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Stock market linkages in emerging markets: evidence from Turkey and Brazil

Abstract

The purpose of this study is to investigate the linkage between Turkey and Brazil's Stock Exchange Markets for the period between 2002 and 2009. In order to determine causal transmission patterns we employed (i) the Johansen and Juselius (1990) cointegration framework and vector error-correction modelling, and (ii) the Granger Causality Test from bivariate VECM estimations.

The study shows that there is a significant market interrelation between Turkey and Brazil. Time zone problem is not effected in this relationship which creates an opportunity for investors to use international hedging strategies and asset allocation.

Keywords: financial market linkage, cointegration method, ISE, BOVESPA.
JEL Classification: G10, G15, F30, C22.

Introduction

Financial markets are in rapid interaction in the globalizing economy. Interactions between international markets arise especially among countries with similar risk levels. Interaction is important for investors, particularly for asset allocation decisions in international markets (For further evidence, see Hietala, 1989; Masih and Masih, 2001; Bekaert and Harvey, 2003). A range of studies investigate international stock market linkage. Some authors find evidence of significant linkage between stock markets around the world (Chen et al., 2002; Olgun and Özdemir, 2007; Phylaktis and Ravazzolo, 2005); while some others find no evidence of significant linkage (Chan, Gup, and Pan, 1992-1997; Huang et al., 2000; Onay, 2007). There is no consensus in the literature on the existence of international stock market linkage. For this reason many studies which investigate the linkage between stock markets around the world use the following three categories: developed countries (Eun and Jang, 1997), emerging countries (Bekaert and Harvey, 1995; Masih and Masih, 1999; Metin and Muradoglu, 2001), both developed and emerging countries together (Wing et al., 2004; Voronkova, 2004; Syriopoulos, 2007).

Some studies explain stock market relationships between countries within one region such as a group of Pacific-Basin countries (Phylaktis and Ravazzolo, 2002) or Central European markets (Syriopoulos, 2007); whereas others investigate inter-regional relationships such as those between United States, Japan and South China (Huang et al., 2000); New York, London, and Tokyo (Eun and Jang, 1997); a group of Pacific-Basin countries with US and Japan (Phylaktis, K. and Ravazzolo, F., 2005); Hong Kong, South Korea, Singapore, Taiwan, Japan, and the United States (Chan, Gup, and Pan, 1992); US and Central European markets (Voronkova, 2004); Brazil and Turkey (Onay, 2007). A survey of literature shows that financial market linkages are more pronounced within regions than between regions.

Several studies investigate the linkage between Brazil and Turkey because both countries are classified as emerging markets, have been heavily indebted to the IMF, and also have similar economic histories (Metin and Muradoglu, 2001; Alper and Yilmaz, 2004; Ozdemir, Baig et al., 2006 Olgun, Onay, 2007; Saracoglu, 2009). For example, Onay (2007) investigates the long-term financial integration of BOVESPA and ISE using Engle-Granger Causality and Johansen Cointegration Test for the period of 1995-2005. The results of this study show that there is no linear long-term relationship between the Brazil and Turkey; whereas there exists a short-run relationship between the two countries. Furthermore, Metin and Muradoglu (2001) investigate the degree of market integration of emerging markets and stress that all national markets including Brazil and Turkey are cointegrated with world leaders for the period from 1988 to 1998.

This study investigates the existence and the direction of linkage between Turkey (ISE: Istanbul Stock Exchange) and Brazil (BOVESPA: São Paulo Stock Exchange) located in distant regions, although there is currently no significant real and financial linkages between Brazil and Turkey. Firstly, we employ the Johansen and Juselius (1990) cointegration framework and vector error-correction modeling in order to determine a *long-run* and *short-run* relationship dynamics respectively. Secondly, in order to determine the direction of causality between Turkey and Brazil, which are known to be co-integrated, we use Granger causality test results obtained from bivariate VECM models.

This study differs from previous ones in three dimensions: firstly, the focus on the inter-regional linkage which is important for the literature owing to the fact that financial market linkages are more pronounced within one region than between different regions. Secondly, the emphasizing emerging markets relationships which is important for the literature in view of the fact that many studies focus on the impact of global markets on emerging markets. Thirdly, time zone differences were taken into consideration by comparing the result of both daily and weekly data. There are practical problems for test procedure, when actual trading hours differ across countries (Dungey, Fry, Hermosillo, Martin, 2005, Martens and Poon, 2001; Milunovich and Thorp, 2007). This paper is organized as follows: Section 1 describes the research method. Section 2 presents data. Section 3 shows the empirical evidences. The last section provides the summary and conclusion.

1. Method

In this study, firstly we apply Johansen-Juselius Cointegration Method for testing long-term balance relationships (Johansen, 1988; 1994; 1995; Johansen and Juselius, 1990). The purpose of the cointegration test is to determine whether groups of non-stationary series are cointegrated or not. Johansen's methodology is usually used in a setting where all variables in the system are I(1).

Johansen's methodology takes its starting point in the vector autoregression (VAR) of order p given by

$$Y_t = \varpi + K_1 y_{t-1} + ... + K_p y_{p-1} + \xi t \quad (1)$$

where Y_t is an nx1 vector of variables that are integrated of order one which is generally denoted by I(1), and ξt is an nx1 vector of residuals. This VAR can be re-written as in Equation (2):

$$\Delta Y_t = \varpi + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \xi t \quad (2)$$

where $\Pi = \sum_{i=1}^{p} K_i - I$ and

$$\Gamma_i = -\sum_{j=i+1}^{p} K_j .$$

If the coefficient matrix Π has reduced rank $r<n$, then there exist nxr matrices Φ and β each with rank r such that $\Pi = \Phi \beta'$ and $\beta' y_t$ is stationary. r is the number of cointegrating relationships, the elements of Φ are known as the adjustment parameters in the vector error correction model and each column of β is a cointegrating vector.

It can be shown that for a given r, the maximum likelihood estimator of β defines the combination of y_{t-1} which yields the r largest canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace and maximum eigen value test.

The asymptotic critical values of the tests can be found in Johansen and Juselius (1990) and are also given by most econometric software packages. Because the critical values used for the maximum eigenvalue and trace test statistics are based on a pure unit-root assumption, they will no longer be correct when the variables in the system are near-unit-root processes (Hjalmarsson and Österholm, 2007).

In addition to cointegration, then we apply the Vector Error Correction Models (VECM) model for testing the short-run dynamic. A VECM model is a restricted VAR model. The VECM specification restricts the long-run behavior of the markets to converge to their long-run equilibrium relationships and allow for the short-run dynamics. The vital point of using VECM models is the condition of cointegration between the two variables with the cointegrating vector. If we consider the relationship between Y_i and X_i in a simple VECM model:

$$\Delta X_t = \Psi_1 (X_{t-1} - \lambda Y_{t-1}) + \zeta_{1t}, \quad \Psi_1 > 0 \quad (5)$$

$$\Delta Y_t = -\Psi_2 (X_{t-1} - \lambda Y_{t-1}) + \zeta_{2t}, \quad \Psi_2 > 0 \quad (6)$$

where ζ_{1t} and ζ_{2t} are white noise disturbances, Ψ_1 and Ψ_2 represent the speed of adjustment parameters. Ψ_1, Ψ_2 and λ are the positive parameters.

The cointegrating term $(X_{t-1} - \lambda Y_{t-1})$ is the error correction term (EC).

In addition to VECM, we apply Variance Decomposition Analysis (VD) for understanding of the dynamic behavior of the model and the relative importance of each random disturbance.

As the last step of this study, in order to determine the direction of causality between Turkey and Brazil we apply Granger causality test results obtained from bivariate VECM models.

The concept of Granger causality is stated as Equation (7):

$$\Delta Y_t = \alpha_o + \lambda \varepsilon_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \sum_{j=1}^{q} \phi_j \Delta X_{t-j} + \zeta_t, \quad (7)$$

where λ is coefficients for the error-correction terms. Critical is the choice of lags j; insufficient lags yield autocorrelated errors. This approach also allows for a determination of the causal direction of the relationships with rejecting H_0 hypothesis, and then we say that X_t "*Granger causes*" Y_t.

2. Data

In this paper, all data are from DataStream. We used the closing price of ISE NATIONAL 100 PRICE INDEX (DataStream code: *TRKISTB*) and BRAZIL BOVESPA PRICE INDEX (DataStream code: *BRBOVES*). To deal with the time zone problem[1], we used both daily (in Panel A) and weekly (in Panel B) data. We chose to start after 2002 which is after the Brazilian crisis in January, 1999; and after two financial crises in Turkey in November 2000 and February 2001. Moreover, before this period there was much other turmoil in financial markets which affected both countries deeply. For example: 19 December 1994 Mexican Financial Crisis (Dungey et al., 2005); 1998 Asia Flue[2] (Dungey et al., 2006); 3 Agust 1999 Russia crisis and 31 August 1999 LTCM crisis (Dungey et al., 2007). In dealing with the problems of missing observations, we used the approach of deleting missing observations (Dungey et al., 2005).

3. Empirical findings

When we look at Figure 1 it is possible to say that there is a relationship between ISE and BOVESPA in a long term.

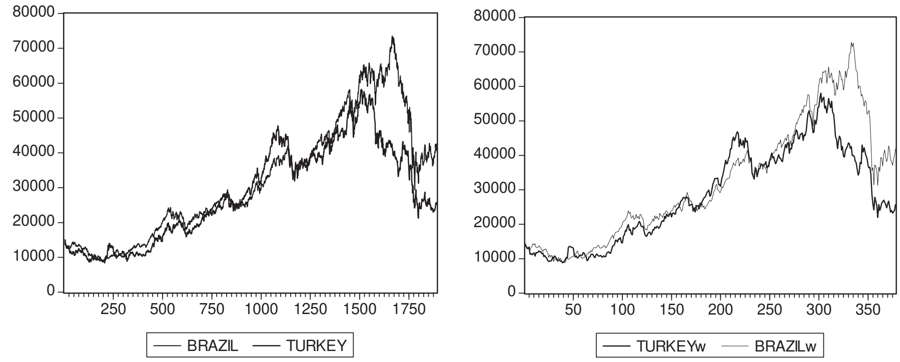

Fig. 1. The price graph of BOVESPA and ISE

The bold line represents ISE, the normal line represents BOVESPA.

The relationship between Turkey and Brazil using the regression method is reported in Table 1.

Table 1. Spurious regression results

Panel A: Daily
$ISE_t = 4589{,}18 + 0{,}7372_{t=93{,}2597} * BOVESPA_t + \varepsilon_t$
$R^2 = 0{,}8306$ Adj. $R^2 = 0{,}8305$ Durbin-Watson (D-W) = 0,0129

Panel B: Weekly
$ISE_t = 4643{,}25 + 0{,}7360_{t=42{,}998} * BOVESPA_t + \varepsilon_t$
$R^2 = 0{,}8310$ Adj. $R^2 = 0{,}8305$ Durbin-Watson (D-W) = 0,0392

Table 1 implies the possibility of spurious regression which was first addressed by Granger and Newbold (1974) (R^2>Durbin-Watson). Therefore, stationary characteristic is an important factor. If two non-stationary series are stationary at the same level, there might be a cointegration relationship between them, which supports the idea that the relationship between the values of original series is not spurious.

In order to understand the relationship between Turkey and Brazil, first the stationary characteristics of the series are examined in Table 2a and Table 2b using Augmented Dickey-Fuller and Phillips-Perron unit root tests, respectively.

[1] There are many ways in the literature to deal with the time zone problem, such as using synchronized data (Martens and Poon, 2001); and using two-day moving average (Dungey et al., 2005); using weekly data (Schotman and Zalewska, 2006); using monthly data (Mateus, 2004). This study adopted weekly data to deal with this time zone problem. Lowering the data frequency is convenient for time-matching a problem which sidesteps the expense of losing information as well (Schotman and Zalewska, 2006).
Trading Hours of ISE NATIONAL 100 PRICE INDEX: The ISE is open from Monday to Friday, and the Stock Market Official Trading Hours are as follows: First Session is 09.30 a.m.-12.30 p.m., second session is 14.00 p.m.-17.00 p.m., The time zone of Turkey is GMT+2 (Istanbul) (http://www.ise.org/markets/stock.htm)
Trading Hours of BRAZIL BOVESPA PRICE INDEX: The BOVESPA is open from Monday to Friday. 9.45 a.m.-10.00 a.m. – pre-opening fixing input of orders for the calculation of the theoretical opening price; 10.00 a.m.-5.00 p.m. – continuous trading session. The time zone of Brazil is GMT-3 (São Paulo). (http://www.bovespa.com.br/BovespaEV/horarioneg_i.htm).

[2] 3 June - 31 July 1997: Thai baht devaluation; 1 October-14 November 1997 Hong Kong speculative attack; 24 December 1997 Korean debt Moretorium; 1 January-27 February 1998 turmoil in Indonesia.

Table 2a. The results of Augmented Dickey-Fuller unit root tests

	Panel A: Daily					
	In price			In return		
	Test statistic x	Lag y	Model& z	Test statistic x	Lag y	Model& z
TURKEY	-0,1596	1	-	-13,3111**	10	-
BRAZIL	-1,2093	22	I	-10,0776**	17	I
	Panel B: Weekly					
TURKEY	-1,4334	16	I	-12,5879**	1	-
BOVESPA	-1,1288	7	I	-13,1540**	1	-

Notes: [x] MacKinnon critical values for the significance levels of 1%, and 5% are -3,43, and -2,96 with (intercept) model respectively. *, and ** represent rejection at the 5% and 1% levels of significance, respectively. [y] Akaike Information Criterion is used for lag order selection. [z] "I", and "-" represent ADF including the intercept, ADF including 'none" both trend and intercept, respectively. [&] Akaike Information Criterion is used for determining an appropriate deterministic structure of ADF model.

Table 2b. The results of Phillips-Perron unit root tests

	Panel A: Daily					
	In price			In return		
	Test statistic x	Band-width y	Model& z	Test statistic x	Band-width y	Model& z
TURKEY	-0,1517	15	-	-42,6378**	17	-
BRAZIL	-1,1094	18	I	-43,6966**	18	-
	Panel B: Weekly					
TURKEY	-0,1621	3	-	-19,4422**	5	-
BRAZIL	0,254	6	-	-21,5786**	6	-

Notes: [x] MacKinnon critical values for the significance levels of 1%, and 5% are -2,56, and -1,94 without (trend + intercept) model; -3,43, and -2,96 with (intercept) model; -3,96, and -3,41 with (trend + intercept) model, respectively. * represents rejection at the 5% level of significance, and ** represents rejection at the 1% level of significance. [y] Newey-West method is used for bandwidth selection. [z] "I", and "-" represent ADF including the intercept, ADF including 'none" both trend and intercept respectively. [&] Akaike Information Criterion is used for determining an appropriate deterministic structure of PP model.

For both Turkey and Brazil, the null hypotheses of unit root were not rejected at price level while rejected at return level for both Panel A and Panel B. This is because of the fact that stock market series in the system are I(1), just like most financial series. Secondly, the Johansen and Juselius (1990) cointegration method was employed to investigate the long-term relationship between Turkey and Brazil. Johansen's methodology seems appropriate for testing long-run relationship. For this framework, the lag length was chosen by applying the indifference VAR models which are presented in Table 3.

Table 3. Lag order selection of stock markets

	Panel A: Daily		Panel B: Weekly	
Lag	AIC	SC	AIC	SC
0	8.493	8.499	11.507	11.528*
1	8.466*	8.484*	11.505*	11.568
2	8.467	8.496	11.511	11.617
3	8.468	8.509	11.531	11.679
4	8.471	8.524	11.551	11.742
5	8.470	8.535	11.552	11.786

Notes: AIC: Akaike information criterion; SB: Shwarz information criterion; * represents lag order selection criterion.

Table 3 shows that the AIC selects 1 lag for both Panel A and Panel B, additionally, the SC selects 0 lags for Panel B. We adopted the AIC criterion and used one lag for both Panel A and Panel B. Then we applied Johansen-Juselius cointegration test using one predetermined lag. The results are presented in Table 4.

Table 4 shows the rejection of the null hypothesis which indicates that there is no cointegration between the two stock exchange markets for both Panel A and Panel B.

Table 4. The results of Cointegration tests

	Panel A: Daily					
Eigenvalue	Trace			Max eigenvalue		
	Trace statistic a	0,05 critical value	prob c	Max-eigen statistic b	0,05 critical value	prob c
0.376361	1612,797	25.8721	0.000**	891.4839	19.3870	0.000**
0,31754	721.3128	12.5179	0.000**	721.3128	12.5179	0.000**
	Panel B: Weekly					
0.363567	296,6687	15.4947	0.000**	169.4537**	14.2646	0.000**
0.287688	127.2150	3.8414	0.000**	127.2150**	3.8414	0.000**

Notes: [a]Trace test indicates one cointegrating equation at the 0.05 level. Zero hypothesis is r =1 and r ≤ 0 for Unrestricted Cointegration Rank Test (Trace), while alternative hypothesis is r≥1, and r=2. [r = number of cointegration vectors].
[b] Max-eigenvalue test indicates one cointegrating equation at the 0.05 level. Zero hypothesis is r =1 and r ≤ 0 for Unrestricted Cointegration Rank Test (Maximum Eigenvalue), while alternative hypothesis is r=1, and r=2. [r = number of cointegration vectors].
[c] MacKinnon-Haug-Michelis (1999) p-values. ** represents rejection at the 1% level of significance. Shwarz Information Criterion is used for determining an appropriate lag of model which is stated as one in Table 2. Trend assumption: Linear deterministic trend (restricted) for Panel A, Linear deterministic trend for Panel B.

Both Trace and Max-eigenvalue value tests indicate two cointegrating equations at the 0.05 level for both Panel A and Panel B, thus it is possible to say that a long-term relationship exists between Turkey and Brazil.

Additionally, as the markets are cointegrated, we then applied the VECM model which captured the short-run dynamics. The results are presented in Table 5.

Table 5 indicates that the error correction term (EC_{t-1}) is significant at the 5% level for both Turkey and Brazil in Panel A and Panel B, which means that deviation from long-run equilibrium is corrected gradually through short-run adjustments[1].

The Variance Decomposition method (VD) was applied for the same period to better understand the dynamic behavior of these markets. The VD shows the proportion of the movements in the endogenous variable sequence as a result of its own shocks against shocks to other variables. The result of the VD is presented in Table 6.

Table 5. The results of Vector Error Correction Model

	Panel A: Daily		Panel B: Weekly	
	$\Delta LISE_{t-i\ -i}$	$\Delta LBOVESPA_t$	$\Delta LBOVESPA_{t-i}$	$\Delta LISE_{t-i}$
EC_{t-1}	-0.3580	0.5141	-0.3689	0.5424
	[-13.2954]	[21.4687]**	[-5.1258]**	[8.5779]**
$\Delta LISE_{t-1}$	-0.3678	-0.3125	-0.3699	-0.3109
	[-16.1383]	[-15.4198]**	[-6.4064]**	[-6.1308]
$\Delta LBOVESPA_{t-1}$	-0.1383	-0.1936	-0.2505	-0.1936
	[-4.6235]**	[-1.8548]	[-3.6089]**	[-3.1758]
Constant	0.0006	-0.0019	0.0416	0.0256
	[-0.0114]**	[-0.0388]	[0.1476]	[0.1036]

Notes: L represents log operator; EC: Error correction term of estimated cointegrating equation. ** represents rejection at the 5% level of significance. Panel A: R^2:0,3231; Adj R^2: 0,3221; log likelihood: -8345,824. Panel B: R^2:0,3427; Adj R^2: 0,4006; log likelihood: -2217,670.

Table 6a. Panel A: Daily. The results of Variance Decomposition for same selected period

Vf	LISE			LBOVESPA		
Period	Std. error	LISE	LBOVESPA	Std. error	LISE	LBOVESPA
1	2.484	100.000	0.000	2.209	20.938	79.062
2	2.827	92.089	7.911	2.333	27.091	72.909
5	4.011	88.658	11.342	3.013	51.099	48.901
10	5.382	86.764	13.236	3.830	63.798	36.202
20	7.402	85.675	14.325	5.089	72.751	27.249
30	8.979	85.283	14.717	6.093	76.289	23.711
40	10.317	85.082	14.918	6.953	78.185	21.815
50	11.501	84.959	15.041	7.718	79.366	20.634
60	12.573	84.876	15.124	8.414	80.172	19.828
70	13.562	84.817	15.183	9.056	80.758	19.242
80	14.482	84.772	15.228	9.656	81.203	18.797
90	15.348	84.737	15.263	10.221	81.552	18.448
100	16.168	84.709	15.291	10.756	81.833	18.167

Notes: L represents log operator. For instance, LISE means that the log price of ISE
Vf: Variance decomposition of LISE and LBOVESPA.

[1] Table 5 shows information on the convergence speeds between Turkey and Brazil using VECM, we estimate the speeds at which the individual variables revert to their long-run values as well as the mean time of the response. In Table 5 Panel A, the coefficient of the error-correction term ranges (in absolute term) from a low of 0.358, and 0.514 for Turkey and Brazil, respectively. Moreover, for Panel B, the coefficient of the error-correction term ranges (in absolute term) from a low of 0.368, and 0.542 for Turkey and Brazil, respectively.

Table 6b. Panel B: Weekly. The results of Variance Decomposition for same selected period

Vf	LISE			LBOVESPA		
Period	Std. error	LISE	LBOVESPA	Std. error	LISE	LBOVESPA
1	5.461	100.000	0.000	4.798	30.114	69.886
2	5.956	96.805	3.195	4.998	35.473	64.527
5	8.450	92.243	7.757	6.661	58.272	41.728
10	11.213	90.235	9.765	8.488	69.532	30.468
20	15.339	89.009	10.991	11.317	77.438	22.562
30	18.569	88.563	11.437	13.567	80.531	19.469
40	21.315	88.331	11.669	15.495	82.180	17.820
50	23.746	88.190	11.810	17.207	83.206	16.794
60	25.950	88.094	11.906	18.764	83.905	16.095
70	27.980	88.026	11.974	20.202	84.413	15.587
80	29.874	87.974	12.026	21.543	84.798	15.202
90	31.654	87.933	12.067	22.806	85.100	14.900
100	33.339	87.901	12.099	24.003	85.343	14.657

Notes: L represents log operator. For instance, LISE means that the log price of ISE
Vf: Variance decomposition of LISE and LBOVESPA.

Table 6 shows that, in the long-run period (for 100 days), the variance decomposition of BOVESPA is explained, approximately 18.16 percent, by its own past shocks, while approximately 81.83 percent is explained by the ISE's past shocks for Panel A.

For Panel B it is explained, approximately 14.65 percent, by its own past shocks, while approximately 85.34 percent is explained by the ISE's past shocks. But it is different for the ISE. The variance decomposition of ISE is explained, approximately 84.70 percent, by its own past shock, while it is explained, approximately 15.29 percent, by the BOVESPA's past shock in a long-run term for Panel A.

For Panel B it is explained, approximately 87.90 percent, by its own past shock, while it is explained approximately 12.09 percent by the BOVESPA's past shock in a long-run term.

As the last step in determining the direction of causality between Turkey and Brazil, which are known to be co-integrated, we use the Granger causality test results obtained from the bivariate VECM models reported in Table 7.

Table 7. Granger causality test from bivariate VECM estimations

	Panel A: Daily		Panel B: Weekly	
	Wald (x^2)	p-values	Wald (x^2)	p-values
Turkey does not cause Brazil	237.7696	0.000**	37.5868	0.000**
Brazil does not cause Turkey	21.3772	0.000**	13.0246	0.000**

Note: ** represents rejection at the 5% level of significance.

Table 7 shows that Turkey Granger causes Brazil for both Panel A and Panel B. Moreover, Brazil Granger causes Turkey for both Panel A and Panel B as well.

The results from the two variable VECM models are in accordance with bivariate models and pairwise Granger causality test results.

Conclusion

In this study we have investigated the linkages and dynamic interaction of the Turkish and Brazilian stock markets. We have conducted this study by applying (i) the Johansen and Juselius (1990) cointegration framework and vector error-correction modelling, and (ii) the Granger Causality Test from bivariate VECM estimations. Our major findings are below:

Firstly, the *Johansen-Juselius Cointegration Test* indicates that there is one cointegrating vector at the 5% level for both Panel A and Panel B, which signifies a long-term relationship between ISE and BOVESPA. Secondly, the *VECM* shows that the deviations of Turkey and Brazil are corrected gradually through short-run adjustments. Thirdly, the *VD* analysis suggests that the variance decomposition of Brazil is explained both by its own past shock and by Turkey's past shock, while the variance decomposition of Turkey is mostly explained just by its own past shock. Finally, there is two-way Granger causality between Turkey and Brazil for both Panel A and Panel B.

In summary, this study emphasizes a close linkage between Turkey and Brazil which is important for the literature because financial markets linkages are more pronounced within one region rather than between different regions. This study supports the linkage between emerging markets which is important because many studies focus on the impact of global markets on emerging markets. Moreover, the time zone differences are taken into consideration by comparing the results of both daily and weekly data which is important for the literature because there is approximately 7 hours difference between markets and this may impose a practical problem on test procedures, but we show that time zone problem is not effected in this relationship[1].

Our analysis of stock market linkages in these emerging markets has indicated that international investors have opportunities for portfolio diversification by investing in both Turkey and Brazil which shows an opportunity for the investors for global hedging strategies. This study recommends further investigation of the volatility spillovers between these two stock markets.

References

1. Alper, C. Emre and Kamil Yılmaz. 2004. “Volatility and Contagion: evidence from the Istanbul stock exchange”, *Economic Systems* 28, no. 4 (December): 353-367.
2. Bekaert, G. and C.R. Harvey. 2003. “Emerging Markets Finance”, *Journal of Empirical Finance* 10, nos. 1-2 (February): 3-55.
3. Chelley-Steeley, Patricia, 2004. Equity Market Integration in the Asia-Pacific Region: A Smooth Transition Analysis, *International Review of Financial Analysis*, Vol. 13, pp. 621-632.
4. Dickey, D.A. & Fuller W.A., 1981. Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica*, 49 (4) July, pp. 1057-1072.
5. Dungey Mardi, Renee F., Gonzalez-Hermosillo, and Martin V.L., 2005. “Empirical Modeling of Contagion: A Review of Methodologies”, *Quantitative Finance*, 5, 1, 9-24.
6. Dungey M., Renee Fry and Vance L. Martin, 2006. Correlation, Contagion and Asian Evidence, Asian Economic Journal, 5 (2), 32-72.
7. Dungey Mardi, Martin V.L. 2007. “Unravelling Financial Market Linkages During Crises”, Journal of Applied Econometrics, 22, 1, 89-119.
8. Enders, Walter, 2003. *Applied Econometric Time Series*, Willey, USA.
9. Eun and Jang, 1997. “Price Interaction in a Sequential Global Market: Evidence from the Cross-Listed Stocks”, *European Financial Management*, Vol. 3, No. 2, pp. 209-235.
10. G. Bekaert and C.R. Harvey, 1995. “Time-Varying world market integration”, *Journal of Finance* 50, pp. 403-444.
11. G. Chen, M. Firth and O. Rui, 2002. “Stock market linkages: Evidence from Latin America”, *Journal of Banking and Finance,* 26, pp. 1113-1141.
12. Granger, C.W.J. (1980), “Testing for Causality: A Personal Viewpoint”, *Journal of Economic Dynamics and Control*, 2, 1, 329-352.
13. Granger, C.W.J. and Newbold, P. 1974. “Spurious regressions in econometrics”. *Journal of Econometrics,* 2: 111-120.
14. Griffiths William E., R. Carter Hill and George G., 1993. *Learning and Practising Econometrics*, Canada: John Wiley & Sons, Inc.
15. Hietala, P.T., 1989. “Asset pricing in partially segmented markets: evidence from the Finnish markets”, *Journal of Finance* 44, 697-718.
16. Hjalmarsson E. and Österholm P., 2007. “Testing for Cointegration Using the Johansen Methodology When Variables are Near-Integrated”, *IMF Working Paper No. 07/141, FRB International Finance Discussion Paper No. 915.*
17. Huang B.N., C.W. Yang and J.W.S. Hu, 2000. “Causality and cointegration of stock markets among the United States, Japan and the South China Growth Triangle”, *International Review of Financial Analysis,* 9, pp. 281-297.
18. Johansen, S. and K. Juselius, 1990. “Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money”, *Oxford Bulletin of Economics and Statistics*, 52, pp. 169-210.
19. Johansen, S., 1994. “The Role of The Constant And Linear Terms in Cointegration Analysis of Nonstationary Variables”, *Econometric Reviews* 13, pp. 205-229.
20. Johansen, S., 1995. Likelihood-based Inference in Cointegrated Vector Autoregressive Models, Oxford: Oxford University Pres.
21. Johansen, S., 2005. “Statistical Analysis Of Cointegration Vectors”, *Journal of Economic Dynamics and Control* 12, pp. 231-254.
22. Kam C. Chan , Benton Gup and Ming-Shiun Pan, 1992. “An Empirical Analysis of Stock Prices in Major Asian Markets and the United States”, *The Financial Review*, Volume 27, Issue 2, pp. 289-307.
23. Kam C. Chan, Benton Gup and Ming-Shiun Pan, 1997. “International stock market efficiency and integration: a study of eighteen nations”, *Journal of Business Finance and Accounting*, Volume 24, No. 6, pp. 803-813.
24. Martens, M. and Poon, S-H. 2001., "Returns Synchronization and Daily Correlation Dynamics Between International Stock Markets", *Journal of Banking and Finance*, 25, 1805-1827.
25. Masih A.M.M. and R. Masih, 1999. “Are Asian stock market fluctuations due mainly to intra-regional contagion effects? Evidence based on Asian emerging stock markets”, *Pacific-Basin Finance Journal,* 7, pp. 251-282.
26. Masih R., and Masih A.M.M. 2001. “Long and Short term dynamic casual transmission amongst international stock markets”, *Journal of International Money and Finance*, 20, 563-587.

[1] There is two-way Granger causality between Turkey and Brazil for both daily (Panel A) and weekly (Panel B) data sets.

27. Mateus, T. 2004. "The Risk and Predictability of Equity Returns of The EU Accession Countries", *Emerging Markets Review*, 5: 241-266.
28. Metin, K. and Muradoglu, G., 2001. "Forecasting Integrated Stock Markets Using International Co-Movements", *Russian and East European Finance and Trade*, 37, No: 5, pp. 45-63.
29. Ng Angela, 2000. "Volatility Spillover Effects from Japan and the US to the Pacific-Basin", *Journal of International Money and Finance*, Vol. 19, pp. 207-233.
30. Olgun and Özdemir, 2007. "Linkages between the center and periphery stock prices: Evidence from the vector ARFIMA model", *Economic Modelling*, In Press, Corrected Proof, Available online 27 September 2007.
31. Onay, C., 2007. "Cointegration Analysis of BOVESPA and Istanbul Stock Exchanges", *Proceedings of Oxford Business and Economics Conference*, 24-26 June 2007, Oxford University, UK.
32. Ozdemir, Z.A., Olgun, H. and Saracoglu, B., 2009. "Dynamic linkages between the center and periphery in international stock markets", *Research in International Business and Finance,* 23, 46-53
33. Phillips P. and P. Perron, 1988. "Testing for unit root in time series regression", *Biometrica*, 75, 335-346.
34. Phylaktis K., and Ravazzolo F., 2002. "Measuring financial and economic integration with equity prices in emerging markets", *Journal of International Money and Finance,* 21, pp. 879-904.
35. Phylaktis, K. and Ravazzolo, F., 2005. Stock Market Linkages in Emerging Markets: Implications for International Portfolio Diversification", *International Financial Markets, Institutions and Money*, 15, pp. 91-106.
36. Schotman, P.C., & Zalewska, A. 2006. "Non-synchronous trading and testing for market integration in central european emerging markets", *Journal of Empirical Finance*, 13 (4-5): 462-494.
37. Syriopoulos, Theodore, 2007. "Dynamic Linkages Between Emerging European and Developed Stock Markets: Has The EMU Any Impact?", *International Review of Financial Analysis*, Volume 16, Issue 1, pp. 41-60.
38. Voronkova S., 2004. "Equity market integration in Central European emerging markets: A cointegration analysis with shifting regimes", *International Review of Financial Analysis*, 13, pp. 633-647.
39. Wing-Keung Wong, Jack Penm, Richard Deane Terrell, Karen Yann Ching, 2004. "The Relationship Between Stock Markets Of Major Developed Countries And Asian Emerging Markets", *Journal of Applied Mathematics & Decision Sciences*, 8, 4, 201.