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# A Logical Process about the Chaos in FOREX Financial Market

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**Abstract**

Foreign exchange market has been subject of studies and discussions for many years. They were created modern theories and models to understand and predict the evolution of the price of money, and embarked on new discussions and new frontiers of study.

In this paper we test the hypothesis of non-linearity and behavior chaotic the latest developments of the markets, to arrive at a solid and unambiguous conclusion on this type of dynamic systems analyzed. In particular, we introduce mathematical concepts and to study the properties of chaotic dynamics and non-linear in nature. It will delve into topics not therefore always present in economics courses in order to base the tests carried out on solid considerations from the point of view of formal mathematical. It will be followed, finally, a scientific rigor during the course of the analysis in order to give an interpretation of the results of logistic type can lead to scientific considerations different from econometric modeling.

**Key words**: Financial Markets, Chaos, Forex Market, Logic Model, non-Linearity

## 1. Introduction and Literature Review

Since the end of the Bretton Woods exchange market has always been characterized by a high degree of volatility and uncertainty that makes this system different from that of fixed exchange rates. The unpredictability of future changes over the years has generated regular interventions by the authorities that have allowed the evolution of the economic literature. Therefore, several models are created to understand and predict the evolution of the price of the currency. Among these we can cite the literature on the model of target zones (Krugman, 1991), those of rational expectations with stochastic rules of interventions by the monetary authorities (Hsieh, 1989), as well as the many interpretations offered in the literature about the non-linearity of the exchange rates (Diebol, 1988; Chinn, 1989; Meese e Rose,1991; Rogoff, 1999; Mele, 2015). Other studies, mainly concerned with the description of the dynamics of exchange rates and the forecast in the short term, they have developed in the univariate models. These works make use of the latest contributions of econometrics time series are non-linear and theoretical foundation in the principle of market efficiency. The basic idea is that if the exchange rate markets are characterized by a certain degree of efficiency, it is reasonable to assume that most of the information is contained in the most recent returns and is thus not necessary to include among the explanatory variables fundamentals cheap. Among the most frequently used models (G) ARCH) and SETAR are those who have so far had the most successful in the description of the dynamics of many economic and financial variables, because they contain a clear economic interpretation (Kräger-Kugler, 1993; Peel-Speight, 1994; Chappell et al., 1996).

In the work of Krager and Kugler (1993) are estimated for descriptive purposes but also forecasting models auto-regressive threshold for changes in the exchange rate against the U.S. dollar, the French franc, the Italian lira, Japanese yen, German mark and franc. The authors identify three different regimes, both the first and the third regime have an estimated standard deviation higher than the intermediate regime, this would be due to the interventions of the central bank in response to strong appreciation or depreciation. The analysis of Krager and Kugler is, in fact, the theoretical foundation of rational expectations monetary model with stochastic rules of interventions by the central bank proposed by Hsieh (1989); an autoregressive model with three regimes could approximate, therefore, represents the solution of this model. According to the authors, the model of Hsieh provides a more adequate representation of the system of managed floating exchange rate than the model of target zones: the central bank intervention depends in the first model to be large variations in the exchange rate, while in the second by the approach the level of the exchange rate to certain thresholds that define the permitted fluctuation bands. In order to assess the relative importance of nonlinearity in the mean and variance of the one, for the same currencies are also proposed GARCH models; the conclusions at which they reach the authors indicate that neither the models nor the threshold autoregressive GARCH models are able to adequately describe the non-linearity present in the series of exchange rates.

Despite numerous attempts to model the exchange rates in the financial markets using econometric techniques and probabilistic mathematics evolved to take account of nonlinearity and asymmetry, are still relatively limited applications performance prediction beyond the usual direct comparisons with the simple random process walk, or in some studies with simulated data based on Monte Carlo experiments (Clements e Smith, 1997, 1999). In the literature, four basic reasons have been advanced concerning the non-linear models, and because not provide more accurate forecasts than simple linear models even when the assumption of linearity is significantly rejected for the estimation period (Diebold e Nason, 1990): (i) non-linearity affecting moments higher than the average and, therefore, does not prove useful to improve the point forecasts; (ii) non-linearity present during the estimation period are due to structural changes or outliers that cannot be exploited to improve the out-of-sample forecasts; (iii) non-linearities in average even though they are a feature of the data generating process are not relevant enough to offer most of the gains in terms of forecast accuracy; (iv) non-linearity present are described by the wrong type of non-linear model. The forecasting performance of non-linear models is, however, explained by Clements and Smith (1998) and Dacco and Satchell (1999) with emphasis on the inadequacy of the measurement approach; based on a Monte Carlo study, the first argue that the evaluation of the predictions of the density function allows us to understand better the gains that can be obtained from nonlinear models, gains that are systematically masked if the comparison with linear models is conducted only in terms of MSFE.

## 2. Financial markets and non-linearity

Starting in ‘90s numerous tests have been developed to verify the non-linearity is to detect the characteristics of the presence of an effect of non-linearity: the financial chaos in a series. In this context, the S & P500 has been recognized in multiple sources and by multiple authors as having non-linear characteristics and therefore chaotic. For example, according to Peters the American market seems to be driven by a minimum of three variables, since the strange attractor of the system has size about 2.3, and has a positive Lyapunov exponent: there exists therefore a chaotic dynamics. As the American market, even the British, Japanese, and German have been studied and seem to have similar characteristics. This has given new insights for scholars to look for similar trends in related markets, but always on the basis of data in the very short term. In fact in the securities markets as in the foreign exchange markets is assumed a price based on fundamentals. These are not always the primary cause of changes in the price of the financial asset, and various models have been proposed to try to understand the dynamic processes hidden behind the price changes. The fact that these markets are non-linear shows that many of the movements of the indexes in question are endogenous. This does not mean that external changes have no influence on the data, but rather that these are not the only source of variability in the data. The theory of non-linearity could offer an interesting description of the financial market if it proves that it is realistic to assume non-linear responses of the operators to new information and new conditions of the market. The assumption underlying the traditional efficient market theory of fame rests on the assumption that investors rationally proceed to buy when the price is low and sell when it is high; the equilibrium price is therefore the best summary of expectations and lends itself to be a good indicator for the allocation of funds to the economy. Everything is seemingly credible, but it is not consistent with the perception of the operators themselves. Some recent results of "behavioral finance" that support the risk-averse behavior persists when the investor is earning, when it is in the area of loss is transformed into a subject frequently inclined to risk for anxiety to recover; it follows that the attitudes of investors, individual and professional, are different if you are in the area of profit or loss in the area and, therefore, the history of the investment - even its graphical trend - is an element that has its own importance. In particular, investments in the area of loss tend to not be mobilized into action because you want to keep the ability to remove them; so there is a psychological effect of blocking wallets in losing investments due to the reluctance to state-first of all to themselves-the error and savvy investors respond to this threat by defining from the outset with the rules of stop-loss. In addition also the investments in the area of profit are held for an excessive period; the hypothetical gains further, that would not be captured in the event of immediate sale, felt like losses and force the investor to recognize that they have not realized the gain set as a target. Therefore, investors savvy respond to this threat immediately with the rules of take profit. In an ideal world, where players are rational in the strong form and the availability of information is ensured, most of the transactions in the markets is accounted for; in a situation of this kind, in fact, the exchanges would be originated by the progress of the life cycles of investors, from changes in preferences and allocations of funds (no trade problem). In fact, it is clear that the level of trade is much higher than we should believe on the basis of the above reasons. In fact, the level of the treated volume is therefore a good justification of the hypothesis of incomplete rationality of operators and of the phenomena of psychological dependence. The analysis of the problem under a profile empirical testing on historical data have ample space on a variety of magazines, mainly at international level. Building a reality of the available results is not easy, since in many cases the results are conflicting and are based on methodologies do not fully "mature" and, for this reason did not adequately powerful. In any case, the attached table may suggest to the reader some interpretations of these tests, in order to develop a opinion about it. The modeling of the financial market can be done in different ways methodology: first, for it can be assumed that the relevant economic relations are linear and that to them is accompanied by a certain level of noise, ie stochastic elements; Alternatively, one may think that the reports are non-linear in the absence of stochastic elements; alternatively you can use, too, but a non-linear modeling with significant stochastic elements. It 'clear that the winning line of interpretation may perhaps be the third, and probably not the second can be found in empirical data.

## 3. A computational model for chaos

In traditional approach the complex systems are treated analytically, ie reducing the linear combination of simpler elements. In this situation a classic linear relationship is that of Hook's law:

$$y = ax + b$$

where (y) is the length, and (x) is the force applied that adjusts the spring force. When the elasticity disappears, stretching the very springy, the graph ceases to be linear. The system is no longer linear, and shows in certain circumstances a sharp change in comportment. In nature, many systems are linear or approximated to linearity, and thanks to the Fourier transform for which every mathematical function can be periodic represented by a series of

pure sine waves, it has come to the modeling of many natural phenomena. Now, introducing the non-linearity, we can say that the linear functions are behave in such a way that: $g(ax+by) = ag(x) + bg(y)$ in cases where this is not true equality, and here comes the non-linearity, everything becomes mathematically more difficult. For example, if $g(x)=0$ and $g(y) = 0$ and for every $a$ and $b$ is not worth g(ax + by)=0, therefore the solution must be sought methods special, like non-linear models. Non-linear systems exhibit complex effects that are not deductible with linear methods, especially characteristic of dynamic systems. A system is said dynamic system when it expresses the variability of a state,
ie a point in a vector space, in time: $dX/dt = F(X,t)$ where $F\colon W \cap R^n \rightarrow R^n$ is differentiable. In this case solution of the system will be the set of trajectories as a function of the initial conditions. A dynamic system is completely defined by a space phases or states, whose coordinates describe him at all times, and by a rule that specifies the future performance of all variables of state. Dynamical systems are deterministic if there is only one result for each state, stochastic if it
there are different with a certain probability distribution as the classic launch
a coin. The phase space is the collection of all possible states of a system
dynamic. It can be done, as in the case of the currency in which we have two states, either infinity if the variables are real numbers. For example, a swap may be a dynamic system with discrete time, discrete geometric space, and discrete state space $s(i,;j)$, where $i$ represents the spatial coordinates $j$ the time, while the rule of fluctuation will be: $s\ (i,j+1) = f(s)$.

Mathematically, we can say that a dynamical system is described by a value problem initial; the trajectory in the phase space traced by a solution of a initial value problem is the trajectory of the dynamical system. In this situation we can define trajectory constant a constant solution x (t) = x (0) of $dX/dt = F(X,t)$, ie a vector x (0) for to which each component of the right part of $dX/dt = F(X,t)$ is zero. A constant trajectory is said to be stable if the following conditions are met: there must be a positive number $\mathcal{E}$ such that every trajectory that starts inside $\mathcal{E}$ of x(0), must approach asymptotically to x (0); for every positive number $\mathcal{E}$, there must be a positive number $\sigma(\mathcal{E})$, this that, a trajectory is guaranteed to stay within $\mathcal{E}$ of x (0) simply requiring that starts before $\sigma(\mathcal{E})$ of x (0); the set of all points that can be the initial states of trajectories that approach asymptotically to a stable trajectory is called the region of attraction of the stable trajectory. In summary, if some trajectories converge at some point, the set of states initials of these trajectories generated is said attraction region of the point. A region of attraction is ultimately a set of points in the state space of finite diameter such that each trajectory enters and does not go out.

## 4. Logic of chaos for the Forex' analysis: empirical analysis

Data analysis about a time series on the Forex market in a situation non-linearity needs to identify the chaotic characteristics, namely the presence of an underlying dynamic of chaotic origin. It is necessary, therefore, to analyze the behavior of deterministic and ergodicity. From the empirical point of view it is obviously difficult to verify whether the dynamics underlying the data is deterministic or not, except that you cannot use the equation that already plays them perfectly. The sensitivity to initial conditions can help once you have found the dynamics to verify the Lyapunov exponents and among them observe whether the "major" is positive or not. Ergodicity provides, however, a point of view entirely unique, objective and more conservative (ie, tending to accept the null hypothesis of the absence of chaos) to check whether the data have the characteristics necessary to continue the analysis of chaotic or less.

In this situation, we will try to determine and estimate a chaotic situation in Forex' market through a new approach: the use of *fuzzy logic*.

In a system of fuzzy logic applied to the paradox of the liar you can start from the premise that the same claim to always tell the fake is already a half-truth. We use the following statement: "This statement is false". Denote by now this statement with *S*, and *s* its truth value in two-valued logic of truth will be equal to S=1-s. This is because if S is true, then its negation, not-S is false, and its truth value is 0. Then, we can say that 1-0=1 and 1-1=0. Therefore, if the truth value of S is s, then the truth value of not-S is 1-s. Hence the paradox: if s = 0, then S tells us that s = 1-0 = 1; and if s=1, then S tells us that s = 1-1 = 0.

In both cases there is a contradiction. In fuzzy logic we can avoid the paradox by giving the value:

s=0,5. The use of a dynamic logic obliges us to correct each time the estimate the truth value of the utterance in question. The value assigned before s = 0.5 is the only one that does not lead to an oscillation: if he had said, for example, that S is true at 30%, we would have found a continuous oscillation of s = 0.3, correct then s = 0.7, p = 0.3 with correct again, and so on with an infinite sequence of truth values ranging between 0.3 and 0.7. To see how fuzzy logic can be useful for us to observe and control chaotic systems through logic in the forex market take another example. Consider the following statement: *euro fluctuates more than the Swiss franc*. We denote this statement with K. We affirm that the truth value of K is k = 0.4. Now consider this second statement G: K is 100% true. If G were 100% true, then K would also be 100% true, but we determined that K is not 100% true. The degree of truth of G, which relates K, depends actual truth value of G and the truth value assigned to K by G. The more our assessment will be inaccurate, false becomes more my statement. We know that k = 0.4, but according to the G value is 1. The difference in this case is equal to 0.6, then G is false to the extent of 60%, that is 40% true. If we said that K is true 50% difference would have been only 10%, then G would be true to 90%. Logically, if we had said that K is true of 40%, we would have been right at 100%. In summary, if we assume that a sentence S with truth value s and a statement J that leads us to estimate the added value of truth of S, the value of truth of J is: $j = 1 - (s - s')$ [1].

This mathematical representation will be our estimation formula. We can then formulate the statement of chaotic liar. This statement is as true as it is estimated false. If its truth value is (-c) then it tells us to estimate a truth value equal to 1-c. According to the formula [1] its truth value is:

1 – [c - (1 - c)] = 1 – [1 - 2c]. Thus we find ourselves in front of a dynamic process: c = 1 – [1 - 2c].

Now we choose two values starting at random, for example, c = 0.129741 and c = 0.13001.

We will discover that successive values are chaotic. If we substitute the value of starting with: c = 1 – [0,999999 - 2c]. In this case we can observe the famous butterfly effect. Of course we have to avoid that the calculation is stable with rounding to 0 or 1. Finally, we start the idea of calculating the truth value of a set of sentences and self- leads to a dynamic process in which you can apply the techniques of chaos theory.

## 5. Conclusion

Mechanisms that regulate the economy are complex and intricate. Contractors, manufacturers, politicians and small investors are protagonists in good and bad markets. Markets affected by macroeconomic events that no one is able to change , but you can learn to understand the economic logic that can help us to avoid making mistakes. There are several economic theories, in recent years the so-called econometric models are the most used. Today, the economies of the countries are completely independent of each other to the point that the economic and political development of a country can influence, in a greater or lesser extent, the economy of another country or political-economic. This means that the economic economy is not longer able to control the effects of the choices made at the macro level from one country to another. The index shows that more than any other balance and economic imbalance between an economy and the other is the value of the currency of a country or economic area. Theoretically there should be no special significance to the fact of knowing that the euro or other currency, we have a certain value, this happens until it expresses the value of a currency relating it to another as happens in Forex.

In the context of the foreign exchange market, which is named in finance forex, certainty about the knowledge of the exchange rate between two currencies is very low. This is because currencies are traded every second in the financial markets and all markets perfectly reflect the price of the effective exchange rate. In truth, the presence of non-regulatory markets, trading made by traders every second, the type of exchange rate (spot, forward, etc. ...) generates in trader uncertainty in the face of exchange rate volatility. And yet, in this situation of uncertainty, the system that drives these markets is still a dynamic and linear. In linear systems, a small change in the initial state of a physical system, chemical, biological, or economic causes a change correspondingly small in its final state, for example, hitting slightly stronger a billiard ball, it will go farther. In contrast, are non-linear situations of a system in which small differences in the initial conditions produce predictable differences in subsequent behavior. A system can also behave chaotically in some cases and not so chaotic in others. In this situation it is impossible to predict the behavior of a chaotic system will have after a fairly short period of time also. In fact, to calculate the future behavior of the system, even if described by a very simple equation, you must enter the values of the initial conditions. Moreover, in the case of a complex system is not linear, given the large sensitivity of the system to agents who ask, a small error in the measurement of the initial conditions, or a change apparently irrelevant data entered, and of course also their subsequent rounding during the calculation, grows exponentially with time, producing a radical change of results. This means that the data relating to the initial conditions of the exchange rates in the forex market should be measured with an accuracy theoretically infinite, but this is virtually impossible. Therefore in this work we tried to propose a simplified model of reproduction of reality, ie an abstraction which considers only the main features of what is the real object of study by applying a logic process. However, such a model, although it may seem limited, as it does not fully reproduces the reality, let's look at the most important aspects of a problem. At the end of the entire process of fuzzy logic can produce self-organization in a new situation, which in turn can play another chaotic moment and so on. This will remain unpredictable, though it is known that takes place in a strict and deterministic. At the end of the entire process of fuzzy logic can produce self-organization in a new situation, which in turn can play another chaotic moment and so on. This will remain unpredictable, though it is known that takes place in a strict and deterministic. It could be concluded that, at least, the use of a logic process avoids getting into chaos deterministic results only fruit of algorithms or methodologies econometric complex and away, in reality, from the original economic problem.

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