Contagion Effect of 2007 Financial Crisis on Emerging and Frontier Stock Markets

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This study examines the contagion effect of a financial crisis on the relationships between the US and some of the emerging stock markets using the recursive cointegration procedure by Yang, Kolari and Sutanto (2004). Our results show that for the whole sample period, the US stock market and each of the foreign stock markets are not cointegrated. However, during the period following the 2007 financial crisis, we observe an increase in the degree of cointegration between the US and some of the emerging stock markets. Although the contagion effect caused by the financial crisis reduces the benefits of international diversification, it tends to be short-lived and dissipates over the long run.

INTRODUCTION

Although most of the early studies on international portfolio diversification focus on the benefits of international portfolios constructed using developed markets (e.g., Eun and Resnick, 1994), US investors are highly recommended to diversify their portfolios with stocks from both developed and emerging markets. In general, emerging stock markets are characterized as investments with higher returns and higher risks. On one hand, the higher potential returns of emerging markets as compared to those of matured developed markets makes it attractive for US investors to include stocks from the emerging markets in their portfolios. On the other hand, the risks associated with investing in emerging markets are significantly higher due to the more frequent political and local economic crises. Nevertheless, most of these risks are considered country specific, and it is believed that the high idiosyncratic risks in emerging market investments can be reduced through portfolio diversification. In other words, from an US investor's perspective, through diversification with investments in emerging stock markets, he/she will be able to capture a higher expected return stemming from the high growth potential of emerging markets and a lower risk due to the low correlation of the stock markets of emerging economies with the US market.

The success of a global portfolio diversification strategy depends greatly on the correlations between constituent stock markets in the portfolio. With the advent of the internet, countries are becoming more interconnected, and as a result, one may argue that the emerging and developed markets are more correlated now than in the past because of greater international financial integration. Despite recent evidence pointing towards increasing international market integration, DeSantis and Gerard (1997) show that international portfolio diversification is still beneficial to investors.

Another track of research examines the stability of correlations. Saunders and Walter (2002) show that the correlations between emerging and developed stock markets have risen over the two sub-periods, namely, 1988-1993 and 1994-1999, when the markets are more volatile. The implication is that markets tend to be more contagious when they encounter major economic crisis and become more volatile. This increased correlation in bear or/and volatile markets further diminishes the benefit of portfolio diversification as low correlations are essentially needed to reduce the contagion effect of a financial crisis.

Contradicting results are reported by existing empirical studies on the long-run cointegration relationships between emerging stock markets and the US stock market. Several studies have reported the failure to detect any long-run cointegration relationship between emerging stock markets and the US stock market.[1] The nonexistence of a long-run cointegration suggests that the US stock market and emerging stock markets are not correlated over the long run. As a result, US investors can still benefit from a global portfolio diversification so long as they hold their diversified portfolios over a longer investment horizon. However, the conflicting empirical results reported by Ghosh, Saidi, and Johnson (1999), Sheng and Tu (2000), and Darrat and Zhong (2002) suggest that the US stock market and emerging stock markets are cointegrated over the long term, and hence, the benefit from long-term global portfolio investment may be overstated.

The conflicting results reported by the two groups of researchers may perhaps be explained by the instability of the long term cointegration relationship between the US market and emerging markets. Yang, Kolari and Sutanto (2004) examine the stability of the long term relationship between the US market and the emerging markets from 1981 to 2001. They found that major financial crises, such as the 1997 Asian Financial Crisis, can change the degree of cointegration. This finding is consistent with those reported by Saunders and Walter (2002) in that the contagion effect is stronger during a bear market, and thus undermine the rationale behind global portfolio diversification.

In addition to the above empirical evidence, the theoretical model derived by Goldstein and Pauzner (2004) suggests that even though two countries may have independent fundamentals, the probability that the effect of a financial crisis in one country will be felt in another country increases if they share the same group of investors. With the increase in the degree of globalization and the popularity of exchange traded country funds, sophisticated investors are more likely to hold a globally well diversified investment portfolio. As a result, one may postulate that a financial crisis in a developed economy may be transmitted to an emerging economy or vice versa despite the dissimilarity of the structure of their economies.

The purpose of this paper is to examine the contagion effect of the 2007 Financial Crisis on the cointegration relationships between the US and emerging stock markets, and to examine whether the effect has a long-term or short-term impact. To study the long term effect, instead of measuring the co-movement of stock markets using correlation, we will re-examine the bivariate relationship between the US and each of the foreign markets using the cointegration analysis. In addition, adopting the recursive cointegration procedure by Yang, Kolari and Sutanto (2004), we will further examine the impact of the financial crisis on the stability of the cointegration relationships of the stock index series.

Our contributions can be considered threefold. Firstly, the empirical results are updated using a more recent sampling period between 2000 and 2013. Given the globalization trend in the financial markets, it is interesting to see whether national markets are more integrated in recent years; thus, reducing the benefits of global diversification. Secondly, a different financial crisis, the financial crisis of 2007, is included in our sample which allows us to re-investigate the impact of a financial crisis on international investing. Thirdly, in addition to the emerging markets examined in previous studies, sixteen frontier markets are also examined in this study. Including frontier markets broadens the potential investment pools for investors in constructing their global portfolios.

This study begins with a data description and discussion of methodology in Data and Methodology, followed by a discussion of the Empirical Results. The concluding remarks are given in last section.

DATA AND METHODOLOGY

Data

The stock index prices of 32 countries are obtained from Morgan Stanley Capital International, Inc. (MSCI) for the sampling period from December 2000 through February 2013. The 33 sampling market indices include the US, 15 emerging market indices (Andean, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, Korea, Morocco, Peru, Poland, Russia, South Africa, and Turkey) and 16 frontier market indices (Argentina, Bahrain, Bulgaria, Estonia, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Nigeria, Pakistan, Qatar, Slovenia, Sri Lanka, Ukraine, and Vietnam). Due to the different data availability for each market index, the sampling period varies from 147 monthly price levels (December 2000 – February 2013) to 76 price levels (November 2006 – February 2013). The MSCI "Total Return Indices with Net dividends" series are used in this study. This index measures the price performance of markets with dividends reinvested after the deduction of withholding taxes. All market indices are measured in US dollars, and therefore the results presented in this study are viewed from the perspective of US investors.

Methodology

Unit Root Tests

Before testing whether two index series are cointegrated, the augmented Dickey-Fuller (ADF) test procedure is applied to the market index series to ascertain that these series are nonstationary with unit roots. If $x_{i,t}$ follows an AR(p) process, we apply the ADF regression model (Corbae and Ouliaris, 1988) as given in equation (1) to each market index.

$$\Delta x_{i,t} = a_{i,0} + a_{i,1}t + a_{i,2}x_{i,t-1} + \sum_{i=1}^{p-1} b_{i,1}\Delta x_{i,t-i} + v_{i,t} \quad (1)$$

The null hypothesis states that $a_{i,2} = 0$; i.e., the variable has a unit root. Consequently, an insignificant ADF t-statistics suggests that one cannot reject the hypothesis of the existence of a unit root.

Cointegration Analysis

We next use Johansen's (1988) maximum-likelihood estimator (MLE) approach to test the hypothesis that there exists a long-run relationship between the US and a foreign stock market indexes. Assuming that two market indices follow a Vector Autoregressive process (VAR(*k*)) with a constant term as shown in equation (2), the cointegration model and the hypothesis of *c* cointegration vectors take the form of equation (3).

$$H_1 : \Delta \mathrm{X}_t = \Pi \mathrm{X}_{t-1} + \sum_{j=1}^{k-1} \Gamma_j \Delta \mathrm{X}_{t-j} + \mu + \upsilon_t \quad (2)$$

where $\mathrm{X}_t = \left(\mathrm{X}_{US,t} \;\; \mathrm{X}_{FOR,t}\right)$

$$Z_{0t} = \Pi Z_{1t} + \Gamma Z_{2t} + \varepsilon_t \quad (3)$$

where $Z_{0t} = \Delta \mathrm{X}_t$

$$Z_{1t} = \mathrm{X}_{t-1}$$

$$Z_{2t} = (\Delta \mathrm{X}'_{t-1}, ..., \Delta \mathrm{X}'_{t-k+1}, 1)'$$

$$\Gamma = (\Gamma_1, ..., \Gamma_{k-1}, \mu)$$

$$\Pi = \alpha\beta'$$

$$H_2 : \Pi = \alpha\beta'$$

To obtain the MLE results, regressions of Z_{0t} and Z_{1t} on Z_{2t} are adopted and the following "R-representation" residuals by Hansen and Johansen (1993, 1999) are produced:

$$R_{0t} = Z_{0t} - A_{0t} Z_{2t} \quad (4)$$

$$R_{1t} = Z_{1t} - A_{1t} Z_{2t} \quad (5)$$

A trace test (Johansen 1991) statistic, testing the hypothesis that there are at most *c* cointegration vectors, is given as:

$$-2\ln(Q; H_2 \mid H_1) = -T \sum_{l=c+1}^{2} \ln(1-\lambda_l) = \lambda_{trace}$$

where $\lambda_{c+1}, ..., \lambda_3$ are the $2-c$ smallest squared canonical correlations of the residuals from equation (4) and (5).

The Johansen (1991) trace statistic, testing the hypothesis that there are at most *c* cointegration vectors, H_0: $c = 0$, is applied to each of pair of markets, that is, between the US and a foreign country, for the available sample period. The TC_{trace} is then calculated as the Trace test normalized by the 5% critical values. That is, $TC_{trace} = \lambda_{trace} / C_{(5\%)}$ where $C_{(5\%)}$ is the 5% trace test critical value. The null hypothesis of $r \leq 1$ (or $r = 0$, i.e., no cointegration exists) will be rejected if $TC_{trace} \geq 1$.

Recursive Cointegration Analysis

A recursive cointegration analysis is employed to examine the stability of the cointegration relationships over time. Following the procedure outlined by Yan, Kolari, and Sutanto (2004), we investigate the constancy of the cointegration rank through time to evaluate the stability of the long-term relationship. The procedure is described as the following:

Step 1. Estimate the model using equation (3) over the full sample period. Theoretically, the short-term parameters are to be fixed to Γ, and will not be re-estimated during the recursive analysis. This can be easily done because by design, the reduced rank regression of Z_{0t} on Z_{1t} conditional on Z_{2t} already filters out the parameter Γ.

Step 2: Re-estimate the model with equations (4) and (5) using the data from the initial 5-year time span (for example, December 2000 to November 2005) as our initial estimation period. The trace statistics is obtained and scaled by the corresponding critical value. That is, $TC_{trace} = \lambda_{trace} / C_{(5\%)}$ where $C_{(5\%)}$ is the 5% trace test critical value. The null hypothesis of $r \leq 1$ (or $r = 0$, no cointegration exists) will be rejected if $TC_{trace} \geq 1$.

Step 3: Add the succeeding observations one at the time, and reconstruct the scaled trace statistic. This procedure is repeated until all sample observations are included in the regression. This procedure will give us a sequence of scaled trace test statistics.

EMPIRICAL RESULTS

Descriptive Statistics

The summary statistics for the emerging markets and the frontier markets are reported in Table 1 Panels A and B, respectively. Overall, the results indicate that except for three frontier market countries, all national stock markets yield positive average returns during our sampling period. Interestingly, among all countries with positive stock returns, the US stock market reports the smallest gain over the period from 2001 to 2013. The negative average returns observed for Bahrain, Bulgaria, and Ukraine, could be due to the fact that their average returns are estimated over a shorter and more recent time period due to limited availability of data for these countries. Not surprisingly, the US market also registers the smallest standard deviation, which supports the well-documented volatile and riskier nature of emerging and frontier markets.

TABLE 1
SUMMARY STATISTICS FOR MONTHLY STOCK RETURNS

Panel A:						Panel B:					
Emerging Market	N	Mean	SD	Min	Max	Frontier Market	N	Mean	SD	Min	Max
Andean	129	0.0181	0.0633	-0.2876	0.1920	Argentina	146	0.0093	0.1249	-0.4168	0.5293
Brazil	146	0.0176	0.1051	-0.3208	0.2849	Bahrain	93	-0.0135	0.0735	-0.2773	0.1745
Chile	146	0.0139	0.0667	-0.2562	0.2011	Bulgaria	93	-0.0096	0.1123	-0.4707	0.3647
China	146	0.0126	0.0825	-0.2274	0.1994	Estonia	129	0.0162	0.1006	-0.3824	0.4925
Colombia	146	0.0304	0.0864	-0.2816	0.2490	Jordan	146	0.0085	0.0608	-0.2317	0.2098
Czech Republic	146	0.0174	0.0791	-0.2944	0.1988	Kazakhstan	87	0.0218	0.1632	-0.2956	1.0345
Egypt	146	0.0185	0.1019	-0.3244	0.4271	Kenya	129	0.0239	0.0865	-0.2873	0.3130
Hungary	146	0.0132	0.1056	-0.4335	0.2730	Kuwait	93	0.0046	0.0715	-0.1921	0.2168
Korea	146	0.0169	0.0907	-0.2612	0.2750	Lebanon	129	0.0128	0.0944	-0.2260	0.4769
Morocco	146	0.0089	0.0590	-0.1555	0.2393	Nigeria	129	0.0176	0.1005	-0.4134	0.4744
Peru	146	0.0242	0.0893	-0.3604	0.2704	Pakistan	146	0.0171	0.0998	-0.5001	0.3748
Poland	146	0.0110	0.1013	-0.3385	0.2819	Qatar	93	0.0074	0.0903	-0.2648	0.2337
Russia	146	0.0182	0.1019	-0.3528	0.3170	Slovenia	129	0.0072	0.0714	-0.2292	0.2620
South Africa	146	0.0143	0.0779	-0.2618	0.1755	Sri Lanka	146	0.0201	0.1106	-0.2410	0.6006
Turkey	146	0.0182	0.1404	-0.4124	0.4482	Ukraine	81	-0.0171	0.1321	-0.3804	0.3635
						Vietnam	75	0.0072	0.1372	-0.2377	0.4868
US	146	0.0032	0.0460	-0.1715	0.1094						

[a] Monthly data for each market index differs. The sampling period ranges from 146 observations (January 2001 – February 2013) to 75 observations (December 2006 – February 2013).

Full Sample Analysis

TABLE 2
BIVARIATE COINTEGRATION TEST BETWEEN US AND EACH OF EMERGING MARKETS

The US and foreign stock markets are assumed to follow a Vector Autoregressive Process (VAR(k)). The AIC is used to select the optimal lag k. Augmented Dickey-Fuller (ADF) tests for stock market indices are reported for the whole sample period applicable to each market. The ADF without trend regression is given as: $\Delta x_{i,t} = a_{i,0} + a_{i,2} x_{i,t-1} + \sum_{i=1}^{p-1} b_{i,1} \Delta x_{i,t-i} + v_{i,t}$. The ADF test is reported for AR(k). The null hypothesis states that the stock index follows a unit root, i.e., $a_{i,2} = 0$. An insignificant ADF t-statistic indicates that one cannot reject the hypothesis of the existence of a unit root. The Johansen (1991) trace statistic, testing the hypothesis that there are at most c cointegration vectors, H: $c = 0$, is applied to each of the bivariate markets for the available sample period. Given no linear trend is found, a constant is restricted in the cointegration vector. Finally, a TC_{trace} ratio is calculated as the Trace test normalized by the 5% critical values.

Panel A:				Panel B:			
Emerging Market	VAR(k)	ADF(k)[a]	TC_{trace} [b]	Frontier Market	VAR(k)	ADF(k)	TC_{trace}
Andean	VAR(2)	-0.42	0.351	Argentina	VAR(1)	-1.45	0.193
Brazil	VAR(1)	-1.13	0.311	Bahrain	VAR(1)	-0.89	0.645
Chile	VAR(3)	-0.58	0.345	Bulgaria	VAR(4)	-1.46	0.877
China	VAR(1)	-1.02	0.303	Estonia	VAR(4)	-2.29	0.780
Colombia	VAR(1)	0.52	0.681	Jordan	VAR(1)	-1.50	0.240
Czech Republic	VAR(1)	-1.45	0.325	Kazakhstan	VAR(1)	-2.74	0.667
Egypt	VAR(1)	-1.36	0.269	Kenya	VAR(1)	-1.22	0.674
Hungary	VAR(1)	-1.75	0.301	Kuwait	VAR(1)	-1.40	0.529
Korea	VAR(3)	-1.14	0.706	Lebanon	VAR(1)	-1.80	0.515
Morocco	VAR(2)	-1.26	0.275	Nigeria	VAR(1)	-1.28	0.887
Peru	VAR(3)	-0.62	0.310	Pakistan	VAR(2)	-1.59	0.572
Poland	VAR(3)	-1.61	0.301	Qatar	VAR(3)	-2.24	0.502
Russia	VAR(2)	-1.87	0.510	Slovenia	VAR(2)	-1.53	0.390
South Africa	VAR(1)	-0.91	0.584	Sri Lanka	VAR(3)	-1.25	0.680
Turkey	VAR(1)	-1.16	0.439	Ukraine	VAR(2)	-1.10	0.526
				Vietnam	VAR(2)	-2.71	0.562

[a] All the ADF t-statistic are insignificant at the 5% level.

[b] All the TC_{trace} are insignificant at the 5% level.

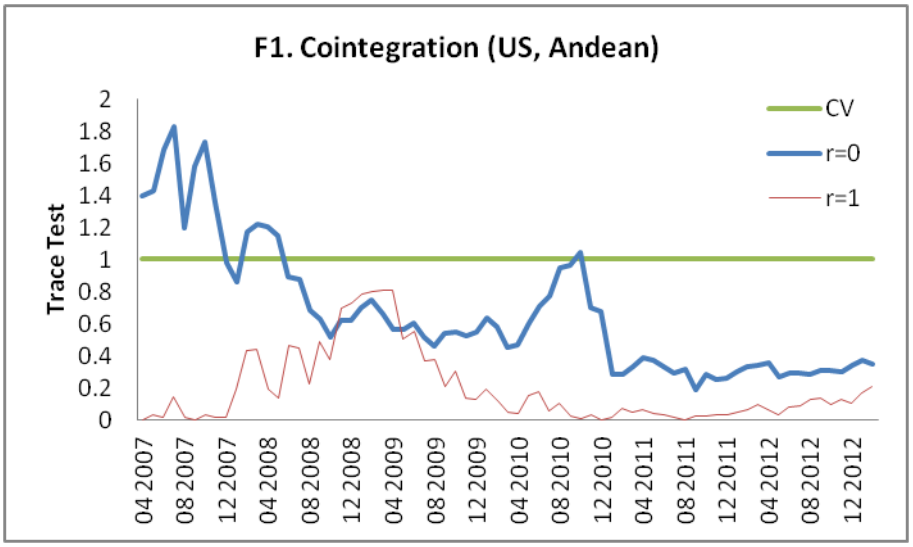
Given a linear trend assumption is rejected in the cointegration analysis (results not shown), we only report our empirical results based on models with no linear trend. That is, the ADF without trend regression is given as $\Delta x_{i,t} = a_{i,0} + a_{i,2} x_{i,t-1} + \sum_{i=1}^{p-1} b_{i,1} \Delta x_{i,t-i} + v_{i,t}$ and a constant is restricted in the cointegration vector. Table 2 reports the bivariate cointegration test results for the whole sample period, including the optimal lag k for the VAR process, the corresponding ADF(k) test and the TC_{trace} ratio. The pair of the US and a foreign stock markets are assumed to follow a Vector Autoregressive Process (VAR(k)), and the Akaike Information Criterion (AIC) is used to select the optimal lag k. The Augmented Dickey-Fuller (ADF) test is reported for AR(k). Similar to Table 1, results for the emerging markets and

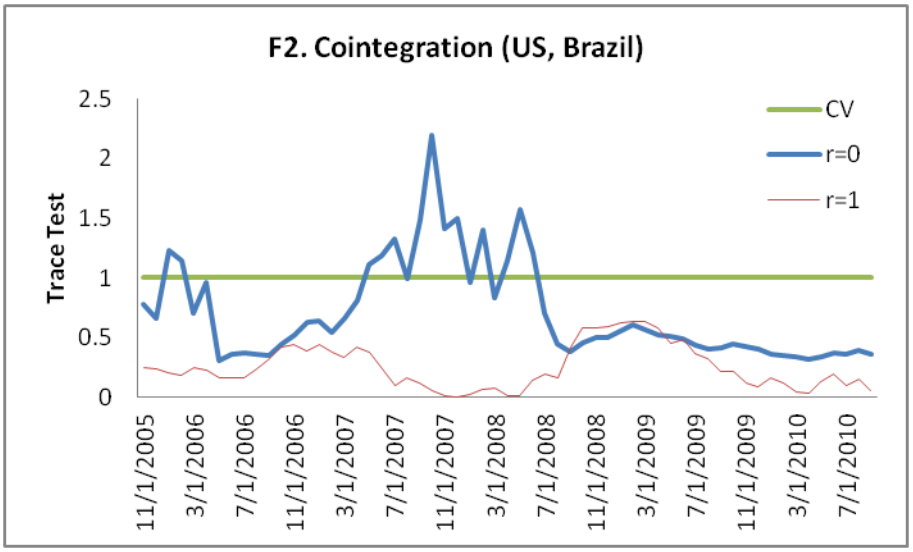
the frontier markets are reported in Panels A and B, respectively. As shown in Table 2, all ADF t-statistics are insignificant suggesting that one cannot reject the null hypothesis of the existence of a unit root for all series. Given the TC_{trace} is smaller than 1 for all pairings of markets between the US and a foreign country, the null hypothesis of no cointegration cannot be rejected. In other words, our empirical results are consistent with those reported by Yang, Kolari and Sutanto (2004) in that we are unable to provide any evidence to suggest that the US stock market is co-integrated with any of the foreign stock markets examined in this study for our whole sampling period.

Recursive Cointegration Results

Results from Emerging Markets

The TC_{trace} series from the recursive cointegration regressions for emerging markets are plotted over time in Figure 1-15. Both TC_{trace} series for the null hypothesis of $r = 0$ (no cointegration exists) and null hypothesis of $r \leq 1$ are presented. It can been seen that although the US market and each of the foreign countries are not cointegrated over the long run, the cointegration relationships in this bivariate system is non-stationary over time. In fact, our figures show that the US market is cointegrated with all emerging markets examined in this study except Colombia, Hungary, South Africa and Turkey during the period between 2006 and 2007. This suggests the financial crisis of 2007 not only affects the US market but also most of the emerging markets. Although the TC_{trace} for Hungary and South Africa does not exceed 1, an increase in the degree of cointegration is evident in Figure 8 and 14. In the case of Colombia, we observe a spike in the TC_{trace} in 2005 instead of 2007, and this could be due to a reaction to the initiation of negotiation in May 2004 between Colombia and its largest trading partner, the US, on a free trade agreement between the two countries. No cointegration is found between the US and the Turkey stock market. In general, the degree of cointegration decreases after 2008 with the TC_{trace} eventually becomes insignificant (as shown in Table 2). This implies the contagion effect caused by the financial crisis tends to be short-lived and dissipates over the long run.




F2. Cointegration (US, Brazil)
Trace Test
2.5
2
1.5
1
0.5
0
CV
r=0
r=1
11/1/2005
3/1/2006
7/1/2006
11/1/2006
3/1/2007
7/1/2007
11/1/2007
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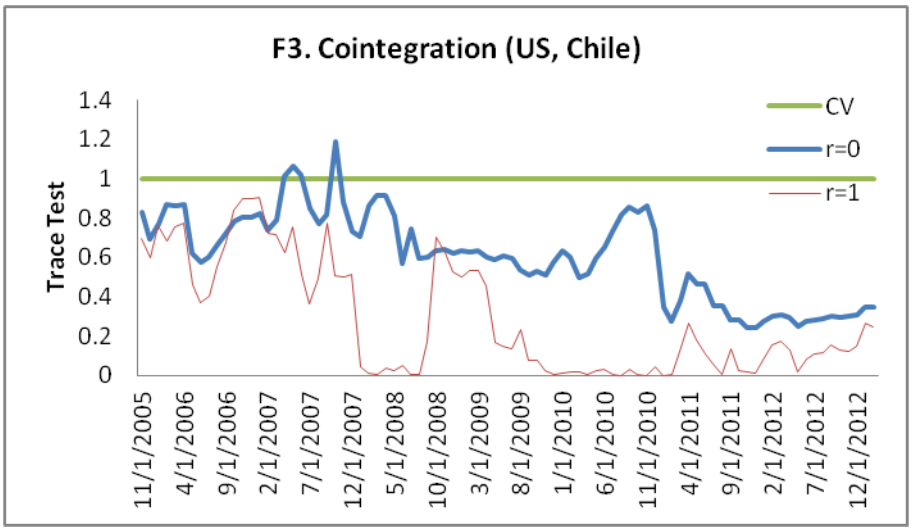
7/1/2010


F3. Cointegration (US, Chile)
Trace Test
1.4
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
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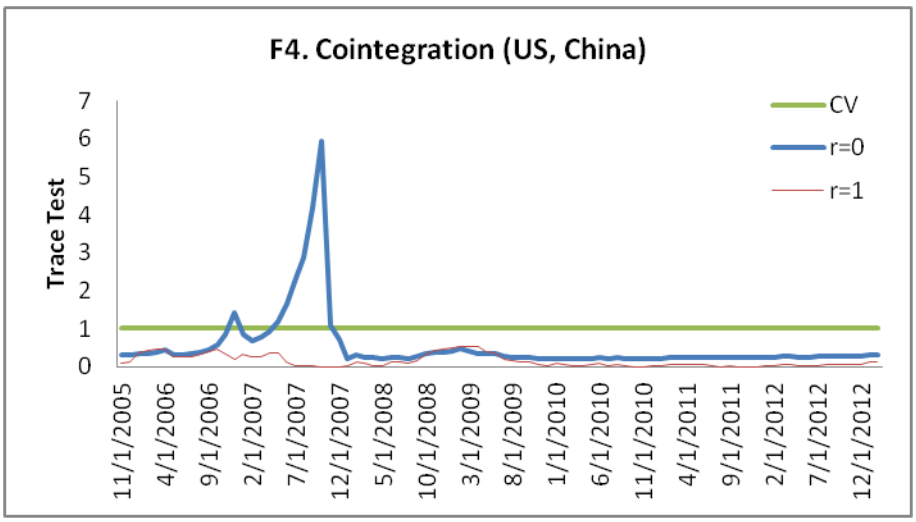
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012


F4. Cointegration (US, China)
Trace Test
7
6
5
4
3
2
1
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
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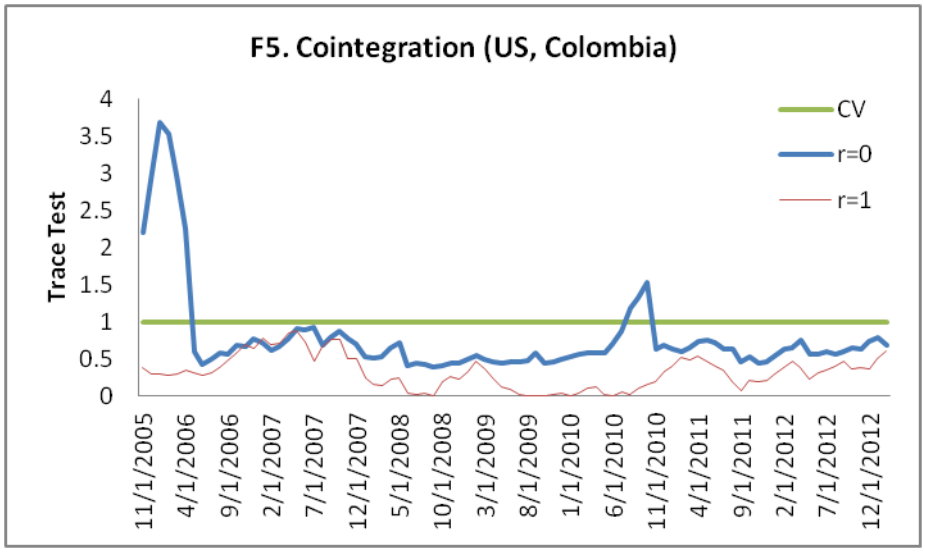
2/1/2012
7/1/2012
12/1/2012


F5. Cointegration (US, Colombia)
Trace Test
CV
r=0
r=1
4
3.5
3
2.5
2
1.5
1
0.5
0
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
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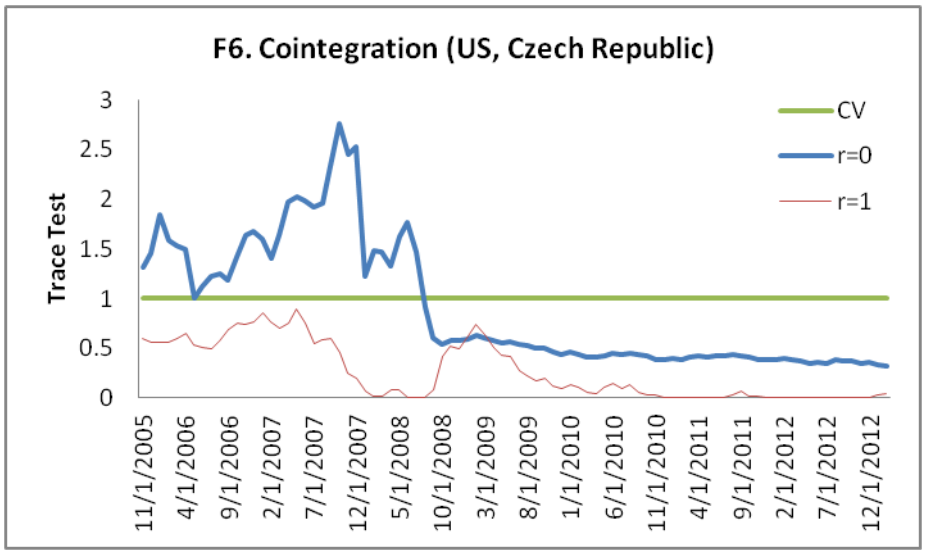
F6. Cointegration (US, Czech Republic)
Trace Test
CV
r=0
r=1
3
2.5
2
1.5
1
0.5
0
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
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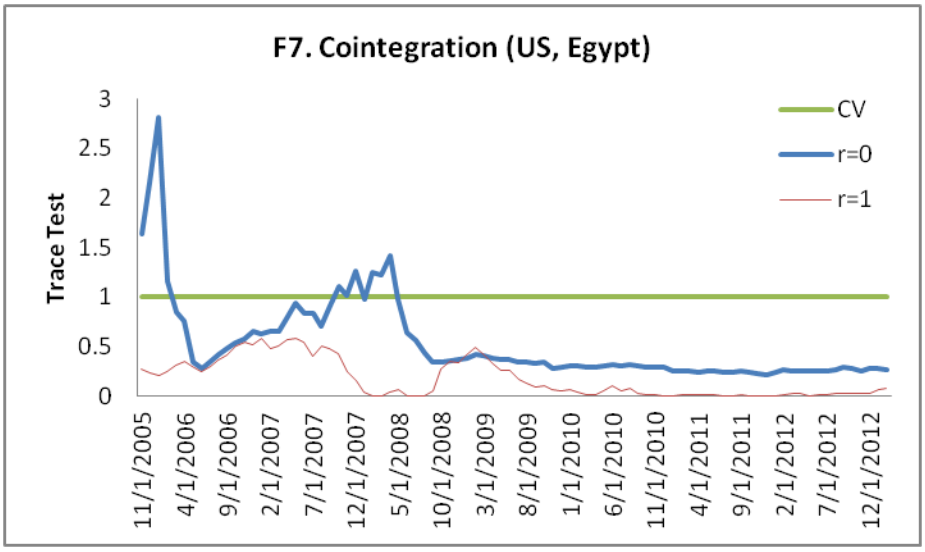
F7. Cointegration (US, Egypt)
Trace Test
CV
r=0
r=1
3
2.5
2
1.5
1
0.5
0
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
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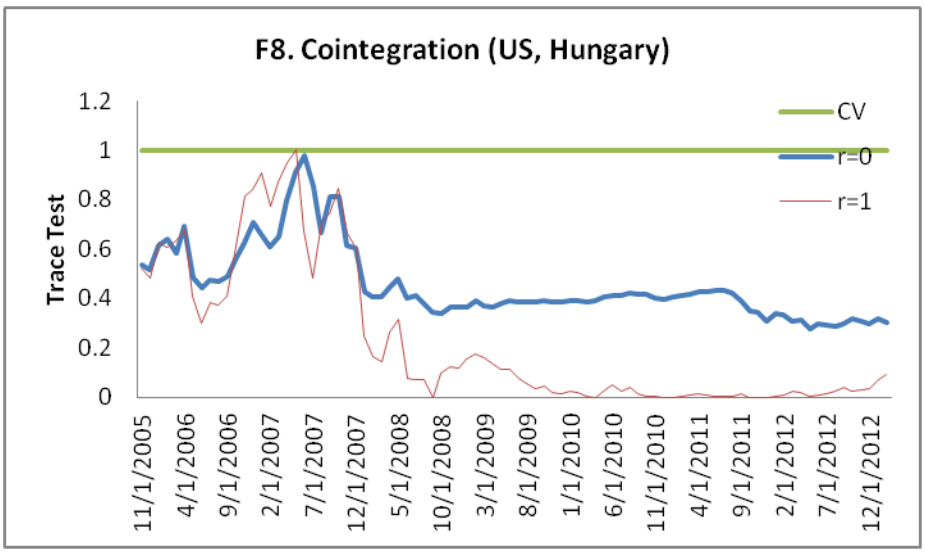
9/1/2011
2/1/2012
7/1/2012
12/1/2012


F8. Cointegration (US, Hungary)
Trace Test
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
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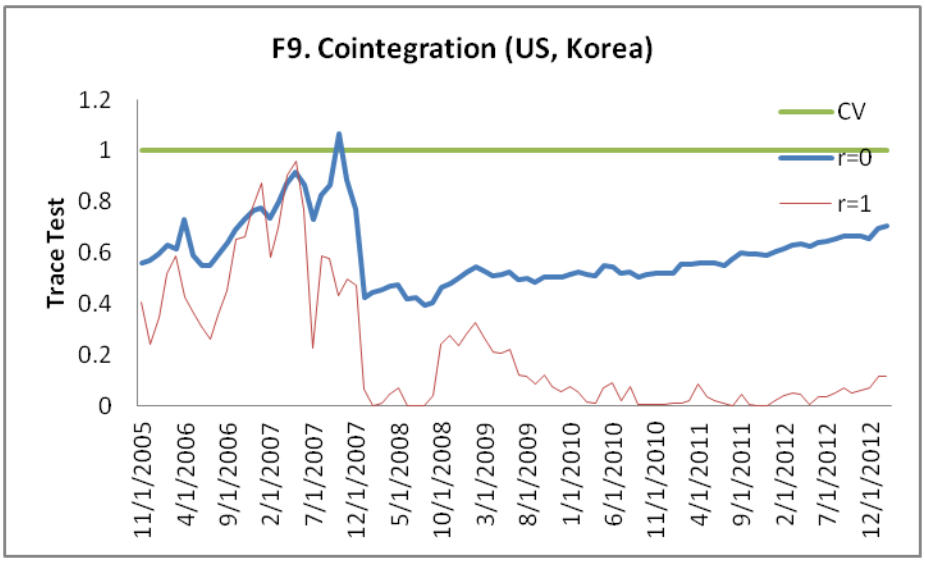
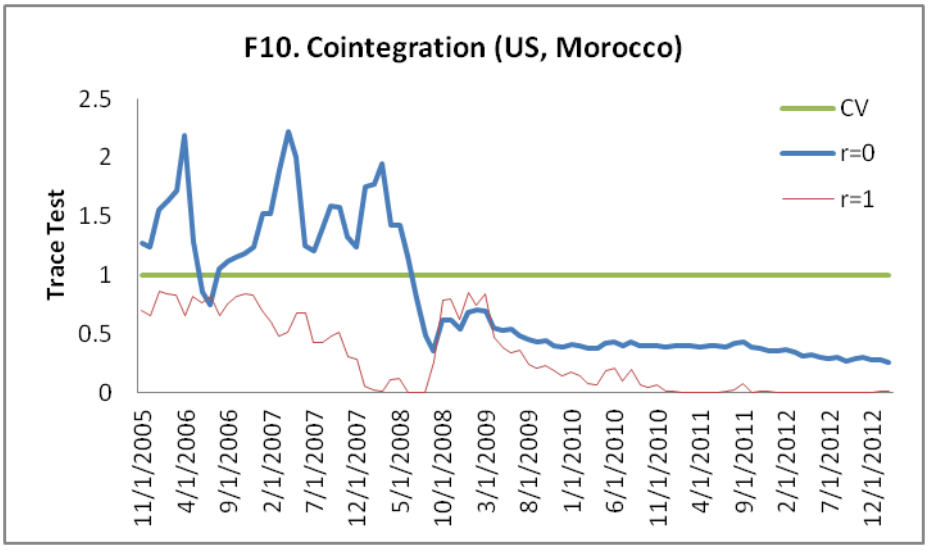
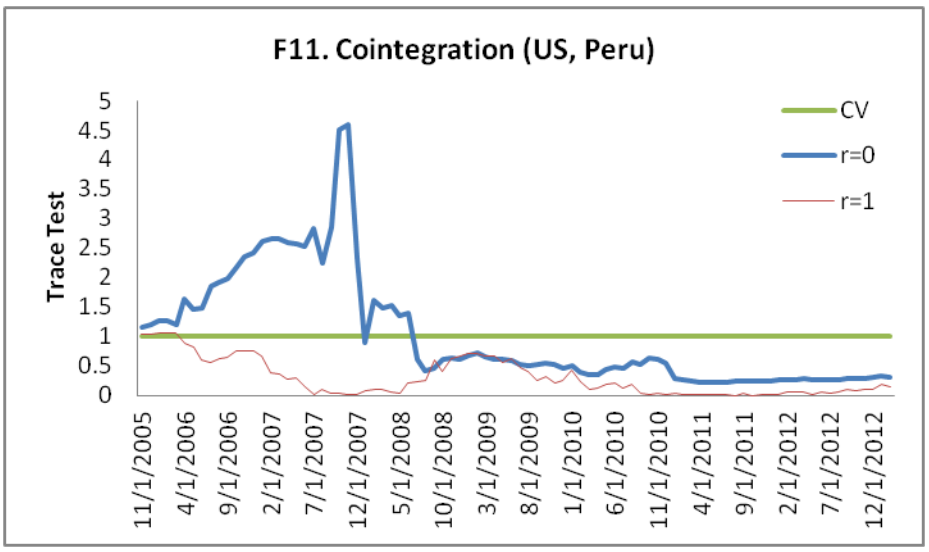
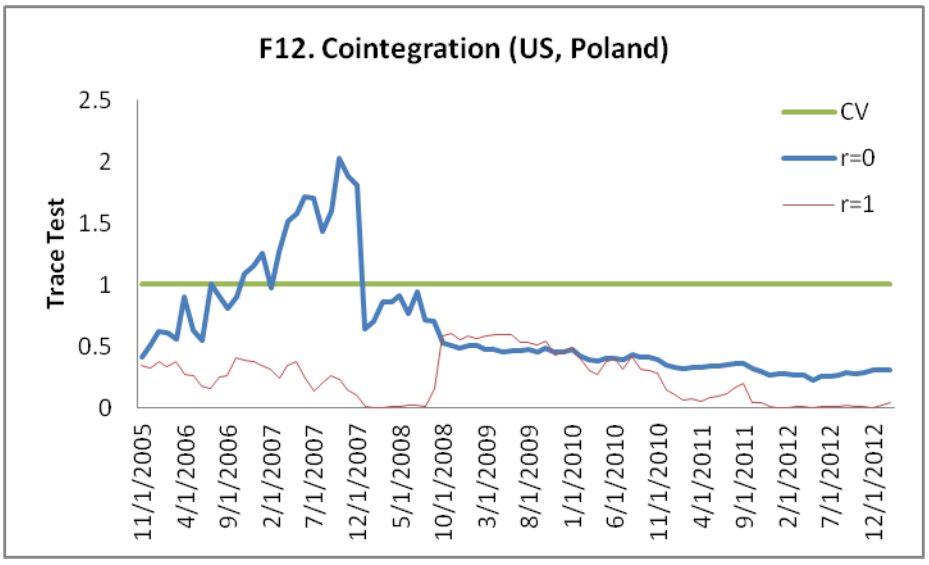
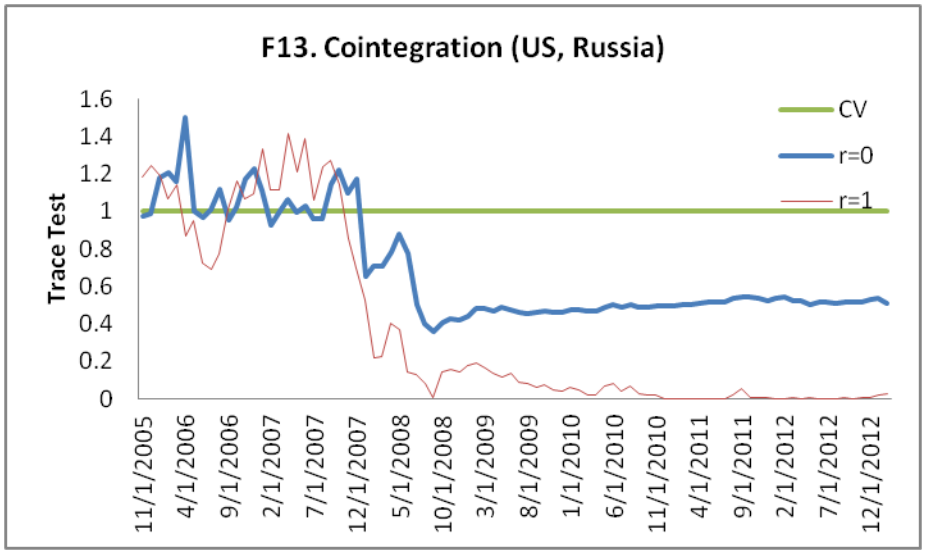
7/1/2012
12/1/2012

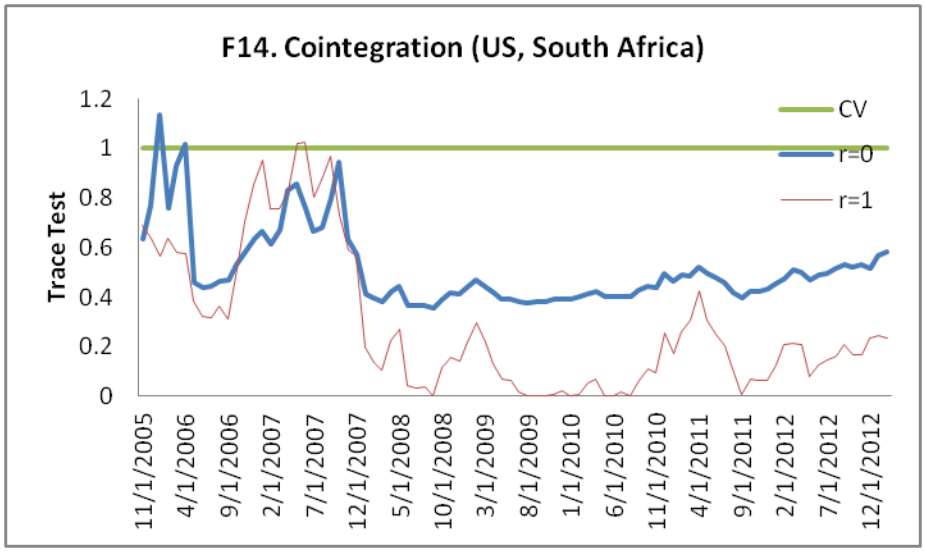

F9. Cointegration (US, Korea)
Trace Test
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012

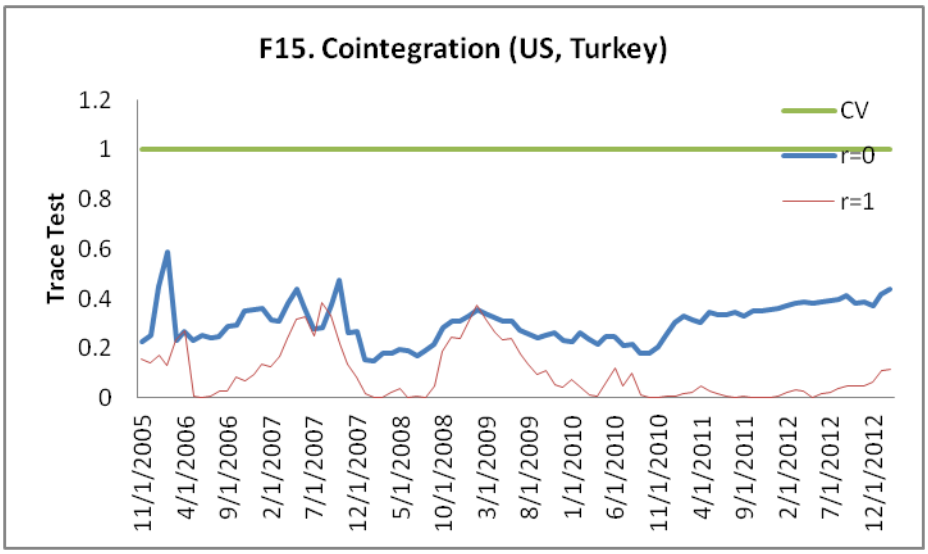

F10. Cointegration (US, Morocco)
Trace Test
2.5
2
1.5
1
0.5
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012


F11. Cointegration (US, Peru)
Trace Test
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012


F12. Cointegration (US, Poland)
Trace Test
2.5
2
1.5
1
0.5
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012

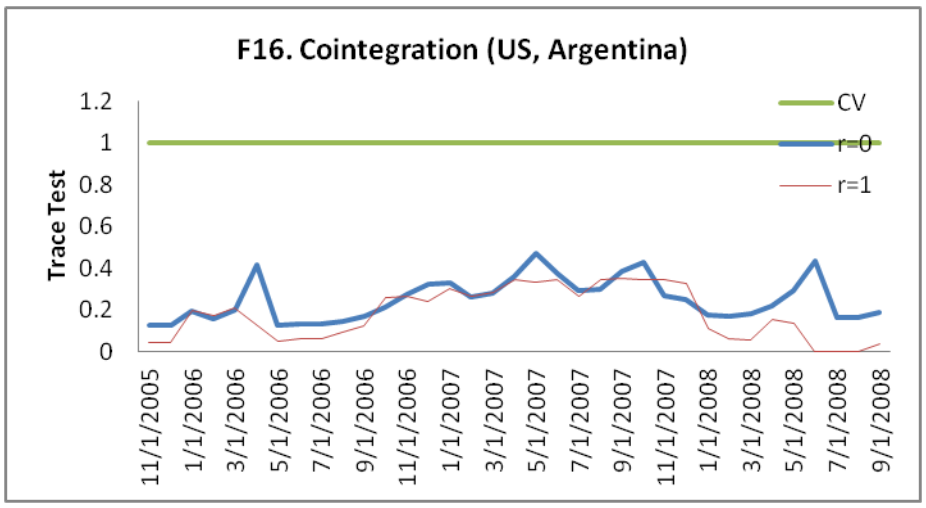

F13. Cointegration (US, Russia)
Trace Test
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012

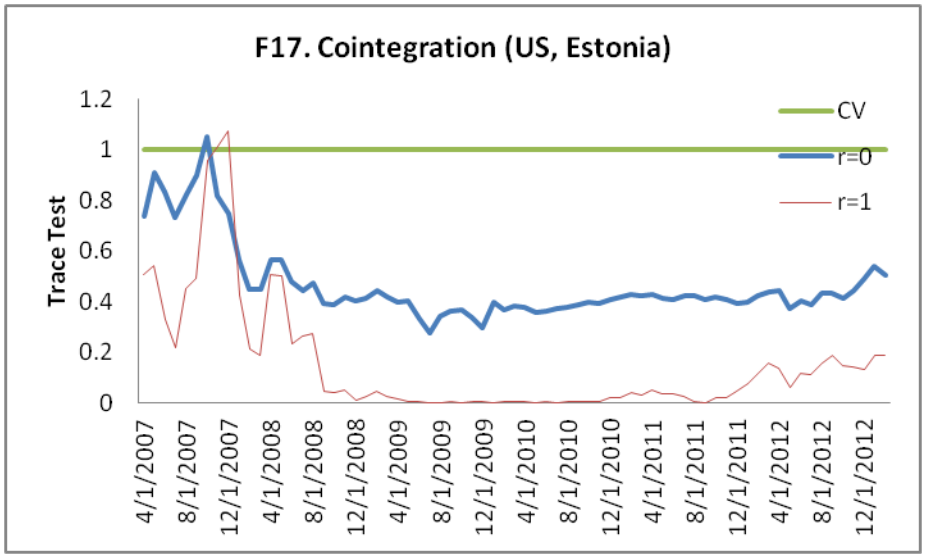


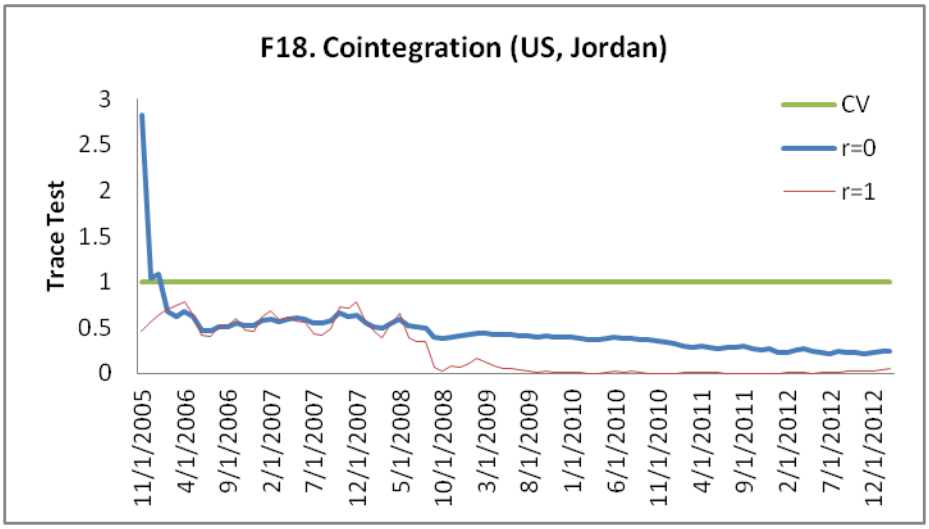


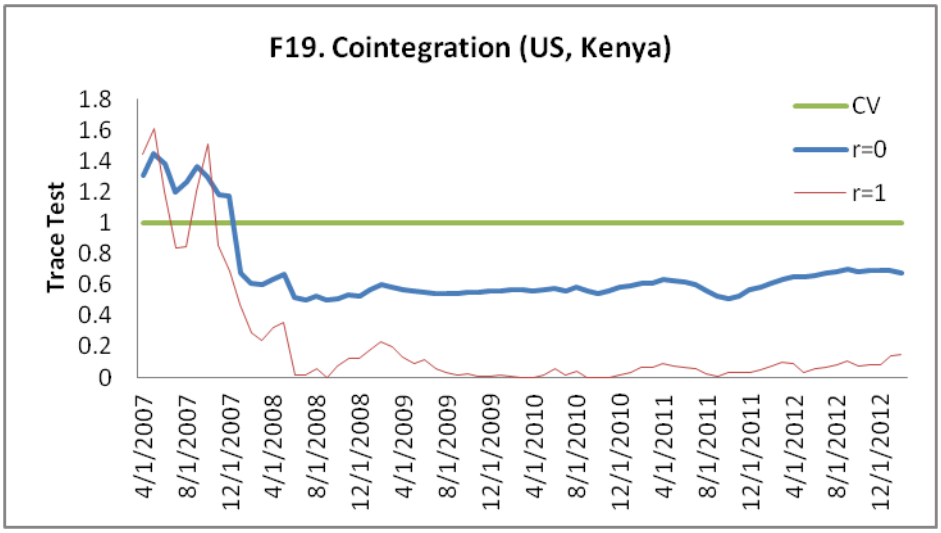
Results from Frontier Markets

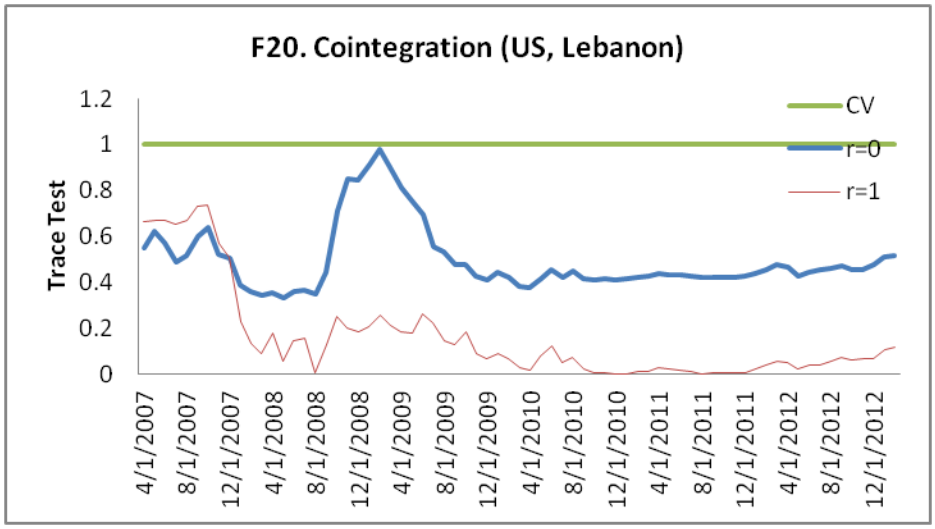
The TC_{trace} series for frontier markets are plotted over time in Figure 16-24. Due to data availability, only nine out of the sixteen frontier markets examined contain more than 100 observations.[2] Six out of the nine countries exhibit similar patterns as seen in the case of the emerging markets, that is, a spike of TC_{trace} is found around 2007. The only three exceptions are Argentina, Jordan, and Lebanon where an increase in TC_{trace} in 2005 is observed for Jordan and in 2008 for Lebanon. For the other seven markets in the frontier market group, no evidence of cointegration is found in recent periods. The exception is Kazakhstan where a spike in cointegration is observed around 2010.

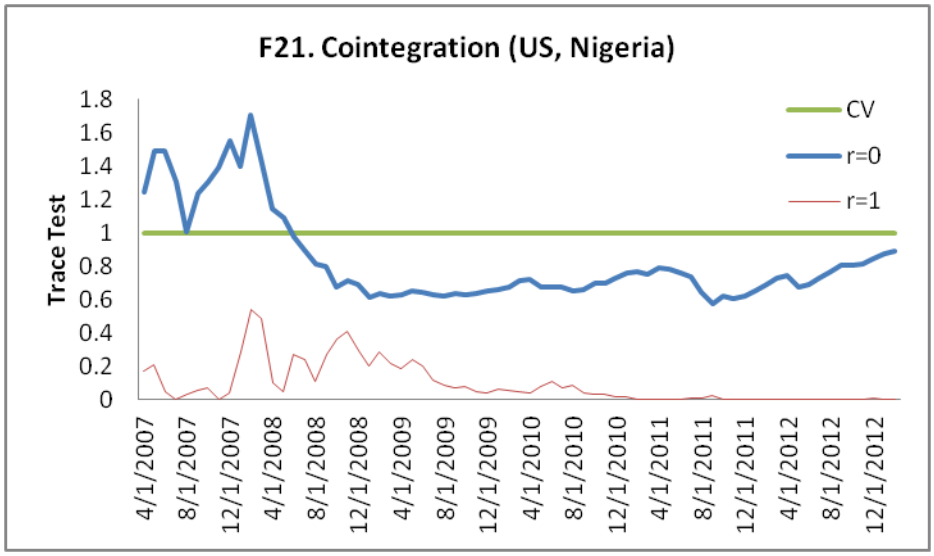

F16. Cointegration (US, Argentina)
Trace Test
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
1/1/2006
3/1/2006
5/1/2006
7/1/2006
9/1/2006
11/1/2006
1/1/2007
3/1/2007
5/1/2007
7/1/2007
9/1/2007
11/1/2007
1/1/2008
3/1/2008
5/1/2008
7/1/2008
9/1/2008

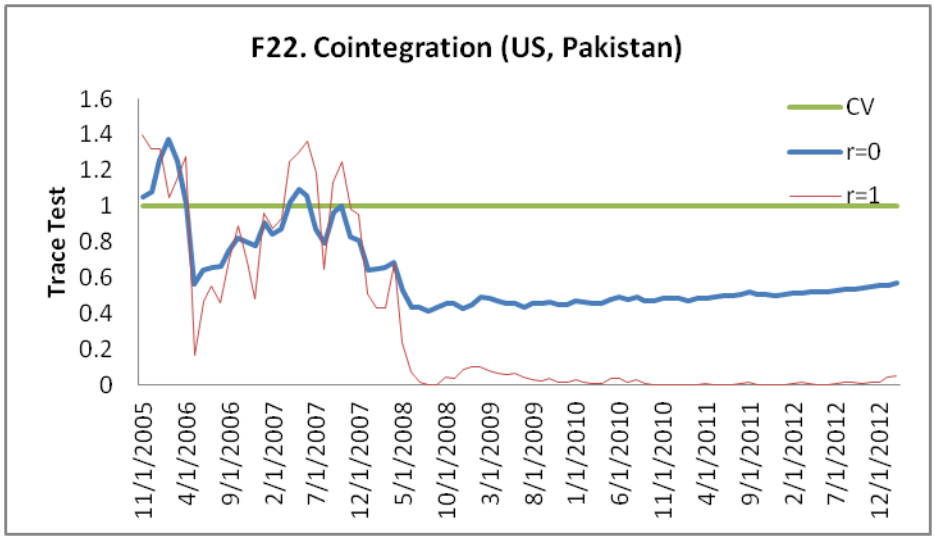

F17. Cointegration (US, Estonia)
Trace Test
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
4/1/2007
8/1/2007
12/1/2007
4/1/2008
8/1/2008
12/1/2008
4/1/2009
8/1/2009
12/1/2009
4/1/2010
8/1/2010
12/1/2010
4/1/2011
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012

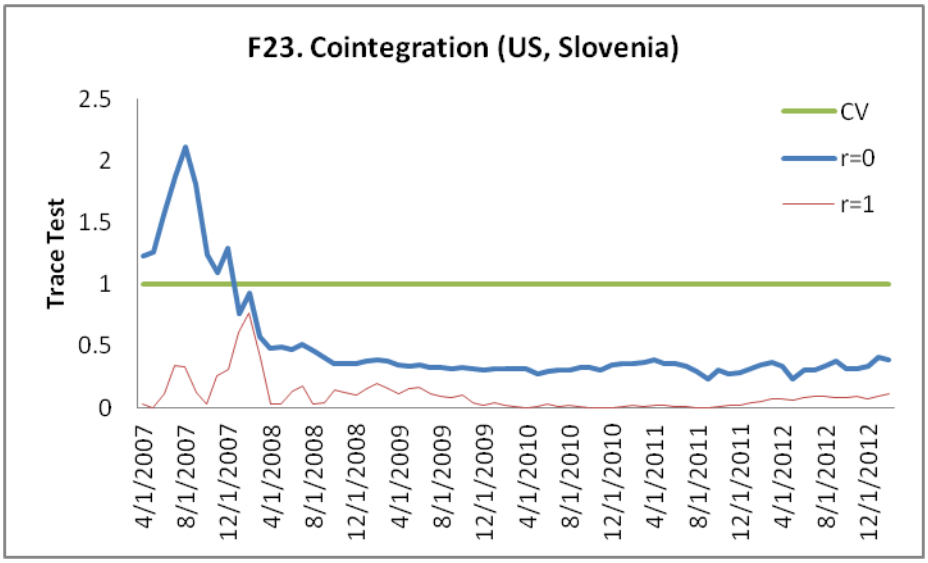

F18. Cointegration (US, Jordan)
Trace Test
3
2.5
2
1.5
1
0.5
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012


F19. Cointegration (US, Kenya)
Trace Test
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
4/1/2007
8/1/2007
12/1/2007
4/1/2008
8/1/2008
12/1/2008
4/1/2009
8/1/2009
12/1/2009
4/1/2010
8/1/2010
12/1/2010
4/1/2011
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012


F20. Cointegration (US, Lebanon)
Trace Test
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
4/1/2007
8/1/2007
12/1/2007
4/1/2008
8/1/2008
12/1/2008
4/1/2009
8/1/2009
12/1/2009
4/1/2010
8/1/2010
12/1/2010
4/1/2011
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012


F21. Cointegration (US, Nigeria)
Trace Test
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
4/1/2007
8/1/2007
12/1/2007
4/1/2008
8/1/2008
12/1/2008
4/1/2009
8/1/2009
12/1/2009
4/1/2010
8/1/2010
12/1/2010
4/1/2011
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012


F22. Cointegration (US, Pakistan)
Trace Test
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012


F23. Cointegration (US, Slovenia)
Trace Test
2.5
2
1.5
1
0.5
0
CV
r=0
r=1
4/1/2007
8/1/2007
12/1/2007
4/1/2008
8/1/2008
12/1/2008
4/1/2009
8/1/2009
12/1/2009
4/1/2010
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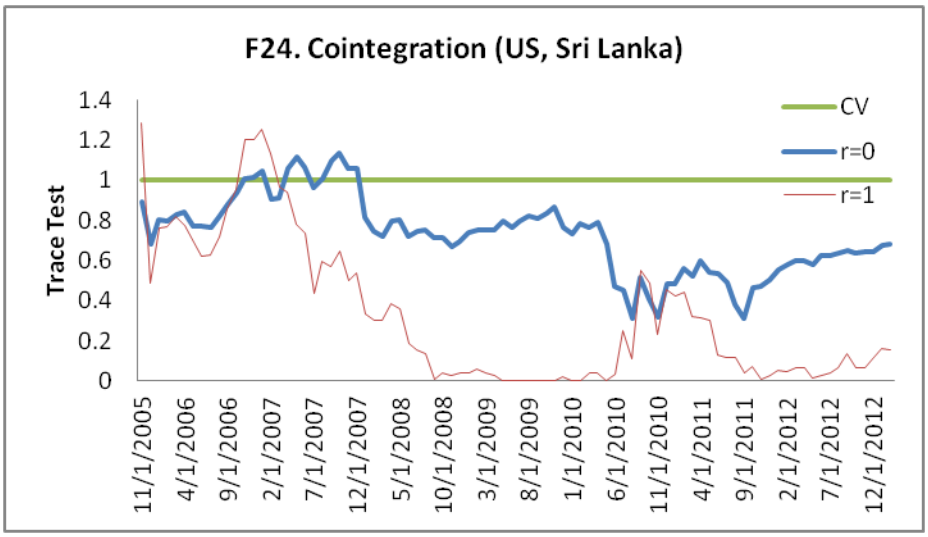
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012


F24. Cointegration (US, Sri Lanka)
Trace Test
1.4
1.2
1
0.8
0.6
0.4
0.2
0
CV
r=0
r=1
11/1/2005
4/1/2006
9/1/2006
2/1/2007
7/1/2007
12/1/2007
5/1/2008
10/1/2008
3/1/2009
8/1/2009
1/1/2010
6/1/2010
11/1/2010
4/1/2011
9/1/2011
2/1/2012
7/1/2012
12/1/2012

CONCLUSIONS

In this paper, we re-examine the contagion effect of a financial crisis on the cointegration relationships between the US and the emerging stock markets, and to examine whether the effect has a long-term or short-term impact. The recursive cointegration procedure by Yang, Kolari and Sutanto (2004) is applied to monthly stock indices for the sample period from 2000 to 2013, which encompasses the financial crisis of 2007. Using a more recent sampling period allows us to observe whether the globalization of financial markets has indeed lead to greater integration of national equity markets, and hence diminishes the value of portfolio diversification in recent years. Our sampling period also includes a different event, that is, the financial crisis of 2007. This special event provides us the opportunity to re-investigate the contagion effect on the cointegration relationship between the US and emerging stock markets. Finally, in addition to the emerging markets examined in previous studies, sixteen frontier markets are also examined in this study. Including frontier markets broadens the potential investment pools for investors in constructing their global portfolios.

Consistent with the results reported by Yang et al. (2004), our results show that the US stock market and each of the foreign stock markets examined is not cointegrated over the period from 2000 to 2013. This suggests that even in today's integrated financial environment, a global portfolio investment is still valuable over a long-term investment horizon. Similar to the observation made by Yang et al. (2004), the financial crisis of 2007 increases the degree of cointegration between the US and most of the emerging and frontier stock markets. The observed strong contagion effect caused by a financial crisis suggests that the downside risk caused by a financial crisis is not so easily diversified away by forming a global portfolio. Nevertheless, this contagion effect tends to be short-lived and dissipates over the long run.

Although our results show that in general, the degree of cointegration between the US and the foreign stock markets increases due to the impact of the financial crisis of 2007, the magnitude of change in the level of cointegration varies across different countries. This observation raises an important question requiring further investigation. That is, what are the factors determining how the US and the foreign stock markets are cointegrated? For example, the cointegration reported in this study may be due to the effect of currency movements or culture similarity. In addition to "country" classification, a "culture" classification with currency-adjusted stock returns may provide a better picture of this cointegration relationship.

ENDNOTES

1. Chan, Gup and Pan (1992) study the cointegration relationship between the US and the Asian emerging markets. While DeFusco, Geppert, and Tsetsekos (1996), Choudhry (1997), and Soydemir (2000) examine the cointegration relationship between the US and the Latin American emerging markets.
2. To conserve space, the figures for 7 frontier markets (Bahrain, Bulgaria, Kazakhstan, Kuwait, Qatar, Ukraine and Vietnam) with limited data are not presented in the paper. However, they are available upon request to the corresponding author.

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