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## An economical analysis for the impact of exchange rate changes on the rate of inflation in Egypt

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**Abstract:** The research aimed to measure the impact of exchange rate changes on the rate of inflation in Egypt, through; (1) Study the evolution of the nominal exchange rate of the EGP against the dollar and annual inflation indicators during the period (2000-2019), (2) Create a standard model to measure the exchange rate change effect on the inflation rate. The research depends on the use of some descriptive and quantitative statistical analysis methods, and specifically; (1) Time series tests, which include: Dickey-Fuller test, and Co-Integration test for Johansen and Jusellius, (2) Vector error correcting model, (3) The model quality tests, which include: LM test, and Jarque-Bura test, (4) Granger Causality test. The research is based on published secondary data from the websites of the international information network represented by the FAO and World Bank, and the data was analyzed on the computer using the two programs SPSS$_{V.16}$, Eviews$_{V.10}$.

**Keywords:** Exchange rate, Inflation, Co-Integration, Error Correction Model, Granger Causality and Egypt.

## 1. Introduction:

The exchange rate for the different currencies is one of the major factors on which the economies of any country in the world depend on, whether it is developed or developing ones, Where it is considered one of the economic and financial indicators that express the quality of the country's economic performance because it greatly affects the various trade operations that happens periodically between countries and some of them as a result of determining the price of the currency that is dealt with in a country compared to its price in another one, the importance of changes in currency exchange rates is due to the fact that they are a link between international economies and a clear measure of the volume of their transactions[1], where the state reduces the value of its currency in relation to the value of other currencies, this leads to economic problems at the local level of countries and at the global level as well, especially after the currencies of developing countries were linked to the currencies of developed countries, which made the latter economically control them through the strength of their main currency[2].

Inflation is one of the most economic problems that nations suffer from, as it affects production, distribution of economic resources and the country's external relations with other countries. A group of internal and external factors affect inflation rates based on the economy of each country and the extent

of openness with the world outside, whereas the countries which don't have a huge production capacity that relies on debt to cover expenses, therefore any increase in spending is reflected in the rise in the general level of prices, which leads to the devaluation of the local currency and weakens the state's ability to plan for the future efficient, which leads to the unwillingness on the part of the economic sectors to produce Long-term and negative impact on economic growth rates[3].

### Context of the problem:

Although the Central Bank of Egypt took a sudden decision on November 3, 2016 to liberalize the exchange rates of the Egyptian pound against foreign currencies and leave the market forces to control the determination of trading prices daily according to the conditions of supply and demand as an item of a set of economic reforms, which also included imposing the value-added tax instead of the sales tax, and the gradual abolition of subsidies on energy and electricity, which the state implemented in exchange for its agreement with the International Monetary Fund in early 2016 to take a loan of about 12 billion US dollars, but this led to a noticeable increase in prices of commodities and services as a result of a rise the U.S. dollar price from about 8.9 pounds to about 18 pounds in the same year, and thus the value of the Egyptian pound fell by almost half within a few days, which led to the annual inflation rate in the general level of prices reaching

unprecedented rates, despite the decline in the price of the US dollar to about 15.67 pounds in 2021[4], but the annual inflation rate in the general level of prices is still high.

**Research objectives:**

The research mainly aims to measure the impact of exchange rate changes on the rate of inflation in Egypt, through the following sub-objectives; (1) Study the evolution of the nominal exchange rate of the EGP against the dollar and annual inflation indicators during the period (2000-2019), (2) Create a standard model to measure the exchange rate change effect on the inflation rate, (3) Reaching a set of proposals that benefit decision makers to improve the inflation rate in the light of devaluation of the Egyptian pound value.

**Research method:**

In achieving its objectives, the research depends on the use of some descriptive and quantitative statistical analysis methods to analyze the data related to the topic of the research, and specifically the following methods and models were used: (1) Simple regression shows the impact of the ex. rate change on inflation in the national economy, (2) Time series tests, which include: Dickey-Fuller test to ensure the stability of time series, and Co-Integration test for Johansen and Jusellius to find out whether there is a balance or a long-run relationship between the variables or not, (3) Vector error correcting model is done its estimate after making sure that there is a vector of co-integration between the variables, (4) The model quality tests, which include: LM test to ensure that there is no autocorrelation between the residuals of the model and Jarque-Bura test to reveal the nature of the distribution of residuals of the model, (5) Granger Causality test after making sure there is Co-Integration to find out the direction of the causal relationship between the variables is in one direction only or in two directions.

**Data sources**:

The research is based on published secondary data from the websites of the international information network represented by the FAO and World Bank, and the data was analyzed on the computer using the two programs SPSS$_{V.16}$, Eviews$_{V.10}$.

**Previous studies and theoretical framework:**

**-Previous studies**:

The most important research and studies related to the topic of research can be identified in the following, to know the most important results that it reached, as follows:

The study of Aljarrah [5] aimed to identify the factors that cause inflation in Saudi Arabia during the period (1970-2007). The study used the descriptive, quantitative and standard analysis methods. The results of study indicated the most important factors for the inflation rates in short and long run which acted in the international prices of exports, the production of the industrialized world, and the degree of economic openness, it also indicated that monetary policy plays an vital role in influencing the rate of inflation.

The study (Jabouri and Baraka, 2014)[6] aimed to identify the extent to which exchange rate systems have an effect on inflation, to identify any of them or those systems that lead to less inflation. The study used the descriptive analytical approach and the standard approach to test the effect of ex. rate systems on inflation. The results indicated that there was a negative and significant effect of fixed exchange rate systems on inflation rates, as these systems provided the best inflationary performance.

The study of Maryam Hashem [7] aimed to know the determinants of inflation in Malaysia. The study used a stepwise regression analysis to study the relationship between inflation and the most important economic variables affecting it. The results of the study indicated that there is a direct positive relationship between inflation and money supply, and an inverse negative relationship between inflation and the GDP, interest rate, and government spending, while it was found that there was no relationship between inflation and imports, the study recommended the necessity of including other variables in the estimated model such as: exchange rate, discount rate, unemployment rate, government revenues, private consumption, and exports Which could explain inflation in Malaysia.

The study of Albashir [8] aimed to determine the factors affecting inflation in Sudan. The study used the descriptive, quantitative and standard methods. The results of the study showed the existence of a direct positive relationship between the inflation rate and each of: the exchange rate, the amount of money Circulation, government spending and imports and there is an inverse negative relationship between inflation and the GDP. The study also indicated that there is a long run equilibrium relationship between the inflation rate and the factors affecting it, and the study recommended the need to control the parallel exchange rate to achieve balance in the exchange market, and to follow acontractionary fiscal policy by reducing government spending and increasing taxes

The study of Elhusseini [9] aimed to measure the effect of exchange rate liberalization on inflation of the Egyptian economy, especially the agricultural sector. The study used both descriptive and inferential analysis in analyzing secondary and primary data. The study results indicated that the annual inflation rate has increased obviously from

beginning of the exchange rate implementation in November 2016, where the average for the second period of exchange rate liberalization (December 2016-May 2018) reached 23.4%, compared to 12.6% for the first period preceding the exchange rate liberalization decision (January 2015-October 2016). The statistical significance of the impact of the liberalization of the ex. rate on the general level of prices in Egypt was revealed.

-**Theoretical framework:**

The theoretical framework of the research includes two parts, the first is to identify the types of the exchange rate, its tools, its objectives, the factors affecting it, and the development of the exchange system in the Egyptian economy, and the second is to identify the concept of inflation, its types, standards and indicators, and the relationship of the exchange rate change to it, as follows:

**A) Types of the exchange rate, tools, objectives, factors affecting it, and the evolution of the exchange system in the Egyptian Economy[10, 11]:**

**(1)Types of the exchange rate:**

There are many concepts of the exchange rate, which are represented in four different types, as shown below:

**1-1 Nominal exchange rate**:

It is defined as the relative price of a monetary currency compared to another, it is the no. of units of the Egyptian pound that we need in order to obtain a foreign currency, and it is determined according to the amount of demand and supply for the monetary currency in the exchange market at a particular moment in time. It is divided into two types: the official exchange rate (the rate applicable in official commercial exchanges), and the parallel exchange rate (the rate applicable in parallel markets).

**1-2 Real exchange rate:**

It expresses the number of units of foreign commodities needed to purchase 1 unit of the domestic commodities, and the increase in this indicator indicates that the exported commodities suffer from a weak ability to compete with foreign commodities, while the decrease indicates an increase in the ability of the exported commodities to compete with foreign commodities.

**1-3 Actual exchange rate:**

It is the amount of change in the ex. rate of a particular currency against other currencies during a certain period of time, and therefore it is equal to the average of several bilateral exchange rates, which indicates the range of the evolution of currency price with the others.

**1-4 The real actual exchange rate:**

It is an average of the changes in the exchange rates of bilateral currencies, and it reveals the extent of the country's competitiveness in an external competitive environment.

**(2) Exchange Rate Tools:**

The most important exchange rate tools are:

**2-1 Currency exchange rate adjustment:**

In the event that the authority wants to rebalance the balance of payments, it works to reduce or reevaluate the currency in the case of a fixed exchange rate, while working to improve or deteriorate the currency in the case of a floating exchange rate. The devaluation policy is widely used to encourage exports.

**2-2 Use of exchange reserves:**

Monetary authorities resort to maintain the exchange rate of their currency at fixed exchange rates. When their currency collapses, they sell their hard currencies against the local currency, and when the value of the currency improves, they buy foreign currencies against the local currency.

**2-3Using the interest rate**:

In the event that the value of the currency is weak, the Central Bank will adopt a high interest rate policy to compensate for the risk of currency collapse.

**2-4 Exchange control:**

It is the subjecting of purchases and sales of hard currency to a special license, and it is used to resist the outflow of capital.

**2-5Establishing a multiple exchange rate:**

To reduce the effects of fluctuations in the markets, and directing trade policy to serve some specific purposes.

**(3) Objectives of the exchange rate policy:**

The most important objectives of the exchange rate policy are as follows:

**3-1 Inflation resistance:**

An increase in the exchange rate leads to a decrease in the level of imported inflation and an improvement in the level of competitiveness of institutions. In the short term, the decrease in import costs will have a positive effect on the decrease in the level of imported inflation.

**3-2 Resource Allocation:**

The real exchange rate leads to change resources to the international export-oriented commodities sector, leading to an increase in the number of exportable commodities.

**3-3 Income distribution:**

The exchange rate plays an important role in the distribution of income between local groups or sectors. When the competitiveness of the traditional export sector (raw materials or agricultural) rises as a result of the decrease in the real exchange rate, this makes it more profitable, and the profit returns to the owners of capital. The purchasing power of wages

decreases, while when the nominal exchange rate decreases, the purchasing power of wages rises.

**3-4 Development of local industries**:

The Central Bank can lower the exchange rate to encourage the national industry, protect the local market from external competition and encourage exports.

**(4)Factors affecting the exchange rate:**

The most important factors affecting the exchange rate are as follows:

**4-1 Relative price levels:**

According to the purchasing power parity theory, when the prices of local commodities rise, the demand for local commodities decreases and the price of the local currency tends to decline, and therefore the sale of imported commodities is continued in a good way and vice versa.

**4-2Tariffs and quotas:**

Both tariffs (taxes on imported commodities, for example) and quotas (restrictions on the amount of commodities that can be imported) affect the exchange rate, which causes an increase in demand for a domestic good.

**4-3 Preferring foreign commodities over domestic commodities:**

Increasing demand for a country's exports causes the raise of the currency value in the long run, while increased demand for imports causes the local currency to depreciate.

**4-4 Productivity**:

If the country is more productive than other countries, it can reduce the prices of local commodities in relation to the prices of foreign commodities, which leads to an increase in demand for local commodities and an increase in the price of the local currency, so that the country makes profits.

**(5) The development of the exchange system in the Egyptian economy**:

It is possible to distinguish between five stages of the development of the exchange rate in Egypt, and they are as follows:

**-The first stage (before May 1987):**

In 1969, Egypt adopted a multi-system of exchange rates with the aim of absorbing the adverse effect resulting from the impact of evaluation the exchange rate and its impact on its ability to compete with the outside world, in addition to the government's dependence on remittances of workers in abroad as a source of foreign exchange with the inability to control these flows, and at the end of 1976 the foreign exchange market was divided into three complexes, the first of which is the Central Bank complex, which is concerned with the transactions of the central government, and the second is the complex of commercial banks, whose proceeds are the remittances of Egyptians working

abroad and export returns and tourism revenues, and the third is the non-banking free market, which contributed to attract some revenues and tourism revenues during managing private sector transactions.

**-The second stage (May 1987-February 1991):**

As a result of a constant rise in the real exchange rate of the Egyptian pound, which led to an increase in the difference between the rates of the various previously mentioned complexes, the government in May 1987 established a new ban in the foreign exchange market that was Setting an initial price of about 2.165 pounds per US dollar, which led to the cancellation of the complex price of approved banks and the encouraging rates and allowing the establishment of exchange companies, in addition to stop the complex of commercial banks in March 1989, which resulted in the continued depreciation of the foreign exchange rate until it reached the banks About 3 pounds for every US dollar at the end of 1990, and with the beginning of 1991 the value of the effective real exchange rate rose significantly, which led to a decline in the competitive position of the economy.

**-The third stage (March 1991-December 2002):**

The multiple exchange rate system was abolished at the beginning of March 1991, and in October of the same year a unified exchange rate was introduced and the Egyptian pound was exchanged in a single exchange market, and there was a noticeable rise in the real exchange rate index as a result of the unification and liberalization of the foreign exchange market until 1999, but as a result of effective pressure on the nominal value of the official exchange rate, which began in mid-1999, this led to the real exchange rate declining again.

**-The fourth stage (January 2003- 2015):**

The government reported for the first time to liberalizing the exchange rate (floating the Egyptian pound) and moving to an exchange rate determined according to supply and demand, and consequently the depreciation of the pound to reach about EGP 5.40 in January 2003, due to some reasons, which is the most important is the events of South East Asia, which caused the depreciation of the currencies of a number of those countries, which prompted Egyptian importers to import from them and this led to an increase in the demand for the dollar locally and the flight of capitals outside Egypt, and as a result of the Luxor accident in Nov. 1997, this led to the exit of part of the for foreign investments from the Egyptian Exchange which leads to increase the demand on the dollar and the foreign exchange market shifted from achieving a surplus in 1991 to a deficit in 1998 and is still continuing until now.

**-The fifth stage (January 2016- 2021):**

Egypt adopted the second liberalization of the exchange rate in November 2016 to achieve a set of goals in the Egyptian foreign policy, perhaps the most important of them are: (1) Reduce the budget deficit and public debt, (2) Reduce the demand for imports and stopping random imports, (3) Increase exports and encouraging domestic and foreign investment, (4) Eliminate the phenomenon of speculation on the dollar on the black market, (5) Increase the central bank's ability to provide the dollar to fill the import gaps in basic and strategic commodities, (6) Move the Egyptian Exchange, which witnessed the exit of a large part of the liquidity to speculate on the dollar, (7) The decline in inflation rates in the medium and long run, and this led to increasing the U.S. dollar price to about L.E. 18 in the same year, but it decreased in the last years and reached to about L.E. 15.67 in 2021.

**(B) Definition, types, measures and indicators of inflation[12]:**

**(1)Definition of Inflation**:

Inflation is defined as a dynamic process in which a continuous rise in the general price level occurs during a certain period of time as a result of an imbalance between total demand and total supply in production factors or final commodities.

**(2) Types of inflation:**

Economists distinguish several types of inflation, and they can be identified after dividing them according to the following:

**2-1 According to the degree of state control over prices**:

Two types of inflation can be distinguished: Open Inflation, which means the continuous actual raising in the general level of prices without a government intervention, and Suppressed Inflation which the government intervention happens directly through put upper limits to the commodities prices.

**2-2 According to the severity of inflationary pressures:**

Two types of inflation can be distinguished: Creeping inflation, which means the slow rise in the price level, and galloping inflation, which means the rapid and successive rise in prices, and it is one of the most dangerous types of inflation.

**2-3 According to the sources, causes and conditions conducive to inflation**:

Three types of inflation can be distinguished: Extraordinary inflation, which results from unusual conditions such as volcanoes, earthquakes or the spread of epidemics, and Demand Inflation, which means an increase in the total demand for commodities and services in the country of the real supply of them is when the economy reaches the stage of full employment, while the cost inflation is the inflation that results from the increase in costs as a result of the increase in the costs of production resources at a rate greater than the increase in production rates, which leads to a rise in the general prices level.

**2-4 According to the criterion of international economic relations**:

It is possible to distinguish between two types of inflation: Export Inflation, which means the rise in prices as a result of the increase in monetary reserves of central banks of dollars known as the base of payment in dollars, and Import Inflation, which means the rise in prices as a result of the global flow to it through imports.

**(3) Inflation measures and indicators:**

There are several measures and indicators of inflation, which can be reviewed as follows:

**3-1Producer Price Index (PPI)**:

It expresses the change in the level of basic prices paid to local producers for commodities and services that they produce upon delivery from the place of production.

**3-2Consumer Price Index (CPI)**:

It expresses the change in the prices level of commodities and services in retail markets during a specific period of time, and it reveals the impact of price changes on the purchasing power of the consumer.

**3-3Implicit Price Index (IPI)**:

It is expressed by dividing Gross National Income at current prices in a particular year by GNI at fixed prices in the same year.

**3-4Core Inflation Rate**:

It is derived from the consumer price index excluding some commodities whose prices are administratively affected and some commodities that are affected by temporary supply shocks.

**3-5Monetary Stability factor**:

It is expressed by dividing the rate of change in domestic liquidity by the rate of change in real gross national product.

**3-6 Excess Demand criterion**:

It is the total national spending at current prices minus the gross domestic product at fixed prices.

**(C) The relationship between a change in the exchange rate and the level of inflation[13]:**

According to the Purchasing Power Parity theory of the Swedish economist Gustav Cassel, the exchange rate of the local currency against other currencies decreases in the same ratio, which as the general level of prices raised (inflation), as the rise in the level of domestic prices compared to the level of international prices leads to an increase in imports and an increase in demand for foreign currency, and a decrease in exports and the supply of foreign exchange and thus increases the foreign exchange

rate. The effect of the ex. rate change on the level of inflation can be demonstrated through the following:

(1) **Using a fixed exchange rate**:

Proponents of using a fixed exchange rate system have pointed out that it works to get rid of the problem of inflation permanently, by restricting monetary policy with a fixed exchange rate system because this increases confidence in maintaining the local currency and stimulates an increase in demand for it, which leads to maintain low rates of inflation, which leads to low rates of money circulation and a rapid decline in interest rates.

(2) **Reducing the exchange rate**:

Decreasing the exchange rate leads to a rise in domestic prices and thus an increase in the rate of inflation, and the extent of the impact varies from one country to another according to each of the nature of the problems facing the national economy of each country, the difference in the economic and social structure of the state, which indicates that the most important effects of inflation to reduce the exchange rate  which can be summarized in the rise in the prices of imported production necessities and the prices of imports of commodities, which leads to competition in the manufacture of alternatives to local imports, in addition to increasing the financial incomes due to the increase in the volume of financial transfers from abroad, the high demand for the local product, as well as the increase in profits of workers in the trade sector external.

**Results and Discussion:**

**First: The evolution of the nominal exchange rate of the Egyptian pound against the dollar, and annual inflation indicators during the period (2000-2019).**

It is clear from the data in "Table (1)" and shown in "Figure (1)" that:

The nominal exchange rate ranged between a minimum of about 3.47 pounds/dollars in 2000, and a maximum of about 17.78 pounds/ dollars in 2017[14] as a result of the Central Bank's decision to liberalize the rate of exchange on November 3, 2016. The nominal exchange rate increased at a statistically significant annual growth rate of about 6.7% of the arithmetic average for the research period of about 7.69 pounds/$. The inflation rate ranged between a minimum of about 2.26% in 2001 and a maximum of about 29.51% in 2017[15]. Inflation increased at a statistically significant annual growth rate of about 8.2% of the geometric mean for the research period, which is about 8.35%.

**Table (1): The evolution of the nominal exchange rate of the Egyptian pound against the dollar, and annual inflation indicators during the period (2000-2019).          2010=100**

| Years | The nominal ex. rate between the Egyptian pound and the dollar (EGP/USD ) | General Consumer Price Index (%) | Inflation rate according to the consumer price index(%) |
|---|---|---|---|
| 2000 | 3.47 | 45.08 | 2.69 |
| 2001 | 3.97 | 46.10 | 2.26 |
| 2002 | 4.50 | 47.36 | 2.73 |
| 2003 | 5.85 | 49.50 | 4.52 |
| 2004 | 6.20 | 55.08 | 11.27 |
| 2005 | 5.78 | 57.76 | 4.86 |
| 2006 | 5.73 | 62.17 | 7.64 |
| 2007 | 5.64 | 67.97 | 9.33 |
| 2008 | 5.43 | 80.42 | 18.32 |
| 2009 | 5.54 | 89.88 | 11.76 |
| 2010 | 5.62 | 100.00 | 11.26 |
| 2011 | 5.93 | 110.06 | 10.06 |
| 2012 | 6.06 | 117.89 | 7.11 |
| 2013 | 6.87 | 129.06 | 9.47 |
| 2014 | 7.08 | 142.05 | 10.06 |
| 2015 | 7.69 | 156.78 | 10.37 |
| 2016 | 10.02 | 178.44 | 13.82 |
| 2017 | 17.78 | 231.09 | 29.51 |
| 2018 | 17.77 | 264.38 | 14.40 |
| 2019 | 16.77 | 288.70 | 9.20 |
| Average | 7.69 | - | 8.35[1] |
| Annual change rate (%) | 6.7** | - | 8.2** |

**(\*\*) indicates statistical significant at the 0.01 level.          (1) Geometric mean.**

**Source: compiled and calculated from:**

**https://databank.worldbank.org/databases. http://www.fao.org/faostat/en/#data.**
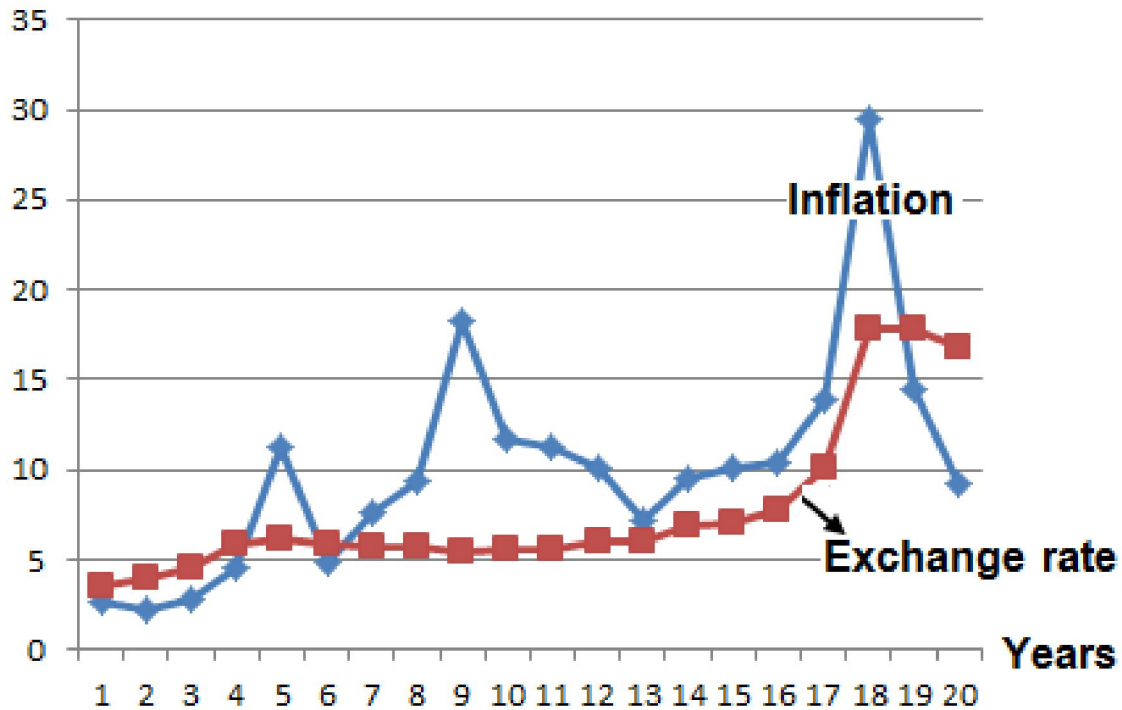
**Figure (1): Evolution of the nominal exchange rate and inflation rate in Egypt during the period (2000-2019). Source: Table (1).**

The results presented in "Table (2)" show the impact of the exchange rate change on inflation in the national economy, where the standard estimate of the regressive relationship between the exchange rate of the dollar in the pound as an independent variable, and the general of consumer price index as a dependent variable, in addition to the dollar exchange rate in the pound as an independent variable, and the annual inflation rate as a dependent variable, where the value of the coefficient of determination was about 0.863, 0.368, respectively, which means that the change in the dollar exchange rate in pounds explains about 86.30%, 36.80% of the change in the previous variables, respectively, and the estimated regression coefficients indicate that the dollar exchange rate change by 1 EGP leads to a change of the previous variables by about 15.67%, 0.890%, respectively. The significance of the two models was confirmed at the probability level 0.01 based on the (F) value, and the significance of the estimated regression coefficients was confirmed at the 0.01 probability level based on the (t) value of each variable.

**Table (2): Standard estimation of the impact of the change in the nominal exchange rate of the EGP against the dollar on the most important annual inflation indicators during the period (2000-2019).**

| Statement | Equation | $R^2$ | F |
|---|---|---|---|
| The effect of the exchange rate change on the general consumer price index | $Y= 4.65 + 15.67\ X$ $(10.99)^{**}$ | 0.863 | $120.95^{**}$ |
| The effect of a change in the exchange rate on the annual inflation rate | $Y= 3.21 + 0.89\ X$ $(3.48)^{**}$ | 0.368 | $12.08^{**}$ |

**(\*\*) indicates statistical significant at the 0.01 level.**
**Source: The results of analyzing the data contained in Table (1) on the computer using the SPSS$_{V.16}$ program.**

**Second: The standard estimation of the exchange rate change effect on the inflation rate**

The relationship between the exchange rate change (the value of the Egyptian pound in dollars) and the rate of inflation can be studied by studying several variables that affect inflation (Y) according to economic theory during the period (2000-2019), and these variables are represented in 6 variables, namely: the nominal exchange rate between the Egyptian pound and dollar $(X_1)$, money supply in billion dollars at current prices $(X_2)$, lending interest rate (%) $(X_3)$, degree of economic openness $(X_4)$ which is come from total exports and imports divided by GDP, Gross domestic product in billion dollars at current prices $(X_5)$, and total government spending in billion dollars at current prices $(X_6)$, and the model takes the mathematical form in the following logarithmic form:

$$Log(Y)= C + Log(X_1) + Log(X_2) - Log(X_3) + Log(X_4) - Log(X_5) + Log(X_6)$$

Because these variables represent a set of regular series of observations arranged in time to describe the change and evolution of each variable over time, it was necessary before the standard estimation of the relationship between these time series to be static or stable at their level or at the first or second differences so that models, methods and traditional econometric methods can be used, therefore the following steps must be taken:

**(A) Data examination and processing:**

This is done by testing the stability of the time series and the co-integration of the data as follows:

**(1)Unit root test for research variables:**

Based on the Null hypothesis that the time series are not static, the Augmented Dickey-Fuller Test was conducted in the case of a break and a trend[16]. The results presented which in "Table (3)" related to the (ADF) test show that time series values to all variables are not stable at their level, as the calculated absolute values of the ADF test are less than the critical values at the probability level of 0.05, after taking the logarithm of the variables, and accordingly the null hypothesis that says the existence of a unit root, i.e. the instability of those series, can be accepted, and by re-testing the variables at the first differences which is stable, which means rejecting the null hypothesis and accepting the alternative hypothesis that there is no unit root, and therefore the time series are static and devoid of the problem of instability, which means that the time series are integrated of the first degree during the research period, which allows the application of the co-integration test.

**Table (3): Results of the Augmented Dickey-Fuller Test for the research variables.**

| Variables | Level | 1$^{st}$ Difference |
|---|---|---|
| Inflation rate according to the consumer price index (%) (Y) | -2.40 | -5.04$^{**}$ |
| | -4.53(1%) | -4.57(1%) |
| | -3.67(5%) | -3.69(5%) |
| The nominal exchange rate between the Egyptian pound and the dollar (EGP/USD) $(X_1)$ | -1.08 | -3.89$^{*}$ |
| | -4.53(1%) | -4.62(1%) |
| | -3.67(5%) | -3.71(5%) |
| Money Supply in billion dollars at current prices $(X_2)$ | -3.39 | -4.15$^{*}$ |
| | -4.73(1%) | -4.80(1%) |
| | -3.76(5%) | -3.79(5%) |
| Lending interest rate (%) $(X_3)$ | 1.32 | -4.14$^{*}$ |
| | -4.62(1%) | -4.80(1%) |
| | -3.71(5%) | -3.79(5%) |
| Degree of economic openness $(X_4)$ | -1.81 | -3.95$^{*}$ |
| | -4.53(1%) | -4.57(1%) |
| | -3.67(5%) | -3.69(5%) |
| Gross Domestic Product in billion dollars at current prices $(X_5)$ | -1.67 | -3.87$^{*}$ |
| | -4.62(1%) | -4.57(1%) |
| | -3.71(5%) | -3.69(5%) |
| Total government spending in billion dollars at current prices $(X_6)$ | -2.91 | -3.80$^{*}$ |
| | -4.53(1%) | -4.57(1%) |
| | -3.67(5%) | -3.69(5%) |

**(*) indicates statistical significant at the 0.05 level. (**) indicates. statist. significant at the 0.01 level.**
**Source: Results of data analysis using E-views$_{v.10}$.**

**(2) Determining the lag period:**

It is clear from the data in "Table (4)" for determining the lag periods based on the var lag test that all criteria have agreed to rely on one lag period for the proposed model.

**(3) Co-integrating Test:**

Co-integration refers to the method of obtaining an equilibrium or a long run relationship between unstable variables, and the number of integration vectors between the variables is determined based on the Johansen test, which depends in its application on the Maximum Likelihood method of more than two variables and this is done through two types of tests: Trace statistic and Max-Eigen statistic [17].

In the event that there is a co-integration between the variables, this means correcting the path of the dependent variable according to the path of the independent variable and according to the random error in previous periods, therefore the change in the dependent variable is related to the change in the independent variable which is also linked to the random error limit, therefore if the test value is more than the critical value at the probability level is 0.05. We reject $H_0$ and the statement that there is no co-integration, and we use a mechanism that prevents the random error resulting from the regression equation of variables from deviating away from its long-run average, which is equal to zero, which is the mechanism called the error correction mechanism[18].

**Table (4): Results of Var lag test to limit lag period for Model**
VAR Lag Order Selection Criteria
Endogenous variables: LOGY $LOGX_1$ $LOGX_2$ $LOGX_3$ $LOGX_4$ $LOGX_5$ $LOGX_6$
Exogenous variables: C
Sample: 2000 2019
Included observations: 19

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|-----|------|----|----|-----|-----|-----|
| 0 | 209.2808 | NA | 1.34e-18 | -21.29272 | -20.94477 | -21.23383 |
| 1 | 385.2955 | 203.8064* | 3.08e-24* | -34.66268* | -31.87907* | -34.19158* |

**\* indicates lag order selected by the criterion.**
**LR: sequential modified LR test statistic (each test at 5% level).**
**FPE: Final prediction error.**
**AIC: Akaike information criterion.**
**Source: Results of data analysis using E-views$_{V.10}$.**

It is clear from the data in "Table (5)" regarding the results of the Johansen test for the statement of co-integration on the logarithm of the variables after taking the first differences for them, the existence of co-integration based on the rejection of $H_0$, which says that there is no co-integration between the set of variables under investigation, whether according to the value of Trace Statistic or the value of Max Eigen Statistic, and their values indicate the presence of 4 vectors of co-integration at

the probability level of 0.05, which indicates that all-time series of the variables are stable and there is a static linear combination between those variables, in addition to make sure that there is a long run equilibrium relationship between inflation and factors which affected on, this means that these variables cannot be separated from each other in the long run, to determine the nature of this relationship, VECM must be estimated.

**Table (5): The Johansen test results for Co-integration.**

| Eigen value | Trace Statistic | 0.05 Critical Value | Max-Eigen Statistic | 0.05 Critical Value | $H_0$ | Decision |
|-------------|-----------------|---------------------|---------------------|---------------------|-------|----------|
| 0.989681 | 221.3308 | 125.6154 | 86.90155 | 46.23142 | r= 0** | Reject $H_0$ at 1% |
| 0.885699 | 134.4293 | 95.75366 | 41.20940 | 40.07757 | r≤ 1** | Reject $H_0$ at 1% |
| 0.840050 | 93.21989 | 69.81889 | 34.82501 | 33.87687 | r≤ 2** | Reject $H_0$ at 1% |
| 0.764543 | 58.39489 | 47.85613 | 27.47833 | 27.58434 | r≤ 3* | Reject $H_0$ at 5% |
| 0.626834 | 28.91656 | 29.79707 | 18.72888 | 21.13162 | r≤ 4 | Accept $H_0$ |
| 0.358003 | 12.18768 | 15.49471 | 4.420254 | 14.26460 | r≤ 5 | Accept $H_0$ |
| 0.179864 | 3.667425 | 3.841466 | 3.667425 | 3.841466 | r≤ 6 | Accept $H_0$ |

**(\*) indicates statistical significant at the 0.05 level. (\*\*) indicates. statistical significant. at the 0.01 level.**
**Source: Results of data analysis using E-views$_{V.10}$.**

**(B) Vector Error Correction Model:**
**(1) Estimation of the Model:**
By stabilizing the time series of the variables at the first differences after taking the logarithm, and after making sure that they have four co-integration vectors, which means that there is a long run equilibrium relationship between inflation and independent variables, the model can be estimated by the error correction model, which includes the short and long-run in addition to that avoids measurement problems caused by spurious correlation[19].

It is clear from the data in "Table (6)" that the coefficient of error correction in (cointEq3) is negative and significant at the probability level of 0.05 and in agreement with the economic logic, and

this indicates the existence of a long-run equilibrium relationship between inflation and the independent variables affecting it, and any short-run change in one of the independent variables must affect the model and push it towards equilibrium in the long term with an correction speed of about 3.68 that can be automatically corrected over time to reach equilibrium in the long-run, i.e. with a response period of about 0.27 to reach their equilibrium value in the long run, while (cointEq1) did not agree with economic logic, and the significance of the error correction coefficients in (cointEq2, cointEq4) was not proven, therefore they have no statistical significance, as shown in the same table statistically evaluating the model.

**Table (6): Results of Vector Error Correction Estimates.**
**Vector Error Correction Estimates**
**Sample (adjusted): 2001 2019**
**Included observations: 19 after adjustments**
**Standard errors in ( ) & t-statistics in [ ]**

| Error Correction: | DLOG(Y) | DLOG($X_1$) | DLOG($X_2$) | DLOG($X_3$) | DLOG($X_4$) | DLOG($X_5$) | DLOG($X_6$) |
|---|---|---|---|---|---|---|---|
| CointEq1 | -1.033121 | -0.040018 | -0.069306 | -0.012571 | 0.070802 | 0.030719 | 0.053948 |
|  | (0.28573) | (0.06663) | (0.04990) | (0.05354) | (0.09111) | (0.03390) | (0.04073) |
|  | [-3.61570] | [-0.60060] | [-1.38900] | [-0.23480] | [ 0.77713] | [ 0.90611] | [ 1.32466] |
| CointEq2 | 0.583272 | -0.721694 | 0.081007 | -0.448712 | -0.298880 | -0.087112 | -0.331810 |
|  | (1.26165) | (0.29420) | (0.22031) | (0.23641) | (0.40228) | (0.14969) | (0.17982) |
|  | [ 0.46231] | [-2.45305] | [ 0.36769] | [-1.89804] | [-0.74296] | [-0.58194] | [-1.84518] |
| CointEq3 | -3.681443 | 1.606511 | 0.334186 | -0.923351 | 0.821128 | -0.219343 | 0.375403 |
|  | (0.95444) | (0.22257) | (0.16667) | (0.17884) | (0.30433) | (0.11324) | (0.13604) |
|  | [-3.85718] | [ 7.21815] | [ 2.00510] | [ -5.16290] | [1.93692] | [-2.69817] | [ 2.75955] |
| CointEq4 | 4.357398 | 0.539633 | -0.365397 | 0.358365 | 0.561590 | 0.111016 | 0.444922 |
|  | (2.20610) | (0.51677) | (0.38698) | (0.41525) | (0.70661) | (0.26294) | (0.31586) |
|  | [1.94625] | [ 1.04424] | [-0.94422] | [ 0.86300] | [ 0.79476] | [ 0.42222] | [ 1.40859] |
| C | 0.028107 | 0.036011 | 0.063013 | 0.004533 | 0.002372 | 0.062868 | 0.063219 |
|  | (0.03031) | (0.00707) | (0.00529) | (0.00568) | (0.00966) | (0.00360) | (0.00432) |
|  | [ 0.92740] | [ 5.09531] | [ 11.9063] | [ 0.79826] | [ 0.24548] | [ 17.4830] | [ 14.6347] |
| R-squared | 0.696940 | 0.828948 | 0.519441 | 0.687600 | 0.663888 | 0.654853 | 0.634347 |
| Adj. R-squared | 0.610351 | 0.780076 | 0.424996 | 0.598343 | 0.567856 | 0.556239 | 0.529875 |
| Sum sq. resids | 0.244334 | 0.013286 | 0.007451 | 0.008579 | 0.024841 | 0.003440 | 0.004964 |
| S.E. equation | 0.132108 | 0.030806 | 0.023069 | 0.024754 | 0.042123 | 0.015674 | 0.018830 |
| F-statistic | 8.048856 | 16.96162 | 4.642832 | 7.703596 | 6.913198 | 6.640595 | 6.071914 |
| Akaike AIC | -0.989465 | -3.901269 | -4.479698 | -4.338690 | -3.275502 | -5.252642 | -4.885845 |
| Schwarz SC | -0.740928 | -3.652733 | -4.231161 | -4.090153 | -3.026965 | -5.004105 | -4.637309 |
| Mean dependent | 0.028107 | 0.036011 | 0.063013 | 0.004533 | 0.002372 | 0.062868 | 0.063219 |
| S.D. dependent | 0.211637 | 0.065690 | 0.024662 | 0.039059 | 0.064078 | 0.023530 | 0.027462 |
| Determinant resid. covariance (dof adj.) |  | 2.48E-16 |  |  |  |  |  |
| Determinant resid. covariance |  | 2.92E-15 |  |  |  |  |  |
| Log likelihood |  | 169.8372 |  |  |  |  |  |
| Akaike information criterion |  | -22.29865 |  |  |  |  |  |
| Schwarz criterion |  | -19.16709 |  |  |  |  |  |

**Source: Results of data analysis using E-views$_{V.10}$.**

**(2) Results of the model quality Tests**:

To measure the quality of the model, several tests were used to standard evaluate of the model, which are the unit root test, the autocorrelation test for errors, and the test for the normal distribution of residuals, as follows[20]:

**- Unit root test:**

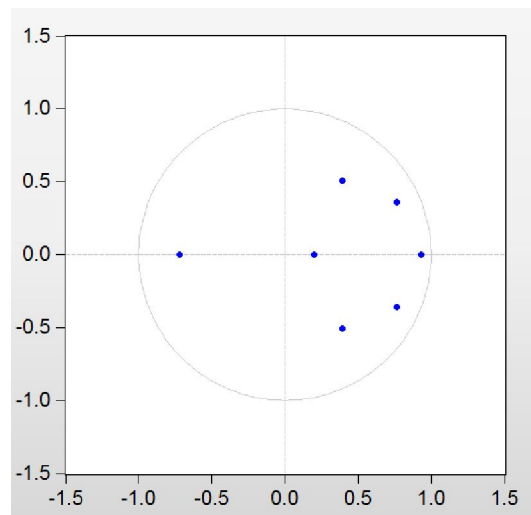It is clear from the results in "Table (7)" that all the coefficients of the unit root are less than or equal to the integer one, and the number of roots equal to the integer one is shown through the following equation:

The number of roots equal to one = the number of study variables - The number of co-integration relationships.

"Figure (2)" shows that the estimated VECM model fulfills the condition of stability due to the fact that all roots are located inside the circle, which means the stability of the model as a whole as it does not suffer from the problem of correlation between errors or instability of variance.

**Table (7): Results of Unit Root Test.**
**Roots of Characteristic Polynomial**
**Endogenous variables: LOGY LOGX$_1$ LOGX$_2$ LOGX$_3$ LOGX$_4$ LOGX$_5$ LOGX$_6$**
**Exogenous variables:**
**Lag specification: 0 0**

| Root | Modulus |
|---|---|
| 1.000000 | 1.000000 |
| 1.000000 | 1.000000 |
| 1.000000 | 1.000000 |
| 0.870205 | 0.870205 |
| -0.711758 | 0.711758 |
| 0.397627 - 0.410565i | 0.571551 |
| 0.397627 + 0.410565i | 0.571551 |

**VEC specification imposes 3 unit root(s).**
**Source: Results of data analysis using E-views$_{V.10}$.**



**Figure (2): Inverse Roots of Ar Characteristic Polynomial.**
**Source: Results of data analysis using E-views$_{v.10}$.**

**- LM Test:**

It is clear from the results in "Table (8)" that the statistical value of (F) is not significant.

Therefore, we accept the null hypothesis that the estimated model is free from the autocorrelation problem of errors.

**Table (8): Results of LM Test.**
**VEC Residual Serial Correlation LM Tests**
**Sample: 2000 2019**
**Included observations: 19**

| | | | Null hypothesis: No serial correlation at lag h | | | |
|---|---|---|---|---|---|---|
| Lag | LRE* stat | DF | Prob. | F-stat | DF | Prob. |
| 1 | 59.76722 | 49 | 0.1394 | 0.992114 | (49, 9.5) | 0.5514 |
| | | | Null hypothesis: No serial correlation at lags 1 to h | | | |
| Lag | LRE* stat | DF | Prob. | F-stat | DF | Prob. |
| 1 | 59.76722 | | 0.1394 | 0.992114 | (49, 9.5) | 0.5514 |

**\*Edge worth expansion corrected likelihood ratio statistic.**
**Source: Results of data analysis using E-views$_{v.10}$.**

**-Normality Test:**

It is clear from the results of the analysis presented in "Table (9)" that the value of the Jarque- Bera test is not significant, and therefore we accept the null hypothesis that the residual series follows a normal distribution.

**Table (9): Results of Normality Test.**
**VEC Residual Normality Tests**
**Null Hypothesis: Residuals are multivariate normal**
**Sample: 2000 2019**
**Included observations: 19**

| Component | Jarque-Bera | DF | Prob. |
|---|---|---|---|
| 1 | 1.893935 | 2 | 0.3879 |
| 2 | 1.018945 | 2 | 0.6008 |
| 3 | 1.199094 | 2 | 0.4451 |
| 4 | 0.235606 | 2 | 0.8889 |
| 5 | 0.356879 | 2 | 0.8366 |
| 6 | 1.352712 | 2 | 0.5085 |
| 7 | 0.120843 | 2 | 0.9414 |
| Joint | 6.17802 | 14 | 0.6580 |

**\*Approximate p-value don't account for coefficient Estimation**
**Source: Results of data analysis using E-views$_{v.10}$.**

**(C) Causality tests between Inflation and the Factors affecting it using one lag Period**:

To test the existence of a causal relationship between the dependent variable and each of the independent variables included in the model, the Granger causality test was used[21,22]. It is clear from the results contained in "Table (10)" shown in "Figure (3)" that there is a clear significance of the existence of a linear Unidirectional Causality relationship extending from the exchange rate to inflation, then it is possible to reject the null hypothesis that the exchange rate doesn't affect inflation and accept the alternative hypothesis that the exchange rate actually affects inflation, as shown by a linear unidirectional causality relationship extending from money supply and government spending to inflation, while there is a bilateral causality relationship between interest rate and inflation, while it turns out that there is a linear unidirectional causality extending from inflation to GDP, thus the local product does not affect inflation, the results did not prove a causal relationship between economic openness and inflation during the research period, therefore it does not affect inflation, which are logical results and consistent with economic theory.

**Table (10): Results of the causality tests between inflation and the factors affecting it using one lag period.**
**Pair wise Granger Causality Tests**
**Sample: 2000 2019**
**Lags: 1**

| Null Hypothesis: | Obs | F-Statistic | Prob. | Decision |
|---|---|---|---|---|
| LOG($X_1$) does not Granger Cause LOG(Y) | 19 | 3.80164 | 0.0539 | Reject |
| LOG(Y) does not Granger Cause LOG($X_1$) | | 0.13800 | 0.7151 | Accept |
| LOG($X_2$) does not Granger Cause LOG(Y) | 19 | 4.96031 | 0.0406 | Reject |
| LOG(Y) does not Granger Cause LOG($X_2$) | | 1.68498 | 0.2127 | Accept |
| LOG ($X_3$) does not Granger Cause LOG(Y) | 19 | 5.19880 | 0.0203 | Reject |
| LOG(Y) does not Granger Cause LOG($X_3$) | | 4.18613 | 0.0419 | Reject |
| LOG($X_4$) does not Granger Cause LOG(Y) | 19 | 0.18671 | 0.2424 | Accept |
| LOG(Y) does not Granger Cause LOG($X_4$) | | 0.46906 | 0.5032 | Accept |
| LOG($X_5$) does not Granger Cause LOG(Y) | 19 | 0.76696 | 0.3941 | Accept |
| LOG(Y) does not Granger Cause LOG($X_5$) | | 5.86500 | 0.0177 | Reject |
| LOG($X_6$) does not Granger Cause LOG(Y) | 19 | 5.29995 | 0.0251 | Reject |
| LOG(Y) does not Granger Cause LOG($X_6$) | | 0.71682 | 0.4097 | Accept |

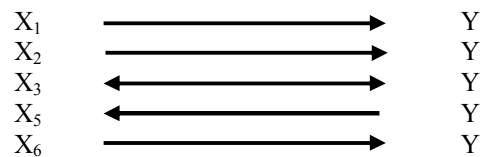**Source: Results of data analysis using E-views$_{V.10}$.**



**Figure (3): Direction of Causality.**
**Source: Table (10).**

**Conclusion:**

The research had come to some important results and conclusion can be summarized a; (1) The standard estimate of the regressive relationship between the exchange rate of the dollar in the pound as an independent variable, and the annual inflation rate as a dependent variable, that estimated regression coefficients indicate that the dollar exchange rate change by 1 EGP leads to a change of the previous variables by about 0.890%. The significance of the model was confirmed at the probability level 0.01 based on the (F) value, (2) By stabilizing the time series of the variables at the first differences after taking the logarithm, and after making sure that they have four co-integration vectors, which means that there is a long run equilibrium relationship between inflation and independent variables, the model can be estimated by the error correction model, which includes the short and long-run in addition to that avoids measurement problems caused by spurious correlation. It is clear that the coefficient of error correction in (cointEq3) is negative and significant at the probability level of 0.05 and in agreement with the economic logic, and this indicates the existence of a long-run equilibrium relationship between inflation and the independent variables affecting it, and any short-run change in one of the independent variables must affect the model and push it towards equilibrium in the long term with an correction speed of about 3.68 that can be automatically corrected over time to reach equilibrium in the long-run, i.e. with a response period of about 0.27 to reach their equilibrium value in the long-run, (3) There is a clear significance of the existence of a linear Unidirectional Causality relationship extending from the exchange rate to inflation, then it is possible to reject the null hypothesis that the exchange rate doesn't affect inflation and accept the alternative hypothesis that the exchange rate actually affects inflation, as shown by a linear unidirectional causality relationship extending from money supply and government spending to inflation, while there is a bilateral causality relationship between interest rate and inflation.

In light of the findings of the research, it recommends the following: (1) Controlling the parallel exchange rate to achieve equilibrium in the exchange market.(2) Raising the interest rate to reduce credit and consequently decreasing total demand levels, this leads to a reduction in inflation rates. (3) Reducing government spending

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