The Impact of Trading Volume, Exchange Rate on Istanbul Index Price: Empirical Results Using ARDL Model

Ishaq Talahmeh[1]

[1] Faculty of Business and Economics, Eastern Mediterranean University (EMU) (North Cyprus)

✉ 19600097@emu.edu.tr

Abstract:

This study aimed to investigate the relationship and the effect of the change in the trading volume and the exchange rate of the Turkish lira on the closing price of the Istanbul 100 Index. Therefore, weekly data were collected for the index, trade volume and exchange rate for the period 2016-2021. After that, we run diagnostic test to ensure that our data fit the necessarily robust characteristics. Thus, we used the unit root test and conclude that the dependent variable is stationary after first difference and other variables are stationary at level and after first difference. Afterwards, we checked that the residuals are fitting our main condition where it should be serially uncorrelated with homogenous slope. The ARDL has been used to explore the short and long run relationship and interaction between variables. First, we reported the bound test results and the F-state showed to be significant at 1%, which is mean that our model has a long-run interaction with the dependent variable. Secondly, we run the long-run ARDL test to check the impact of each independent variable on the dependent variable. The results showed that the exchange rate has statistically significant effect on the index price. The results showed that the exchange rate of the Turkish lira against the dollar negatively affected the price of the Istanbul Stock Exchange index. While, the trading volume was insignificant in the long-run. However, the results of short run cointegration is different. The current and lagged value of trading volume were significant. Finally, we tested the stability of our model. The results were different between CUSUM and CUSUMSQ. Where they CUSUM results came up to show the stability of coefficient in the model. Nevertheless, the CUSUMSQ showed that we have unexpected change in the structure

تأثير حجم التداول وسعر الصرف على سعر مؤشر إسطنبول: النتائج التجريبية باستخدام نموذج ARDL

إسحاق تلاحمة[1]

[1] كلية الأعمال والاقتصاد، جامعة شرق البحر الأبيض المتوسط (EMU) (شمال قبرص)

✉ 19600097@emu.edu.tr

ملخص:

تهدف هذه الدراسة إلى تحليل العلاقة بين التغيّر في حجم التداول وسعر صرف الليرة التركية وأثر ذلك على سعر أسهم الشركات المُدرجة في بورصة اسطنبول. تم التوصل إلى ذلك من خلال جمع بيانات أسبوعية عن قيم مؤشر بورصة اسطنبول (BIST 100) إضافة إلى حجم التداول وسعر الصرف لليرة التركية مقابل الدولار الأمريكي في الفترة الواقعة ما بين 2016–2021. تم إجراء اختبارات تشخيصية للتأكّد من أن البيانات المستخدمة تتناسب مع خصائص النموذج المستخدم من خلال اختبار جذر الوحدة الذي أظهر أن المتغير التابع مستقر بعد الفرق الأول والمتغيرات الأخرى مستقرة في المستوى الأصلي وبعد الفرق الأول أيضًا. وأظهرت الاختبارات أن البواقي تتناسب مع الحالة الرئيسة حيث يتطلب أن تكون غير مرتبطة بشكل متسلسل مع المنحدر المتجانس، ومن خلال استخدام منهجية الانحدار الذاتي للفجوات الزمنية الموزعة (ARDL) لاستكشاف العلاقة والتفاعل على المدى القصير والطويل بين المتغيرات تبين أن هناك علاقة بين المتغيرات التابعة والمستقلة على المدى الطويل، حيث أظهرت النتائج أن سعر الصرف له تأثير سلبي ذي دلالة إحصائية على أسعار الأسهم المُدرجة في بورصة اسطنبول بينما حجم التداول له تأثير ضئيل على المدى الطويل.

ومع ذلك، فإنّ نتائج التكامل المشترك على المدى القصير مختلفة. وكانت القيمة الحالية والسابقة لحجم التداول ذات دلالة إحصائية كبيرة. وأخيرًا تم اختبار استقرار النموذج فكانت النتائج مختلفة بين CUSUM وCUSUMSQ. حيث أظهرت نتائج CUSUM بأن هناك استقرار في النموذج وعلى النقيض من ذلك أظهرت نتائج CUSUMSQ أن معاملات الانحدار غير ثابتة.

الكلمات المفتاحية: *سعر الصرف؛ اختبار ARDL؛ حجم التداول؛ سعر السهم؛ مؤشر بورصة اسطنبول؛ CUSUM؛ CUSUM-of-square.*

1. Introduction

The Turkish financial market has recently witnessed many events that have had their effects on the returns and profits of investors. Starting with the battle against the Corona pandemic and its economic consequences, passing through the geopolitical factors in the region, and ending with the fluctuation of the value of the Turkish lira against the US dollar. All these factors and others made the Turkish financial market a suitable place for speculators who are looking for high profit against high risk. Many researchers Tursoy and Faisal (2018) and Marashdeh (2005) have tried to study the financial market and the factors that determine its profitability and index prices. However, one of the most annoying factors for investors in the Turkish market is the change in the exchange rate of the Turkish lira against other currencies. The volatility in the currency rate is a key factor in investors' decisions about whether or not to pursue investment possibilities. This capacity to assess risk is largely due to the fact that fluctuating foreign currency rates commonly lead to dangerous investment decisions (Muriu, 2003). As some studies indicated that the exchange rate is one of the forms of uncertainty faced by investors and make them hesitant in the investment decision (Türsoy, 2017). On the other hand, it is no secret to anyone the importance of studying the behavior of the investor in the desire to buy shares and its impact on the returns of the financial market. Many studies Bhattacharya et al. (2019) have indicated this by linking the demand for shares to the volume of liquidity in the market. Also, Dhaoui and Bacha (2017) where they discussed that the demand for stocks in addition to being the main catalyst for liquidity, it helps in understanding the psychological aspect of the investor by linking it with the investor confidence in the market. Therefore, linking the three elements together, the exchange rate, the volume of trade, and their impact on the market price has an important role in predicting the future of financial markets. Hence, this study will follow the latest literature and which used autoregressive distributed lag (ARDL) to study the interaction between variables in short and long run. To achieve this goal, the study collected a sample of exchange rate data, trade volume, and closing price for the Istanbul Index for the time period 2016-2021.

This sample is characterized by its inclusion of the most important events that faced the financial market, from the pandemic crisis to geopolitical events, in addition to the sharp drop in the exchange rate and the high inflation. Robust tests were also conducted to generalize the results to the Turkish economy and other economies.

This study came to fill the gap in the literature on the study of this relationship during a sensitive period in the life of the Turkish economy, and it will add references to the library related to the ARDL study and confirm or refute the results of some previous studies.

Our main findings, is the effect of the exchange rate of the Turkish lira against the dollar, and the trade volume on the closing price of the Istanbul Stock Exchange index. This effect was varied between the long-term and the short-term.

2. Literature Review:

The study of the dynamic relationship between the foreign exchange rate, trading volume, and financial market indicators has become a crucial interest to many researchers and academics because of its impact on economic changes and development. Economic policymakers in both emerging and developed nations are interested in studying the determinants of stock market price, like exchange rate, trading volume, inflation, and interest rate. One of the fundamental foundations on which economic growth plans are formed is the exchange rate. Many economists and scholars are interested in stock prices and the changes that occur on them, as well as the variables that influence them. Previous research has shown that changes in exchange rates cause a positive or negative shift in stock

values. Gordon (1959) presented an "elementary theory of variation in stock prices with dividends and earnings" to study the link between earnings, dividends, and stock market price. Campbell and Shiller (1988) examined that the earnings and macroeconomic indicators such as production and inflation dividends are linked to share prices. Nasseh and Strauss (2000) findings give credibility to the presence of a substantial, long-run link between stock prices and domestic and international economic activity in six European countries. Savasa and Samiloglub (2010) they found evidence of long-run cointegration between stock returns and a variety of macroeconomic factors. Tursoy (2019) the study reveals a long-standing and considerable correlation between stock prices and domestic interest rates in Turkey's financial markets. Mroua and Trabelsi (2020) Attempt to explore both the causation and dynamic relationships between exchange rates and stock market indexes together. They test the short- and long-term impact of the US dollar on the key stock market indexes in Brazil, Russia, India, China, and South Africa (BRICS). They find that there is a significant relationship between the exchange rates previous and current fluctuations market indices of the study's target nations According to the Jefry and Djazli (2020) the study, which aimed to examine the impact of the change in inflation, interest rates, and exchange rates on the industrial company's stocks listed on the Indonesia Stock Exchange. They found that Inflation, interest rates, and exchange rates all have a significant impact on the stock market price. Father more the relationship between the volume of trading and stock returns studied by Chandrapala (2011) the result of the research revealed that stock returns are positively correlated with the current change in trading volume. Bhattacharya, et al (2019). Found that there is along with the relationship between market liquidity's dimensions and Indian stock market index. Recently, Vurur (2021) try to test the causal link between sector returns and exchange rate volatility. These findings show that changes in the dollar exchange rate affect the investment choices of participants in the relevant index. Also, they found that conventional theories are mostly applicable in the instance of Turkey. Moreover Ozdemir (2020). Found that in both pre-and post-crisis eras, stock price and trading volume showed bidirectional volatility spillovers. Volatility spillover from stock prices to trading volume is unidirectional in crisis periods.

The most important thing that distinguishes this study from its predecessors is the target sample in the study, as it includes a sensitive period in the Turkish economy. It started from geopolitical events, through the decline in the exchange rate of the Turkish lira, and the end of the Corona pandemic. This study also dealt with the interpretation of the relationship of demand for shares with the prices of the Istanbul Stock Exchange index. As to the researcher's knowledge, none of the previous studies preceded the addition of this variable, but were limited to studying the impact of liquidity on the Turkish market. Finally, this study has updated the results of previous studies, which included the exchange rate of the Turkish lira and its relationship to the index price. Where this study supported the results of previous studies in the importance of maintaining the value of the Turkish lira against other currencies.

3.Data and Methodology:

3.1 Sample

The BIST 100 index was chosen as the stock market's indicator since it contains the 100 most liquid firms listed on the Istanbul Stock Exchange. However, the study's aim is to identify the impact of changes in the exchange rate and stock trading volume on the closing price of index. Therefore, the Turkish lira/US dollar exchange rate and weekly trading volume, which is a proxy for investors' propensity to invest in stock (Bhattacharya et al., 2019), were obtained from Yahoo Finance and DataStream on a weekly basis from January 2016 to December 2021. This sample is unique in that it encompasses a critical period in the Turkish economy. Such as before and during the Corona

pandemic and the Turkish lira exchange rate crisis, as well as other regional geopolitical events. The following figure (1) shows the movement of the closing price of the Istanbul Index during the sample period.

To give more details about our variables, we have shown the short and long name of the variable in addition to the source of this variable in Table (1).

Table (1): Variables details

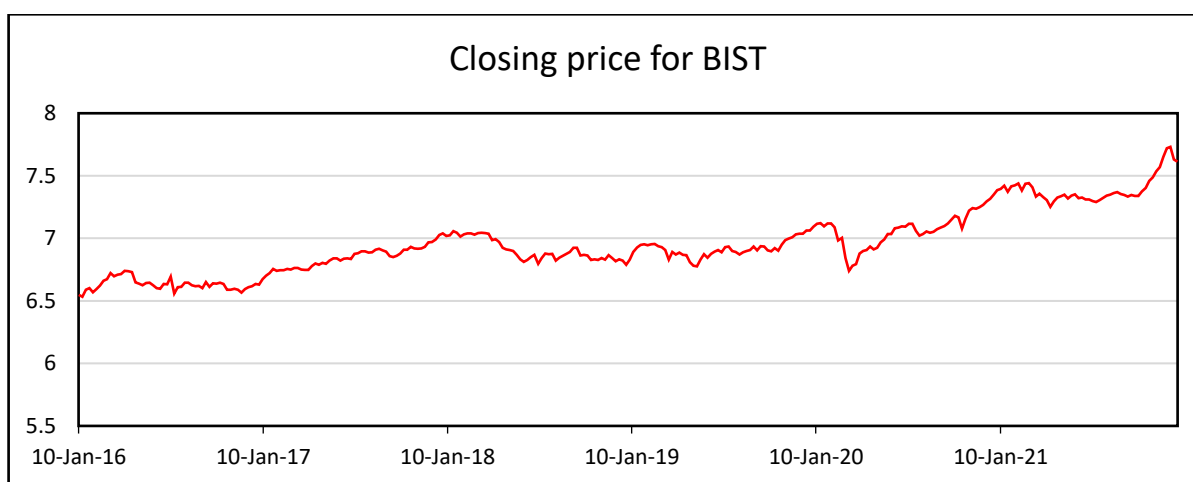| Short name	Long name	Source
P	Closing price	DataStream
Vol	Trading volume	Yahoo finance
Exe	Exchange rate	Yahoo finance

Figure (1): weekly closing price 2016 - 2021

The main objective of the study is to explain the relationships in the following equation (1), where this model stated that, the logarithm of closing price (Lnp) is a function of change in logarithm of trading volume (Lnvol) and the logarithm of exchange rate (Lnexe),

$$Lnp = f(\Delta Lnvol, Lnexe) \qquad\qquad (1)$$

To achieve this goal, we first presented the descriptive statistics for the variables in the following table (2).

Table (2): Descriptive statistics

	LNP	LNEXE	LNVOL
Mean	9.924595	-1.630142	0.000190
Median	9.876090	-1.698581	-0.007732
Maximum	10.38052	-1.026904	4.828355
Minimum	9.423932	-2.809950	-4.563199
Std. Dev.	0.246393	0.378885	0.297560
Skewness	0.215328	-0.134892	0.531900
Kurtosis	1.738796	2.105910	86.57331
Jarque-Bera	110.2663	54.14788	433691.1
Probability	0.000000	0.000000	0.000000
Sum	14787.65	-2428.911	0.283013
Sum Sq. Dev.	90.39619	213.7521	131.8386
Observations	1490	1490	1490

According to previous results, the skewness of the data is symmetric since its value is close to zero. While the thickness of the tail is close to normal only for the exchange rate. Whereas (vol), have a thick tail. Moreover, the Jarque-Bera test results shows that the data doesn't follow the normal distribution. However, to ensure the robust of our results and, we ran some diagnostic test and we reported the results is table (3). According to these results our data is serially uncorrelated with probability 0.4274. Also, we used Brueuush- Bagn test to test of homoscedasticity showed that the slope of our residual is constant with prob value (0.2468). Hence, we ensure that the error term is coming up with the condition which we assume, white noise and serially uncorrelated. After that, we used the augmented dickey fuller (FULLER, 1976) and Phillips and Perron (1988) test to test the stationarity of our data, and we presented the results the following table (4). The unit root test shows that we have mix integrated variable. Where trading volume is stationary at level, whereas closing (the dependent variable) is stationary after first difference. Unlike the previous results, the ADF test for exchange rate showed that it's stationary at level with intercept and trend, while according to pp test, it's stationary after first difference. And we adopt the results of pp test since it's considered to be stronger test than ADF.

Table (3): Diagnostic test

Test	F – static	Obs*R – squared	Prob f (2.255)
Serial correlation LM test	0.852326	1.722908	0.4274
Heteroscedasticity test – white	1.386885	4.158506	0.2468

Table (4): Unit root test

	ADF			PP		
Variable	**Level (Intercept)**	**Intercept and trend**	**First difference**	**Level (Intercept)**	**Intercept and trend**	**First difference**
P	-1.7243	-2.7521	-33.314***	-1.269846	-2.5743	-33.148***
Vol	-	-	-	-	-	-
	19.9874***	19.97***		157.290***	157.72***	
Exe	0.009159	-3.321**	-	0.147898	-3.071570	-
			34.88737***			34.70578***

*** stationary at 1%, ** stationary at 5%, * stationary at 10%.

According to previous results table (4), and in line with the main objective of our study, we will use Autoregressive Distributed Lag (ARDL) (Pesaran et al., 1996) test. Where this test is suitable for mixed integrated variables, as well as, it can catch the short and long-run co-movement between variables for a small sample size (Pesaran et al., 2001). Also, unlike other approaches of cointegration that require similar lag lengths for all variables, the ARDL model permits unequal choice of lag lengths for each variable (Camba et al., 2020). The ARDL is a regression include lags of independent and dependent variables. In other world, we can generalize the ARDL through the following equation with (L, N_1……….. N_j).

$$y_t = \alpha + \sum_{i=1}^{L} \gamma_i y_{t-1} + \sum_{i=1}^{j} \sum_{i=0}^{N_j} X_i, t - i\beta_{ii} + \varepsilon_t \qquad (2)$$

Where L is the number of lags of the dependent variable. And N_j is the number of lags of the ith Independent variables. To apply this equation to the variables of our study, we can rewrite

cointegration equation (2) as follows

$$lnp = \beta_0 + \beta_1 \sum_{t-1}^{t} lnp + \beta_2 \sum_{t-1}^{t} lnexe + \beta_3 \sum_{t-1}^{t} \Delta lnvol + \lambda_1 lnp_{t-1} + \lambda_2 lnexe_{t-1} + \lambda_3 \Delta lnvol_{t-1} + \varepsilon_t$$

In the above equation β_0 is the constant part, and the term Δ represent the change in the variable? In the previous equation we can conclude that there is cointegration if the F-value is higher than the upper bound. While if it's the opposite that's mean no cointegration. But if the value is between the upper and lower bounds, this means that the relationship cannot be determined. The relationship with symbols can be formulated as follows,

$$H_0: \lambda_1 = \lambda_2 = \lambda_3 = 0$$
$$H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq 0$$

If the estimated findings revealed a long-term relationship between the research variables, long-term variances were calculated using the ARDL model.

$$lnp = \beta_0 + \beta_1 \sum_{t-1}^{t} lnp + \beta_2 \sum_{t-1}^{t} lnexe + \beta_3 \sum_{t-1}^{t} \Delta lnvol + \varepsilon_t$$

In the last equation, β_1 and β_2 is the long-run coefficient relationship between the variables. And ε_t is a white noise error term. Additionally, to determine appropriate lag for research variables, we follow Khan (2019) and depend on VAR model to estimate the best lag length for ARDL model. After that, we used the following equation to estimate the short run error correction model of ARDL,

$$\Delta lnp_t = \beta_0 + \rho_1 \sum_{t-1}^{t} \Delta lnp + \rho_2 \sum_{t-1}^{t} \Delta lnexe + \rho_3 \sum_{t-1}^{t} \Delta lnvol + \phi ECT_{t-1} + \varepsilon_t$$

In the following equation, ρ_1, ρ_2 represents the short-term relationship between the research variables. ECT represents the speed of adjustment toward stability, and ϕ represents the coefficient of speed of adjustment. Besides, we used the Breusch-Godfrey Test as well as the Breusch-Pagan-Godfrey test to examine correlation and homogeneity of variance. Whereas CUSUM and CUSUM square have been used to check coefficient durability.

Table (4): Lag Length Section Criterion

Lag	LogLZ	LR	FPE	AIC	SC	HQ
0	54.94267	NA	0.000143	-0.337290	-0.300958	-0.322763
1	1203.185	2266.660	8.78e-08	-7.734966	-7.589637	-7.676857
2	**1237.053**	**66.19779***	**7.47e-08***	**-7.896450***	**-7.642125***	**-7.794760***
3	1243.653	12.77003	7.59e-08	-7.880861	-7.517540	-7.735589
4	1246.862	6.147873	7.88e-08	-7.843260	-7.370942	-7.654406

Table 4 shows the AIC, SIC, and HQ findings for optimal lag. The AIC, FPE and HQ indicate that lag 2 is appropriate for our model. We utilize the AIC lag length to choose a reasonable lag since the AIC deal with other criteria selection test. Therefore, the optimal lag according to AIC, is 2. After we have carried out the necessary tests to ensure that we can use the ARDL test, first of all, we apply the ARDL bound test, and we presented the results in table (5). According to table (5), the computed F-statistic, after comparing it with lower and upper bond, it suggests that we have long-run

relationship between the variables. Where comparing the F-value with the bounds we found it is significant at level 1%. After that, we chick the significance of each variable separately, and we reported the results in table (6). Table (6) illustrated that there is a long run relationship between exchange rate and index price. In other words, for 1% increase in exchange rate will decrease the price of stock by 60.45%. This shows the extent to which investors are affected by the exchange rate of the Turkish lira. This is confirmed Saidi et al. (2021) results where they found the exchange rate is negatively effect on the index stock price. On the other hand, the results show that the trading volume is not significant and it doesn't effect on the index stock price in the long-run. This result contradicts with Bhattacharya et al. (2019) study, where they found the investors' desire to invest in the financial market enhances the market value of the index's stock. This may be the result of investors searching for other alternatives to invest other than shares. Nevertheless, the table (6) also shows that the dependent variable, index price, did not appear among the results, which is mean it has a zero-lag length.

Table (5): ARDL bound test

Test	Value	K
F-statistic	5.527181	2
Bounds Critical Values		
Significance	Lower Bound	Upper Bound
10%	2.17	3.19
5%	2.72	3.83
2.5%	3.22	4.5
1%	3.88	5.3

If we have nonstationary series and we run the regression, the results will be superiors. In other word the coefficients of model will not be robust. One way to solve this problem is to differentiate the variable to (I) times. But the problem of this method is data will lose its future behavior, which is our main concern in this article. However, we can use another method that will solve the superior problem, as well as, catching the long run and short run behavior of series which is error correction model (ECM) (Nkoro & Uko, 2016). Therefore, we ran the short run ARDL test to identify the interaction between series and we presented the results in table (7). Table (7) illustrated that in short-run trading volume has statistically significant effect on the index stock price at level 1%. In a more precise sense, the current value of trading volume effect on index stock price by 2.55%. Which is mean a 1% increase in trading volume at time (0) will lead to 2.55% increase in stock price. Conversely, the lag of trading volume (e.g., t = -1) negatively effect on stock price, where 1% increase in trading volume in one day, will decrease the stock price by 20.12% in the next day. Here, the influence of speculators who seek to achieve profits through continuous buying and selling appears, keeping the market in a permanent state of instability. Finally, the error coefficient (-0.000871) negative, less than unity, and statistically significant at 1%. These results confirm that we have a causal relationship between the explanatory variable and dependent variable. Also, it means that the short run relationship will converge to become long-run relationship with adjustments speed (-0.000871).

Table (6): ARDL Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob
Lnexe	-6.459053	3.578163	-1.805131*	0.0720
Lnvol	69.22245	108.6124	0.637335	0.5244

Table (7): ARDL Short Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob
D(VOL)	0.025579	0.007572	3.378305***	0.0008
D(VOL(-1))	-0.020125	0.007595	-2.649632***	0.0085
CointEq(-1)*	-0.000871	0.000213	-4.085373***	0.0001

At the last step, we test the stability of our system through the cumulative sum (CUSUM) and cumulative sum square (CUSUM of Square) which proposed by (Brown et al., 1975). The main difference between two tests is that, the CUSUM is robust in case of stationary series only while CUSUM of square is robust in both stationary and nonstationary series, which makes the second test stronger than first one in catching the change in the system (Caporale & Pittis 2004). We presented the results in Figure (2). The CUSUM test identifies structured changes among the regression coefficients, while the CUSUM of squares test detects unexpected changes from the stability of the regression coefficients.
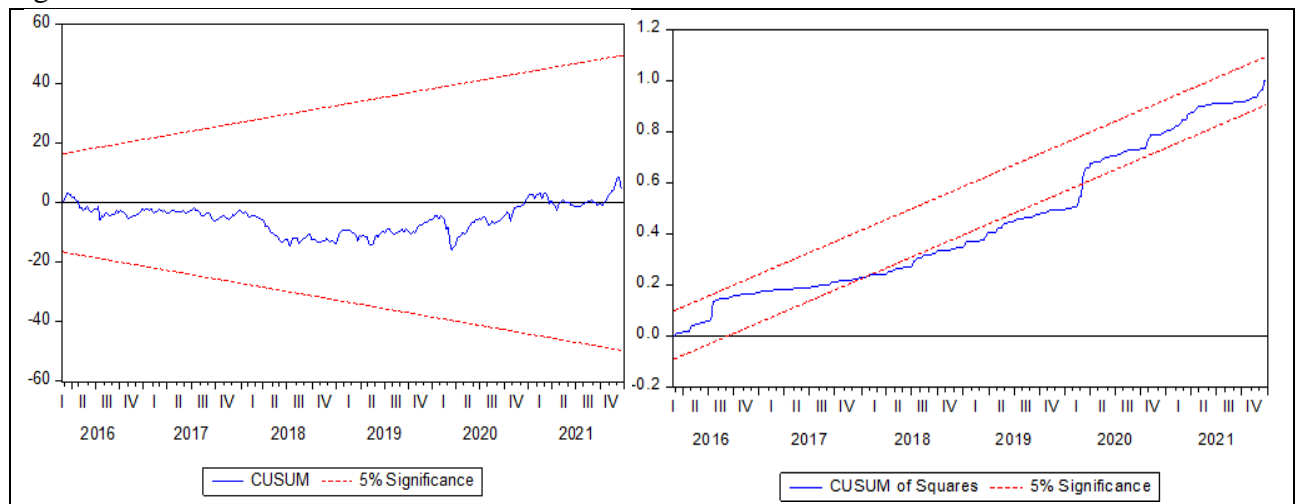

Figure (2): Cumulative sum and cumulative sum square

According to CUSUM the coefficients of system is stable, since the plot lie inside the upper and lower bound with significance level 5%. While, the CUSUM of square is not stable since it touches the lower bound in 2017 and 2019, and show to be out of bounds from 2018 to 2019. And these results indicate that the coefficient of the system is not stabile during this period of time as a result of unexpected change in its structure. However, according to Caporale and Pittis (2004), using of any of ADL make the results robust against any serial correlation or unexpected structural change. However, this discrepancy in results has been explained by Turner (2010) where he argued that the CUSUM will be more powerful if the break is in intercept. At contrary, if the break is in slope coefficient or in error variance the CUSMQ is consider to be more powerful.

4. Conclusion

This study aimed to investigate the relationship and the effect of the change in the trading volume and the exchange rate of the Turkish lira on the closing price of the Istanbul 100 Index. Therefore, weekly data were collected for the index, trade volume and exchange rate for the period 2016-2021, as this period included hot events in the Turkish economy.

After that, we run diagnostic test to ensure that our data fit the necessarily robust characteristics. Thus, we used the unit root test and conclude that the dependent variable is stationary after first difference and other variables are stationary at level and after first difference. Afterwards,

we checked that the residuals are fitting our main condition where it should be serially uncorrelated with homogenous slope.

The ARDL has been used to explore the short and long run relationship and interaction between variables. First, we reported the bound test results and the F-state showed to be significant at 1%, which is mean that our model has a long-run interaction with the dependent variable. Secondly, we run the long-run ARDL test to check the impact of each independent variable on the dependent variable. The results showed that the exchange rate has statistically significant effect on the index price.

The results showed that the exchange rate of the Turkish lira against the dollar negatively affected the price of the Istanbul Stock Exchange index. In other words, if the value of the Turkish lira falls against the dollar, investors will look for more stable investments to maintain the value of their wealth. This shows that the rise in the index price is an unreal increase, but rather an increase in inflation resulting from the depreciation of the Turkish lira against other currencies. While, the trading volume was insignificant in the long-run. However, the results of short run cointegration is different. Where the lag of exchange rate didn't appear on the results which means its lag is zero, whilst the current and lagged value of trading volume were significant. Moreover, the results showed the role of speculators in manipulating in the index stock price. The results showed a difference between the negative and positive impact of the trading volume on the exchange rate. This discrepancy in results has been explained by

Finally, we tested the stability of our model. The results were different between CUSUM and CUSUMSQ. Where they CUSUM results came up to show the stability of coefficient in the model. Nevertheless, the CUSUMSQ showed that we have unexpected change in the structure. This discrepancy in results has been explained by difference in the source of break between the slope, error term or the intercept.

5. Policy and implication

The importance of this study lies in the fact that it explained the effect of the exchange rate on the index price, in addition to clarifying the impact of the demand for stocks by investors. This article recommends the need to maintain the exchange rate of the Turkish lira and try to find alternatives to improve its strength against other currencies to avoid the reluctance of investors to invest in current assets and replace them with long-term investments, or even take their wealth outside Turkey. The study also recommends the necessity of regulating the buying and selling of shares in order to make it more stable and less prone to manipulation by speculators.

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