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Stock prices and the efficient market hypothesis: Evidence from a panel stationary test with structural breaks

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ABSTRACT

This paper investigates whether the efficient market hypothesis holds in stock markets under different economic development levels over the period January 1999 to May 2007. We employ a state-of-the-art panel data stationarity test which incorporates multiple structural breaks. Evidence indicates that when accommodating general forms of cross-sectional dependence as well as controlling for finite-sample bias, the real stock price series appear to be stationary in 32 developed and 26 developing countries, respectively, which is in sharp contrast to the findings in the existing literature. Thus, real stock price indices are stationary processes that are inconsistent with the efficient market hypothesis. This shows the presence of profitable arbitrage opportunities among stock markets. According to these estimated structural breakpoints, we are also able to discover the reason for why there has been a huge impact from past stock prices.

1. Introduction

The purpose of this study is to demonstrate whether different economic development levels exhibit the same efficient market hypothesis (EMH). This is a worthwhile question, because there is a close link between stock markets and the real economy (Bose, 2005; Mauro, 2003). Fama (1970) proposes the stock market efficiency hypothesis, in which the dynamics of stock prices are described by a random walk with a drift (a weak form).[1] Such a process can be separated into two non-stationary components: a linear deterministic trend and a stochastic trend. If the EMH holds, then stock prices should be characterized by a unit root (random walk).[2] This implies that shocks have permanent effects on the level of stock prices through the stochastic part of the trend. Another implication of the random walk process is that the volatility of stock prices increases without bound over time, providing information for investment decisions and strategies. By contrast, if stock prices are mean reversion (trend stationary) processes, then it follows that the price level will return to its trend path over time. From an investment point of view, this ensures that one can forecast future movements in stock prices based on past behavior, and trading strategies can be developed so as to earn higher-than-average returns.[3]

There is a large body of literature that investigates the issue of stationarity in stock prices using a variety of methodologies (see Table 1), but there is no consensus among analysts due to the inconclusive results therein. It is widely agreed in empirical studies that allowing for potential structural changes in economic processes is an important issue. Although there is a vast body of empirical literature, there is a dearth of empirical studies concerning market efficiency that investigate stock markets with structural breaks in a panel framework, thereby controlling for cross-sectional dependence through bootstrap methods.

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[1] Fama (1970) demonstrates a seminal review of stock market efficiency in which three versions of the EMH are formulated. A weak form of the EMH implies that the changes in stock prices show a random walk process.

[2] Here, we use the terms "random walk" and "unit root" interchangeably throughout the paper; see Chaudhuri and Wu (2003) and Narayan (2006, 2008).

[3] Financial theory discovers that if the market is inefficient, then speculators or active managers can outperform the market. Thus, before the costs of transacting are taken into account, taking an active position is preferable (see Sharpe, 1991).

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Table 1
Comparison of previous results from various unit root tests for stock markets.

Author(s)	Sample countries	Method	Sample period	Results
Part A. Univariate unit root without breaks				
Choudhry (1997)	6 Latin American countries	ADF test	January 1989–December 1993	Efficient market
Kawakatsu and Morey (1999)	16 emerging markets	DF-GLS and KPSS tests	January 1976–December 1997	Efficient market
Chaudhuri and Wu (2003)	17 emerging markets	ADF and PP tests	January 1985–February 1997	Efficient market
Part B. Univariate unit root with breaks				
Chaudhuri and Wu (2003)	17 emerging markets	Zivot and Andrews (1992)	January 1985–February 1997	Inefficient market
Lee and Strazicich (2003)	S&P 500	Two-break LM unit root test	1860–1970	Efficient market
Narayan (2005)	Australia and New Zealand	Caner and Hansen (2001) threshold unit root test	January 1960–April 2003	Efficient market
Narayan (2006)	U.S.	Caner and Hansen (2001) threshold unit root test	June 1964–April 2003	Efficient market
Narayan and Smyth (2007)	G7 countries	Two-break LM unit root test	January 1975–April 2003	Efficient market
Qian et al. (2008)	Shanghai stock exchange composite index	Caner and Hansen (2001) threshold unit root test	December 1990–June 2007	Efficient market
Part C. Panel unit root without breaks				
Chaudhuri and Wu (2004)	17 emerging markets	Panel tests based on OLS and SUR estimation	January 1985–April 2002	Inefficient market
Narayan and Narayan (2007)	G7 countries	Panel tests based on IPS, LLC, LM, SUR and MADF test	January 1975–April 2003	Efficient market
Narayan and Prasad (2007)	17 European countries	Panel unit root test based on LLC, SUR, and MADF tests	January 1988–March 2003	Efficient market
Part D. Panel unit root with breaks				
Narayan and Smyth (2005)	22 OECD countries	Im et al. (2002) test	January 1991–June 2003	Efficient market
Lean and Smyth (2007)	8 Asian countries	Panel LM unit root test with one and two breaks	January 1998–June 2005	Inefficient market
Narayan (2008)	G7 countries	Panel LM unit root test with one and two breaks	January 1975–April 2003	Inefficient market

Note: SUR denotes the seemingly unrelated regression method. MADF denotes the multivariate Augmented Dickey Fuller method.

Moreover, the breaks which were estimated are meaningful and coincide with the most extreme events that have affected the stock markets.

The novelty of our work is as follows. First, we notice that few studies in the literature focus on different economically developed stock markets. Interest rate loosening, exchange rate flexibility, and bank privatization are more liberal in developed markets than in emerging markets. Compared to developed markets, emerging markets are relatively isolated from the capital markets of other countries and have a relatively low correlation with developed markets, especially the United States. Therefore, this paper further examines whether different economic development levels exhibit the same efficient market hypothesis.

Second, despite the abundance of studies on the behavior of stock prices, the specification of volatility is commonly time-invariant. Recent studies, though, do find that stock prices tend to be specified as non-linear data-generating processes. This implies volatility may not be constant over time, indicating that the reliability of the findings from existing studies is questionable (see Kanas, 2001; Narayan, 2005; Qi, 1999).

Third, previous studies do not even take structural breaks into account. One noticeable characteristic is that most stock price series are affected by multiple breaks (see Figs. 1 and 2). There are two important factors when performing tests that allow for structural breaks. This first factor is that structural breaks may be associated with atypical events (domestic and international, financial market liberalization, integration, regulations, and globalization).[4] The second aspect is that considering structural breaks allows us to obtain more detailed information on the behavior of stock prices. Thus, we apply the Carrion-i-Silvestre et al. (2005) (CBL hereafter) panel data stationary test, which simultaneously takes up panel and individual data stationary tests with multiple structural breaks. As explained in Harris and Tzavalis (1999), CBL generalize the model that specifies the individual effects in order to take into account a structural break that shifts the mean of each individual time series on the same date.

Fourth, the majority of studies apply the traditional method in testing for the null hypothesis of a unit root of stock prices. It is well-known that the traditional unit root test is powerless if the true data-generating process of a series exhibits structural breaks (see Perron, 1989). For this reason, we employ the panel data stationarity test of CBL, which assumes a highly flexible trend function by incorporating an unknown number of changes in level and slope. This test is thus more general than the panel unit root test by Im et al. (2005) that incorporates no more than two changes in level, but not in the slope coefficient. This can be very restrictive for stock price series which generally show a trending behavior and have been subject to several infrequent shocks of great magnitude such as liberalizing financial markets to various degrees.

Finally, under the null of a unit root as in Im et al. (2003; IPS hereafter) and Maddala and Wu (1999) and under the null of stationarity as in Hadri (2000), these tests allow us to consider a higher degree of heterogeneity in cross-sectional dynamics and show higher power than their time series equivalents. Allowing for structural breaks in the panel unit root tests, such as those of Im et al. (2003) and Levin et al. (2002; LLC hereafter), is quite difficult, because the distribution of these panel unit root tests with structural breaks critically depends on nuisance parameters which indicate their location, as noted by IPS. Hence, we allow for more general forms of cross-sectional correlation than that implied by the traditional cross-sectional demeaning of the data which assumes a common factor affecting all units with the same intensity. We do so by simulating the bootstrap distribution of the panel data stationarity test with multiple breaks following the approach by Maddala and Wu (1999). The allowance for general forms of cross-sectional dependence is crucial for panel unit root

[4] The classical dichotomy distinguishing between non-stationary and trend stationary processes supports the view that the trend is either changing every period or is never changing. By controlling for multiple breaks, however, we allow for a process that is stationary around a trend that infrequently shifts due to the occurrence of occasional large shocks.