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Testing for bubbles in stock markets with irregular dividend distribution☆

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ABSTRACT

Recursive right-tailed unit root tests have recently become a popular tool to test the existence of stock price bubbles. These tests require continuous data on dividend distribution that is not always available, in particular when it comes to sectoral indexes or individual stocks. In this paper we show that it is possible to circumvent this problem by applying the test to an equity bubble using the book-to-market ratio. We illustrate our framework by testing for a bubble in the Israeli stock market, where data on continuous dividend distribution are uncommon.

1. Introduction

Asset price bubbles, and stock price bubbles in particular, have gained a tremendous amount of attention both in public discussion and in academia. Recent empirical work suggests that such bubbles might have devastating consequences for the economy, especially when coupled with a credit boom (Jordà et al., 2015; 2016). The most recent example of such a phenomenon is the "Dot-com" bubble of the 1990s during which advanced economies' stock prices, mostly related to the rapidly growing Internet sector, surged, only to witness a sharp reversal during the late 1990s–early 2000s. As its name suggests, this boom and bust period in Internet stock prices is perceived as a bubble, suggesting that the surge in prices was mostly speculative in nature and unrelated to fundamentals. Nonetheless, at least in academia, the mere existence of bubbles, let alone the ability to detect them in real time, remains in debate.

In recent years, new econometric methods that aim at testing the existence and prevalence of bubble periods, attracted a great deal of attention in the literature. One prominent strand of this literature, initiated by Phillips et al. (2011) and Phillips et al. (2015), applies time series methods in order to detect and date-stamp bubbles. The key innovation is the use of recursive right-tailed unit root tests. These exhibit good power properties against the alternative of a bubble, are often used as a real time monitoring device for bubbles (e.g., Homm and Breitung, 2012), and have many applications in various markets – from stocks through commodities to housing markets.

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In order to test for a bubble in stock prices, the literature initiated by Phillips et al. (2011) usually uses data on prices and dividends and tests whether the former is explosive while the latter is not or whether the ratio between them is explosive. Examples include Phillips et al. (2011) who investigate the Nasdaq composite price index and the Nasdaq composite dividend; Phillips et al. (2015) who analyze the S&P 500 price-to-dividend ratio; Homm and Breitung (2012) who test the Nikkei 225, FTSE 100, Hang Seng, and Shanghai indexes[1]; Christensen and Andersen (2015) who test price-to-dividend ratios from a panel of 23 countries; and Chang et al. (2016) who test the Brazil, Russia, India, China and South Africa (BRICS) stock price-dividend ratios.[2] The above examples highlight the fact that testing for the existence of bubbles is deeply dependent on the availability of a continuous dividend series. Hence, using these tests to determine the existence of a bubble in individual stocks or markets where the distribution of dividends is not continuous are bubbly is challenging.

The purpose of this paper is to provide a framework that allows the implementation of the Phillips et al. (2011) and Phillips et al. (2015) tests for bubbles in cases where data on dividends are discontinuous or even missing. In particular, instead of testing for explosiveness in prices and dividends (or in the price-to-dividend ratio), we apply the standard test to the more readily available book-to-market ratio data, and provide a theoretical justification, based on the dynamic book-to-market model (Vuolteenaho, 1999; 2002). Accordingly, explosive behavior in the book-to-market ratio may serve as evidence for an asset price bubble.

We illustrate the use of our proposed method by applying the tests for bubbles to data from the Israeli stock market (July 1996 to November 2014). The Israeli stock market is chosen due to the usual tendency of this market not to distribute dividends continuously. We find no evidence of bubble periods in any of the sectors we examine. Our empirical application in this study is related to a series of recent studies that ask whether leading equity indices around the world exhibit bubble behavior.

The article is structured as follows. Section 2 describes the dynamic book-to-market model and provides the theoretical justification for using it to tests for bubbles. Section 3 briefly describes the bubble detection methodology. Section 4 illustrates our proposed framework by an empirical application to Israeli book-to-market data, and Section 5 concludes.

2. Bubbles and the book-to-market ratio

According to the standard present-value model, the general solution to the price of an asset is given by

$$P_t = \mathbb{E}_t \sum_{j=1}^{\infty} (1+R)^{-1} D_{t+j+1} + B_t, \tag{1}$$

where P_t denotes the price of an asset at time t, D_t the dividend, R a constant discount rate, $\mathbb{E}_t$ the mathematical expectation conditioned on information at time t, and B_t the rational bubble component that satisfies

$$\mathbb{E}_t[B_{t+1}] = (1+R)B_t. \tag{2}$$

The first component on the right-hand side of Eq. (1) is the "fundamental value." When no bubble exists, i.e., when $B_t = 0$, the price reflects the fundamental value. Conversely, $B_t \neq 0$ describes a situation where investors are willing to pay a premium over the fundamental value. According to condition (2), paying such a premium is justified since it is expected to increase at a rate of $1 + R$ over the next period.

Since the discount rate is strictly positive, Eq. (2) implies that the B_t follows an *explosive* path. Moreover, if an explosive bubble is present it will eventually dominate the stochastic behavior of P_t, which will be explosive as well. In effect, the explosiveness feature of the bubble component provides an identifying restriction that can be used to empirically test for the presence of a bubble. In particular, finding that P_t is explosive while D_t is not may serve as evidence for the presence of a bubble.

Testing for a bubble in equities for which dividends data are discontinuous is technically impossible To tackle this problem, we suggest using the book-to-market model of Vuolteenaho (1999, 2002), that starts off with the identity

$$V_t - V_{t-1} = X_t - D_t, \tag{3}$$

where V_t denotes the book value at time t, X_t the earnings, and D_t the dividends. According to this identity the change in book value from time $t-1$ to t equals earnings less dividends.

Vuolteenaho continues with the definition of the log book-to-market ratio

$$vm_t = \log(V_t/M_t) = v_t - m_t, \tag{4}$$

where M_t denotes the market equity value at time t, and derives an expression for the log book-to-market ratio that is analogous to the dynamic Gordon growth model (Campbell and Shiller, 1988):

$$vm_t = k_t + \mathbb{E}_t \sum_{j=1}^{\infty} \rho^j r_{t+j+1} - \mathbb{E}_t \sum_{j=1}^{\infty} \rho^j (r^e_{t+j+1} - r^f_{t+j+1}) + b_t, \tag{5}$$

where r_t denotes the log gross extra return over market valuation at time t, r^e_t the log gross return on equity (ROE), r^f_t the log gross

[1] Homm and Breitung (2012) note that dividend series were only available for the S&P 500 and the Hang Seng.

[2] One can also find applications of the Phillips et al. (2015) test for bubbles for other types of assets, such as houses and bonds (e.g., Caspi (2016) and Phillips and Shi (2017)), as well as to oil and commodities markets (e.g., Alexakis et al. (2017) and Caspi et al. (2015)).