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An investigation of Forex market efficiency based on detrended fluctuation analysis: A case study for Iran

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ABSTRACT

The efficient market hypothesis (EMH) states that asset prices fully reflect all available information. As a result, speculators cannot predict the future behavior of asset prices and earn excess profits at least after adjusting for risk. Although initial tests of the EMH were performed on stock market data, the EMH was soon applied to other markets including foreign exchange (FX). This study uses the detrended fluctuation analysis (DFA) technique to test 01:12:2005–18:04:2010 Iranian Rial/US Dollar exchange rate time series data to see if it can be explained by the weak form of the EMH. Moreover, to determine changes in the degree of inefficiency over time, the whole period has been divided into four subperiods. The study shows that the Iranian Forex market (the Rial/Dollar case) is weak-form inefficient over the whole period and in each of the subperiods. However, the degree of inefficiency is not constant over time. The findings suggest that profitable risk-adjusted trades could be made using past data.

1. Introduction

The efficient market hypothesis (EMH) originally introduced by Fama [1] is concerned with the behavior of prices in asset markets, and it states that prices fully reflect all available information. To be more precise, this hypothesis focuses on informational efficiency [2]. In an informationally efficient market, changes in asset prices will occur in response to news which cannot be predicted in any systematic manner. In other words, asset prices respond only to the unexpected part of any news, since the expected part of the news is already embedded in prices, and so more profit without higher risk is impossible [3].

The analysis of foreign exchange market efficiency has been considered in the international finance literature over three decades. The question of currency market efficiency is important. Exchange rates have a penetrating effect on all other prices. If the currency market is inefficient, currencies are often incorrectly priced. This distortion will spread over all other markets, and it causes misallocation of resources that leads eventually to welfare losses. On the other hand, inefficiency in currency markets can lead to excessive exchange rate volatility. Exchange rate volatility is inevitable when rates float, but excess exchange rate volatility increases the exchange rate risk and may decrease the flow of trade and investment [4].

The structure of this paper is as follows. Section 2 reviews the literature. Section 3 provides the data and the methodology of the research. Section 4 presents an estimation along with some discussion. Finally, the paper ends with the conclusions in Section 5.

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2. Literature review

Although the idea of the EMH may be traced to the 1990 work of Louis Bachelier, the organized modern presentation of the EMH is due to Eugene Fama. In 1970, Fama published his now-famous paper, "Efficient Capital Markets: A Review of Theory and Empirical Work". He helps with the focus and direction of future research by defining three different forms of market efficiency depending on the specification of the information set: weak form, semi-strong form, and strong form; see Refs. [5,6].

Weak-form efficiency.

The weak form of market efficiency states that the information content of all past prices is reflected in the current market price. This implies that, in contrast to the methods of "technical analysts", it is impossible to obtain a market advantage by analyzing only past prices.[1] For a foreign exchange market this means that no profitable information about future exchange rate movements can be obtained by analyzing the past exchange rates. However, fundamental analysis can be successfully applied [8].[2] The present paper examines the validity of this sample version of EMH. Test of weak-form foreign exchange market efficiency can be categorized into three groups: uncovered interest rate parity (UIP), forward market efficiency, and spot market efficiency.

Uncovered interest parity (UIP) postulates that the expected foreign exchange gain from holding one currency rather than another must be just offset by the interest rate differential. The UIP condition can be expressed as

$$E_t(r_{t+k}) - r_t = i_{t,k} - i^*_{t,k}, \tag{1}$$

where $E_t(r_{t+k})$ denotes the logarithm of the expected spot exchange rate at time $t+k$, when the expectation is made at time t; r_t denotes the logarithm of the spot exchange rate at time t; $i_{t,k}$ and $i^*_{t,k}$ are the nominal interest rates at time t available on similar domestic and foreign securities, respectively, with k periods to maturity. A test of market efficiency can therefore be designed to examine whether the interest rate differential is an unbiased estimator of the future spot rate [4]. Unbiasedness has been tested by regressing the change in exchange rate on the interest rate differential using the following equation:

$$\Delta r_{t+k} = \beta_1 + \beta_2(i_{t,k} - i^*_{t,k}) + \varepsilon_{t+k}. \tag{2}$$

This is known as the uncovered interest parity condition test for market efficiency. Δr_{t+k} is the change in the logarithm of the spot price over period k, and ε_{t+k} is a disturbance term. The null hypotheses are $\beta_1 = 0$ and $\beta_2 = 1$.

According to *forward market efficiency*, the forward exchange rate should be an unbiased predictor of the future spot exchange rate. By replacing the interest rate differential in the above equation with the difference between the forward and spot rate such that

$$\Delta r_{t+k} = \beta_1 + \beta_2(f_{t,k} - r_t) + \varepsilon_{t+k}, \tag{3}$$

the forward rate unbiasedness can be tested. $f_{t,k}$ is the logarithm of the k-period forward rate, i.e., the rate agreed now for an exchange of currencies k periods ahead. Similar to the UIP test, foreign exchange market efficiency is considered to hold if the estimates of α and β are not significantly different from zero and unity, respectively [4].

Since a forward market has not yet been developed in Iran and as a result the forward exchange rate is absent, so this category cannot be used for testing the efficiency of the foreign exchange market of Iran.

Spot market efficiency can easily be tested using historical data and studying the predictability in asset returns through correlations [9]. The null hypothesis is that changes in spot exchange rates are serially uncorrelated. In other words, the question is whether the spot exchange rate behaves as a random walk. In this paper, the focus is on the spot market efficiency.

Semi strong-form efficiency.

In a semi-strong efficient market, prices reflect all publicly available information about economic fundamentals [8]. Therefore, it is not possible for any investor to earn abnormal returns using any publicly available information [6]. In this level of efficiency, neither fundamental nor technical analysis can systematically produce abnormal returns [7].

Strong-form efficiency.

In the highest level of efficiency, no investor can earn excess return by using any information available, whether it is private or public information. In another words, while the semi-strong form precludes the profitability of both technical and fundamental analyses, strong-form efficiency implies that even those with privileged information cannot expect to earn excess returns. This extreme form serves mainly as a limiting case [6]. Grossman and Stiglitz [10] identified a major theoretical problem with the hypothesis termed the *paradox of efficient markets*, which they developed in the context of equity markets. The argument starts by noting that 'all available information' is costly, and therefore there must be a financial incentive for traders to gather and analyze it. But if markets were perfectly efficient, traders would not be able to make excess returns on any available information. Partly for these reason, Campbell et al. [11] suggest that the debate about perfect efficiency is pointless, and that it is more sensible to evaluate the degree of inefficiency than to test for absolute efficiency [12].

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1 Technical analysis is the practice of identifying recurring patterns in historical prices in order to forecast future price trends [7].

2 In fundamental analysis, one tries to forecast future price trends by studying macroeconomic variables such as inflation, interest rate, public debt levels, GDP, and money supply.