and help the financial decision making. Assistance in multidimensional decision provides financial managers and analysts making a wide range of methods, which are well adapted to the complexity of the financial decision problems.
The purpose of this document is to provide an in-depth presentation of contributions in the field of finance, focusing on the neural network method as an appropriate tool for forecasting financial bubbles. Indeed, we test a sample of countries in the appearance of the phenomenon of financial bubbles over a period of 13 years by connecting a set of structural variables presented on several dimensions.
Keywords—Forecasting Financial Bubbles, Neuronal Network, Decision Making.

1. INTRODUCTION

During the last decade, with the deregulation and liberalization of international capital movements, financial markets have evolved in a spectacular way. This move comes after a multiplicity of crises in different markets. Among the various interpretations of crisis is the 'bubble' phenomenon, which is the resulting of phenomena that inflate the values in a particular sector. Their forecasting are even so difficult and economists must take it into account and must model a variety of heterogeneous behaviour. Thus, if all may see market growth and recognize the presence of a financial bubble in the market, we can avoid a possible crisis. in this context, several methodologies have been taken only during the last decades, seeking to identify major and dynamic components leading to the risk of bursting bubbles and thus prevent the situation.

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In the general sense, the bubble is defined in several ways. We can first, be regarded as an overestimate of an asset from its fundamental value. It is then synonymous with a rapid increase in prices in the financial markets, because artificial unrelated to the real value of the underlying assets, and followed at some point by the sudden return (crash) to price more close to the equilibrium asset value. Swelling prices may be due to irrational behaviour of financial players 'amateur' [Adam M.Ch. Szafarz & A. (1989)] **[1]**. Specifically, the bubble phenomenon is a highly significant increase in the price of an asset or group of financial assets (stocks, bonds), real estate or commodities, in a continuous and autonomous process. The initial rise leads to expectations of future increases which in turn attracts new investors in the markets. Rising prices then feeds itself. The increase "irrational" is progressively disconnected from the state of the real economy. The expected returns on assets are then based primarily on the expected gain of resale. The financial bubble is most often followed by a reversal of expectations and a sharp fall in prices that can sometimes accompany a financial crisis. The crisis is characterized by an adjustment phase and return to fundamental equilibrium price.

The economic literature offers many theoretical and empirical studies of asset bubbles but it leaves each time a number of issues, in fact, they did not allow studying the reaction of international investors holding account the information available on the markets. In this study, our aim is to provide a model for forecasting financial bubbles. this model is to relate a set of determinants or criteria dictating its multidimensional nature and also take into account the preferences of the financial actors.

2. LITTERATURE REVIEW

The most used of the forecast financial bubbles studies is to understand the causes of past crises to then derive an estimable econometric specification (in reduced form or not) to predict the occurrence of such events in the future. Indeed, there is now a very large number of studies intended to demonstrate the presence of permanent structural changes and the existence of asymmetries in the dynamics of the main macroeconomic and financial aggregates.

Although many studies have been initiated on the financial market to detect and prevent the existence of asset bubbles, they do not allow to surround all dimensions and variables or because of market complexity and the interdependence between its different determinants. Thus, all markets are imperfect and prone to failure. Financial markets are more likely than others to fail because they are infested with three particular flaws: asymmetric information, mass behaviour and panics that feed on themselves. Unstable financial flows often lead to the emergence of speculative bubbles and therefore attacks. Indeed, the models of rational and irrational bubbles have been criticized because they did not allow studying the reaction of international investors given the information available in the markets. For example, for the descriptive approach, all models "have bubbles as exogenous phenomena relative to the fundamental values and recognize them any possibility of reconstruction after dismantling." So, these models certainly succeed to some extent in spreading trends of long-term price, but they certainly do not allow to predict the short-term and even to explain the expost variations.

As for the econometric approach wish explain the dynamics of short-term price and to better anticipate critical macroeconomic variables. But there is very little evidence about its ability to predict the behaviour of bubbles. From a methodological point of view, this approach has certainly helped to qualitatively analyze the links between the dynamics in action during the crisis, is only an ex-post analysis instrument phenomena. Furthermore it is limited in scope when the magnitude of change is strong. The reliability of results is questioned as soon as the disturbance is particularly marked.

The regime change approach allows testing the contagion and interdependence between financial markets. Thus, it allows to study the predictive performance indicators of financial activities and to identify the state of the market for investors. However, it remains an expost analysis of identification of the financial turmoil and the source of changes in asset prices. Indeed we noted a low probability of success of these theories and this is because of deficiencies related problems of macroeconomic models in the explanation of prices on the financial markets.

In the international context, these approaches are not always appropriate measures fully incorporating all criteria that investors consider in an investment decision. Indeed, several important aspects, which may affect the expected performance of these portfolios, may not be explicitly taken into account by the mean and variance. Therefore, the traditional measures that are used in markets are unsuited to catch the bubbles in all its dimensions [Maillet and Michel (2002)] [16].

All these reasons confirm that the bubble detection must be evaluated by a multidimensional approach. This approach, based on the simultaneous observation of several time scales and criteria, has the advantage of understanding the most standard indicators, taking into account the dependence of the characteristics of financial time series with the observation frequency and provide a consistent measure of risk on all investment horizons.

3. METHODOLOGY SPECIFICATION

The most used of the forecasting financial bubbles studies is to understand the causes of past crises for then derive an estimable econometric specification (in reduced form or not) to predict the occurrence of such events in the future.

We proposed a structure based on neural networks that can be perfectly adapted to the resolution of this problem. This is justified as much for reasons often cited in the literature as the properties of these connectionist models: specialization, generalization and sparingly. It consists of determining the synaptic weights of the input criteria from the available data. In general, the relationship between these parameters is very complicated.

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In our case the anticipation in the financial market of the speculative bubble is approached as a supervised classification problem (type) with two classes: the "no bubble" class and the "existence of bubbles" class. To build a forecast relating to the given phenomenon, we must have examples of each class, previously labelled as "existence" or "no." So, the classifier is built with a training algorithm. If this training is done correctly, the model is able to estimate, for each new data, the probability of existence in the relevant market (weight criterion or coefficient). This method took three steps. The first is the data mining; the second is the learning that has allowed us to find the optimal network configuration so that the forecasting error was lowest. The last part is to predict the bubble for a given horizon from previously calibrated network.

Data analysis (the selection and preparation of data samples) is necessary in the development of neural network processes. For an entry presented to the network, it is fit a specific target (binary value bubbles). The weight adjustment is made by comparing the network response (output) and the target until the output is the best for the target. A brutal method is to try all possible configurations. Many optimization techniques exist, more or less rapid, efficient and intensive memory. To overcome this difficulty, in our study, we used the algorithm of gradient back-propagation related to Levenberg Marquardt allowing the use of conventional methods of optimization in specific cases of multi linear Perceptron MLP. It provides an equivalent result which requires very less time calculation. We start with a simple network type "Multilayer Perceptron" with one hidden layer. The activation function is the standard sigmoid and the weights of the neurons are optimized by the gradient back-propagation algorithm. The neural network minimizes the mean squared error (MSE). The training will stop when the MSE does not decrease or when we achieve miles iterations. For Neural Network, the number of hidden neurons is proportional to the number of input layers (overestimated in the first sorting). A good generalization is to find the minimum number of hidden neuron that can solve the problem.

The choice of samples is a crucial step that determines the type of the appropriate network which solves this problem. The sample presentation affects several elements, such as the type of network, the number of cells- input, the number of cells-output, and how it will conduct the training, testing and validation. In this context, we apply this approach to resolve the problem of forecasting financial bubbles on a sample of countries consisting of emerging countries, developing and developed countries. The training base is formed of desired input and output variable. A series of financial data on these countries has been collected over a period of 13 years and 17 financial variables were calculated. These will serve as input variables for the neural network model. In the following time, we present the distribution of the countries in our sample about 13 years depending on risk class and the size.

So, we will lead a decision aid for financial actors and stakeholders. It is a medium that they react given their preferences. The neural network that we have chosen is a PMC with 17 criterions -inputs and one output. The learning stopped after 1000 iterations.

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Method	Multi layer Perceptron (MLP)
Input PE	17 criterion
Output	1 (bubble)
Input optimisation	Genetic Algorithm
Input Projection Algorithm	None
Read from existing File	Train =60%, cross val= 30%, test= 10%
Transfer function	Sigmoid Axon
Learning Rule	Levenberg-Marquardt
Max Epoch	1000
Learning rate	0.15
Max error	0.01

TABLE I. NEURAL NETWORK PARAMETERS

4. DATA AND RESULTS

The first method is to choose low-frequency periods consistent with the fundamental data (annual or quarterly) and to construct indicators that have this periodicity, from the data of high frequencies, relating to the existence or not of a crisis financial. The second method is to use direct or indirect information daily changing fundamentals. This statistic the periodicity of data obviously refers to an economic problem background. Given that the average values of financial ratios change over time, we have not chosen a very long time. We chose to reduce the field to 13 years horizon (1999-2011). We must also consider special years that could disrupt the model as the period of the technology bubble in 2000, the subprime bubble that burst in 2007 or liquidity crisis.

By following this procedure, we are building a heterogeneous sample of 30 countries (emerging, developing and developed) exhibiting strong similarities in terms of development and grouped by continent (Middle East, Africa, Asia, America, Europe). Then we introduce into our analysis of specific variables phenomena bubbles we analyze their effect on the financial market.

Our choice is focused on the architecture to 3 hidden layers and the number of neurons per layer is [2 4 3]. The MSE is minimum of 5.06 x 10-3. This structure will ensure a good generalization on new data. The overall performance presented by this network is 97.53%. The confusion matrix shows that our neural network presents interesting results which the error rate is 2.19%. It presents a good compromise between learning and test performance. Thus, the model correctly classified the major part of the country on learning data and the test data: CT_{entr}=97.53% and CT_{test} = 97.05%. Furthermore the condition of the proximity of learning outcomes and the test is satisfied: CT_{entr} - CT_{test} = 0.48% >0 is minimal.

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Method : Multi layer Perceptron (MLP)							
Architecture				[2 4 3]			
Error rate train				0.02191			
Error rate test				0.02028			
CT_{TRAIN}				97.53%			
CT_{TEST}				97.05%			
Global Performance				97.53%			
Confusion matrix test				**Confusion matrix train**			
	Bubble	***no bubble***	***Sum***		***Bubble***	***No bubble***	***Sum***
Bubble	0	1	1	***Bubble***	0	5	5
Pas bubble	0	33	33	***Pas de bubble***	0	198	198
Sum	0	34	34	***Sum***	0	203	203

TABLE II. PERFORMANCE OF OPTIMUM ARCHITECTURE

From the optimum network determine, we deduce essentially the values of connections corresponding to an optimum obtained on the learning and the test sets. The execution of the neural network software in our sample allows us to provide financial bubbles several times in the financial market. The results obtained by our neural network are always flexible behaviour of decision makers (their expectations and desires, whether short term or long term). Forecasts were selected to perform over 5 years.

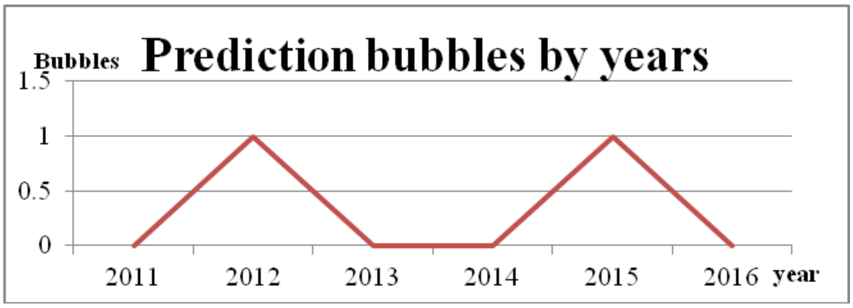

Fig. 1. Forecasting of bubbles by the RN over 5 years

Our model therefore provides an accumulation of speculative bubbles in the financial market in general for the years 2012 and 2015. We took apart every year to determine risk countries (bubble).

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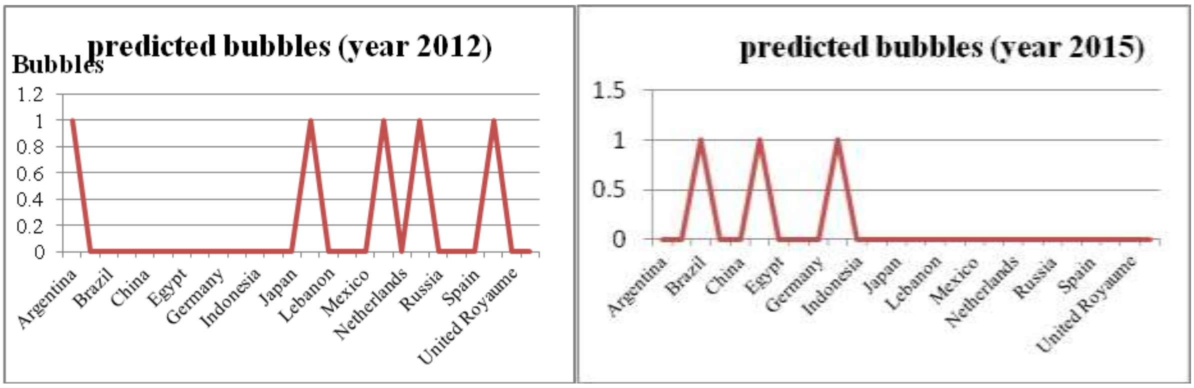

Fig. 2. Forecasting of financial bubbles by RN- year 2012 and 2015

The network follows the evolution of the series of bubbles after discovering the relationship between inputs and outputs. The MSE = 3.4 * 10-3 and the error rate is 21.24%. Consequently, this neural network MLP [17-2-4-3-1] is able to generate weekly forecasts bubbles. So for 2012, the countries Argentina, Jordan, Morocco, Romania and Tunisia represents an accumulation of bubbles and therefore a risk of crises that we must intervene to avoid maximum (by regulation, regulation). Similarly, for the year 2015, countries like Brazil, Denmark and India represents an accumulation of bubbles and therefore a risk of crises.

5. CONCLUSION

The main objective of this research was to develop a forecasting methodology of speculative bubbles by the neural network. The focus is mainly concerned with multilayer Perceptron networks. The results obtained on the basis of a series of annual observations covering the period 1999-2015 show that this technique seems well suited to the problem of forecasting bubbles to an entire country.
This technique has detected a model that has a great ability to track the state of the financial market (or no risk) and provides better performance in terms of predictive power. Indeed, the neural network allows considering the existing interaction between the different ratios used in the study and through the network of interconnections.
In terms of results, the neuronal network offer many types of results: It predicts and detects bubbles according to the space (countries affected) and time (year of detection short and long term) factors.

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