How Does Liberalization Impact on Exceedance Correlation?

Evidence from Emerging Stock Markets

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Abstract

We investigate exceedance correlation for 31 emerging stock markets in the context of evolving market liberalization. Our results provide empirical evidence that the liberalized submarket is more responsible for extreme movements in the aggregate market; and exceedance correlation has a bearing on both local and regional liberalizations with the interplay of the wealth-constraint and portfolio-rebalancing effects being the underlying mechanism. We also find that the regional liberalization impact is more positive than the local one; and both the local and regional liberalization impacts are more positive for extreme downside market moves than for upside moves.

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We investigate exceedance correlation for 31 emerging stock markets in the context of market liberalizations, to explore the issue of how evolving local and regional liberalizations of emerging stock markets impact on these markets' extreme movements. Our interest is not in exceedance correlations across different emerging markets nor between emerging and developed markets. Rather, we are interested in exceedance correlations *within* each individual emerging market.

Focusing on the impact of e*volving* liberalization, our study treats liberalization as a continuous process. Therefore, following Bekaert (1995) and Edison and Warnock (2003), we use the so-called Liberalization Intensity measure (Bekaert, Harvey and Lundblad (2005)). That is, we measure the changing degree of local stock market liberalization by the proportion of the market's assets accessible to foreign investors (henceforth, "accessible assets"; and conversely, "inaccessible assets"); and measure the changing degree of regional stock market liberalization by the proportion of the region's accessible assets (excluding the market under investigation). This measure also enables us to define the "liberalized submarket" as the "accessible" portion, and the "unliberalized submarket" as the "inaccessible" portion, of an aggregate stock market.

We then model exceedance correlation between returns on an aggregate national stock market and returns on its liberalized submarkets or its unliberalized submarkets, for market downturns and market upturns respectively. Exceedance correlation is related to tail risk, and utilizes Extreme Value Theory (EVT) to describe dependence between tail observations of risky asset returns. This EVT-based approach has recently become popular in the finance literature (See, for example, Longin and Solnik (2001), and Boyer, Kumagai and Yuan (2005)). However, we innovate in the approach by considering time-varying exceedance correlation in addition to constant one. When modeling time-varying exceedance correlation, we allow the correlation structure to depend on the changing levels of local and regional market liberalizations.

Based on the estimates of the model parameters, we conduct a battery of tests to investigate the following four questions. We form the test hypotheses on the wealth-constraint and portfolio-rebalancing theories, inspired by Boyer, Kumagai and Yuan (2005) who apply the theories in investigating how stock market crises spread. We attempt to shed some light on what mechanism underlies the liberalization impact on exceedance correlation.

The first question to interrogate is: Which submarket, the liberalized or the unliberalized, is more responsible for extreme movements in the aggregate market? If the liberalized submarket bears more the blame than the unliberalized submarket for extreme movements in the aggregate stock market, the former should have a greater exceedance correlation with the aggregate market than the latter.

Second, we ask whether there exists the wealth-constraint effect in both the liberalized and unliberalized submarkets. The existence of the wealth-constraint effect would be implied by the observation that exceedance correlation is asymmetrically higher in downside than upside market movements. And this observation should be consistent between the "liberalized" and "unliberalized" equity portfolios.

Third, as a main contribution of our paper, we discuss in detail and empirically investigate the question of how the wealth-constraint effect interacts with the portfolio-rebalancing effect in determining the local and regional liberalization impacts on exceedance correlation. The impact of local liberalization involves the local emerging market and local investors, while the impact of regional liberalization involves local and neighboring emerging markets and developed markets, and local and international investors. In the local liberalization case, information and liquidity shocks work in the same direction, as no other markets than the local one are involved in the transmission of the shocks. In the regional liberalization case, however, these two types of shocks may neutralize the portfolio effect as they transmit through other markets including developed and emerging markets (Kodres and Pritsker (2002)). If this is true, we expect to see that the local liberalization impact is more negative (or less positive) than the regional liberalization impact on exceedance correlation.

Finally, as another important contribution of our present paper, we explore the question of whether asymmetry exists in the impact of local liberalization, and in the impact of regional liberalization, across market downturns and upturns. If the interaction between the wealth-constraint and portfolio-rebalancing effects underlies the impacts of local and regional liberalizations and if the portfolio-rebalancing effect is symmetric, then the impacts of local and regional liberalizations should demonstrate asymmetry between bear and bull markets: greater (more positive) for bear than for bull markets. Therefore, the existence of the asymmetry of liberalization impacts can be taken as further evidence that the underlying mechanism of liberalization impacts is the interaction between the wealth-constraint and portfolio-rebalancing effects.

Our work is relevant to the debate on the liberalization of financial markets in emerging economies. Some two decades ago, stock market liberalization for emerging economies was almost unanimously advocated, but today it has become the single most controversial policy prescription. Following a series of financial crises in emerging economies in the 1990s, the debate has shifted from when to liberalize the stock market to whether to liberalize it at all. The pros of stock market liberalization center on stimulating economic growth, while the cons of stock market liberalization revolve around worsening economic instability (Tornell and Westermann (2005)). In the context of this debate, our results have implications at several levels. For example, at the level of economic reform, extreme market movements, in addition to excess volatility as emphasized in Bekaert and Harvey (2000), if indeed induced by foreign investors, will serve as another argument in favor of the need for prudent and well-sequenced liberalization. In addition, if changes in liberalization accompany changes in extreme market movements, risk management measures would need to incorporate updated estimations of risk as the degree of liberalization changes. Adverse extreme market movements are associated with rare and potentially catastrophic events that could result in institutional failure. Thus, regulatory groups like the Basle Committee have promoted some risk measures that capture such market movements as a way of monitoring and managing risk and as a basis for setting regulatory minimum capital standards.

Our study of the liberalization impact on exceedance correlation is related to several areas of finance. One branch of the finance literature is on the relationship between financial liberalization and market risk in emerging stock markets. These studies have focused on systematic and idiosyncratic risks in order to investigate whether the cost of equity capital increases or decreases as the equity markets become more integrated with the rest of the world.[1] A second branch concerns financial contagion across stock markets during crisis periods.[2] For example, Boyer, Kumagai and Yuan (2005) provide evidence that the Asian Crisis in 1997 spread through changes in international investors' asset holdings rather than changes in each country's market fundamentals, and the transmission mechanism of crisis shocks across countries is market frictions including asymmetric wealth constraints and symmetric portfolio rebalancing. These findings motivate our interest in seeking empirical evidence for further hypotheses. Liberalized submarkets (accessible asset markets) are the main arena where international investors spread crisis, and market liberalization enlarges this arena. As a logical result, we should expect to see that liberalized submarkets are more responsible for extreme movements in the aggregate market; exceedance correlation for liberalized submarkets has a more significant bearing on evolving liberalization; and wealth constraints and portfolio rebalancing also play an important role in determining the impact of liberalization. However, the literature has not paid attention to these issues. Given their importance and relevance, these neglected issues are the focus of our research. Evidence supporting these hypotheses can also be taken as additional evidence further supporting the investor-induced contagion hypothesis studied in Boyer, Kumagai and Yuan (2005).

I. Models and Data

To examine exceedance correlation in the context of evolving market liberalization, we employ two models. One is the generalized Pareto distribution model which deals with the tails of the marginal distribution of each return series concerned. The other is the Gumbel copula model, a device useful for estimating correlation between the tails of several univariate marginal distributions. To estimate the models, we use a unique set of data for emerging stock markets. This section gives brief descriptions of the models and data used. More details of the models can be found in Longin and Solnik (2001), and an excellent and detailed description of the data on emerging market stocks is given in Boyer, Kumagai and Yuan (2005).

A. Generalized Pareto Distribution Model

Following Longin and Solnik (2001), we define extreme values as exceedances exceeding a threshold. Extreme value theory suggests that whatever kind of distribution of its exceedances a return series might have, asymptotically or as the threshold tends to the upper endpoint, the non-degenerate limit distribution of its exceedances can be approximated only by the generalized Pareto distribution (GPD). This is true regardless of whether or not the return series is identically and independently distributed (See Leadbetter, Lindgren and Rootzen (1983), Longin and Solnik (2001)). For this reason, we adopt the GPD approach ignoring the possible presence of stochastic volatility in the return data.

The tails of the univariate marginal return distribution can be modeled as follows:

$$F(R_{jt}) = (1-P_j) + P_j G(R_{jt}) = 1 - P_j \left(1 + \xi_j \frac{R_{jt} - \mu_j}{\sigma_j}\right)_+^{-1/\xi_j} \qquad (1)$$

where $G(R_{jt})$ is the so-called GPD function (cumulative distribution function):

$$G(R_{jt}) = 1 - \left(1 + \xi_j \frac{R_{jt} - \mu_j}{\sigma_j}\right)_+^{-1/\xi_j} \qquad (2)$$

The subscripts G, I and N represent, respectively, global stocks, accessible stocks and inaccessible stocks. So R_G, R_I and R_N denote, respectively, global index returns, accessible index returns and inaccessible index returns. ξ_j, μ_j and σ_j are, respectively, the tail index (or shape parameter), the threshold, and the dispersion parameter. P_j represents the probability with which a positive exceedance (R_{jt} - $\mu_j \geq 0$ and $\mu_j > 0$), drawn from the limit univariate distribution $G(R_{jt})$, occurs. Thus, $1 - P_j$ is the probability that a return R_{jt} does not belong to the positive exceedance (or the positive tail). The above discussion applies to negative return exceedances by changing signs as appropriate.

B. Copula Model

A copula is a function that connects marginal distributions. Among a number of copula models, the Gumbel copula is a popular one in financial applications because of its simplicity that only one parameter is required to model exceedance correlation, and thus is used in this study. The cumulative distribution function (CDF) of the Gumbel copula in our case reads

$$C[F(R_{jt}), F(R_{kt})] = \exp\left\{-\left[\left(-\log F(R_{jt})\right)^{1/\alpha} + \left(-\log F(R_{kt})\right)^{1/\alpha}\right]^{\alpha}\right\} \qquad (3)$$

where $0 < \alpha \leq 1$ is a parameter that controls the amount of dependence between positive return exceedances: R_j - $\mu_j \geq 0$ and R_k - $\mu_k \geq 0$ (The same applies to negative return exceedances by changing signs). The relationship between the exceedance correlation coefficient ρ and α is $\rho = 1 - \alpha^2$. Equation (3) is a constant copula model where exceedance correlation remains unchanged over time.

Modeling time-varying tail dependence has been attempted by several studies. Patton (2002) and Dias and Embrechts (2003) are two examples. Inspired by their works, we hypothesize that the exceedance correlation structure could be varying over time, but remain particularly interested in the central questions of our research. That is, we model exceedance correlation as a function of the level of local market liberalization and the level of regional market liberalization to see if there are any market-liberalization impacts on exceedance correlation.

The time-varying copula model that serves our purpose consists of the following:

$$C[F(R_{jt}), F(R_{kt})] = \exp\left\{-\left[\left(-\log F(R_{jt})\right)^{1/\alpha_t} + \left(-\log F(R_{kt})\right)^{1/\alpha_t}\right]^{\alpha_t}\right\} \quad (4)$$

$$\alpha_t = \sqrt{1-\rho_t}$$

$$\rho_t = 1/[1+\exp(-X_t)]$$

$$X_t = b_0 + b_1 V_{t-1}^{LOC} + b_2 V_{t-1}^{REG}$$

where V_{t-1}^{LOC} and V_{t-1}^{REG} denote, respectively, the level of local market liberalization and the level of regional market liberalization, lagged by one period.

We use a logistic transformation, $1/[1+\exp(-X)]$, to keep ρ_t between 0 and 1 at all times.[3] The parameters to be estimated for both the positive and negative return exceedances are b_0, b_1 and b_2. The constant copula (3) is a special case of the time-varying copula (4): if $b_1 = 0$ and $b_2 = 0$, ρ_t (= $1/[1+\exp(-b_0)]$) becomes constant and (3) is recovered. We term b_1 and b_2 as the local liberalization impact parameter and the regional liberalization impact parameter respectively throughout.

In estimating equations (3) and (4) respectively with the maximum likelihood method, the threshold value μ_j is set to be 1.5 sample deviation from the mean, following Ang and Chen (2002) and Boyer, Kumagai and Yuan (2005).

D. Data

All data used for model estimation are weekly, to avoid market microstructure complications daily data notoriously possess, and to make our results comparable with those in prior work that uses the same data set at the weekly frequency (See Boyer, Kumagai and Yuan, 2005). We obtained the data from the Emerging Markets Data Base EMDB 2000.

EMDB 2000 provides information and statistics on 35 emerging economies in four geographical regions: Asia, Europe, Latin America and Middle East/Africa. We select 31 economies for investigation, however, because the four discarded economies (Bahrain, Nigeria, Oman and Saudi Arabia) do not have data on accessible stocks. The sample period varies across economies due to data availability. The longest sample period spans from January 1989 to September 2003, while the shortest from December 1996 to March 1999.

EMDB 2000 contains Global and Investable Stock Total Return Indexes, and other related statistics. The "Global Index" refers to the index which includes two types of stocks. One type is accessible to domestic investors only, while the other is readily accessible to foreign investors (called "Investable"). We take the Global Index to represent the aggregate national stock market, although it does not include all stocks traded in the country. Since EMDB 2000 does not provide the return indexes of stocks that are inaccessible to foreign investors, we follow Boyer, Kumagai and Yuan (2005) when constructing a series of inaccessible index returns. Inaccessible index returns are calculated as:

$$R_{N,,t} = (M_{G,t\text{-}1} \times R_{G,t} - M_{I,t\text{-}1} \times R_{I,t})/(M_{G,t\text{-}1} - M_{I,t\text{-}1}) \qquad (5)$$

where R_G, R_I and R_N denote, respectively, global, accessible and inaccessible index returns which are calculated as the first difference of the natural logarithm of the corresponding stock total return index. M_G, M_I and M_N are the market capitalization of, respectively, the global, accessible and inaccessible stocks. With data on M_G and M_I available, we construct an indicator of the degree of local liberalization V^{LOC} by using the ratio of the market capitalization of a market's accessible stocks to the market capitalization of the market's global stocks, M_I/M_G. The indicator of the degree of regional liberalization V^{REG} is constructed in a similar matter, as the ratio of the market capitalization of a region's accessible stocks to the market capitalization of the region's global stocks but with the concerned economy in the region being excluded from the calculation.

II. Theories and Hypotheses

To empirically investigate the four questions posed at the beginning of this paper, we do a couple of things in this section. First, we briefly introduce the theories of the wealth-constraint effect and the portfolio-rebalancing effect. Next, we discuss the test hypotheses regarding constant exceedance correlation for the liberalized and unliberalized submarkets. Finally, we draw the testable implications from the wealth-constraint and portfolio-rebalancing theories for the liberalization impact parameters in time-varying exceedance correlation.

A. Wealth-Constraint Effect and Portfolio-Rebalancing Effect

Recently developed finance theories on the wealth-constraint (WC) effect and the portfolio-rebalancing (PR) effect seem to be most relevant to our research. In our discussion below, the ideas of the WC effect are mainly taken from Kyle and Xiong (2001), and those of the PR effect from Kodres and Pritsker (2002).

The WC theory suggests that when investors lose money in one asset/market, their capacity for bearing risks is reduced and so positions will be liquidated in that asset/market and others. When investors make money in one asset/market, however, they do not have to hold more positions in both that asset/market and others. In other words, asymmetry may characterize the WC effect. The PR theory states that investors respond to shocks in one market by readjusting their portfolios in other markets, optimally in a sense that the readjusted portfolios will maintain exposure to some risk factors at the optimal level which the pre-readjusted portfolios have.

However, the WC theory does not suggest that the WC effect can only characterize the behavior of investors from emerging markets, nor does the PR theory suggest that the PR effect can only characterize the behavior of investors from developed markets. We believe that investors from emerging markets include both WC and PR investors, and so do investors from developed markets. Whether WC investors dominate PR investors or PR investors dominate WC investors is an empirical issue, and this applies to investors from either emerging or developed markets.

Nevertheless, the WC theory suggests that the WC effect should be greater in market downturns than in market upturns, while the PR theory suggests that the PR effect should be symmetrical across market downturns and market upturns. In other words, when markets turn from being "bear" to being "bull", wealth constraints become no binding for WC investors,[4] while portfolio-rebalancing activity remains the same for PR investors. Exploring the interaction between the asymmetry of the WC effect and the symmetry of the PR effect distinguishes our study from previous ones that fail to consider such an interaction.

Note also that "a flight to quality" is only one portfolio-rebalancing activity. Boyer, Kumagai and Yuan (2005) empirically test the "flight-to-quality" hypothesis, to examine financial contagion across different markets. They do not find evidence in support of the view that local investors are rebalancing their portfolios in a flight to quality (i.e., to government bonds). Motivated by this result, we will assume that local investors are rebalancing their portfolios to inaccessible assets (not to government bonds), for the purpose to maintain the optimal risk-exposure level of their portfolios - this lies in the heart of the PR theory (Kodres and Pritsker (2002)).

B. Test Hypotheses Regarding Constant Exceedance Correlation

For each emerging market, we estimate the exceedance correlation coefficient (ρ) of its global index returns (indexed by G) with its accessible index returns (indexed by I) and its inaccessible index returns (indexed by N), for extreme market downturns (indexed by "–") and upturns (indexed by "+"). We then compare the difference between the global-vs-accessible and global-vs-inaccessible exceedance correlations. If the liberalized submarket is more responsible for extreme movements in the aggregate market than the unliberalized submarket, we should observe a greater co-movement of global and accessible index returns than of global and inaccessible index returns. Accordingly, the relevant test statistic for the blame of the liberalized submarket is the difference in exceedance correlations across the global-vs-accessible and global-vs-inaccessible cases.

Test 1A *(Blame of the Liberalized Submarket: Market upturns) If the liberalized submarket bears more the blame for causing extreme movements in the aggregate market than the unliberalized submarket, co-movement is higher between global and accessible index returns than between global and inaccessible index returns, during market upturns.*

$$\begin{cases} H_0 : \rho^{+}_{G,I} - \rho^{+}_{G,N} \leq 0 \\ H_1 : \rho^{+}_{G,I} - \rho^{+}_{G,N} > 0 \end{cases}$$

Test 1B *(Blame of the Liberalized Submarket: Market upturns) If the liberalized submarket bears more the blame for causing extreme movements in the aggregate market than the unliberalized submarket, co-movement is higher between global and accessible index returns than between global and inaccessible index returns, during market downturns*

$$\begin{cases} H_0 : \rho^{-}_{G,I} - \rho^{-}_{G,N} \leq 0 \\ H_1 : \rho^{-}_{G,I} - \rho^{-}_{G,N} > 0 \end{cases}$$

For each individual economy, we perform the one-sided *t*-test. To aggregate the results across economies, we use two nonparametric tests: the sign test and the Wilcoxon signed-ranks test. The sign test answers the question of *how often*. That is, under the null hypothesis that the liberalized and unliberalized submarkets equally contribute to the tail risk of the aggregate market, the number of markets with the global-vs-accessible exceedance correlation *higher* than the global-vs-inaccessible exceedance correlation should be approximately equal to the number of markets with the global-vs-accessible exceedance correlation *lower* than the global-vs-inaccessible exceedance correlation. The Wilcoxon signed-ranks test has the same null hypothesis as the sign test, but it concerns the question of *how much* - that is, it takes into account the magnitude of the observations. All the tests discussed in Section II are done using the sign test and the Wilcoxon signed-ranks test, if they concern conclusions drawn at the world's aggregate level.

We are also interested in the issue of asymmetric correlations of equity portfolios in emerging stock markets. Ang and Chen (2002) find evidence of asymmetric correlations between US stocks and the aggregate US market. If this correlation asymmetry also exists in emerging stock markets, co-movements of the aggregate market and the liberalized submarket (or the unliberalized submarket) should be greater at the downside tails than at the upside ones.

Correlation asymmetry is implied by the asymmetry of the WC effect. Take exceedance correlation between global and accessible index returns as an example, and let us apply the WC and PR theories in discussing this example. When a large, negative shock hits the liberalized submarket, it may trigger a selling spree of accessible stocks. The local WC investors will at the same time sell in the unliberalized submarket, causing the prices of inaccessible stocks to fall. However, when a large, positive shock to the liberalized submarket triggers a buying spree of accessible stocks, the local WC investors do not have to (symmetrically) buy in the unliberalized submarket. These suggest an asymmetry of the WC effect. Since the PR effect is symmetric, the asymmetry of exceedance correlation between global and accessible index returns across market downturns and upturns is sorely determined by the asymmetry of the WC effect, and the correlation should be greater at the downside tails than at the upside ones. This is also true for the asymmetry of exceedance correlation between global and inaccessible index returns across market downturns and upturns.

Test 2A *(Asymmetry of the wealth-constraint effect*: *Liberalized submarket) If the wealth constraint effect is asymmetric, co-movement of the aggregate market and its liberalized constituent is higher for extreme downside market moves than for upside moves.*

$$\begin{cases} H_0 : \rho^{-}_{G,I} - \rho^{+}_{G,I} \leq 0 \\ H_1 : \rho^{-}_{G,I} - \rho^{+}_{G,I} > 0 \end{cases}$$

Test 2B *(Asymmetry of the wealth-constraint effect: Unliberalized submarket) If the wealth constraint effect is asymmetric, co-movement of the aggregate market and its unliberalized constituent is higher for extreme downside market moves than for upside moves.*

$$\begin{cases} \boldsymbol{H_0} : \boldsymbol{\rho^{-}_{G,N}} - \boldsymbol{\rho^{+}_{G,N}} \leq \mathbf{0} \\ \boldsymbol{H_1} : \boldsymbol{\rho^{-}_{G,N}} - \boldsymbol{\rho^{+}_{G,N}} > \mathbf{0} \end{cases}$$

C. Test Hypotheses Regarding the Liberalization Impact Parameters

In this subsection, we relax the assumption that exceedance correlation is constant, and explore the question of how local and regional market liberalizations cause exceedance correlation to vary over time through the interaction between the WC and PR effects. Our discussion presented below is only focused on the global-vs-accessible case. Similar discussion can be applied to the global-vs-inaccessible case.

To facilitate exposition, let Country 1 refer to an emerging market in a region (e.g., Asia), Country 3 to all other emerging markets in the same region as Country 1, and Country 2 to a developed market. We assume that local investors from Country 1 can invest in both accessible and inaccessible assets in the home country and in accessible assets of Country 3. International investors from Country 2 can invest in accessible assets of both Country 1 and Country 3. The "large transaction costs" and "home bias" phenomena may be present but should not be exaggerated: they may reduce, for example, the Country 1 and Country 2 investors' holdings of Country 3's accessible assets but only to a certain degree. Otherwise, accessible assets would become *de facto* inaccessible if investors only purchase their home country stocks, which would make pointless foreign investor accessibility to domestic assets.

First, consider the local liberalization impact parameter b_1 for market downturns. Its sign signals whether it is the WC effect that dominates the PR effect or conversely, when changes in local market liberalization impact on correlation between the downside tails of global and accessible index returns. For the ease of exposition, we focus on Country 1. Suppose that accessible assets experience a large loss due to an exogenous negative shock. According to the WC theory, the local WC investors will liquidate part of positions in inaccessible assets causing these asset prices to fall. This then *increases* the probability that global assets may suffer a large loss, leading to a relative large correlation between the downside tails of global and accessible index returns. On the other hand, the PR effect discussed in Section II.A suggests that the local PR investors, when facing a decline in the liquidation value of accessible assets, will sell some of their accessible assets, which lowers their exposure to the home country's risk factor below an optimal level. To raise exposure back to its optimal level, the local PR investors will buy inaccessible assets since accessible and inaccessible assets of Country 1 share the same systematic macroeconomic risk factors. The purchases of inaccessible assets cause these asset prices to rise, offsetting the fall in the prices of accessible assets, which reduces the probability that global assets also suffer a large loss. As a result, correlation between the downside tails of global and accessible index returns would be relatively small.

As local market liberalization V_{t-1}^{LOC} increases, more assets become accessible, and a negative shock to accessible assets will have a larger spreading impact on inaccessible assets. If the WC (PR) effect dominates the PR (WC) effect, the net effect will be of the WC (PR) nature, which will be increasingly reinforced as the local market becomes more liberalized. In this case, correlation between the downside tails of global and accessible index returns will increase (decline) as the level of local market liberalization rises, i.e., $b_1 > 0$ ($b_1 < 0$). In other words, the sign of the impact parameter b_1 will shed some light on which mechanism (the net WC effect or the net PR effect) underlies the impact.

Next, consider the regional liberalization impact parameter b_2 for market downturns. Its sign messages how changes in regional market liberalization affect correlation between the downside tails of global and accessible index returns. The theory on contagion through the cross-market rebalancing channel proposed by Kodres and Pritsker (2002) seems to be relevant in this regard. According to the theory, there are two kinds of shocks at work: the negative information shock and the negative liquidity shock.

A negative information shock to Country 1's accessible asset liquidation value leads to informed sales in the accessible markets of Countries 1 and 3, which depress prices in those markets. The WC investors from Country 1 who hold the accessible assets of Country 3 may liquidate part of their positions in the inaccessible assets of home country (Country 1), thus causing the prices of Country 1's inaccessible assets to decline. This implies a relatively large probability that Country 1's global index returns take a large (in absolute terms) negative value, and hence a relatively large correlation between the downside tails of global and accessible index returns. The PR investors from Country 1 who hold the accessible assets of Country 3 will sell the assets, leading to a lower exposure of the investors to Country 3's risk factor than the optimal level. They may choose to buy Country 2's assets in order to raise their exposure to Country 3's risk factor back to the optimal level. This, however, also raises their exposure to Country 1's risk factor above the optimal level, since Country 2's assets are exposed to both Country 1 and Country 3's risk factors (See Kodres and Pritsker (2002) on page 781). Accordingly, the investors need to sell Country 1's assets including inaccessible ones, in order to reduce their exposure to Country 1's risk factor. As a result, correlation between the downside tails of Country 1's global and accessible index returns will become relatively large, reinforcing the WC effect.

A negative liquidity shock in Country 1's accessible market causes prices to decline in Country 1's accessible market but to rise in Country 3's accessible markets. The WC investors from Country 1 who hold the accessible assets of Country 3 may do nothing about their positions in the inaccessible assets of home country (Country 1), known as asymmetry. The PR investors from Country 1, on the other hand, will buy the accessible assets of Country 3, leading to a higher exposure of the investors to Country 3's risk factor than the optimal level. They may choose to sell Country 2's assets in order to reduce their exposure to Country 3's risk factor back to the optimal level. This, however, also reduces their exposure to Country 1's risk factor below the optimal level. Accordingly, the investors need to buy Country 1's assets including inaccessible ones, in order to raise their exposure to Country 1's risk factor. As a result, correlation between the downside tails of Country 1's global and accessible index returns will become relatively small.

Overall, negative information and liquidity shocks tend to cancel out in terms of the PR effect, and so the net effect inclines to be of the WC nature, i.e., the net effect on exceedance correlation is positive. As regional liberalization increases, investors from each emerging market are able to hold more accessible assets of other emerging markets in the same region. Since accessible assets are the conduit for shocks to transmit through, this implies that evolving regional liberalization would strengthen the WC nature of the net effect.

Note that information and liquidity shocks transmit through Country 2 between Countries 1 and 3, which concerns the impact of regional liberalization, but the impact of local liberalization only involves Country 1. Accordingly, the issue of information and liquidity shocks canceling out in terms of the PR effect may not be relevant to the impact of local liberalization. This suggests that the impact of local liberalization is much less likely to be characterized as the net WC effect. To see if this is true, the third set of tests may be stated as follows.

Test 3A *(Relative WC nature of the net effect across local and regional liberalization impacts*: *Local liberalization) In the presence of both negative information and liquidity shocks, the net effect tends to be of the PR nature in the impact of local liberalization on exceedance correlation.*

$$\begin{cases} \boldsymbol{H_0 : b_1 \geq 0} \\ \boldsymbol{H_1 : b_1 < 0} \end{cases}$$

Test 3B *(Relative WC nature of the net effect across local and regional liberalization impacts*: *Regional liberalization) In the presence of both negative information and liquidity shocks, the net effect tends to be of the WC nature in the impact of regional liberalization.*

$$\begin{cases} H_0 : b_2 \leq 0 \\ H_1 : b_2 > 0 \end{cases}$$

Test 3C *(Relative WC nature of the net effect across local and regional liberalization impacts*: *Difference) In the presence of both negative information and liquidity shocks, the net effect is more of the WC nature in the impact of regional liberalization than in the impact of local liberalization on exceedance correlation.*

$$\begin{cases} H_0 : b_2 - b_1 \leq 0 \\ H_1 : b_2 - b_1 > 0 \end{cases}$$

In other words, we hypothesize that the impact of local liberalization tends to be of the PR nature (i.e., $b_1 < 0$), and the impact of regional liberalization tends to be of the WC nature (i.e., $b_2 > 0$); or the latter is of more the WC nature than the former (i.e., $b_2 > b_1$). We test these hypotheses at the world's aggregate level.

Test 3 can also be conducted for the correlation between the *upside tail*s of global and accessible index returns. However, theory suggests that the WC effect is stronger during market downturns than market upturns, and a large body of the literature has documented supportive evidence. Our fourth set of tests, as follows, is to test this hypothesis.

Test 4A (*Asymmetry of the wealth-constraint effect*: *Local liberalization*) *If the wealth-constraint effect is asymmetric, the impact of local liberalization on the global-accessible exceedance correlation are larger (i.e., more positive or less negative) in the downside tails than in the upside tails.*

$$\begin{cases} H_0 : b_1^- - b_1^+ \leq 0 \\ H_1 : b_1^- - b_1^+ > 0 \end{cases}$$

Test 4B (*Asymmetry of the WC effect*: *Regional liberalization*) *If the wealth-constraint effect is asymmetric, the impact of regional liberalization on the global-accessible exceedance correlation are larger (i.e., more positive or less negative) in the downside tails than in the upside tails.*

$$\begin{cases} H_0 : b_2^- - b_2^+ \leq 0 \\ H_1 : b_2^- - b_2^+ > 0 \end{cases}$$

III. The Impact of Market Liberalization on Exceedance Correlation

A. Test Results Regarding Constant Exceedance Correlation

We only report the estimates of exceedance correlation coefficients in Table I, since other model parameters in equations (1) to (3), such as ξ, μ, σ and P, are not relevant to our research questions. Overall, we observe that 24 of 31 economies have statistically significant correlation between positive global and accessible return exceedances, and 24 between negative global and accessible return exceedances (plus 1 only economically significant). In contrast, the global-vs-inaccessible case witnesses much less supportive evidence for correlation: only 9 of 31 economies show statistically significant correlation between positive global and inaccessible return exceedances (2 are only economically significant), and 10 between negative global and inaccessible return exceedances (1 is only economically significant). In Europe and Latin America, no unliberalized submarkets at all have correlation with their aggregate stock markets.

Tests 1A and 1B provide strong evidence that the liberalized submarket bears more the blame for extreme movements in the aggregate national market than the unliberalized submarket. The one-sided *t*-test yields the following two results: (1) 18 of 31 economies have higher correlation for the liberalized submarket than for the unliberalized submarket during market upturns, with 17 at a higher than 5% significance level, while 8 have the reverse and 5 have no difference (column 6 in Table I). (2) For market downturns, 19 of 31 economies have higher correlation for the liberalized submarket than for the unliberalized submarket, with 16 at the 1% level, while 8 have the reverse and 4 have no difference (column 7 in Table I). Furthermore, both the sign and Wilcoxon signed-ranks test statistics (columns 6 and 7 in Table I) allow us to reject, at a higher than 5% level, the null of equivalent exceedance correlations across the global-vs-accessible and global-vs-inaccessible cases, in favor of the alternative that the global-vs-accessible exceedance correlation is higher than the global-vs-inaccessible exceedance correlation, for both upside and downside market moves, at the world's aggregate level of emerging economies.

Some evidence on the asymmetry of the WC effect is provided by Tests 2A and 2B, but appears to be less strong. At the level of individual economies, only 2 one-sided *t*-test statistics are significant (columns 8 and 9 in Table I). Across 31 economies, the sign test statistic rejects the null of equivalent correlation between market downturns and upturns at the 10% level, while the Wilcoxon signed-ranks test statistic cannot, for the liberalized submarket. As far as the unliberalized submarket is concerned, the sign test statistics cannot reject the null, although the Wilcoxon signed-ranks test statistic can at the 5% level.

To sum up, when comparing the liberalized and unliberalized submarkets in terms of their extreme co-movements with the aggregate market, we find that in a majority of emerging economies, there are significantly larger exceedance correlations between global and accessible index returns than between global and inaccessible index returns. This finding suggests that the liberalized submarket contributes more to the tail risk of the aggregate market than the unliberalized submarket. This finding is also consistent with the evidence provided in Boyer, Kumagai and Yuan (2005) that financial crisis spreads through the asset holdings of international investors, rather than domestic investors. Regarding the asymmetry of the WC effect, supporting evidence is not very strong, as compared to Boyer, Kumagai and Yuan (2005). We subject this issue to further investigations that consider time-varying, rather than constant, exceedance correlation, and explore the question of how evolving liberalization causes exceedance correlation to change over time.

B. *Estimation of the Time-Varying Copula Model*

Having established that the liberalized submarket is more responsible for extreme movements of the aggregate market, we turn to the key question of this study: how does evolving liberalization impact on exceedance correlation. Before discussing the test results related to this question, we take a look at the estimation of the time-varying copula model on which the tests are based.

Exceedance correlation is a *positive* dependence concept: its lowest possible value is zero, corresponding to independence. So, if an exceedance correlation coefficient ρ is found to be zero on average over the entire sample (when treated as a constant), its time-varying estimates must either contain negative values at some data points which violates the non-negativity nature of the concept, or be zero at all data points which does not violate the non-negativity concept. Thus, we estimate the time-varying copula model (4) only for those markets whose constant correlation parameters are found to be significantly different from zero, either statistically or economically, in the global-vs-accessible and global-vs-inaccessible cases and for market downturns and upturns. In the case where constant exceedance correlation is zero, the liberalization impact parameters are also taken to be zero.[5]

Only the estimates of the liberalization impact parameters are presented in Tables II and III, as we are not interested in the estimates of other model parameters such as ξ, μ, σ and P. Table II concerns the global-vs-accessible cases. For positive and negative return exceedances respectively, 24 economies qualify for the estimation of the time-varying copula model, according to columns 2 and 3 in Table I. Both Panels A and B in Table II show that out of these 24 economies, 20 b_1^+'s, 21 b_2^+'s, 21 b_1^-'s and 23 b_2^-'s estimates are statistically significant based on the two-sided t-test statistics (many at the 1% level). Further tests using the likelihood-ratio statistics yield consistent results that these b_1's and

b_2's estimates are indeed significant at the 10% level or higher (many at the 1% level), and so confirm that the results are robust. We also test a joint null hypothesis that both b_1 and b_2 are zero. In the case of upside return exceedances, 22 likelihood-ratio statistics reject the null, while 19 do in the case of downside return exceedances.

Table III pertains to the global-vs-inaccessible cases. For extreme upside and downside market moves respectively, only 11 economies qualify for the estimation of the time-varying copula model, according to columns 4 and 5 in Table I. Out of these 11 economies, 11 b_1^+'s, 10 b_2^+'s, 10 b_1^-'s and 11 b_2^-'s are statistically significant based on the two-sided t-test statistics (many at the 1% level). Further tests using the likelihood ratio statistics confirm that almost all of these b_1's and b_2's estimates are indeed significant at the 10% level or higher (many at the 1% level). The only inconsistency between the t-test and the likelihood-ratio test results appears with b_1^+ for Jordan. Again the joint null hypothesis that both b_1 and b_2 are equal to zero is rejected for 9 of 11 upside, and 10 of 11 downside, global-vs-inaccessible exceedance correlations.

Tables II and III provide evidence in support of the view that evolving local and regional liberalizations impact on exceedance correlation. But what underlie the impact needs further investigations. We now turn to the more informative test results regarding the liberalization impact parameters, to investigate the question of how the WC and PR effects interact to help evolving liberalizations influence exceedance correlation,

C. Test Results Regarding the Liberalization Impact Parameters

Tables IV and V once again report the estimates of the local and regional liberalization impact parameters, but indicate the statistical significance of these parameter estimates based on the one-sided t-test statistics, not on the two-sided ones as in Tables II and III. For comparisons and hypothesis testing at the world's aggregate level, we also include in the two tables those economies with zero constant exceedance correlation coefficients and hence zero liberalization parameters. Table IV concerns the relation between the aggregate stock market and its liberalized constituent, while Table V between the aggregate stock market and its unliberalized constituent.

(1). Test 3: Relative WC nature of the local and regional liberalization impacts

We first examine whether the impact of regional liberalization is more of the WC nature than the impact of local liberalization. The results in Tables IV and V show evidence in support of an affirmative answer. We focus on the liberalized submarket first (Table IV).

The results of Test 3A indicate that the local liberalization impact parameters tend to take a negative value, which suggests that the PR effect tends to dominate the WC effect in the underlying mechanism of the impact of local liberalization. In Table IV, we observe that out of 31 emerging markets, 16 b_1^+'s are negative while 8 positive and 7 zero (column 1 in Table IV); and 15 b_1^-'s are negative while 9 positive and 7 zero (column 3 in Table IV). Among those negative parameter estimates, 13 b_1^+'s are significant at the 1% level and 1 at the 10% level; and 11 b_1^-'s are significant at the 1% level and 1 at the 5% level. Across 31 emerging economies, the sign test rejects the null of b_1^+ being positive or zero at the 10% level (column 1 in Table IV), although it cannot reject the null of b_1^- being positive or zero at this level (column 3 in Table IV). However, the Wilcoxon signed-ranks test reject the null for both b_1^+ and b_1^- at a higher than 5% level (columns 1 and 3 in Table IV).

In contrast, the results of Test 3B show that the regional liberalization impact parameters have a tendency of being positive, which implies that the WC effect largely dominates the PR effect in the underlying mechanism of the impact of regional liberalization. Table IV demonstrates that out of 31 emerging markets, 17 b_2^+'s are positive while 7 negative and 7 zero (column 2 in Table IV); and the same applies to b_2^- (column 4 in table IV). Among those positive parameter estimates, 14 b_1^+'s are significant at the 1% level and 1 at the 10% level; and 16 b_1^-'s are significant at the 1% level. At the world's aggregate level, the sign test rejects the null that b_2^+, and b_2^- too, is negative or zero at the 5% level (columns 2 and 4 in Table IV); and the Wilcoxon signed-ranks test reject the null for b_1^+ at a higher than 5% level (column 2 in Table IV), and for b_1^- at a higher than 1% level (column 4 in Table IV).

For the purpose of comparison (Test 3C), we present the test results of the difference in the local and regional liberalization impact parameters. There is evidence that the regional liberalization impact parameters appear to be larger in value than their local counterparts. This suggests that, for example, if both the local and regional liberalization impacts are characterized by the WC (PR) nature, the latter is more (less) so than the former. Column 5 in Table IV reveals that out of 31 emerging economies, 17 have b_2^+ larger than b_1^+, while 7 smaller and 7 equal. Of these 17 positive differences, 16 are significant at the 1% level, for the upside global-vs-accessible exceedance correlation. The sign test statistic rejects the null of a negative or no difference between b_2^+ and b_1^+ at the 5% level, and the Wilcoxon signed-ranks test statistic too at the 1% level.

Column 6 in Table IV provides less strong evidence for the downside global-vs-accessible exceedance correlation. 15 of 31 economies have b_2^- greater than b_1^-, while 9 smaller and 7 equal. Of these 15 positive differences, 14 are significant at the 1% level. Thus, the sign test statistic cannot reject the null of a negative or no difference between b_2^- and b_1^- at the 10% level but at the 20% level. However, the Wilcoxon signed-ranks test statistic decisively rejects this null hypothesis at a higher than 1% level, as the test takes into account the magnitudes of the difference.

Turning to the unliberalized submarket (Table V), we observe similar contrasting patterns across the local and regional liberalization impact parameters, and the evidence is even stronger as both the sign and Wilcoxon signed-ranks test statistics reject the null hypotheses at a higher than 5% level in columns 1 through to 6. More specifically, it also seems to be true that the local liberalization impact parameters tend to be negative, the regional liberalization parameters positive, and the latter greater than the former in value, during both market upturns and downturns, for the unliberalized submarket. These results are amazing, as 20 unliberalized submarkets exhibit no exceedance correlation and hence no impact of liberalization. A closer inspection of Table V enables us to claim that the above results come mainly from the emerging stock markets in Asia, less so from Middle East/Africa, and not at all from Europe and Latin America.

In summary, Tests 3A, 3B and 3C provide statistical evidence that the WC effect is stronger (more positive) while the PR effect weaker (less negative) in determining the impact of regional liberalization than the impact of local liberalization. More in depth, this evidence supports the conjecture by Kodres and Pritsker (2002) that information and liquidity shocks cause the asset prices of the third (emerging) market to change in the opposite directions, and hence the implied hypothesis that information and liquidity shocks neutralize or lessen the influence of the PR effect on the impact of regional liberalization. Our findings indicate that the interaction between the WC and PR effects acts as the underlying mechanism for liberalizations to impact on exceedance correlation.

(2). Test 4: Asymmetry of the wealth-constraint effect

Having shed some light on the mechanism underlying the impact of liberalization on exceedance correlation, we next investigate whether the impact is asymmetric between extreme upside and downside market moves, due to the well-documented asymmetry of the WC effect. The test results are presented, again, in Tables IV and V (columns 7 and 8).

Focusing on the impact of local liberalization (Test 4A), our answer to the above question is largely affirmative. We find evidence that the downside impact parameters are larger than the upside ones, and this is especially so for the liberalized submarket. For the global-vs-accessible case, 21 economies have larger local liberalization impact parameters in the downside tails, as opposed to 6 in the upside tails and 4 zeros (column 7 in Table IV). Of these 21 positive differences, 14 are significant at the 1% level, 2 at the 5% level and 1 at the 10% level. According to the sign and Wilcoxon signed-ranks test statistics, the null of a negative or no difference between b_1^- and b_1^+ can be rejected at a higher than 1% level, for all 31 emerging economies.

For the unliberalized submarket, supportive evidence is also observed, albeit slightly weaker. 10 economies have larger local liberalization impact parameters in the downside tails, as opposed to 1 in the upside tails and 20 zeros (column 7 in Table V). Of these 10 positive differences, 4 are significant at the 1% level, 2 at the 5% level and 1 at the 10% level. Despite the small number of positive differences, the sign and Wilcoxon signed-ranks test statistics still allow us to reject the null of a negative or no difference between b_1^- and b_1^+ at a higher than 1% and 5% level respectively, when aggregating across all emerging economies.

Now turn to Test 4B. Consistent with the results of Test 4A for the impact of local liberalization, the results of Test 4B for the impact of regional liberalization also demonstrate that the downside impact parameters are larger than the upside ones, which is again more pronounced for the liberalized submarket. Column 8 in Table IV indicates that out of 31 economies, 22 have b_2^- larger than b_2^+, 5 smaller and 4 equal. Of these 22 positive differences, 13 are significant at the 1% level and 1 at the 5% level. These results are further corroborated by the sign and Wilcoxon signed-ranks test statistics that allow us to decisively reject the null of a negative or no difference between b_2^- and b_2^+ at a higher than 1% level. Thus, we are able to claim that the evidence for a larger regional liberalization impact parameter in the downside tails is very strong for the global-vs-accessible exceedance correlation or for the liberalized submarket.

The similar evidence becomes weaker when we examine the unliberalized submarket. Column 8 in Table V uncovers that only 9 of 31 economies have b_2^- greater than b_2^+, 2 smaller and 20 equal. Of these 9 positive differences, 5 are significant at the 1% level, and 1 at the 5% level. Overall, the Wilcoxon signed-ranks test statistic cannot reject the null of a negative or no difference between b_2^- and b_2^+ at the 10% level but at the 15% level, although the sign test statistic can at the 5% level thus providing some supportive evidence across 31 emerging economies.

To summarize, both Test 4A and Test 4B show that the null hypothesis that liberalization (local or regional) has the same impact on exceedance correlation across upside and downside market moves can be rejected for emerging stock markets, in favor of the alternative that the liberalization impact is greater (more positive) for downside than for upside market moves. These results support the view that when markets turn from being "bear" to being "bull", wealth constraints become non binding for WC investors, while portfolio-rebalancing activity remains unchanged for PR investors. In this regard, our findings are consistent with the similar findings of many previous studies such as Boyer, Kumagai and Yuan (2005). Note, however, that our earlier investigation of constant exceedance correlation yielded some evidence of asymmetry, but not very strong; and our further investigation of the impact of liberalization on exceedance correlation discloses more pronounced asymmetry. Since the interaction between the WC and PR effects underlies the impact of liberalization and the PR effect is symmetric, the asymmetry of the impact of liberalization is explained by the asymmetry of the WC effect between upside and downside market moves. We thus take the findings of asymmetric liberalization impacts as further evidence in support of our conjecture that evolving liberalization causes exceedance correlation to change through the interaction between the WC and PR effects. This new contribution distinguishes our study from previous ones in the literature.

IV. Conclusions

Our investigations of how evolving local and regional liberalizations impact on exceedance correlation for the liberalized and unliberalized submarkets of 31 emerging stock markets have yielded fruitful results. Based on the constant copula model, our tests provide evidence supporting the hypothesis that the liberalized submarket is more responsible than the unliberalized submarket for extreme movements in the aggregate national market. By comparing constant exceedance correlation coefficients across market upturns and downturns, we find that co-movements between the aggregate market and its constituent market increase when all of them fall together, albeit not very significantly, and this is true for both the liberalized and unliberalized submarket portfolios.

To examine the liberalization impact on exceedance correlation, we estimate the time-varying copula model to obtain the estimates of the local and regional liberalization impact parameters. We find evidence that exceedance correlation has a bearing on both local and regional market liberalizations, and this is especially so for the liberalized submarket. We then move further by comparing the impact parameters across local and regional liberalizations, and find the regional liberalization impact parameters tend to be more positive than the local liberalization ones. These results have two implications. First, they support Kodres and Pritsker's (2002) hypothesis that information and liquidity shocks cause prices to change in the opposite directions in the third emerging stock market, and hence our hypothesis that information and liquidity shocks tend to neutraliuze the portfolio-rebalancing effcet in its influence on the regional liberalization impact. Second, the results suggest that the interaction between the wealth-constraint and portfolio-rebalancing effcets may be the underlying mechanism by which liberalizations impact on exceedance correlation. In analysing possible asymmetric impact of liberalizations across upside and downside market moves, we find that the liberalization impacts are asymetrically more positive during market downturns than duering market upturns. This result further supports the view that the wealth-constraint and portfolio-rebalnicing effects interact to the impacts of liberalizations on co-movements of the aggregate market and its liberalized/unliberalized submarket.

In their paper, Boyer, Kumagai and Yuan (2005) conclude that market frictions, such as asymetric wealth constraints and symetric portfolio rebalancing, are the transmission mechanism of crisis shocks across countries. In our paper, we may conclude, by adding our findings to theirs, that such market frictions are *also* the undelying mechanism of liberalization impacts on exceedance correlation in emerging stock markets.

NOTES

1. See Bekaert and Harvey (1997), Henry (2000), Errunza and Miller (2000), De Jong and De Roon (2005), Bekaert and Harvey (2000), Stulz (1999), Meyer and Rose (2003), Bekaert, Harvey and Lundblad (2001).

2. See Bekaert, Harvey and Ng (2005), Pownall and Koedijk (1999), and Ho, Burridge and Theobail (2000).

3. There are two other possible transformations for this purpose: a square-root transformation $\rho_t = \sqrt{X_t}/\left(1+\sqrt{X_t}\right)$ and a square transformation $\rho_t = X_t^2/\left(1+X_t^2\right)$. However, the problem with the square-root transformation is that the *b* parameters need to be restricted to be non-negative, and this rules out the possibility that liberalizations might have negative impacts on exceedance correlation. The problem with the square transformation is that ρ_t is not a monotonic function of the local and regional integration variables even if the signs of b_1 and b_2 are determined.

4. We take "no binding" to mean that investors **may or may not** hold more positions in both the money-making asset/market and others.

5. The logistic transformation $\rho_t = 1/[1+\exp(-X_t)]$ implies that if ρ_t is zero, at least one of the *b* parameters in X_t must equal $-\infty$. In this case, whatever finite values the remaining *b* parameters take, it makes no difference in terms of $\rho_t = 0$ if they are taken to be zero. In fact, we tried the square-root transformation and the square transformation, and found that in the case of $\rho_t = 0$, all the *b* parameters are indeed very small or zero. This is the advantage of the square-root and square transformations. However, their problems as stated in footnote 2 overweigh their advantage, and so we have decided to use the

logistic transformation for cases where ρ_t is greater than zero. For cases where $\rho_t = 0$, we simply take all the liberalization impact parameters to be zero.

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Table I
Constant exceedance correlation coefficients

This table reports the estimated exceedance correlation coefficients for the global-vs-accessible index returns at the upside and downside tails (2 and 3), and for the global-vs-inaccessible index returns at the upside and downside tails (4 and 5). The table also reports the test results of various differences in these estimated correlation coefficients (6, 7, 8 and 9). The two-sided *t*-test statistic is used to indicate the significance level of the correlation coefficients, while the one-sided *t*-test statistic is used to indicate the significance level of the estimated differences in correlations. In the rows below the differences are the null hypotheses and the alternative hypotheses for the one-sided *t*-test, the numbers of positive differences, the numbers of negative differences, the numbers of zero differences, the p-values of the sign test, and the p-values of the Wilcoxon signed-ranks test. * indicates the rejection of the null against the alternative at the 10% level, ** at the 5% level, and *** at the 1% level. N is the number of observations used in the estimation of the constant copula model.

		Global vs Accessible		Global vs Inaccessible		Difference in Correlation			
Market	N	Upside	Downside	Upside	Downside	T-stat	T-stat	T-stat	T-stat
	(1)	(2)	(3)	(4)	(5)	(6)=(2)-(4)	(7)=(3)-(5)	(8)=(3)-(2)	(9)=(5)-(4)
China	551	0.000	0.000	0.550**	0.692***	-2.810	-3.857	0.000	0.537
India	560	0.761***	0.708***	0.829***	0.838***	-0.357	-0.585	-0.306	0.041
Indonesia	670	0.764***	0.813***	0.278	0.328	1.650**	1.675***	0.183	0.157
Korea	604	0.809***	0.818***	0.271	0.463*	2.076**	1.099	0.035	0.608
Malaysia	761	0.743***	0.819***	0.401*	0.536***	1.136	1.226	0.303	0.476
Pakistan	553	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Philippines	761	0.417**	0.345*	0.522***	0.598***	-0.417	-1.036	-0.254	0.363
Sri Lanka	461	0.000	0.000	0.584***	0.569***	-3.853	-3.429	0.000	-0.069
Taiwan	656	0.800***	0.775***	0.835***	0.827***	-0.195	-0.246	-0.142	-0.036
Thailand	761	0.725***	0.748***	0.726***	0.759***	-0.114	-0.787	0.165	0.212
Czech Republic	396	0.000	0.187	0.000	0.000	0.000	0.940	0.940	0.000
Greece	357	0.922***	0.925***	0.000	0.000	1.933**	2.124***	0.005	0.000
Hungary	396	0.806***	0.841***	0.000	0.000	4.074***	5.627***	0.140	0.000
Poland	396	0.917***	0.933***	0.000	0.000	6.998***	3.817***	0.056	0.000
Portugal	170	0.768***	0.778***	0.000	0.000	4.094***	2.843***	0.030	0.000
Russia	338	0.000	0.668***	0.000	0.000	0.000	5.031***	5.031***	0.000
Slovakia	247	0.752***	0.782***	0.000	0.000	4.035***	5.436***	0.128	0.000
Turkey	396	0.886***	0.000	0.000	0.000	1.825**	0.000	-1.825	0.000
Argentina	761	0.788***	0.743**	0.000	0.000	5.422***	5.512***	-0.228	0.000
Brazil	761	0.488***	0.706***	0.000	0.000	2.672***	7.339***	1.058	0.000
Chile	761	0.725***	0.000	0.000	0.000	7.437***	0.000	-7.437	0.000
Colombia	561	0.660***	0.523***	0.000	0.000	6.007***	2.948***	-0.658	0.000
Mexico	761	0.589***	0.772***	0.000	0.000	4.701***	6.903***	1.095	0.000
Peru	552	0.690***	0.745***	0.000	0.000	5.094***	6.679***	0.311	0.000
Venezuela	617	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Egypt	338	0.802***	0.723***	0.000	0.000	5.516***	4.165***	-0.352	0.000
Israel	343	0.778***	0.890***	0.000	0.000	3.992***	3.776***	0.365	0.000
Jordan	305	0.608***	0.000	0.721***	0.668***	-0.536	-3.795	-3.407	-0.252
Morocco	338	0.000	0.589***	0.000	0.000	0.000	2.826***	4.701***	0.000
South Africa	396	0.951***	0.991***	0.000	0.000	14.037***	35.750***	0.549	0.000
Zimbabwe	305	0.597**	0.693***	0.681***	0.777***	-0.297	-0.380	0.356	0.414
H_0						≤ 0	≤ 0	≤ 0	≤ 0
H_1						> 0	> 0	> 0	> 0
Positive						18	19	18	8
Negative						8	8	9	3
Zero						5	4	4	20
S test (pv)						0.038	0.026	0.061	0.113
W test (pv)						0.000	0.001	0.200	0.020

Table II
Liberalization impact parameters for the global-vs-accessible index returns

This table reports the estimates of the liberalization impact parameters for the global-vs-accessible index returns at the upside tails (Panel A) and the downside tails (Panel B), together with the two-sided *t*-test and the likelihood-ratio test results. 24 emerging economies are included in the estimation of the time-varying copula model for upside return exceedances, and 24 for downside return exceedances, because their constant correlations are not zero with either economical or statistical significance according to Table I. The row below "LR test" gives the null hypotheses for the likelihood-ratio test. b_1 and b_2 are respectively the local and regional liberalization impact parameters, while b_0 is a constant. "+" denotes the upside return exceedance, and "–"denotes the downside return exceedance. * indicates the rejection of the null that the parameter is equal to zero against the alternative that it is not at the 10% level, ** at the 5% level, and *** at the 1% level.

Market	Panel A: Upside Return Exceedances						Panel B: Downside Return Exceedances					
	Parameter Estimates			LR Test			Parameter Estimates			LR test		
	b_0^+	b_1^+	b_2^+	H$_0$: $b_1^+=0$	H$_0$: $b_2^+=0$	H$_0$: $b_1^+=b_2^+=0$	b_0^-	b_1^-	b_2^-	H$_0$: $b_1^-=0$	H$_0$: $b_2^-=0$	H$_0$: $b_1^-=b_2^-=0$
India	-99.080***	37.639***	129.25***	8.524***	7.498***	9.782***	-144.82***	56.436***	175.94***	6.332**	6.344**	6.372**
Indonesia	14.757***	-36.961***	20.541***	17.722***	17.620***	18.432***	8.996***	-27.331***	27.565***	22.748***	6.504***	24.180***
Korea	1.8847*	-38.350***	23.742***	26.348***	18.652***	27.282***	-5.693**	-27.496***	41.402***	36.952***	32.792***	40.500***
Malaysia	65.074***	-84.634***	29.345***	15.932***	10.634***	27.044***	-15.31***	-16.914***	64.644***	20.924***	12.564***	21.222***
Philippines	-53.189***	-46.734***	124.34***	9.300***	9.300***	18.234***	-81.359***	-36.096***	157.09***	8.474***	8.474***	17.018***
Taiwan	-1.643*	-16.375***	18.576***	5.400***	4.488**	5.466*	-0.947	-20.009***	19.503***	5.382**	2.772*	7.656**
Thailand	18.843***	-56.836***	2.255	17.308***	0.038	18.778***	8.647***	-8.941*	-17.610***	2.836*	14.476***	17.804***
Czech Republic	--	--	--	--	--	--	-26.360***	17.520***	14.595***	4.076**	4.078**	4.076
Greece	137.62***	-139.36***	6.958***	7.870***	8.176***	10.106***	123.86***	-129.645***	10.115***	5.724**	8.374***	8.360***
Hungary	9.204***	10.784***	-19.842***	3.898**	8.864***	10.008***	3.738***	12.039***	-15.996***	13.186***	10.184***	2.218
Poland	13.128***	-0.904	-11.345***	0.000	3.340*	3.264	11.809***	-0.3558	-10.311***	0.328	5.440**	1.514
Portugal	65.361***	-86.915***	15.450***	16.762***	13.592***	16.992***	61.306***	-81.820***	17.556***	13.440***	7.748***	16.746***
Russia	--	--	--	--	--	--	-134.49***	-31.579***	162.17***	10.460***	10.602***	10.602***
Slovakia	26.695***	19.678***	-44.676***	4.598**	14.242***	14.394***	3.010	29.381***	-34.520***	5.962**	8.410***	8.414**
Turkey	7.422***	4.424***	-11.667***	4.168**	3.152*	3.152	--	--	--	--	--	--
Argentina	-9.660***	-0.110	17.178***	2.384	6.908***	32.526***	-22.688***	7.266***	23.029***	11.368***	11.368***	12.786***
Brazil	-37.221***	-2.150	45.497***	0.052	10.760***	35.764***	-6.769***	5.800***	5.138***	3.452*	3.452*	8.688**
Chile	-9.044***	1.673	11.923***	0.754	5.438**	10.008***	--	--	--	--	--	--
Colombia	71.450***	-21.025***	-95.685***	9.080***	7.448***	10.608***	22.973***	-1.067	-30.670***	1.032	5.944**	7.202**
Mexico	-3.577***	10.162***	-5.650***	7.714***	2.826*	8.796**	-8.289	-7.246	2.286	0.028	1.380	1.908
Peru	-49.419***	28.363***	29.141***	4.108**	8.826***	18.916***	-16.964***	-24.196***	43.747***	9.744***	10.201***	10.968***
Egypt	-46.670***	-19.287***	73.588***	8.078**	7.218***	8.508**	-59.961***	-16.951***	85.880***	12.836***	12.280***	13.450***
Israel	-4.660***	-4.643***	18.202***	8.310***	7.924***	10.304***	-8.849***	17.668***	-8.128***	5.500**	4.624**	0.602
Jordan	25.876***	-73.584***	0.146	6.604**	0.010	6.932**	--	--	--	--	--	--
Morocco	--	--	--	--	--	--	-57.309***	11.689***	58.454***	9.630***	11.872***	11.884***
South Africa	4.034***	3.834***	-14.737***	6.214**	9.256***	10.404***	-0.253	6.409***	-10.473***	4.476**	9.220***	9.524***
Zimbabwe	56.615***	-268.57***	6.385	3.366*	0.002	5.056*	-27.257***	-37.464***	45.048***	9.658***	8.470***	10.616***

Table III

Liberalization impact parameters for global-vs-inaccessible index returns

This table reports the estimates of the liberalization impact parameters for the global-vs-inaccessible index returns at the upside tails (Panel A) and the downside tails (Panel B), together with the two-sided *t*-test and the likelihood-ratio test results. 11 emerging economies are included in the estimation of the time-varying copula model for upside return exceedances, and 11 for downside return exceedances, because their constant correlations are not zero with either economical or statistical significance according to Table I. The row below "LR test" gives the null hypotheses for the likelihood-ratio test. b_1 and b_2 are respectively the local and regional liberalization impact parameters, while b_0 is a constant. "+" denotes the upside return exceedance, and "–"denotes the downside return exceedance. * indicates the rejection of the null that the parameter is equal to zero against the alternative that it is not at the 10% level, ** at the 5% level, and *** at the 1% level.

Market	Panel A: Upside Return Exceedances						Panel B: Downside Return Exceedances					
	Parameter Estimates			LR Test			Parameter Estimates			LR test		
	b_0^+	b_1^+	b_2^+	H$_0$: $b_1^+ = 0$	H$_0$: $b_2^+ = 0$	H$_0$: $b_1^+ = b_2^+ = 0$	b_0^-	b_1^-	b_2^-	H$_0$: $b_1^- = 0$	H$_0$: $b_2^- = 0$	H$_0$: $b_1^- = b_2^- = 0$
China	-33.366***	-125.62***	99.754***	5.876**	5.876**	5.876*	-11.835***	-7.200**	25.193***	5.932**	5.933**	7.240**
India	-19.229***	11.247**	25.330***	3.470*	3.470*	3.962	-33.151***	29.905***	35.426***	8.732***	7.740***	8.996***
Indonesia	15.949***	-29.187***	16.665***	56.848***	29.514***	65.854***	8.315***	-24.176***	22.842***	21.590***	5.920**	21.592***
Korea	2.368*	-29.216***	20.287***	34.188***	13.376***	41.588***	-4.378**	-26.203***	37.233***	30.192***	36.770***	41.862***
Malaysia	-60.022***	-26.909***	141.07***	4.850**	4.850**	10.380***	-67.167***	-21.971***	153.54***	13.598***	17.336***	24.426***
Philippines	-79.133***	-36.459***	156.45***	11.840***	11.842***	19.7380***	-94.390***	-1.435	157.29***	1.480	18.675***	18.719***
Sri Lanka	-101.09***	83.567***	126.01***	3.300*	8.378***	8.462**	-109.50***	85.169***	130.34***	4.282**	3.138*	4.388
Taiwan	-77.135***	-145.59***	225.92***	8.138***	6.832***	8.140***	-8.702***	-36.839***	39.436***	6.024**	6.034**	6.392**
Thailand	23.490***	-79.451***	15.202***	18.490***	18.072***	20.278***	20.404***	-70.586***	19.955***	6.618***	11.052***	13.502***
Jordan	2.918***	-4.230**	-0.349	0.318	0.004	0.594	22.976***	-177.63***	38.290***	10.732***	8.776***	10.738***
Zimbabwe	-12.891***	-33.950***	28.528***	4.480***	4.192**	5.490*	-25.883***	-31.546**	37.658***	5.168**	5.170**	6.512**

Table IV
Differences in the liberalization impact parameters: the global-vs-accessible case

This table reports the differences between the estimated liberalization impact parameters and zero (1, 2, 3 and 4), and the *t*-test statistics for the differences across the estimated liberalization impact parameters (5, 6, 7 and 8), for the global-vs-accessible index returns. All the *t*-test statistics used are one-sided. In the rows below the estimated liberalization impact parameters and the differences across these parameters are the null hypotheses and the alternative hypotheses for the one-sided *t*-test, the numbers of positive differences, the numbers of negative differences, the numbers of zero differences, the p-values of the sign test, and the p-values of the Wilcoxon signed-ranks test. * indicates the rejection of the null against the alternative at the 10% level, ** at the 5% level, and *** at the 1% level.

	Upside Tail		Downside Tail		Difference in Impact Parameters			
Market	b_1^+ (1)	b_2^+ (2)	b_1^- (3)	b_2^- (4)	T-stat (5)=(2)-(1)	T-stat (6)=(4)-(3)	T-stat (7)=(3)-(1)	T-stat (8)=(4)-(2)
China	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
India	37.639	129.25***	56.436	175.94***	13.894***	28.766***	2.920***	10.631***
Indonesia	-36.961***	20.541***	-27.331***	27.565***	9.547***	15.585***	2.463***	1.215
Korea	-38.350***	23.742***	-27.496***	41.402***	5.697***	9.432***	0.948	2.752***
Malaysia	-84.634***	29.345***	-16.914***	64.644***	29.216***	11.650***	18.710***	4.937***
Pakistan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Philippines	-46.734***	124.34***	-36.096***	157.09***	110.88***	33.730***	2.216**	9.398***
Sri Lanka	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Taiwan	-16.375***	18.576***	-20.009***	19.503***	13.402***	13.882***	-1.225	0.354
Thailand	-56.836***	2.255	-8.941**	-17.610	11.642***	-1.335	8.051***	-3.483
Czech Republic	0.000	0.000	17.520	14.595***	0.000	-1.320	11.438***	9.117***
Greece	-139.36***	6.958***	-129.645***	10.115***	41.408***	69.488***	3.864***	0.988
Hungary	10.784	-19.842	12.039	-15.996	-19.395	-19.728	0.872	2.460***
Poland	-0.904	-11.354	-0.356	-10.311	-7.424	-6.948	0.407	0.701
Portugal	-86.915***	15.450***	-81.820***	17.556***	50.315***	41.416***	2.322**	0.934
Russia	0.000	0.000	-31.579***	162.17***	0.000	128.69***	-26.199	179.77***
Slovakia	19.678	-44.676	29.381	-34.520	-43.738	-14.330	2.898***	3.084***
Turkey	4.424	-11.667	0.000	0.000	-8.674	0.000	-3.543	-8.504
Argentina	-0.110	17.178***	7.266	23.029***	6.398***	8.879***	3.892***	2.234**
Brazil	-2.150*	45.497***	5.800	5.138***	23.479***	-0.412	4.274***	-22.430
Chile	1.673	11.923***	0.000	0.000	5.942***	0.000	-1.199	-11.763
Colombia	-21.025***	-95.685	-1.067	-30.670	-8.552	-12.554	2.902***	11.072***
Mexico	10.162	-5.650	-7.246	2.286	-12.832	0.000	-0.000	0.000
Peru	28.363	29.141***	-24.196***	43.747***	0.413	43.309***	-3.2932	8.486***
Venezuela	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Egypt	-19.287***	73.588***	-16.951***	85.880***	77.931***	12.958***	0.364	2.555***
Israel	-4.643***	18.202***	17.668	-8.128	8.460***	-13.059	11.890***	-9.505
Jordan	-73.584***	0.146	0.000	0.000	18.664***	0.000	19.939***	-0.104
Morocco	0.000	0.000	11.689	58.454***	0.000	9.075***	3.186***	16.154***
South Africa	3.834	-14.737	6.409	-10.473	-6.074	-6.695	1.485*	1.196
Zimbabwe	-268.57***	6.385***	-37.464***	45.048***	15.384***	19.662***	12.986***	8.577***
H_0	≥ 0	≤ 0	≥ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0
H_1	< 0	> 0	< 0	> 0	> 0	> 0	> 0	> 0
Positive	8	17	9	17	17	15	21	22
Negative	16	7	15	7	7	9	6	5
Zero	7	7	7	7	7	7	4	4
S test (pv)	0.076	0.032	0.154	0.032	0.032	0.154	0.003	0.001
W test (pv)	0.011	0.021	0.041	0.006	0.005	0.009	0.004	0.003

Table V

Differences in the liberalization impact parameters: the global-vs-inaccessible case

This table reports the differences between the estimated liberalization impact parameters and zero (1, 2, 3 and 4), and the *t*-test statistics for the differences across the estimated liberalization impact parameters (5, 6, 7 and 8), for the global-vs-inaccessible index returns. All the *t*-test statistics used are one-sided. In the rows below the estimated liberalization impact parameters and the differences across these parameters are the null hypotheses and the alternative hypotheses for the one-sided *t*-test, the numbers of positive differences, the numbers of negative differences, the numbers of zero differences, the p-values of the sign test, and the p-values of the Wilcoxon signed-ranks test. * indicates the rejection of the null against the alternative at the 10% level, ** at the 5% level, and *** at the 1% level.

	Upside Tail		Downside Tail		Difference in Impact Parameters			
	b_1^+	b_2^+	b_1^-	b_2^-	T-stat	T-stat	T-stat	T-stat
Market	(1)	(2)	(3)	(4)	(5)=(2)-(1)	(6)=(4)-(3)	(7)=(3)-(1)	(8)=(4)-(2)
China	-125.62***	99.754***	-7.1995**	25.193***	10.877***	7.802***	5.990***	-9.981
India	11.247	25.330***	29.905	35.426***	2.450***	0.604	1.930**	2.098**
Indonesia	-29.187***	16.665***	-24.176***	22.842***	23.045***	18.031***	2.640***	2.309***
Korea	-29.216***	20.287***	-26.203***	37.233***	9.678***	9.316***	0.4757	2.976***
Malaysia	-26.909***	141.07***	-21.971***	153.54***	46.627***	49.667***	1.828**	2.926***
Pakistan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Philippines	-36.459***	156.45***	-1.435	157.29***	136.87***	28.640***	7.709***	0.242
Sri Lanka	83.567	126.01***	85.169	130.34***	3.271***	2.751***	0.090	0.390
Taiwan	-145.59***	225.92***	-36.839***	39.436***	51.788***	11.092***	12.965***	-34.999
Thailand	-79.451***	15.202***	-70.586***	19.955***	12.041***	29.142***	1.477*	0.799
Czech Republic	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Greece	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hungary	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Poland	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Portugal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Russia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Slovakia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Turkey	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Argentina	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Brazil	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Chile	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Colombia	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mexico	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Peru	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Venezuela	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Egypt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Israel	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jordan	-4.230**	-0.349	-177.63***	38.290***	1.839**	28.333***	-24.437	14.533***
Morocco	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
South Africa	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Zimbabwe	-33.950***	28.528***	-31.546***	37.658***	12.681***	5.064***	0.1774	1.641**
H_0	≥ 0	≤ 0	≥ 0	≤ 0	≤ 0	≤ 0	≤ 0	≤ 0
H_1	< 0	> 0	< 0	> 0	> 0	> 0	> 0	> 0
Positive	2	10	2	11	11	11	10	9
Negative	9	1	9	0	0	0	1	2
Zero	20	20	20	20	20	20	20	20
S test (pv)	0.033	0.006	0.033	0.001	0.001	0.001	0.006	0.033
W test (pv)	0.025	0.002	0.055	0.002	0.003	0.002	0.025	0.143