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London calling: Nonlinear mean reversion across national stock markets☆

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ABSTRACT

This paper revisits empirical evidence of mean reversion of relative stock prices in international stock markets. We implement a strand of univariate and panel unit root tests for linear and nonlinear models of 18 national stock indices from 1969 to 2016. Our major findings are as follows. First, we find strong evidence of nonlinear mean reversion of the relative stock price with the UK index as the reference, calling attention to the stock index in the UK, but not with the US index. Our results imply an important role of the local common factor in the European stock markets. Second, panel tests yield no evidence of linear and nonlinear stationarity when the cross-section dependence is considered, which provides conflicting results from those of the univariate tests. Last, we show how to understand these results via dynamic factor analysis. When the stationary common factor dominates nonstationary idiosyncratic components in small samples, panel tests that filter out the stationary common factor may yield evidence against the stationarity null hypothesis in finite samples. We corroborate this conjecture via extensive Monte Carlo simulations.

1. Introduction

It is an interesting question in international finance whether deviations between stock indices are short-lived. If so, one can diversify international portfolios by short-selling well performing assets and purchasing poorly performing assets to obtain excess returns as shown by Balvers, Wu, and Gilliland (2000). Such a strategy is called the contrarian investment strategy, and it may imply that stocks become less risky in the long run and are attractive for long-term investors (Spierdijk, Bikker, & Hoek, 2012). On the contrary, if deviations are permanent, one should short worse performing assets while buying better performing ones, because winner-loser reversals are not likely to happen. This is called the momentum strategy.

Since the end of the 1980's, many researchers have examined mean reversion properties in stock markets. Fama and French (1988) and Poterba and Summers (1988) among others were the first to provide the evidence in favor of mean reversion. Fama and French (1988) state that 25–40% of the variation in 3–5 year stock returns can be attributed to negative serial correlation. Poterba and Summers (1988) found that a substantial part of the variance of the US stock returns is due to a transitory component. However, Richardson and Smith (1991) showed that there is no evidence for long-term mean reversion if the small-sample bias is controlled. Kim, Nelson, and Startz (1991) report very weak evidence of mean reversion in the post-war era. Jegadeesh (1991) shows that mean reversion in stock prices is entirely concentrated in January.

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An array of researchers investigated possible cointegration properties of the stock indices and their fundamental variables. For example, Campbell and Shiller (2001) examine the mean-reverting behavior of the dividend yield and price-earnings ratio over time. If stock prices are high in comparison to firms' fundamentals, it is expected that adjustments toward an equilibrium will be made. They find that stock prices contribute most to adjusting the ratios towards an equilibrium level.

Balvers et al. (2000) considered relative stock price indices of eighteen OECD countries compared to a world index to get around the difficult task of specifying a fundamental or trend path. Under the assumption that the difference between the trend path of one country's stock price index and that of a reference index is stationary, and that the speeds of mean reversion in different countries are similar, they found substantial panel evidence of mean reversion of relative stock price indices with a half-life of approximately 3.5 years. Similar evidence has been reported by Chaudhuri and Wu (2003) for 17 emerging equity markets.

However, it may be too restrictive to assume a constant speed of mean reversion, since the speed of mean reversion may depend on the economic and political environment, and also it may change over time. For example, Kim et al. (1991) conclude that mean reversion is a pre-World War II phenomenon only. Poterba and Summers (1988) find that the Great Depression had a significant influence on the speed of mean reversion. Furthermore, their panel unit root test may have a serious size distortion problem in the presence of cross-section dependence (Phillips & Sul, 2003). Controlling for cross-section dependence, Kim, 2009 reports much weaker evidence of mean reversion of relative stock prices across international stock markets.

In recent work, Spierdijk et al. (2012) employed a wild bootstrap method to get the median unbiased estimation and a rolling window approach to a long horizon data (1900–2009) for their analysis. They find that stock prices revert more rapidly to their fundamental values in periods of high economic uncertainty, caused by major economic and political events such as the Great Depression and the start of World War II. They report a statistically significant mean reversion for most of their sub-sample periods, but their panel test results don't seem to match their univariate test results very well.[1] Also in their panel model, they assumed that the speed of mean reversion is constant as in Balvers et al. (2000), which is not ideal because estimated mean reversion rates are very different across countries.

Wälti (2011) studied the relationship between stock market co-movements and monetary integration. He reports that greater trade linkages and stronger financial integration contribute to greater stock market co-movements.[2]

In the present paper, we revisit the findings by Balvers et al. (2000) by re-examining the mean reversion of the relative stock price in international stock markets, employing nonlinear unit root tests in addition to linear tests for 18 developed countries during the period 1969 to 2016.[3,4] Our major findings are as follows.

First, we find strong evidence of nonlinear mean reversion of relative stock prices when the UK serves as the reference country. On the other hand, very little evidence was found when the US stock price serves the reference index, which is in stark contrast with Balvers et al. (2000). This finding suggests that the contrarian investment strategy, using the UK index as the reference, might outperform the momentum strategy when deviations of the relative stock price are large. We note that 12 out of 18 developed countries in the sample are European countries, which implies an important role of local fundamental variables that govern European stock markets. That is, when stock prices are co-trending, the contrarian strategy can be useful since deviations from the common (stochastic) trend tend to be short-lived. Wälti (2011) also pointed out that monetary, trade, and financial integration through the Economic and Monetary Union (EMU) has contributed to higher degree of stock market return comovements in Europe.

In essence, our findings imply that the contrarian investment strategy would be useful when national equity prices deviate sufficiently from the UK stock index, while one may employ the momentum strategy with the US as a reference.

Next, we re-examine our findings employing a series of panel unit roots tests: the linear panel unit root test by Pesaran (2007) and a nonlinear panel (PESTAR) unit root test (Cerrato Mario, De Peretti Christian, & Larsson Rolf, 2011). These tests allow different mean reversion rates across countries and also cross-sectional dependence. Thus, our approach is less restrictive than Balvers et al. (2000) and Spierdijk et al. (2012) and it should give more statistically reliable results. Surprisingly, we report very weak panel evidence of mean reversion from these linear and nonlinear panel unit root tests, which seems to be inconsistent with the univariate ESTAR test results with the UK as the reference index that provide strong evidence of nonlinear mean reversion.

To look into these seemingly conflicting statistical results, we conducted a principal component analysis via the PANIC method developed by Bai and Ng (2004). We note the empirical evidence of stationarity of the estimated first common factor or cross-section means that served as proxy variables for the common factor in our tests using the methods by Pesaran (2007) and Cerrato et al. (2011) with the UK reference. When the *stationary* first common factor dominates highly persistent or even *nonstationary* idiosyncratic components in small samples, the panel unit root tests that filter out the stationary common factor may yield evidence that favors nonstationarity in small samples, while the univariate test rejects the null of nonstationarity. Via Monte Carlo simulations, we

[1] For example, with the US benchmark, only France shows mean reversion with the univariate test but there is a solid stationarity with the panel test.

[2] Also the author concludes that lower exchange rate volatility and joint EMU membership are associated with stronger stock market comovements. The joint significance of these two variables indicates that monetary integration raises return correlations by reducing transaction costs coming from exchange rate uncertainty, and through the common monetary policy and the convergence of inflation expectations leading to more homogeneous valuations.

[3] Mean reversion of the relative stock price implies that deviations from a common stochastic trend are short-lived, which implies a cointegrating relationship for a pair of international stock indices as we describe later in Eq. (1).

[4] Nonlinear models have been widely used in the study of financial data to account for state-dependent stochastic behavior due to market frictions such as transaction costs; examples include, for exchange rates and law of one price, Obstfeld and Taylor (1997), Taylor, Peel, and Sarno (2001), Lo and Zivot (2001), Sarno, Taylor, and Chowdhury (2004) and Lee and Chou (2013), and for stock prices or returns, Bali, Demirtas, and Levy (2008), Zhu and Zhu (2013) and Kim and Ryu (2015). Nonlinear models are also used for the study of commodity prices (for example, Balagtas & Holt (2009), Holt & Craig (2006), and Goodwin, Holt, & Prestemon (2011)) to address nonlinear adjustments towards the equilibrium due to costly transactions, government interventions, or different expectations by individuals (Arize, 2011).