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Testing Integration between The Major Emerging Markets

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Abstract

This study examines the stock market integration between major emerging markets in different regions of the world, namely, Turkey, Russia, Brazil, Korea, South Africa, and Poland. The study employs a variety of co-integration tests; i.e., Engle-Granger (EG) (1987), Johansen (1988), Johansen and Juselius (1990), the Bounds test (Pesaran et al) (2001) to measure the long-term relationship, and Granger causality approach for the short-term relationship between those markets. The results unfolded that between Brazil and Polish markets long and short-term relationship could be diagnosed through the aforementioned tests save the Bounds test; whilst the same Bounds test confirmed the existence of a significant co-integration between Russian and Korean stock markets.

JEL Classification: G15, F21, C32.
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1. Introduction

Emerging markets (EMs) have long captured the attention of international investors and global portfolio managers due to the general tendency to remove capital market constraints throughout the world which made accession into these markets less burdensome as well as the emergence of new and vibrant markets offering high return opportunities via diversification, the logic of which simply rests upon the distribution of the risk of investment by channelling the funds to less integrated markets.

In retrospect, the studies on integration sought to deal with the relevant issues appeared solely in the developed markets (DMs) of US, Japan, and Western Europe. Yet, the issue of EMs has recently gained a common parlance among the financial literati because they provide the investors with lucrative opportunities of portfolio diversification for the assets which were formerly invested only in the DMs obviously thanks to the low correlation coefficient in between (see Cheung and Ho (1991), Divecha (1992)).

Many researchers analyzed long and short-run relationships between markets or groups of markets by employing varied methods. DeFusco (1996) and Felix (1998) found no long-run co-movement between US and EMs. In their study, Kwan et al (1995) claimed that Taiwan, South Korea, Singapore and Hong Kong were co-integrated with the G-7 countries rather than with each other. Choudhry (1997) examined the long run relationship between six Latin American and the US stock markets and found out a sound evidence of co-integration and equally significant causality among six Latin American indices with or without US index. Similarly Linne (1998) confirmed co-integration among the central European markets, yet, could not run into it any credible evidence supporting their co-integration with the mature markets. However, in the previous studies Mac Donald (2001) and Varankova (2004) discovered significant long run relations between Central European and DMs. Syriopulos (2005) measured the impact of EMU on stock market linkages and unfolded a long run co-movement between Central European and DMs (US and Germany).

In another study, Ratanapakorn and Sharma (2002) handled the long and short run relationships among stock indices of US, Europe, Asia, Latin America and Eastern Europe-Middle East before and during the Asian crises. Although they did not find out a meaningful indicator proving co-integration in the preceding period, they reported that one significant co-integrating vector and some short-term (causal) relations were observed during the involved crises. Yang et al (2004) encountered with a clear evidence of co-integration between most EMs and the US in response to the global EM crises during 1997-1998 and realized that significant events potentially caused to structural breaks in co-integration tests.

It follows that majority of the aforementioned studies examined the integration among EMs within their own region and with the DMs, and only a few of them scouted out for co-integration among EMs in different regions. In our study we try to cover this gap by handling the issue of co-integration among major EMs (Turkey, Brazil, Russia, Korea, South Africa, and Poland) in different regions (Middle East, Latin America, Far East, Africa and Eastern Europe) along December 1994-August 2006 period. We focus on the EMs with the highest market capitalization values in year 2001 in their own region because of their high capability of representing their region. The combination of market capitalization values of the countries which this study selected as its locus point constitutes approximately 45 percent of the total market capitalization values of the 20 countries which are supposed to be developing markets of 2001. The share of Brazil in the Latin American stock market now approaches to 42 percent, whereas it is 28 percent for Korea, and 82 percent for Russia and Poland in their respective regions. Turkey and South Africa dominates Middle East and Africa respectively where there has been no any serious competitor to them so far. We incorporate the Turkish stock market into our study because of its categorically high market capitalization within the region it situates, as well as its potential as a serious candidate for full membership in the EU which attracts many international investors and global portfolio managers. Lastly, the paper continues with sections, one briefly introducing the data, and another summarizing the methodology and the final one presenting the empirical results and discussing the implications.

2. Methodology

2.1. Testing Unit Root

In order to test whether the two markets are co- integrated, it is necessary to first determine the each national stock index is individually integrated at the same order. Testing for unit root we use the Augmented Dickey and Fuller (ADF) (1981) test. Because of the short comings of this test, we also apply Phillips and Perron (PP) (1988) and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) (1992) unit root tests.

According to the KPSS test, a time series can be decomposed into the sum of a deterministic trend, a random walk, and a stationarity error:

$$y_t = \delta_t + r_t + \varepsilon_t \tag{1}$$

here r_t is a random walk. thus:

$$r_t = r_{t-1} + u_t \tag{2}$$

where the u_t are iid(0, σ^2).

KPSS tests the null hypothesis that time series has no unit root is based on calculating LM statistics and comparing critical values derived by Kwiatkowski et al (1992). LM statistics is:

$$\text{LM} = T^{-2}\sum_{t=1}^{T} s_t^2 / s_{\varepsilon_t}^3 \tag{3}$$

where $s_{\varepsilon_t}^3$ is estimator of the variance of ε_t and $S_t = \sum_{i=1}^{t} e_i$.

2.2. Testing Cointegration

We start with Engle-Granger (1987) two-step procedure that is applied to estimate the long-run equilibrium relationship by applying ADF unit root tests for the estimated residuals. When it is found that each time series is integrated with the same order, Engle-Granger (1987) two-step procedure can be used for estimating co-integration. First residuals are obtained. After that, ADF test procedure is implemented on estimated residuals.

Other methods of co-integration applied for estimating and testing the numbers of long run co-integrating relationships between variables are Johansen (1988) and Johansen and Juselius (1990) co-integration tests. "Trace" and "maximum eigenvalue" test statistics are used for testing the null hypothesis that there is no co-integration between series. Trace statistics testing the null hypothesis that there is at most r distinct co-integrating vectors corresponds to:

$$\lambda_{trace}(r) = -2\log Q = -T\sum_{i=r+1}^{n}\log(1-\hat{\lambda}_i) \tag{4}$$

where Q(.) is the LR statistics, $\hat{\lambda}_{r+1}$,…., $\hat{\lambda}_p$ are the p – r smallest eigenvalues, and T is the number of observations. Maximum Eigenvalues is applied for comparing the null hypothesis of r cointegrating vectors against the alternative of (r+1) co-integrating vectors. The max statistics is given by

$$\lambda_{\max}(r, r+1) = -2\log Q = -T\log(1-\hat{\lambda}_{r+1}) \tag{5}$$

Johansen (1998) and Engle-Granger (1987) co-integration procedure can be used only if both the time series investigated are I(1). Bounds test (Pesaran et al) (2001) can be used in case of some time series are I(0) others I(1). Bounds test is based on estimated unrestricted Error Correction Model (UECM) which can be written as:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 x_{t-1} + \sum_{i=1}^{p} \beta_3 \Delta y_{t-i} + \sum_{j=0}^{p} \beta_4 \Delta x_{t-j} + \varepsilon_t \quad (6)$$

where β_0 is constant term, β_1 and β_2 are long term multipliers and p is the optimum lag. Because monthly data set is used, first P is set to 12 and decreased one by one to get minimum AIC for each model. Bounds test is based on testing significance β_1 and β_2 by using Wald test. Critical value bounds created by Pesaran are used for testing. Calculated F statistics bigger than I(1) critical values means the existence of co-integration; and, Calculated F statistics smaller than I(0) critical values emphasize no co-integration. Calculated F statistics between critical value bounds emphasizes in empirical results.

2.3. Investigating Short Run Relationship

Although Johansen (1998) and Engle-Granger (1987) co-integration procedures are used for determining long-term equilibrium relations, short-term relations can be determined by Granger causality test:

$$\Delta y_{1t} = \alpha_0 + \sum_{i=1}^{K} \alpha_{1i} \Delta y_{1t-i} + \sum_{i=1}^{K} \alpha_{2i} \Delta y_{2t-i} + \varepsilon_{1t} \quad (7)$$

$$\Delta y_{2t} = \beta_0 + \sum_{i=1}^{K} \beta_{1i} \Delta y_{1t-i} + \sum_{i=1}^{K} \beta_{2i} \Delta y_{2t-i} + \varepsilon_{2t} \quad (8)$$

where y_{1t} and y_{2t} are the countries' stock indices. K is the lag length determined by AIC in this paper. Not rejecting the null hypothesis of $H_0 : \alpha_{21} = \alpha_{22} = ... = \alpha_{2k} = 0$ means that y_{2t} does not Granger-cause y_t. Moreover, not rejecting the null of $H_0 : \beta_{21} = \beta_{22} = ... = \beta_{2k} = 0$ means that y_{1t} does not Granger-cause y_{2t}.

3. Data

The data consist of monthly stock market index observations for major EMs; Turkey, Brazil, Russia, Korea, South Africa and Poland in different regions. The indices are provided from Morgan Stanley Capital International (MSCI). All series are in US dollars and in natural logs. The sample period is December 1994- August 2006 giving a total of 129 observations.

Table 1 gives descriptive statistics of the monthly stock market returns. The returns are computed as logarithmic differences. The monthly returns are between

6.619 and 4.885 percent with standard deviations between 0.774 and 0.307. Kurtoses of indices are relatively low and the null of normality is rejected in all except Brazil and Russia by Jarque-Bera test.

Table 1
Descriptive Statistics for Monthly Stock Market Returns in US Dollars (Dec 1994-Aug 2006)

	Turkey	Brazil	Russia	Korea	S. Africa	Poland
Mean	5.298	6.619	5.484	4.885	5.292	6.190
Median	5.59	6.572	5.546	4.950	5.292	6.172
S.D.	0.481	0.394	0.774	0.477	0.313	0.307
Skewness	0.398	0.446	-0.114	-0.571	0.550	0.724
Kurtosis	2.204	3.303	2.458	3.471	2.850	3.157
Jarque-Bera	7.449**	5.224	2.028	8.975**	7.250**	12.459**

Notes: "**" denotes significant at 5 percent level.

4. Empirical Results

4.1. Unit Root Test Results

The results for the ADF, PP and KPSS for unit root are presented in Table 2. The ADF and PP tests indicate that the null hypothesis of existence of unit root can not be rejected at level of series at 5% level, and the null of unit root is rejected at first difference of series at 5% levels; thus all indices have unit root according to the ADF and PP test. However, KPSS test results are more complicated. Since the null of stationarity can not be rejected at level with or without trend of series at 5% level in Turkey; price index of Turkey is integrated of order 0 or I(0) at level of data at 5% level. For Korea, the null of stationarity is rejected at level with or without trend of series at 5% level; consequently, Price index of Korea are I(1) at level of data at 5% level.

Table 2
Unit Root Tests (Jan 1996-Aug 2006)

	ADF test				PP test				KPSS			
	z_t		Δz_t		z_t		Δz_t		z_t		Δz_t	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TR	-2.00 (0)	-2.29 (0)	-12.00*** (0)	-11.96*** (0)	-2.01 (3)	-2.33 (3)	-12.00*** (1)	-11.96*** (1)	0.39* (9)	0.13* (9)	-	-
BR	-1.09 (0)	-1.47 (0)	-12.37*** (0)	-12.41*** (0)	-1.05 (2)	-1.42 (2)	-12.37*** (0)	-12.42*** (1)	0.29 (9)	0.21** (9)	0.19 (1)	0.07 (2)
RS	-1.78 (4)	-2.83 (4)	-9.04*** (1)	-9.01*** (1)	-1.06 (4)	-2.54 (5)	-10.30*** (4)	-10.27*** (4)	1.05*** (9)	0.12 (9)	-	-
KR	-1.07 (0)	-1.86 (0)	-10.99*** (0)	-11.08*** (4)	-1.07 (7)	-1.91 (8)	-11.00*** (9)	-11.07*** (11)	0.52** (9)	0.22*** (9)	0.23 (2)	0.04 (3)
SA	-0.91 (0)	-1.28 (0)	-11.75*** (0)	-6.92*** (4)	-0.75 (7)	-1.04 (8)	-11.87*** (9)	-12.11*** (11)	0.40* (9)	0.33*** (9)	0.33 (9)	0.08 (12)
PL	-1.43 (0)	-1.85 (0)	-7.73*** (3)	-7.84*** (3)	-1.16 (13)	-1.61 (12)	-13.89*** (18)	-14.02*** (19)	0.41* (9)	0.24*** (9)	0.19 (26)	0.12 (29)

Notes: z_t: levels; Δz_t: first differences. (1): trend; (2): trend and intercept. TR: Turkey; BR: Brazil; RS: Russia; KR: Korea; SA: South Africa; PL: Poland. Numbers in parenthesis are optimum number of lags determined according to AIC; critical values are based on MacKinnon (1991). For PP and KPSS tests, numbers in parenthesis are the truncation lag determined by using Bartlett. The symbols *, **, *** indicate that the null hypothesis is rejected at the 10%, 5%, and 1% levels, respectively.

The null of stationarity can not be rejected at the level of series without trend and can be rejected at the level of series with trend at 5% significance level for S. Africa, Brazil and Poland. Conversely, the null of stationarity is rejected at the level of series without trend and can not be rejected at the level of series with trend at 5% significance level for Russia. After investigating figures of distribution of data, we realize that there are trends in data; consequently we consider the test results with trend. For this reason, the stock indices of S. Africa, Brazil and Poland are I(1) and the stock indices of Russia and Turkey are I(0) according to the result of KPSS test results with trend.

In order to test co-integration, both of series must be I(1). Thus, if we consider ADF or PP tests as a valid test for determining stationarity, we can use Johansen, and Engle-Granger Co-integration Method. But if KPSS is used as a valid test, co-integration between Russia and the other countries except Russia can be tested by Bounds test since Turkey is I(0) and the others except Russia are I(1).

Table3
Bounds Test Results

Turkey		Russia	
Calculated F statistics	**F-stat**	**Calculated F statistics**	**F-stat**
F_{TR}(TR|BR)	3.35	F_{TR}(RS|BR)	2.04
F_{TR}(TR|KR)	3.40	F_{TR}(RS|KR)	6.30**
F_{TR}(TR|SA)	3.24	F_{TR}(RS|SA)	4.32*
F_{TR}(TR|PL)	3.72	F_{TR}(RS|PL)	2.02

I(0) critical value bonds at 10%, 5%, and 1% levels are 4.04, 4.94, and 6.84 respectively.
I(1) critical value bonds at 10%, 5%, and 1% levels are 4.78, 5.73, and 7.84 respectively.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3 reports the bounds test results, calculated F statistics fall below the I(0) critical bounds of the F statistics, thus the null of no co-integration can not be rejected. Consequently Turkish stock market is not pair-wise co-integrated with each of the equity markets in Brazil, Korea, S. Africa, and Poland. Russia is pair-wise co-integrated with Korea at 5% level and with South Africa at 10% level.

4.2. Cointegration Test Results

We start with Engle-Granger and Johansen procedure for testing cointegration based on the result of ADF and PP tests that all series are I(1).

Table 4 reports the Engle-Granger co-integration procedure; the null of no co-integration is rejected for Turkey and Brazil at 10% as well as Brazil and Poland at 1% level. There is no co-integration relationship between other countries.

Table4
Engle-Granger Cointegration Method Results (ADF Test Statistics)

	Independent variables									
	TR		BR		RS		KR		SA	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TR	-	-	-	-	-	-	-	-	-	-
BR	-3.27*(1)	-3.16* (1)	-	-	-	-	-	-	-	-
RS	-2.32 (0)	-2.32(0)	-1.52(2)	-1.22(1)	-	-	-	-	-	-
KR	-2.33(0)	-2.33(0)	-1.49(0)	-1.59(0)	-1.64(0)	-3.04(7)	-	-		
S.A	-2.60(0)	-2.60(0)	-2.47(0)	-2.52(0)	-2.81(4)	-3.23*(4)	-2.46(5)	-2.88(5)	-	-
PL	-2.40(0)	-2.33(2)	-4.44***(0)	-4.41***(0)	-1.71(3)	-2.27(3)	-1.95(0)	-2.27(0)	-3.01(0)	-2.95(0)

Note: (1): trend; (2): trend and intercept . Numbers in parenthesis are optimum number of lags determined according to AIC. The symbols *, **, *** indicate that the null hypothesis is rejected at the 10%, 5%, and 1% levels, respectively.

Table 5
Johansen-Cointegration Tests

Turkey										Critical Value	
Trace test				TR	BR	RS	KR	SA	PL	95%	99%
Null	r = 0	Alternative	R ≥ 1	-	15.52	7.58	6.48	8.34	14.88	19.96	24.60
	r ≤ 1		R ≥ 2	-	2.08	1.93	0.65	1.17	2.50	9.24	12.97
Maximal Eigenvalue											
Null	r = 0	Alternative	r = 1	-	13.44	5.64	5.83	7.17	12.38	15.67	20.20
	r ≤ 1		r = 2	-	2.08	1.93	0.65	1.17	2.50	9.24	12.97
Brazil											
Trace test											
Null	r = 0	Alternative	r ≥ 1	-	-	6.41	6.72	11.25	25.76**	19.96	24.60
	r ≤ 1		r ≥ 2	-	-	2.02	1.79	1.81	1.80	9.24	12.97
Maximal Eigenvalue											
Null	r = 0	Alternative	r = 1	-	-	4.39	4.93	9.44	23.96***	15.67	20.20
	r ≤ 1		r = 2	-	-	2.02	1.79	1.81	1.80	9.24	12.97
Russia											
Trace test											
Null	r = 0	Alternative	r ≥ 1	-	-	-	11.92	5.89	8.38	19.96	24.60
	r ≤ 1		r ≥ 2	-	-	-	1.71	1.37	1.35	9.24	12.97
Maximal Eigenvalue											
Null	r = 0	Alternative	r = 1	-	-	-	10.21	4.52	7.03	15.67	20.20
	r ≤ 1		r = 2	-	-	-	1.71	1.37	1.35	9.24	12.97
Korea											
Trace test											
Null	r = 0	Alternative	r ≥ 1	-	-	-	-	10.67	7.79	19.96	24.60
	r ≤ 1		r ≥ 2	-	-	-	-	2.29	1.45	9.24	12.97
Maximal Eigenvalue											
Null	r = 0	Alternative	r = 1	-	-	-	-	8.37	6.34	15.67	20.20
	r ≤ 1		r = 2	-	-	-	-	2.29	1.45	9.24	12.97
South Africa											
Trace test											
Null	r = 0	Alternative	r ≥ 1	-	-	-	-	-	12.83	19.96	24.60
	r ≤ 1		r ≥ 2	-	-	-	-	-	1.26	9.24	12.97
Maximal Eigenvalue											
Null	r = 0	Alternative	r = 1	-	-	-	-	-	11.57	15.67	20.20
	r ≤ 1		r = 2	-	-	-	-	-	1.26	9.24	12.97

Notes: Order of VAR=1 and selected through Akaike's information criterion (AIC) and Schwarz Bayesian criterion (SBC). The symbols *, **, *** indicate that the null hypothesis is rejected at the 10%, 5%, and 1% levels, respectively.

Table 5 presents Johansen co-integration tests results together with 95% and 99% critical values of the trace and maximum eigenvalue statistics. The computed values of both statistics are below the corresponding critical values, suggesting that the null hypothesis of no cointegration cannot be rejected for all except Brazil and Poland, in parallel with the results obtained through the Engle-Granger co-integration test.

4.3. Granger Causality Tests Results

Table 6 reports the results of the Granger-causality test which is employed to assess the short-term causal relationships between each market in our study. The results suggest that there is no two-way causality between each market. However, there is a Granger causality running from the South Africa and Poland to Brazil; from Korea to Russia and from Poland to South Africa at 5% level and from Poland and Brazil to Turkey at 10% level.

Table 6
Granger Causality Test Results

Yi granger causes Xi	TR	BR	RS	KR	SA	PL
TR	-	**3.15***	0.20	0.14	0.02	0.73
BR	1.05	-	0.03	0.53	0.93	0.87
RS	1.05	1.58	-	0.50	0.05	0.62
KR	1.80	2.71	**6.97****	-	6.15	2.70
SA	1.91	**6.63****	1.04	0.99	-	**6.12****
PL	**3.61***	**9.74*****	1.24	0.16	0.17	-

The null hypothesis (Ho) refers the fact that "no causal relation". Lag length is 1 selected by AIC. The symbols *, **, *** indicate that the null hypothesis is rejected at the 10%, 5%, and 1% levels, respectively.

5. Conclusion

The findings of the study confirm our hypothesis on the grounds that the international investors and global portfolio managers can reap large profits by diversifying their portfolio into different EMs in the different regions. In addition, the study provides us with some hints regarding how to diversify portfolio in the most lucrative fashion. For instance, one can infer from the results of the analyses thereof the fact that there exists a long-run relationship primarily between Brazil and Poland; hence, it would not be meaningful for international investors and portfolio managers to invest simultaneously in those two markets which pose as strongly co-integrated. On the other side, the results unveiled a delicate long term co-integration relationship between Turkish and Brazilian, and between Russian and South African stock markets, a setting which may delimit the alternatives for investors to steer their money. However, when the Bounds test was employed, it was run into a meaningful long-term co-integration between Russia and Korea. Besides, while the study found out that some of the stock markets can moderately influence each other in the short run, ironically, it could not find any credible mark of co-integration, be long or short-term, between Turkey, a candidate member for the full membership in the European Union and Poland, a Union member, as well as Russia, a neighboring country. To the contrary, the study unearthed a linkage, albeit flimsy, between Brazil and Turkey, comparatively more distant markets.

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