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GRANGER CAUSALITY RELATION BETWEEN INTEREST RATES AND STOCK MARKETS: EVIDENCE FROM EMERGING MARKETS

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ABSTRACT

This research analyses the granger cause relation between interest rates and stock market for four emerging markets as Turkey, Brasil, China and Hungary. The database includes daily prices of stock market indices of BIST100 Index (Turkey), the IBOV Index (Brasil), the SHCOMP Index (China), and the BUX Index (Hungary) and government securities with different maturities. As the initial step, the stationarity of the variables is tested with Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. Then Granger Causality is implemented.

Keywords: *Granger causality, stock market, interest rates, emerging markets*
JEL: G10, G15.

1. Introduction

Analyzing the movements of stock prices and macroeconomic variables is important for institutional and individual investors in managing their portfolios. Therefore, this relationship is being examined by academicians and practitioners for many years. The financial theory explains that the volatility in interest rates affects the firm's cash flows, hence the market value of the shares. Furthermore, the theory discusses the negative relation between interest rates and stock returns. The reason for this negative relation lies under the investors' behavior of comparing high-risk investments with low-risk interest-bearing securities. Briefly saying, an investor might not make an investment in a high-risk stock market if there is an increase in the interest rates. On the other hand, a decrease in the interest rates stock returns becomes more attractive, and the investors shift from fixed-income instruments to stock market. With another point of view, an increase in the interest rates may affect the spending of households, which cuts down the earnings of companies and ends up with a decrease in the value of the stock. In contrast, Titman and Warga (1989) state that the stock returns might determine the interest rates by arguing that the market reflects the expectations of the financial variables on the prices. Many researches in literature tried to highlight the relation direction between the stock market and many macroeconomic indicators. This research analyses the granger cause relation between interest rates and stock market for four emerging markets as Turkey, Brasil, China and Hungary. The database includes daily prices of stock market indices of BIST100 Index (Turkey), the IBOV Index (Brasil), the SHCOMP Index (China), and the BUX Index (Hungary) and government securities with different maturities. All data are gathered from Bloomberg.

2. Literature Review

There are many researches that examine the relation between stock markets and multiple macroeconomic variables such as interest rates, exchange rates, gross domestic product (GDP), and the money supply. The studies of Chen et al. (1986), Poon and Taylor (1991), Mukherjee and Naka (1995), and Kim (2003) are based on developed markets, whereas the studies of Arango et al. (2002), Gunasekarage et al. (2004), Aydemir and Demirhan (2009), and Bhattacharya and Mukherjee (2002) are some based on emerging markets.

Fama (1981) examines the relationship between real output and stock prices and finds that there is a strong relationship between stock prices and gross national product (GNP). Huang and Kracaw (1984) indicate that changes in the log of real GNP and unemployment are Granger-caused by the variation of stock market returns in the United States. Chen, Roll, and Ross (1986) examine if some macroeconomic variables are priced in the stock exchange markets. Their research indicates that the spread between long and short interest rates, expected and unexpected inflation, industrial production and the spread between high- and low-grade bonds have a crucial influence on the stock prices.

Kwok (1992) applies Granger to test the causal relationship among real output, exports, and stock returns in Taiwan and South Korea and finds no clear causal relationship in these markets. Gallinger (1994) examines the relation between stock return and real activity and finds that stock market Granger-cause the interest rate spread between commercial papers and T-bills. Mukherjee and Naka (1995) explore the relationship between stock market and exchange rate, inflation, money supply, real economic activity, long-term government bond rate, and call money rate in Japan. Their findings support a cointegration relation. Mookerjee and Yu (1997) examine a similar relation in Singapore and find that money supply and foreign exchange reserves have a long-run relationship with stock prices.

Kwon, Shin, and Bacon (1997) conduct research to assess the relation between some macrofactors and stock exchange market for South Korea. The independent factors consist of inflation, production index, risk premium, term structure, dividend yield, trade balance, foreign exchange rate, oil price, and money supply. The data cover a period between January 1980 and December 1992. They regress the monthly time series of macrovariables with the Korea Composite Stock Index. Their results indicate that the Korean stock market was affected by foreign exchange rates, trade balance, money supply, and the production index. Niarchos and Alexakis (2000) investigate the effect of inflation, money supply, and exchange rate on the stock market in the Athens Stock Market for the period of January 1984 to December 1994. Their findings support that stock prices in the Athens Stock Market are positively correlated to those variables. Bhattacharya and Mukherjee (2002) examine if a causal relationship exists between stock prices and three macroeconomic variables such as exchange rate, foreign exchange reserves, and value of trade balance in India. They use monthly data for the periods 1990 to 1991 and 2000 to 2001. They applied unit root tests, cointegration, and the long-run Granger noncausality test recently proposed by Toda and Yamamoto (1995) to test the causal relationships. Their findings indicate that there is no causal relation between stock prices and the three variables for the tested periods.

Muradoglu et al. (2000) investigate the causal relation between market returns and exchange rates, interest rates, inflation, and industrial production for 19 emerging markets from 1976 to 1997. Their findings support that the relation between stock returns and macroeconomic variables was mainly linked to the size of the stock market. Nath and Smantha (2002) find that changes in industrial production affect stock prices in India. Kim (2003) uses monthly data for the period between January 19741 and December 1998 in the United States. The findings support that stock price has a positive correlation with industrial production, but a negative relationship with the real exchange rate, interest rate, and inflation. Nishat and Shaheen (2004) examine the relationship between a set of macroeconomic variables and the stock market in Pakistan using the Index of Karachi Stock Exchange. The macroeconomic variables in their study include industrial production index, money supply, interest rate, and inflation. They found that industrial production has the largest positive relationship with stock prices.

Chakravarty (2005) also examines the dynamics of the stock market in India. The findings support a positive relationship between industrial production and stock prices using the Granger causality test. Gay (2008) investigates the time series relationship between the stock market index exchange rate and oil prices for Brazil, Russia, India, and China (BRIC) using the Box-Jenkins ARIMA model. No significant relationship is found between respective exchange rate and oil price on the stock market index prices. Aydemir and Demirhan (2009) investigate the causal relationship between stock prices and exchange rates in Turkey. The results of the empirical study indicate that there is a bidirectional causal relationship between exchange rate and all stock market indices. Mahmood and Dinniah (2009) examine the relationship between stock prices and economic variables in six selected Asian-Pacific countries: Malaysia, Korea, Thailand, Hong Kong, Japan, and Australia. They use monthly data from January 1993 to December 2002. They find a long-run relationship in Japan, Korea, Hong Kong, and Australia, while a short-run relationship in all countries, except for Hong Kong and Thailand, shows some interactions. In Hong Kong there is a relationship only between exchange rate and stock price, while in Thailand, a significant interaction between output and stock prices only was reported.

Ray (2012) searches for the relation between different macroeconomic variables and the stock prices in India for the periods 1990 to 1991 and 2010 to 2011. The author implemented Granger causality to examine whether there exists any causal linkage between stock prices and macroeconomic variables. The findings indicate that there is no causal association between stock price and interest rate, stock price, and index of industrial production; but a unidirectional causality exists between stock price and inflation, stock price and foreign direct investment, stock price and GDP, stock price and exchange rate, and stock price and gross fixed capital formation. However, a bidirectional causality exists between stock price and foreign exchange reserve, stock price and money supply, stock price and crude oil price, and stock price and whole price index.

3. Data and Methodology

3.1.Data

This research analyses the granger cause relation between interest rates and stock market for four emerging markets as Turkey, Brasil, China and Hungary. The database includes daily prices of stock market indices of BIST100 Index (Turkey), the IBOV Index (Brasil), the SHCOMP Index (China), and the BUX Index (Hungary) and government securities with different maturities. This research aims to figure out if stock prices are granger cause of interest rates with different maturities. Therefore the maturities of government securities are selected as 1 month, 3 months, 6 months, 1 year, 3 years, and 5 years. The modelling period however is different for the countries. All data are gathered from Bloomberg. The time dimension is determined as the period from 2009 to 2013. The main aim was to understand the new trends and impacts after the crisis from 2007 to 2008. For this reason, daily data from January 5, 2009, to April 1, 2013, for Brazil, China, and Hungary is used. But for Turkey, because of the structural change in 2010, the relation in the periods from January 4, 2010 to April 1, 2013 is analysed.

3.2.Econometric Methodology

The main aim of this study is to find the causality between countries' stock exchange market returns and T-bill rates. After finding a significant causality between those variables, this paper tries to explain the long-run relation between stock market return and T-bill rates for each country analyzed. As the initial step, test the stationarity of the variables is tested. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used for testing the stationarity. Then run Granger Causality test is implemented. The testing methodology is explained below.

ADF Unit Root Test

The Dickey-Fuller (DF) (1979) test refers to a kind of *t*-statistic that is named as τ (tau) of γ coefficient on the following regressions:

$$\Delta y_t = \lambda y_{t-1} + u_t \qquad (1)$$

$$\Delta y_t = m_0 + \lambda y_{t-1} + u_t \qquad (2)$$

$$\Delta y_t = m_0 + \lambda y_{t-1} + m_2 t + u_t \qquad (3)$$

The first equation shows a pure white noise process, the second equation contains a constant term, and the third equation takes into consideration both the constant term and a deterministic trend. This test assumes that the error terms in first three equations are pure white noise. Because of this strict assumption, the DF test is extended with an autocorrelation process and named as the augmented Dickey-Fuller (ADF) test. The extended versions of equations 1, 2, and 3 are as follows:

$$\Delta y_t = \lambda y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-1} + u_t \qquad (4)$$

$$\Delta y_t = m_0 + \lambda y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-1} + u_t \qquad (5)$$

$$\Delta y_t = m_0 + \lambda y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-1} + m_2 t + u_t \qquad (6)$$

The ADF regression tests for the existence of unit root of y_t . The variable Δy_t expresses the first differences with lags, and u_t is the variable that adjusts the error terms of the autocorrelation process. The coefficient λ is being estimated. The null and alternative hypotheses for the existence of unit root in variable y_t are as follows:

$$H_0 : \lambda = 0 \quad and \quad H_1 : \lambda \prec 0$$

The null hypothesis indicates that y_t is stationary, and the alternative hypothesis tests the existence of the unit root. A number of alternative information criteria are suggested for determining the lag length such as the final prediction error (FPE), Akaike information criterion (AIC), Schwartz criterion (SC), Bayesian information criterion (BIC), and Hannan-Quinn criterion (HQ).

PP Unit Root Test

Phillips-Perron (1988) developed an alternative unit root test procedure that does not affect the asymptotic distribution of the test statistics while testing for a unit root and also robust to general forms of heteroskedasticity. The test adds two important factors to analysis, which are quite important during its implementation. The first is the existence of a constant, and the second is the existence of a constant and linear trends. Similar to the DF test, the PP test is also formed on one of the three different regression models. The regression equations of the PP test are formed as follows:

$$y_t = \alpha y_{t-1} + u_t \qquad (7)$$

$$y_t = \hat{\mu} + \hat{\alpha} y_{t-1} + \hat{u}_t \qquad (8)$$

$$y_t = \tilde{\mu} + \tilde{\beta}(t - T/2) + \tilde{\alpha} y_{t-1} + \tilde{u}_t \qquad (9)$$

For regressions (7), (8), and (9), they defined *t*-statistics of coefficient estimates. With these modifications, they made in their study a nonparametric approach that is appropriate for weakly dependent and heterogeneously distributed data.

Granger Causality Analysis

Granger (1989) supposed two types of causality.The first type of test is through lagged variables (Y_{t-i}, X_{t-i}), when the coefficients of these variables are all statistically significant, and the second type can be used if the variables are cointegrated and uses an error correction-term-based causality.

The first type of Granger causality test can be expressed as follows:

$$Y_t = \alpha_1 + \sum_{i=1}^{n} \alpha_{2i} Y_{t-i} + \sum_{j=1}^{n} \alpha_{3j} X_{t-j} + u_{1t} \qquad (10)$$

$$X_t = \beta_1 + \sum_{i=1}^{n} \beta_{2i} Y_{t-i} + \sum_{j=1}^{n} \beta_{3j} X_{t-j} + u_{2t} \quad (11)$$

From those equations, X_t is said to cause Y_t, provided α_{3j} is nonzero. Similarly, Y_t is causing X_t if β_{2i} is not zero in equation (11). If both of those significances occur, this shows us a bidirectional causality. The significance of those parameters are tested with joint hypothesis $\alpha_{3j} = 0$ for equation (10) and $\beta_{2i} = 0$ for equation (11).

3.3. Results

The necessary condition for the causality analysis is the stationarity of all variables, which is analyzed by ADF and PP tests. Both the ADF and PP tests states that the variables are stationary of the order I(1). The statistics are exhibites in Table 1 below.

Table 1: Unit Root Test Results

Variable	ADF test statistic	PP test statistic	ADF test statistic (first difference)	PP test statistic (first difference)	Order of stationarity
Turkey BIST 100	–1.629	–1.629	–28.50	–28.51	I(1)
Turkey 3M	–1.975	–2.115	–35.784	–36.005	I(1)
Turkey 6M	–1.883	–1.888	–18.577	–27.368	I(1)
Turkey 1Y	–1.153	–1.398	–27.695	–27.813	I(1)
Turkey 3Y	–0.449	–0.316	–6.327	–28.744	I(1)
Turkey 5Y	1.235	1.306	–27.819	–27.819	I(1)
Brazil IBOV	–2.233	–2.162	–33.161	–33.194	I(1)
Brazil 3M	–0.374	0.0986	–16.264	–29.429	I(1)
Brazil 6M	–0.983	–1.147	–6.814	–29.403	I(1)
Brazil 1Y	–1.885	–2.078	–29.579	–29.618	I(1)
Brazil 2Y	–2.685*	–3.188**	–19.859	–30.807	I(1)
Brazil 3Y	–2.861*	–3.312**	–8.488	–30.869	I(1)
China SHCOMP	–2.081	–2.147	–27.564	–27.511	I(1)
China 3M	–1.316	–1.324	–24.719	–24.836	I(1)
China 6M	–1.035	–1.078	–26.979	–26.979	I(1)
China 2Y	–0.424	–0.291	–6.138	–27.995	I(1)
China 4Y	–1.101	–0.539	–6.444	–32.842	I(1)
China 5Y	–1.327	–0.644	–4.923	–27.652	I(1)
Hungary BUX	–1.764	–1.873	–13.364	–32.027	I(1)
Hungary 3M	–0.628	0.321	–5.168	–30.515	I(1)
Hungary 6M	–0.641	–0.087	–5.744	–28.863	I(1)
Hungary 1Y	–0.923	–0.472	–6.659	–30.406	I(1)
Hungary 3Y	–1.376	–1.745	–15.499	–27.82	I(1)
Hungary 5Y	–1.535	–1.899	–16.018	–28.618	I(1)
Phillips-Perron test statistic critical values: 1% = –3.436696, 5% = –2.8864230, 10% = –2.568255 Augmented Dickey-Fuller test statistic critical values: 1% = −3.436696, 5% = −2.8864230, 10% = −2.568255 * 5% significant ** 10% significant					

Then the Granger causality test is implemented to highlight the causality relation between interest rates and the stock market. The outputs for Turkey, Brasil, China and Hungary are illustrated in tables 2,3,4 and 5 respectively. As for Turkey, the results do not show a bidirectional causality and the granger causality test results differ for different maturities. The outputs point a causality from BIST100 index to 3-month T-Bills and 5-year T-Bonds. On the other hand,, the 6-month T-Bills 1-year and 3-year bonds rates are the Granger cause of the BIST 100 Index.

Table 2: Granger Causality Test Results for Turkey

			Lag length	*F*-statistic	Result
BIST 100	Does not Granger-cause	3M	2	2.336	Granger Cause
3M		BIST 100	2	0.178	X
BIST 100		6M	1	1.006	X
6M		BIST 100	1	2.899	Granger Cause
BIST 100		1Y	2	3.431	X
1Y		BIST 100	2	0.129	Granger Cause
BIST 100		3Y	2	0.663	X
3Y		BIST 100	2	2.838	Granger Cause
BIST 100		5Y	2	3.200	Granger Cause
5Y		BIST 100	2	0.448	X

Table 3 shows the causality results for Brazil IBOV Index and government securities. For 3-month and 6-month T-bill rates, there is a unidirectional causality to the IBOV Index. On the other hand, the IBOV Index is Granger cause for 2-year and 3-year bonds. Only the relation between the 1-year T-bill rate and the IBOV index illustrates a bidirectional causality.

Table 3: Granger Causality Test Results for Brazil

			Lag length	*F*-statistic	Result
IBOV	Does not Granger-cause	3M	1	1.640	X
3M		IBOV	1	3.493	Granger Cause
IBOV		6M	4	1.498	X
6M		IBOV	4	1.999	Granger Cause
IBOV		1Y	1	7.069	Granger Cause
1Y		IBOV	1	5.071	Granger Cause
IBOV		2Y	5	2.133	Granger Cause
2Y		IBOV	5	0.644	X
IBOV		3Y	1	15.02	Granger Cause
3Y		IBOV	1	2.297	X

As reported in Table 4 for Chinese market; 2 and 5 year maturity bonds are Granger cause of the SHCOMP Index. While the index shows a Granger cause for 3-month, 6-month, and 4-year government securities.

Table 4: Granger Causality Test Results for China

			Lag length	*F*-statistic	Result
SHCOMP	Does not Granger-cause	3M	21	1.471	Granger Cause
3M		SHCOMP	21	0.962	X
SHCOMP		6M	21	1.489	Granger Cause
6M		SHCOMP	21	1.335	X
SHCOMP		2Y	2	0.202	X
2Y		SHCOMP	2	2.868	Granger Cause
SHCOMP		4Y	2	2.732	Granger Cause
4Y		SHCOMP	2	0.294	X
SHCOMP		5Y	2	0.766	X
5Y		SHCOMP	2	2.559	Granger Cause

Table 5 exhibits the outputs for Hungary. The outputs that the strongest granger causality relation exist in Hungary compared with the other emerging markets. As exhibited in the table; there is a bidirectional causality on majority of the variables. The only exception is for the relation between stock market and the 1 year and 5 year bonds.

Table 5: Granger Causality Test Results for Hungary

			Lag length	*F*-statistic	Result
BUX	Does not Granger-cause	3M	1	11.532	Granger Cause
3M		BUX	1	7.342	Granger Cause
BUX		6M	2	6.248	Granger Cause
6M		BUX	2	2.640	Granger Cause
BUX		1Y	2	0.025	X
1Y		BUX	2	13.667	Granger Cause
BUX		3Y	4	2.533	Granger Cause
3Y		BUX	4	2.123	Granger Cause
BUX		5Y	4	8.15	Granger Cause
5Y		BUX	4	1.112	X

4. Conclusion

There are many studies in literature that tries to explain the relation between stock market and various macroeconomic factors such as GDP, production opportunities, money supply, interest rates etc. The objective of this study is to investigate if there exists a causality relation between stock market and the interest rates in emerging markets as of Turkey, Brasil, China and Hungary. The stock market indices and different maturities of T-Bills and T-Bonds daily returns constitute the database of the research. The relation among these variables is explored by Granger causality. The examination of this relation gives the signal of investors' behavior on risk, and this is important, especially in emerging markets. However, analyzing this subject using different maturities is also important for analyzing the investment behavior from the point of risk and time length. This helps to analyze the tradeoff between riskiness of an asset also with the length of maturity. Initially, the stationarity of each time series is tested by ADF and PP models and the series is found to be stationary in the order I(1). Then, Granger test is implemented. As indicated with the results; the causal relation and direction differs between the countries and the maturities. As stated before; Hungary market shows the most causal relation between the stock market and the interest rate while China markets predicate a lower causal relation. Except for Brazil, each stock market returns are Granger cause of 3-month T-bill rates. Six-month T-bill rates are Granger cause of stock returns of the BIST and IBOV indices, but the SHCOMP and BUX index returns are Granger cause of 6-month T-bills. In contrast to short-term rates, the causality relation of T-bonds between countries' indices returns is fewer, except for Hungary.

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