The Efficiency of Financial Markets by Non-Parametric Models: Artifcial Neural Networks

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***Abstract*– The efficiency of financial markets, the basis of the modern theory of portfolio. However, new techniques from some of the physics research, provide new perspectives. The object of this article is to briefly introduce the hypothesis of market efficiency (HEM) and show interest may have these techniques in finance. In this paper, we use a non-linear models (MLP) to study the fficiency of Tunisian financial market.**

***Keywords*– Informational Efficiency, Artifcial Neural Networks (ANN), Multilayer Perceptron (MLP) and Financial Crashes**

I. INTRODUCTION

Into the field of finance, to predict the future returns of a credit is of course an obstacle of first importance for the operators. If somebody can know in advance the return which will take on a title, even with a credibility and a limited precision, It can exploit this information to invest with its best profit. But in reality, to produce this kind of information is far from being as simple.

The definition of efficiency has changed since the first work of Fama. It is less strict today and authorizes certain forms of predictibility. The robust statistical tests make it possible to highlight certain trends of evolutions of the return of the financial titles. Initial efficiency, one evolved to an efficiency meaning impossibility of obtaining a substantial profit. There is contradiction besides: Challenging efficiency, it is to call into question the whole of many modern work which is based on this theory. This is why the conclusions of the researches undertaken in this context, remain moderate.

Edgar E. Peters (1996), the assumption of efficiency of the markets is strongly related to the theory of random walk. Indeed, the form most generally used efficiency of the markets supposes the independence of the past and the present returns : the trends of prices of the actions are due only to the taking into account of information not yet published or envisaged, and thus do not depend on past returns. Several techniques were developed to try to modelize the financial series. Among these techniques, the model of Gaussian random walk became one of the pillars of modeling in finance. This model is suitably robust and general that to be able to apply in any series. In practice, the financial operators know that the market has much more than an only behavior. This phenomenon seems in conflict with the financial methods of modeling, and in the first time with the hypothesis of Gaussian random walk. These observations would empirically explain the utility to examine complex models, the nonlinear models able to modelize various dynamic .

The asymmetry of the financial series can be a sign of the presence of non-linearity in the process of evolution of these series. However, the linear models can generate only one symmetrical behavior of the series and cannot thus give an account of the phenomenon of asymmetry. The nonlinear models can thus enable us to reconcile the concepts of asymmetry and non-linearity.

The linearity constitutes a restrictive hypothesis to be able to describe events such as crash and the strong variations characteristic of the typical turbulent periods of the stock markets. It was considred as an hypothesis which restricts possible dynamic of the economic cycle.

II. NETWORKS OF THE NEURONS ORIGINS AND EVOLUTIONS

Several work tried to explain the very strong persistence of the deviations of the prices of the financial credits. These studies distinguished several limits preventing the price from a credit from fixing itself in the vicinity of its value of balance. These limits are a diversity of a physical nature (costs of transport), legal (prohibition for an investor to pass from the orders of transaction on other markets) and commercial(trade policy). The existence of these limits makes the study of dynamic financial series difficult by standard linear models and let's think of the nonlinear models. The class of the nonlinear models appears relevant to explain the irregularities noted in the evolution of the financial series. It takes account of the presence of the costs of transaction, the existence of behaviors and heterogeneous reactions, of the phenomenon of asymmetry between the phases of a cycle, excessive variability of the financial series and the effects of rigidities of the prices. The assumption of the efficient market supposes that the stock exchanges follow a random walk, primarily driving with the conclusion which the future price is completely unforeseeable on using the available information. Some authors call into question this assumption of random walk Gencay (1996-1998) found that to employ a moving average is successful with the forecasts of exchange rate than a model which supposes exchange rates follows a random walk. The assumption of the efficient market predicts that advantageous occasions are entirely exploited

as soon as they occur do not continue to exist. The obviousness exists which indicates that the assumption of the efficient market is not a precise description of the market, Pesaran and Timmermann (1995) showed that when the volatility of the market is high, the outputs of the actions are foreseeable. Campbell (1987) proved that the structure of term of interest rate can be employed to envisage excessive outputs of the actions. Lo and MacKinley (1988) use estimators of dissension to show illogical random model of walk.

Moreover, the assumption of the efficient market is insufficient to support the existence of the technical analysis that the assumption suggests that there should be no value by looking at historical data and variables to try to predict the movement of share price since no new information is contained in historical data. The investors still continue to seek systematically to exploit the inefficiences and the deviations at the market to create wallets with a performance which exceeds the performance of the market. The trick is to identify the inefficience and to exploit it before it disappears. While seeking to carry out greater levels of exactitude, the investor searches the new quantitative methods of prediction to compare with the methods currently used. There is a variety of methodologies which appeared in the literature which was employed to envisage the movement of exchange the stocks Jorion (1995) found that models "the implied standard deviation" are more valid in the prediction of volatility on the foreign exchange markets than of the models of time series.

Hutchinson and al, (1994) announce about the study of networks of neurons (ANN) as will perceptrons multi-layer is valuable when the parametric methods are inalienable. The networks of neurons are conceived to imitate organisational competences of the human brain. We learn the network presenting from the data of sample like entries and by changing the weighting factor in the algorithm which determines the corresponding outputs. ANN is also proved to be a variable tool to discover models at the financial market, which can then be employed to envisage the future movements of the prices. As noted Sharda and Patil (1992), ANN is a promising choice with the prediction of time series. IQ and Maddala (1999) found that the forecasting models of excess of output are improved by not imposing a linear structure on the model; the networks of the neurons allow predicts based on nonlinear model was employed successfully in the prediction or the studies of forecasts in all the functional spheres of activity, including accounting, Lenard (1995), finances, Trippi and Turban E. (1996), of the management information systems, Zhu and al (2001), marketing, Papatla and al. (2002) and the production control, Kaparthi et al. (1994). In a study of comparative analysis, Bhattacharyya et al. (1998) and Jiang and al (2000) found that ANN consists more powerful indeed it is more precise with the forecast or the prediction than other traditional and quantitative methods. In most these applications, of the networks of neurons exceeded traditional and statistical models, as the discriminating analysis and ofregression, Zhang and al (1998).

III. ESTIMATE OF THE PARAMETERS OF MODEL MLP

The networks of neurons can be seen like a tool making it possible to achieve nonlinear regressions. This technique resulting from the Artificial intelligence consists in miming the behavior of the neurons and the synaptic connections to imitate a training. Thus it appears very interesting if we want a system learns how to recognize forms("patterns") having already had course on the financial markets, because we will then be able to predict what is supposed to arrive right afterwards. This technique is developed so much that programs are sold making it possible to put at the work . This kind of models without intervening in the adjustments of the engine(stages of "tuning"), They are essential, but they require a perfect knowledge, and in particular a good experiment relating to asignificant number of case. The next step in our work is to estimate and identify a multi-layer perceptron (MLP) and to check if non-linearity improves or not the results got before with the entropy of Shannon in the second chapter. The networks of neurons are more and more studied in research. Thanks to their capacity to predict, memorize, learn, decide, and reason the complex problems as their mechanisms of training are based on the parallel treatment of information. For that, various architectures and techniques of trainings were proposed and treated in the literature in order to solve several problems in particular to predict the stock exchange course

A) Principle of the artificial neurons

The artificial neuron is a small statistical model which must achieve two tasks : i) The synthesis of information which is provided to it, ii) The change (often nonlinear) of this information into certain thing again. Why the artificial neuron is a model ? Tenons a linear regression: The entering information(values of the explanatory variables) is combined with weights (coefficients of the model) then transformed (with identical) to produce an answer which is the value predicted by the model. The coefficients of the model are calculated in order that the provinding values are as close as possible to those discussed.

The behavior of the artificial neuron will be rather comparable: it will seek to assemble a coefficient associated with each entering information (we are talking about synaptic weight) in order to decrease a function of error. The modification carried out at the time of the second phase can use any mathematical function or almost. The unlike weights, this transfer function (or activation) is selected in advance: it belongs to the architectural choices. The phase where the synaptic weights will be transformed to see a minimum of this function of error names the phase of training

B) Tests of stationnarity

The stationnarity of a series is a requirement in any procedure of a model's estimation to prove that this latter is a representative of the studied phenomenon. To

apprehend or not the stationary character of series of profitabilities and indicators of feelings, it is necessary to use the two tests of unit root: the test of Dickey and Fuller Augmented (1981), and the test of Philipp Perron (1987) to avoid the erroneous estimates. In Table 1, we have the results of Dickey-Fuller Augmented, Philips-Perron (PP) tests of unit root and Kwiatkowski, Philips, Schmidt and Shin (KPSS) test of stationnarity. Tests ADF and PP without any doubt reject the assumption of root unit for all the output smonthly of index TUNINDEX. Therefore, the series of output do not have long-term memory. For the test KPSS, the results show that we cannot reject the worthless assumption of stationnarity on a significant level of 1%.

Table 1 : Racine unitaire, stationnarité et analyse de la mémoire à long terme

ADF	-7.109571
PP	-7.102543
KPSS	0.151428 $\{< 1\}$

C) Forecast of return

Graphics (1) present the desired series (reality) and the series of network of neurons(MLP) of the final Model selected to a hidden layer with ten units and the function of sigmoid activation. The estimate of the MLP gives the following results represented in Fig. 1.

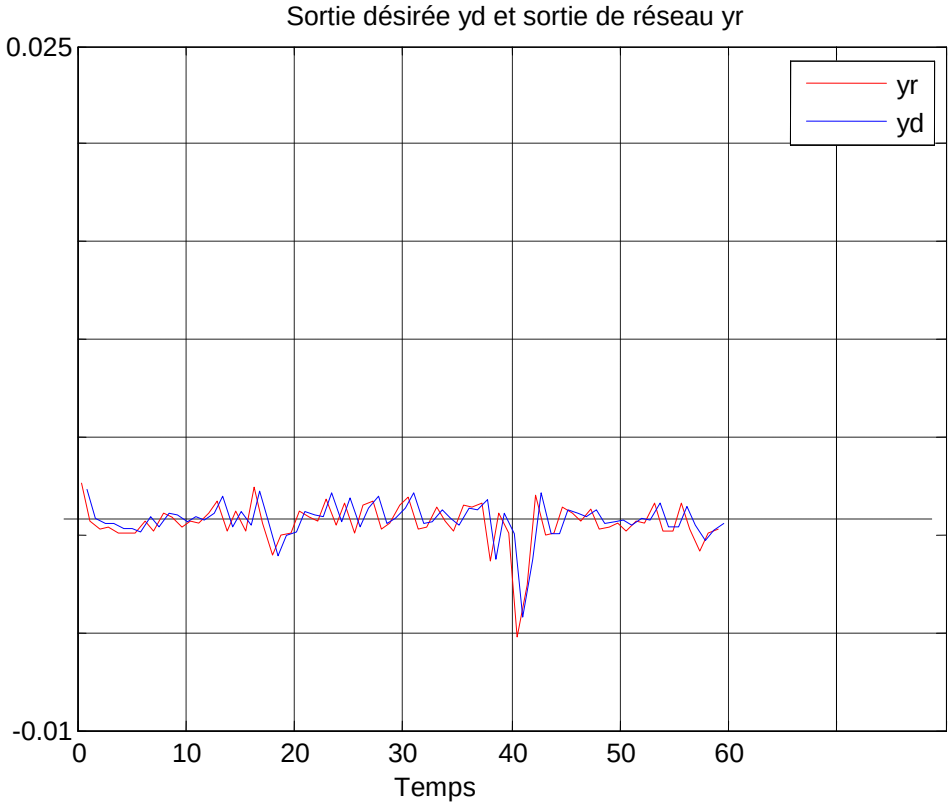

Fig. 1: Comparison between the desired series and provisioned by MLP

We note that the MLP model happens to predict the price is that we can conclude the existence of periods of inefficiency. The assumption of the efficient market supposes that the stock exchanges follow a random walk, primarily driving with the conclusion that the future price is completely unpredictable is using available information. about the forecasting quality what interests the forecaster is to predict variation of the stock index, which calls on the disputes around the efficiency or the inefficience of the stock market. To the extent that a market is efficient, it is impossible to carry out forecasts. Or it is difficult to demonstrate that a market actually is. However, it is easier to demonstrate it is not efficient. In our case, the forecast of output starting from their historical values is feasible and relatively reliable. What indicates that the Tunisian stock market is inefficient and presents some anomalies. Hellara, (1998) confirmed this result by a study carried out on this market. Consequently, the presence of anomalies consolidates the inefficience of the stock market. The anomalies are united with the micro-economic behavior of the various speakers. Among them, one could quote: techniques of cover available, irrationality, competing intensity, the existence of destabilizing

speculators, asymmetry of information, imitation or seasonal variation, crises financial.

We summarize, starting from Fig. 1, we notice spades at the following dates:

- June 2008
- January and May 2010
- May and October 2011

According to the study of the studied period we note that the causes of these spades are the international financial crises, the social situation and national policy.

III. SUMMARY

In this section, we presented some basic concepts concerning the networks of neurons, their types and their fundamental properties. The second part of the section was devoted to the principles of neuronal modeling and the algorithms which it is advisable to implement for the adjustment of the parameters. The neural networks are a crucial importance in several fields. Finance does not escape the use of this kind of methods or modern technologies. It is about a tool originating in the artificial intelligence, usually employed in applied sciences (biology, physics, etc). In finance, the network of neurons can be practised for various interrogations. We could mention: the evaluation of credits, Bolgot and Meyfredi, (1999), the management of wallet, the forecast of the financial series, of exchange rate, the detection of the companies in difficulty, and the choice of strategies, Montagnon, Sexton &Smith, (2002). Pacquet, (1997), we distinguish between two essential reasoning which encourages the scholars to be interested in this mechanics: contrary to the classical statistical methods, the neural network does not pose any assumption on the variables. Also, RNA represents an instrument adapted to study complex and not organized problems, where incapacity to indicate the form of the relation between the studied variables.

The networks of neurons were employed atends of forecast by using the past of a variabl ein order to remove relations making it possible to predict its future value. Tir & Abbas, (2004) carry out a study on the Tunisian financial market and show how the neural network improves the forecasts of stock indexes. The speakers on the financial market use generally, the statistical techniques to envisage the variations of the prices of the credits. However, the relevance of these techniques is disputed more and more. That is especially due to the inefficience of the market, The anomalies and simplicities of the assumptions. Thus, to suppose the linearity of the distributions of the courses, for example , the poor results found by Gradojevic & Young, (2000); Medeiros and al. (2000) which do not have a direction. In our study, the prediction of future performance from their past values is possible and partially reliable. This indicates that the Tunisian stock market is inefficient and presents some anomalies.

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