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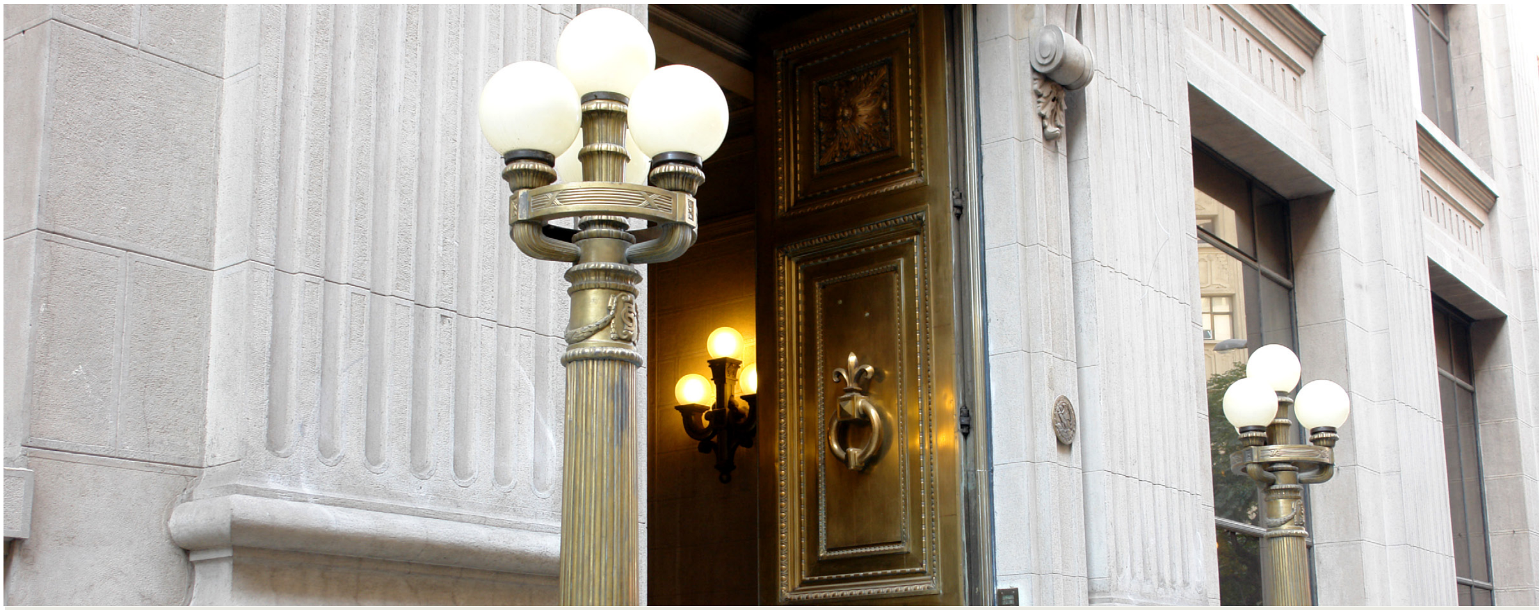

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ARE INTERNATIONAL MARKET LINKAGES STRONGER? COMPARISON BETWEEN 1990s AND 2000s*

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Resumen

Este estudio examina las conexiones intra y extra regionales de los mercados bursátiles más importantes de los países desarrollados y emergentes. Los índices de las series utilizadas tienen raíz unitaria con excepción de Venezuela. De esta forma, se utilizó la técnica de cointegración multivariada de Johansen, la cual examina la dependencia en los índices accionarios. Como conclusión general, los resultados indican que el grado de conexión entre éstos mercados ha aumentando levemente o se ha mantenido estable luego de periodos de crisis financieras o económicas. La única excepción se encuentra entre los subgrupos de América Latina y Asia emergente. Esto implica que el grado y naturaleza de la integración de mercados accionarios tiende a cambiar a través del tiempo. Otra importante conclusión, es el inesperado bajo número de vectores de cointegración que se encuentran en el periodo post- crisis, especialmente en los mercados emergentes. Lo cual significa que los mercados accionarios locales siguen mayormente distintas tendencias comunes no estacionarias. Por lo tanto, se puede inferir que existe un espacio considerable para diversificar el riesgo del portafolio.

Abstract

This study examines the intra- and inter-regionally change in stock market linkages of the most important stock exchanges in developed and emerging economies. The index level series have a unit root with the exception of Venezuela. So, I use the Johansen multivariate cointegration technique to examine dependencies in stock indices. The results indicate as a general conclusion, that the degree of market linkage among these markets has been slightly increased or has been stable after the crisis period. The only exceptions were some subgroups in Latin America and Emerging Asia. This implies that the degree and nature of stock market integration tend to change over time. Another important conclusion that stands out is the unexpectedly small number of cointegrating vectors found in the post-crisis period, especially in Emerging Markets. This implies that national markets largely follow separate non-stationary common trends. Hence, it can be inferred that there is considerable space for portfolio risk diversification.

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1. Introduction

During the 1980s, investors started to look beyond the U.S. market for new investment opportunities with higher returns. Given that the correlation between developed and emerging markets' asset returns is very small, there has been much debate among economists on the diversification of benefits for U.S.-based investors holding emerging market equities (Erruza, 1983). However, the correlation structure between these markets has increased between the 1990s and the initial years of the 2000s (Table 1)[1]. This outcome should lead to a strong reduction in the probabilities of gains from international diversification.

There is extensive literature about international stock market linkages for both developed markets[2] and emerging stock markets[3]. As a general overview, these studies have found that after a financial crisis, the stock market linkage between the countries studied increases or remains stable.

The present study has two main objectives. The first one is to determine how stock market linkages have changed over time among different emerging regions excluding the periods of the financial crises at the end of the 90s and begging of the 2000s. The second objective is to examine inter-regional stock market linkages in emerging and developed regions and the BRICs economies.

The main contribution of the current research is the testing of linkages in emerging markets within each region, as well as across different regions[4].

To assess the effect of a crisis on long-run stock market relationship, the existing literature typically compares the number of co-integrating vectors before and after a crisis (e.g., Masih and Masih, 1997; Chen et al., 2002). Other works like those of Kasa (1992) and Darrat and Zhong (2005) have demonstrated that most developed stock market indices share one common stochastic trend, which implies limited gains from long-horizon international diversification. In the present research, I use the Johansen multivariate co-integration technique to examine dependencies in stock indices. Disclosing some results as a general conclusion, co-integration tests indicate that the degree of market linkage has been slightly increased or has been stable after the crisis period, although the evolution in the degree of market linkage depends on the group of countries tested.

The present work is organised as follows. The second section shows the empirical evidence obtained by previous studies. The third section gives the theoretical framework of the Johansen's

[1] Using the Box's M statistic to test for homogeneity of the covariance matrices, the result shows that the matrices are significantly different at 95% of confidence.

[2] See Eun and Shim, 1989; Kasa, 1992; Arshanapalli and Doukas, 1993; Masih and Masih, 1997.

[3] See Arshanapalli et al., 1995; Ghost et al., 1999; Chen et al., 2002; Manning, 2002; Darrat and Zhong, 2005; Yang et al., 2006; Arouri et al., 2008.

[4] For further detail of the countries selected and regions see appendix A.

test (1988) and the empirical results. Finally, the concluding remarks and suggested possible extensions to the present work are given in the last section.

2. Literature Review

Many studies have investigated the relationship between national equity markets. However, initial studies have concentrated on developed markets. Eun and Shim (1989) estimate a nine-market value at risk (VaR) system for Australia, Canada, France, Germany, Hong Kong, Japan, Switzerland, the U.K, and the U.S. The results show that there is a substantial cross-country interaction among them. Further, the U.S. market has an influential role over other markets, although no foreign market can clearly explain U.S. market actions.

Moreover, as is well-known, financial and economic series generally contain a single unit root, that is, they are non-stationary. Using the first difference in this kind of series for any modelling process when the relationship between variables is important can be misleading. Specifically, pure first difference models do not have any long-run solutions and often yield unstable and contradictory short-term empirical outcomes (see Kasa, 1992 and Manning, 2002).

The above is the main reason why researchers turned to co-integration techniques to study interdependencies in stock markets. The benefit of international diversification is limited when national equity markets are co-integrated because the presence of common factors limits the amount of independent variation[5].

The portfolio theory has been used to examine different equity markets. Kasa (1992) estimates a vector error-correction model (VECM) to detect and estimate common stochastic trends in the equity markets of the U.S., Japan, Britain, Germany, and Canada. His research shows that the evidence is consistent with the presence of a single common stochastic trend driving these countries' stock markets, with this trend being more important in the Japanese market and least important in the Canadian market. His findings also suggest that the gains from long-run international diversification have most probably been excessive.

Further, an important number of studies have also investigated how stock market linkages can be influenced by a global financial crisis. Arshanapalli and Doukas (1993) use error-correction analysis to test the long-run dynamic adjustment process between two stock markets, the U.S. market and the French, German, U.K., or Japanese market. They find that after the 1987 crash, the

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[5] If a linear combination of two or more non-stationary variables results in a stationary series, the variables are co-integrated. Therefore, these variables exhibit a stable long-run relationship. On the contrary, if they are not co-integrated, they have no long-run link, and they can wander far away from each other.

degree of international co-movements among stock prices has substantially increased, except that of the Japanese market which does not seem to be fully integrated with the other stock markets. The results also show that U.S. stock market innovations have a significant effect on the French, German, and U.K. markets, but not otherwise.

Another research that examined the stock market linkages between the periods pre and post the 1987 crash for developed markets is that of Masih and Masih (1997). Their results show that there is support of a single co-integrating vector over each period's samples, and the U.S. market still has the relative leading role over other markets. They also provide confirming evidence that the crash has brought about greater interaction amongst markets.

During the mid-1990s, researchers started to investigate stock return linkages among emerging markets due to the decline in government formal barriers to the flow of capital across countries, as well as the development and growth of derivative securities that have been stimulated by financial integration. Arshanapalli et al. (1995) analyse the stock price movements between U.S. and Asian stock market movements during the post-October 1987 period using co-integration methods. Their evidence suggests that the co-integrating structure that ties these stock markets has substantially increased since the crash, and the influence of the U.S. stock market was also found to be greater during the post-October period.

In another work, Ghosh et al. (1999) investigate which Asian-Pacific stock markets are moved by the markets of Japan and the U.S. Their empirical evidence suggests that the stock markets of some countries, such as Hong Kong, India, Korea, and Malaysia, are dominated by the U.S. market; the stock markets of Indonesia, the Philippines, and Singapore are dominated by that of Japan, and those of the remaining countries (Taiwan and Thailand) are dominated by neither during the time period investigated.

Manning (2002) uses two different estimation approaches, Johansen maximum likelihood and the Haldane and Hall Kalman Filter technique, to demonstrate that equity markets in South East Asia have shown signs of convergence during the 1990s. In general, they find that there are two common trends present in these market indices. Moreover, they argue that the convergence process in Asian emerging markets has been abruptly halted and somewhat reversed by the Asian financial crisis in 1997.

The co-movements between Latin American markets have been studied by several recent papers, and significant linkages have been found. Chen et al. (2002) investigate the interdependence of the major stock markets in Latin America: Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela. They find that there is one co-integrating vector which explains the dependencies in the region, and they conclude that the Asian and the Russian crises did not have a significant effect on the interdependence across these stock markets.

Another recent study is that of Arouri et al. (2008). They estimate the conditional correlations between Latin American markets and the world market using the DCC-GARCH model and estimate a VECM to investigate short and long-run market co-movements. Their analysis shows that the national correlations of Latin American markets with the world market are relatively low. However, these national correlations have significantly increased in recent years, and the co-integration analysis has shown that many correlations share a common trend.

The long-run price relationships among the four major Eastern European stock markets (Russia, Poland, Hungary, and the Czech Republic) and U.S. and Germany were studied by Yang et al. (2006). They took particular attention on the effect of the 1998 Russian financial crisis. Their study's results show that both long-run price relationship and dynamic price transmission were strengthened among these markets after the crisis. There was also a much less significant influence of Russia in the region after the crisis. The influence of the U.S. and Germany became noticeable on all Eastern European markets only after the crisis but not before it. Finally, they suggest that the degree of stock market integration tends to change over time, especially around periods marked by financial crises.

Finally, Fujii (2005) describes well inter-market relationships, both within and across several emerging stock markets in Asia and Latin America since 1990. Using GARCH models, he conducts residual cross-correlation function tests to investigate cross-market causality. The empirical results reveal significant market interactions both within each region and across the two regions. Moreover, the significance of the causality considerably varies over time. More importantly, the causal relationships tend to strengthen particularly at the time of major financial stress.

On the other hand, none of the mentioned studies explains why the co-movements increased after financial crises. An example is the work of Bruno and Shin (2012). They developed a model of global liquidity where international banks are the main transporters of liquidity conditions and they proposed that the increased in the market's connexion could be explained due to the increase in the global liquidity in the economy because of the monetary authorities' responses to the financial crises. However, this issue is not the purpose of this study and could be tackled in a further study.

3. Empirical results of the Co-integration test

Before testing for co-integration, it is necessary to determine the order of integration of national stock price indices. The results of the ADF unit root test and P–P unit root test[6] of national stock indices on the levels and first differences are reported in Table 2. The findings show that the null hypothesis cannot be rejected in the level of most of the indices for both tests; this result means there is evidence of unit root in stock price indices. The only exception is Venezuela, which rejects the null hypothesis at 5% level of significance. Therefore, it is not included in the co-integration test.

On the other hand, the null hypothesis of non-stationary is strongly rejected for all countries for the first log difference for both ADF test and P–P test, indicating that the returns of the stock indices do not contain unit root. Therefore, the indices tested are non-stationary in level but stationary in differences. These results are consistent with those of other studies and with the hypothesis that stock price indices are integrated of order one, that is, they are an $I(1)$ process.

When a linear combination of $I(1)$ variables generates a stationary series, this set of variables is defined as co-integrated. This means that these series are bound by some relationship in the long term. Therefore, a co-integrating relationship may also been seen as an equilibrium phenomenon.

Therefore, in order to test for the presence of co-integrated vectors or whether there is a long-run equilibrium relation among several groups of countries, I use the Johansen and Juselius (1992) co-integration test[7]. The choice of optimal lags is selected based on the Akaike information criterion (AIC). In addition, to allow for the possibility of a drift in the long-run equilibrium relation, an intercept was included in the co-integrating vector.

As I previously mentioned, there are five major groups of countries: Developed Countries, Latin America, Emerging Asia, Emerging Europe, and BRIC. The first three groups are divided according to their market capitalisation[8] in order to perform a further detailed analysis. The Developed Countries group is divided into three sub-groups: all developed countries, countries with more than US$1T in market capitalisation, and the most important markets. For Latin America and Emerging Asia, there are also three sub-groups: all economies, the markets with the biggest market

[6] The theoretical framework is in Appendix B.
[7] Further detail of the theoretical framework of this test is in Appendix C.
[8] Table 4 shows the market capitalisation of each country in 2010 according to the World Bank, with Peru as the only exception as it used the WCAP Index from Bloomberg. WCAP data do not include ETFs and ADRs as they do not directly represent companies. They include only actively traded, primary securities on the country´s exchanges to avoid double counting as well. Therefore, the values will be significantly lower than the expected market capitalization values of a country´s exchanges.

capitalisation, and the ones with the smallest market capitalisation. At the same time, all sub-groups for emerging economies are tested also with and without their most relevant developed countries partner; for instance, U.S. and Japan are included for the Emerging Asian markets. Therefore, each one of these sub-groups is tested to determine the rank of co-integration vectors.

Panels A through F of Table 5 report the co-integration test results for developed markets based on the estimation of the λ_{trace} and λ_{max} tests for both pre- and post-crisis periods.

For the first sub-group, the null hypothesis, that is, that the stock indices of all developed countries do not have co-integrating relations ($r = 0$) against the alternative of one or more co-integrating vectors ($r > 0$), is rejected for the two periods (Panels A and B). This result is attributed to the λ_{trace} and λ_{max} statistics exceeding the critical values at 1% significance level. For Panels A and B, the λ_{trace} statistic indicates the presence of no more than two co-integrating vectors because the test fails to reject H_0 of $r \leq 2$. Meanwhile, the λ_{max} statistic suggests no more than one co-integrating relationship because it cannot reject the null hypothesis of $r \leq 1$. This result means that the stock indices of the 10 countries in the developed market group share between one and two long-term equilibrium, and they are stable as time goes by.

Panels C (pre-crisis period) and D (post-crisis period) list the estimated trace test and maximal eigenvalue test statistic values for the second sub-group of developed countries, which includes economies with more than US$1T in market capitalisation (the U.S., Japan, the U.K., Canada, Australia, Germany, and Switzerland). In Panel C, the null hypothesis that the stock indices in this sub-group do not have co-integrating relations against the alternative of one or more co-integrating vectors is rejected at 5% significance level. However, the λ_{trace} and λ_{max} statistics present no more than one co-integrating relationship because they fail to reject H_0 of $r \leq 1$, that is, the $\lambda_{trace}(1)$ statistic of 81.0 is less than the critical value of 94.15 at 5% significance level, and the $\lambda_{max}(1)$ statistic of 29.88 is less than the critical value of 39.37 at 5% significance level. Then in Panel D, the results are similar, suggesting the existence of no more than one co-integrating vector at 1% significance level. Therefore, the degree of market linkage in the sub-group seems to have been stable between both periods at one long-term relationship.

The results for the last sub-group of developed markets, the U.S., Japan, the U.K., and Germany, are illustrated in Panels E (pre-crisis period) and F (post-crisis period). In Panel E, the null hypothesis cannot be rejected at any significance level. This result means that the stock indices of these four countries do not share any long-term equilibrium during the pre-crisis period. On the contrary, in Panel F, both the λ_{trace} and λ_{max} statistics indicate the presence of two co-integrating structures or long-term relationships among these four countries between January 2003 and June 2007. This finding means I cannot reject the hypothesis that two stochastic trends are present in the four-dimensional stock market system. Hence, the degree of market linkage in the sub-group appeared to have increased through time.

Table 6 reports the multivariate co-integration results for Latin American countries for both periods. As I previously mentioned, all sub-groups of emerging economies are tested also with and without their most relevant developed countries partner. In the case of Latin American markets, the U.S. market is included in the tests. These results should supply information on the extent of regional integration among Latin American stock exchanges and the U.S. market.

Panel A shows the results for the pre-crisis period for all Latin American countries, and Panel C does the same but includes the U.S. market into the sample. The null hypothesis that the stock indices in both sub-groups do not have co-integrating vectors is rejected at 5% significance level in both panels. However, the λ_{trace} and λ_{max} statistics do not indicate more than one co-integrating relation, that is, the $\lambda_{trace}(1)$ and $\lambda_{max}(1)$ statistics are less than their critical values at 5% significance level. The previous result reasserts the finding of Chen et al. (2002) for the sub-sample prior to the Asian crisis. Regarding the post-crisis period in Panels B and D (the difference between them is that Panel D incorporates U.S. into the group), both the λ_{trace} and λ_{max} test statistics do not show any presence of long-term equilibrium among these countries. Therefore, the stock indices of the six Latin American countries (and the U.S.) seemed to have decreased their long-term relationship as time goes by. One inference from the analysis of the January 2003–June 2007 period is that investing in a wide range of different Latin American countries does help diversify investment in international portfolios.

The sub-sample results for the Latin American countries with the three biggest market capitalisations (Brazil, Mexico, and Chile) and the U.S. market are shown in Panels E through H. For the pre-crisis period, Panels E and G reveal that the null hypothesis, that is, that the stock indices of the three countries (and the U.S. market) are not co-integrated, cannot be rejected at any level of significance. Whereas Panels F and H give the results for the post-crisis period, they are somewhat different. In Panel F, the trace tests and maximal eigenvalues tests do not indicate the existence of a co-integrating vector, but in Panel H, when the U.S. market is included into the sub-group, the null hypothesis of no co-integration is rejected and shows the existence of one co-integrating vector at 1% level. This finding indicates that in the post-crisis period, these three countries do not have any co-integrating relationship. However, when the U.S. market is aggregated, they share a long-term equilibrium.

Panels I through L show the results for the last sub-group of Latin American markets or the countries with the smallest market capitalisation (Colombia, Argentina, and Peru). In the pre-crisis period, Panel I shows that there is a single co-integration relationship between these three markets, whereas if the U.S. market is included in the sample (Panel K), the results indicate that the null hypothesis of no co-integration is not rejected. However, for the post-crisis period and both Panels J and L (with and without the U.S. market, respectively), the system of the three or four stock markets does not appear to be co-integrated at 5% level of significance.

As a summary, after all the crises during the end of the 1990s and the beginning of the 2000s, there does not seem to be a degree of market linkage between Latin American markets, allowing the diversification of risk for international investors. Only for the three countries with the biggest market capitalisations and the U.S. was there one possible co-integrating relation or long-term equilibrium.

The co-integration test results for Emerging Asian markets are presented in Table 7. For Emerging Asia, the U.S. and Japanese markets are added in the analysis (Arshanapalli et al., 1995).

Panels A and C show the results for the pre-crisis period for all Emerging Asian markets and for the same countries included the U.S. and Japanese markets. Panel A reveals the existence of no more than two co-integrating vectors at 5% significance level, whereas when the U.S. and Japanese markets are included, the outcome suggests at least three co-integrating vectors for the entire sample. These results are similar to those of Manning (2002) in which several co-integrating vectors are found. Concerning the post-crisis period, in both Panels B and D, the results seem to suggest the existence of one co-integrating relation or long-term equilibrium among them. Therefore, the stock indices of these countries seem to have been decreasing their long-term relationship through the years.

The next sub-sample results for the Emerging Asian countries with the four biggest market capitalisations (China, India, Korea, and Taiwan) and the U.S. and the Japanese markets are shown in Panels E through H. For the pre-crisis period, Panels E and G reveal that the null hypothesis, that is, that the stock indices of the three countries (and the U.S. market) are not co-integrated, cannot be rejected at any level of significance. Meanwhile, for the post-crisis period (Panels F and H), the null hypothesis of no co-integration is rejected and indicates the presence of one co-integrating vector at 1% level. This result means that after the crisis period, the degree of market linkage in the sub-group has increased for both sub-samples.

For the last sub-group, which contains the countries with the smallest market capitalisation (Indonesia, Malaysia, the Philippines, and Thailand), the results are shown in Panels I through L. In the pre-crisis period, Panel I shows that the λ_{trace} and λ_{max} statistics suggest the existence of a single co-integration relationship between these economies at 5% level of significance. Nevertheless, once the U.S. market is included (Panel K), the results imply that the null hypothesis of no co-integration cannot be rejected. For the post-crisis period and both Panels J and L (with and without the U.S. market, respectively), the evidence supports the existence of one co-integrating vector or long-term equilibrium at 1% level of significance.

Table 8 shows the co-integration tests for Emerging European stock indices based on the estimation of the λ_{trace} and λ_{max} tests. For this group of countries, the U.S. and German markets are incorporated into the test (Yang et al., 2006). Panels A and B list the estimated trace test and maximal eigenvalue test statistic values for the whole group of Emerging European countries. In Panel A, the null hypothesis that the stock indices of the four countries do not have co-integrating relations against the alternative of one or more co-integrating vectors cannot be rejected. However, in Panel B, the λ_{trace} and λ_{max} statistic results present no more than one co-integrating relationship because they fail to reject the H_0 of $r \leq 1$, that is, the $\lambda_{trace}(1)$ statistic of 37.56 is less than the critical value of 47.21 at 5% significance level, and the $\lambda_{max}(1)$ statistic of 23.54 is less than the critical value of 27.07 at 5% significance level. Similar results can be seen from Panels C and D, where the U.S. and German markets are integrated in the estimation. For the period before the crisis, there is no evidence of co-integration between the six markets. Nonetheless, for the sample after the crisis, the results show that there exist no more than two long-run equilibrium relationships. Therefore, the degree of market linkage between intra- and extra-regions among stock exchanges has seemed to increase as time goes by.

Table 9 displays the multivariate co-integration results for BRIC for both pre- and post-crisis periods. In the case of this group, the U.S., Japanese, and German markets are included in the estimation. Panels A and B show the results for the whole group. As both panels indicate, the null hypothesis of no co-integration vectors cannot be rejected in the pre- and post-crisis periods. This finding means that the four biggest emerging markets do not share any long-term relationship. Once the U.S., Japanese, and German markets are integrated in the estimation, the outcome slightly changes. For the period before the crisis, the evidence still shows no sign of co-integration between the seven markets. However, for the post-crisis period, the results show the presence of no more than one co-integrating vector. Therefore, the degree of market linkage between extra-regions among stock exchanges has seemed to increase through the years.

A summary of the multivariate co-integration results for each group and sub-group based on the estimation of the λ_{trace} and λ_{max} tests for both pre- and post-crisis periods is shown in Table 10. As a general conclusion, the degree of market linkage has been stable or slightly increased through time. The only samples that have shown a decrease in the number of co-integration vectors between the pre- and post-crisis periods are all markets of and the small market capitalisation of Latin American market sub-groups and all Emerging Asian markets. This peculiar result can be attributed to the increasing differences in the economic policies among these countries during the 2000s.

Also, the number of co-integration vectors in Emerging markets, especially after the crises period, seems to be quite small. This result means that the numbers of stochastic trends present in each stock market system are rather significant, allowing for a greater scope for portfolio diversification, especially in Latin American markets, whereas in some sub-groups, there is no co-integration vector.

Comparing these results with those of other studies is difficult mainly because the sample post-crisis period that I take does not match those of other papers. However, studies that investigated how stock market linkages were affected by the Asian and Russian crises find similar results for emerging economy markets. Chen et al. (2002) conclude that such crises did not have a significant effect on the interdependence across Latin American stock markets, but the long-run co-integration relationship disappeared in the period after the Russian crisis. Also, Manning (2002) argues that the convergence process in Asian Emerging markets was suddenly interrupted and somewhat reversed by these financial crises. Yang et al. (2006) show that both long-run price relationship and dynamic price transmission were strengthened among Eastern European markets after the crisis.

4. Conclusions and extensions

The present study examines the behaviour of the stock index prices of the most important stock exchanges in developed and emerging economies, based on univariate and multivariate system approaches. Each series of stock index prices is shown to have a unit root, with the exception of Venezuela. This finding is consistent with those of other studies and with the hypothesis that stocks price indices are integrated of order one.

The Johansen's co-integration test (1988) indicates, as a general conclusion, that the degree of market linkage among these markets has been slightly increased or has been stable after the crisis period (as shown in Table 10). The only exceptions were some sub-groups in Latin America and Emerging Asia. Another important issue that stands out in the results is the unexpectedly small number of co-integrating vectors found in the post-crisis period in Emerging Markets. This finding implies that national markets largely follow separate non-stationary trends. Stock and Watson (1988) developed two tests for the number of common stochastic trends (i.e., for the order of co-integration) in a multiple time series, and they showed the existence of the relationship between the number of variables (h) in the co-integration test, the number of co-integrating vectors (r) and the number of common stochastic trends (g), where in the extreme, if $g = 1$, the tested markets would be totally integrated with a single global non-stationary common trend. In the present work, the maximum co-integration relationships found were two, meaning that only two non-stationary national trends can be removed, and there are at least $h - 2$ national factors that follow separate random walks. Hence, if $h – r$ is close to the number of variables in the VaR, there can be a space for portfolio risk diversification.

For Developed markets, there is an increase from zero to two co-integrated vectors among the U.S., Japanese, U.K., and German markets, implying that these markets have been more integrated after than before the crises. This result means investors do not have much space to diversify their portfolios by buying stocks in these four countries. In the case of Emerging Asian markets, there is some significant divergence in the number of co-integrating vectors between both the λ_trace and λ_max tests before the crises period. However, during the post-crisis period, both of them provide the same results, ascertaining the likely existence of a one long-run equilibrium. This finding means that the possibility of diversification is reduced to some degree. In general, for Emerging European markets, the empirical results reveal that the dynamic linkages among them were strengthened after the crisis and that these markets have become more regionally and globally (with the U.S. and Germany) integrated after than before the crises. This result also suggests that since January 2003, arbitrage activities between these equity markets have substantially increased.

For Latin America, the outcome is quite the opposite. For the entire region, there was one long-run relationship before the crises, but the test results for the post-crisis period show there is no statistical support for co-integration. Therefore, there is no evidence of a single underlying equilibrium relationship, indicating that between these countries, there are only non-stationary common trends. This finding implies that investors can diversify systematic risk by buying stocks in the six countries. Also, there is no integration between emerging markets from different regions (BRIC) (when no developed market is included) before and after the crises. The sub-group has the same consequences as in Latin American markets, which gives investors a really good opportunity to diversify their portfolios.

Therefore, regarding the effect of the examined crises on developed and emerging stock market integration, there is not just one answer. The evolution of the degree of market linkage would depend on the group of countries tested. This finding implies that the degree and nature of stock market integration tend to change over time. More generally, these findings have important implications for international portfolio management that aims to reduce systematic local risk by using international diversification for stock portfolios.

The next step for future studies would be to use error correction VaR techniques and to conduct the decomposition of forecast error variances in order to investigate specific dynamic interactions among each country in all sub-groups that show co-integrating relationships.

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Appendix A: Data Description

The data used are daily index prices collected from Datastream International. In the estimation, the indexes are measured in natural logarithms. For the Developed markets, the period covered is January 1989 to June 2007; for the Asian and Latin American markets, it is January 1993 to June 2007, and for the Emerging European countries, it is January 1995 to June 2007. The starting date of each series is different due to the lack of data.

The regions and countries for each group are as follows: (1) Developed Countries (the U.S., Japan, the U.K., Canada, Australia, Germany, Switzerland, Sweden, Norway, and New Zealand), (2) Latin America (Brazil, Argentina, Chile, Colombia, Mexico, Peru, and Venezuela), (3) Emerging Europe (Czech Republic, Hungary, Poland, Russia, and Turkey), (4) Emerging Asia (China, India, Indonesia, Korea, Malaysia, the Philippines, Taiwan, and Thailand), and BRIC.

I use dollarised stock market indices as a way to represent the point of view of an international U.S.-based investor[9]. For developed markets, I take the principal stock market indices in the local currency; then they are dollarised using the end-of-day exchange rate. For most of the emerging markets, I take the MSCI Global Equity Indices in U.S. dollars as a proxy of dollarised stock market indices. The exceptions are Hungary, Malaysia and Venezuela.

During the second half of the 1990s and the first years of the 2000s, the world was under immense pressure due to a stream of various crises. The first major crisis with an international effect in financial markets was the Asian crisis in the second half of 1997. One year later, the Russian financial market collapsed, forcing the government to float the exchange rate. As a result of these two crises and some adopted macroeconomic policies, in January 1999, the Central Bank of Brazil announced that its exchange rate would be allowed to float. At the same time, Argentina plunged into a deep economic crisis, reaching its highest point in January 2002. Meanwhile, the dot-com bubble in the U.S. market burst on March 2000. The market also took a major downturn in the wake of terrorist attacks in the U.S. in September 2001.

In the present study, the sample period is divided into two non-overlapping periods: pre- and post-crisis periods. The aim is to isolate the potential effect of the various financial and economic crises previously described on international stock market integration. The pre-crisis period lasted until May 1997 (prior to the Asian financial crisis); the post-crisis period began in January 2003 (after all crises) and ended in June 2007 (prior to the subprime crisis).

[9] Koch and Koch (1991), Chen et al. (2002), and Darrat and Zhong (2005) use series measured in both local currency and U.S. dollars, and their empirical results did not significantly change.

The focus of the analysis is the pre- and post-crisis periods because generally, markets are more volatile, and the estimation of correlation coefficients tends to increase and be biased upward during crisis periods (Forbes and Rigobon, 2002). Therefore, measuring the effect of the crises on international stock market relations can be more meaningful by comparing both periods.

Appendix B: Unit root analysis

The use of non-stationary data in standard regression techniques can lead to spurious regressions. Sometimes, the variables can be trended over time but not be related. As a result, the regression can seem right under standard measures, but it is really valueless because the classical assumption for inference will be not valid. For this reason, before testing for co-integration, the order of integration of national stock price indices must be determined.

I begin the analysis by subjecting the data to both the augmented Dickey–Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips–Perron (P–P) test (Phillips and Perron, 1988) to check for the unit root for each country. The null hypothesis is the existence of the unit root in the index price or return against the alternative hypothesis where the series is stationary.

i. Augmented Dickey–Fuller regression:

$$\Delta y_t = \varphi_0 + \varphi_1 y_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta y_{t-i} + u_t \tag{1}$$

ii. Phillips–Perron regression:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \varepsilon_t \tag{2}$$

Both tests are similar and often give the same conclusions, but the P–P test allows for auto-correlated residuals.

Appendix C: Theoretical framework of co-integration

There are two main tests for co-integration: one proposed by Engle and Granger (1987) which is quite similar to the testing for unit root in the estimated residual of a levels regression, and the other proposed by Johansen (1988) and Johansen and Juselius (1990). The advantage of the latter test is that it recognises and utilises the error structure of the underlying process.

This section provides an informal and summarised description of Johansen's maximum likelihood approach for testing the number of co-integrating vectors, which uses an autoregressive process with independent Gaussian errors.

First, a set of h variables ($h \geq 2$) is assumed as $I(1)$, and they might be co-integrated. This vector of $I(1)$ variables, y_t, can be represented by the following VAR with k lags specification:

$$y_t = c + \beta_1 y_{t-1} + \cdots + \beta_k y_{t-k} + \varepsilon_t \tag{3}$$

where c is a constant, and ε_t is assumed to be an i.i.d. Gaussian process.

The VAR (k) above is transformed into a VECM in order to use the Johansen test. Defining $\Delta = 1 - L$, where L is the lag operator, Equation (3) is formulated as follows:

$$\Delta y_t = c + \Pi\, y_{t-k} + \Gamma_1 \Delta y_{t-1} + \cdots + \Gamma_{k-1} \Delta y_{t-(k-1)} + \varepsilon_t \tag{4}$$

$$\Gamma_j = -\sum_{j=1}^{i} \beta_j, \qquad j = 1, 2, \cdots, k-1 \tag{5}$$

$$\Pi = \sum_{i=1}^{k} \beta_i - I_g \tag{6}$$

where Δy_t contains h variables in first differenced form. The right-hand side of this VAR includes (k – 1) lags of the dependent variables in differences, each of which has a Γ coefficient matrix attached to it denominated as 'short-run dynamics'.

The main objective of this test is the examination of the Π matrix, which is known as the 'long-run impact matrix', because in equilibrium, all the Δy_{t-i} will be zero, and the expected value of the error terms, ε_t, will be zero and will leave $\Pi\, y_{t-k} = 0$. As a result, the rank of this matrix will determine the number of co-integrating vectors.

If r is the rank of Π, there are three options. First, Π can be of full rank (h), implying the stationarity of the error term in Equation (3) and of the $\mathrm{y_t}$ process themselves. As a result, the system would have not any stochastic trend contrary to the original $I(1)$ specification. Second, if Π has rank zero, Equation (4) depends only on $\Delta \mathrm{y_{t-j}}$ and not on $\mathrm{y_{t-k}}$, reducing the model to a standard VAR in the first differences. Therefore, there are no long-run relationships among the elements of $\mathrm{y_{t-1}}$, and there is no co-integration. The third case is when Π is of intermediate rank r ($0 < r < h$), where r is the number of co-integrating vectors. In this case, Π is defined as $\Pi = \alpha\beta^{'}$, where α and β are h x r matrices. The r columns of matrix β give the co-integrating vectors (those linearly independent combinations of $\mathrm{y_t}$ that are stationary), whereas the matrix α (known as the 'adjustment parameters') indicates how many of each of these r co-integrating relations enter each equation of the VECM.

In sum, if Π has rank r, then there are r co-integrating relations between the elements of $\mathrm{y_t}$, or likewise, $h - r$ common stochastic trends. Kasa (1992) indicates that the strength of the Johansen's test mainly comes from his assumptions. When he fully specifies a Gaussian data generation process, Johansen can integrate the co-integration subject into the maximum likelihood estimation and testing framework.

As a result, under the null hypothesis that there are r co-integrating vectors, so that $\Pi = \alpha\beta^{'}$ with α and β being h x r matrices, Equation 4 can be rewritten as follows:

$$\Delta \mathrm{y_t} = \mathrm{c} + \alpha\beta' \,\mathrm{y_{t-k}} + \sum_{\mathrm{i=1}}^{\mathrm{k-1}} \Gamma_{\mathrm{i}} \Delta \mathrm{y_{t-i}} + \varepsilon_{\mathrm{t}} \tag{7}$$

Johansen (1988 and 1991) proposes testing for the co-integration between different process $\mathrm{y_t}$ by looking at the rank of the Π matrix via its eigenvalues, λ_i, or the characteristic roots that are different from zero. If the set variables are not co-integrated, the rank of matrix Π and hence λ_i will not be significantly different from zero.

There are two test statistics for co-integration under the Johansen approach, differing only in the assumption of the alternative hypothesis. They are formulated as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln\left(1 - \hat{\lambda}_i\right) \tag{8}$$

$$\lambda_{max}(r, r+1) = -T \, \ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{9}$$

where r is the number of co-integrating vectors, and $\hat{\lambda}_i$ is the estimated value for the ith-ordered eigenvalue from the Π matrix. As expected, the bigger $\hat{\lambda}_i$is, the larger and more negative will $\ln\left(1-\hat{\lambda}_i\right)$ be, and consequently, the larger will the statistic be. In this way, if an eigenvalue is significantly different from zero, cointegrating vector is also significant.

The trace test is a likelihood ratio test where the null hypothesis is as follows: the number of co-integrating vectors is $r \le q$ ($q \le h$) against a general alternative that they are more than r. Then $\lambda_{trace} = 0$ when all $\lambda_i = 0$, for i = 1, . . . , h.

The maximal eigenvalue test conducts separate tests on each eigenvalue, making the alternative hypothesis more precise. The null hypothesis is identical to the trace test, whereas the alternative is that only one additional co-integrating vector exists, that is, $r + 1$.

The distribution of both test statistics is a non-standard asymptotic distribution, and Johansen and Juselius (1990) provide critical values for these two statistics. They depend on the value of $h - r$, the number of non-stationary variables, and whether the intercepts are added in each of the equations. These can be included either in the co-integrating vectors or as additional terms in the VAR. If the constant is incorporated in the specification of the VAR, it is the same as including a trend in the data-generating processes for the levels of the series.

If the calculated test statistic is larger than the value given in Johansen's tables, the null hypothesis that there are r co-integrating vectors has to be rejected in favour of the alternative, which can be that there are more than r (for λ_{trace}) or $r + 1$ (for λ_{max}) co-integrating vectors.

In general, the trace stat tends to have greater power than λ_{max} when the eigenvalues are evenly distributed. By contrast, the maximal eigenvalue test tends to give better results when the λ_i is either large or small. Chen et al. (2002) indicate that the value of r is best chosen by a consideration of both statistics, along with an inspection of the eigenvalues themselves.

Appendix D: Tables

Table 1: Index market monthly returns correlations
Panel A: Between 1995 and 2000

	U.S.	UK	Germany	Japan	Canada	Australia	Switzerland	Sweden	Norway	N. Zealand	Argentina	Brazil	Chile	China	Colombia	Czech Rep.	Hungary	India	Indonesia	Korea	Malaysia	Mexico	Peru	Philippines	Poland	Russia	Taiwan	Thailand	Turkey
UK	0.78	1.00																											
Germany	0.62	0.63	1.00																										
Japan	0.47	0.42	0.30	1.00																									
Canada	0.71	0.60	0.67	0.39	1.00																								
Australia	0.68	0.76	0.56	0.48	0.65	1.00																							
Switzerland	0.53	0.61	0.50	0.23	0.31	0.43	1.00																						
Sweden	0.65	0.58	0.78	0.34	0.76	0.60	0.40	1.00																					
Norway	0.56	0.53	0.55	0.16	0.73	0.62	0.33	0.63	1.00																				
N. Zealand	0.58	0.58	0.39	0.39	0.51	0.67	0.49	0.49	0.62	1.00																			
Argentina	0.41	0.38	0.44	0.48	0.56	0.55	0.09	0.47	0.52	0.44	1.00																		
Brazil	0.49	0.49	0.49	0.38	0.58	0.61	0.21	0.51	0.55	0.41	0.74	1.00																	
Chile	0.49	0.38	0.37	0.39	0.52	0.53	0.25	0.46	0.59	0.56	0.63	0.73	1.00																
China	0.28	0.21	0.09	0.24	0.32	0.37	-0.01	0.11	0.28	0.24	0.35	0.35	0.37	1.00															
Colombia	0.35	0.28	0.32	0.04	0.32	0.28	0.18	0.29	0.39	0.33	0.44	0.51	0.49	0.04	1.00														
Czech Rep.	0.16	0.11	0.39	0.13	0.40	0.35	0.04	0.46	0.42	0.23	0.43	0.39	0.30	0.16	0.29	1.00													
Hungary	0.51	0.45	0.57	0.15	0.55	0.58	0.29	0.60	0.61	0.49	0.53	0.64	0.58	0.18	0.53	0.57	1.00												
India	0.17	0.12	0.36	0.27	0.35	0.28	-0.05	0.42	0.37	0.20	0.36	0.26	0.27	0.13	0.14	0.43	0.34	1.00											
Indonesia	0.41	0.32	0.20	0.35	0.37	0.42	0.11	0.31	0.35	0.50	0.38	0.38	0.53	0.44	0.38	0.32	0.38	0.22	1.00										
Korea	0.44	0.32	0.20	0.53	0.36	0.49	0.17	0.37	0.24	0.44	0.21	0.25	0.42	0.34	0.14	0.34	0.29	0.28	0.54	1.00									
Malaysia	0.28	0.25	0.25	0.40	0.44	0.38	0.09	0.30	0.24	0.33	0.31	0.25	0.34	0.49	0.10	0.30	0.22	0.32	0.61	0.52	1.00								
Mexico	0.46	0.41	0.39	0.41	0.51	0.56	0.01	0.46	0.50	0.39	0.79	0.73	0.63	0.31	0.43	0.31	0.46	0.32	0.30	0.18	0.19	1.00							
Peru	0.35	0.32	0.45	0.33	0.51	0.44	0.17	0.47	0.53	0.42	0.72	0.71	0.68	0.18	0.47	0.41	0.60	0.35	0.33	0.15	0.18	0.68	1.00						
Philippines	0.49	0.41	0.34	0.40	0.43	0.58	0.22	0.34	0.40	0.51	0.49	0.45	0.58	0.56	0.27	0.30	0.41	0.30	0.65	0.45	0.71	0.43	0.38	1.00					
Poland	0.46	0.44	0.56	0.29	0.59	0.68	0.26	0.64	0.62	0.58	0.57	0.56	0.57	0.21	0.26	0.63	0.73	0.39	0.36	0.39	0.40	0.47	0.58	0.50	1.00				
Russia	0.50	0.43	0.35	0.25	0.54	0.50	0.18	0.44	0.60	0.39	0.49	0.59	0.66	0.27	0.56	0.32	0.60	0.30	0.42	0.24	0.23	0.59	0.53	0.38	0.44	1.00			
Taiwan	0.34	0.28	0.32	0.48	0.38	0.41	0.12	0.39	0.29	0.29	0.46	0.45	0.52	0.49	0.25	0.35	0.35	0.42	0.42	0.45	0.47	0.37	0.33	0.50	0.32	0.47	1.00		
Thailand	0.36	0.35	0.23	0.45	0.32	0.55	0.14	0.25	0.28	0.50	0.40	0.35	0.45	0.51	0.19	0.30	0.27	0.29	0.66	0.62	0.74	0.32	0.19	0.77	0.40	0.30	0.53	1.00	
Turkey	0.37	0.38	0.33	0.05	0.36	0.31	0.17	0.39	0.52	0.35	0.25	0.44	0.46	-0.04	0.42	0.12	0.42	0.18	0.09	0.12	0.06	0.36	0.41	0.08	0.37	0.48	0.21	0.05	1.00
Venezuela	0.27	0.20	0.14	0.02	0.37	0.24	0.13	0.32	0.27	0.29	0.26	0.35	0.24	0.29	0.28	0.20	0.36	0.10	0.31	0.21	0.23	0.13	0.17	0.21	0.23	0.21	0.12	0.19	0.20

Panel B: Between 2001 and 2007

	U.S.	UK	Germany	Japan	Canada	Australia	Switzerland	Sweden	Norway	N. Zealand	Argentina	Brazil	Chile	China	Colombia	Czech Rep.	Hungary	India	Indonesia	Korea	Malaysia	Mexico	Peru	Philippines	Poland	Russia	Taiwan	Thailand	Turkey
UK	0.84	1.00																											
Germany	0.84	0.86	1.00																										
Japan	0.54	0.57	0.58	1.00																									
Canada	0.80	0.80	0.79	0.64	1.00																								
Australia	0.85	0.90	0.82	0.58	0.87	1.00																							
Switzerland	0.82	0.90	0.89	0.59	0.75	0.84	1.00																						
Sweden	0.85	0.84	0.87	0.59	0.80	0.83	0.84	1.00																					
Norway	0.62	0.77	0.79	0.54	0.78	0.72	0.73	0.69	1.00																				
N. Zealand	0.42	0.47	0.50	0.32	0.52	0.59	0.45	0.49	0.52	1.00																			
Argentina	0.27	0.34	0.34	0.18	0.43	0.29	0.21	0.37	0.42	0.29	1.00																		
Brazil	0.71	0.70	0.76	0.52	0.79	0.74	0.68	0.72	0.72	0.47	0.53	1.00																	
Chile	0.67	0.66	0.66	0.46	0.71	0.70	0.62	0.69	0.67	0.44	0.45	0.77	1.00																
China	0.68	0.68	0.72	0.62	0.74	0.71	0.64	0.66	0.62	0.46	0.44	0.64	0.61	1.00															
Colombia	0.45	0.42	0.43	0.33	0.50	0.46	0.42	0.43	0.48	0.33	0.34	0.44	0.38	0.44	1.00														
Czech Rep.	0.52	0.65	0.58	0.49	0.67	0.66	0.64	0.61	0.63	0.48	0.34	0.66	0.52	0.54	0.40	1.00													
Hungary	0.47	0.57	0.51	0.36	0.60	0.61	0.53	0.55	0.61	0.36	0.24	0.62	0.51	0.46	0.38	0.72	1.00												
India	0.57	0.58	0.60	0.54	0.68	0.61	0.55	0.67	0.57	0.45	0.47	0.67	0.58	0.72	0.53	0.50	0.48	1.00											
Indonesia	0.33	0.39	0.43	0.32	0.50	0.47	0.45	0.38	0.48	0.32	0.12	0.46	0.46	0.31	0.48	0.33	0.40	0.50	1.00										
Korea	0.60	0.56	0.66	0.54	0.66	0.66	0.61	0.64	0.63	0.43	0.28	0.66	0.55	0.59	0.53	0.60	0.52	0.68	0.46	1.00									
Malaysia	0.30	0.35	0.40	0.30	0.41	0.35	0.33	0.37	0.47	0.32	0.24	0.40	0.44	0.39	0.37	0.30	0.27	0.50	0.60	0.40	1.00								
Mexico	0.76	0.72	0.73	0.52	0.71	0.72	0.67	0.64	0.68	0.41	0.39	0.73	0.55	0.62	0.59	0.56	0.59	0.62	0.40	0.70	0.42	1.00							
Peru	0.28	0.37	0.40	0.27	0.55	0.44	0.35	0.33	0.52	0.32	0.30	0.56	0.53	0.44	0.34	0.36	0.41	0.53	0.47	0.44	0.50	0.42	1.00						
Philippines	0.40	0.41	0.44	0.26	0.40	0.40	0.39	0.32	0.45	0.29	0.41	0.55	0.43	0.39	0.43	0.25	0.23	0.52	0.51	0.47	0.46	0.55	0.48	1.00					
Poland	0.61	0.69	0.60	0.51	0.70	0.71	0.64	0.64	0.64	0.51	0.32	0.67	0.55	0.62	0.42	0.71	0.70	0.59	0.24	0.59	0.21	0.60	0.42	0.34	1.00				
Russia	0.37	0.44	0.37	0.43	0.55	0.55	0.42	0.39	0.53	0.30	0.36	0.53	0.51	0.51	0.50	0.57	0.43	0.41	0.36	0.61	0.29	0.49	0.42	0.34	0.55	1.00			
Taiwan	0.55	0.50	0.61	0.43	0.54	0.53	0.50	0.57	0.56	0.46	0.47	0.66	0.52	0.55	0.47	0.46	0.36	0.64	0.38	0.75	0.49	0.60	0.32	0.56	0.50	0.46	1.00		
Thailand	0.37	0.42	0.50	0.40	0.56	0.48	0.45	0.41	0.53	0.44	0.38	0.57	0.44	0.46	0.51	0.45	0.33	0.60	0.57	0.59	0.40	0.44	0.57	0.58	0.46	0.42	0.57	1.00	
Turkey	0.63	0.63	0.58	0.44	0.67	0.68	0.58	0.69	0.54	0.36	0.47	0.68	0.67	0.60	0.47	0.62	0.55	0.62	0.31	0.68	0.36	0.59	0.42	0.39	0.64	0.59	0.54	0.47	1.00
Venezuela	0.30	0.37	0.35	0.28	0.27	0.32	0.24	0.36	0.28	0.12	0.34	0.33	0.28	0.32	0.20	0.15	0.05	0.28	0.21	0.20	0.18	0.27	0.17	0.24	0.24	0.34	0.26	0.26	0.39

Table 2: Unit root test of stock index series: Augmented Dickey-Fuller and Phillips-Perron regression[1]

Panel A: January 1989 – June 2007

		ADF test		P-P test	
		Lags	**t-statistics**	**Lags**	**t-statistics**
Australia	Level	1	-0.72	11	-0.68
	Δ	0	-65.68 *	9	-65.60 *
Canada	Level	1	0.64	0	0.87
	Δ	0	-63.60 *	5	-63.63 *
Germany	Level	0	-0.55	15	-0.46
	Δ	0	-70.08 *	14	-70.21 *
Japan	Level	0	-2.08	5	-2.02
	Δ	0	-70.68 *	4	-70.73 *
New Zealand	Level	0	-0.82	15	-0.87
	Δ	0	-68.20 *	14	-68.21 *
Norway	Level	1	0.25	15	0.30
	Δ	0	-74.04 *	12	-74.30 *
Sweden	Level	0	-0.64	18	-0.58
	Δ	0	-67.18 *	20	-67.23 *
Switzerland	Level	0	-0.99	21	-0.96
	Δ	0	-70.29 *	21	-70.65 *
UK	Level	0	-1.04	16	-0.92
	Δ	2	-43.46 *	17	-70.08 *
USA	Level	0	-1.39	29	-1.42
	Δ	0	-70.02 *	29	-70.55 *

Panel B: January 1993 – June 2007

		ADF test		P-P test	
		Lags	**t-statistics**	**Lags**	**t-statistics**
Argentina	Level	0	-0.880	7	-0.883
	Δ	0	-59.185 *	4	-59.144 *
Brazil	Level	1	-1.286	19	-1.153
	Δ	0	-54.654 *	23	-54.370 *
Chile	Level	1	-0.175	17	-0.329
	Δ	0	-49.513 *	12	-49.930 *
China	Level	1	-1.538	9	-1.525
	Δ	0	-51.875 *	14	-51.717 *
Colombia	Level	1	0.647	11	0.624
	Δ	0	-47.321 *	2	-47.348 *
India	Level	1	0.268	0	0.628
	Δ	0	-54.492 *	7	-54.521 *
Indonesia	Level	6	-0.963	15	-1.084
	Δ	5	-26.948 *	20	-53.685 *
Korea	Level	9	-0.784	6	-0.679
	Δ	8	-19.317 *	1	-56.099 *
Malaysia	Level	6	-1.206	21	-1.315
	Δ	5	-26.154 *	24	-55.996 *
Mexico	Level	1	0.063	1	0.187
	Δ	0	-56.406 *	5	-56.331 *
Peru	Level	1	0.552	14	0.672
	Δ	0	-52.948 *	20	-52.820 *
Philippines	Level	1	-0.933	1	-0.833
	Δ	0	-50.877 *	11	-50.566 *
Taiwan	Level	0	-2.566	9	-2.670
	Δ	0	-59.594 *	7	-59.640 *
Thailand	Level	1	-1.185	7	-1.142
	Δ	0	-51.587 *	13	-51.470 *
Venezuela	Level	1	-3.140 **	11	-3.137 **
	Δ	0	-58.613 *	8	-58.578 *

Panel C: January 1995 – June 2007

		ADF test		P-P test	
		Lags	**t-statistics**	**Lags**	**t-statistics**
Czech Rep.	Level	1	1.20	12	1.31
	Δ	0	-50.74 *	15	-50.68 *
Hungary	Level	1	-0.34	7	-0.26
	Δ	0	-52.72 *	11	-52.64 *
Poland	Level	1	-0.50	10	-0.43
	Δ	0	-51.34 *	14	-51.36 *
Russia	Level	1	-0.79	11	-0.85
	Δ	0	-52.40 *	8	-52.55 *
Turkey	Level	0	-1.54	8	-1.61
	Δ	0	-54.49 *	10	-54.48 *

[1] The lag length in the ADF regression is chosen by Akaike's Information Criterion. Critical values are: 10%, -2.567; 5%, -2.862; 1%, -3.432. The lag length in the P–P test is chosen to match that in the autocovariances of residuals under the null of of $\alpha = 1$. The details of the adjusted t-statistic are from Phillips and Perron (1988). Null Hypothesis: existence of unit root. * Significance at the 1% level. ** Significance at the 5% level.

Table 4: Market capitalization of listed countries (U.S. billions), 2010

Country	Market capitalization
U.S.	17,138.98
China	4,762.84
Japan	4,099.59
UK	3,107.04
Canada	2,160.23
India	1,615.86
Brazil	1,545.57
Australia	1,454.55
Germany	1,429.71
Switzerland	1,229.36
Korea	1,089.22
Russia	1,004.52
Taiwan	789.41
Sweden	581.17
Mexico	454.35
Malaysia	410.53
Indonesia	360.39
Chile	341.58
Thailand	277.73
Turkey	270.76
Norway	250.92
Colombia	208.50
Polonia	190.23
Philippines	157.32
Peru*	99.83
Argentina	63.91
Czech Rep.	43.06
New Zealand	36.30
Hungary	27.71
Venezuela	3.99

Sources: World Bank and Bloomberg. For World Bank, listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles. For Bloomberg use WCAP Index. WCAP data does not include ETFs and ADRs as they do not directly represent companies. It includes only actively traded, primary securities on the country´s exchanges to avoid double counting as well. Therefore the values will be significantly lower than expected market capitalization values of a country´s exchanges. * Peru is the only country to use Bloomberg indicator.

Table 5: Johansen's cointegration test results of dollarized stock market indices of Developed Countries

H_0	H_A	Eigenvalues	λ_{trace}		Critical value (1) 95%	99%	λ_{max}		Critical value (1) 95%	99%
U.S., Japan, UK, Canada, Australia, Germany, Switzerland, Sweden, Norway and New Zealand										
Panel A: Pre-crisis period (January 1, 1989 to May 30, 1997)										
r = 0	r > 0	0.0333	268.36	**	233.13	247.18	74.12	**	62.81	69.09
r ≤ 1	r > 1	0.0252	194.23	*	192.89	204.95	55.85		57.12	62.80
r ≤ 2	r > 2	0.0178	138.38		156.00	168.36	39.29		51.42	57.69
r ≤ 3	r > 3	0.0151	99.08		124.24	133.57	33.41		45.28	51.57
r ≤ 4	r > 4	0.0104	65.67		94.15	103.18	22.93		39.37	45.10
r ≤ 5	r > 5	0.0076	42.74		68.52	76.07	16.73		33.46	38.77
r ≤ 6	r > 6	0.0060	26.00		47.21	54.46	13.28		27.07	32.24
r ≤ 7	r > 7	0.0039	12.72		29.68	35.65	8.65		20.97	25.52
r ≤ 8	r > 8	0.0018	4.07		15.41	20.04	4.06		14.07	18.63
r ≤ 9	r > 9	0.0000	0.01		3.76	6.65	0.01		3.76	6.65
Panel B: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0615	282.51	**	233.13	247.18	82.56	**	62.81	69.09
r ≤ 1	r > 1	0.0422	199.96	*	192.89	204.95	56.03		57.12	62.80
r ≤ 2	r > 2	0.0296	143.93		156.00	168.36	39.15		51.42	57.69
r ≤ 3	r > 3	0.0252	104.78		124.24	133.57	33.18		45.28	51.57
r ≤ 4	r > 4	0.0185	71.60		94.15	103.18	24.35		39.37	45.10
r ≤ 5	r > 5	0.0149	47.25		68.52	76.07	19.51		33.46	38.77
r ≤ 6	r > 6	0.0110	27.75		47.21	54.46	14.36		27.07	32.24
r ≤ 7	r > 7	0.0058	13.39		29.68	35.65	7.51		20.97	25.52
r ≤ 8	r > 8	0.0035	5.88		15.41	20.04	4.61		14.07	18.63
r ≤ 9	r > 9	0.0010	1.27		3.76	6.65	1.27		3.76	6.65
Biggest market capitalization: U.S., Japan, UK, Canada, Australia, Germany and Switzerland										
Panel C: Pre-crisis period (January 1, 1989 to May 30, 1997)										
r = 0	r > 0	0.0201	125.41	*	124.24	133.57	44.41		45.28	51.57
r ≤ 1	r > 1	0.0135	81.00		94.15	103.18	29.88		39.37	45.10
r ≤ 2	r > 2	0.0106	51.12		68.52	76.07	23.46		33.46	38.77
r ≤ 3	r > 3	0.0063	27.66		47.21	54.46	13.88		27.07	32.24
r ≤ 4	r > 4	0.0044	13.78		29.68	35.65	9.67		20.97	25.52
r ≤ 5	r > 5	0.0019	4.12		15.41	20.04	4.11		14.07	18.63
r ≤ 6	r > 6	0.0000	0.00		3.76	6.65	0.00		3.76	6.65
Panel D: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0448	150.57	**	124.24	133.57	59.58	**	45.28	51.57
r ≤ 1	r > 1	0.0265	91.00		94.15	103.18	34.90		39.37	45.10
r ≤ 2	r > 2	0.0188	56.10		68.52	76.07	24.67		33.46	38.77
r ≤ 3	r > 3	0.0117	31.43		47.21	54.46	15.31		27.07	32.24
r ≤ 4	r > 4	0.0088	16.12		29.68	35.65	11.50		20.97	25.52
r ≤ 5	r > 5	0.0034	4.62		15.41	20.04	4.39		14.07	18.63
r ≤ 6	r > 6	0.0002	0.23		3.76	6.65	0.23		3.76	6.65
U.S., Japan, UK and Germany										
Panel E: Pre-crisis period (January 1, 1989 to May 30, 1997)										
r = 0	r > 0	0.0093	41.57		47.21	54.46	20.48		27.07	32.24
r ≤ 1	r > 1	0.0055	21.09		29.68	35.65	12.00		20.97	25.52
r ≤ 2	r > 2	0.0041	9.09		15.41	20.04	9.01		14.07	18.63
r ≤ 3	r > 3	0.0000	0.08		3.76	6.65	0.08		3.76	6.65
Panel F: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0293	71.22	**	47.21	54.46	38.73	**	27.07	32.24
r ≤ 1	r > 1	0.0181	32.49	*	29.68	35.65	23.81	*	20.97	25.52
r ≤ 2	r > 2	0.0066	8.67		15.41	20.04	8.67		14.07	18.63
r ≤ 3	r > 3	0.0000	0.00		3.76	6.65	0.00		3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

Table 6: Johansen's cointegration test results of dollarized stock market indices of Latin America

H_0	H_A	Eigenvalues	λ_{trace}	Critical value [1]		λ_{max}	Critical value [1]	
				95%	99%		95%	99%
All LatAm: Argentina, Brazil, Chile, Colombia, Mexico and Peru								
Panel A: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0447	109.70 **	94.15	103.18	52.50 **	39.37	45.10
r ≤ 1	r > 1	0.0221	57.20	68.52	76.07	25.64	33.46	38.77
r ≤ 2	r > 2	0.0111	31.56	47.21	54.46	12.82	27.07	32.24
r ≤ 3	r > 3	0.0086	18.74	29.68	35.65	9.92	20.97	25.52
r ≤ 4	r > 4	0.0067	8.82	15.41	20.04	7.66	14.07	18.63
r ≤ 5	r > 5	0.0010	1.16	3.76	6.65	1.16	3.76	6.65
Panel B: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0305	81.66	94.15	103.18	36.21	39.37	45.10
r ≤ 1	r > 1	0.0153	45.46	68.52	76.07	18.08	33.46	38.77
r ≤ 2	r > 2	0.0123	27.38	47.21	54.46	14.43	27.07	32.24
r ≤ 3	r > 3	0.0070	12.94	29.68	35.65	8.22	20.97	25.52
r ≤ 4	r > 4	0.0040	4.72	15.41	20.04	4.72	14.07	18.63
r ≤ 5	r > 5	0.0000	0.00	3.76	6.65	0.00	3.76	6.65
All LatAm and U.S.								
Panel C: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0457	137.56 **	124.24	133.57	53.65 **	45.28	51.57
r ≤ 1	r > 1	0.0252	83.91	94.15	103.18	29.33	39.37	45.10
r ≤ 2	r > 2	0.0192	54.58	68.52	76.07	22.21	33.46	38.77
r ≤ 3	r > 3	0.0141	32.37	47.21	54.46	16.33	27.07	32.24
r ≤ 4	r > 4	0.0084	16.05	29.68	35.65	9.72	20.97	25.52
r ≤ 5	r > 5	0.0055	6.32	15.41	20.04	6.27	14.07	18.63
r ≤ 6	r > 6	0.0000	0.05	3.76	6.65	0.05	3.76	6.65
Panel D: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0311	105.09	124.24	133.57	37.00	45.28	51.57
r ≤ 1	r > 1	0.0221	68.10	94.15	103.18	26.20	39.37	45.10
r ≤ 2	r > 2	0.0152	41.89	68.52	76.07	17.91	33.46	38.77
r ≤ 3	r > 3	0.0100	23.99	47.21	54.46	11.78	27.07	32.24
r ≤ 4	r > 4	0.0067	12.21	29.68	35.65	7.83	20.97	25.52
r ≤ 5	r > 5	0.0037	4.38	15.41	20.04	4.37	14.07	18.63
r ≤ 6	r > 6	0.0000	0.01	3.76	6.65	0.01	3.76	6.65
Biggest market capitalization: Brazil, Mexico and Chile								
Panel E: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0066	15.06	29.68	35.65	7.60	20.97	25.52
r ≤ 1	r > 1	0.0034	7.47	15.41	20.04	3.96	14.07	18.63
r ≤ 2	r > 2	0.0031	3.51	3.76	6.65	3.51	3.76	6.65
Panel F: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0130	23.61	29.68	35.65	17.09	20.97	25.52
r ≤ 1	r > 1	0.0050	6.52	15.41	20.04	6.50	14.07	18.63
r ≤ 2	r > 2	0.0000	0.02	3.76	6.65	0.02	3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

CONTINUATION TABLE 6: Johansen's cointegration test results of dollarized stock market indices of Latin America

H_0	H_A	Eigenvalues	λ_{trace}		Critical value (1)		λ_{max}		Critical value (1)	
					95%	99%			95%	99%
Biggest market capitalization and U.S.										
Panel G: Pre-crisis period (January 1, 1993 to May 30, 1997)										
r = 0	r > 0	0.0196	40.59		47.21	54.46	22.70		27.07	32.24
r ≤ 1	r > 1	0.0111	17.88		29.68	35.65	12.87		20.97	25.52
r ≤ 2	r > 2	0.0043	5.02		15.41	20.04	4.97		14.07	18.63
r ≤ 3	r > 3	0.0000	0.05		3.76	6.65	0.05		3.76	6.65
Panel H: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0249	55.32	**	47.21	54.46	32.82	**	27.07	32.24
r ≤ 1	r > 1	0.0127	22.49		29.68	35.65	16.66		20.97	25.52
r ≤ 2	r > 2	0.0045	5.84		15.41	20.04	5.82		14.07	18.63
r ≤ 3	r > 3	0.0000	0.01		3.76	6.65	0.01		3.76	6.65
Smallest market capitalization: Colombia, Argentina and Peru										
Panel I: Pre-crisis period (January 1, 1993 to May 30, 1997)										
r = 0	r > 0	0.0192	28.06		29.68	35.65	22.22	*	20.97	25.52
r ≤ 1	r > 1	0.0039	5.84		15.41	20.04	4.43		14.07	18.63
r ≤ 2	r > 2	0.0012	1.41		3.76	6.65	1.41		3.76	6.65
Panel J: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0089	13.51		29.68	35.65	11.70		20.97	25.52
r ≤ 1	r > 1	0.0013	1.80		15.41	20.04	1.75		14.07	18.63
r ≤ 2	r > 2	0.0000	0.06		3.76	6.65	0.06		3.76	6.65
Smallest market capitalization and U.S.										
Panel K: Pre-crisis period (January 1, 1993 to May 30, 1997)										
r = 0	r > 0	0.0203	36.59		47.21	54.46	23.59		27.07	32.24
r ≤ 1	r > 1	0.0072	13.01		29.68	35.65	8.26		20.97	25.52
r ≤ 2	r > 2	0.0037	4.75		15.41	20.04	4.29		14.07	18.63
r ≤ 3	r > 3	0.0004	0.46		3.76	6.65	0.46		3.76	6.65
Panel L: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0110	30.85		47.21	54.46	14.36		27.07	32.24
r ≤ 1	r > 1	0.0079	16.49		29.68	35.65	10.26		20.97	25.52
r ≤ 2	r > 2	0.0038	6.23		15.41	20.04	5.01		14.07	18.63
r ≤ 3	r > 3	0.0009	1.22		3.76	6.65	1.22		3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

Table 7: Johansen's cointegration test results of dollarized stock market indices of Emerging Asia

H_0	H_A	Eigenvalues	λ_{trace}		Critical value (1) 95%	Critical value (1) 99%	λ_{max}		Critical value (1) 95%	Critical value (1) 99%
All Emerging Asia: China, India, Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand										
Panel A: Pre-crisis period (January 1, 1993 to May 30, 1997)										
r = 0	r > 0	0.0433	183.25	**	156.00	168.36	50.79		51.42	57.69
r ≤ 1	r > 1	0.0347	132.47	*	124.24	133.57	40.49		45.28	51.57
r ≤ 2	r > 2	0.0247	91.98		94.15	103.18	28.71		39.37	45.10
r ≤ 3	r > 3	0.0212	63.27		68.52	76.07	24.61		33.46	38.77
r ≤ 4	r > 4	0.0174	38.66		47.21	54.46	20.21		27.07	32.24
r ≤ 5	r > 5	0.0086	18.46		29.68	35.65	9.87		20.97	25.52
r ≤ 6	r > 6	0.0074	8.59		15.41	20.04	8.50		14.07	18.63
r ≤ 7	r > 7	0.0001	0.08		3.76	6.65	0.08		3.76	6.65
Panel B: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0336	160.53	*	156.00	168.36	44.44		51.42	57.69
r ≤ 1	r > 1	0.0277	116.09		124.24	133.57	36.63		45.28	51.57
r ≤ 2	r > 2	0.0240	79.46		94.15	103.18	31.58		39.37	45.10
r ≤ 3	r > 3	0.0174	47.88		68.52	76.07	22.87		33.46	38.77
r ≤ 4	r > 4	0.0098	25.01		47.21	54.46	12.78		27.07	32.24
r ≤ 5	r > 5	0.0057	12.23		29.68	35.65	7.45		20.97	25.52
r ≤ 6	r > 6	0.0035	4.78		15.41	20.04	4.61		14.07	18.63
r ≤ 7	r > 7	0.0001	0.18		3.76	6.65	0.18		3.76	6.65
All Emerging Asia, U.S. and Japan										
Panel C: Pre-crisis period (January 1, 1993 to May 30, 1997)										
r = 0	r > 0	0.0498	263.46	**	233.13	247.18	58.66		62.81	69.09
r ≤ 1	r > 1	0.0384	204.80	*	192.89	204.95	44.95		57.12	62.80
r ≤ 2	r > 2	0.0361	159.86	*	156.00	168.36	42.23		51.42	57.69
r ≤ 3	r > 3	0.0280	117.63		124.24	133.57	32.65		45.28	51.57
r ≤ 4	r > 4	0.0245	84.98		94.15	103.18	28.50		39.37	45.10
r ≤ 5	r > 5	0.0190	56.49		68.52	76.07	22.00		33.46	38.77
r ≤ 6	r > 6	0.0154	34.48		47.21	54.46	17.78		27.07	32.24
r ≤ 7	r > 7	0.0100	16.70		29.68	35.65	11.50		20.97	25.52
r ≤ 8	r > 8	0.0043	5.20		15.41	20.04	4.99		14.07	18.63
r ≤ 9	r > 9	0.0002	0.20		3.76	6.65	0.20		3.76	6.65
Panel D: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0500	249.77	**	233.13	247.18	66.76	*	62.81	69.09
r ≤ 1	r > 1	0.0322	183.01		192.89	204.95	42.56		57.12	62.80
r ≤ 2	r > 2	0.0293	140.45		156.00	168.36	38.70		51.42	57.69
r ≤ 3	r > 3	0.0239	101.75		124.24	133.57	31.49		45.28	51.57
r ≤ 4	r > 4	0.0221	70.26		94.15	103.18	29.02		39.37	45.10
r ≤ 5	r > 5	0.0121	41.24		68.52	76.07	15.87		33.46	38.77
r ≤ 6	r > 6	0.0101	25.37		47.21	54.46	13.21		27.07	32.24
r ≤ 7	r > 7	0.0056	12.16		29.68	35.65	7.30		20.97	25.52
r ≤ 8	r > 8	0.0035	4.86		15.41	20.04	4.62		14.07	18.63
r ≤ 9	r > 9	0.0002	0.24		3.76	6.65	0.24		3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

CONTINUATION TABLE 7: Johansen's cointegration test results of dollarized stock market indices of Emerging Asia

H_0	H_A	Eigenvalues	λ_{trace}	Critical value (1) 95%	Critical value (1) 99%	λ_{max}	Critical value (1) 95%	Critical value (1) 99%
Biggest market capitalization: China, India, Korea and Taiwan								
Panel E: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0193	43.95	47.21	54.46	22.43	27.07	32.24
r ≤ 1	r > 1	0.0130	21.52	29.68	35.65	15.03	20.97	25.52
r ≤ 2	r > 2	0.0050	6.49	15.41	20.04	5.70	14.07	18.63
r ≤ 3	r > 3	0.0007	0.78	3.76	6.65	0.78	3.76	6.65
Panel F: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0228	44.26	47.21	54.46	29.01 *	27.07	32.24
r ≤ 1	r > 1	0.0094	15.25	29.68	35.65	11.84	20.97	25.52
r ≤ 2	r > 2	0.0026	3.41	15.41	20.04	3.21	14.07	18.63
r ≤ 3	r > 3	0.0002	0.20	3.76	6.65	0.20	3.76	6.65
Biggest market capitalization, U.S. and Japan								
Panel G: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0265	85.71	94.15	103.18	30.79	39.37	45.10
r ≤ 1	r > 1	0.0219	54.91	68.52	76.07	25.40	33.46	38.77
r ≤ 2	r > 2	0.0157	29.51	47.21	54.46	18.18	27.07	32.24
r ≤ 3	r > 3	0.0057	11.33	29.68	35.65	6.59	20.97	25.52
r ≤ 4	r > 4	0.0040	4.74	15.41	20.04	4.63	14.07	18.63
r ≤ 5	r > 5	0.0001	0.12	3.76	6.65	0.12	3.76	6.65
Panel H: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0303	97.28 *	94.15	103.18	40.12 *	39.37	45.10
r ≤ 1	r > 1	0.0221	57.17	68.52	76.07	29.03	33.46	38.77
r ≤ 2	r > 2	0.0126	28.13	47.21	54.46	16.50	27.07	32.24
r ≤ 3	r > 3	0.0063	11.64	29.68	35.65	8.23	20.97	25.52
r ≤ 4	r > 4	0.0026	3.40	15.41	20.04	3.37	14.07	18.63
r ≤ 5	r > 5	0.0000	0.03	3.76	6.65	0.03	3.76	6.65
Smallest market capitalization: Indonesia, Malaysia, Philippines and Thailand								
Panel I: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0256	48.08 *	47.21	54.46	29.69 *	27.07	32.24
r ≤ 1	r > 1	0.0086	18.39	29.68	35.65	9.84	20.97	25.52
r ≤ 2	r > 2	0.0058	8.55	15.41	20.04	6.67	14.07	18.63
r ≤ 3	r > 3	0.0016	1.87	3.76	6.65	1.87	3.76	6.65
Panel J: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0256	49.97 *	47.21	54.46	33.81 **	27.07	32.24
r ≤ 1	r > 1	0.0076	16.16	29.68	35.65	9.89	20.97	25.52
r ≤ 2	r > 2	0.0046	6.27	15.41	20.04	5.99	14.07	18.63
r ≤ 3	r > 3	0.0002	0.28	3.76	6.65	0.28	3.76	6.65
Smallest market capitalization, U.S. and Japan								
Panel K: Pre-crisis period (January 1, 1993 to May 30, 1997)								
r = 0	r > 0	0.0317	86.63	94.15	103.18	36.95	39.37	45.10
r ≤ 1	r > 1	0.0143	49.68	68.52	76.07	16.48	33.46	38.77
r ≤ 2	r > 2	0.0108	33.20	47.21	54.46	12.44	27.07	32.24
r ≤ 3	r > 3	0.0091	20.76	29.68	35.65	10.53	20.97	25.52
r ≤ 4	r > 4	0.0089	10.23	15.41	20.04	10.23	14.07	18.63
r ≤ 5	r > 5	0.0000	0.00	3.76	6.65	0.00	3.76	6.65
Panel L: Post-crisis period (January 1, 2003 to June 29, 2007)								
r = 0	r > 0	0.0419	109.80 **	94.15	103.18	50.06 **	39.37	45.10
r ≤ 1	r > 1	0.0258	59.74	68.52	76.07	30.54	33.46	38.77
r ≤ 2	r > 2	0.0120	29.21	47.21	54.46	14.17	27.07	32.24
r ≤ 3	r > 3	0.0074	15.04	29.68	35.65	8.73	20.97	25.52
r ≤ 4	r > 4	0.0052	6.31	15.41	20.04	6.12	14.07	18.63
r ≤ 5	r > 5	0.0002	0.19	3.76	6.65	0.19	3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

Table 8: Johansen's cointegration test results of dollarized stock market indices of Emerging Europe

H_0	H_A	Eigenvalues	λ_{trace}		Critical value (1) 95%	Critical value (1) 99%	λ_{max}		Critical value (1) 95%	Critical value (1) 99%
Emerging Europe: Czech Republic, Hungary, Poland and Russia										
Panel A: Pre-crisis period (January 1, 1995 to May 30, 1997)										
r = 0	r > 0	0.0410	56.93		68.52	76.07	26.23		33.46	38.77
r ≤ 1	r > 1	0.0282	30.71		47.21	54.46	17.94		27.07	32.24
r ≤ 2	r > 2	0.0137	12.77		29.68	35.65	8.64		20.97	25.52
r ≤ 3	r > 3	0.0053	4.13		15.41	20.04	3.35		14.07	18.63
r ≤ 4	r > 4	0.0012	0.78		3.76	6.65	0.78		3.76	6.65
Panel B: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0405	91.39	**	68.52	76.07	53.82	**	33.46	38.77
r ≤ 1	r > 1	0.0179	37.56		47.21	54.46	23.54		27.07	32.24
r ≤ 2	r > 2	0.0081	14.02		29.68	35.65	10.53		20.97	25.52
r ≤ 3	r > 3	0.0024	3.49		15.41	20.04	3.18		14.07	18.63
r ≤ 4	r > 4	0.0002	0.31		3.76	6.65	0.31		3.76	6.65
Emerging Europe, U.S. and Germany										
Panel C: Pre-crisis period (January 1, 1995 to May 30, 1997)										
r = 0	r > 0	0.0613	119.48		124.24	133.57	39.65		45.28	51.57
r ≤ 1	r > 1	0.0456	79.83		94.15	103.18	29.30		39.37	45.10
r ≤ 2	r > 2	0.0318	50.54		68.52	76.07	20.24		33.46	38.77
r ≤ 3	r > 3	0.0278	30.30		47.21	54.46	17.66		27.07	32.24
r ≤ 4	r > 4	0.0119	12.64		29.68	35.65	7.49		20.97	25.52
r ≤ 5	r > 5	0.0064	5.15		15.41	20.04	4.02		14.07	18.63
r ≤ 6	r > 6	0.0018	1.12		3.76	6.65	1.12		3.76	6.65
Panel D: Post-crisis period (January 1, 2003 to June 29, 2007)										
r = 0	r > 0	0.0403	151.18	**	124.24	133.57	53.55	**	45.28	51.57
r ≤ 1	r > 1	0.0292	97.63	*	94.15	103.18	38.52		39.37	45.10
r ≤ 2	r > 2	0.0190	59.11		68.52	76.07	24.91		33.46	38.77
r ≤ 3	r > 3	0.0163	34.20		47.21	54.46	21.34		27.07	32.24
r ≤ 4	r > 4	0.0069	12.86		29.68	35.65	8.95		20.97	25.52
r ≤ 5	r > 5	0.0026	3.91		15.41	20.04	3.37		14.07	18.63
r ≤ 6	r > 6	0.0004	0.54		3.76	6.65	0.54		3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

Table 9: Johansen's cointegration test results of dollarized stock market indices of BRICs

H_0	H_A	Eigenvalues	λ_{trace}	Critical value (1) 95%	Critical value (1) 99%	λ_{max}	Critical value (1) 95%	Critical value (1) 99%
BRIC: Brazil, Russia, India and China								
Panel A: Pre-crisis period (January 1, 1995 to May 30, 1997)								
$r = 0$	$r > 0$	0.0378	44.80	47.21	54.46	24.15	27.07	32.24
$r \leq 1$	$r > 1$	0.0220	20.65	29.68	35.65	13.95	20.97	25.52
$r \leq 2$	$r > 2$	0.0106	6.70	15.41	20.04	6.70	14.07	18.63
$r \leq 3$	$r > 3$	0.0000	0.00	3.76	6.65	0.00	3.76	6.65
Panel B: Post-crisis period (January 1, 2003 to June 29, 2007)								
$r = 0$	$r > 0$	0.0219	39.10	47.21	54.46	25.93	27.07	32.24
$r \leq 1$	$r > 1$	0.0070	13.17	29.68	35.65	8.21	20.97	25.52
$r \leq 2$	$r > 2$	0.0041	4.96	15.41	20.04	4.86	14.07	18.63
$r \leq 3$	$r > 3$	0.0001	0.10	3.76	6.65	0.10	3.76	6.65
BRICs, U.S., Japan and Germany								
Panel C: Pre-crisis period (January 1, 1995 to May 30, 1997)								
$r = 0$	$r > 0$	0.0555	114.17	124.24	133.57	35.82	45.28	51.57
$r \leq 1$	$r > 1$	0.0491	78.35	94.15	103.18	31.56	39.37	45.10
$r \leq 2$	$r > 2$	0.0284	46.78	68.52	76.07	18.04	33.46	38.77
$r \leq 3$	$r > 3$	0.0247	28.75	47.21	54.46	15.69	27.07	32.24
$r \leq 4$	$r > 4$	0.0125	13.06	29.68	35.65	7.89	20.97	25.52
$r \leq 5$	$r > 5$	0.0082	5.16	15.41	20.04	5.16	14.07	18.63
$r \leq 6$	$r > 6$	0.0000	0.01	3.76	6.65	0.01	3.76	6.65
Panel D: Post-crisis period (January 1, 2003 to June 29, 2007)								
$r = 0$	$r > 0$	0.0446	126.81 *	124.24	133.57	53.39 **	45.28	51.57
$r \leq 1$	$r > 1$	0.0263	73.41	94.15	103.18	31.22	39.37	45.10
$r \leq 2$	$r > 2$	0.0154	42.19	68.52	76.07	18.16	33.46	38.77
$r \leq 3$	$r > 3$	0.0108	24.03	47.21	54.46	12.71	27.07	32.24
$r \leq 4$	$r > 4$	0.0066	11.32	29.68	35.65	7.71	20.97	25.52
$r \leq 5$	$r > 5$	0.0030	3.61	15.41	20.04	3.46	14.07	18.63
$r \leq 6$	$r > 6$	0.0001	0.15	3.76	6.65	0.15	3.76	6.65

(1) H_0 (H_A) refers to null (alternative) hypothesis. λ_{trace} and λ_{max} statistics with a constant in the cointegrating vector estimation. The lag profiles in the cointegration tests are based on the AIC. The 95% and 90% critical values are obtained from Osterwald-Lenum (1992). * Denotes rejection of the null hypothesis of no cointegration at the 10% significance level. ** Denotes rejection at the 5% significance level.

Table 10: Summary of Johansen cointegration test results of dollarized stock market indices at a 5% level of significance

	Pre-Crisis from Jan.1989 to May.1997		Post-Crisis from Jan.2003 to Jun.2007	
	λ_trace Test	λ_max Test	λ_trace Test	λ_max Test
Developed				
All Developed	2	1	2	1
Biggest market capitalization*	1	0	1	1
U.S., Japan, UK and Germany	0	0	2	2

	Pre-Crisis from Jan.1993 to May.1997		Post-Crisis from Jan.2003 to Jun.2007	
	λ_trace Test	λ_max Test	λ_trace Test	λ_max Test
Latin America				
All LatAm	1	1	0	0
All LatAm and U.S.	1	1	0	0
Biggest market capitalization*	0	0	0	0
Biggest market capitalization and U.S.*	0	0	1	1
Smaller market capitalization**	0	0	0	0
Smaller market capitalization and U.S.**	0	1	0	0
Emerging Asia				
All EA	2	0	1	0
All EA and U.S. & Japan	3	0	1	1
Biggest market capitalization*	0	0	0	1
Biggest market capitalization and U.S. & Japan*	0	0	1	1
Smaller market capitalization**	1	1	1	1
Smaller market capitalization and U.S. &Japan**	0	0	1	1

	Pre-Crisis from Jan.1995 to May.1997		Post-Crisis from Jan.2003 to Jun.2007	
	λ_trace Test	λ_max Test	λ_trace Test	λ_max Test
Emerging Europe				
All EE	0	0	1	1
All EE and U.S. & Germany	0	0	2	1
Special				
BRIC	0	0	0	0
BRIC and U.S., Japan & Germany	0	0	1	1

* For developed markets include all developed countries with more than 1,000 USD$ billions in market capitalization (U.S., Japan, UK, Canada, Australia, Germany Switzerland). For Latin American markets included the countries with the three biggest market capitalizations (Brazil, Mexico and Chile). For Emerging Asia included the countries with the fourth biggest market capitalization. ** Included the countries with the smallest market capitalizations. For Latin America they are Colombia, Peru and Argentina. For Emerging Asia they are Malaysia, Indonesia, Thailand and Philippines.

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