Anggaran : Jurnal Publikasi Ekonomi dan Akuntansi
Volume. 2 No. 4 Desember 2024
e-ISSN : 3031-3384, and p-ISSN : 3031-3392, Page. 40-52
DOI: https://doi.org/10.61132/anggaran.v2i4.873
Available online at: https://journal.areai.or.id/index.php/anggaran

The Long-Term Relationship Between the Rate of Exchange and Inflation in Iraq: An Application of the Vector Error Correction Model

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Abstract : *This research aims to investigate whether the exchange rates and inflation in Iraq have a long-term equilibrium relationship or not. A dataset of exchange rates and inflation from 2000 to 2020 was used. Johansen's cointegration test was employed to confirm that there is a long-term correlation between these variables. The Vector Error Correction Model (VECM) was utilized, along with Granger causality tests, to understand the long and short run connections and to determine if the causality flow is bidirectional or unidirectional. The results provided proof of a long-run equilibrium connection among inflation and rates of exchange, with strong evidence of a unidirectional causal flow from rates of exchange to inflation in Iraq.*

Keywords : *Exchange rate, VECM, Inflation,*

1. INTRODUCTION

Exchange rates and inflation are macroeconomic indicators that impact the economic level of any country. Understanding the relationship between these two indicators is crucial for maintaining economic stability. So, inflation is the rate of continuous rise in the common price level. A decrease or increase in the rate of exchange can affect the inflation level, and the common price level may rise if there is inadequate supply to meet the growing demand for goods and services. This kind of increase in demand could be due to supply shortages, a steady increase in the population, or an increase in monetary issuance. Inflation causes are generally classified into two main sides: the first is demand-side inflation, where general price levels can rise when the prices of materials continuously increase or when the local currency loses its value due to the rising rate of exchange of foreign currencies against the local currency. This leads to higher costs for importing materials. In Iraq, the rate of exchange is used to maintain the general price level, control inflation, and achieve economic growth. Therefore, the research aims to detect the presence of a long-term association using the VECM model and concludes with a set of findings and recommendations.

2. THE RESEARCH PROBLEM

The issue can be outlined as follows:

To which extent does the rate of exchange impact changes on annual inflation in Iraq? To answer this main question, the sub-questions below were considered:

- What is meant by nominal rate of exchange and inflation?

Received: Juli 19, 2024; Revised: Agustus 15, 2024; Accepted: September 11, 2024;
Online Available: September 13, 2024;

- What is the reality of the development of the nominal active rate of exchange and inflation in Iraq, and what type of relationship exists between them?

The Research Hypotheses:

The research hypothesizes the following:

1. Shifts in the nominal in effect rate of exchange affect annual inflation in Iraq (a one-way causal relationship).
2. There is a short-run relation among the nominal rate of exchange and the annual inflation rate.
3. There is a long-run connection among the nominal efficient rate of exchange and the monthly inflation rate.

The Research Importance:

This research is of vital significance because the topics of inflation and exchange rates have a local dimension in Iraq, given their substantial impact on economic stability. This underscores the necessity to study and understand the nature of the relationship between them.

The Research Objectives:

The main objectives can be outlined as follows:

1. To trace the course of the nominal rate of exchange and inflation in Iraq.
2. To measure the effect of shifts in the nominal rate of exchange on inflation in Iraq over the study period (2000-2020).

3. METHODOLOGY

The study adopts a descriptive-analytical approach for theoretical variables and a case study method for economic measurement.

The Research Structure:

To comprehensively cover the topic, the study falls into three key sections:

- The first is dedicated to previous studies.
- The second covers the evolution of the nominal rate of exchange and inflation during the study period.
- The third stresses on the econometric analysis.

4. RESULTS AND DISCUSSION

Previous Studies

There are numerous previous studies that have explored the relation mong rates of exchange and inflation in various countries using different methods. Some notable studies include:

- **Previous Studies**

1. Between Exchange Rate (1999) Relationship Between Exchange Rate and Inflation, Pakistan Economic and Social Review Volume XXXVII, No.2 (Winter 1999)

   This research examines the concurrent determination of the common price level and the rate of exchange in Pakistan. It found that the adjustment speed of both the common price level and the rate of exchange to local or external shocks is slow. It also concluded that it is not feasible to implement policies to mitigate inflation or manage the exchange rate independently of each other. Instead, attention should be focused on monetary policies, such as money supply management.
2. Sabah Al-Nouri Abbas (2008) The Effect of Inflation on the Equilibrium Exchange Rate of the Iraqi Dinar for the Period 1990-2005, College of Baghdad for Economic Sciences, Issue 17

   This study aims to clarify the different exchange rate systems and the factors affecting them, including inflation, during the period from 1990 to 2005. Using linear regression and relying on the SPSS statistical program, the study estimated the linear function among inflation and the exchange rates. The results indicated a direct relationship among inflation and exchange rates, meaning that higher inflation rates cause a growth in the rate of exchange of the Iraqi dinar against the dollar.
3. Abdul Majid Bouesak (2021) Application of the Error Correction Model in (VECM) to Study the Relationship Between the Nominal Effective Exchange Rate and Monthly Inflation in Algeria During the Period (1980-2020), Journal of Economic and Administrative Studies, Vol. 15, No. 1, 2021. This study aims to clarify the connection among the nominal active rate of exchange and inflation rates from 1980 to 2020. The study found a one-way causal relationship from the nominal active rate of exchange to the inflation rate. It also indicated that these variables have a long-run equilibrium link, which allowed for the application of ECM.

Conceptual Framework for Inflation and Exchange Rates

- **Inflation**

Inflation is one of the issues faced by both developed and developing economies. Economists have differing opinions on the causes of inflation and the resulting economic and social effects, leading to a lack of a universally agreed-upon definition. Some economists define inflation as occurring when increasing aggregate demand is not matched by the rise in production, which results in rising prices and an increase in the common price level (Husseini & Abouhat, 2018, p. 185). Another view is that inflation is resulted by too much money chasing too few goods, which leads to rising prices of goods. Despite these differing views, there is a consensus that inflation denotes a continuous and increasing rise in the common price level (Al-Amin & Pasha, 1978, p. 193). The term is used to describe various related phenomena.

- **Rate of Exchange**

The rate of exchange serves as a mirror of a country's economic position about the external world through its imports and exports. It is a tool that connects the local economy with the global economy. It is a series of units of a foreign currency needed to obtain a single unit of the local currency or as the number of units of the local currency exchanged for single unit of foreign currency (Masoud, 1997, p. 89).

- **The Relationship Between Rates of Exchange and Inflation in Iraq**

Rates of exchange are among the most important tools used in developing countries, including Iraq, to achieve economic stability and curb inflation. As seen in the table below, exchange rates have a direct impact on inflation. Changes in exchange rates are significant factors affecting inflation. Increasing the rate of exchange (a depreciation of the local currency) causes increasing the general price level of goods and services by influencing both the demand and supply parts of the economy. Regarding demand, increasing the rate of exchange causes higher import prices for consumer goods and services, which reduces aggregate demand due to the decreased purchasing power of individuals and institutions as a result of rising prices. On the other hand, higher prices for production goods lead to increased costs for all production inputs, which in turn raises production costs. This results in a decrease in aggregate supply, reflected in the rise in the common price level of domestically produced goods and services (Ali, 2018, p. 110).

It is observed that the inflation level in Iraq is directly affected by the nominal rate of exchange set by the central bank. For instance, in 2001, the rate of exchange was 1929, with an inflation rate of 16.4%. As the exchange rate decreased, inflation also dropped. By 2009, the exchange rate had fallen to 1170, and the inflation rate decreased to 2.8%. During the period from 2015 to 2019, the exchange rate was 1190, and the inflation rate in 2019 was 0.2%. However, when the exchange rate increased to 1234 in 2020, the inflation rate rose to 0.6%.

Table 1: Rates of Exchange and Inflation in Iraq

Year	Exchange rate	Inflation	Year	Exchange rate	Inflation
2000	1930	4. 9	2011	1170	5.6
2001	1929	16.4	2012	1166	6.1
2002	1957	19.3	2013	1166	1.9
2003	1896	33.6	2014	1166	2.2
2004	1453	27	2015	1190	1.4
2005	1469	37	2016	1190	0.5
2006	1467	53.2	2017	1190	0.2
2007	1255	30.8	2018	1190	0.4
2008	1193	2.7	2019	1190	0.2
2009	1170	2.8	2020	1234	0.6
2010	1170	2.4			

Ministry of Planning, Statistical Bulletins for Multiple Years

The Econometric Aspect of the Relationship Between Rates of Exchange and Inflation in Iraq

- **Data Sources and Variable Definitions**

A set of time series data on exchange rates and inflation was taken from the Central Bank's statistical bulletins, covering the period from 2000 to 2020. The variables are: The rate of exchange is represented by (R), and inflation is represented by (IN).

- **Unit Root Tests**

There are various indicators and tests that can be used to assess the level of stationarity in data (Farid, 2017, p. 14). Many macroeconomic time series exhibit common variance, non-stationary behavior, and time-varying means. The tests of unit root are crucial for examining the integration order of timeseries data, and these tests have evolved over time. This study will focus on using the Phillips-Perron test to determine whether there is a spurious regression, indicating that the time series includes a single unit root.

- **Results of the Unit Root Test Using the Phillips-Perron (PP) Test**

The Phillips-Perron (PP) test addresses the issue of autocorrelation in the residuals of the unit root test equation by making a non-parametric adjustment to the model variance to account for autocorrelation. This reflects the dynamic nature of the timeseries. The PP test proposes a non-standardized method to correct autocorrelation, unlike the Augmented Dickey-Fuller (ADF) test, which uses a standardized method. Additionally, the PP test is less sensitive to the absence of conditions for the classical random error distribution. Unlike the ADF test, the PP test excludes lagged values and allows for a non-zero mean and a linear time trend. The following equations represent the PP test models (Shikhi, 2012, p. 210):

1. Without constant term and time trend, as shown in the following equation:

$$\Delta Y_t = pY_{t-1} + \mu_t ----------------(1)$$

2. With only a constant term, as in the following equation:

$$\Delta Y_t = a + pY_{t-1} + \mu_t ------------(2)$$

3. With a constant term and a time trend, as in the following equation:

$$\Delta Y_t = a + a_1 T + pY_{t-1} + \mu_t ---------(3)$$

The null hypothesis is tested by lacking stationarity in the time series at its levels (p = 0) against the alternate hypothesis of stationarity (p < 0). When the (p)-value is significant and negative, this shows rejecting the null hypothesis and supporting the alternate hypothesis, indicating that the timeseries is static (Idris & Murad Ismail, 2013, p. 9).

As shown in Table 1, when conducting the unit root test, it becomes evident that the timeseries for the variables (exchange rate and inflation) are non-stationary at their levels, as all (p)-values are higher than the 5% significance level. However, after taking the first differences, the series becomes stationary at the 5% significance level with significant and negative (p)-values. This shows that the null hypothesis is supported, whereas the alternate hypothesis is refuted, confirming the stationarity of the time series.

Table (1): Results of the Phillips-Perron (PP) Unit Root Test for Time Series

UNIT ROOT TEST TABLE (PP)					
		At Level		At First Difference	
		IN	R	d(IN)	d(R)
With Constant	t-Statistic	-1.43	-2.5415	-3.9979	-3.9615
	Prob.	0.547	0.1212	0.0071	0.0076
With Constant & Trend	t-Statistic	-2.6446	-0.2598	-3.6685	-8.171
	Prob.	0.2666	0.9859	0.0505	0
Without Constant & Trend	t-Statistic	-1.2844	-1.8729	-3.8898	-3.681
	Prob.	0.1767	0.0596	0.0006	0.0009

Source: Outputs from 12 EVIEWS

Determining the Optimal Lag Length

As observed from Table (2), the maximum lag length for the VARmodel is 3, as it achieved the lowest criterion values: (SC = 17.38588), (HQ = 19.78885), and (AIC = 16.69336).

Table (2): Selection of Lag Length for the Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-187.4835	NA	4771608.	21.05372	21.15265	21.06736
1	-162.5125	41.61824	467025.0	18.72361	19.02040	18.76454
2	-159.9544	3.695141	561317.4	18.88382	19.37847	18.95202
3	-136.2403	28.98387*	66437.42*	16.69336*	17.38588*	16.78885*

Source: Outputs of EVIEWS12

- **Johansen and Juselius Test**

The Johansen and Juselius test, developed by Johansen (1988) and Juselius (1990), addresses the limitations of the Engle-Granger test, especially for small sample sizes and multiple variables. This test can detect if there is a longrun equilibrium association, or cointegration. It is crucial in cointegration theory because if no cointegration is found, there is no long-run equilibrium connection among these variables (Salami et al., 2013, p. 126).

To determine the number of cointegration vectors, Johansen and Juselius suggested performing two tests:

Test 1: Trace Test

This test is calculated using the following relationship:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} log(\hat{\lambda}_i) \quad \text{.......... (9)}$$

Where:

- (T) is the size of sample.
- (r) the number of cointegration vectors.
- ($\hat{\lambda}_i$) are the eigenvalues of the variance-covariance matrix.

The null hypothesis (r = 0) is verified against the alternate hypothesis (r = 1). If the calculated value of the impact test is less than the critical value, the null hypothesis is supported, which indiactes that the total of cointegration vectors is zero. Conversely, in case the calculated value of the impact test is higher than the critical value, the alternate hypothesis is supported, denoting that the number of co-integration vectors is higher than zero, suggesting the presence of cointegration among the studied variables (Abdul Razzaq, 2012, p. 155).

- **Maximum Eigenvalue Test**

The Maximum Eigenvalue Test is calculated adopting the following formula:

$$\lambda_{Max} = -T \text{ Log } (1 - \hat{\lambda}_i) .... (10)$$

Where:

The null hypothesis (r = 0) is tested against the alternate hypothesis (r = 1). If the calculated value of the maximum eigenvalue test in the Johansen-Juselius test is larger than the critical value at a given significance level, the alternative hypothesis is supported and the null hypothesis is refuted. This shows the presence of cointegration among the studied variables and at least one cointegration vector. Conversely, if the alternative hypothesis is refuted and the null hypothesis is supported, this indicates the absence of cointegration (Asterion & Stephen, 2011, p. 265).

In this case, if the calculated value of the Maximum Eigenvalue Test goes above the critical value with a significance level of (0.0000), it supports the alternate hypothesis, indicating that the total of cointegration vectors is greater than zero and there is co-integration among the variables. As observed from Table (3), the calculated values of the Maximum Eigenvalue Test was higher than the critical values in the Johansen-Juselius test at a significance level of (0.0000). This supports the alternative hypothesis and rejects the null hypothesis, indicating that there is a kind of co-integration among the studied variables.

Table (3): Results of the Johansen-Juselius Test

Date: 06/07/24 Time: 18:32
Sample (adjusted): 2004 2020
Included observations: 17 after adjustments
Trend assumption: Linear deterministic trend
Series: IN R
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.984994	97.68732	15.49471	0.0000
At most 1 *	0.787118	26.29928	3.841465	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.984994	71.38804	14.26460	0.0000
At most 1 *	0.787118	26.29928	3.841465	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Outputs of EVIEWS12

- **Granger Causality Test**

As observed from Table (4), the probability value for the Granger causality test from the independent variable, exchange rate (R), to the dependent variable, inflation (IN), is less than 5%. This indicates that the exchange rate significantly affects inflation rates in Iraq. On the other hand, the probability value for the causality from inflation to the exchange rate is 0.0552, which is greater than 0.05, suggesting a weak relationship.

Table (4): Results of the Granger Causality Test

Pairwise Granger Causality Tests			
Date: 06/10/24 Time: 19:14			
Sample: 2000 2020			
Lags: 3			
Null Hypothesis:	Obs	F-Statistic	Prob.
R does not Granger Cause IN	18	33.9263	0.000007
IN does not Granger Cause R		3.44782	0.0552

- **Vector Error Correction Model (VECM)**

After confirming that the variables in the linear model are co-integrated in the long term using the Johansen test, the following pace is to detect the long-term equilibrium relationship among inflation (IN) and the exchange rate (R) through the Error Correction Model (ECM). From Table (5), which summarizes the estimation of the ECM, we observe that the error correction term coefficient is (-0.411608), which is significant with a p-value of (0.0054), below the 0.05 significance level. This means a long-run equilibrium relationship running from the independent variables to the dependent variable, and this relationship is statistically significant. Furthermore, a short-run equilibrium is also observed, though it is less significant with a probability value greater than 5%. Additionally, the value of R-squared 0.92 shows that the model account for 92% of the difference in the dependent variable. This suggests that the independent variables included in the model are the main factors impacting the response of the dependent variable, with the remaining 8% of the variation attributed to variables not included in the model, represented by the error term. The calculated F-statistic is 15.035, which is significant with a p-value of (0.000256), less than 0.05. This indicates that the model is statistically significant.

Table (5): Results of the Error Correction Model (ECM)

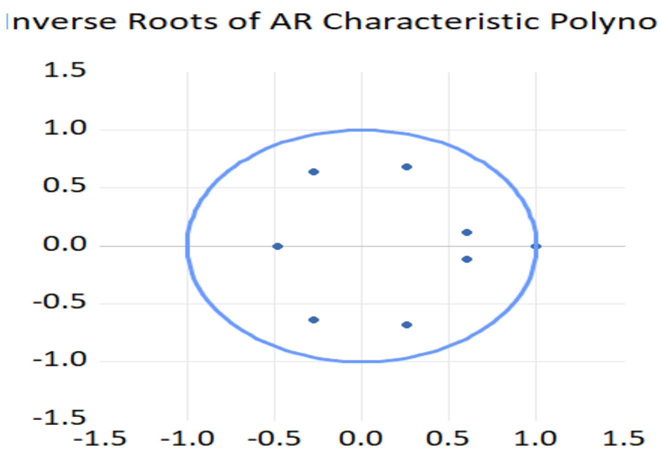
Dependent Variable: D(IN)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Date: 06/07/24 Time: 18:34
Sample (adjusted): 2004 2020
Included observations: 17 after adjustments
D(IN) = C(1)*(IN(-1) + 0.0319743559103*R(-1) - 53.0326914147) +
C(2)*D(IN(-1)) + C(3)*D(R(-1)) + C(4)*D(IN(-2)) + C(5)*D(R(-2)) +
C(6)*D(IN(-3)) + C(7)*D(R(-3)) + C(8)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.411604	0.113211	-3.635713	0.0054
C(2)	0.886086	0.146910	6.031506	0.0002
C(3)	-0.056692	0.013921	-4.072256	0.0028
C(4)	-0.160279	0.137168	-1.168486	0.2726
C(5)	-0.063914	0.011368	-5.622101	0.0003
C(6)	0.016891	0.147195	0.114755	0.9112
C(7)	0.025169	0.015430	1.631174	0.1373
C(8)	-5.332363	1.470640	-3.625878	0.0055

R-squared	0.921225	Mean dependent var	-1.941176
Adjusted R-squared	0.859955	S.D. dependent var	10.19645
S.E. of regression	3.815772	Akaike info criterion	5.821351
Sum squared resid	131.0410	Schwarz criterion	6.213451
Log likelihood	-41.48148	Hannan-Quinn criter.	5.860326
F-statistic	15.03560	Durbin-Watson stat	3.418838
Prob(F-statistic)	0.000265		

- **Model Validity Tests**

1. **Unit Root Test**



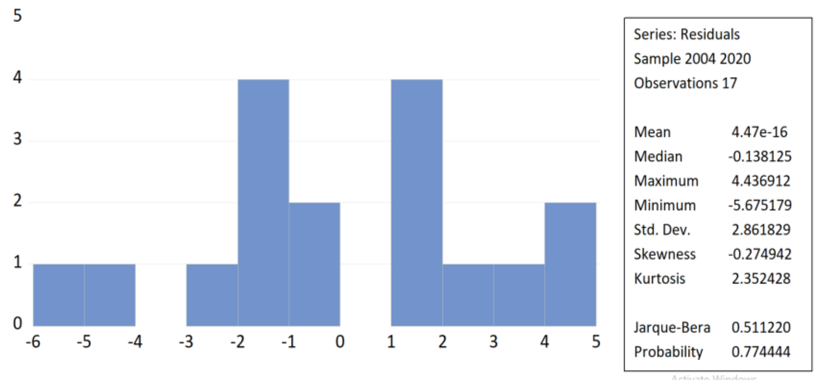
Source: Outputs: 12 EVIEWS

It is obvious from Fig () that the estimated model meets the stability requirement, with the whole roots lying in or on the unit circle.

2. **Normality Test of Residuals**

This test is conducted to verify whether the residuals of the time series model under study exhibit properties of a normal distribution. The Jarque-Bera test was performed, yielding a value of \(0.77444\), which is not statistically significant at the 5% level. Therefore, we reject the alternative hypothesis of serial correlation in the residuals of the model.

Figure (2): Normality Test of Errors in the Economic Growth Model



Source: Outputs: 12 EVIEWS

3. **ARCH Test**

This test determines whether the model may suffer from the issue of heteroscedasticity if the probability values are less than 5% for both Chi-squared and F-statistic tests. However, according to the following table, there appears to be no problem with heteroscedasticity. This is illustrated in Table (6).

Table (6): Results of the Homoscedasticity Test

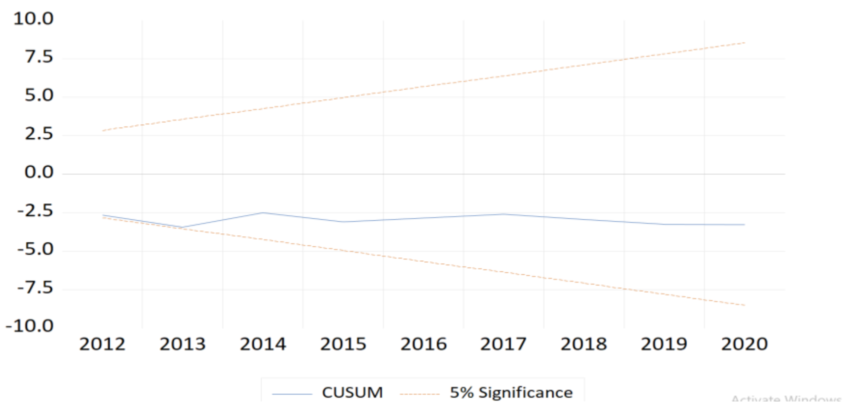
Heteroskedasticity Test: ARCH

F-statistic	0.796674	Prob. F(3,10)	0.5233
Obs*R-squared	2.700584	Prob. Chi-Square(3)	0.4401

Source: Outputs: 12 EVIEWS

4. **Cumulative Sum**

To ensure stability in structural changes within the adopted model, appropriate tests such as the CUSUM test should be used (Naja, 2014, p. 14). The following chart shows the cumulative sum and its squares, indicating that the behavior of the phenomenon remains within the positive bounds. According to this test, it can be concluded that the selected model does not suffer from structural changes, as shown in the following chart:



Source: Outputs: 12 EVIEWS

5. CONCLUSIONS AND SUGGESTION

Conclusions

The research investigated in case there would be a long-run connection among interest rates and inflation in Iraq. The study employed unit root tests to verify the order of integration among the timeseries variables and used the Johansen and Juselius cointegration test. In light of the statistics and the Vector Error Correction Model (VECM), which illustrates long and short term equilibrium relationships, and causality analysis, the findings are:

1. Both variables are static at the first variation level.
2. These variables have a long-run and short-run equilibrium association.
3. The results reveal that rates of exchange contribute to greater rates of inflation in the long-run.
4. Increasing the rate of exchange contributes to stimulating inflation in the long term.

Suggestion

1. It is essential for monetary policymakers in Iraq to understand the long-term equilibrium relationship among exchange rates and inflation to manage inflation and achieve economic stability.
2. There is a need to select appropriate exchange rates that align with the nature of Iraq's rentier economy and mitigate imported inflation.

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