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Time varying causality between stock market and exchange rate: evidence from Turkey, Japan and England

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ABSTRACT

In this study, the relationship between exchange rates and stock market indices in Turkey, Japan and England was analysed by using the time varying causality test. First, by the Kapetanios unit root test that allows determining structural breaks endogenously and more than two breaks, stationary levels and break numbers of series were identified. Second, based on the belief that the result of especially long-term causality can have different consequences in different periods due to economic and political crises, a time-varying causality test with bootstrap developed by R. Scott Hacker and Abdulnasser Hatemi-J was used. As a result of the study using monthly data spanning the period of January 1990 to April 2013, there existed two-way causality for the three countries in periods when local and global crises were occurring.

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1. Introduction and literature review

In the literature on the dynamic relationships between the exchange rate and stock market index, two different opinions are mentioned. One is the traditional approach. According to this idea, a decrease in national currency makes companies more challenging and encourages them to invest on foreign countries. This causes an increase in their export and share prices. According to this approach, the stock exchange is the cause of share prices. The second opinion is the portfolio approach. According to this idea, an increase in share prices stimulates investors in the national currency (Yau & Nieh, 2009). As in all areas, globalisation affects the exchange rate and share prices. Moreover, it increases the significance of international portfolio diversification. In this respect, the effect of global activities – such as great crises on country markets – should be always taken into account (Śmiech & Papież, 2013). In the literature, although there are different analyses for different countries there is no accepted judgement.

In their study spanning the period November 2001 to June 2012, Śmiech and Papież (2013) analysed the dynamic relationship between stock market index, exchange rate and

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fuel prices in Germany. There has been two-way causality between the variables except for the period 2006 to 2008. Similarly, Piccillo (2009) observed two-way causality in the Japanese, English and German stock markets, in many periods, between the exchange rate and stock prices in his study using a time-varying causality test. Unlike the others, Hatemi-J and Roca (2005) divided their dataset into two – crisis periods and others – in their study analysing Asian countries. As a result of their analysis, they obtained that the effect between these two variables disappeared during a crisis period.

By using a cointegrated regression model, Tsagkanos and Siriopoulos (2013) analysed the last crisis period on the EU and the US and obtained causality from stock prices to exchange rate in their study. Nieh and Lee (2001) examined G7 countries and observed no relationship between these two variables. Tudor and Dutaa (2012) analysed 13 developed and developing countries in their study. They observed causality from stock prices to exchange rate for Brazil and England, from exchange rate to stock prices for the US and two-way causality for South Korea. For other countries, there was no causality. Laborde and Rey (2001) obtained that exchange rate was the Granger cause of stock prices from their study analysing US and French stock markets. While examining Pakistan, India and Bangladesh, as three South Asia countries, Rahman and Uddin (2009) found no causality between stock prices and exchange rates of these countries.

Köseoğlu and Çevik (2013) have examined the relationship between the markets of the Czech Republic, Hungary and Poland with Turkey in their study spanning the period 2002 to 2011. As a result, they observed that exchange rate was influenced by stock prices. Supporting these findings, Köse, Doğanay, and Karabacak (2010) in their study analysing Borsa Istanbul (BIST) concluded that stock prices were the Granger cause of exchange rate. Similarly, Tabak (2006) also supported this result in his study on the stock market of Brazil. He observed causality from the stock market index to exchange rate. Hatemi-J and Irandoust (2002) examined the Swedish stock market in their study and reached similar findings.

Liang, Lin, and Hsu (2013) used the Pedroni (2000) panel causality test in their study analysing five Asian countries between 2008 and 2011. As a result, they found causality from exchange rate to stock prices and that these countries were managed better after the Asia financial crisis. Zhao (2010) analysed the relationship between the exchange rate and index in China and observed no causality. Similarly, Liu and Wan (2012) studied the stock market of China, used linear and nonlinear causality tests in their study and observed no causality. In their study, Pan, Fok, and Liu (2007) investigated seven Asian countries in the period before the Asia financial crisis and found causality from exchange rate to stock prices. Jiranyakul (2012) found causality from exchange rate to stock prices in his study on Taiwan. Bhunia (2012) used a causality test on India and determined causality from exchange rate to stock prices. In his study analysing six Asian countries, Tsai (2012) observed negative causality from exchange rate to stock market index. Lin (2012) investigated six Asian countries in his study spanning the period from 1986 to 2000; he determined the movement from stock market prices to exchange rate in crisis periods. By the aid of the Granger causality test, Phylaktis and Ravazzolo (2005) studied the Pacific countries and determined causality from exchange rate to stock prices. They also arrived at a decision that financial crises had an impact on the markets of these countries causing them to act jointly. Kisaka and Miwasaru

(2012) analysed the stock market of Kenya and concluded that there was causality from exchange rate to stock market index. In addition, Stefanescu and Dumitriu (2009) concluded their study on the Romanian stock market with the same findings.

By using a threshold cointegration test, Yau and Nieh (2009) investigated the markets of Taiwan and Japan and observed correlation between exchange rate and stock market prices. In addition, Yoshida (2009) analysed the Japanese stock market in the period 1984 to 2009 and reached the same results. In a manner supporting these results, Oben, Pech, and Shakur (2006) studied the New Zealand stock market and determined long-term integration between exchange rate and stock market prices.

2. Econometric methodology

By using the Kapetanios (2005) unit root test (Table 1), the restriction of determining break numbers as the priory can be removed. The investigator will just identify the maximum break number and thereby a suitable break number will be determined endogenously via this test. The model used in this test is as follows:

$$y_t = \mu_0 + \mu_1 t + \alpha y_{t-1} + \sum_{i=1}^{k} \gamma \Delta y_{t-i} + \sum_{i=1}^{m} \emptyset_i DU_{i,t} + \sum_{i=1}^{m} \vartheta DT_{i,t} + \in_t \tag{1}$$

$$DU_{i,t} = 1\left(t > T_{b,i}\right), \quad DT_{i,t} = 1\left(t > T_{b,i}\right)(t - T_{b,i}) \tag{2}$$

The main hypothesis here is that the series has a unit root; the alternative hypothesis is that the series is stationary.

$$\text{H0: } \alpha = 1 \tag{3}$$

$$\text{H1: } \alpha{:} < 1 \tag{4}$$

In the mechanism of this test, for a specific break number, primarily one break is sought during the entire example and t-statistics of the α=1 hypothesis are gained. Then, the structural break date of the model, which contains the sum of least residual squares, is chosen and the second structural break date among the remaining parts is searched by adding the first estimated break date into the model. T-statistics for α=1 are obtained and the break date is determined by using the sum of least residual squares. This process continues until one gets m break numbers. An appropriate break number is a number that gives minimum t-statistics.

$$SSR = \sum_{t=k+2}^{T} (y_t - \mu_0 - \mu_1 t + \alpha y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-1} + \emptyset_1 DU_{1,t} + \varphi_1 DT_{1,t} \tag{5}$$

Compared with the Toda and Yamamoto (1995) causality test, the most significant difference in the Hacker and Hatemi-J (2006) causality test is that critical values are determined according to the Monte Carlo simulation method. In this study, the time varying causality test of the model developed by Hacker and Hatemi-J will be used.

Unlike Toda and Yamamoto (1995), Hacker and Hatemi-J (2006) do not ignore the possible normal dispersion of errors and there is no difference between these tests except the acquisition of critical values by the bootstrap method in Hacker and Hatemi-J (2006). In this test, the causality relationship between two series is tested via delayed the Vector Autoregressive Model (VAR):

$$y_t = \alpha + A_1 y_{t-1} + \ldots + A_p y_{p-1} + u_t \quad (6)$$

Here, y_t represents a variable vector in 2×1 dimensions and a state parameter vector. In order to gain Wald statistics that will be used to test the main hypothesis showing no Granger causality between series, the VAR model represented in this equation is as follows:

$$Y = DZ + \delta \quad (7)$$

This model can be expressed as:

$$\begin{aligned} Y &:= \left(y_1^+, y_2^+, y_3^+, \ldots., y_T^+\right) \\ D &:= \left(\alpha, A_1, A_2, A_3, \ldots, A_p\right) \\ Z &:= \left(Z_0, Z_1, Z_2, \ldots, Z_{T-1}\right) \\ Z_t &:= \begin{bmatrix} 1 \\ y_1^+ \\ y_{t-1}^+ \\ . \\ . \\ y_{t-p+1}^+ \end{bmatrix} \\ \delta &:= \left(u_1^t, u_2^t, u_3^t, \ldots, u_T^t\right) \end{aligned} \quad (8)$$

The main hypothesis showing no Granger causality can be tested with the following Wald test statistics:

$$\text{W} = (\text{C}\beta)\text{I} \ [\text{C}(\text{ZIZ}) - 1 \text{ x Su}) \text{ CI}) \text{ CI}] - 1 \ (\text{C}\beta) \quad (9)$$

Here, ⊗ represents the Kronecker multiplier and C shows the indicator function containing restrictions. Also, β is of the form β=vec(D) and vec refers to the column stacking operator. Q shows the number of lags in each VAR equality, SU represents the calculated variance-covariance matrix for the unrestricted VAR model as $\left(\hat{\delta}_U' \hat{\delta}_U'\right) / \left(T - q\right)$.

In this study, we will investigate the time varying form of the Hacker and Hatemi-J (2006) test. The general process of the time varying causality test can be explained as follows. First, the Hacker and Hatemi-J (2006) causality test is applied for the period from the first to the Nth (last) observation. In the second step, the first observation is omitted and then the test is applied for the period from the second to the (N+1)th observation. This process continues by omitting the first observation and adding the following observation to the last one of the previous test until our dataset contains the last observation of our data range.

Test statistics obtained in each observation range are normalised by the critical value of the bootstrap in order to test the meaningfulness of these gained test statistics. The main point we must emphasise is that both the Wald test statistics and the bootstrap critical values are changing with time. Therefore, every test statistic obtained from its observation range is normalised by the 10% bootstrap critical value of the same range. In order to evaluate normalised Wald statistics, graphs of values are created. In graphs, while values bigger than '1' indicate the existence of Granger causality, values less than '1' shows no causality (Yılancı, 2013).

3. Data

In our study, in order to investigate the relationship between the exchange rate and the stock market index of the England, Japan and Turkey stock markets in the period spanning January 1990 to April 2013, monthly data from the FTSE, NIKKEI and BIST are supplied from Yahoo Finance (www.ukfinance.yahoo.com); nominal exchange rates of these countries against the US-dollar, which is an important variable in shaping the world economy, are obtained from www.oanda.com.

Before analysing, real exchange rates are calculated by taking into account the effect of inflation. In addition, in order to avoid the heteroscedasticity problem of returns, logarithmic differences of data on the stock market indices are included in the analysis (Assogbavi, 2007).

4. Kapetanios unit root test results

The stationary levels of variables are vital in order to choose a suitable model in the research of causality between variables used in our study. Unlike unit root tests which do not take into account breaks like Augmented Dickey and Fuller (1979) (ADF), Phıllıps and Perron (1988) (PP) and Kwiatkowski, Phillips, Schmidt, and Shin (1992) (Kwiatkowski, Phillips, Schmidt and Shin-KPSS) or test which takes into account one break like Zivot and Andrews (1992) or tests which takes into account two breaks like Ben-David, Lumsdaine and Papell (1997), Lee and Strazicich (2003); in our study Kapetanios (2005) unit root test which is far more advanced from tests mentioned above and eliminates the restriction of determining break numbers as priory is used.

Table 1. Results of Kapetanios unit root test.

	Turkey		England		Japan		
Breaks	Exchange rate	Index	Exchange rate	Index	Exchange rate	Exchange rate (1st dif.)	Index
5	−14.58*	−10.82*	−8.77*	−13.97*	−10.88*	−10.28*	−9.14*
4	−12.99*	−10.51*	−8.40*	−13.44*	−10.60*	−9.92*	−8.93*
3	−12.89*	−9.03*	−8.28*	−13.18*	−7.22*	−9.62*	−8.46*
2	−12.79*	−8.59*	−8.14*	−13.06*	−5.94	−9.38*	−7.93*
1	−11.22*	−6.18*	−8.00*	−7.94*	−4.19	−9.15*	−5.44*

Note: Critical values are −8.34 for five breaks, −7.73 for four breaks, −7.00 for three breaks, −6.11 for two breaks, −5.08 for one break in 5% significance and taken from the study of Kapetanios (2005), entitled 'Unit-Root Testing Against The Alternative Hypothesis of up to M Structural Breaks'.
Source: Authors' calculations.

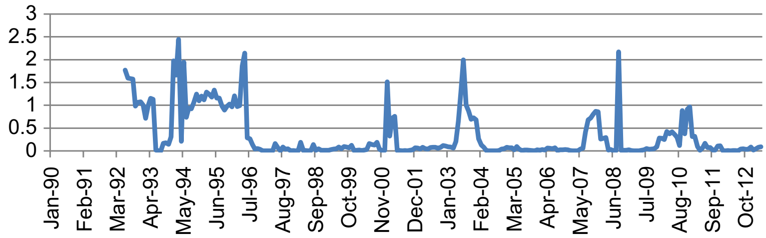

Figure 1. From index to exchange rate. Source: Authors' calculations.

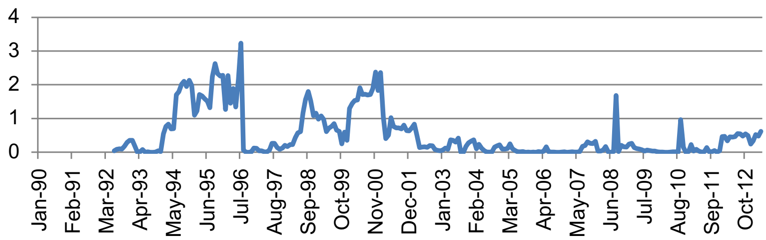

Figure 2. From exchange rate to index. Source: Authors' calculations.

According to the Kapetanios (2005) unit root test, T values for all breaks are calculated and, based on a break that has a minimum T value among these calculations, it is decided whether the series is stationary. The results of the Kapetanios (2005) unit root test are given below.

All series are stationary except for the stock market of Japan with respect to the Kapetanios (2005) unit root test. Our study has continued by taking first differences of this series.

As is known, classical causality tests can make judgments for all data period. In our study, by passing far beyond Granger Causality (1969), Toda-Yamamoto Granger Causality (1995) and Hacker and Hatemi-J (2006) bootstrap Granger causality tests, we tried to show the differentiation of causality according to the periods and effects of economic and political events with a time-varying bootstrap causality test. Here, a Monte Carlo bootstrap simulation value was set at 10,000. The relationship between index and exchange rate in the Turkey, Japan and England stock markets will be explained with the aid of Figures 1–6.

5. Time varying causality test results

5.1. Turkey

As can be seen in Figures 1 and 2, there was a causality relationship both from index to exchange rate and from exchange rate to index, especially in crisis periods. Values from the 1994 Economic Crisis, 2001–2002 twin crises in Turkey and 2008 mortgage crisis are observed above line '1'. Furthermore, by changing the exchange rate system in February 2001 in Turkey, the period of transition from a fixed to a floating exchange rate system is reflected as two-way causality in the figures. This situation shows us the cause of two-way causality between the exchange rate and stock market index is both local and global crises as well as economic activities.

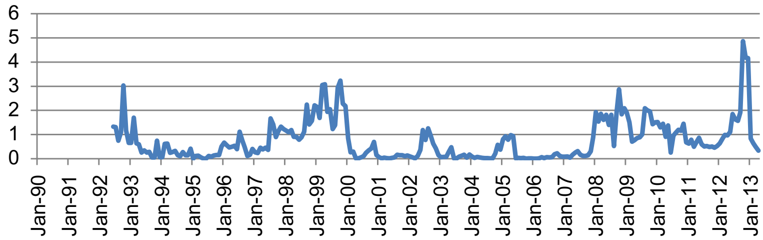

Figure 3. From index to exchange rate. Source: Authors' calculations.

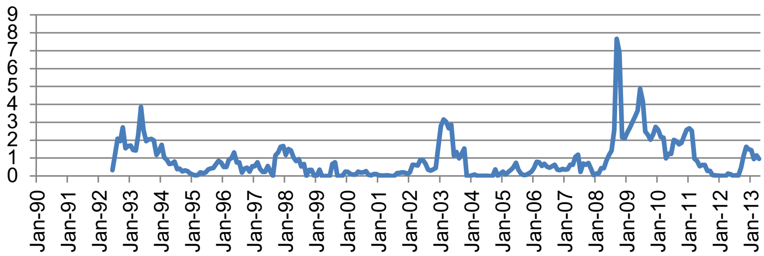

Figure 4. From exchange rate to index. Source: Authors' calculations.

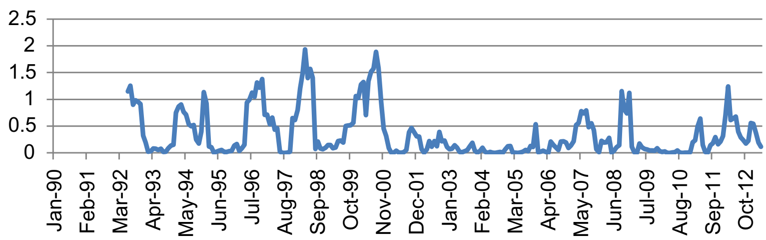

Figure 5. From index to exchange rate. Source: Authors' calculations.

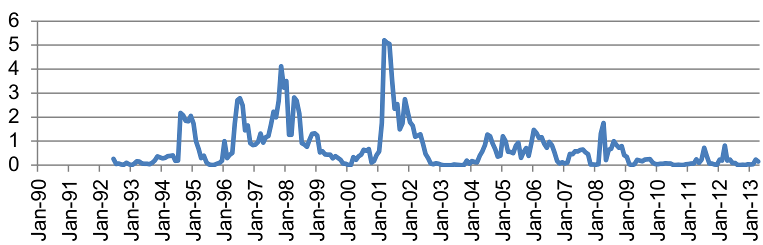

Figure 6. From exchange rate to index. Source: Authors' calculations.

5.2. England

Referring now to Figures 3 and 4, there was a high and two-way causality relationship between exchange rate and index during the 2008 mortgage crisis period. Another interesting fact is that the causality relationship occurred in a short period of time and ended quickly compared with the other two countries. This situation can be interpreted as that England had a quite powerful economy and was able to get rid of external factors.

5.3. Japan

From Figures 5 and 6, the reflections of the crisis periods can be seen clearly. As with two of the other countries, the effects of the 2008 mortgage crisis have been reflected in the results of Japan. Furthermore, the effects of in particular, the 1997 Asia financial crisis have continued for long time as two-way causality.

6. Conclusions

Using a time-varying bootstrap causality test, the most significant result we gained from our study on Turkey, England and Japan, spanning the period January1990 to April 2013 is that local and global crises strengthen the causality relationship between the exchange rate and the stock market index as two-way causality.

Compared with the studies in the literature, the results we reached support the findings of Piccillo (2009), Tudor and Dutaa (2012) and Śmiech and Papież (2013). Śmiech and Papież (2013) have examined the dynamic relationship between index, exchange rate and fuel prices in Germany in the period October 2001 to June 2012 and they have reached a strong causality relationship between the exchange rate and stock market index during the periods of crisis. Supporting these findings, Piccillo (2009) has found two-way causality between the exchange rate and stock prices during many periods in his study on Japan, England and Germany using a time-varying causality test. Unlike our findings, Hatemi-J and Roca (2005) has observed a weakening in the causality relationship between these two variables during crisis periods.

Looking at the literature in general, while there was a causality relationship from exchange rate to stock prices in studies on countries in, especially, regions of Asia, there was also causality from stock prices to exchange rate in studies on countries in the regions of Europe and the US. As a result, there was no conclusion that can be accepted. The reason for this situation can be interpreted as that such periodical economic and politic movements can change the direction of causality.

What is lacking in this study is that causality between variables was not separated as positive and negative shocks. In following studies, this lack can be removed by using the Hatemi-J (2012) asymmetric causality test in order to split positive and negative shocks. In addition, in the scope of investment assessment, availability to do comprehensive evaluation can be found by adding the rates of gold and interest in further studies.

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