International Review of Economics and Finance 48 (2017) 339–354

Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/iref

Asymmetric adjustment and smooth breaks in dividend yields: Evidence from international stock markets

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ARTICLE INFO

JEL classification:
G12
C22

Keywords:
Present value model
Bubble
Asymmetric adjustment
Structural break

ABSTRACT

Based on a present value model with time-varying expected returns, this paper examines the bubble-like behavior in the logarithm of the dividend yields of eight international stock markets under the assumptions of an asymmetric adjustment and structural breaks, respectively. To this end, we adopt a number of nonlinear unit root tests and propose a new test for the null hypothesis of a unit root against the alternative hypothesis that encompasses the asymmetric adjustment and two smooth breaks in the trend at the same time. Among the main results, it is found that the hypothesis of a unit root cannot be rejected for the logarithm of the dividend yields of these stock markets based on the conventional linear unit root tests. However, empirical results favor the presence of a structural break for the indexes of the DAX 30, FTSE Denmark and Nikkei 500. With the exception of BEL 20, the empirical results do not demonstrate strong evidence of an asymmetric adjustment for the logarithm of the dividend yield, implying that the hypothesis of the periodically collapsing bubbles is not empirically verified for these stock markets.

1. Introduction

The present value model plays an important role in stock pricing in the financial literature. It argues that stock prices are determined by the present discounted value of the future expected dividends (e.g., Campbell & Shiller, 1987; Campbell, Lo & MacKinlay, 1997; Cochrane, 2001). If both stock prices and dividends are respective integrated processes of order one, together with the assumption of a time-invariant discount rate, then the present value model predicts that there is a long-run equilibrium (cointegration) relationship between stock prices and dividends. Besides, if the present value model is valid, and assuming a time-varying discount rate instead of a constant one, then the logarithm of the dividend yield (i.e., the difference between the logarithm of the dividend and stock price) follows a stationary process (Diba & Grossman, 1988a; Campbell & Shiller, 1988a, 1988b).

Empirical studies of the present value model in bubble detecting have been extensively conducted in the unit root and cointegration framework. If the stock price and dividend exhibit a long-run relationship as evidenced by any number of cointegrating vectors, they then serve as evidence against the existence of a bubble in the stock price (see Diba & Grossman, 1988a, 1988b; Brooks & Katsaris, 2003). However, many studies (e.g., see Froot & Obstfeld, 1991; Balke & Wohar, 2002; Bohl & Siklos, 2004; Jahan-Parvar & Waters, 2010) argue that the stock price and dividend remain on a common long-run trend path but that substantial deviations from this common behavior can occur. Such deviations could imply *nonlinear* dynamics within the price-dividend relationship (Campbell et al., 1997, p. 260).

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http://dx.doi.org/10.1016/j.iref.2016.12.001
Received 9 September 2016; Received in revised form 24 November 2016; Accepted 1 December 2016
Available online 28 December 2016
1059-0560/

The rationale for such nonlinearity comes from several factors including the presence of a speculative rational bubble (Blanchard & Watson, 1982; West, 1987; Evans, 1991; Charemza & Deadman, 1995), the behavior of noise traders (Kirman, 1991, 1993; Shleifer, 2000) or fads (Shiller, 1981), and the presence of an intrinsic bubble (Driffill & Sola, 1998), as well as the theory on booms and slumps in economic activity developed by Phelps (1994) and Phelps and Zoega (2001). As such, several authors have considered nonlinear modeling approaches that may be consistent with such bubble-like dynamics (van Norden, 1996; van Norden & Vigfusson, 1998; Bohl, 2003; Bohl & Siklos, 2004; Kanas, 2005; Brooks & Katsaris, 2003; McMillan, 2007a; Nunes & Da Silva, 2008; Shi, 2013). In particular, Evans (1991) argues that the standard linear unit root test and cointegration approach will not be able to detect a class of periodically collapsing rational bubbles. The reason for this is that the sudden collapse of a bubble may be mistaken by standard cointegration tests for mean reversion, resulting in a bias toward the rejection of the null hypothesis of no cointegration.[1]

Many studies, for example, Taylor and Peel (1998), Hall, Psaradakis & Sol (1999), Psaradakis, Sola, & Spagnolo (2001), Bohl (2003), Bohl and Siklos (2004), Sollis (2006), McMillan and Speight (2006), McMillan (2007a), Doffou (2007), Pierdzioch (2010), Phillips, Wu, & Lu (2011), Jahan-Parvar and Waters (2010), Gutierrez (2011), Yoon (2012), Vishwakarma (2013), Feng and Wu (2015), Balcilar et al. (2016) and Chen et al. (2016), have devoted much effort to detecting rational bubbles and periodically collapsing bubbles in a variety of stock markets.[2] In particular, some authors have adopted the momentum threshold (hereafter MTAR) unit root test, proposed by Enders and Granger (1998) and Enders and Siklos (2001), in their empirical studies.[3] This is because the Monte Carlo simulation findings of Bohl (2003) and Doffou (2007) show that the MTAR unit root test provides a sufficiently powerful test to detect the periodically collapsing bubble when the actual data generating process is given by the bubble model put forward by Evans (1991). In the literature this type of nonlinearity is referred to as *sign asymmetry* or *asymmetric adjustment* (McMillan, 2008, p.592).

It is worth noting that, recently, Phillips et al. (2011, hereafter PWY) and Phillips, Shi, & Yu (2015, hereafter PSY) have proposed new bubble detection strategies based on recursive and rolling ADF unit root tests (sup-ADF) that enable us to detect bubbles in the data and to date-stamp their occurrence. These types of tests use a right tail variation of the Augmented Dickey-Fuller unit root test wherein the null hypothesis is of a unit root and the alternative is of a mildly explosive process. For applications of the PWY and PSY to detect bubbles in the different asset markets, readers are referred to, for example, Gutierrez (2011), Yiu, Yu, & Jin (2013), Engsted, Hviid, Pedersen (2016), Fantazzini (2016) and Escobari and Jafarinejad (2016). However, as noted by Adämmer and Bohl (2015, p. 69), this approach cannot answer the question of dependencies between different prices and fundamentals since the sup-ADF test investigates whether prices are temporarily mildly explosive. On the contrary, the MTAR approach avoids this deficiency by estimating a small number of parameters in the regression.

The second culprit to account for the deviation from the present value model is that the logarithm of the dividend yield has undergone a *structural break* or level shift. With respect to the structural break, this can arise through either a shift in the dividend growth rate and may also occur as a result of a change in the discount rate. Some authors have emphasized the importance of a structural break in testing for the validity of the present value model. For example, Bohl and Siklos (2004, p. 209) point out that "if we take as given the long-run validity of the present value model, the low power of unit root tests in particular, nonlinearities, *structural breaks* and/or outliers are possible candidates for the mixed findings." McMillan and Wohar (2010) also emphasize that it is important to consider time-variation in the mean parameter or level shift, and hence the structural break within the data, perhaps due to a policy announcement or macroeconomic shocks. Previous studies such as Carlson et al. (2002), McMillan (2007b, 2009a, 2009b), Homm and Breitung (2012) and Esteve, Navarro-Ibáñez, & Prats (2013) highlight the importance of a structural break and focus on examining the rational bubble hypothesis by allowing explicitly for a level shift or endogenous structural break.[4]

The aim of this paper is to re-examine the importance of the asymmetric adjustment (sign asymmetry) and structural break, respectively, in explaining the bubble-like behavior in the logarithm of the dividend yields for a selection of eight international stock markets. To this end, we adopt the following nonlinear unit root tests in this study. First, we employ the MTAR unit root test, proposed by Enders and Granger (1998), because it has been proved to be a powerful method to characterize the asymmetric adjustment in the logarithm of the dividend yield, which is theoretically justified by, for example, the periodically collapsing bubbles. As explained in Bohl and Siklos (2004), the MTAR model can be used to analyze bubble-driven run-ups in stock prices followed by a crash in a cointegration framework with the asymmetric adjustment (i.e., sign asymmetry). If the null hypothesis of a unit root and null hypothesis of the asymmetric adjustment are both rejected by the MTAR method, then such outcomes can be theoretically justified by, for example, the periodically collapsing bubbles.

Second, we use the logistic trend function that allows for smooth breaks in the trend, championed by Leybourne, Newbold, & Vougas (1998) and Harvey and Mills (2002), to model single and double gradual breaks in the logarithm of the dividend yield by reason of a policy announcement or financial shocks.[5] Third, we employ the Cook and Vougas (2009) unit root test that allows for a single smooth break in the trend and stationary asymmetric adjustment in the logarithm of the dividend yield at the same time under

[1] Alternatively, several researchers (Caporale and Gil-Alana, 2004; Cuñado et al., 2005; Koustas and Serletis, 2005) argue that the price-dividend ratio exhibits fractional integration such that it is characterized by long memory, while the series is ultimately mean reverting. It is of interest to notice that "while the fractional integration approach may provide for statistical modeling of the data it provides no economic rationale for this behavior" (McMillan, 2007a, p.801).

[2] Please refer to Gürkaynak (2008) for a good survey on applying various econometric methods in detecting rational bubbles.

[3] Payne and Waters (2005, 2007), Jirasakuldech, Campbell, & Knight (2006), Waters and Payne (2007) and Xie and Chen (2015) also test for the periodically collapsing bubbles in the real estate investment trust markets by using the MTAR unit root test.

[4] The evidence on structural breaks paves the way for other regime-switching specifications as in Gutiérrez and Vázquez (2004), Anderson, Brooks, & Katsaris (2010), Al-Anaswah and Wilfling (2011) and Londono Regúlez & Vázquez (2015).

[5] Leybourne and Mizen (1999) point out that "when considering aggregate behavior, the time path of structural changes in economic series is likely to be better captured by a model whose deterministic component permits gradual rather than instantaneous adjustment."