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Pattern of fluctuations in the exchange rate change from fixed to floating, in Brazil, Argentina and Mexico

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Abstract

This study evaluates the reaction of exchange market, in a macroeconomic point of view, with new information came from the change of regime from fixed to floating in local currencies in Brazil, Argentina and Mexico. So, we used the method RMS (Root Mean Square), which estimates the Hurst exponent of the considered series. The Hurst exponent is a measure that is associated with macroeconomic properties such as market efficiency. The results show a pattern in the efficiency tendency of these markets that is associated with an initial drop to anti-persistent H values, followed by a rapid rise to persistence in the exact moment of regime change, also by a period of stability in persistence. This period of stability ends at the efficient market behavior (H=0.5). The average time between regime change and the efficiency was about a year for all countries considered.

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1. Introduction

The efficient market hypothesis (Fama 1970; 1991) states that asset prices adjust to reflect fully the information available. Although the formulation of this hypothesis implies that this occurs quickly and without bias, in practice the price is not adjusted instantaneously, but after a shorter or longer period of time depending on the time it takes the new information to be absorbed by the market. The time and manner in which the market adjusts its prices to the market efficiency is an important factor in the efficiency hypothesis (Chorgia *et al*, 2008), with notable practical implications for trading and risk management.

This effect can be best studied in the dynamics of the fluctuations in exchange rates, since in some countries, such as Argentina, Mexico and Brazil, the foreign exchange market has undergone a sudden change of regime of the floating exchange in a short period of time. In these countries, the exchange has moved from a regime of fixed or semi-fixed rates to floating (Faucher and Armijo, 2004; Souza, 2005; Souza *et al*, 2006). Determining the time and manner in which the market absorbs new momentum trading is the purpose of this article. Is there a common pattern to the stabilization of the markets?

Empirically, several studies have evaluated the efficiency market in terms of the speed with which prices react to new information arising from any specific event (Busse and Green, 2002) or, more generally, when no specific event is identified (Amihud and Mendelson, 1987). The initial studies that evaluated the efficiency of market testing employed the linear autocorrelation and variance ratio test (Lo and Mackinlay, 1988) of daily data for monthly and annual stock returns. However, these tests assumed linearity (Hong and Lee, 2003; Hsieh, 1991; McQueen and Thorley, 1991).

In counterpart, the dynamics of fluctuations in exchange rates is legitimately an emergent effect of the sum of innumerable local variables, ranging from the psychological reactions of agents to new information to the big auction currency exchange control agencies, making gear characteristics a genuine exchange of a complex system with non-linear dynamics. Understanding this mechanism is not an easy task, since many of the severable are not accessible. However, there are several approaches, stemming from the complexity theory, that allow an analysis of the macroscopic properties of patterns that indicate generic models of interaction between the parties. Thereby, there is no reason to assume that asset prices are inherently linear. Error in human reasoning or information processing (e.g., information bias or excessive concern) may explain the imperfections in information dissemination in financial markets that may lead to non-linearity of prices (Kahneman and Tversky, 2000). Non-linearity can also arise from trends in prices, rational bubbles (McQueen and Thorley, 1991) or the assumption that prices are the result of complex interactions between informed and unin formed traders in the market. The statistical tests developed by Hurst (1951) and Russ (1994) are considered superior to linear autocorrelation tests since they are able to detect the presence of short and long term dependence.

Based on these tests, we propose an approach to detect the pattern of non-linear dependence in the fluctuation of the exchange rate in the period of regime change. This approach uses the RMS method (“root mean square”) to determine the patterns of persistence/anti-persistence over the period of regime change and thereby obtain information about the mechanism of absorption of information in the market for financial assets.

This paper is structured as follows. In the second section, the methodology used is presented. The third section shows the relation between the Hurst exponent, persistence and market efficiency. The fourth shows the data used. In the fifth section, the results of this work are shown, and in the last section the final considerations are presented.

2. Methodology

To determine the patterns of local persistence of the studied exchange rate series, the RMS method was used. The method consists of determining the RMS deviation around the average height for a number of points that are within a square window on its side τ. The procedure is repeated for windows of different sizes and represents the average deviation versus the typical size τ of the windows. In practice there are several options, so that windows may be used at the same size τ distributed randomly or systematically by the series (Russ, 1994). This method estimates the Hurst exponent of a series and therefore can be used to study the effectiveness and persistence of markets. Miranda and Andrade (1999) evaluated the accuracy of different methods for estimating the Hurst exponent from comparisons with simulated theoretical models, and concluded that among the methods studied, the RMS method (Russ, 1994) attained the most accurate values.

The RMS method considered as input a series $Z(x_i)$,where *xi* is the date of occurrence of Z given and the measure. The first step in the method is to calculate the average roughness for a range τ,$\overline{W}(\tau)$,which is given by the following expression:

$$\overline{W}(\tau) = \frac{1}{N_\tau} \sum_{u=1}^{N_\tau} \left\{ \frac{1}{m_\tau} \sum_{i \in \tau} \left[Z(x_i) - \overline{Z}_\tau \right]^2 \right\}^{\frac{1}{2}} \tag{1}$$

Where N_τ is the total number of side windows τ, m_τ is the number of points in each window of length τ,$\sum_{i \in \tau}$ symbolizes the sum over all the points belonging to window size τ and $\overline{Z}_\tau$ represents the average value of heights to the points of the window. The end $\overline{Z}_\tau$ brackets are the square of the RMS deviation for a window, so that the sum outer performs averaging over all the windows distributed over the entire series sequentially.

For time series showing correlations in the form of a power law exponent, we can estimate the Hurst(H) exponent by adjusting the following expression:

$$\overline{W}(h) \propto \tau^H \tag{2}$$

This method is commonly used in the determination of the exponent H for the entire data series; however, for series with high density of points we can calculate the local Hurst exponent and therefore estimate the temporal evolution of the persistence of the phenomenon. The exponent of that Hurst exponent consists of systematically applying relations (1) and (2) to a sliding window size ε.Thus, we can define the site as Hurst exponent $H_\varepsilon(t)$.

3. Hurst exponent, persistence and efficiency

The Hurst exponent is a tool that is often used in statistical physics, and is capable of displaying information about the source of the signal's reflected persistence in property and this in turn is related to economic properties, one of which is the efficiency of a market. According to Feder (1988), the series that have ½ < H < 1 are defined as persistent, the series that have 0 < H < ½ are anti-persistent and independent time series are manifested with H = ½, in which their behavior is not correlated. Both series have anti-persistent and long-term memory, while the non-correlated series are out of memory (Sutcliffe, 1978; Souza *et al*, 2006).

There is a relationship between market efficiency and the Hurst exponent: a market is efficient if it reflects all the available information, thus the prices can be modified only by new information, when there is no correlation between past and current returns (Lima and

Ohashi, 1999; Malkiel, 2003; Mandelbrot, 1972; Samuelson, 1965). From this perspective, a financial number can only be considered effective if the Hurst exponent is 0.5.

From this view point, there are some studies that indicate a relationship between market efficiency and the Hurst exponent of the series for various financial markets (see Cajueiro and Tabak, 2005; Di Matteu *et al*, 2005; Ramirez *et al*, 2008). Especially Cajueiro and Tabak (2004), when considering the exchange rates (against the dollar) from 29 countries and 32 stock market indices, observed that developed countries have a Hurst closer to 0.5 than developing countries and found the same relationship between stock index values when analyzing the distribution of returns for a sample of selected countries.

4. Data

Data were collected on dollar daily prices in Brazil, Argentina and Mexico, as shown in Table1. The periods were chosen to contain the respective events of the regime change from a fixed to a floating exchange rate, also shown in Table1.

Table1. Summary of the data collected

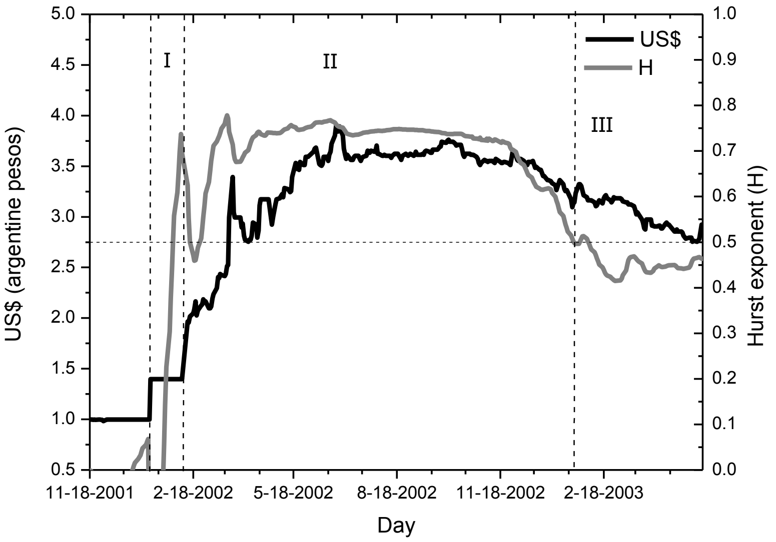
COUNTRY	START DATE	FINAL DATE	TOTAL NUMBER OF DATA	DATE OF CHANGE OF EXCHANGE RATE REGIME
BRAZIL	01/02/1995	12/31/2008	3513	01/18/1999
ARGENTINA	01/02/1995	12/31/2008	3513	01/06/2002
MEXICO	01/01/1992	12/31/2008	6052	12/22/1994

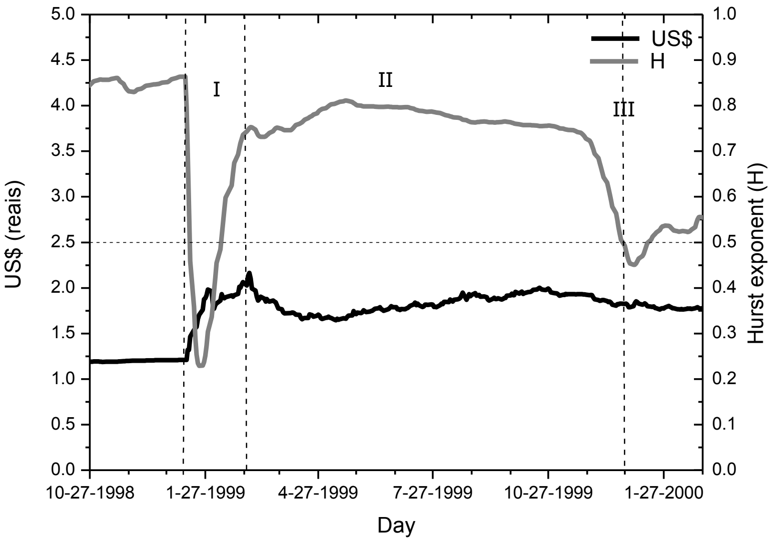
Source:http://www.banxico.org.mx/tipcamb/tipCamIHAction.do,http://www4.bcb.gov.br/pec/taxas/port/ptaxnpesq.asp?id=txcotacao.

The dates of change of the exchange rate regimes in Brazil, Argentina and Mexico were obtained from Souza *et al.* (2006), Faucher and Armijo (2004) and Souza (2005), respectively. The graphs presented in Figure 1 expose the daily prices of the U.S. dollar and the values of the Hurst exponent versus time for Brazil, Mexico and Argentina. We observe a sharp increase in prices associated with a steep drop in values of the Hurst exponent for anti-persistence at the time of transition.

5.Results

The graphs in Figure 1 show the results of the evolution of the local Hurst exponent for Brazil, Argentina and Mexico. The exponents have been calculated for the time interval of two years around the point in time when there was a change in the system. We used a window ε=250 days for each exponent and the date of the first day of the window as a reference in the graphs. Thus, the Hurst exponent calculated for 01/01/2001 represents the linear regression fit of the curve of roughness (equation1) between day 1 and the following data in the 249 series; quotes are not given for weekends and holidays and this scale corresponds to approximately one year.


US$
H
I
II
III
US$ (argentine pesos)
Hurst exponent (H)
11-18-2001
2-18-2002
5-18-2002
8-18-2002
11-18-2002
2-18-2003
Day


US$
H
I
II
III
US$ (reais)
Hurst exponent (H)
10-27-1998
1-27-1999
4-27-1999
7-27-1999
10-27-1999
1-27-2000
Day

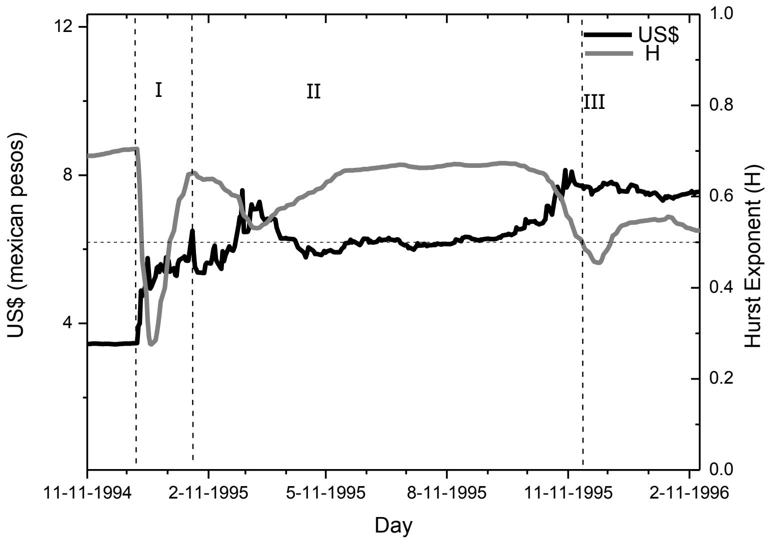


Figure 1.Bold – temporal evolution of the local currency according to the U.S. dollar, in the gray series of the local Hurst exponent, calculated for a sliding window of 250 days with the linear fit RMS method, between the scale of 2 and the scale of 50days. The dashed horizontal line represents the boundary between persistence and anti-persistence (H=0.5).

The negative values of the Hurst exponent observed in Figure 1 for the Argentina series cannot be considered to have physical meaning, since the Central Bank of Argentine sought to maintain parity in the currency 1:1, causing the fluctuations in the prices to be practically nil, 1000 times smaller than the average oscillation period in the series. For such oscillations, the method for estimating the Hurst exponent fails. The values of H close to 1 for the period before the regime change in Brazil are due to the smooth and linear growth in the prices of currency controlled by the central bank.

A general observation about the results of the evolution of the Hurst exponent over changes in the regime of countries shows that there was a similar pattern of fluctuation in the three countries. This pattern can be separated into three phases: I – initiation of the change in regime, which shows an initial drop in the exponent values for anti-persistent (in the case of Argentina, the exponent values were already due to persistent anti-small fluctuations, as mentioned previously) followed by a sharp increase for persistent H values as a result of the continuing price increase, possibly caused by the return of market confidence; II – brief stable values to the persistent H followed a slight fall, ending at instant H=1/2; and III – values fluctuating around H=1/2.

Phase I, which represents the time of initial absorption of the new dynamic, lasted for approximately one month for Argentina and Mexico and two months for Brazil. However, this period of initial absorption is not sufficient to stabilize the market since, at the end of Phase II, the Hurst exponent gently fell back to values close to 0.5, suggesting a tendency towards efficiency, in which case Brazil, Argentina and Mexico still grew back. Phase III somehow involves the features of an emerging market, which could be related to a natural tendency to stabilize the efficiency of free markets. That time lasted for 13 months for Argentina and 12 months to11 months in Brazil and Mexico.

6. Final Considerations

In this paper we used the Hurst exponent as a measure of the statistical properties of group behavior of the exchange market. The field of study concerned the behavior pattern of the index at the time of regime change from a fixed to a floating exchange rate for the countries Argentina, Brazil and Mexico. The results showed a pattern in the mechanism of absorption of momentum, which was divided into three phases. The duration of each phase was determined and two intervals were observed to have change persistence. Phase I, lasting for a few months, can be associated with the absorption time of the new dynamics of the foreign exchange market by agents causing a persistent tendency to emerge due to the initial state of fear in the market. The second, lasting several months (~1year), represents the thermalization time of market efficiency. The agents quickly learn the mechanism; however, market inertia is high.

This suggests that by adopting the system of a floating exchange rate, Brazil, Argentina and Mexico, even with the uncertainty at the time of transition from the fixed to the floating exchange market, became more random and/or competitive.

According to Souza (2005), the Brazilian post-regime change resembled a floating pure market and interference by the central bank was minimal, indicating that the pattern observed in this study can be considered as a process of genuinely self-regulated progress to the typical efficiency of complex systems. This result can serve as a basis for future models in an attempt to generate new hypotheses.

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