ELSEVIER

Physica A 316 (2002) 469–482

PHYSICA A

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Nonlinearities in the exchange rates returns and volatility

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Received 16 May 2002

Abstract

Recent findings of nonlinearities in financial assets can be the product of contamination produced by shifts in the distribution of the data. Using the BDS and Kaplan tests it is shown that, some of the nonlinearities found in foreign exchange rate returns, can be the product of shifts in variance while other do not. Also, the behavior of the volatility is studied, showing that the ARFIMA modeling is able to capture long memory, but, depending on the *proxy* used for the volatility, is not always able to capture all the nonlinearities of the data

PACS: 02.05.Ey; 05.45.Tp

Keywords: Exchange rates; Volatility; Nonlinearities; Nonstationarities; Long-memory processes

1. Introduction

The purpose of this paper is to investigate whether the foreign exchange rates behave nonlinear. At the same time some methodology issues in detecting nonlinear behavior will be discussed. Simulating studies [1–6] have shown that the BDS and the Kaplan tests have power against a large class of alternatives, so they will be used in this paper. Also, these tests have been widely applied to investigate the behavior of financial time series as in Refs. [1,7], most of them yielding to the acceptance of nonlinearity in

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0378-4371/02/$ - see front matter
PII: S0378-4371(02)01203-7

financial time series. There are two main explanations for the nonlinearity of financial returns. Concretely, one explanation for the nonlinear dependence in exchange rates is that they come from a deterministic process that looks random (e.g. chaotic process). A second explanation is that exchange rates changes are nonlinear stochastic functions of their own past. In this sense, Hinich and Patterson [8] show that stock prices are realizations of nonlinear stationary stochastic processes, also Hsieh [7] finds that rejections of linearity in stock returns are due to neglected conditional heteroskedasticity and cannot be attributed to structural changes.

Following the second explanation, some of the models used for asset prices and volatility assume that the unconditional distribution of assets rates is constant over time, which means that returns are stationary. This is the case of the autoregressive conditional heteroskedasticity models or ARCH processes.

In this investigation we will use a modification of the test proposed by Lima [9] that attempts to discriminate the findings of nonlinearity caused for intrinsic mechanisms, from those due to nonstationarities in the data. We will show that some of the findings of nonlinearity are due to possible shifts in distribution, that is nonstationarities of exchange rates while others are not.

Also, we use this methodology to study the behavior of the volatility using the ARFIMA models that are able to capture the long memory of this variable.

2. Testing nonlinearity

Among the tests of nonlinearities, the BDS and the Kaplan tests have been proven as very powerful and it will be used to test nonlinearities in exchange rate series in our paper.

2.1. The BDS test

The Brock, Dechert and Scheinkman (BDS) [10] is a test for independence based on the estimation of the correlation integral at various dimensions. It has power against virtually all types of linear and nonlinear departures so it does not currently provides a direct test either for nonlinearity or for chaos.

The BDS follows asymptotically a normal distribution with zero mean and unit variance under the null hypothesis of independence. Hence the hypothesis of nonlinearity and chaos are nested within the alternative hypothesis, which includes both non-independent linear and non-independent nonlinear processes.

Only when all the linear possibilities have been removed from the data by prefiltering, the test can be interpreted as a test of nonlinearities. The filtering can be done fitting the data with the proper ARMA [11] model, because the residuals of the model should be in principle linear independent, and any dependence found in the residuals must be nonlinear.

The BDS uses the correlation function that has two arguments, the embedding dimension m and the size of dimensional distance ε. The proper choice of the two parameters