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The Relationship Between the Exchange Rate and the General Index of the Istanbul Stock Exchange (BIST100) by Machine Learning Application

Adil R N[1,*], Abdul Razzaq H H[1]

[1] Department of Banking and Financial Sciences, College of Administration and Economics, Tikrit University, Tikrit, Iraq

Abstract

The purpose of this research is to understand the type of relationship between the exchange rate for the period (2020-2022) and the Istanbul Stock Exchange index by using machine learning application. This research stems from the assumption that exchange rate fluctuations directly affect the overall market indicator. The interval model of self-regression distribution is used in general market indicators, and the GRANGER test was used to demonstrate the cause-effect relationship among economic variables. Turning to the market index, the study concluded that the exchange rate explains the changes in the general market index (best 100) (97%) and (3%) for variables other than the standard model, and there is a long-term joint integration relationship between the research variables, the result is that the exchange rate explains the changes in the general market index (best 100) (97%) and (3%) for variables other than the standard model.

Keywords: machine learning, exchange rate, market indices, Istanbul Stock Exchange, Turkish lira, (BIST100)

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1. Introduction

The rapid technological progress and the increase in the volume of international trade and capital movements have a role in making exchange rates one of the main determinants of corporate profitability and the prices of their shares because it directly affects the competitiveness of companies through its impact on the prices of inputs and outputs that ultimately lead to fluctuations in the volume of future cash flow that reflects We have stock prices, we can say that exchange rates are one of the most important variables that lead to the fluctuation of the stock index, and whose risks result from fluctuations in the exchange rates of foreign currencies against the local currency, as this effect varies from one country to another and according to the exchange system in place, and that each system has The negatives and positives according to the economic conditions and emergency matters that happen, hence this study came to know The relationship between the exchange rate and the volume index of the Istanbul Stock Exchange and to know its type and trends despite its academic and intellectual controversy.

The exchange rate entered as a new and effective economic variable in the movement of cash flows after the signing of the Bretton Woods Agreement, the International Monetary Fund was established, which led to increased economic cooperation at the international level and the consolidation of International Monetary relations as well as increasing the movement of international capital flows, hence the exchange rate takes its importance because the financial market activity is part of the economic activity. Any fluctuation in it will find an instant resonance in this market.

Exchange rate fluctuations are among the most important risks financial institutions and companies operating internationally and listed on the stock exchange face. These fluctuations directly affect stock prices due to the sensitivity that characterizes these prices and the increasing international diversification and return correlations across markets, and the gradual abolition of flow barriers. Capital and foreign

*Corresponding author. Email: adil.r.nassif@tu.edu.iq / adil.rashed2003@gmail.com

exchange restrictions or the adoption of more flexible exchange rates in emerging countries and countries in transition, these two markets have become interdependent [1], so the change in the value of the currency will inevitably affect stock prices in particular and the market index in general.

It is impossible to determine the tolerance of stock market returns to the change that occurs in macroeconomic variables, because they differ in different countries from young to emerging to developed. However, it is commonly claimed that global variables are more important in illustrating stock returns than local variables. [2] Therefore, the studies explaining the dynamic of the relationship between the exchange rate and the financial market indices differed, where we find some of them suggesting that the depreciation of the country's currency would lead to a decrease in the value of shares for foreign investors, which increases their demand for them, and their circulation increases and their prices rise, and on the one hand On the other hand, the devaluation of the country's currency leads to some local investors who keep local cash balances to get rid of them and go towards investing in stocks, so their price rises and vice versa, and this effect occurs in developed countries that are characterized by the speed of directing investments quickly, while the other part says that the decline The value of the country's currency often leads to an increase in exports and a decrease in imports, which increases the competitiveness of companies and increases the demand for their products. The increase in production volume and the increase in profits positively affect stock prices, but this effect varies between positive for companies that use local raw materials and negative. For companies that use imported raw materials, We will discuss those economic theories that show the relationship between financial market indicators and the currency exchange rate.

The theory of the effect of international exchange or the traditional theory: The author Fisher & Dornbusch (1980) formulated this theory based on the commodity market, Assuming that the exchange rate is often determined by the performance of the trade balance and current account, and this affects the competitiveness of the economy, and then the future cash flows of the stock market are affected by trade and investment, so the ultimate goal is to determine the movement of shares, as it is believed that in the event of a change in the exchange rate, it also changes the direction of movement of share prices.

Theoretically, the decline in the local currency exchange rate increases the competitiveness of companies in global markets, which affects the foreign operations of multinational companies and increases their profits, thus increasing their share prices directly [3], and it also has an impact On the local exporting companies in a positive way, because the depreciation of the currency allows them to export more goods, which increases their profits and raises the prices of their shares. On the other hand, the effect is negative on the imported companies through their lack of imports, which leads to a decrease in their profits and a decrease in the prices of their shares. From here, it becomes clear that the impact of the exchange rate movements, up or down, depends on the importance of foreign trade and the balance of payments in the economy [4].

The portfolio equilibrium theory dates back to Branson and Frankel (1983) and reviews the cause-effect relationship extending from stock prices to exchange rates. An increase in stock prices leads to an increase in demand and, consequently, the increase in interest rates, and this leads to attracting more capital, as it leads to a rise in the value of the local currency and vice versa. In other words, the rise of domestic securities prompts investors to buy domestic assets and sell foreign assets from their portfolios to reap the local currency. The purchase of new domestic notes leads to a high demand for the local currency and attract foreign currency in the currency exchange markets, thereby increasing the value of the local currency [5].

Turkey suffered during the years 1994, 1999, and 2001 from severe financial crises, which led to the collapse of the Turkish lira to its lowest levels and a significant increase in inflation. Furthermore, discussions began about Turkey's accession to the European Union. In addition, structural changes took place in the banking, retail and communications sectors, all of which contributed to the increase in foreign investment, both direct and indirect, and investor confidence in the amendments approved by the Turkish government increased, which increased hope for Turkey's entry into the European Union [6].

After the economic growth achieved as a result of the reforms, it became necessary to make adjustments to the Turkish lira, so the currency regulation law was issued in 2004, which requires the deletion of 6 zeros from the currency, and since then, the new journey of the Turkish lira began, and it became equal to 1.34 against the US dollar.

Economic expectations and strained relations between the United States of America and Turkey in 2018 led to the decline of the Turkish lira from (3.75) to (7), and the process of decline and deterioration of the currency continued, reaching (18.76) at the end of 2022 [7].

Stock indices are adopted on the Istanbul Stock Exchange to calculate the price-return performance of all stocks based on the relevant markets and sectors. Until the end of 1996, Bursa Istanbul only computed BIST 100, financial and industrial price indices. Starting from 1997, the Istanbul Stock Exchange started calculating the indices of the main sectors and sub-sectors based on prices and total return [8].

The best 100 - index is the main index of the Istanbul Stock Exchange and the best 100 consists of 100 companies selected from among the companies traded in the national market, real estate investment funds and investment capital investment funds traded in the collective product market, according to the criteria set by the Istanbul Stock Exchange. The BIST 100 index automatically covers the BIST 50 and BIST 30 index components. The BIST 100 index is also calculated using a volume-weighted average price and a cap of 10% [8].

2. Literature Review

[2] The aim of the study is to investigate the relationship between the returns of the Istanbul Stock Exchange and the Turkish macroeconomic variables. Using the common integration test and Vector error correction (vecm) models on a package of quarterly data, a stable long-term relationship was found between the IES and four macroeconomic variables, GDP, exchange rate, interest rate and current account balance. As a result of testing the cause-effect relationship, we found that there is a unidirectional relationship between the aggregate indicators and the IIS indicator. In line with the current literature, those changes in GDP, foreign exchange rate and current account balances affect the Istanbul stock exchange index. However, contrary to expectations, changes in stock market indices will affect interest rates.

[1] This study uses data on Turkey from February 23, 2001 to January 11, 2008 to investigate the causal relationship between stock prices and exchange rates. The reason for choosing this period is because the exchange rate system is designed to be floating. The National 100 index, the service industry index, the financial index, the Industrial Index and the technology index were used as an indicator of stock prices. The results showed that there is a two-way causal relationship between the exchange rate and all stock market indices. Although there is a negative causal relationship between the National 100 index, the service industry index, the financial index, the Industrial Index and the exchange rate, there is a positive causal relationship between the technical index and the exchange rate. On the other hand, a negative causal relationship of the exchange rate to all stock market indicators is determined.

[3] The aim of this research is to verify the relationship between the exchange rate and stock prices in the money market in Turkey. Granger uses a causal testing method to show the causal relationship between those variables. This research reinforces the previous literature, in the Turkish financial market, using daily observations for the period from 23/2/2001 until 4 /11 / 2009, there is a one-way causal relationship of stock prices affecting exchange rates. However, the model used in this study expands the range of exchange rate variables to include five currencies: the US dollar, the euro, the Japanese yen, the pound sterling, the Swiss franc and two currencies of the Turkish secretariats of foreign trade in them. These results have implications for the view of monetary policy makers and economic actors of stock price movements as dynamic variables, which has an impact on the success of their policies.

[9] This study aims to analyze relationship between the Iraqi stock market index and the parallel Iraqi dinar exchange rate in the market, with the impact of the fluctuations of the stock market index on the foreign exchange rate of the country's currency that fluctuates in the main stock market, using common integration models that have been used recently in analyzing and detecting fluctuations in financial markets in particular and their risks. The research also includes the analysis of the annual data of the state of Iraq for the period (2007-2017).

The research used traditional and applied approaches in discussing and analyzing the relationship between the fluctuations in the financial market and exchange rate fluctuations.

[10] The study aimed to test the effect of changes in the exchange rate and the rate of inflation on the stock market's performance in Egypt. The study concluded that there is long-term equilibrium relationship trending from exchange rate and inflation rates to stock market performance indicators in Egypt (30); the study recommended raising the efficiency of the Egyptian stock market, achieving stability in the exchange rate, and limiting the rise in inflation rates.

[11] The purpose of this research is to understand the theoretical framework of the exchange rate and market indicators that are traded by foreign investors in financial markets, and that the increased risk of exchange rate fluctuations indirectly affect the long-term trading indicators. After clarifying the theoretical aspects related to exchange rates and indicators of foreign investors in the Iraqi financial markets, this research also aims to clarify the exchange rates and indicators of foreign investors in the Iraqi financial markets during the period from 2008 to 2021, and apply the research to the indicators of banks listed on the Iraqi stock market on a case - by-case basis. Purchase prices, selling prices and the total set such as purchase prices and selling prices. Excel Version 16 will be used to analyze the correlation relationship between those variables and to test hypotheses.

[12] The purpose of this research is to propose some measures to measure the performance of the Arab financial markets and to create a model through which macroeconomic variables (exchange rates, inflation, GDP, interest rates, oil prices) can be clarified as indicators to measure the performance of the Arab financial markets (the number of listed companies, annual changes of the price index and the values of shares traded). The size and direction of the impact of (independent) (dependent) variables, and a sample consisting of seven Arab countries (Kuwait, Bahrain, Saudi Arabia, Qatar, Tunisia, the United Arab Emirates, Egypt) for the period from (2011-2019).

To achieve this, the correlation relationship between the study variables was tested, using the Kay box to detect the presence of distortions in the data, using the Shapiro-Wilk test to detect the normal distributions of the study variables, and the weighted minimum results were used to show that exchange rate variables have the opposite effect in all approved research models, while GDP reflects its positive effect in most models and results.

2. Data, methodology and empirical findings

2.1 Study Variables

The study consists of the following variables:
Dependent variable (Y) General Market Index (BIST 100): Each stock exchange has an index by which the general performance is measured, along with other detailed performance indicators such as market value, number of companies, number of deals, etc. (BIST100) is considered the main index of the stock exchange and consists of (100) companies selected from among the companies traded in the national market, real estate investment funds and venture capital investment funds traded in the collective product market, according to the criteria set by the Istanbul Stock Exchange. The index automatically covers the components of the (BIST 50) and (BIST 30) index. The index is calculated using Weighted average prices for volume and maximum by (10%).

The independent variable: the exchange rate (X): which is the number of paid units of the national currency in exchange for obtaining one unit of the foreign currency, and the number of these units is not fixed because it is affected by many factors that lead to a change in that value**.**

2.2 The mathematical formula of the standard model

Due to the different units of measurement of the study variables, we will use the logarithmic mathematical formula for both sides and (Ui) represents the error limit, which is as follows:

$$Log(Y) = B_0 + B_1 log(X) + U_i$$

2.3 Testing the stability of the time series

After drawing the time series, it cannot be judged that it is not stationary except after conducting the unit root test, as this test is performed to ensure that no unreal results are obtained through false regression. The level, whether without a constant or with a constant and a trend or without constant and a trend and after making the first difference, the results proved its stillness and stability, whether without a constant or with a constant and a trend or without a constant and a trend, see Table (1).

Table 1. The result of checking the roots of unity Phelps Peron (PP)

At Level		LOG(Y)	LOG(X)
With Constancy	T_Statstic	2,3303	-0,3587
	Prob	0,8799	0.9226
With Constancy & Trend	T_Statestic	-1,8693	-1,8693
	Prob	0,5924	0,5924
Without Constancy & Trend	T_Statestic	3,0524	3,0797
	Prob	0,8791	0,8791
In the first teams			
		D_(LOG /Y)	D_ (LOG /X)
With Constancy	T_Statestic	-5,6971	-5,1924
	Prob	0,000	0,0002
With Constancy & Trend	T_Statestic	-5,6916	-5,1261
	Prob	0,0002	0,0011
Without Constancy & Trend	T_Statestic	-4,6028	-4,4889
	Prob	0.000	0.000

Table: Prepared by the researcher based on the statistical program (EViews.12).

Due to the stability and stability of the data at the first difference, the automatic distributed delayed time model (ARDL) will be used.

2.4 The impact of exchange rates on the general market index

A. Determine the degree of delay: In order to determine the appropriate degree of delay for the standard model, this is done through (VAR) models chosen according to the commonly used statistical standard (Akaike, Schwarz), as it showed that the best degree of delay is the same for the dependent variable and the independent variable, see Table (2).

Table 2. Degree of slowdown according to the (VAR) model for the variable (Y)

Order selection criteria VAR			
Internal variants – LOG/ Y1-LOG /X			
External variants: C			
informations criterion			
lag	**Akike**	**Schwarez**	**Hennan-Quenn**
1	**0.44109**	**0.53099**	**0,47080**

2	- 4,511033*	- 4,2390*	- 4,4189*
3	- 4,35506	- 3,9020	- 4,2132
4	- ,.15401	- 3,5190	- 3,9409

Table: Prepared by the researcher based on the statistical program (EViews.12).

The following chart, according to (Akaike) criterion, is that there are two models, and the best of them is one degree slowing down for the dependent variable (Y) and (0) for the independent variable.

B. The explanatory power of the model:
Based on the estimated model, its explanatory power through the coefficient of determination was (0.97), meaning that the exchange rates explained (97%) of the change in the general market index (BIST100) and (3%) for other variables outside the standard model. The corrected specification amounted to (0.969), and the model is valid for prediction and planning due to the statistical value (F), which amounted to (534.8), which is significant at the level of (1%), see Table (3).

Table 3. Results of applying the lagging gaps model to the variable of the general market index (BIST100) (Y)

Test	Value		Test	
R-squared	0.97		The coefficient of determination	1
Adjusted R-squared	0.967		Corrected coefficient of determination	2
F-statistic	F-statistic	Prob (F-statistic)	Fisher's test	3
	534.8	0.000		

Table: Prepared by the researcher based on the statistical program (EViews.12).

C. Testing the co-integration relationship of the general market index variable (BIST100): in order to test the existence of a long-term equilibrium relationship between (the exchange rate) as an independent variable and a variable (the general market index (BIST100) as a follower using the F-Bounds Test) as follows in Table (4).

Table 4. Limits test results for the general market index variable [BIST-100]

F-Bounds, Test The nothingness hypothesis: there is no relationship of levels				
Test_ Statestic	Value	Sig	$I_{(0)}$	$I_{(1)}$
F_statestic	5.66394	10%	3.01	3.50
k	1	5%	3.61	4.17

Table: Prepared by the researcher based on statistical program (EViews.12).

From the previous table, it is clear that the value of F-statistic has reached (5.66), which is greater than the upper limit of I(1) and the lower limit of integration I(0) at a significant level (5%), and this indicates the existence of a long-term co-integration relationship between the study variables.

D. The results of the assessment of the short and long-term relationship: The results showed the following:

1. Short-term relationship: The symbol is positive, that is, the direct relationship between the exchanges rate and the general market index, and is based on the t-statistic (2.47), which is significant at the level of (1%), which means the independent variable, the exchange rate, the influence dependent variable, the general index. In addition, an increase in exchange rates by one unit led to an increase in the total market index by (0.22).
2. Parameters of error correction: the error correction value is (-0,136), which is negative at the level of (10%), which means that short-term errors can be corrected and return to the long-term equilibrium position in the events of an impact within the units (14%).The time (Month) is shown in Table (5).
3. Long-term relationship: The symbol is positive, that is, the direct relationship between the exchange rate and the company, and according to the (t-statistics) statistics (3.850), it is significant at the (1%) level, which means that the independent variable exchange rate affects the dependent variable company, and the exchange rate increases by one unit one, which leads to an increase in the company (1.66).

Table 5. The results of the assessment for the short and long terms of the impact of exchange rates on the general index of the market

ARDL long-term shape and boundary testing Case-2 (Bound constant and no direction)				
the dependent variables - DLOG /[Y1]				
(Short Run Equation)				
Variables	Coefficint	Std,Error	T_ Statestic	Prob
C	0.522344	0.390912	1.33E+0	0.1909
LOG(Y1[-])*	-0.14047	0.076987	-1.75904	0.0901
LOG[X]**	0.228091	0.092024	2.473093	0.0209
(Long Run Equation)				
LOG/ [X]	1.666002	0.433025	3.851046	0.0015
C	3.827006	0.897038	4.269027	0.0012

Table: Prepared by the researcher based on the statistical program (EViews.12).

E. Diagnostic tests:

A. Self-correlation test: The results showed that the probability values of the self-correlation test (Breusch-Pagan LM) amounted to (0.745), which is greater than the level of significance at (5%) of the problem.
B. Test of heterogeneity of variance: the probability values of the statistical heterogeneity of variance test (Breusch-Pagan-Godfrey) reached (0.309), which is greater than the level of significance at (5%), The estimated problem, see Table (6).

Table 6. First model diagnostic test

Brush-Godfrey Chain link			
NH : There is no series correlation			
F_statestic	0,295941	Prob F- [2,29]	0,7459
Heteroskedasticity, ARCH			
F_statestic	1,065011	Prob_ F- (1. 32)	0,3089

Table: Prepared by the researcher based on statistical program (EViews.12).

2.5 Causal Relationship Test

The results of the Granger test for analyzing the relationship between the study variables showed that there is a unidirectional causal relationship, since the exchange rate causes the Corporate Index (best 100), that is, (x y 1), and the Corporate Index (best 100) does not cause the exchange rate at a significant level (5%), see Table (7).

Table 7. Causal relationship test

Pairwise Granger Causality Tests Lag ; 2			
NH	N	F-Statestic	Prob.
LOG_ [X] _ It does not have a Grange Cause / LOG_[Y]	34	3,58706	0,0416
LOG_ [Y1]_ It does not have a Grange Cause _[X]		0,27909	0,7606

Table: Prepared by the researcher based on the statistical program (EViews.12).

Conclusions

i) There is a direct relationship between the exchange rate of the Turkish lira and the general index of the BIST100 market, and this is consistent with the traditional economic theory, where the decline in the values of the country's currency would make stock prices lower for foreign investors, which would increase the demand for them and thus increase their circulation and increase their prices, either from the side of the investors Locals who keep local cash balances aim to protect their savings. Stocks are considered safe havens, which also increases stock prices, and vice versa.

ii) Exchange rates explained (97%) of the change in the general index of the market (BIST100) and (3%) to other variables outside the standard model, and there is a long-term co-integration relationship between the variables of the study.

iii) The results of the tests showed that there is a one-way causal relationship from the exchange rates to the main index in the Istanbul Stock Exchange, while the general market index (BIST100) does not cause the exchange rate to be at a significant level (5%).

Recommendations

i) The exchange rate policy is considered one of the most important policies of the central bank because of its importance in economic stability and achieving external and internal balances of the economy while following it with other complementary policies, as the central bank must carry out evaluation procedures to indicate the benefits and drawbacks of its decisions on the performance of financial markets.

ii) Work to achieve stability in the exchange rate and limit the rise in inflation rates because these two variables are considered among the most important indicators of economic stability whose effects will be reflected on investment decisions, whether real or financial, and thus on stocks. The researcher believes that this can be achieved by working to increase interest rates.

iii) Through the study results, the researcher recommends the possibility of continuing the study in these two variables because the relationship differs from one country to another and from one period to another.

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