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Modelling long run comovements in equity markets: A flexible approach

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ABSTRACT

International equity markets linkages are characterized by nonlinear dependence and asymmetries. We investigate shifts in long run comovements in stock markets by means of an 'interrupted' Markov switching cointegration specification. This flexible approach allow us to study to what extent documented changes in global integration are permanent, or whether market linkages are subject to changes. Using an illustrative sample from 1980 to 2012 for USA, UK and Hong Kong stock price indices, we find evidence of interrupted cointegration across these markets between May 1997 and April 2002, which is consistent with the decoupling of stock prices from fundamentals during the dot-com bubble.

1. Introduction

It seems to be now consensual that an important feature of globalization and increased capital mobility has been the gradually integrated nature of financial markets. As a consequence, several issues arise. On the one hand, tighter cross-market financial linkages may lead to more efficient capital allocation, lower probability of asymmetric shocks and thus better conditions for economic development (see Umutlu et al. (2010)). On the other hand, growing financial interdependence increases the risk of financial contagion, in which shocks originating in one market can quickly spread to others due to (potentially episodic) intensified cross-market linkages. Furthermore, increased comovements may curtail national governments' ability to design appropriate stabilization policies.

Different explanations for the transmission of contagion effects have been put forward, ranging from information/news propagation effects affecting the balance sheet of firms holding assets in the troubled market (see King and Wadhwani (1990) and Kiyotaki and Moore (2002)), a liquidity channel in which a flight-to-quality effect leads to liquidity shortages in integrated markets (see Allen and Gale (2000), Kodres and Pritsker (2002) and Brunnermeier and Pedersen (2009), for example) or time-varying risk premiums, in which negative shocks in one market affects the willingness of agents to bear risk in other markets (see Acharya and Pedersen (2005)). Regardless of the propagation mechanism, it is clear that firmer market linkages and financial contagion may affect portfolio diversification, due to the equalization of returns, and thus endanger financial stability.

In this context, it is crucial to empirically reassess the evidence on equity markets comovements and to which extent different markets are integrated. We suggest in this paper that the degree of integration across equity markets is better viewed as time-varying.[1] Here, rather than studying short run linkages, we choose to focus on long run integration of price levels (which are unlikely to be stationary) in a manner that captures the well known time-varying nature of international asset markets correlations. Thus, for this purpose, we suggest employing a class of single-equation 'interrupted' cointegration models in which we allow for (possibly) several periods out of equilibrium. The statistical law behind the generating break points is stochastic, the equilibrium term dynamics – modelled as an AR(1) – depending upon an unobserved state process

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[1] Alternative mechanisms may lie behind such nonlinearities on the long run relationship of stock prices: shifts in expectations leading to multiple equilibria due to expectation shifts, time-varying herd behaviour caused by changes in fundamentals, etc.

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that is a stationary first-order Markov chain in two states, stationarity and non-stationarity.

Once the least squares residuals of the equation in levels are obtained, the model is estimated and inference is conducted by means of likelihood methods. We employ Qu's (2007) tests for changes in cointegration rank, given their advantage over others of not having to specify any particular cointegration model and of allowing for more than one change over time in the cointegration rank.

Several other studies have considered cointegration methods in an attempt to uncover whether or not a unifying force exists across markets, such that individual equity indices converge to some sort of long run equilibrium. Thus, deviations of one market away from the common trajectory are expected to be reversed in the long term - for example, if a market has performed above expectations, then a reversal should be expected in the future.[2] The results, however, are mixed. Kasa (1992), Arshanapalli and Doukas (1993), Corhay et al. (1993), Chou et al. (1994), Richards (1995) and Manning (2002), *inter alia*, applied Engle-Granger and Johansen cointegration methods, with results differing according to the method, the sample period and the markets considered.

In fact, one of the shortcomings of standard cointegration approaches is that it is assumed that cointegration will always exist and that the cointegrating vector(s) do not change over time, which is quite restrictive and does not take into account the well known variation in equity risk premia (see Campbell (1987) and Bekaert and Harvey (1995), for example; Haldane and Hall (1991) tackle this issue using the Kalman filter, but not in a cointegration framework, studied by Lucey et al. (2010). Thus, modelling asset market integration without considering the time-varying nature of financial linkages may result in misleading conclusions. Our approach allows for more flexibility in studying the dynamics of financial integration and may therefore help to shed light on the contradictory findings in the literature.

We should note that there is a vast literature that investigates stock market linkages focusing mostly on cross-country correlations of asset returns. Several methods have been employed, ranging from standard GARCH models (Longin and Solnik, 1995), adjusted measures of correlation (Forbes and Rigobon, 2001, 2002), switching ARCH methods (Ramchand and Susmel (1998)) or copula models (Rodriguez (2007) and Garcia and Tsafack (2011), for example), just to name a few. Much of these studies focus on returns correlations, rather than prices (which are intrinsically nonstationary, unlike returns). The main strength of our approach is that it simultaneously accounts for long run comovements amongst stock price indices, whilst endogenously allowing for well-documented shifts in the linkages among financial markets. Indeed, by modelling the long run relationship in prices of different markets, we are able to capture underlying economic fundamentals, otherwise omitted in papers focusing on returns correlation, therefore addressing an important source of misspecification typical of studies of contagion, as pointed out by Favero and Giavazzi (2002) and Forbes and Rigobon (2002). In turn, modelling comovements between different indices may be potentially very useful in improving empirical models of stock returns.[3]

To illustrate our point, we use weekly data from March 1980 to March 2012 for a representative set of markets: the US, the UK and Hong-Kong. Our approach allows us to analyse different episodes in which there may have been changes in financial linkages, in particular covering the recent financial crisis, while incorporating long-term information in a flexible way. Indeed, we find evidence of momentarily interrupted equilibrium between May 1997 and April 2002, which is consistent with the decoupling of stock prices from fundamentals during the dot-com bubble.

The remainder of the paper is structured as follows. In Section 2 we present the model specification and the data properties, and we discuss the estimation and testing procedures. In Section 3 we illustrate the merits of our approach with an application to USA, UK and Hong Kong financial data and Section 4 concludes.

2. Cointegration 'interruptions' in a single equation model

2.1. Setup

In this study, we investigate the linkages amongst a representative group of stock price levels in a cointegration setting. While individual stock prices are integrated processes with infinite unconditional variance (and therefore unpredictable in univariate terms), when prices are cointegrated and the difference between them is mean reverting then we do have information about long run equilibrium, which could be very helpful for policy makers, investor and market participants. The crucial difference is that we allow for potential 'interruption' in the long run equilibria.

Indeed, changes in taste, technology, or economic policies shocks can lead to cases in which cointegration does not hold for some periods of the sample.[4] The existing literature on cointegration and 'structural' breaks has essentially focused on developing procedures to detect breaks or to estimate the temporal location of eventual parameter shifts (see, for example, Hansen (1992a), Quintos (1997), Seo (1998), Hansen and Johansen (1999) and Lutkepohl et al. (2003)). Nevertheless, a few modelling devices that take into account temporary or permanent, smooth or dramatic shifts in economic cointegrated relationships have also been considered: 'threshold' cointegration as in Blake and Fomby (1997), where the equilibrium error follows a threshold autoregression that is mean-reverting outside a given range and has a unit root inside the range; 'Markov-switching' cointegration as in Hall et al. (1997) where the long-run vector switches across states according to a Markov law; 'sudden-shift' cointegration of Hansen (2003), where the coefficient regime shifts are sudden, with a known number of breakpoints; and 'smooth' cointegration by Park and Hahn (1999), Saikkonen and Choi (2004) and Bierens and Martins (2010), where the cointegrating vectors smoothly or gradually change regimes or time.

Modeling nonstationary cointegrated variables with globally stationary equilibrium errors, but locally nonstationary, has not been fully explored in the literature. The notable exceptions are Siklos and Granger (1997), Granger and Yoon (2002) and Kim (2001, 2003). Siklos and Granger call this type of relationships 'regime-sensitive' cointegration and model it through the existence (or not) of an extra common stochastic trend depending on the nature of the policy regime in place. On the other hand, Granger and Yoon (2002) propose 'hidden' cointegration, in which the modelling strategy is based on the decomposition of the time series as cumulative sums of positive and negative shocks. Finally, in Kim's 'segmented' cointegration the equilibrium errors are stationary over time, except for a unique sub-period. He proposes modified ADF and Phillips-Perron Z_α and Z_t test statistics for cointegration in an AR(1) model for the disturbance process that is $I(1)$ over the whole sample under the null hypothesis and at a particular subperiod under the alternative.

[2] Naturally, this also implies a relatively high degree of returns predictability.

[3] Our approach does not focus on the transmission of (measures of) volatility (see King and Wadhwani (1990), King et al. (1994) or, more recently, Corradi et al. (2012), amongst others), although it easily allows for heteroskedasticity.

[4] Robert Engle, in his interview for *Econometric Theory* (volume 19, pages 1175/6) explains that "you may have cointegration for a while, but then you will get big shocks to the system, and those will be permanent shocks, and they will move the cointegrating relationship to a new place. And so you no longer get the reversion to the old equilibrium."