ELSEVIER

Review of Financial Economics 13 (2004) 245–258

RFE
Review of Financial Economics

www.elsevier.com/locate/econbase

Fractional cointegration and tests of present value models

Guglielmo Maria Caporale[a,*], Luis A. Gil-Alana[b]

[a] *London South Bank University, 103 Borough Road, London SE1 0AA, UK*
[b] *University of Navarra, Spain*

Received 6 October 2002; received in revised form 29 June 2003; accepted 19 September 2003

Available online 21 November 2003

Abstract

This paper tests the validity of present value (PV) models of stock prices by employing a two-step strategy for testing the null hypothesis of no cointegration against alternatives which are fractionally cointegrated. Monte Carlo simulations are conducted to evaluate the power and size properties of this test, which is shown to outperform existing ones, and to compute appropriate critical values for finite samples. It is found that stock prices and dividends are both I(1) nonstationary series, but they are fractionally cointegrated. This implies that, although there exists a long-run relationship, which is consistent with PV models, the equilibrium errors exhibit slow mean reversion. As the error correction term possesses long memory, deviations from equilibrium are highly persistent.

JEL classification: C32; C22; G12; G14
Keywords: Efficient Markets Hypothesis (EMH); Present value (PV) models; Fractional integration; Fractional cointegration

1. Introduction

One of the central propositions of modern finance theory is the efficient markets hypothesis (EMH), which in its simplest formulation states that the price of an asset at time t should fully reflect all the available information at time t. This has often been tested by using the present value (PV) model of stock prices, since, if stock market returns are not forecastable, as implied by the EMH, stock prices should equal the present value of expected future dividends. As pointed out by Campbell and Shiller (1987) in their seminal paper, this implies that stock prices and dividends should be cointegrated, and recent studies of PV models have mainly used cointegration techniques. However, the discrete options I(1) and I(0) offered by classical cointegration analysis are rather restrictive, which might explain why the

* Corresponding author. Tel.: +44-20-7815-7012; fax: +44-20-7815-8226.
E-mail address: g.m.caporale@lsbu.ac.uk (G.M. Caporale).

1058-3300/$ - see front matter
doi:10.1016/j.rfe.2003.09.009

available empirical evidence is inconclusive. Adjustment to equilibrium might in fact take a longer time than suggested by standard cointegration tests. In other words, stock prices and dividends might be tied together through a fractionally integrated I(d)-type process such that the equilibrium errors exhibit slow mean reversion.

The contribution of the present paper is twofold. First, we propose a two-step strategy for testing the null of no cointegration against alternatives, which are fractionally cointegrated. We conduct Monte Carlo simulations to evaluate the size and power properties of this test, which is shown to outperform existing ones, and to compute appropriate critical values for finite samples. Second, we apply the new methodology to an updated version of the Campbell and Shiller's (1987) dataset to test the adequacy of PV models of stock prices. We find that stock prices and dividends are both I(1) nonstationary series, but they are fractionally cointegrated. This implies that, although there exists a long-run relationship, which is consistent with PV models, the error correction term possesses long memory, and hence, deviations from equilibrium are highly persistent.

The layout of the paper is the following. Section 2 briefly reviews the existing literature on PV models. Section 3 starts by describing the concepts of fractional integration and cointegration, and then introduces a procedure for testing the null hypothesis of no cointegration against fractionally cointegrated alternatives, and its properties are investigated by conducting Monte Carlo experiments. This methodology is applied in Section 4 to test PV models, and Section 5 offers some concluding remarks.

2. Review of the literature

The literature on PV models has rapidly grown in the last two decades. Early studies, such as Shiller (1981) and LeRoy and Porter (1981), assumed that dividends were trend-stationary. They carried out variance bounds tests, finding that prices were too volatile to be consistent with the present value of rationally expected future dividends discounted by a constant real interest rate. Subsequent studies pointed out that the assumption of trend-stationarity for stock prices and dividends might be invalid. In particular, Marsh and Merton (1986) showed that the results were reversed if the variables of interest were in fact integrated. Kleidon (1986) then developed variance bounds tests, which were valid under integration, and reported that the evidence was not inconsistent with the EMH. West (1988a) also tested for excess volatility by developing a method valid under either integration or trend-stationarity, though its parameter estimates were not consistent if dividends were trend-stationary as opposed to difference-stationary as he assumed.

The above tests crucially depend on being able to establish the order of integration of the variables. But, as it was shown in the econometric literature, unit root tests have very low power in finite samples, and it is practically impossible to distinguish between a unit and a near-unit root (see Campbell & Perron, 1991; McCallum, 1993; West, 1988b).

In a seminal paper, Campbell and Shiller (1987) tested the PV model of stock prices adopting Engle and Granger's (1987) cointegration procedure, an approach which is valid provided stock prices and dividends are stationary in first differences rather than in levels. They used the Standard and Poor's (S&P's) dividends and value-weighted and equally weighted New York Stock Exchange (NYSE) 1926–1986 datasets. In the case of the S&P series they were unable to reject the null for stock prices, but rejected it for dividends, whilst they could not reject it in both cases when using the NYSE data. As