Testing the financial market informational efficiency in emerging states

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Abstract. The Efficient Markets Hypothesis (EMH) has been one of the most influential ideas in the past years and highlights that asset prices incorporate all information rationally and instantaneously. The last financial crisis has led to criticism of this hypothesis. Many practical observations concerning the reaction of investors, but also the mechanisms for the information encompassing in the price of stocks, come to highlight the aspects of “market inefficiency”. Despite its simplicity, the EMH is surprisingly difficult to test and considerable care has to be exercised in empirical tests. It has attracted a considerable number of studies in empirical finance, particularly in determining the market efficiency of an emerging financial market. Empirical tests have given mixed results about efficiency in these markets. The major challenges to EMH are mainly in the following forms: empirical tests for EMH show no evidence in favour of EMH, the existence of the limitations of the statistical and mathematical models for EMH, the evidence of the excess volatility mean reversion predictability, the existence of bubbles, and non-linear complex dynamics and chaos in the stock market. Efficiency tests in emergent markets are rarely definitive in reaching a conclusion about the issue, because, for a test to be reliable, it should take into consideration the institutional features of these markets. To test the hypothesis of informational efficiency of an emergent market, one should take into account some peculiarities of these markets, like: nonlinearity of asset prices, thin trading, the financial liberalization impact on the performance of emerging markets. The paper proposes a critical analysis regarding the testing methods of the informational efficiency theory of the capital market and also proposes new perspectives that are meant to relax the strong EMH assumptions in emerging markets.

Keywords: EMH, information, tests, emerging markets

JEL Codes: G14, D8, G00

1. Introduction

In his famous study, which will definitively mark the theory of efficient markets, Efficient Capital Markets: A Review of Theory and Empirical Work, written by Fama in 1970, he gives the following definition: “A market in which prices always reflect the available information is called an efficient market”. In this paper, he realizes a synthesis of previous research concerning the predictability of capital markets, the notions of fair game and random walk becoming well formulated. The distinction between the three forms of efficiency is being made: efficiency in its strong form, semi-strong efficiency and weak efficiency.

This paper is structured as follows: this section provides a literature review of the market efficiency hypothesis. Section 2 discusses the most common methods, such as the statistical tests, used in testing the classes of informational efficiency. Section 3 presents some previous applied tests on emerging capital

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markets informational efficiency. In section 4 we evaluate in a critical way these tests and we propose in conclusion some issues in order to improve the relevance of these testing methods for the emerging capital markets.

The weak efficiency form sustains the hypothesis that the current price of stocks fully reflects all the information concerning the stock market, such as: past prices, exchange rates, volumes of transactions and any other information concerning the markets. In an efficient market, past prices of the titles cannot be used to beat the market or to obtain adjusted rentabilities for a superior risk. In such a context, the chartist or technical analysis is useless.

Semi-strong efficiency look, in addition, to the immediate integration within the new course of any new information with a public character, concerning the firms wealth, its results, dividends, the distribution of free stocks, stock market introduction, etc. In an efficient market, in its semi-hard form, fundamental analysis, founded on public information, is useless.

Strong efficiency implies, more than that, the quick integration within the market prices, of all available information about the traded asset, including privileged information. Such efficiency (as the semi-hard one) puts into discussion the validity of the entire fundamental value analysis, as the intrinsic value is the market price itself.

The capital and financial markets in emergent countries are remarkable for their lack of sophistication (Tarun, Krishna, Jayant, 2005). There are not many reliable intermediaries like credit-rating agencies, investment analysts, merchant bankers or venture capital firms. Multinationals can’t count on raising debt or equity capital locally to finance their activities. There is no access to really accurate information on companies. Corporate governance is also poor in emerging markets. Transnational companies, therefore, can’t trust their partners to adhere to local laws and joint venture agreements. In fact, since crony capitalism thrives in developing countries, multinationals can’t assume that the profit aim alone is what is driving local companies.

2. Methods used for testing the informational efficiency of capital markets

Fama (1965) was in the view that the statement about the informational efficiency is general and needs to be tested; moreover, it demands to build up mathematical models and formulations for market equilibrium which will be used for testing the market efficiency.

Despite its simplicity, the EMH is surprisingly difficult to test and considerable care has to be exercised in empirical tests. Forecasting experiments have to specify at least five factors (Timmermann, Granger, 2004), namely:

- the set of forecasting models available at any given point in time, including estimation methods;
- the search technology used to select the best (or a combination of best) forecasting model(s);
- the available ‘real time’ information set, including public versus private information and ideally the cost of acquiring such information;
- an economic model for the risk premium reflecting economic agents’ trade-off between current and future payoffs;
- the size of transaction costs and the available trading technologies and any restrictions on holdings of the asset in question.

Broadly speaking, the incident of white noise, random walk, martingale and fair game properties of financial time series is evidence in favour of EMH. To reiterate, the absence of arbitrage opportunities expresses the idea that the only chance for speculators to gain an opportunity to earn abnormal profits occurs
if mispriced stocks exist in an economy populated by rational agents. In fact, the mispriced stocks will be automatically adjusted (Islam et al., 2007).

Fama (1991) reviewed his 1970 work and classified empirical tests of market efficiency in the following categories: tests for return predictability; event studies; tests for private information, which follow the three forms of informational efficiency. Megginson (1997) completed Fama’s classification with tests for rational fundamental valuation (Dragota, Caruntu, Stoian, 2005).

During the last years, there have been published various studies regarding the analysis of the informational efficiency of the emergent capital markets. All of these studies have tried to validate the hypothesis of weak form informational efficiency of these emerging capital markets. Because this form of market informational efficiency has been seldom validated, it is not use to talk about the other two forms of market informational efficiency in the case of emergent capital markets. That is why we present as follows the most important tests used to verify the weak form of EMH.

The main approach to the empirical evaluation of EMH on the weak form consists in the identification of market prices behaviour as random-walk processes. The random walk model states that the prices in the financial markets evolve accordingly to a random-walk (with or without drift). Therefore, identifying trends or patterns of price changes in a market couldn’t be used to predict the future value of assets (Saramat, Dima, 2011).

2.1. Statistical tests for independence

Given the assumption that the weak-form EMH states that the rates of return on the market are independent, the tests used to examine the weak form of the EMH test for the independence assumption. The tests should imply that an investor couldn’t anticipate with gains the future prices, using historical prices (Todea).

The week form of EMH states that two conditions have to be accomplished in the same time:

a. the autocorrelation coefficients of variable $R_{j,t}$ must be close to zero (serial uncorrelation);

b. the process $R_{j,t}$ has to be integrated by 0 order (stationarity condition: series is said to be (weakly or covariance) stationary if the mean and autocovariances of the series do not depend on time).

The weak form argues that there should be no correlation of price movements over time. This can be tested statistically. One form of statistical test would look for auto (or serial) correlation. Autocorrelation sets out the case where the stock price movement for one period of time is related to the price movements in a previous period. The serial autocorrelation is used to test the relationship between the time series its own values at different lags. If the serial autocorrelation is negative it means it is mean reverting and accepts the null hypothesis and if the result is positive coefficients then it rejects the null hypothesis.

In statistics, the autocorrelation (Box and Jenkins, 1976) of a random process describes the correlation between values of the process at different points in time, as a function of the two times or of the time difference. Autocorrelation is a correlation coefficient. However, instead of correlation between two different variables, the correlation is between two values of the same variable at times $X_i$ and $X_{i+k}$. This is the correlation coefficient for values of the series periods apart.

Tests have found that usually there is not significant level of autocorrelation, except in the case of some portfolios of small shares. Even this may be due to measurement problems when collating stock price information. It is difficult to rely on prices for small stocks since they are often infrequently traded (the problem of non-synchronous trading).

Alternatively, a run test can look at the changes in price through time and compare the actual changes to what would be expected for a random series. Run test of randomness is an alternative test to test
autocorrelation in the data. To confirm whether or not the data has correlation with the lagged value, run test of randomness is applied.

The run test is a non-parametric test whereby the number of sequences of consecutive positive and negative returns is tabulated and compared against its sampling distribution under the random walk hypothesis. In the stock market, run test of randomness is applied to know if the stock price of a particular company is behaving randomly, or if there is any pattern. Run test of randomness is basically based on the run. Run is basically a sequence of one symbol such as + or -. A run is defined as the repeated occurrence of the same value or category of a variable. It is indexed by two parameters, which are the type of the run and the length. Stock price runs can be positive, negative, or have no change. The length is how often a run type occurs in succession. Run test of randomness assumes that the mean and variance are constant and the probability is independent.

Another technique that will be used for testing the autocorrelation is Ljung-Box (1979), for autocorrelations with lag more or equal to 1 (Todea, 2002), or Lagrange Multiplier test (LM) (Lazar, Ureche, 2007). The Ljung–Box test is a type of statistical test of whether any of a group of autocorrelations of a time series are different from zero. Instead of testing randomness at each distinct lag, it tests the "overall" randomness based on a number of lags, and is therefore a portmanteau test. This test is sometimes known as the Ljung–Box Q test, and it is closely connected to the Box–Pierce test. The Box–Pierce test statistic is a simplified version of the Ljung–Box statistic for which subsequent simulation studies have shown poor performance. Ljung-Box test provides a superior fit to the chi-square distribution for little samples.

In mathematical optimization, the method of Lagrange multipliers (named after Joseph Louis Lagrange) provides a strategy for finding the local maxima and minima of a function subject to equality constraints.

The formal method to test the stationarity of a series is the unit root test. Augmented Dickey-Fuller (ADF) test is applied to test the presence of unit root in the time series of stock price changes in the indices. Majorly it is used to test the stationarity of the time series. ADF test implies that the series of natural logarithms of stock indexes to follow the stochastic process, type AR(1). In other words, ADF Test Statistic represents the t test for accepting or rejecting the null hypothesis of the Dickey-Fuller test. It is an augmented version of the Dickey–Fuller test for a larger and more complicated set of time series models. The augmented Dickey–Fuller (ADF) statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence.

Phillips and Perron have developed a more comprehensive theory of unit root nonstationarity. The tests are similar to ADF tests, but they incorporate an automatic correction to the DF procedure to allow for autocorrelated residuals. Phillips-Perron test is a test that does not include in the tested equation differences between the past series and is using the method of least squares in a simple form. The test itself is a t-statistic for regression coefficient, but adjusted to remove errors. The tests usually give the same conclusions as the ADF tests, and the calculation of the test statistics is complex.

For testing a series (or the first or second difference of the series) for the presence of a unit root, in addition to Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests, one can compute the GLS-detrended Dickey-Fuller (Elliot, Rothenberg, and Stock, 1996), Kwiatkowski, Phillips, Schmidt, and Shin (KPSS, 1992), Elliott, Rothenberg, and Stock Point Optimal (ERS, 1996), and Ng and Perron (NP, 2001) unit root tests.

An extra test, in order to confirm that the applied regression is viable, consists in the study of error variance that has to be normal distributed, 0 mean and constant variance. To study the normality, one can use the following indicators: Kurtosis, Skewness and Jarque-Bera.
A significant assumption of the random walk theory is investigated through variance ratio test. One popular approach, the Lo and MacKinlay (1988, 1989) overlapping variance ratio test, examines the predictability of time series data by comparing variances of differences of the data (returns) calculated over different intervals. If we assume the data follow a random walk, the variance of a period difference should be times the variance of the one-period difference. Evaluating the empirical evidence for or against this restriction is the basis of the variance ratio test.

2.2. Trading tests

Another point we discussed regarding the weak-form EMH is that past returns are not indicative of future results, therefore, the rules that traders follow are invalid. An example of a trading test would be the filter rule, which shows that after transaction costs, an investor cannot earn an abnormal return. These tests study the weak form of informational efficiency in an indirect way, evaluating the possibility to gain extra profits by using the historical evolution of the asset through a trade strategy.

3. Main results of previous tests applied on emerging capital markets

Emerging equity markets are widely thought to be places of substantial trading profits and weak and semi-strong form market inefficiencies when compared to developed markets. In their article, Griffin, Kelly and Nardari, 2009, examine the extent to which this is true using a variety of methodologies and data from 28 developed and 28 emerging markets. Emerging markets exhibit similar autocorrelation in firm returns, suggesting that they are not under or overreacting to news contained in past returns any more than in developed markets. Emerging markets incorporate past market and portfolio returns into prices slightly better than developed markets.

Using the article of Basu and Morey (2005), who developed a theoretical model that explores the effect of trade openness on stock return autocorrelation patterns, the paper of Lim and Kim, 2008, brings their proposition to the data, examining the impact of liberalization policies, both trade and financial, on the informational efficiency of 23 emerging stock markets. In general, the key results from fixed effects panel regressions support their prediction that trade liberalization, rather than financial openness, matters the most for informational efficiency.

Employing both cointegration analysis and a variety of Granger causality tests, Guttler, Meurer, Da Silva (2007) examine whether the Brazilian stock market is efficient in processing new information about public macroeconomic data (semi-strong efficiency). They found the stock market to be inefficient, which is in line with most results for other emerging markets. They found a long run relationship between selected macroeconomic variables of the Brazilian economy and its stock market index.

Islam, Watanapalachaikul, Clark (2007) proposed a theory-free paradigm of non-parametric tests of market efficiency for an emerging stock market, the Thai stock market, consisting of two tests which are run-test and autocorrelation function tests (ACF), to establish a more definitive conclusion about EMH in emerging financial markets. The result of this research demonstrates that an autocorrelation on Thai stock market returns exists particularly during the post-crisis period.

Despite the fact that there have been developed various specialty papers linked to the Bucharest Stock Exchange, the approaches linked to the way of evaluating these securities in the specific context of the capital market in Romania are more symptomatic (Bratianu, Opreana, 2010). Besides, their content represents more of some translations of developed studies for other economies, which beyond the scientific importance, many times indisputable, cannot always catch the particularities of the Romanian capital market.
In other words, although the approaches linked to the formal side of the stock operations accurately present the phenomenology of the capital market, they do not equally catch the substance of the problem, given by the stock evaluation logic, base of the transactions done in a rational manner. On the other hand, the issues related to the evaluation of the financial assets, as a premise of an advanced management of the portfolio, are favorite topics in the economic scientific research, even on an international scale.

Regarding Romanian capital market, it has been investigated rationality of Romanian investors, and efficiency market hypothesis represented a useful tool in order to achieve this goal (Dragota, Mitrica, 2004). The tests suggested by Fama [1970] have been successfully applied by many authors. Therefore, for many Romanian researchers it was incentive to proceed on investigating informational efficiency of Romanian capital market. Most of these studies have focused on the weak form of informational market efficiency using in that sense autocorrelation coefficients, normality and stationarity tests (Augmented Dickey-Fuller and Phillips-Perron) in order to test random walk pattern for stock returns.

One particular study, relatively recent and different from those existing, is that of Voineagu and Pele (2008), in which the efficiency of the capital market in Romania is tested using an econometric model based on the random walk theory, proving the weak form efficiency of this market.

Lazar and Ureche (2007) tested weak-form market efficiency of eight emerging markets: Romania, Hungary, Czech Republic, Lithuania, Poland, Slovakia, Slovenia, Turkey. The used tests determined empirically the presence of linear and nonlinear dependences, for most of the returns series. Most of these emerging equity markets were not weak-form efficient.

In their paper, Omay and Karadagli (2010) addressed weak form stock market efficiency of emerging economies, by testing whether the price series of these markets contain unit root. The results of ADF and PP indicated that Bulgarian, Greek, Hungarian, Polish, Romanian, Russian, Slovenian and Turkish stock markets were weak form efficient, while the results of nonlinear unit root test implied that Russian, Romanian and Polish stock markets were not weak form efficient.

The analysis done in their paper (Dima, Barna, Pirtea, 2007) suggests the following aspects: the financial sector of the market reflected by the BET-FI index can be described „up to a point” as being „informational efficient” (in the weak way of the concept), but the assembly of the weak characteristics does not fully respect the demands raised by such a characterization.

In their paper, Dragota, Caruntu, Stoian (2005) reveal that it is not necessary that a market is informational efficient only if prices follow a random walk. In other words, this is a necessary condition, but not a sufficient one. For example, on Romanian capital markets, some studies reveal a random walk evolution of prices. However, their study proves that there is a significant difference between price and an intrinsic value for some assets, which represents a major feature of Romanian capital markets, because that anomaly is persistent in time. Basically, the results of their study put in question investors’ rationality on Romanian capital markets.

Another recent paper (Bratian, Opreana, 2010) tested the hypothesis of efficient market in the case of capital market in Romania during the economic financial crisis. The authors intended to test the informational efficiency on the capital market in Romania during the economic and financial recession which affected the economic environment globally. It was analyzed the evolution of stock indices BET, BET-C and BET-FI. Their empirical test followed the research of the random walk hypothesis of three stock indices of the Bucharest Stock Exchange, being made the following tests:

- Tests regarding the observance of the normality hypothesis of distributed instantaneous yields (logarithmic) of stock indices;
Stationary tests for instantaneous yields (logarithmic) of stock indices. Also, the log normal distribution was used in order to model the processes from the capital market because it eliminated the shortcomings of normal distribution.

Following the upper statistical tests applied to stock indexes BET, BET-C and BET-FI, the authors reached the following conclusions:

- applied statistical tests to detect random-walk type behavior led to the rejection of hypothesis behavior of these daily series of stock indices;
- had not obtained sufficient evidence to support the efficient market hypothesis in weak form, for the daily stock indices.

From a statistical viewpoint, the test results did not confirm the random-walk hypothesis of stock indices value and the instantaneous returns were autocorrelated for certain lags. The statistical tests performed for each of the stock indexes indicated the fact that the evolution of the training was independent from one period to another (autocorrelation coefficients were significantly different from zero), which invalidated the efficiency hypothesis of weak form market.

4. Conclusions: critical evaluation of testing methods for the emerging capital markets

From the above review, it can be concluded that empirical tests have given mix results about efficiency in emerging markets. For a test to be reliable it should take into consideration the institutional features of these markets. These empirical studies have used the conventional efficiency tests, which have been developed for testing mature markets. Emerging markets are characterized by low liquidity, thin trading, unreliable information, and less informed investors. Furthermore, the rationality assumption implies that investors are risk averse, instantaneously respond to new information, and make unbiased forecasts. Based on these assumptions we expect prices to respond linearly to the arrival of information.

The weak-form of informational efficiency is put in doubt by some anomalies, like the \textit{week-end effect} and \textit{January effect}. These anomalies are empirical results that seem to be inconsistent with maintained theories of asset-pricing behavior. They indicate either market inefficiency (profit opportunities) or inadequacies in the underlying asset-pricing model. An anomaly or regularity is where empirical evidence contradicts the EMH. For example, it may be the case that if a share price rises one day, it is more likely to rise the next day and if it falls one day it is more likely to fall the next day. This knowledge would enable us to predict future price movements with some accuracy it would contrabandist the EMH and as a result would be referred to as an anomaly.

The major challenges to EMH are mainly in the following forms: empirical tests for EMH show no evidence in favour of EMH, the existence of the limitations of the statistical and mathematical models for EMH, the evidence of the excess volatility mean reversion predictability, the existence of bubbles, and non-linear complex dynamics and chaos in the stock market. To test the hypothesis of informational efficiency of an emergent market, one should take into account some peculiarities of these markets, like: nonlinearity of asset prices, thin trading, the financial liberalization impact on the performance of emerging markets.

The new studies in this field should eliminate two effects from the random walk hypothesis testing:
- the effect of thin trading;
- the effect of nonlinearity.

In testing the efficiency of emerging markets, it is necessary to take into account some of their characteristics, like \textit{thin trading}. Among the consequences of thin trading is the appearance of a serial correlation, studied by Miller, Muthuswamy and Whaley (1994). To remove the impact of this artificial
correlation, a correction is applied to the observed returns. The methodology proposed by Miller, Muthuswamy and Whaley suggests an autoregressive model AR(1) to separate the effect of infrequent trading (Lazar, Ureche, 2007).

Many studies showed that low liquidity, as a result of the thin trading of assets can imply a wrong rejection of weak form informational efficiency because the artificial autocorrelations. We mention in this sense a study that tests random walk hypothesis by eliminating the effect of thin trading. Abraham, Seyyed and Alsakran (2002) analyze the main exchange indexes of Saudi Arabia, Kuwait and Bahrain. They say that inferences drawn from tests of market efficiency are rendered imprecise in the presence of infrequent trading. As the observed index in thinly traded markets may not represent the true underlying index value, there is a systematic bias toward rejecting the efficient market hypothesis. For the three emerging Gulf markets examined in their paper, correction for infrequent trading significantly alters the results of market efficiency and random walk tests.

Conventional tests based on autocorrelation coefficients detect only linear autocorrelation. Emerging markets are typically characterized by a non-linear information behavior in stock prices (Todea, 2005).

To detect nonlinear correlations in the returns series, Lazar, Ureche (2007) performed a BDS test (Brock, Dechert, Scheinkman and LeBaron, 1996); BDS is a powerful tool for detecting serial dependence in time series. The runs test relies only on the successive returns signs, without interest in their dimension and does not require assumptions about the distribution of the returns. A sequence with too many or too few runs suggests that the sample is not random.

In their paper, Hassan, Al-Sultan, Al-Saleem, 2003, examine the market efficiency of a frontier capital market of Kuwait by taking into consideration the role of infrequent trading, non-linearity in emerging stock market and regulatory changes. Correction has been made to accommodate thin trading and possible non-linearity. The results do not support the null hypothesis of market efficiency for the whole study period and earlier sub periods.

The emergent markets are characterized by quick structural changes and gradually financial liberalization. In these conditions, many researchers built tests that could show the possible increase of efficiency in time. These tests of efficiency evolution could be done by using:

- Kalman filters: we mention here the paper of Rockinger, Urga (2000) that introduces a model, based on the Kalman filter framework, which allows for time varying parameters, latent factors, and a general GARCH structure for the residuals. With this extension of the Bekaert and Harvey (1997) model it is possible to test if an emerging stock market becomes more efficient over time and more integrated with other already established markets in situations where no macroeconomic conditioning variables are available;
- The test of the report of variances with autocorrelation coefficients variable in time: the article of Kvedaras and Basdevant (2002) combines the methodology for testing the efficiency of capital market using the variance ratio robust to heteroscedasticity with the state-space representation, which enabled them to use an efficient filtering technique - the Kalman filter - to get time varying autocorrelations.

The impact of financial liberalization upon the emergent markets performance is other element that should be taken into account when testing the weak form of informational efficiency. The classical models that require the constancy of parameters in time are incapable to show the level of efficiency evolution. More than that, the returns are far from the normal distribution, because they are not independent and identical distributed. In these conditions, one should use a model that takes into account all these aspects (see Nguyen, Bellalah, 2008).
Most studies on the informational efficiency submit on the idea that the deviation from random walk process is perceived as a deviation from the hypothesis of informational efficiency. This deviation is caused by the presence of long or short run dependencies:

- **long run dependencies** can be tested with Hurst exponent. The presence of long memory dependence in asset returns has been subject of a long and extensive research. In a recent paper, Cajueiro and Tabak (2005) have shown that long-range dependence for equity returns is time-varying and therefore the dynamics of these Hurst exponents should be explored. Furthermore, Cajueiro and Tabak presented a rank for efficiency built by analyzing median Hurst exponents for different countries;
- **short run dependencies** of financial market can be tested with the General Spectral Test (GST) proposed by Escanciano & Velasco (2006). However, stock returns may show non-linear dependence. Based on this, they proposed a generalized spectral (GS) test, which can capture both linear and non-linear dependence.

The research of emergent markets efficiency will have new dynamics because, beside the classical analysis instruments, new research models will be applied, based on the technical progress and on the high speed of incorporating the information. As a conclusion, all the efficiency tests, the scientific identification of markets inefficiencies help the improvement of our knowledge regarding the assets behaviour and the returns evolution in time. They help to improve the assets evaluation models, but also the practice and the vision of professionals in the capital markets.

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6. **References**


