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Structural change and international stock market interdependence: Evidence from Asian emerging markets ☆

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ABSTRACT

This study investigates the evolving pattern of the interdependence among selected Asian emerging markets and three major stock markets (Japan, UK and US). Using rolling cointegration methods and the recently developed algorithms of inductive causation, we found that time-varying cointegration relationships exist among these stock markets. The results indicate that the wave of financial liberalization policies in the early 1990s led to a significant increase in market linkages which was later weakened during the 1997 Asian financial crisis. Furthermore, the data indicate that Japan and the US have the greatest influence on the emerging markets while the influence of Singapore and Thailand has increased since the Asian financial crisis.

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1. Introduction

In recent years, the economic successes of several Asian economies and their increasingly important roles in the global financial market have motivated several studies on linkages between emerging stock markets.[1] If international stock markets are highly integrated in the long-run, the potential long-term gains from international portfolio diversification may not be substantial (Taylor and Tonks, 1989). Thus, previous studies have examined this issue by exploring both long-run and short-run dynamic linkages (Masih and Masih, 1999; Ghosh et al., 1999). Despite a large body of literature on international market interdependence, the existing empirical evidence remains ambiguous and has yielded conflicting results regarding the nature of the dynamic interdependence among developed and/or emerging markets. For example, while some previous studies have found no long-run relationship (i.e., cointegration) between Asian emerging stock markets (e.g., Chan et al., 1992; DeFusco et al., 1996), others have reported positive evidence (e.g., Darrat and Zhong, 2002; Bessler and Yang, 2003).

In order to reconcile the ambiguity in past studies, some researchers argue that the mixed results may be due to the time-varying nature of international stock market relationships (Bekaert and Harvey, 1995; Yang et al., 2003; Brada et al., 2005; De Jong and De Roon, 2005). Also, some analysts suggest the need for exploring the impact of capital market liberalization in the emerging markets and the effects of past episodes of financial crisis as potential sources of instability in the pattern of stock market linkages (Phylaktis and Ravazzolo, 2005; Charles and Darne, 2006; Dungey and Martin, 2007). While several authors have argued that international market linkages may be strengthened by a financial crisis (Arshanapalli et al., 1995), there is still no consensus on whether a crisis-induced strengthening of international market linkages is transitory or permanent.

In this paper, we contend that explicitly accounting for time variation in stock market linkages is important. Furthermore, we reexamine three unresolved empirical questions in the literature on capital market co-movements with the aid of recently developed modeling techniques. The paper investigates the following questions: (i) did stock market linkages strengthen after financial market liberalization; (ii) did the Asian financial crisis stimulate stronger linkages among emerging Asian markets? (iii) which major stock market (Japan, UK, US) dominated the Asian emerging markets?

While these questions have been previously addressed by some researchers, this paper is able to shed more light on these issues by more thoroughly examining various aspects of market linkages. Specifically, this paper extends the existing literature in the following important aspects. First, we explore the potential time-varying behavior of long-run stock market relationships. For investors to be able to adequately exploit knowledge of the structure of stock market co-movements, they

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[1] See Eun and Shim (1989) and Bessler and Yang (2003) for more detailed review of the earlier and the more recent literature on the relationship between major stock markets. Choudhry (1997) provide evidence for emerging stock market efficiency in non-Asian transition economies. There is another line of research focusing on stock market volatility spillover in major or emerging stock markets, which is not pursued in this study.

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would need to possess reliable information on the stability of the observed market linkages (Panton et al., 1976). Indeed, while numerous studies draw on the implication of the (non)existence of cointegration for long-run diversification potentials, the instability of the long-run relationships has not yet received much attention. In this context, the financial liberalization in the Asian emerging markets and the episode of 1997 Asian financial crisis are conceivably potential sources of structural breaks in international stock market integration. Furthermore, the rolling cointegration technique used in this study (Swanson, 1998; Brada et al., 2005) serves as a formal statistical tool to detect potential multiple structural breaks. The approach extends the recent literature on dating financial market integration (Bekaert and Harvey, 1995; Bekaert et al., 2002) which argues for the importance of detecting endogenous structural break points in a data-determined manner.[2]

Second, although the importance of contemporaneous information transmission among stock markets is well recognized, there is generally a lack of in-depth analysis of instantaneous price shock transmission in international financial markets (Eun and Shim, 1989; Bessler and Yang, 2003). To our knowledge, this paper is the first study to explore the contemporaneous information flow among emerging markets and between emerging markets and major developed markets. Such investigation certainly help us better understand the nature of these stock market relationships and may carry implications for trading (e.g., day trading). Similar to earlier studies, the directed acyclic graph (DAG) technique is employed for the purpose (Spirtes et al., 2000; Pearl, 2000). Further extending previous studies (e.g., Bessler and Yang, 2003; Demiralp and Hoover, 2003; Haigh and Bessler, 2004), this study explicitly accounts for the time-varying pattern of instantaneous price shock transmission, and also uses a more sophisticated and powerful DAG algorithm (i.e., GES) instead of the basic and commonly used PC algorithm.

Finally, as shown in Swanson and Granger (1997), contemporaneous causal patterns, as identified through DAG analysis of the correlation (covariance) matrix of a vector autoregression (VAR) or error correction model (ECM) residuals, further provides a data-determined solution to the basic problem of orthogonalization.

The empirical results confirms that time varying cointegrating relationships exists among the stock markets and that financial market liberalizations and the 1997–98 Asian crisis affected the stability of market linkages. This study also provides strong evidence suggesting that Japan serves as the most dominant market in Asia, and its influence in the region in the longer-run is comparable to that of the US. There is additional evidence in support of previous studies confirming US market leadership role in the long-run. Nevertheless, while the US has great influence on Asian markets in the long-run, its influence in contemporaneous time is insignificant. Rather, the results show that Japan (and Singapore) provides leadership to the other Asian markets in contemporaneous time. The remainder of the paper is organized as follows. Section 2 discusses the empirical methodology, Section 3 describes the data, Section 4 presents the empirical results, and Section 5 contains concluding remarks.

2. Empirical methodology

2.1. Rolling cointegration analysis

While recursive cointegration analysis (Hansen and Johansen, 1999) or the cointegration analysis with allowance for one regime shift (Gregory and Hansen, 1996) may shed some light on the instability of long-run relationship, rolling cointegration analysis is substantially different and econometrically more suited for the purpose. In particular, as pointed out in Swanson (1998, p.456–457), recursive estimation with a growing window of data assumes that the system is evolving to some final form and thus is inadequate in tracking a possibly evolving system in the sense of time-varying parameters. Specifically, if there is (at least) a structural break, parameter estimates after the break is based on the data mixed with two (or more) different regimes and thus may be imprecise or even invalid. By contrast, rolling cointegration analysis with a fixed-length window can ensure that the effects of regime shifts are isolated and restricted to the event period, rather than being allowed to cloud the overall picture (Elyasiani and Kocagil, 2001).

Long-run relationships between economic variables can be explored using the Johansen (1991) cointegration technique which models time series as a reduced rank regression based on maximum likelihood estimation. Let X_t denote a vector which includes p nonstationary time series ($p=12$ in this case). If p time series are cointegrated, it can be expressed by an error correction model (ECM):

$$\Delta X_t = \alpha\beta' X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \mu + \varepsilon_t (t = 1,\ldots,T) \quad (1)$$

where the rank of $\prod = \alpha\beta'$ determines the number of cointegration vectors.

Following the literature (Swanson, 1998; Brada, Kutan, and Zhou, 2005), rolling cointegration analysis is applied in this study to examine the time varying behaviour of the cointegration rank. Basically, all the parameters of the ECM are re-estimated during the rolling estimations. Let $Z_{0t}=\Delta X_t$, $Z_{1t}=X_{t-1}$, $Z_{2t}=(\Delta X'_{t-1},\ldots,\Delta X'_{t-k+1})$. For the ease of presentation, we can ignore deterministic terms such as μ in Eq. (1). Eq. (1) can thus be re-expressed as:

$$Z_{0t} = \alpha\beta' Z_{1t} + \Gamma Z_{2t} + \varepsilon_t \quad (t = 1, \ldots, T) \quad (2)$$

Maximum likelihood estimation of Eq. (2) consists of a reduced rank regression of Z_{0t} on Z_{1t} conditional on Z_{2t}. Define $R_{0t}^{(n)}$ and $R_{1t}^{(n)}$ as residuals from the regression of Z_{0t} and Z_{1t} on Z_{2t}, respectively, where the superscript n denotes that estimation of short-run dynamics is based on the rolling fixed-length window with n observations. That is,

$$R_{0t}^{(n)} = Z_{0t} - M_{02}^{(n)} \left[M_{22}^{(n)}\right]^{-1} Z_{2t}$$

$$R_{0t}^{(n)} = Z_{1t} - M_{12}^{(n)} \left[M_{22}^{(n)}\right]^{-1} Z_{2t}$$

where

$$M_{ij} = \sum_{s=1}^{n} Z_{it} Z_{jt}' \quad (i,j = 0,1,2)$$

The remaining analysis can be based on the following regression equation where the parameter Γ has been filtered out:

$$R_{0t}^{(n)} = \alpha\beta' R_{1t}^{(n)} + R_{\varepsilon t}^{(n)} \quad (t = 1, \ldots, n) \quad (3)$$

Defining $S_{ij}^{(n)}$ as the product moment matrices associated with Eq. (3), the maximum likelihood estimator of the cointegrating space is determined by the solution to the eigenvalue problem as follows:

$$|\lambda S_{11} - S_{10} S_{00}^{-1} S_{01}| = 0 \quad (4)$$

which gives eigenvalues $1>\hat{\lambda}_1>\ldots>\hat{\lambda}_p>0$ and $\hat{\lambda}_{p+1}=0$. The eigenvalues of Eq. (4) can be used in various ways to form different tests. The

[2] Arguably, the most fundamental type of structural breaks in VAR modeling of nonstationary time series should be the (possible) structural breaks in the long-run (cointegration) relationship, if such exists. Such a consideration is important, as the presence of cointegration is important for proper model specification and sound causal inference. To our knowledge, no previous work has addressed such an issue in this line of research. Some earlier studies (e.g., Cheung and Ho, 1991; Chakrabarti and Roll, 2002) have explored the stability of short-run relationships between Asian stock markets and major developed equity markets. These results are based on correlations of stock market returns.