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Robust global stock market interdependencies

Brian M. Lucey [a,b,*], Cal Muckley [c]

[a] School of Business Studies, Trinity College Dublin, Dublin 2, Ireland
[b] Caledonian Business School, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA, Scotland
[c] Smurfit Business School, University College Dublin, Dublin 4, Ireland

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ABSTRACT

In this paper, we examine the scope for in ternational stock portfolio diversification, from the viewpoint of a United States representative investor, in regard to both the Asian and the European stock markets. Our findings indicate that despite correlation style evidence to the contrary, the European stock markets provide a superior long-term diversification opportunity relative to that provided by the Asian stock markets. Hence, a short-term measurement of interdependence appears to be uninformative with respect to the diversification opportunities of investors with longer term investment horizons. In terms of methodology, we adopt common stochastic trend tests, including a common stochastic trend test which accounts for generalised autoregressive conditional heteroskedasticity effects in conjunction with the recursive estimation of these tests to estimate the development of long-term stock market interdependence linkages. Recursively estimated robust correlations between the international stock markets are utilised to reveal the nature of short-term stock market interdependence linkages.

1. Introduction

Are global stock market correlations an appropriate calibration of the global scope for stock portfolio diversification with regard to investors with long-term investment horizons? In particular, in this article, we consider whether the classical mean-variance portfolio allocation framework (Markowitz, 1952a,b, 1987) identification of the correlation measurement as a fundamental feature in the determination of the composition of an optimal portfolio, in a context of uncertainty, is an appropriate strategy to inform long-term portfolio allocation decisions.

Salient shortcomings of the classical mean-variance approach to portfolio allocation are described in the literature including the implications of neglected estimation error with regard to small changes in the expected returns and correlations (Garlappi, Uppal, & Wang, 2007; Scherer, 2002), the apparent long-term instability of the correlations among global stock markets over time (Bekaert & Harvey, 2000; Engle, Capiello, & Sheppard, 2006; Goetzmann, Rouwenhurst, & Lingfeng, 2005; Kim, Moshirian, & Wu, 2005; Longin & Solnik, 1995), the presence of inescapable transaction costs (commissions, fees, bid-ask-spreads and taxes) and turnover constraints as a result of the likelihood of illiquidity arising in the markets as well as the associated possibility of a costly price impact of trades (Acharya & Pedersen, 2005; Amihud, 2002). Notwithstanding the provision in this literature of valuable (albeit partial) solutions to these shortcomings, it is generally evident that the more extended the investor's investment time horizon, the more severe the deleterious implications of the outlined shortcomings inherent to the mean-variance portfolio allocation framework. As a result, it may be the case, in regard to an investor with a relatively long-term investment horizon that an alternative measurement of interdependence should be adopted which is expected to necessitate fewer opportunities to rebalance the investor's stock portfolio with a view to availing of the potential for international stock market diversification.

Time-varying volatility effects further accentuate the dilemma of estimation error with respect to the estimation of the main features of the classical mean-variance portfolio allocation framework. Specifically, it is well established, at least since Forbes and Rigobon (2002), that failure to take account of the time-varying nature of the covariance structure of a system of traded securities may lead to significant biases in estimated and interpreted correlation style results. To overcome this impasse a number of approaches have been developed in the extant literature. *First*, Forbes and Rigobon (2002) provide an estimate of unconditional correlation corrected for time-varying volatility effects. *Second*, a substantial body of literature has used various autoregressive conditional heteroskedasticity (henceforth ARCH) models such as the Dynamic Conditional Correlation (Engle & Sheppard, 2001) approach to estimate directly the dynamics of the correlation process across time. For example, Hardouvelis, Malliaropulos, and Priestley (2006) in regard to European stock markets and Hyde, Bredin, and Nguyen (2007) in

* Corresponding author at: School of Business Studies, Trinity College Dublin, Dublin 2, Ireland.
E-mail address: blucey@tcd.ie (B.M. Lucey).

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regard to Asian stock markets have extracted time-varying correlations which explicitly model the structure of the correlation and covariance matrix at each point in time. Notwithstanding these approaches to resolving the phenomenon of a time-varying covariance structure in respect to the estimation of correlations, there remain the outlined shortcomings with respect to the validity of correlations as a calibration of the global scope for portfolio diversification (Naranjo & Porter, 2007, particularly over relatively long-term time horizons.

In addition, it is evident that these shortcomings of the correlation measurement as an indicator of interdependence may have far reaching consequences for the empirical asset pricing literature where heretofore these shortcomings have been neglected (de los Rios, 2009; Dey, 2005; Dvorak & Podpiera, 2006; Goriaev & Zabotkin, 2006; Grandes, Panigo, & Pasquini, 2010; Saleem & Vaihekoski, 2008) as well as the stock market integration and contagion literatures (Alagidede & Panagiotidis, 2009; Cajueiro, Gogas, & Tabak, 2009; Chuang, Lu, & Tswei, 2007; Gannon, 2005; Hasan & Schmiedel, 2004; Kearney & Lucey, 2004; Lin & Swanson, 2008; Singh, Kumar, & Pandey, 2010; Swanson, 2003; Tai, 2007) and those contributions which seek to explicate the correlation structure as dependent on economic freedom, cultural distance, the legal framework or network strategies (Buchanan & English, 2007; Hasan & Schmiedel, 2004; Lucey & Zhang, 2010; Smimou & Karabegovic, 2010). In summary, these latter contributions, while valuable in their own right, are incapable of reflecting long-run relations which are not necessarily consistent with the documented short-run relations estimated in these studies. As a result, a set of papers in the literature has adopted alternative models of common stochastic trends to capture long-term interdependence linkages between international stock markets.

While a significant body of papers has documented the nature of long-term relations in both Asian (Azman-Saini, Azali, Habibullah, & Matthews, 2002; Chang & Caudill, 2006; Choudhry, Lu, & Peng, 2007; Laopodis, 2005; Manning, 2002; Phylaktis & Ravazzolo, 2005; Yang & Siregar, 2001) and European (Aggarwal, Lucey, & Muckley, 2010; Chan, Gup, & Pan, 1997; Phengpis & Apilado, 2004; Rangvid, 2001; Serletis & King, 1997; Syriopoulos, 2007; Voronkova, 2004; Yang, Hsiao, Li, & Wang, 2006) stock markets only a few recent contributions have adopted techniques that control for alterations in regime and time-varying volatility effects. For example, Lucey and Voronkova (2008) allow for regime switching in cointegrating relationships for Russian and European stock markets and Lagoarde-Segot and Lucey (2007) examine Middle East and North African stock markets and use, in addition to a regime switching cointegration methodology, the nonparametric cointegration model of Breitung (2002) and the stochastic volatility cointegration model of Harris, McCabe, and Leybourne (2002).

In fact, it is clear that the literature in the area of cointegration testing, in the context of ARCH style disturbances, is in its infancy. The theoretical literature (Lee and Tse (1996), Silvapulle and Podivinsky (2000) and Hoglund and Ostermark (2003)) indicates that these non-spherical disturbances aggrandise the size of the Johansen (1988) cointegration test. For example, Lee and Tse (1996) report that while the Johansen (1988) cointegration test tends to overreject the null hypothesis of no cointegration in favour of finding cointegration, the problem is generally not harmful. Silvapulle and Podivinsky (2000) report results that are similar. In contrast, Hoglund and Ostermark (2003) find that the eigenvalues of the long-term information matrix for the Johansen (1988) cointegration test are highly sensitive to conditional heteroskedasticity and that therefore this multivariate statistic is only reliable in the context of homoskedastic processes. This latter finding, regarding the size of the cointegration test, becomes increasingly pronounced the more integrated the ARCH process considered. That said, these contributions pertain to low dimensional systems and, as a result, are of limited empirical relevance. In contrast, empirical contributions (Alexakis and Apergis (1996), Gannon (1996) and Pan, Liu, and Roth (1999)), across a wider range of system dimensions, tend to indicate that these ARCH effects and their variants exert a significant and deleterious impact on the statistical test's power properties. Specifically, the aforementioned empirical literature identifies significant gains in statistical power once ARCH effects are controlled, when testing for cointegration, using the Johansen (1988) technique.

It is in the spirit of this latter set of papers, which aims to control for heteroskedasticity when testing for cointegration that we work. In particular, this paper examines three interrelated issues: *first* the extent to which intra-group predominant Asian (Hong Kong, Japan, Korea, Singapore and Taiwan) and European (France, Germany, Italy, the United Kingdom and Sweden) stock markets are statistically interdependent, during the period 1988 through to 2007.[1] These groups are also extended to include the United States stock market.[2] Statistical interdependence is estimated from both short- and long-term vantage points. *Second*, the time-varying dynamics and alterations in regime of these interdependence linkages are examined by means of recursive methodologies. *Third*, the extent to which conventional measurements, of short- and long-term interdependence, are susceptible to the detection of "spurious" interdependence as a consequence of inadequate test specification, in particular in how they account for heteroskedasticity, is addressed in this article. We provide methodological novelty in particular in the latter, estimating a recent test for cointegration under the assumption of ARCH style disturbances. This test, following Gannon (1996) and Aggarwal and Muckley (2010), developed in the framework of the Johansen (1988) cointegration statistic, permits the evaluation of the nature of interdependence while correcting for ARCH style disturbances. We demonstrate how and when the traditional Johansen (1988) and the new modified test statistic show divergent evolutions of interdependence. In addition, we estimate the correlations—the short-term interdependencies—in a manner, following Forbes & Rigobon, 2002, which seeks to control for heteroskedasticity.

Compared to previous literature, our contribution is threefold. *First,* we find that the set of important European stock markets exhibits a significantly larger correlation with the United States stock market than exhibited by the group of important Asian stock markets. Moreover, our findings indicate that this discrepancy is growing slightly over time. *Second*, in contrast to the evidence provided by our examination of the continental stock market correlations, the long-term relations appear to bind the Asian stock markets and the United States stock market, while these long-term relations are largely absent between the European stock markets and the United States stock market. As a result, our findings build directly on those of Hsin (2004) who indicates distinct levels of interdependence between the United States market and the European markets versus the interdependence between the United States market and the Asian markets. *Third*, following from these outlined contributions, our findings indicate that the popular and traditional co-movement measurement (*i.e.* the correlation measurement) is uninformative with respect to the diversification decisions of a representative United States investor with a long-term investment horizon.

The remainder of this article is organised as follows: Section 2 describes the econometric methodologies adopted in this article to model interdependence linkages between Asian and European stock markets and the United States stock market. Section 3 describes our data and presents the main finding from our estimation work. Finally, concluding remarks are presented in Section 4.

[1] This period starts after the global financial crisis of 1987 and ends before the advent of the global financial crisis in 2008. Thus, it is the longest recent period that is uncontaminated by the largest rapid adjustments in stock markets' value in recent decades.

[2] These markets were selected on the criterion of average market capitalisation in United States dollars during the approximate twenty year period (depending on data availability) prior to December 2007.