Re-testing for financial integration of the Turkish Stock Market and the US Stock Market: An Evidence from co-integration and error correction models

Turgut TURSOY
Near East University, Department of Banking and Finance, Nicosia, North Cyprus

Faisal FAISAL
Near East University, Department of Banking and Finance, Nicosia, North Cyprus

ABSTRACT

This paper investigates financial market integration among U.S. stock market and Turkish stock market using monthly data for the period of 1989 to 2015. The purpose of this article is to examine whether share prices of two countries showing a common trend. Using cointegration analysis, the study provides empirical evidence of common trends among for US and Turkey stock markets. The empirical results of the study highlighted that Turkish and US stock markets are strongly cointegrated and moving together in the long run. Furthermore, the results of Granger causality test confirm the absence of weak causality. However, a uni-directional (strong Granger causality) was found from US stock market to Turkish stock market. The confirmation of significant error correction term also implies the evidence of a long-run relationship. The findings of the study suggested that Turkish stock market which is the local market is strongly integrated with the US stock market. The reliability and stability of the estimations are confirmed by diagnostic checks and CUSUM test.

Keyword: *Financial integration, Cointegration, Granger Causality, Stock price.*
JEL Classification: *C32, C58, F36, G1*

1. INTRODUCTION

The stock market is an important sector for the economy. It is a key indicator for the economy for showing the investment activity in the country. Furthermore, it is the most watched indicator by the market participants for giving a decision for their investment activities and economist to having an idea about the economy. Additionally, after globalisation, local stock markets are integrated to the global market, and this integration increased the association of the local markets with each other. As a result, it upsurges the investment and international risk diversification opportunities that are the benefits of globalisation, in the meantime, a discussion for the interconnectedness may increase the volatility of the local stock markets (Köse et al. (2003) investigate the volatility in the concept of financial integration). Of course, it creates the motivation to investigate the interconnection between the Turkey and US stock market for this study to derive a result for understanding the causality between Turkey and US stock markets. The aim of the study is to analyse the causality between Turkish Stock Market and US Stock Market. Therefore, the paper attempts to investigate three points. Firstly, it will focus on whether US stock market and Turkish stock market are cointegrated or not. Secondly and most importantly, the paper will analyse the period which covers the US subprime crises period. To the extent of authors' knowledge no study in the existing literature analyses the time span which is covering the turmoil period. That creates the motivation for the study to reinvestigate the causation between two markets. The Johansen and Juselius (1990), Cointegration method will be applied that has the power of estimating all possible cointegrating vectors and performs well in a large sample. The Granger causality is applied to investigate the direction of causality using the error correction model (ECM). The rest of the article is organised as follows. Section 2 highlights brief literature review. Section 3 elucidates the data and econometric methodology. Section 4 outlines the empirical results and discussion. Finally, section 5 concludes.

2. BRIEF LITERATURE REVIEW

The interconnectedness of the stock market has been the subject of empirical studies (for example, Kasa, 1992; Corhay et al., 1993; Pascual, 2003; Mylonidis and Kollias, 2010). Corhay et al. (1993) state that this interest for this subject increased by the flow of capital across national boundaries, possible gains from international diversification and the existence of lead-lag interrelationship among stock exchanges. Also, there are studies which are related to financial market integration has examined the existence of cointegration relationship between the national stock markets to investigate the long-run behaviours in those markets. The basic hypothesis in the past studies which is provided by Rangvid (2001) is that an already converge/integrated system of stock prices should be driven by one (or at least a reduced number of) underlying common stochastic trend(s). Particularly in the past studies, several share prices are used to investigate the relationship between the trends and the number of cointegration vectors in the multivariate system. For example, Corhay et al. (1993) found evidence of cointegration between the stock price series of several European countries. Moreover, this result reveals the existence of some common long-run stochastic trends. Pascual (2003) provide evidence of increasing financial integration be found in European stock markets. Rangvid (2001) present paper was devoted to a recursive analysis of the degree of convergence between European stock prices. This paper tests revealed that it could not be rejected that the European stock markets were being increasingly integrated throughout the 1980s and 1990s.

There are also studies in the literature that investigate the relationship between Turkey stock market and the other countries stock market. For example, Guloglu and Bayri (2005) paper analysed the integration between Turkey and the European Union and the US, before and after the 2001 crises period. This article result shows that there is a strong long-term relationship between Turkey and European Union and US stock markets. Bozoklu and Saydam (2010) investigate the integration between Brazilian, China, India, Russia and Turkey capital markets. This paper showed a result that the capital markets of these countries are integrated. Erbaykal et al. (2008) demonstrated the relationship between Istanbul (Turkey), Merval (Argentina) and Bovespa (Brazil) stock exchange markets. This paper analysis detected a long-run relationship between the stock markets. Ibicioglu and Kapusuzoglu (2011) examined the relationship between Turkey's stock market and the stock market of the EU Mediterranean countries. This study result showed that there is the integration of the national stock markets. Ergun and Nor (2010) paper investigated the dynamic relationship and volatility spillover between the stock market and the US under the conditions for Turkey's accession to the European Union for the period 1988-2008. They found that there was a strong dynamic relationship between Turkey and US, and significant volatility spillovers exist from NASDAQ to the Istanbul Stock Exchange for the sample period.

3. METHODOLOGY

3.1. Data

For the case of Turkey, the liberalisation started in 1980 and end in 1989. After liberalisation Turkey became an open economy. Therefore, the period of the study starts with the early of 1989 and end with the data of 2015. This period also covering the 2008 crises in the US. That is, this paper investigates the financial market integration between Turkey and US during the period 1989-2015 on a monthly basis. The data are obtained from the

Federal Reserve Bank of St. Louise (FRED). The data set is on a monthly basis, and it covers the May of 1989 until the March of 2015. The variables SPTR and SPUS are total share prices for all shares for Turkey and US (OECD description ID: SPASTT01, OECD "Main Economic Indicators-Complete database).

3.2. Unit Root Tests

For using the Error Correction Model (ECM), it requires the estimated variables must be integrated of the same order. In order to analyse the order of integration, the Augmented Dickey-Fuller (Dickey and Fuller, 1979) and KPSS from Kwiatkowski et al., (1992) tests are used.

3.3. Johansen Cointegration Test

Johansen and Juselius cointegration procedure employ two tests to determine the number of cointegration vectors by using equation 1.

$$X_t = \Pi_1 X_{t-1} + \ldots + \Pi_K X_{t-K} + \mu + e_t \quad (1)$$

Where X_t the represents the vector of endogenous variables in the model that is I (1). i.e., while μ is a (n x 1) vector of constant terms, and Π_1 are the (n x n) coefficient matrices and k denotes the lag length of the model, e_t is a (n x 1) vector of the error terms with zero mean and μ represents the vector of the constant terms. The reparameterization of equation 1 can be written as below.

$$\Delta X_t = \mu + \sum_{i=1}^{k} \Gamma_i \Delta X_{t-i} + \Gamma X_{t-k} + e_t \quad (2)$$

Where Γ_i = -I+Π_1+……..+Πi since i=1,2….,p-1) and Γ=-1 +Π_1 +…..+Πp . Since Γ represents the rank of matrix that determines the long-run relationship among the estimated variables in the model. ΓX_{t-k} represents the error correction factor. Both the variables in eq. 1 and eq. 2 are considered endogenous and, the cointegrating relationship can be estimated via Max-Eigen values and Trace statistics. Both the trace statistics and the Max-Eigen value tests the null hypothesis of r cointegrating relations against the alternatives of r+1 cointegrating relations for r=0, 1, 2, …n-1. The conclusion about the cointegration among the endogenous variables can be made only, if both the tests give the same results.

The lag length can be identified via unrestricted VAR in can be determined by using many lag criteria's, but SBC, the adjusted likelihood ratio tests (LR), and AIC are normally used for the optimal lag selection. The LM test for serial correlation is performed at levels under the unrestricted VAR to check for serial correlation at the particular selected via SBC, AIC and LR test.

3.4. Granger Causality test

The Granger's theorem suggested that if the cointegration relationship exists among the variables, then there must be causality in at least one direction. The Granger causality test is conducted by using the first difference variables under the VAR will be misrepresentative in the existence of a co-integrated relationship among the variables (Engle and Granger, 1987). Therefore, to avoid misleading problem an extra variable the Error Correction term will be added into the VAR system that helps to capture the long term relationship. To apply the error correction term to the VAR system and augmented form of the Granger Causality test by formulating a bivariate *p*th order of vector correction model.

$$\Delta LSPTR = \delta_0 + \sum_{i=1}^{p} \lambda_{1i}\, \Delta LSPTR_{t-1} + \sum_{i=1}^{q} \lambda_{1i}\, \Delta LSPUSA_{t-1} + \varphi_1 ECT_{t-1} + e_{1t} \quad (3)$$

$$\Delta LSPUSA = \delta_0 + \sum_{i=1}^{q} \lambda_{2i}\, \Delta LSPUSA_{t-1} + \sum_{i=1}^{p} \lambda_{2i}\, \Delta LSPTR_{t-1} + \varphi_2 ECT_{t-1} + e_{2t} \quad (4)$$

Where ECT_{t-1} denotes the error correction term added to both the equations. e_{1t} and e_{2t} represents the error term that must be white noise. Where *LSPTR* represents the stock prices for Turkey and *SPUSA* represents the stock prices for USA. Both the variables are taken in log form to decrease the effects of potential heteroscedasticity and minimize the variation in the time series data (Tursoy and Faisal, 2016). The long-run and short-run Granger causality can be differentiated with the help of error correction model. The short-run effects of the whole system can be captured by the individual coefficients of the lagged term. The statistical significance of the ECT_{t-1} shows the speed of adjustment of the system back to the equilibrium after a short run shock given and identifies the long run causality. That verifies the stability of the whole dynamics in the system. The coefficient of ECT_{t-1} should be between 0 and 1 with a negative sign and statistically significant at least at 1%. Both the short and long run causation can be checked together to confirm if they are jointly significant. The error correction vector in equation 2 and 3 is tested without changing the lag length as already estimated in the unrestricted VAR framework (see Narayan and Smyth, 2006).

3.5. Model Stability And Diagnostic Tests

The evidence of cointegration using Equation 2 doesn't necessarily imply about the stability of estimated coefficients (Bahmani-oskooee and

Chomsisengphet, 2002). To resolve the stability issue associated with the estimated coefficients, several diagnostic tests and model stability tests for the ECM model is conducted to verify the assumptions of the classical linear regression model. In this regard, the normality test is used to analyse the normality of residuals, along with the heteroscedasticity test. Furthermore, the residual serial correlation test will be undertaken to ensure that the residuals must be white noise. Moreover, the stability of the model will be carried out by using CUSUM test as suggested by Brown *et al.* (1975).

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Unit Root Test for Stationarity

The unit root tests were conducted for the estimated variables both at the level and first difference by using the Schwarz information criterion to select the optimum as recommended by (Pesaran and Shin, 1997). Table 1 shows the summary of ADF unit root test in which the variable stock price for Turkey and US are non-stationary at level. However, they all become stationary by taking the first difference. Kwiatkowski-Philips-Schmidt-Shin test confirmed the same results. A summary of ADF and KPSS test is given in Table 1 and 2. So, therefore, it can be concluded that all the variables in the estimated model are non-stationary at the level, but they become stationary by taking the first difference. None of the variables is *I* (2).

Augmented Dickey-Fuller Unit Root test results for Stationarity of variables

Table 1

Country (Sample Period)	ADF		ADF	
Level of integration (1989M05-2015M03)	Level		First Difference	
Models	Intercept	Intercept and Trend	Intercept	Intercept and Trend
LSPTR	-2.9869** (15)	-3.0997 (15)	-7.1939*** (12)	-7.2442*** (13)
LSPUSA	-2.4469 (06)	-2.7427 (06)	-12.8477***(5)	-12.8301***(5)

Note: (i) The Augmented Dickey-Fuller test was used to identify the integration order. The test is conducted first with intercept and then with intercept and trend. The figures in the parenthesis represent the lags. **, *** represents significant at 1%, 5%, and 10%. *Source: Authors' own estimation*

Kwiatkowski-Philips-Schmidt-Shin Unit Root test results for Stationarity of variables

Table 2

Country (Sample Period)	KPSS		KPSS	
Level of integration (1989M05-2015M03)	Level		First Difference	
Models	Intercept	Intercept and Trend	Intercept	Intercept and Trend
LSPTR	0.4864** (01)	0.3205*** (01)	0.0079 (01)	0.0056 (01)
LSPUSA	1.3159*** (05)	0.47793***(06)	0.02112 (07)	0.0210 (09)

Note: The KPSS results are shown in table2. The Spectral estimation method selected is Bartlett Kernel, and Newey-West method is used for Bandwidth. Whereas **, *** represents significant at 5%, and 10% of the null hypothesis of stationary against the alternative hypothesis test of non-stationary in KPSS test. Critical values for the KPSS test are from Kwiatkowski et al., (1992).
Source: Authors' own estimation

Given that the series is integrated of the same order, we can utilise Johansen cointegration tests to determine whether the two series are cointegrated over a sample period. The lag selection is done by using the Lag criteria. The AIC, FPE, and LR test is used to select the optimal lag under the unrestricted VAR framework. The diagnostic tests have been carried out at lag 7 and found the absence of serial correlation, heteroscedasticity and all the root lies inside the circle that confirms the stability of the unrestricted VAR model. The results of Johansen cointegration has been shown in Table 3. The results should show that both the trace statistics and Max-Eigen value rejected the null hypothesis of no cointegration at 5%. This implies that both the series are cointegrated and moving in the long run together.

Johansen and Juselius's maximum likelihood cointegration results. (Case#3: Intercept and no trend)

Table 3

Hypothesized No. of cointegrating vectors	H_0	[a] Trace statistics	Critical Values		Max Eigen	Critical Values	
			5%	1%		5%	1%
None	R=0	25.2136*	15.41	20.04	18.8625*	14.07	18.63
At most one	R≤1	6.3511**	3.84	6.65	6.3511**	3.76	6.65

Note: * and ** show the significance at 1% and 5% level respectively. The lag length was selected by using the Lag criteria. The Autocorrelation LM tests were performed and confirmed the absence of serial correlation problem. Case 3 was chosen based on the stationarity behaviour of the data that allows for the linear deterministic trend in the data by choosing intercept with no trend in CE under the unrestricted VAR.
Source: Authors' own estimation

Following the detection of cointegration between the two series, an error correction model was set up to determine the direction of causality. The results of Granger causality have been shown in Table 3.

Several tests were applied to determine the direction by using Granger causality. (1) short-run or Weak Granger causality–that can be estimated by the sum of the lagged coefficient by using joint F test (Wald test); (2) long-run Granger causality–can be determined by the significance of coefficient of the error-correction term with a negative sign by using t-test. The coefficient of the error correction term should be in between 0 and 1. (3) Joint Granger causality (Strong Granger Causality) that goes from short-run to re-build the long-run equilibrium–the joint significance of the sum of lagged coefficients and the error correction term using joint F test (Wald test). The results of the Granger causality test has been shown in Table 4.

Results of Granger Causality Tests

Table 4

Dependent Variable	*F*-Statistics (Probability)		long-run	Joint (Short- and long-run)	
	ΔLSPTR	ΔLSPUSA	EC_{t-1} (*t*-statistics)	ΔLSPTR.EC_{t-1}	ΔLSPUSA.EC_{t-1}
ΔLSPTR		1.1354 (0.1994)	-0.33 [-3.9553]***		3.1771(0.0018)***
ΔLSPUSA	0.3784(0.9146)		-0.02 [-1.7129]*	0.5039(0.8530)	

Note: *,*** represents the significance level at 1% and 10% respectively.
F-Statistics probabilities and t-ratios are given in parenthesis and square brackets respectively. The optimal lag chosen is lag 3 based on the lag criteria estimated under the VAR model by LR test. The residuals are found to be white noise estimated via autocorrelation LM test. For serial correlation, the Godfrey LM tests have been applied and the estimation confirmed the absence of serial correlation in the ECM.
Source: Authors' own estimation

The Granger causality test results showed there exists a bidirectional causality between both the Stock for USA and Turkey. If the error correction is negative and statistically significant that suggests the speed of adjustment by which the system converges backs to an equilibrium position after a short-run shock. The coefficient of the error correction terms showed that Turkish stock market corrects its previous disequilibrium with 33 percent in a one month and the US in 2 percent. This implies the stability of the system in the long run. While there is an absence of short-run or Weak Granger causality, there is a Joint Causality (strong Granger causality) from Stock prices for the USA to Turkey. This result suggests that US stock market is causing a change in the Turkish stock market but not vice versa. That implies the Turkish Stock market which is the local market is strongly integrated with the Global market.

4.2. Diagnostics tests with CUSUM and CUSUMQ test results

The diagnostic checks for Equation 3 and Equation 4 error correction model has been reported in table 5. Our estimations pass all the diagnostic tests. The estimation has got no serial correlation problem. White test, Breusch-Pagan-Godfrey and Arch test confirmed the residuals are homoscedastic. The correlogram of residual (Q-statistics) showing no problem of autocorrelation at any lag. DW value in both equations indicates no problem of autocorrelation. The diagnostic test further strengthens the reliability of our findings and estimations.

Diagnostic test

Table 5

Equation 3 Diagnostic tests	**Corr. P-Values**	**Equation 4 Diagnostic tests**	**Corr. P-Values**
χ^2_{SC} Breusch-Godfrey Serial Correlation LM test	1.3965(0.4975)	χ^2_{SC} Breusch-Godfrey Serial Correlation LM test	0.8460(0.6651)
χ^2_{W} White test for heteroscedasticity	24.41996(0.0583)	χ^2_{W} White test for heteroscedasticity	12.7926(0.6183)
χ^2_{AR} Arch test for heteroscedasticity	0.2550(0.6135)	χ^2_{AR} Arch test for heteroscedasticity	0.4850(0.4861)
R^2	0.4024	R^2	0.4037
Adjusted R^2	0.3712	Adjusted R^2	0.3773
F-Statistics (Prob Value)	12.8855***	F-Statistics (Prob Value)	13.2023
DW Statistics	1.99	DW Statistics	1.97

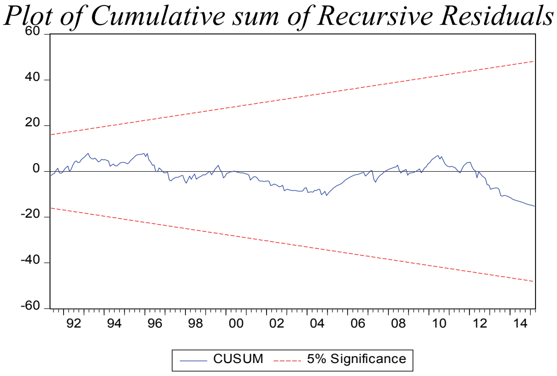
Source: Authors' own estimation

The *CUSUM* and *CUSUMQ* have been used to analyse the stability of our estimated models. Both the graphs of the *CUSUM* and *CUSUMQ* have been given in figure 1 and figure 2. As both the plots of *CUSUM* and *CUSUMQ* statistics fall inside the critical bounds, that indicates that the estimated coefficients of the error correction model are stable over a period from 1989M05 to 2015M03.

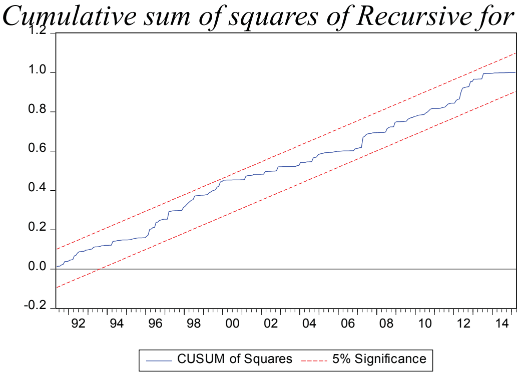
CUSUM and CUSUMSQ Plots for Equation 3

Figure 1

Plot of Cumulative sum of Recursive Residuals



Plot of Cumulative sum of squares of Recursive for residuals

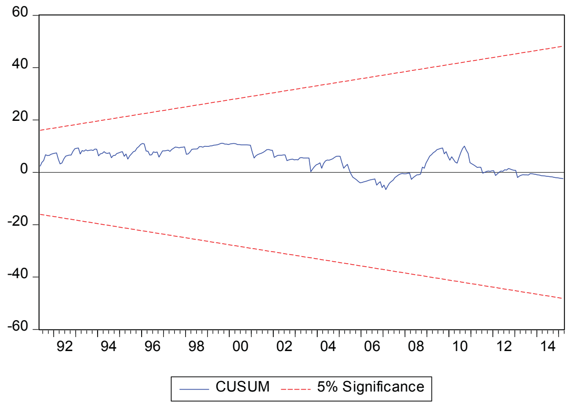


Note: The Straight line represents critical bounds at 5% significance level. The estimated line is within the critical bounds indicating the stability of the CUSUM.

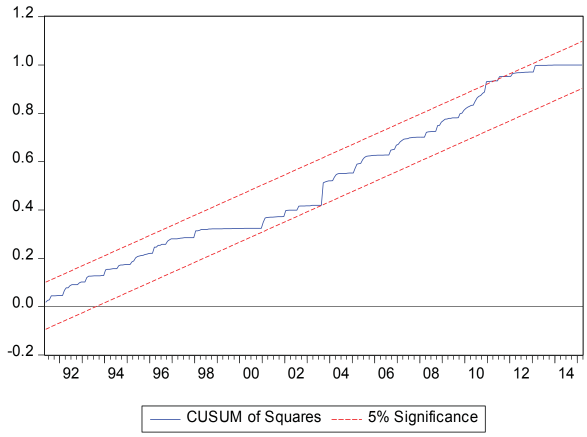
CUSUM and CUSUMSQ Plots for Equation 4

Figure 2

Plot of Cumulative sum of Recursive Residuals



Plot of Cumulative sum of squares of Recursive for residuals



Note: The Straight line represents critical bounds at 5% significance level. The estimated line is within the critical bounds indicating the stability of the CUSUM

5. CONCLUSİON

This paper focuses on the relationship between the US and Turkish stock prices via applying cointegration analysis for providing evidence of potential links between national stock markets. Using the Johansen cointegration, the study finds evidence of cointegration between the stock price series. The study also employed three forms of Granger causality 1) Weak form or Short run causality, 2) Long run Causality, 3) Strong form or Joint Short run and long run causality. Our findings indicated that evidence of no causality in the short run (weak causality), but a uni-directional (strong Granger causality) was found from US stock market to Turkish stock market. The findings of the study suggested that Turkish stock market which is the local market is strongly integrated with the US stock market which is in concordance with the previous studies conducted by Ergun and Nor (2010). The study suggested that Turkish stock market is affected globally by US stock market and is strongly integrated. The findings based on our study suggests that the Turkish stock market is sharing a common trend with the US stock market, which can be concluded that the Turkish stock market is strongly connected with global financial markets. The main purpose of the study was applying the appropriate method to measure the integration of the local stock market with global financial markets via using a proxy. Proxy was here the US stock market, and the results are supporting the view that Turkish stock market is connected with the global. Consequently, if a market is linked with the world markets, it is meant that it can be affected by the events that happened in the other markets. For participants to the local market for investment, this matters also checking the facts that what is going on in the other markets. If countries domestic market integrated to the other markets, this is meant that nor the local factors is affecting investor's investment and their decision about the revision of their portfolio, also the other either global or other events which are not local are affecting their perceptions and revisions.

Acknowledgement: We would like to thank the Editor and an anonymous reviewer for their comments that highly improved the quality of the paper.

REFRENCES

1. **Bahmani-Oskooee, M., Chomsisengphet, S.**, 2002, "*Stability of M2 demand functions in industrial countries"*, Applied Economics, 34, pp. 2075–2083.
2. **Bozoklu, S., Saydam, I. M.**, 2010, *"The Analysing Capital Market Integration with Parametric and Nonparametric Cointegration Tests among BRIC Countries and Turkey"*, Maliye Dergisi, Vol. 159, pp. 416-431.
3. **Brown, R.L., Durbin, J.,** and **Evans J.M.**, 1975, "Techniques for Testing the Constancy of Regression Relationships over Time. Journal of Royal Statistical Society, (2). 149-163.
4. **Corhay, A., Tourani Rad, A.** and **Urbain, J–P,** 1993, *"Common stochastic trends in European stock markets"*, Economic Letters, 42, pp. 385-390.
5. **Dickey, D. and Fuller, W. A.**, 1981, *"Likelihood ratio statistics for autoregressive time series with a unit root",* Econometrica, vol. 49, pp. 1057-72.
6. **Engle, R.F., Granger, C.W.J.**, 1987, *"Cointegration and error correction: representation, estimation, and testing"*, Econometrica, 55, pp. 251–276.

7. **Erbaykal, E., Okuyan, H. A., Kadıoglu, O.**, 2008, *"Cointegration and Priority Relationship between Stock Markets of Turkey, Brazil and Argentina"*, European Journal of Economics, Finance and Administrative Sciences, Issue 10, pp. 151-158.
8. **Ergun, U., Nor, H. S. M.**, 2010, *"The Stock Market Relationship Between Turkey and The United States under Unionisation"*, Asian Academy of Management Journal of Accounting and Finance, Vol. 6, No. 2, pp. 19-33.
9. **Güloglu, B., Bayri, O.**, 2005, *"Hisse senedi ve Yabancı para piyasalarının entegrasyonu: Türkiye, AB ve ABD örneği"*, Journal Iktisat, Isletme ve Finans, Vol. 20, Issue 234, pp. 13-34.
10. **Ibicioglu, M., Kapusuzoglu, A.**, 2011, *"An empirical analysis of the integration of the stock exchange of the ISE with those of European Union Mediterranean Countries"*, Anadolu University Journal of Social Sciences, Vol. 11, Issue 3, pp. 85-102.
11. **Johansen, S., Juselius, K.**, 1990, *"Maximum likelihood estimation and inference on cointegration - with application to the demand for money"*, Oxford Bulletin of Economics and Statistics 52, pp. 169–210.
12. **Kasa, K.**, 1992, *"Common stochastic trends in international stock markets"*, Journal of Monetary Economics, 29(1), pp. 95-124.
13. **Köse, M. Ayhan, Prasad E. S., Terrones, M. E.**, 2003, *"Financial Integration and Macroeconomic Volatility"*, IMF Staff Papers, Vol. 50 pp. 119-142.
14. *Kwiatkowski, D., Phillips, P. C. B., Schmidt, P. and Shin, Y.*, 1992, *"Testing the Null of Stationarity Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series Have a Unit Root?"*, Journal of Econometrics, 5, pp. 159.78.
15. **Mylonidis, N., Kollias, C.**, 2010, *"Dynamic European stock market convergence: evidence from rolling cointegration analysis in the first euro-decade"*, Journal of Banking & Finance, 34, pp. 2056-2064.
16. **Narayan, P.K., Smyth, R.**, 2005, *"Electricity consumption, employment and real income in Australia evidence from multivariate Granger causality tests"*, Energy Policy, 33, pp. 1109–1116.
17. **Pascual, A. G.**, 2003, *"Assessing European Stock Markets (Co)integration"*, Economic Letters, 78, pp. 197-203.
18. **Rangvid, J.**, 2001, *"Increasing convergence among European stock markets? A recursive common stochastic trends analysis"*, Economic Letters, 71, pp. 383-389.
19. **Tursoy, T., & Faisal, F.,** 2016, *Causality between stock price and GDP in Turkey: An ARDL Bounds Testing Approach.* Romanian Statistical Review, 64(4), 3-19.