Int. J. Financial Stud. **2015**, *3*, 557-586; doi:10.3390/ijfs3040557

OPEN ACCESS
International Journal of
Financial Studies
ISSN 2227-7072
www.mdpi.com/journal/ijfs

Article

Do Markets Cointegrate after Financial Crises? Evidence from G-20 Stock Markets

Mahfuzul Haque [1] and Hannarong Shamsub [2,*]

[1] Department of Accounting, Finance, Insurance and Risk Management, Scott College of Business, Indiana State University, Terre Haute, IN 47809, USA; E-Mail: mahfuzul.haque@indstate.edu

[2] Thailand Institute of Nuclear Technology (Public Organization), Ministry of Science and Technology, 16 Vibhavadi Rangsit Rd, Ladyao, Chatuchak, Bangkok 10900, Thailand

* Author to whom correspondence should be addressed; E-Mail: hannarong.shamsub@gmail.com; Tel.: +66-2-579-0230.

Academic Editor: Kuan Min Wang

Received: 22 August 2015 / Accepted: 6 November 2015 / Published: 10 December 2015

Abstract: The results of the single-equation cointegration tests indicate that patterns of cointegration in the two main and four sub-periods are not homogeneous. Two key findings emerge from the study. First, fewer stock markets cointegrated with S&P 500 during the crisis period than they did during the pre-crisis. In other words, as the 2008 financial crisis deepened, S&P 500 and G-20 stock indices moved towards less cointegration. The decreasing number of cointegrating relationships implies that the U.S. stock markets and other G-20 markets have experienced different driving forces since the start of the U.S. crisis. Second, among those markets that are cointegrated with S&P 500, they happened to be deeply affected by S&P and the shocks emerging from it. The 2007–2009 financial crises can be considered a structural break in the long-run relationship and may have resulted from effective joint intervention/responses taken by members of G-20 nations.

Keywords: financial crises; euro crises; stock markets-developed and developing; cointegration; vector auto regression; granger causality and variance decomposition

JEL Classification: C5; G01; F3; F36

---

1. Introduction

The rising number of financial crises that happened in recent times and studies looking at these events from various perspectives has enriched the literature on financial crises. The world witnessed the dreadful events of 11 September 2001, the attack on the Twin Towers in New York, USA, which caused the stock markets to plunge in the USA. The aftermath of the tragedy was visible worldwide as its impact was felt in major equity markets, which suffered sharp declines, signifying that market participants perceived the event as a global shock. The 2001 event was followed by another crisis of greater magnitude in the United States, namely the housing bubble. The subprime mortgage crisis of 2007–2009, in which the housing market collapsed, causing the values of securities connected to housing prices to tumble thereafter, damaged major financial institutions. In recent years, due to the increase in the degree of integration of world capital markets, financial crises originating from one country have had a worldwide impact. The tragedy of 11 September 2001 and the financial crisis that followed affected more economies than the world has ever seen. Several other crises followed, such as the 2008–2009 Russian financial crises, the 2008–2012 Icelandic financial crises and the 2008–2010 Ireland banking crisis, and the news of the European sovereign debt (Euro) crisis followed, shattering investors' confidence and causing the global stock markets to plummet.

Since the seminal work of King and Wadhwani (1990) [1], international finance literature has examined how shocks are spread across the borders [1]. Despite the fact that much of the literature studies the cointegration between the U.S. stock markets and other countries, very little has explored the co-movement of the U.S. markets and the rest of the G-20 markets. Our paper joins this crisis transmission literature and investigates the transmission of shocks from the U.S. market (S&P) to those of the G-20 nations. The U.S. financial crisis had global implications and brought about a fundamental change in the global economic governance, with the G-20 taking over the leadership of the world economy from the G-7. The G-20 was formed as a group in 1999 after the Asian crisis of 1997, and is an international forum of finance ministers and central bank governors from the twenty most economically developed countries that meet annually to discuss the critical issues affecting the global economy. The G-20 countries, which constitute over three-quarters of the global GDP (on a market exchange rate basis) and over two-thirds of the world's population, became the de facto major global grouping of countries that is pushing responses to the crisis. The G-20's work only gained importance in recent years, especially after the Pittsburgh summit in September 2009, though the diplomatic unanimity was formed at the London summit in April 2009. To ease the 2007–2009 financial crises the leaders of G-20 agreed on an action plan, which included reinforcing international cooperation, reforming the international financial institutions and ensuring that the IMF, World Bank and other multilateral development banks have sufficient resources to continue playing their role in overcoming the crisis [2]. Building the resilience of the financial sector has been at the heart of the G-20's work since

---

[1] Taylor and Tonks (1989) [2], Kasa (1992) [3] and, subsequently, Masih and Masih (1997) [4], Chowdhry (1994) [5] and Chowdhry *et al.* (2007) [6], among several others, have used the cointegration hypothesis to assess the international integration of financial markets. Rao and Naik (1990) [7], Chan *et al.* (1997) [8], Kasa [3] and Kwan *et al.* (1995) [9] have examined the integration of financial markets before the Asian economic crisis. The second group of studies examined the effects of the economic crisis on the financial integration after the Asian crisis.

[2] The Australian Government Treasury (2015) [10].

the global financial crisis. To a large degree, the actions of the G20 economies helped to reverse the direction of the crisis and our findings lends credence to that fact.

In this study, we investigated if any cointegration exists between the G-20 markets with the U.S. after the stabilizing measures put into action by the G-20 countries during the global financial crisis of 2007–2009 [3]. We also attempted to identify whether the G-20 markets moved toward more or toward less integration after the financial crisis of 2007 [4]. Our findings provide evidence of the patterns of cointegration and of the effectiveness of G-20 intervention/responses to the crisis. We applied the following methodologies: (1) Cointegration (CI); (2) Vector Auto regression (VAR); (3) Granger Causality (GC) and (4) Variance decomposition (VC) to perform two levels of analysis: bivariate analyses, using the U.S. (S&P) and each individual country, and multivariate analyses, using regional cointegration.

The paper is organized as follows. Section 2 presents the main contributions of the literature. Section 3 discusses the data and the sample, while Section 4 deals with the methodology. Section 5 reports and discusses the empirical results, while Section 6 concludes the study.

2. Literature Review

Market contagion and co-integration/co-movement related to financial crises and their responses to the market are issues of enormous interest in the literature. Bekaert, Harvey and Ng (2005) [13] have identified contagion in equity markets. Papers have been written proposing quantitative measures of contagion (Karolyi (2003) [14], Dungey *et al.* (2004) [15]) and developing theories to explain it (Allen and Gale (2000) [16]). Concerning the U.S. financial crisis, Wei and Hui (2011) [17] found that the average decline in stock prices during the crisis in a sample of 4000 firms in 24 emerging countries was more severe for those firms intrinsically more dependent on external finance (in particular on bank lending and portfolio flows). Hau and Lai (2011) [18] state that stocks with a high share of equity funds ownership performed relatively well during the crisis, whereas stocks with ownership links to funds that were heavily affected by portfolio losses in financial stocks severely underperformed. Yang *et al.* (2003) [19] examined whether long-run integration between the United States and many international stock markets has strengthened over time. Their results show that there is no long-run relationship between most of these markets and the United States [5].

---

[3] Angeloni, I. and J. Pisany-Ferry (2015) [11]. The G20 acted as a crisis manager when global financial markets were under threat in 2008 and 2009, and contributed to a positive outcome.

[4] Duca and Stracca (2014) [12] ran an event study to test whether G20 meetings at ministerial and leaders level have had an impact on global financial markets. By focusing on the period from 2007 to 2013, looking at equity returns, bond yields and measures of market risk such as implied volatility, skewness and kurtosis. They found that G20 summits have not had a strong, consistent and durable effect on any of the markets that we consider, suggesting that the information and decision content of G20 summits is of limited relevance for market participants.

[5] Dornbush, Park and Classens (2000) [20] adopt the definition of contagion as being the dissemination of market disturbances, most of the time with negative consequences, from one market to another, while Pritsker (2001) [21] also defines contagion as the occurrence of a shock in one or more markets, countries or institutions that spread to other markets, countries or institutions. Rangvid (2001) [22] investigates the degree of convergence among three major European stock markets, and is analyzed within the framework of a recursive common stochastic trends analysis. The

Many researchers have also pointed out the increased vulnerability to crises that comes with financial and economic integration [6]. Bekaert *et al*. (2011) [13], using the 2007–2009 financial crisis as a laboratory case, analyzed the transmission of crises to country-industry equity portfolios in 55 countries. They find statistically significant evidence of contagion from U.S. markets and from the global financial sector, but the effects are economically small. By contrast, there has been substantial contagion from domestic equity markets to individual domestic equity portfolios, with its severity inversely related to the quality of countries' economic fundamentals and policies. Their findings confirm the old "wake-up call" hypothesis, with markets and investors focusing substantially more on country-specific characteristics during the crisis. Slimane *et al.* (2013) [28] found that the spread of the global financial crisis of 2008/2009 was rapid and affected the functioning and the performance of financial markets. Their paper investigates the patterns of linkage dynamics among three European stock markets, France, Germany and the U.K., during the global financial crisis by analyzing the intra-day dynamics of linkages among these markets during both calm and turmoil phases and applying a VAR-EGARCH framework to high frequency five-minute intra-day returns on selected representative stock indices. It found evidence that the interrelationship among European markets increased substantially during the period of crisis, pointing to an amplification of spillovers. Furthermore, during this period, French and U.K. markets herded around the German market, possibly due to the behavior factors influencing the stock markets on or near dates of extreme events [7]. Wasim *et al.* (2014) [37] examined the contagion effects of the stock markets of Greece, Ireland, Portugal, Spain and Italy (GIPSI), as well as the U.S. stock markets, on seven Eurozone and six non-Eurozone stock markets. Empirical results suggest that among GIPSI stock markets, Spain, Italy, Portugal and Ireland appear to be most contagious for Eurozone and non-Eurozone markets. Their study found that the Eurozone countries of France, Belgium, Austria and Germany, as well as the non-Eurozone countries of UK, Sweden and Denmark, were strongly hit by the contagion shock. Prorokowski (2013) [38] combined quantitative and qualitative research methods and painted the picture of the contemporary European financial markets with particular attention paid to the existing cross-market linkages, vulnerabilities, systemic risks and flawed regulations that altogether constituted a group of factors propagating the financial crisis contagion. Thakor (2015) [39] reviewed the literature

---

results point towards a decreasing number of common stochastic trends influencing the stock markets, *i.e.*, the degree of convergence among European stock markets has been increased during the recent two decades.

6 Mendoza and Quadrini (2010) [23] for a theoretical analysis, and Fratzscher (2012) [24] for empirical evidence during the 2007–2009 crises. Khan Taimur A. (2011) [25], paper examines the long-run convergence of the United States and 22 other developed and developing countries. Using daily data to run the Johansen (1988) [26] and the Gregory and Hansen (1996) [27] test, and find stock markets of most countries have become cointegrated by 2010. Also using the relative risk of each country (the CAPM model) to measure performance of each country over the recession of the 2000s and finds that the relative risk of a country is a good predictor of country performance in a recession.

7 In addition to testing for cointegration, researchers have also examined causality among international indices. Sheng and Tu (2000) [29] have found evidence suggesting that the U.S. market still causes some Asian markets (such as Hong Kong and South Korea) during the period of the financial crisis and conclude that the results reflect the U.S. market's dominant role. Masson (1998) [30] and (1999) [31], Calvo and Reinhart (1995) [32], Forbes and Rigobon (2002) [33], Pesaran and Pick (2003) [34], Dornbush *et al.* (2000) [19], Pritsker (2001) [20], Pericoli and Sbracia (2003) [35] and Corsetti *et al.* (1999) [36], however, assert that an excessive increase in correlation occurs between the country causing the crisis and all other countries where contagion prevails.

on the 2007–2009 crises and discusses the pre-crisis conditions, the crisis triggers, the crisis events, the real effects and the policy responses to the crisis. The author states that the pre-crisis conditions contributed to the housing price bubble and the subsequent price decline that led to a counterparty-risk crisis in which liquidity shrank due to insolvency concerns. The policy responses were influenced both by the initial belief that it was a market-wide liquidity crunch and the subsequent learning that insolvency risk was a major driver. Gennaioli *et al.* (2015) [40] modeled financial markets in which investor beliefs are shaped by representativeness. The authors express that the investors overreact to a series of good news because such a series is representative of a good state. A little bad news does not change the minds of investors because the good state is still representative, but enough bad news leads to a radical change in beliefs and a financial crisis. The model generates debt over-issuance, "this-time-is-different" beliefs, neglect-of-tail risks, and under- and over-reaction to information, boom-bust cycles and excessive volatility of prices in a unified psychological model of expectations. Reinhart *et al.* (2014) [41] examined the evolution of real per capita GDP around 100 systemic banking crises. Part of the costs of these crises is due to the protracted nature of recovery. On average, it takes about 8 years to reach the pre-crisis level of income; the median is about 6.5 years. Five to six years after the onset of the crisis, only Germany and the United States (out of 12 systemic cases) have reached their 2007–2008 peaks in real income. Forty-five percent of the episodes recorded double dips. Post-war business cycles are not the relevant comparator for the recent crises in advanced economies.

3. Data and Sample

The indices (equity daily price indices (PI)) in U.S. dollars (USD) or conversions to USD are used in the study and include Australia, Brazil, India, France, Germany, UK, Italy, Indonesia, South Korea, Argentina, Mexico, Japan, Russia, Canada, China, and South Africa [8]. After matching the sample periods for each time series, a common sample period from 1 January 2000 to 30 April 2013, with the number of daily observations for each panel, is selected mainly from Yahoo Finance, the Federal Reserve St. Louis database, and Quandl. This period encompasses the three major events that have occurred since the advent of the 21st century—11 September 2001 (hereafter referred as 9/11), the 2007–2009 subprime mortgage crises in United States, and the burst of Europe's sovereign debt (Euro) crisis in 2010. The purpose was to conduct extensive empirical research on the three events and to compare the impact these events had on the major economies. The sample period has been divided as follows: Two (2) main periods, four (4) subsample periods, and one (1) overall period. Main Period 1 ranges from 1 January 2000 to 31 December 2008. This period coincides with U.S. President George W. Bush's two terms in office, which also coincided with 9/11 and the start of the subprime mortgage crises in the United States. Main Period 2 spans from 1 January 2009 to the end of our sample period, *i.e.*, 30 April 2013, and includes the post U.S. financial crises and Europe's sovereign debt (Euro) crisis. Subsample Period 1 covers 1 January 2000 to 10 September 2001 and is labeled as "Pre-9/11." Subsample Period 2 extends from 15 September 2001 to 31 December 2006. U.S. stock markets were closed for a few days immediately following 9/11. This subsample period is

[8] Due to non-availability, data for Saudi Arabia and Turkey (to match our main or even the smaller sub periods) was not included in the G20 sample.

labeled as "Post 9/11 and Pre-Financial Crisis." Subsample Period 3, which extends from 1 January 2007 to 31 December 2009, is labeled as "Peak Financial Crises," while the last subsample, Period 4, covers 1 January 2010 to 30 April 2013 and is labeled as "Post U.S. Crisis and Euro Crisis." The overall period of the data sample is from 1 January 2000 to 30 April 2013.

4. Methodology

Engle & Granger's (1987) [42] residual-based single-equation of cointegration was employed to analyze the data and estimated the following long-run equilibrium equation:

$$y_t = \alpha_{t+}\beta_t . X_t + e_t \quad (1)$$

where y_t represents S&P 500 and X_t are individual stock market indices of the G-20 nations.

The augmented Dickey-Fuller (ADF) was used to check whether our time series data are I (1). For a variable to be I (1), the variable must be non-stationary at its level and become stationary after the first difference. We estimated ADF in Equation (2), shown below,

$$\Delta y_t = \beta' . D_t + \pi . y_{t-1} + \sum_{j=1}^{p} \varphi_j . \Delta y_{t-1} + \varepsilon_t \quad (2)$$

in which D_t is a vector of deterministic terms.

The single-equation technique was preferred over Johansen cointegration because of its intuitive interpretability. While the Johansen methodology is suitable for a system that involves more than two variables, Engle-Granger cointegration has an advantage when performing bivariate testing (Alexander, 1999 [43]). In this study, we performed bivariate testing between S&P 500 and the stock market of each G-20 country. In addition to the cointegration test, VAR and innovation accounting was also applied to analyze the series that are cointegrated with S&P 500. Regarding the choice of U.S. stock markets, we used S&P 500 instead of the Dow Jones Industrial Average (DJIA) because S&P 500 is a broader measure of market movements than DJIA.

5. Empirical Results and Discussion

The unit root test was conducted on all the periods. The results in Table 1 show that the time series process of all stock indices in all periods are non-stationary at their levels, except British and German Indices in Sub-Period 1, Chinese Index in Sub-Period 2 and South African Index in Sub-Period 4. Their first differences are stationary in all periods.

Table 1. Unit Root Test Results.

Countries	Main Period 1			Main Period 2			Sub-period 1			Sub-period 2			Sub-period 3			Sub-period 4		
	Level of Significance		Lag	Level of Significance		Lag	Level of Significance		Lag	Level of Significance		Lag	Level of Significance		Lag	Level of Significance		Lag
	Level	1st Difference		Level	1st Difference		Level	1st Difference		Level	1st Difference		Level	1st Difference		Level	1st Difference	
Australia	0.9923	0.0000 ***	1	0.4709	0.0000 ***	1	0.2075	0.0000 ***	1	0.5468	0.0000 ***	0	0.9378	0.0000 ***	0	0.2452	0.0000 ***	1
Brazil	0.9316	0.0000 ***	1	0.4426	0.0000 ***	0	0.4400	0.0000 ***	0	0.5574	0.0000 ***	1	0.9385	0.0000 ***	0	0.1144	0.0000 ***	2
India	0.8965	0.0000 ***	3	0.8538	0.0000 ***	1	0.1902	0.0000 ***	0	0.9573	0.0000 ***	0	0.8934	0.0000 ***	3	0.7186	0.0000 ***	1
France	0.7576	0.0000 ***	0	0.4262	0.0000 ***	1	0.1062	0.0000 ***	0	0.4942	0.0000 ***	0	0.8851	0.0000 ***	0	0.3398	0.0000 ***	1
Germany	0.743	0.0000 ***	0	0.2323	0.0000 ***	1	0.0329 **	0.0000 ***	0	0.7504	0.0000 ***	0	0.8225	0.0000 ***	0	0.1827	0.0000 ***	1
UK	0.7533	0.0000 ***	4	0.2861	0.0000 ***	1	0.0124 **	0.0000 ***	2	0.4318	0.0000 ***	0	0.8099	0.0000 ***	0	0.1864	0.0000 ***	0
Italy	0.9914	0.0000 ***	0	0.4919	0.0000 ***	1	NA	NA	NA	0.4158	0.0000 ***	0	0.9374	0.0000 ***	0	0.3617	0.0000 ***	1
Indonesia	0.9611	0.0000 ***	1	0.4825	0.0000 ***	0	0.4968	0.0000 ***	1	0.8573	0.0000 ***	1	0.9908	0.0000 ***	3	0.2901	0.0000 ***	0
South Korea	0.9340	0.0000 ***	0	0.7069	0.0000 ***	1	0.2640	0.0000 ***	0	0.8509	0.0000 ***	0	0.9395	0.0000 ***	1	0.4558	0.0000 ***	1
Argentina	0.9958	0.0000 ***	0	0.8496	0.0000 ***	0	0.7238	0.0000 ***	0	0.1469	0.0000 ***	0	0.9953	0.0000 ***	0	0.9676	0.0000 ***	0
Mexico	0.8211	0.0000 ***	1	0.3295	0.0000 ***	3	0.1438	0.0000 ***	1	0.9605	0.0000 ***	1	0.9462	0.0000 ***	1	0.0617	0.0000 ***	3
Japan	0.5214	0.0000 ***	0	0.3728	0.0000 ***	0	0.334	0.0000 ***	0	0.5422	0.0000 ***	0	0.9952	0.0000 ***	1	0.4927	0.0000 ***	1
Russia	0.9915	0.0000 ***	16	0.6172	0.0000 ***	1	0.3818	0.0000 ***	0	0.9876	0.0000 ***	0	0.9352	0.0000 ***	0	0.6782	0.0000 ***	1
Canada	0.9754	0.0000 ***	1	0.6043	0.0000 ***	1	0.3501	0.0000 ***	0	0.3778	0.0000 ***	1	0.9223	0.0000 ***	0	0.4197	0.0000 ***	1
China	0.8507	0.0000 ***	5	0.0370**	0.0000 ***	0	0.6762	0.0000 ***	0	0.9988	0.0000 ***	0	0.7360	0.0000 ***	0	0.232	0.0000 ***	0
South Africa	0.9439	0.0000 ***	2	0.2635	0.0000 ***	1	NA	NA	NA	0.2644	0.0000 ***	0	0.7845	0.0000 ***	1	0.0312 **	0.0000 ***	0

Note: *, ** and *** denote levels of significance at 10%, 5% and 1%. NA = Data not available. Time Periods: Main Period 1 (01/01/2000–12/31/2008), Main Period 2 (01/01/2009–04/30/2013), Sub-Period 1 (01/01/2000–09/10/2001), Sub-Period 2 (09/15/2001–12/31/2006), Sub-Period 3 (01/01/2007–12/31/2009), Sub-Period 4 (01/01/2012–04/30/2013).

Table 2 presents the Pearson's Correlation. The average correlations with S&P 500 of Periods 1 and 2 are very similar, with the correlation coefficients of 0.92 and 0.87 respectively. Among the four sub-periods, Sub-Period 4 shows lowest average correlation of 0.32. The average correlation of Sub-Period 1 is 0.65, while those of Sub-Period 2 and 3 are 0.92 and 0.87 respectively. During the Sub-Period 1, the stock markets of France, Japan and Canada show highest correlations with S&P 500. The markets that show highest correlation in Sub-Period 2 are Germany, the United Kingdom and France. The French and Italian markets exhibit the highest correlations with S&P 500 in Sub-Period 3. We find the markets that are highly correlated with S&P 500 during Sub-Periods 1 to 4 are in Europe and Asia. In the next section, we perform the bivariate cointegration test between the stock market in the G-20 country with S&P 500.

Table 2. Pearson's Correlation between S&P 500 and Individual G-20 Market.

Index	Main Period 1	Main Period 2	Sub-Period 1	Sub-period 2	Sub-period 3	Sub-period 4
NIKKEI_225_JAP_USD	0.91881247	0.798268284	0.848302	0.9194643	0.9720458	0.493656953
AORD_AUS_USD	0.910417391	0.878534471	0.7096561	0.9704026	0.9420739	0.677888613
BOVESPA_BRAZIL_USD	0.712741676	0.394379943	0.8466674	0.9427273	0.4551339	−0.423957789
BSE_SENSEX_INDIA_USD	0.82356243	0.507993402	0.7146341	0.9546012	0.7582756	−0.282360057
CAC_40_FRANCE_USD	0.950542631	0.217592254	0.914945	0.9782175	0.9898299	−0.033576787
DAX_GERMANY_USD	0.81484941	0.887061205	0.8276481	0.9758126	0.9338245	0.672849902
FTSE_100_UK_USD	0.947752306	0.890154093	0.8765646	0.9685831	0.9747434	0.773895442
FTSE_MIB_ITALY_USD	0.918584634	−0.285123418	NA	0.9178387	0.9906913	−0.413138549
JAKARTA_COMPOSITE_USD	0.812614777	0.927260023	0.6217197	0.9512123	0.6951186	0.787976012
KOPSI_COMPOSITE_SK__USD	0.909494238	0.893780439	0.7439795	0.9355421	0.9270682	0.666669139
MERVAL_ARG_USD	0.93089746	0.788128298	0.6540438	0.951406	0.8370185	0.389796718
MEXABOL_MEX_USD	0.840413702	0.961142926	0.3576683	0.9625362	0.9230826	0.898493919
MSCI_SOUTH_AFRICA___USD	0.892404524	0.921946026	NA	0.9337427	0.8337503	0.765137815
S_P_TSX_CANADA_USD	0.864382184	0.830291092	0.9120119	0.9512283	0.8957494	0.440639497
SSE_COMPOSITE_CHINA_USD	0.674345803	−0.089640613	−0.4321285	0.3052762	0.6672256	−0.400101793
RTSI_RUSSIA_USD	0.511592565	0.738090139	0.3094396	0.8729418	0.9199462	0.185714189

Note: NA = Data not available. Time Periods: Main Period 1 (01/01/2000–12/31/2008), Main Period 2 (01/01/2009–04/30/2013), Sub-Period 1 (01/01/2000–09/10/2001), Sub-Period 2 (09/15/2001–12/31/2006), Sub-Period 3 (01/01/2007–12/31/2009), Sub-Period 4 (01/01/2012–04/30/2013).

Table 3 shows the results of single-equation cointegration tests. Nikkei is the only index that cointegrates with S&P during the Main Period 1. In Main Period 2, only Mexico's Mexabol cointegrates. Testing cointegration during sub-periods, we find that three stock markets namely Canada, Japan and France are cointegrated with S&P 500 in Sub-Period 1. Like Sub-Period 1, three markets cointegrate with S&P 500 in Sub-Period 2; including Germany, UK and Italy. The number of cointregating relationships reduces in Sub-Periods 3 and 4. Only two markets, France and Italy, are cointegrated with S&P 500 during Sub-Period 3. Sub-Period 4 shows no evidence of cointegration. In addition to performing single-equation cointegration tests, we also used the Johansen methodology [9] to estimate the same data set to obtain the results presented in Tables A6–A11 of the Appendix section.

[9] As suggested by the anonymous referee and the editor.

The results of the Johansen estimation indicate that no markets are cointegrated with S&P during the two main periods and four sub-periods, except French and UK Indices, which cointegrate with S&P in Sub-Period 3. Regarding the choice of using either the Engle-Granger or the Johansen methodology to estimate the bivariate cointegration relationships discussed in the methodology section, we decided to adhere to the cointegration tests performed using the Engle-Granger methodology. The overall result shows that there are more stock markets of the G-20 nations that are cointegrated with S&P 500 during the pre-crisis era than during the post-crisis periods. The results of the cointegration analysis in Table 3 reveal two observations.

First, it shows that the markets cointegrated with S&P 500 were deeply affected by S&P 500 and shocks emanating from it. This finding is robust, as the summary of the impulse-response analyses shown in Table 4 and the vector auto regression analyses shown in Table 5 and Tables A1, A2 in the Appendix confirm, and is consistent with the study of Slimane *et al.* (2013) [28]. Second, in general, an increasing number of cointegration relationships indicate that stock markets become more integrated over time because they are being driven by the same common stochastic trends (Rangvid 2001 [21]). However, our results show the opposite. Fewer stock markets cointegrate with S&P 500 during the crisis than during the pre-crisis. In other words, S&P 500 and G-20 stock indices moved toward less cointegration after the 2008 global financial crisis. The findings are similar to those of Bekaert *et al.* [13], which found weak evidence of contagion from U.S. markets to equity markets globally. The decreasing number of cointegration relationships in our findings may imply that the U.S. stock markets and other G-20 markets have experienced different driving forces since the start of the U.S. crisis. It may also imply that the 2008 financial crisis can be considered a structural break in the long-run relationship. For the sake of brevity, the sub-periods' tables (Tables A1–A5) are not reported here.

Next, we tested to see if the regional market cointegration exhibits the same pattern as that of each individual market and S&P 500. We classify G-20 markets into Asia, Europe, and Latin America. The results in Table 5 below illustrate that only Sub-Period 1 European markets exhibit regional cointegration. Sub-periods 2, 3, and 4 show no cointegration [10]. This implies that, as the crisis deepened, fewer G-20 markets were cointegrated with S&P, and no regional markets were integrated.

[10] Estimation using the Johansen methodology reveals slightly different results. European markets were cointegrated in Sub-Periods 2 and 3. See Tables A12–A15 in the Appendix.

Table 3. Single Equation Cointegration Test.

Countries	Index	Main Period 1		Main Period 2		Sub-period 1		Sub-period 2		Sub-period 3		Sub-period 4	
		Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag
Australia	S&P500	−7.200094	2	−3.317521	3	−15.56785	0	−12.37486	1	−13.83172	2	−2.691071	3
	AORD_AUS_USD	−3.975226	2	−6.121626	3	−7.91813	1	−10.60015	1	−13.81755	2	−14.61537	0
Brazil	S&P500	−1.773832	2	0.663513	1	−14.10122	0	−14.17864	1	−0.377335	2	−10.78181	2
	BOVESPA_BRAZIL_USD	−2.819699	0	−3.795968	0	−11.24209	0	−11.45343	1	−2.834878	1	−16.29929	2
India	S&P500	−7.883913	3	0.919674	1	−5.902659	2	−11.91348	0	−4.22559	1	−5.282954	2
	BSE_SENSEX_INDIA_USD	−4.328007	3	−3.94162	0	−9.533653	0	−10.00444	0	−6.519719	0	−7.052886	1
France	S&P500	−11.67254	2	0.095937	1	−30.83013 ***	0	−14.74001	2	−30.09887 *	2	−2.32585	0
	CAC_40_FRANCE_USD	−9.376443	3	−9.471818	1	−28.98695 ***	0	−13.03703	2	−30.42807 *	2	−11.58858	1
Germany	S&P500	−3.577158	2	−8.592587	4	−13.41144	0	−20.17685 *	1	−8.439093	1	−4.930092	4
	DAX_GERMANY_USD	−2.393752	2	−15.40544	0	−11.1103	0	−18.53736 *	1	−9.285599	1	−14.54054	0
UK	S&P500	−10.08726	2	−10.84975	1	−11.42596	3	−19.23137 *	1	−11.50893	2	−8.58515	1
	FTSE_100_UK_USD	−8.05128	3	−14.2115	1	−12.05265	3	−17.89519 *	1	−11.72394	2	−21.26507	0
Italy	S&P500	−13.44762	2	−3.984392	0	NA	NA	−18.67027 *	0	−32.93658 ***	2	−6.141464	0
	FTSE_MIB_ITALY_USD	−16.06314	2	−8.829984	1	NA	NA	−19.61084 *	0	−32.62543 ***	2	−9.699914	0
Indonesia	S&P500	−8.044271	2	−15.67027	1	−5.805099	0	−18.43866	0	−1.519716	2	−11.05801	1
	JAKARTA_COMPOSITE_USD	−3.610141	2	−16.96303	1	−5.646501	0	−14.10619	0	−3.366907	0	−9.582708	3
South Korea	S&P500	−6.308443	2	−6.22948	1	−11.01358	0	−11.69572	1	−12.31377	1	−2.612514	1
	KOPSI_COMPOSITE_SK__USD	−2.979517	2	−9.134565	1	−14.85928	0	−8.433819	1	−11.72236	1	−8.701936	1
Argentina	S&P500	−6.702195	0	−2.405125	0	−7.169274	0	−7.136114	0	−1.971854	0	0.695596	2
	MERVAL_ARG_USD	−3.494824	0	−3.61143	0	−4.361313	0	−6.445001	0	−1.754497	0	−1.828516	0
Mexico	S&P500	−5.825149	2	−19.17152 *	0	−2.425258	0	−11.30257	0	−5.361411	2	−13.68178	0
	MEXABOL_MEX_USD	−2.155301	0	−19.79081 *	0	−11.16462	1	−7.385563	0	−6.867709	0	−15.03155	0

Table 3. *Cont.*

Countries	Index	Main Period 1		Main Period 2		Sub-period 1		Sub-period 2		Sub-period 3		Sub-period 4	
		Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag	Z-statistics	Lag
South Africa	S&P500	−3.304964	0	−3.819678	0	NA	NA	−17.67198	0	−5.89509	0	−2.353485	0
	MSCI_SOUTH_AFRICA___USD	−3.741844	0	−9.42348	0	NA	NA	−16.48067	0	−8.467631	1	−17.0169	0
Japan	S&P500	−22.91169 **	1	−10.03418	1	−20.27009 *	0	−16.20637	1	−12.33512	2	−5.268025	1
	NIKKEI_225_JAP_USD	−24.77195 **	1	−12.78574	1	−17.22679 *	0	−15.63515	1	−13.40394	2	−15.50236	1
Russia	S&P500	−5.792565	2	−1.403994	1	NA	NA	−9.021417	1	−10.53898	1	−2.948822	3
	RTSI_RUSSIA_USD	−4.466203	1	−4.779908	0	NA	NA	−5.466924	1	−10.99763	1	−6.267271	1
Canada	S&P500	−6.279241	1	2.217043	0	−21.25206**	1	−10.60676	1	−7.866446	0	1.742409	1
	S_P_TSX_CANADA_USD	−3.102329	1	−3.719326	0	−20.01905*	1	−9.578988	1	−7.076633	0	−8.772155	1
China	S&P500	−6.218043	2	−3.041641	0	−3.879123	0	9.371242	0	−5.180191	2	−10.42231	0
	SSE_COMPOSITE_CHINA_USD	−6.192247	4	−11.36211	0	−7.95213	0	−2.123558	0	−6.797784	1	−5.110996	0

Note: Since the results of Tau and Z-statistics do not contradict, we report only Z statistics. *, ** and *** represent levels of significance at 10%, 5% and 1%. NA = Data not available. Time Periods: Main Period 1 (01/01/2000–12/31/2008), Main Period 2 (01/01/2009–04/30/2013), Sub-Period 1 (01/01/2000–09/10/2001), Sub-Period 2 (09/15/2001–12/31/2006), Sub-Period 3 (01/01/2007–12/31/2009), Sub-Period 4 (01/01/2012–04/30/2013).

Table 4. Impulse Response Analysis.

Period	Response of:	To a One-Standard Deviation Shock in:	Average Response *
Sub-Period 1	France	S&P	50
	SP	France	1
	Japan	S&P	1.1
	S&P	Japan	1
	Canada	S&P	80
	S&P	Canada	−1
Sub-Period 2	Germany	S&P	51
	S&P	Germany	0.2
	UK	S&P	56
	S&P	UK	0.15
	Italy	S&P	200
	S&P	Italy	0.05
Sub-Period 3	France	S&P	85
	S&P	France	0.1
	Italy	S&P	450
	S&P	Italy	1.02

Note: * Average 10-period response to a one standard shock. The table shows that the response of the markets to the shock that emanated from S&P is substantially greater than that of the stock markets to S&P.

Table 5. Test for Possible Regional Cointegration.

Region	Markets	Sub-period 1			Sub-period 2			Sub-period 3			Sub-period 4		
	Dependent	z-statistic	Prob.	Max lag	z-statistic	Prob.	Max lag	z-statistic	Prob.	Max lag	z-statistic	Prob.	Max lag
Asia	BSE_SENSEX_INDIA_USD	−23.26814	0.4887	15	−25.88965	0.4048	20	NA	NA	NA	−18.543	0.5460	18
	SSE_COMPOSITE_CHINA_USD	−17.48218	0.7432	15	0.672663	1.0000	20	NA	NA	NA	−15.322	0.6994	18
	JAKARTA_COMPOSITE_USD	−15.50621	0.8205	15	−17.32684	0.7617	20	−11.01445	0.7445	18	−6.2132	0.9801	18
	KOPSI_COMPOSITE_SK__USD	−15.64015	0.8156	15	−20.9571	0.6095	20	−22.79866	0.2066	18	−9.7271	0.9145	18
	NIKKEI_225_JAP_USD	−0.261355	1.0000	15	−12.05376	0.9272	20	−17.62167	0.4020	18	NA	NA	NA
Latin America	BOVESPA_BRAZIL_USD	−10.45948	0.5759	16	−17.27755	0.2360	21	−9.303261	0.6525	19	−9.3033	0.6525	19
	MERVAL_ARG_USD	−11.72475	0.4977	16	−5.803602	0.8599	21	−22.42196	0.0998	19	−22.422	0.0998	19
	MEXABOL_MEX_USD	−11.17971	0.5309	16	−15.43034	0.3097	21	−6.680201	0.8130	19	−6.6802	0.8130	19
Europe	CAC_40_FRANCE_USD	−52.48735	0.0029 **	16	−45.12552	0.0344	20	−47.70421	0.0226	19	−27.513	0.3429	19
	DAX_GERMANY_USD	−47.33319	0.0080 ***	16	−46.99762	0.0258	20	−27.5133	0.3429	19	−20.023	0.6481	19
	FTSE_100_UK_USD	−39.61041	0.0316 **	16	−41.42607	0.0601	20	−20.02302	0.6481	19	−22.107	0.5583	19
	FTSE_MIB_ITALY_USD	NA	NA	NA	−31.29039	0.2282	20	−22.10658	0.5583	19	−47.704	0.0226	19
BRIC	BOVESPA_BRAZIL_USD	−20.35026	0.2814	16	−29.63916	0.0754	22	−11.02259	0.7451	18	−3.4015	0.9869	18
	RTSI_RUSSIA_USD	−7.934639	0.8842	16	−12.08934	0.6902	22	−5.852853	0.9486	18	−4.0937	0.9797	18
	BSE_SENSEX_INDIA_USD	−24.75549	0.1502	16	−28.84251	0.0854	22	−19.1822	0.3336	18	−4.6926	0.9713	18
	SSE_COMPOSITE_CHINA_USD	−17.49232	0.4019	16	0.585733	0.9996	22	−16.60899	0.4504	18	−9.1886	0.8334	18

Note: *,**, and *** denote levels of significance at 10%, 5%, and 1%. Maximum lag automatically selected based on Schwrz criteria. NA = Data Not Available. Only European G-20 markets are cointegrated. The cointegration occurs in sub-period 1. BRIC is not a regional trading block. Time Periods: Main Period 1 (01/01/2000–12/31/2008), Main Period 2 (01/01/2009–04/30/2013), Sub-Period 1 (01/01/2000–09/10/2001), Sub-Period 2 (09/15/2001–12/31/2006), Sub-Period 3 (01/01/2007–12/31/2009), Sub-Period 4 (01/01/2012–04/30/2013).

6. Conclusions

The results of the single-equation cointegration tests indicate that patterns of cointegration in all main and sub-periods are not homogeneous. Two major findings emerge from the study. First, fewer stock markets cointegrated with S&P 500 during the crisis period than they did during the pre-crisis period. As the 2007 financial crisis deepened, S&P 500 and G-20 stock indices moved toward less cointegration. The decreasing number of cointegrating relationships may indicate that the U.S. stock markets and other G-20 markets have experienced different driving forces since the start of the U.S. crisis. Second, among those markets that were cointegrated with S&P 500, they happened to have been deeply affected by S&P and the shocks that emerged from it. The 2007–2009 financial crises can be considered a structural break in the long-run relationship and may have resulted from effective joint intervention/responses taken by members of G-20 nations. For international investors, findings suggest that, in the long run, there were probable rewards, which may have been acquired by smart investors through portfolio diversification. While the global financial markets were being assimilated, with the economies turning out to be more interdependent, the instantaneous outcomes of the markets may not have been associated to the rising ability of information-processing by the financial markets. Our results for the sample periods, including the sub-periods, support the findings of Bekaert *et al.* (2011) [13], which pointed out that, during most of the global crisis, the market's external exposure played a very small role in determining its equity market performance. Though Prorokowski (2011) [38] states that the role of the USA in propagating the financial crisis was far more important, his study considers the financial crisis contagion in Europe only and recommends a future study that would investigate the role of the USA in propagating the global financial crisis. We believe that the findings from our study fill the gap and contribute to the literature. It is apparent from the study that, as the crisis deepened, the G-20 markets moved toward less cointegration with the U.S. market. G-20 markets perhaps should be investigated more intensely in a future study to determine whether the degree of contagion was lessened by a single country's domestic intervention or by the G-20's joint international responses to the crisis.

Acknowledgments

The authors' gratefully acknowledge the comments and suggestions from the three anonymous referees and thank the editor for their helpful suggestions. The usual disclaimer applies.

Author Contributions

Mahfuzul Haque collected the data and wrote the Introduction, Literature Review, Data and Sample, and Conclusion sections.

Hannarong Shamsub analyzed the data and wrote the Methodology, Empirical Results and Discussion, and Conclusion sections.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix

Table A1. Vector Autoregression Estimates for Sub-period 1.

Sub-period 1	France		Japan		Canada	
	S&P 500	**CAC 40**	**S&P 500**	**NIKKEI**	**S&P 500**	**S&P TSX**
C	21.09390 *	−2.631597	35.25743 ***	−1.439342	14.09819	−67.46486
	(12.3560)	(55.4936)	(15.0272)	(1.58807)	(13.7162)	(72.0172)
S&P 500 (−1)	0.969790 ***	1.290730 ***	0.979064 ***	0.051899 ***	1.031769 ***	0.945515 ***
	(0.05439)	(0.24428)	(0.05182)	(0.00548)	(0.06780)	(0.35597)
S&P 500 (−2)	−0.024779	−1.243955 ***	−0.019607	−0.050389 ***	−0.049896	0.757188 ***
	(0.05460)	(0.24523)	(0.05245)	(0.00554)	(0.06740)	(0.35389)
CAC 40 (−1)	−0.002113	0.915999 ***				
	(0.01182)	(0.05310)				
CAC 40 (−2)	0.011808	0.072035				
	(0.01187)	(0.05333)				
NIKKEI (−1)			0.164443	1.016849 ***		
			(0.44289)	(0.04680)		
NIKKEI (−2)			−0.025792	−0.022785		
			(0.43976)	(0.04647)		
S&P TSX (−1)					−0.014676	0.975012 ***
					(0.01294)	(0.06793)
S&P TSX (−2)					0.016280	−0.006405
					(0.01272)	(0.06680)
Adj. R-squared	0.974517	0.983690	0.974909	0.996109	0.973061	0.984757
F-statistic	3815.594	6017.193	3634.004	23,939.97	3567.935	6380.843
Log likelihood	−1723.254	−2324.106	−1615.849	−773.0942	−1716.373	−2373.069
Akaike AIC	8.641269	11.64553	8.644527	4.149836	8.693802	12.01045
Schwarz SC	8.691162	11.69542	8.696886	4.202195	8.744073	12.06072
Determinant resid covariance (dof adj.)		1,791,949		1194.873		1,749,841
Determinant resid covariance		1,747,431		1163.222		1,705,932
Log likelihood		−4009.882		−2387.757		−3965.024
Akaike information criterion		20.09941		12.78804		20.07588
Schwarz criterion		20.19920		12.89275		20.17642

Note: *, **, and *** denote levels of significance at 10%, 5%, and 1%.

Table A2. Vector Autoregression Estimates for Sub-period 2.

Sub-period 2	Germany		UK		Italy	
	S&P 500	**DAX**	**S&P 500**	**FTSE 100**	**S&P 500**	**FTSE MIB**
C	6.202999	−59.02332 *	7.145254 ***	−1.97451	6.218217	−963.6439 ***
	(4.92074)	(33.1596)	(3.20529)	(25.9995)	(5.49276)	(469.551)
S&P500 (−1)	0.963801 ***	1.621340 ***	0.979557 ***	2.613688 ***	0.942779	7.992102 ***
	(0.03430)	(0.23115)	(0.03164)	(0.25665)	(0.03414)	(2.91824)
S&P500 (−2)	0.026923	−1.527808 ***	0.003943	−2.59485 ***	0.051119	−6.650008 ***
	(0.03440)	(0.23179)	(0.03168)	(0.25697)	(0.03436)	(2.93754)
DAX (−1)	0.001754	0.842618 ***				
	(0.00501)	(0.03377)				
DAX (−2)	−0.000878	0.148926 ***				
	(0.00499)	(0.03362)				
FTSE 100 (−1)			−0.002788	0.842054 ***		
			(0.00377)	(0.03054)		
FTSE 100 (−2)			0.004189	0.155980 ***		
			(0.00377)	(0.03054)		
FTSE MIB (−1)					-4.68×10^{-5}	0.953878 ***
					(0.00040)	(0.03407)
FTSE MIB (−2)					8.79×10^{-5}	0.030525
					(0.00040)	(0.03387)
Adj. R-squared	0.994670	0.997560	0.994769	0.997327	0.994244	0.995992
F-statistic	59672.42	130748.6	59860.98	117417.8	38907.42	55971.73
Log likelihood	−4814.257	−7256.335	−4732.428	−7369.954	−3150.578	−7162.986
Akaike AIC	7.530089	11.34584	7.519727	11.70628	6.996847	15.89354
Schwarz SC	7.550224	11.36597	7.540119	11.72667	7.023480	15.92017

Note: *, **, and *** denote levels of significance at 10%, 5%, and 1%.

Table A3. Vector Autoregression Estimates for Sub-period 3.

Sub-period 3	France		Italy	
	S&P 500	**CAC 40**	**S&P500**	**FTSE MIB**
C	4.920230	−54.97064 ***	19.03720 **	−567.558 *
	(5.33725)	(27.4212)	(9.64657)	(315.142)
S&P500 (−1)	0.885546 ***	2.409731 ***	0.850657 ***	12.67524 ***
	(0.04544)	(0.23344)	(0.04490)	(1.46669)
S&P500 (−2)	0.099719 ***	−2.101178 ***	0.104169 ***	−11.24646 ***
	(0.04628)	(0.23778)	(0.04545)	(1.48472)
CAC 40 (−1)	−0.013579	0.713610 ***		
	(0.00848)	(0.04356)		
CAC 40 (−2)	0.015531 *	0.235352 ***		
	(0.00827)	(0.04251)		
FTSE MIB (−1)			−0.000937	0.850992 ***
			(0.00133)	(0.04340)
FTSE MIB (−2)			0.001767	0.120711 ***
			(0.00129)	(0.04217)

Table A3. *Cont.*

Sub-period 3	France		Italy	
	S&P 500	**CAC 40**	**S&P500**	**FTSE MIB**
R-squared	0.993948	0.995883	0.994037	0.997661
Adj. R-squared	0.993915	0.995860	0.994003	0.997648
F-statistic	29769.56	43839.99	29462.82	75386.49
Log likelihood	−3208.44	−4403.164	−3127.208	−5609.539
Akaike AIC	8.803946	12.07716	8.798337	15.77118
Schwarz SC	8.835405	12.10862	8.830416	15.80326

Note: *, **, and *** denote levels of significance at 10%, 5%, and 1%.

Table A4. Granger Causality Tests.

Country	Null Hypothesis:	Obs	F-Statistic	Prob.
	Sub-period 1			
France	CAC_40_FRANCE_USD does not Granger Cause S_P_500_USD	400	3.85082	0.0221
	S_P_500_USD does not Granger Cause CAC_40_FRANCE_USD		14.0427	1×10^{-6}
Japan	NIKKEI_225_JAP_USD does not Granger Cause S_P_500_USD	375	2.86207	0.0584
	S_P_500_USD does not Granger Cause NIKKEI_225_JAP_USD		44.9236	3×10^{-18}
Canada	S_P_TSX_CANADA_USD does not Granger Cause S_P_500_USD	396	0.94386	0.39
	S_P_500_USD does not Granger Cause S_P_TSX_CANADA_USD		4.39530	0.013
	Sub-period 2			
Germany	DAX_GERMANY_USD does not Granger Cause S_P_500_USD	1280	0.68681	0.5034
	S_P_500_USD does not Granger Cause DAX_GERMANY_USD		25.2503	2×10^{-11}
UK	FTSE_100_UK_USD does not Granger Cause S_P_500_USD	1260	3.29314	0.0375
	S_P_500_USD does not Granger Cause FTSE_100_UK_USD		52.0742	2×10^{-22}
Italy	FTSE_MIB_ITALY_USD does not Granger Cause S_P_500_USD	902	0.24099	0.7859
	S_P_500_USD does not Granger Cause FTSE_MIB_ITALY_USD		6.43881	0.0017
	Sub-period 3			
France	CAC 40 France does not Granger Cause S&P 500	730	1.81206	0.1641
	S&P 500 does not Granger Cause CAC 40 France		53.7003	2×10^{-22}
Italy	FTSE MIB Italy does not Granger Cause S&P 500	712	2.55981	0.078
	S&P 500 does not Granger Cause FTSE MIB Italy		37.3441	4×10^{-16}

Note: Among eight pairs of cointegration from Period 1 to 3, S&P 500 Granger Causes all markets; while only four markets Granger Cause S&P. Time Periods are as follows: Sub-Period 1 (01/01/2000–09/10/2001); Sub-Period 2 (09/15/2001–12/31/2006); Sub-Period 3 (01/01/2007–12/31/2009).

Table A5. Impulse Response Functions.

Panel A

	France [1]				**Japan [1]**			
	Response of S_P_500_USD:		**Response of CAC_40_FRANCE_USD:**		**Response of S_P_500_USD:**		**Response of NIKKEI_225_JAP_USD:**	
Period	S_P_500_USD	CAC_40_FRANCE_USD	S_P_500_USD	CAC_40_FRANCE_USD	S_P_500_USD	NIKKEI_225_JAP_USD	S_P_500_USD	NIKKEI_225_JAP_USD
1	18.09228	0.000000	33.58940	73.98941	18.11433	0.000000	0.152025	1.908265
2	17.47474	-0.156321	54.12010	67.77420	17.76009	0.313801	1.094705	1.940417
3	16.78078	0.578868	52.04274	67.20916	17.20920	0.577102	1.118651	1.945917
4	16.36991	1.223526	51.49131	67.38725	16.65641	0.828812	1.110781	1.948630
5	15.96528	1.823443	51.16947	67.42721	16.12408	1.070395	1.101302	1.951060
6	15.57722	2.391280	50.82379	67.44905	15.61238	1.302314	1.092070	1.953323
7	15.20784	2.927523	50.48643	67.45859	15.12055	1.524950	1.083165	1.955432
8	14.85587	3.433733	50.15847	67.45469	14.64783	1.738667	1.074580	1.957393
9	14.52040	3.911484	49.83894	67.43812	14.19347	1.943812	1.066302	1.959213
10	14.20058	4.362247	49.52745	67.40960	13.75674	2.140720	1.058319	1.960896

Panel B

	Canada [1]				**Germany [2]**			
	Response of S_P_500_USD:		**Response of S_P_TSX_CANADA_USD:**		**Response of S_P_500_USD:**		**Response of DAX_GERMANY_USD:**	
Period	S_P_500_USD	S_P_TSX_CANADA_USD	S_P_500_USD	S_P_TSX_CANADA_USD	S_P_500_USD	DAX_GERMANY_USD	S_P_500_USD	DAX_GERMANY_USD
1	18.57264	0.000000	66.60684	71.22387	10.42448	0.000000	41.88960	56.39172
2	18.18517	−1.04526	82.50317	69.44411	10.12060	0.098907	52.19854	47.51667
3	17.70975	−0.93809	83.14629	66.26430	10.08969	0.129182	50.70422	48.59696
4	17.48791	−0.75768	83.51538	64.06814	10.04006	0.170706	51.39451	48.08347
5	17.28779	−0.59641	84.02137	62.03667	9.993914	0.209694	51.72037	47.83276
6	17.09097	−0.44496	84.49111	60.08590	9.948068	0.248400	52.09875	47.54480
7	16.89923	−0.30119	84.91131	58.21797	9.903017	0.286469	52.46228	47.26802
8	16.71270	−0.16476	85.28572	56.43048	9.858668	0.323969	52.82195	46.99450
9	16.53115	−0.03534	85.61691	54.71975	9.815023	0.360900	53.17607	46.72544
10	16.35438	0.087387	85.90700	53.08229	9.772069	0.397272	53.52502	46.46058

Table A5. *Cont.*

Panel C								
	UK [2]				Italy [2]			
	Response of S_P_500_USD:		Response of FTSE_100_UK_USD:		Response of S_P_500_USD:		Response of FTSE_MIB_ITALY_USD:	
Period	S_P_500_USD	FTSE_100_UK_USD	S_P_500_USD	FTSE_100_UK_USD	S_P_500_USD	FTSE_MIB_ITALY_USD	S_P_500_USD	FTSE_MIB_ITALY_USD
1	10.37029	0.000000	40.50538	73.72337	7.978265	0.000000	148.9598	665.5597
2	10.04538	−0.205509	61.21241	62.07906	7.514778	-0.031115	205.8526	634.8629
3	9.879973	−0.065506	57.20835	63.23618	7.496091	-0.000499	207.9087	625.6496
4	9.814578	0.018818	57.47737	63.29344	7.459686	0.024506	214.5395	616.3758
5	9.732344	0.106657	57.33762	63.37925	7.424280	0.049270	220.7605	607.2447
6	9.653049	0.193035	57.21667	63.47122	7.389332	0.073506	226.8561	598.2834
7	9.574802	0.278096	57.09915	63.55988	7.354835	0.097237	232.8167	589.4856
8	9.497664	0.361896	56.98257	63.64707	7.320782	0.120473	238.6451	580.8485
9	9.421626	0.444448	56.86750	63.73263	7.287167	0.143223	244.3439	572.3692
10	9.346671	0.525769	56.75385	63.81659	7.253980	0.165495	249.9155	564.0446
Panel D								
	France [3]				Italy [3]			
	Response of S_P_500_USD:		Response of CAC_40_FRANCE_USD:		Response of S_P_500_USD:		Response of FTSE_MIB_ITALY_USD:	
Period	S_P_500_USD	CAC_40_FRANCE_USD	S_P_500_USD	CAC_40_FRANCE_USD	S_P_500_USD	FTSE_MIB_ITALY_USD	S_P_500_USD	FTSE_MIB_ITALY_USD
1	19.68037	0.000000	65.46874	77.05505	19.62357	0.000000	389.9819	508.8169
2	16.53887	-1.046316	94.14353	54.98726	16.32768	-0.476545	580.6048	432.9991
3	16.34689	-0.476445	81.09224	54.85317	16.07863	0.088026	527.4267	423.8582
4	16.48620	-0.41706	84.66559	53.13552	15.91003	0.393253	539.0931	419.4429
5	16.33920	-0.286403	84.88301	50.82393	15.63579	0.699693	543.2658	412.1015
6	16.27546	-0.160068	85.23220	48.96018	15.40164	0.991239	546.6450	405.7725
7	16.20299	-0.045759	85.68784	47.11604	15.17810	1.264123	550.1409	399.7494
8	16.13169	0.064160	86.05447	45.37142	14.96625	1.521083	553.3236	394.0399
9	16.06343	0.167944	86.40380	43.71710	14.76595	1.762801	556.2829	388.6421
10	15.99682	0.266178	86.72468	42.14510	14.57635	1.990155	559.0291	383.5334

Note: [1] = cointegrated in Sub-period 1; [2] = cointegrated in Sub-period 2; [3] = cointegrated in Sub-period 3.

Table A6. Test for Johansen Cointegrtion in Main Period 1.

Markets	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
Australia	None	0.002084	5.057000	15.49471	0.8027	4.187299	14.26460	0.8391
	At most 1	0.000433	0.869701	3.841466	0.3510	0.869701	3.841466	0.3510
Brazil	None	0.007113	13.66359	15.49471	0.0926	12.44860	14.26460	0.0949
	At most 1	0.000696	1.214996	3.841466	0.2703	1.214996	3.841466	0.2703
India	None	0.004111	8.370612	15.49471	0.4266	7.183719	14.26460	0.4676
	At most 1	0.000680	1.186894	3.841466	0.2760	1.186894	3.841466	0.2760
France	None	0.003552	9.132479	15.49471	0.3533	7.479244	14.26460	0.4341
	At most 1	0.000786	1.653235	3.841466	0.1985	1.653235	3.841466	0.1985
Germany	None	0.002054	6.511837	15.49471	0.6350	4.314573	14.26460	0.8247
	At most 1	0.001047	2.197264	3.841466	0.1383	2.197264	3.841466	0.1383
UK	None	0.002827	7.727786	15.49471	0.4950	5.728996	14.26460	0.6482
	At most 1	0.000987	1.998790	3.841466	0.1574	1.998790	3.841466	0.1574
Italy	None	0.008047	11.18937	15.49471	0.2001	10.93924	14.26460	0.1573
	At most 1	0.000185	0.250130	3.841466	0.6170	0.250130	3.841466	0.6170
Spain	None	0.001230	3.378736	15.49471	0.9471	2.451677	14.26460	0.9764
	At most 1	0.000465	0.927059	3.841466	0.3356	0.927059	3.841466	0.3356
Indonesia	None	0.004752	8.598941	15.49471	0.4038	8.077967	14.26460	0.3708
	At most 1	0.000307	0.520974	3.841466	0.4704	0.520974	3.841466	0.4704
South Korea	None	0.001733	3.632726	15.49471	0.9309	2.941742	14.26460	0.9506
	At most 1	0.000407	0.690984	3.841466	0.4058	0.690984	3.841466	0.4058
Argentina	None	0.003418	7.875160	15.49471	0.4788	6.018437	14.26460	0.6108
	At most 1	0.001056	1.856722	3.841466	0.1730	1.856722	3.841466	0.1730
Mexico	None	0.003201	7.064051	15.49471	0.5702	6.039840	14.26460	0.6081
	At most 1	0.000543	1.024210	3.841466	0.3115	1.024210	3.841466	0.3115
South Africa	None	0.005811	8.420008	15.49471	0.4216	8.193691	14.26460	0.3593
	At most 1	0.000161	0.226317	3.841466	0.6343	0.226317	3.841466	0.6343
Japan	None	0.004162	7.990352	15.49471	0.4664	6.960949	14.26460	0.4938
	At most 1	0.000617	1.029403	3.841466	0.3103	1.029403	3.841466	0.3103
Canada	None	0.002323	4.622999	15.49471	0.8475	4.457498	14.26460	0.8082
	At most 1	8.63×10^{-5}	0.165501	3.841466	0.6841	0.165501	3.841466	0.6841
China	None	0.005141	13.73957	15.49471	0.0904	11.18465	14.26460	0.1452
	At most 1	0.001177	2.554924	3.841466	0.1099	2.554924	3.841466	0.1099

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values.

Table A7. Test for Johansen Cointegrtion in Main Period 2.

Markets	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
Australia	None	0.008270	8.102303	15.49471	0.4545	7.897501	14.26460	0.3892
	At most 1	0.000215	0.204802	3.841466	0.6509	0.204802	3.841466	0.6509
Brazil	None	0.014351	12.34638	15.49471	0.1411	12.07012	14.26460	0.1080
	At most 1	0.000331	0.276258	3.841466	0.5992	0.276258	3.841466	0.5992
India	None	0.011989	9.795371	15.49471	0.2968	9.794168	14.26460	0.2258
	At most 1	1.48×10^{-6}	0.001203	3.841466	0.9719	0.001203	3.841466	0.9719
France	None	0.007473	7.816439	15.49471	0.4852	7.763251	14.26460	0.4033
	At most 1	5.14×10^{-5}	0.053188	3.841466	0.8176	0.053188	3.841466	0.8176
Germany	None	0.006852	7.350736	15.49471	0.5372	7.294706	14.26460	0.4549
	At most 1	5.28×10^{-5}	0.056031	3.841466	0.8129	0.056031	3.841466	0.8129
UK	None	0.012119	12.90853	15.49471	0.1182	11.82712	14.26460	0.1173
	At most 1	0.001114	1.081401	3.841466	0.2984	1.081401	3.841466	0.2984
Italy	None	0.007356	7.346910	15.49471	0.5376	6.932663	14.26460	0.4971
	At most 1	0.000441	0.414247	3.841466	0.5198	0.414247	3.841466	0.5198
Spain	None	0.008357	8.616241	15.49471	0.4021	8.551683	14.26460	0.3254
	At most 1	6.34×10^{-5}	0.064559	3.841466	0.7994	0.064559	3.841466	0.7994
Indonesia	None	0.013129	11.01324	15.49471	0.2107	10.86313	14.26460	0.1612
	At most 1	0.000183	0.150107	3.841466	0.6984	0.150107	3.841466	0.6984
South Korea	None	0.002904	2.544756	15.49471	0.9837	2.533052	14.26460	0.9729
	At most 1	1.34×10^{-5}	0.011704	3.841466	0.9136	0.011704	3.841466	0.9136
Argentina	None	0.001881	1.619405	15.49471	0.9984	1.466935	14.26460	0.9983
	At most 1	0.000196	0.152470	3.841466	0.6962	0.152470	3.841466	0.6962
Mexico	None	0.008237	7.540186	15.49471	0.5158	7.510357	14.26460	0.4307
	At most 1	3.29E-05	0.029829	3.841466	0.8628	0.029829	3.841466	0.8628
South Africa	None	0.007318	8.117858	15.49471	0.4529	7.954434	14.26460	0.3833
	At most 1	0.000151	0.163424	3.841466	0.6860	0.163424	3.841466	0.6860
Japan	None	0.007715	8.223236	15.49471	0.4418	6.110433	14.26460	0.5991
	At most 1	0.002674	2.112802	3.841466	0.1461	2.112802	3.841466	0.1461
Russia	None	0.006969	6.803334	15.49471	0.6006	6.210532	14.26460	0.5863
	At most 1	0.000667	0.592802	3.841466	0.4413	0.592802	3.841466	0.4413
Canada	None	0.005961	5.802667	15.49471	0.7187	5.547921	14.26460	0.6716
	At most 1	0.000274	0.254746	3.841466	0.6138	0.254746	3.841466	0.6138
China	None	0.013852	13.64880	15.49471	0.0931	13.41871	14.26460	0.0677
	At most 1	0.000239	0.230089	3.841466	0.6315	0.230089	3.841466	0.6315

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values.

Table A8. Test for Johansen Cointegration in Sub-period 1.

Markets	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
Australia	None	0.016532	6.849101	15.49471	0.5953	6.301316	14.26460	0.5749
	At most 1	0.001448	0.547784	3.841466	0.4592	0.547784	3.841466	0.4592
Brizil	None	0.014529	4.847701	15.49471	0.8248	4.785905	14.26460	0.7686
	At most 1	0.000189	0.061796	3.841466	0.8037	0.061796	3.841466	0.8037
India	None	0.007379	3.487769	15.49471	0.9404	2.466254	14.26460	0.9758
	At most 1	0.003063	1.021515	3.841466	0.3122	1.021515	3.841466	0.3122
France	None	0.015437	6.005038	15.49471	0.6950	5.818588	14.26460	0.6366
	At most 1	0.000498	0.186450	3.841466	0.6659	0.186450	3.841466	0.6659
Germany	None	0.008839	3.660278	15.49471	0.9290	3.426974	14.26460	0.9143
	At most 1	0.000604	0.233303	3.841466	0.6291	0.233303	3.841466	0.6291
UK	None	0.021135	8.898695	15.49471	0.3748	8.117508	14.26460	0.3669
	At most 1	0.002054	0.781187	3.841466	0.3768	0.781187	3.841466	0.3768
Spain	None	0.006465	2.712591	15.49471	0.9784	2.348107	14.26460	0.9804
	At most 1	0.001006	0.364483	3.841466	0.5460	0.364483	3.841466	0.5460
Indonesia	None	0.036162	12.06975	15.49471	0.1536	10.42336	14.26460	0.1856
	At most 1	0.005801	1.646384	3.841466	0.1995	1.646384	3.841466	0.1995
South Korea	None	0.030301	9.205119	15.49471	0.3468	9.200076	14.26460	0.2699
	At most 1	1.69×10^{-5}	0.005043	3.841466	0.9424	0.005043	3.841466	0.9424
Argentina	None	0.005264	1.719854	15.49471	0.9978	1.715257	14.26460	0.9958
	At most 1	1.41×10^{-5}	0.004597	3.841466	0.9450	0.004597	3.841466	0.9450
Mexico	None	0.030505	10.14329	15.49471	0.2699	10.13061	14.26460	0.2035
	At most 1	3.88×10^{-5}	0.012678	3.841466	0.9101	0.012678	3.841466	0.9101
Japan	None	0.014865	5.065481	15.49471	0.8018	4.987126	14.26460	0.7435
	At most 1	0.000235	0.078355	3.841466	0.7795	0.078355	3.841466	0.7795
Russia	None	0.015017	6.487521	15.49471	0.6379	6.370126	14.26460	0.5662
	At most 1	0.000279	0.117396	3.841466	0.7319	0.117396	3.841466	0.7319
Canada	None	0.032430	12.78169	15.49471	0.1231	12.16483	14.26460	0.1046
	At most 1	0.001670	0.616866	3.841466	0.4322	0.616866	3.841466	0.4322
China	None	0.013341	6.223024	15.49471	0.6692	5.654277	14.26460	0.6579
	At most 1	0.001350	0.568748	3.841466	0.4508	0.568748	3.841466	0.4508

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values.

Table A9. Test for Johansen Cointegration in Sub-period 2.

Markets	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
Australia	None	0.004244	5.090542	15.49471	0.7991	5.027246	14.26460	0.7384
	At most 1	5.35×10^{-5}	0.063296	3.841466	0.8013	0.063296	3.841466	0.8013
Brazil	None	0.007100	7.381957	15.49471	0.5337	7.353230	14.26460	0.4482
	At most 1	2.78×10^{-5}	0.028727	3.841466	0.8654	0.028727	3.841466	0.8654
India	None	0.002083	3.080181	15.49471	0.9632	2.162466	14.26460	0.9865
	At most 1	0.000885	0.917715	3.841466	0.3381	0.917715	3.841466	0.3381
France	None	0.007647	9.636552	15.49471	0.3097	9.634289	14.26460	0.2371
	At most 1	1.80×10^{-6}	0.002262	3.841466	0.9601	0.002262	3.841466	0.9601
Germany	None	0.006437	8.017102	15.49471	0.4636	8.008221	14.26460	0.3779
	At most 1	7.16×10^{-6}	0.008881	3.841466	0.9246	0.008881	3.841466	0.9246
UK	None	0.004768	6.279090	15.49471	0.6625	5.697005	14.26460	0.6524
	At most 1	0.000488	0.582085	3.841466	0.4455	0.582085	3.841466	0.4455
Italy	None	0.009336	9.013441	15.49471	0.3641	8.432197	14.26460	0.3365
	At most 1	0.000646	0.581245	3.841466	0.4458	0.581245	3.841466	0.4458
Spain	None	0.003039	4.669229	15.49471	0.8429	3.536624	14.26460	0.9047
	At most 1	0.000974	1.132605	3.841466	0.2872	1.132605	3.841466	0.2872
Indonesia	None	0.007758	8.915298	15.49471	0.3733	7.873849	14.26460	0.3916
	At most 1	0.001030	1.041449	3.841466	0.3075	1.041449	3.841466	0.3075
South Korea	None	0.012549	12.70458	15.49471	0.1261	12.70406	14.26460	0.0869
	At most 1	5.17×10^{-7}	0.000520	3.841466	0.9838	0.000520	3.841466	0.9838
Argentina	None	0.003016	3.830283	15.49471	0.9167	3.138490	14.26460	0.9371
	At most 1	0.000666	0.691793	3.841466	0.4056	0.691793	3.841466	0.4056
Mexico	None	0.007288	9.371861	15.49471	0.3321	8.258281	14.26460	0.3530
	At most 1	0.000986	1.113580	3.841466	0.2913	1.113580	3.841466	0.2913
South Africa	None	0.008390	8.020138	15.49471	0.4633	7.599277	14.26460	0.4209
	At most 1	0.000466	0.420860	3.841466	0.5165	0.420860	3.841466	0.5165
Japan	None	0.012308	12.10013	15.49471	0.1522	12.01296	14.26460	0.1102
	At most 1	8.99×10^{-5}	0.087171	3.841466	0.7678	0.087171	3.841466	0.7678
Russia	None	0.003620	5.455167	15.49471	0.7587	4.794474	14.26460	0.7675
	At most 1	0.000500	0.660693	3.841466	0.4163	0.660693	3.841466	0.4163
Canada	None	0.002821	3.138096	15.49471	0.9603	3.138096	14.26460	0.9371
	At most 1	7.45×10^{-11}	8.28×10^{-8}	3.841466	0.9997	8.28E-08	3.841466	0.9997
China	None ***	0.015334	20.58719	15.49471	0.0078	20.52122	14.26460	0.0045
	At most 1	4.97×10^{-5}	0.065966	3.841466	0.7973	0.065966	3.841466	0.7973

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values. ***denotes significance at 1%.

Table A10. Test for Johansen Cointegration in Sub-period 3.

Markets	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
Australia	None	0.008520	7.220410	15.49471	0.5522	5.929632	14.26460	0.6223
	At most 1	0.001861	1.290778	3.841466	0.2559	1.290778	3.841466	0.2559
Brazil	None	0.008567	5.034634	15.49471	0.8051	5.016350	14.26460	0.7398
	At most 1	3.14×10^{-5}	0.018284	3.841466	0.8923	0.018284	3.841466	0.8923
India	None	0.007859	7.229679	15.49471	0.5511	4.355280	14.26460	0.8201
	At most 1	0.005194	2.874399	3.841466	0.0900	2.874399	3.841466	0.0900
France	None **	0.021569	15.84816	15.49471	0.0442	15.32898	14.26460	0.0338
	At most 1	0.000738	0.519184	3.841466	0.4712	0.519184	3.841466	0.4712
Germany	None	0.014349	12.56030	15.49471	0.1320	10.20389	14.26460	0.1989
	At most 1	0.003332	2.356405	3.841466	0.1248	2.356405	3.841466	0.1248
UK	None ***	0.028124	20.55749	15.49471	0.0079	19.42671	14.26460	0.0070
	At most 1	0.001659	1.130783	3.841466	0.2876	1.130783	3.841466	0.2876
Italy	None	0.017621	12.50972	15.49471	0.1341	12.08932	14.26460	0.1073
	At most 1	0.000618	0.420398	3.841466	0.5167	0.420398	3.841466	0.5167
Spain	None	0.010643	7.867951	15.49471	0.4796	7.383279	14.26460	0.4448
	At most 1	0.000702	0.484672	3.841466	0.4863	0.484672	3.841466	0.4863
Indonesia	None	0.003104	1.799838	15.49471	0.9971	1.797068	14.26460	0.9946
	At most 1	4.79×10^{-6}	0.002770	3.841466	0.9555	0.002770	3.841466	0.9555
South Korea	None	0.009007	6.398610	15.49471	0.6484	5.474212	14.26460	0.6812
	At most 1	0.001527	0.924398	3.841466	0.3363	0.924398	3.841466	0.3363
Argentina	None	0.004063	3.369810	15.49471	0.9476	2.345287	14.26460	0.9805
	At most 1	0.001777	1.024523	3.841466	0.3114	1.024523	3.841466	0.3114
Mexico	None	0.008072	5.090408	15.49471	0.7991	5.089833	14.26460	0.7304
	At most 1	9.17×10^{-7}	0.000576	3.841466	0.9826	0.000576	3.841466	0.9826
South Africa	None	0.009779	8.531364	15.49471	0.4105	7.380308	14.26460	0.4452
	At most 1	0.001532	1.151056	3.841466	0.2833	1.151056	3.841466	0.2833
Japan	None	0.009480	7.320375	15.49471	0.5407	5.143431	14.26460	0.7236
	At most 1	0.004023	2.176944	3.841466	0.1401	2.176944	3.841466	0.1401
Russia	None	0.015848	11.00270	15.49471	0.2113	10.23986	14.26460	0.1967
	At most 1	0.001189	0.762843	3.841466	0.3824	0.762843	3.841466	0.3824
Canada	None	0.004428	4.044147	15.49471	0.8999	2.862213	14.26460	0.9555
	At most 1	0.001831	1.181934	3.841466	0.2770	1.181934	3.841466	0.2770
China	None	0.007612	6.171812	15.49471	0.6752	5.196007	14.26460	0.7169
	At most 1	0.001434	0.975805	3.841466	0.3232	0.975805	3.841466	0.3232

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values; ** denotes significance at 5%;*** denotes significance at 1%.

Table A11. Test for Johansen Cointegration in Sub-period 4.

Markets	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
Australia	None	0.005165	3.746912	15.49471	0.9229	3.743922	14.26460	0.8853
	At most 1	4.13×10^{-6}	0.002990	3.841466	0.9548	0.002990	3.841466	0.9548
Brazil	None	0.016426	11.35116	15.49471	0.1908	10.63286	14.26460	0.1736
	At most 1	0.001118	0.718305	3.841466	0.3967	0.718305	3.841466	0.3967
India	None	0.013382	8.785962	15.49471	0.3856	8.703441	14.26460	0.3117
	At most 1	0.000128	0.082521	3.841466	0.7739	0.082521	3.841466	0.7739
France	None	0.010896	8.804117	15.49471	0.3838	8.710258	14.26460	0.3111
	At most 1	0.000118	0.093859	3.841466	0.7593	0.093859	3.841466	0.7593
Germany	None	0.010404	8.741382	15.49471	0.3899	8.565241	14.26460	0.3241
	At most 1	0.000215	0.176142	3.841466	0.6747	0.176142	3.841466	0.6747
UK	None	0.011750	8.883080	15.49471	0.3763	8.770164	14.26460	0.3058
	At most 1	0.000152	0.112916	3.841466	0.7368	0.112916	3.841466	0.7368
Italy	None	0.012064	8.605186	15.49471	0.4032	8.605136	14.26460	0.3205
	At most 1	7.14×10^{-8}	5.06×10^{-5}	3.841466	0.9967	5.06E-05	3.841466	0.9967
Spain	None	0.014054	11.31861	15.49471	0.1926	11.16757	14.26460	0.1460
	At most 1	0.000191	0.151039	3.841466	0.6975	0.151039	3.841466	0.6975
Indonesia	None	0.013479	10.04374	15.49471	0.2774	8.685320	14.26460	0.3133
	At most 1	0.002120	1.358416	3.841466	0.2438	1.358416	3.841466	0.2438
South Korea	None	0.002687	2.361293	15.49471	0.9885	1.754276	14.26460	0.9953
	At most 1	0.000931	0.607017	3.841466	0.4359	0.607017	3.841466	0.4359
Argentina	None	0.003377	2.566219	15.49471	0.9831	2.019455	14.26460	0.9903
	At most 1	0.000915	0.546764	3.841466	0.4596	0.546764	3.841466	0.4596
Mexico	None	0.013850	9.758950	15.49471	0.2997	9.734721	14.26460	0.2299
	At most 1	3.47×10^{-5}	0.024228	3.841466	0.8762	0.024228	3.841466	0.8762
South Africa	None	0.011258	9.426911	15.49471	0.3274	9.408303	14.26460	0.2537
	At most 1	2.24×10^{-5}	0.018607	3.841466	0.8914	0.018607	3.841466	0.8914
Japan	None	0.011941	8.402059	15.49471	0.4234	7.328128	14.26460	0.4511
	At most 1	0.001759	1.073930	3.841466	0.3001	1.073930	3.841466	0.3001
Russia	None	0.006314	4.409483	15.49471	0.8678	4.091540	14.26460	0.8496
	At most 1	0.000492	0.317944	3.841466	0.5728	0.317944	3.841466	0.5728
Canada	None	0.003270	3.780035	15.49471	0.9205	2.351821	14.26460	0.9803
	At most 1	0.001987	1.428213	3.841466	0.2321	1.428213	3.841466	0.2321
China	None	0.005563	4.089750	15.49471	0.8962	3.999846	14.26460	0.8593
	At most 1	0.000125	0.089904	3.841466	0.7643	0.089904	3.841466	0.7643

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values.

Table A12. Test for Possible Regional Cointegration in Asia.

Sub-period	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
1	None	0.209668	61.39358	69.81889	0.1950	36.70720	33.87687	0.0223
	At most 1	0.085136	24.68639	47.85613	0.9268	13.88085	27.58434	0.8308
	At most 2	0.049461	10.80554	29.79707	0.9657	7.913240	21.13162	0.9089
	At most 3	0.014967	2.892295	15.49471	0.9716	2.352426	14.26460	0.9803
	At most 4	0.003455	0.539869	3.841466	0.4625	0.539869	3.841466	0.4625
2	None	0.056462	58.36424	69.81889	0.2890	29.98913	33.87687	0.1359
	At most 1	0.030030	28.37511	47.85613	0.7972	15.73268	27.58434	0.6883
	At most 2	0.019944	12.64244	29.79707	0.9072	10.39505	21.13162	0.7070
	At most 3	0.003994	2.247383	15.49471	0.9909	2.064993	14.26460	0.9892
	At most 4	0.000353	0.182389	3.841466	0.6693	0.182389	3.841466	0.6693
3	None	0.060698	50.26330	69.81889	0.6263	19.97508	33.87687	0.7584
	At most 1	0.044566	30.28822	47.85613	0.7042	14.54302	27.58434	0.7834
	At most 2	0.028822	15.74520	29.79707	0.7301	9.329197	21.13162	0.8050
	At most 3	0.016416	6.416002	15.49471	0.6463	5.280055	14.26460	0.7062
	At most 4	0.003555	1.135947	3.841466	0.2865	1.135947	3.841466	0.2865
4	None	0.074399	47.07593	69.81889	0.7580	22.26589	33.87687	0.5870
	At most 1	0.035463	24.81003	47.85613	0.9236	10.39891	27.58434	0.9785
	At most 2	0.030918	14.41112	29.79707	0.8168	9.044820	21.13162	0.8288
	At most 3	0.013521	5.366298	15.49471	0.7687	3.920641	14.26460	0.8676
	At most 4	0.005007	1.445657	3.841466	0.2292	1.445657	3.841466	0.2292

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values.

Table A13. Test for Possible Regional Cointegration in Latin America.

Sub-period	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
1	None	0.045652	12.34441	29.79707	0.9192	10.37339	21.13162	0.7090
	At most 1	0.008225	1.971013	15.49471	0.9954	1.833497	14.26460	0.9940
	At most 2	0.000619	0.137516	3.841466	0.7108	0.137516	3.841466	0.7108
2	None	0.023096	20.77200	29.79707	0.3720	17.47876	21.13162	0.1506
	At most 1	0.004358	3.293239	15.49471	0.9520	3.266602	14.26460	0.9274
	At most 2	3.56×10^{-5}	0.026636	3.841466	0.8703	0.026636	3.841466	0.8703
3	None	0.028272	16.45818	29.79707	0.6797	12.01667	21.13162	0.5460
	At most 1	0.009890	4.441505	15.49471	0.8649	4.164519	14.26460	0.8416
	At most 2	0.000661	0.276986	3.841466	0.5987	0.276986	3.841466	0.5987
4	None	0.036117	18.66109	29.79707	0.5175	16.11189	21.13162	0.2184
	At most 1	0.004842	2.549198	15.49471	0.9836	2.125768	14.26460	0.9876
	At most 2	0.000966	0.423430	3.841466	0.5152	0.423430	3.841466	0.5152

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values.

Table A14. Test for Possible Regional Cointegration in Europe.

Sub-period	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
1	None	0.051945	22.20692	29.79707	0.2872	18.77667	21.13162	0.1035
	At most 1	0.009512	3.430251	15.49471	0.9440	3.364331	14.26460	0.9196
	At most 2	0.000187	0.065920	3.841466	0.7974	0.065920	3.841466	0.7974
2	None **	0.039579	57.05138	47.85613	0.0054	32.62984	27.58434	0.0103
	At most 1	0.022405	24.42154	29.79707	0.1832	18.30886	21.13162	0.1187
	At most 2	0.007159	6.112679	15.49471	0.6822	5.805624	14.26460	0.6383
	At most 3	0.000380	0.307055	3.841466	0.5795	0.307055	3.841466	0.5795
3	None *	0.040574	58.40464	47.85613	0.0038	26.63287	27.58434	0.0658
	At most 1 *	0.031397	31.77177	29.79707	0.0292	20.51214	21.13162	0.0608
	At most 2	0.016317	11.25964	15.49471	0.1960	10.57856	14.26460	0.1766
	At most 3	0.001059	0.681073	3.841466	0.4092	0.681073	3.841466	0.4092
4	None	0.031213	37.74498	47.85613	0.3132	21.08768	27.58434	0.2709
	At most 1	0.015201	16.65730	29.79707	0.6652	10.18657	21.13162	0.7269
	At most 2	0.009683	6.470722	15.49471	0.6399	6.470362	14.26460	0.5536
	At most 3	5.42×10^{-7}	0.000360	3.841466	0.9869	0.000360	3.841466	0.9869

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values; * denotes significance at 10%;** denotes significance at 5%.

Table A15. Test for Possible Regional Cointegration in BRIC.

Sub-period	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Max-Eigen Statistic	0.05 Critical Value	Prob.
1	None	0.070134	32.47937	47.85613	0.5857	19.12391	27.58434	0.4050
	At most 1	0.027035	13.35545	29.79707	0.8747	7.208190	21.13162	0.9453
	At most 2	0.014388	6.147265	15.49471	0.6781	3.811518	14.26460	0.8787
	At most 3	0.008842	2.335746	3.841466	0.1264	2.335746	3.841466	0.1264
2	None	0.025190	42.40098	47.85613	0.1478	21.09870	27.58434	0.2703
	At most 1	0.015842	21.30229	29.79707	0.3391	13.20630	21.13162	0.4335
	At most 2	0.007216	8.095987	15.49471	0.4552	5.989613	14.26460	0.6145
	At most 3	0.002544	2.106374	3.841466	0.1467	2.106374	3.841466	0.1467
3	None	0.054586	43.83036	47.85613	0.1136	20.54453	27.58434	0.3047
	At most 1	0.032284	23.28583	29.79707	0.2323	12.01073	21.13162	0.5466
	At most 2	0.022171	11.27510	15.49471	0.1951	8.205983	14.26460	0.3581
	At most 3	0.008350	3.069113	3.841466	0.0798	3.069113	3.841466	0 .0798
4	None	0.018206	13.22545	47.85613	1.0000	6.706381	27.58434	0.9999
	At most 1	0.010108	6.519070	29.79707	0.9996	3.708085	21.13162	0.9997
	At most 2	0.006981	2.810985	15.49471	0.9748	2.556875	14.26460	0.9718
	At most 3	0.000696	0.254110	3.841466	0.6142	0.254110	3.841466	0.6142

Note: Prob. = Probability based on MacKinnon-Haug-Michelis (1999) [44] *p*-values. BRIC is not a trading block.

References

1. King, M.A.; Wadhwani, S. Transmission of Volatility between Stock Markets. *Rev. Financ. Stud.* **1990**, *3*, 5–33.
2. Taylor, M.P.; Tonks, I. The internationalization of stock markets and abolition of UK exchange control. *Rev. Econ. Stat.* **1989**, *71*, 332–336.
3. Kasa, K. Common stochastic trends in international stock markets. *J. Monet. Econ.* **1992**, *29*, 95–124.
4. Masih, A.M.; Masih, R. Dynamic linkages and the propagation mechanism driving major international markets: An analysis of the pre- and post-crash areas. *Q. Rev. Econ. Financ.* **1997**, *37*, 859–885.
5. Chowdhry, A.R. Stock market interdependencies: Evidence from the Asian NIEs. *J. Macroecon.* **1994**, *16*, 629–651.
6. Chowdhry, T.; Lu, L.; Peng, K. Common stochastic trends among Far Eastern stock prices: Effects of Asian financial crisis. *Int. Rev. Financ. Anal.* **2007**, *16*, 242–261.
7. Rao, B.S.R.; Naik, U. Inter-relatedness of stock market spectral investigation of USA, Japan and Indian markets note. *Artha Vignana* **1990**, *32*, 309–321.
8. Chan, K.C.; Gup, B.E.; Pan, M.S. International stock market efficiency and integration: A study of eighteen nations. *J. Bus. Financ. Account.* **1997**, *24*, 803–813.
9. Kwan, A.C.C.; Sim, A.B.; Cotsomitis, J.A. The causal relationships between equity indices on world exchanges. *Appl. Econ.* **1995**, *27*, 33–37.
10. The Australian Government Treasury. Available online: http://www.treasury.gov.au/PublicationsAndMedia/Publications/2011/Australia-and-the-IFIs/Australia-and-the-IFIs/Section-1-Responding-to-the-global-economic-crisis (accessed on 12 September 2015).
11. Angeloni, I.; Pisany-Ferry, J. Wanted: A stronger and better G20 for the global economy. Available online: http://bruegel.org/2011/10/wanted-a-stronger-and-better-g20-for-the-global-economy/ (accessed on 9 June 2015).
12. Duca, M.L.; Stracca, L. *The Effect of G20 Summits on Global Financial Markets*; Working Paper Series, No. 1668; European Central Bank: Frankfurt, Germany, 2014.
13. Bekaert, G.; Harvey, C.R.; Ng, A. Market integration and contagion. *J. Bus.* **2005**, *78*, 39–70.
14. Karolyi, A. Does international finance contagion really exist? *Int. Financ.* **2003**, *6*, 179–199.
15. Dungey, M.; Fry, R.; Gonzalez-Hermosillo, B.; Martin, V.L. Empirical modeling of contagion. A review of methodologies. *Quant. Financ.* **2004**, *5*, 9–24.
16. Allen, F.; Gale, D. Financial contagion. *J. Political Econ.* **2000**, *108*, 1–33.
17. Wei, S.-J.; Hui, T. The Composition Matters: Capital Inflows and Liquidity Crunch during a Global Economic Crisis. *Rev. Financ. Stud.* **2011**, *24*, 2023–2052.
18. Hau, H.; Lai, S. The Role of Equity Funds in the Financial Crisis Propagation. Available online: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1742065 (accessed on 17 January 2015).
19. Yang, J.; Khan, M.M.; Pointe, L. Increasing Integration Between the United States and Other International Stock Markets, A Recursive Cointegration Analysis. *Emerg. Mark. Financ. Trade* **2003**, *39*, 39–53.

20. Dornbush, R.; Park, Y.C.; Claessens, S. Contagion: Understanding how it spreads. *World Bank Res. Obs.* **2000**, *15*, 177–197.
21. Pritsker, M. The Channels for Financial Contagion. In *International Financial Contagion*; Claessens, S., Forbes, K., Eds.; Kluwer Academic Publishers: Boston, MA, USA, 2001; pp. 67–97.
22. Rangvid, J. Increasing Convergence among European Stock Markets?: A Recursive Common Stochastic Trends Analysis. *Econ. Letters* **2001**, *71*, 383–389.
23. Mendoza, E.; Quadrini, V. Financial Globalization, Financial Crises and Contagion. *J. Monetary Econ.* **2010**, *57*, 24–39.
24. Fratzscher, M. Capital Flows, Push *versus* Pull Factors and the Global Financial Crisis forthcoming. *J. Int. Econ.* **2012**, *88*, forthcoming.
25. Khan, T.A. Cointegration of International Stock Markets: An Investigation of Diversification Opportunities. Available online: http://digitalcommons.iwu.edu/cgi/viewcontent.cgi?article=1153&context=uer (accessed on 2 May 2015).
26. Johansen, S. Statistical Analysis of Cointegration Vectors. *J. Econ. Dyn. Control* **1988**, *12*, 231–254.
27. Gregory, A.; Hansen, B. Residual-based tests for cointegration in models with regime shifts. *J. Econ.* **1996**, *70*, 99–126.
28. Slimane, F.B.; Mehanaoui, M.; Kazi, I.A. How Does the Financial Crisis Affect Volatility Behavior and Transmission Among European Stock Markets. *Int. J. Financ. Stud.* **2013**, *1*, 81–101.
29. Sheng, H.C.; Tu, A.H. A study of cointegration and variance decomposition among national equity indices before and during the period of the Asian financial crisis. *J. Multinatl. Financ. Manag.* **2000**, *10*, 345–365.
30. Masson, P. Contagion: Macroeconomic models with multiple equilibria. *J. Int. Money Financ.* **1998**, *18*, 587–602.
31. Masson, P. Contagion: Monsoonal effects, spillovers, and jumps between multiple equilibria. In *The Asian Financial Crisis: Causes, Contagion and Consequences*; Agenor, P.R., Miller, M., Vines, D., Weber, A., Eds.; Cambridge University Press: Cambridge, UK, 1999.
32. Calvo, S.; Reinhart, C. Capital Inflows to Latin America: Is There Evidence of Contagion Effects? Available online: https://mpra.ub.uni-muenchen.de/7124/1/MPRA_paper_7124.pdf (accessed on 13 June 2015).
33. Forbes, K.; Rigobon, R. No contagion, only interdependence: Measuring stock market co-movement. *J. Financ.* **2002**, *57*, 2223–2261.
34. Pesaran, M.H.; Pick, A. *Econometric Issues in the Analysis of Contagion*; Working Paper 1176; University of Cambridge: Cambridge, UK, 2003
35. Pericoli, M.; Sbracia, M. A primer on financial contagion. *J. Econ. Surv.* **2003**, *17*, 571–608.
36. Corsetti, G.; Pesenti, P.; Roubini, N. What caused the Asian currency and financial crisis? *Jpn. World Econ.* **1999**, *11*, 305–373.
37. Wasim, A.; Bhanumurthy, N.R.; Sehgal, S. The Eurozone crisis and its contagion effects on the European stock markets. *Stud. Econ. Financ*. **2014**, *31*,325–352.

38. Prorokowski, L. Recovery from the current banking crisis: Insights into costs and effectiveness of response regulations. *Qualit. Res. Financ. Mark.* **2011**, *3*, 193–223.
39. Thakor, A.V. The Financial Crisis of 2007–2009: Why Did It Happen and What Did We Learn? *Rev. Corp. Financ. Stud.* **2015**, *4*, 155–205, doi:10.1093/rcfs/cfv001.
40. Gennaioli, N.; Shleifer, A.; Vishny, R. Neglected Risks: The Psychology of Financial Crises. *Am. Econ. Rev.* **2015**, *105*, 310–314.
41. Reinhart, C.M.; Rogoff, K.S. Recovery from Financial Crises: Evidence from 100 Episodes. *Am. Econ. Rev.* **2014**, *104*, 50–55.
42. Engle, R.F.; Granger, C.W.J. Co-integration and Error Correction: Representation, Estimation and Testing. *Econometrica* **1987**, *55*, 251–276.
43. Alexander, C. Optimal Hedging Using Cointegration. *Philos. Trans. R. Soc. Lond.* **1999**, *357*, 2039–2058.
44. MacKinnon, J.G.; Haug, A.A.; Michelis, L. Numerical Distribution Functions of Likelihood Ratio Tests for Cointegration. *J. Appl. Econom.* **1999**, *14*, 563–577.