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Original Research Article

The Impact of Exchange Rate Fluctuations and Central Bank Policy Intervention on the Output Gap in Business Cycles in Iraq: LSTR Approach

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Exchange rate fluctuations significantly impact key economic variables such as inflation, production, exports, and imports. Furthermore, the central bank's role while applying financial strategies aimed at managing price rises and manage exchange rate fluctuations under varying economic conditions warrants further examination. The primary the purpose of this research is to evaluate how changes in currency values affect and central bank policy interventions on the output gap within the business cycle in Iraq. To test the research hypotheses, the study employs the LSTR approach, utilizing data from 2008 to 2022. For model estimation, indicators of market stress along with the index measuring central bank's policy actions were determined. After performing diagnostic tests, the model was estimated. The results reveal that exchange rate fluctuations, acting as a transition variable, contribute to an increased output gap during business cycles. Additionally, the estimated coefficients of the central bank intervention policy index, along including the direction and meaningfulness of the estimated parameter, indicate that Iraq's monetary authority's actions within the currency trading sector have been inconsistent. Consequently, the exchange rate follows a trajectory that is undesirable from the perspective of monetary authorities. In other words, to mitigate exchange rate instability during periods of severe fluctuations, the central bank intervenes by injecting currency into the market, thereby reducing exchange rate volatility and preventing drastic fluctuations in production.

Keywords: Foreign exchange volatility, Central Bank Intervention, Business Cycles, Output Gap.
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1 Introduction

In the 1970s, new classical economists developed macroeconomic models grounded in microeconomic foundations, asserting that the behavior of economic agents—households and firms—leads to competitive prices and wages. Sargent and Wallace (1975), introducing the concept of rational expectations, argued that predictable monetary the measures taken do not influence production levels or job numbers, but unanticipated financial strategies can temporarily reduce unemployment and boost output. Similarly, Kydland and Prescott (1982), through their development of real business cycle (RBC) theory, emphasized the role of non-monetary factors—particularly technological shocks—in driving economic fluctuations. They proposed a model in which economic agents aim to maximize long-term profitability and utility, assuming fully flexible prices. This framework relies on calibration techniques to evaluate economic predictions and identify the influence of technological shocks. Nelson and Plosser (1982) also supported the view that real shocks, especially those related to technological changes, are key drivers of economic fluctuations. They linked these shocks to both output growth and increases regarding the pace at which the monetary base expands. On the other hand the New Keynesian School critiques the inability of new classical models to adequately account for economic fluctuations. Researchers such as Fischer (2001) and Lucas (1976) demonstrated that nominal demand shocks can have real economic effects. Furthermore, economists including Menkhoff (2013), Romer (1990), and Humala and Rodriguez (2010) emphasized the role of monetary policy in shaping demand-side dynamics, although many maintained that predictable monetary policy does not influence output or employment (Blanchard ,2013).

Exchange rate shocks have significant negative impacts on economic stability, leading to increased price uncertainty, rising costs, reduced profits, and disruptions in decision-making and planning. These shocks also dampen investment incentives and affect production across various sectors of the economy, ultimately contributing to the formation of business cycles. In oil-dependent countries like Iraq, exchange rate shocks expand government size and expenditures through increased oil revenues. During periods of declining oil revenues, the government borrows from the monetary authority, leading to a rise in the monetary base and liquidity. Initially, the increase in available funds fails to integrate with the actual economic activities causing inflation to rise. Despite decades of scientific research into business cycles, there is still no clear consensus on the origins and mechanisms of these economic

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fluctuations, an issue that becomes even more critical in economies like Iraq, which are heavily reliant on oil revenues. In Iraq's economy, oil shocks not only affect fiscal policies but also alter monetary policies through the conversion of oil revenues into dinars. This complex relationship between oil revenues, fiscal policies, and monetary policies leads to exchange rate instability and rising general price levels. As oil prices are an exogenous variable highly sensitive to international developments, Iraq's economy becomes extremely vulnerable to external factors, underscoring the need for a more precise understanding of business cycles and central bank intervention strategies. However, to date, Iraq has lacked a comprehensive, systematic study on the impact of oil-related shocks on monetary policy and central bank performance, particularly in inflationary contexts. This research gap exists at a time when the formulation of effective economic stabilization policies, without a proper understanding of the sources of fluctuations, risks not only inefficiency but also exacerbates instability. Therefore, conducting rigorous scientific research on business cycles, identifying key shocks, and analyzing the responses of monetary policymakers in Iraq is essential for strengthening economic stability and improving the effectiveness of macroeconomic policies.

The innovation of this study lies in its novel analysis of the impact of exchange rate fluctuations and central bank policy interventions on the output gap within Iraq's business cycles, employing the nonlinear Logistic Smooth Transition Regression (LSTR) approach. Unlike previous studies that have largely focused on linear, static models or examined fluctuations in currency values and financial regulatory measures in isolation, this research utilizes a dynamic nonlinear framework that enables the investigation into the consequences caused by fluctuations in currency values and central bank policies vary across various stages within economic expansion and contraction periods—namely expansion and recession. By focusing on the output gap as a key variable in the dynamic analysis of business cycles and by investigating the asymmetric response of Iraq's monetary policy to exchange rate shocks, this study introduces several innovative dimensions. Furthermore, it is the first to model the complex interaction between currency valuation, financial regulatory actions, and the difference between actual and potential economic output in relation to the Iraqi economy using the LSTR framework. This approach, particularly in oil-dependent and import-reliant economies such as Iraq—which are highly vulnerable to external shocks—offers a valuable tool for policymakers to design more adaptive, gradual, and effective responses to economic fluctuations.

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Given the preceding discussion on the influence of variations in currency values and the monetary authority's strategies affecting production levels and economic cycles, and in pursuit of the study's main objective—namely, examining how fluctuations in currency values and monetary authority actions influence outcomes on the output gap within Iraq's business cycles—the following hypotheses are tested using the Smooth Transition Regression LSTR approach.

H1: Central bank policy intervention has a significantly negative impact on the output gap during Iraq's business cycles.

H2: Changes in the value of foreign currencies play a major role in narrowing the output gap throughout Iraq's economic fluctuations.

This document is structured in the following manner: initially, the conceptual foundations are presented; next, the research methodology is outlined. This is followed by an in-depth analysis of the empirical findings, and finally, the study concludes with key takeaways and suggestions for strategic actions.

2 Literature Review

2.1 Theoretical Foundations

Real Exchange Rate Fluctuations

The real exchange rate represents the comparison between local price levels and those abroad and is commonly explained through the concept explaining equalized buying power across countries (PPP). This theory is typically classified into two types: "complete purchasing power equality" and "proportional purchasing power parity".

$$E_t = P_t - P_t^* \tag{1}$$

In this context, E_t: represents the logarithm of the nominal exchange rate (the value of domestic currency relative to a unit of foreign currency), P_t: represents the logarithm of domestic prices, and P_t^* :represents the logarithm of foreign prices. The second type of purchasing power parity, considered a weaker form, is referred to as proportional purchasing power parity. According to proportional purchasing power parity, the currency exchange rate consistently reflects the comparison between local and international price indices. In other words:

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$$E_t = \alpha + P_t - P_t^* \quad (2)$$

McDonald (1999) and other economists use the proportional purchasing power parity framework is used to forecast long-term real exchange rates, with this concept regarded as accurate.

$$q_t = E_t - P_t + P_t^* \quad (3)$$

In equation (3), q_t: represents the logarithm of the real exchange rate, P_t: is the logarithm of the domestic price index, and P_t^*: is the logarithm of the foreign price index. The domestic price index of each country can be analyzed as a combined average, adjusted by importance, of price levels for goods that can and cannot be traded internationally, as shown in equation (4):

$$P_t = (1 - a)P_t^T + aP_t^{NT} \quad (4)$$

In equation (4), $(1 - a)$ and a indicate the proportions assigned to tradable and non-tradable goods within the local price index composition, respectively. P_t^T: is the logarithm of the price index for tradable goods, andP_t^{NT}: is the logarithm of the price index for non-tradable goods. The foreign price index, expressed as an importance-adjusted mean of goods that are both exchangeable and non-exchangeable, is given by equation (5):

$$P_t^* = (1 - b)P_t^{T^*} + bP_t^{NT^*} \quad (5)$$

In equation (5), $(1 - b)$ and b indicate the proportions of tradable and non-tradable items within the foreign nation's price index composition, respectively. $P_t^{T^*}$: is the logarithm of the price index for tradable goods, and$P_t^{NT^*}$: is the logarithm of the price index for non-tradable goods. By inserting equations (4) and (5) into equation (3), one arrives at equation (6), which is expressed as follows:

$$q_t = E_t + P_t^{T^*} - P_t^T + b\left(P_t^{NT^*} - P_t^{T^*}\right) - a(P_t^{NT} - P_t^T) = q_t^T + Z_t \quad (6)$$

In equation (6), $q_t^T = E_t + P_t^{T^*} - P_t^T$: represents the real exchange rate based on the tradable goods index in both countries. $Z_t = b\left(P_t^{NT^*} - P_t^{T^*}\right) - a(P_t^{NT} - P_t^T)$: is the difference in the price index ratio of non-tradable to tradable goods between the two countries. Based on equation (6), exchange rate fluctuations are divided into two components:

1) The relative price of tradable goods between countries.

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2) The difference in the relative price of non-tradable to tradable goods across countries.

According to equation (6), if the principle of equal buying power remains valid over extended time horizons, movements in the real exchange rate are attributed to the price ratio between non-exchangeable and exchangeable goods. Consequently, fundamental economic disturbances are key drivers behind variations in the real exchange rate (Balassa & Samuelson, 1964). However, in the absence of short-term purchasing power parity, nominal shocks cause changes in the real exchange rate, as interpreted within the framework of price rigidity models. (Wang & Dunne, 2003).

Output Gap in Business Cycles

The output gap refers to how much actual economic output deviates in percentage terms from its estimated maximum sustainable level. Both policymakers and researchers in the field of business cycles consider the deviation in output is considered to have considerable importance. A positive output gap indicates an economic boom, while a negative output gap signals an economic recession or inefficient use of the economy's productive resources. Accurately calculating potential GDP is essential for determining the output gap. Potential GDP represents the maximum level of goods and services an economy can produce without causing inflationary or deflationary pressures. In most advanced industrial countries, the output gap is viewed as a leading indicator for predicting inflation and a key factor influencing monetary and fiscal policies. Potential output follows cyclical patterns, furthermore, the output gap indicates departures from the long-term trend. One should recognize that the output gap represents the disparity between what an economy currently produces and what it could produce at full capacity.

$$\text{Output Gap} = \left(\frac{y_t - \tau_t}{\tau_t}\right) \times 100 \quad (7)$$

In which: y_t: represents actual output, and τ_t: represents potential output (trend). In broad terms, a pair of primary approaches has been proposed to measure the economy's maximum output capacity and the gap relative to actual performance:

1) **Statistical Detrending Methods**: In this method, data collected over time is separated into lasting trends and recurring fluctuations, and it is a purely statistical method. Statistical detrending is performed using one of the following methods:
   - Hodrick-Prescott filter

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- Beveridge-Nelson decomposition, (1981) (univariate and multivariate)
- Band-pass filter (Baxter-King filter,1995; Christiano-Fitzgerald filter)
- Unobservable components model (State space model and Kalman filter)
- Rottemberg filter

2) **Structural Estimation Methods**: This method is based on economic theory, including production function methods, trend analysis of adjusted peaks, and other methods such as the production-to-capital ratio, the Econ method, real trend methods, and inverse factor demand methods. Next, the Hodrick-Prescott filter method is explained[1]. The Hodrick-Prescott filter (y_t) decomposes the time series data into a trend component (τ_t) and a cyclical component (c_t).

$$y_t = \tau_t + c_t \tag{8}$$

The Hodrick-Prescott filter extracts the output gap by assigning appropriate weights (λ) to the signal versus the trend. Therefore, if the weight (λ) equals zero, $c_t = 0$ and $y_t = \tau_t$. However, if the weight (λ) becomes very large ($\lambda \to \infty$), τ_t: approaches the estimate from the least squares method. Therefore, the Hodrick-Prescott filter is expressed as follows:

$$Min_{\{\tau_t\}_{i=1}^{T}} : \sum_{t=1}^{T}(y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1}[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \tag{9}$$

The advantage of the Hodrick-Prescott filter method is its flexibility, while its drawback is the sensitivity of the results to the weight (λ) (Hodrick-Prescott, 1997).

Effect of Currency Value Fluctuations on Economic Production Gap

In this section, to interpret how changes in currency values affect the difference between actual and potential economic output, the perspectives of the Neoclassical and New Keynesian schools are first presented. The discussion is then expanded to explain the influence of currency value fluctuations on economic supply and demand dynamics.

The Neoclassical school maintains that exchange rate fluctuations have symmetric and self-correcting effects on output and the general price level.

[1] Due to space limitations, only the Hodrick-Prescott filter method has been presented. However, upon request from the esteemed readers of the journal, explanations of other methods will be made available.

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According to this view, an increase in currency value—particularly after the local money has weakened—can potentially, in the short run, increase production costs, particularly in developing countries that rely heavily on imported raw materials and intermediate goods. This can lead to a decline in domestic production and a widening of the output gap. However, in the long run, market mechanisms contribute to economic equilibrium through increased exports and reduced imports, as domestic goods become more attractive. As a result, the adverse effects of currency volatility are mitigated. Neoclassicists emphasize that exchange rate fluctuations are considered temporary factors with short-term impacts that are adjusted through automatic market responses—especially via changes in prices and resource allocation. Thus, over time, the output gap narrows and the economy moves toward equilibrium. Nonetheless, this theory falls short of capturing the full complexity of economic realities, especially in developing countries. In such contexts—where economic structures differ and dependence on imports is high—exchange rate volatility may have distinct effects on production levels and the balance of trade. Thus, examining the effects of currency fluctuations on the output gap requires close attention to each country's specific economic conditions and domestic policy environment (Parianom et al., 2024).

The New Keynesian perspective on exchange rate fluctuations and their impact on the output gap asserts that these effects are asymmetric with respect to both overall price index and production. This means that fluctuations in currency value can differently influence output and cost levels within over both brief and extended periods. Initially, a rise in currency value may boost output levels costs due to the higher cost of imports and intermediate goods—especially in countries heavily dependent on imports. These increased costs may result in reduced domestic production leading to an expanding difference between actual and potential output. Over an extended period, nonetheless, the impacts of currency fluctuations are more complex. In New Keynesian economies, it is believed that incomplete adjustment of prices and wages over the near term causes the continued presence of adverse impacts from currency fluctuations volatility. This misalignment can result in a decline in gross domestic product and a rise in inflation, as the economy is unable to respond swiftly to exchange rate changes when wages and prices are sticky. From the New Keynesian point of view, this stickiness may stem from structural frictions and inefficiencies in labor and goods markets, which slow down the response to price changes. Therefore, in this theory, exchange rate fluctuations are believed to exert not only short-term impacts but also potentially long-lasting negative effects on both the price level and output. Overall, this view

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emphasizes that a thorough examination of how variations in currency values influence the output gap must consider structural and temporal factors, as their impacts—particularly in complex and unstable economies—may be variable and nonlinear (Oniha, 2021).

Variations in currency values play a crucial role in affecting the production segment of the economy. In emerging nations, where often rely heavily regarding the purchase of basic inputs and semi-finished products from abroad, such fluctuations can lead to significant changes in production costs. When the exchange rate rises, firms must pay more for imported inputs and machinery. These cost shifts are especially pronounced in industries that depend on advanced technologies and imported equipment. In such situations, the rise in production costs reduces firms' competitiveness and ultimately leads to a decline in domestic output. According to economic theory, fluctuations in currency values may have an indirect impact on the path of output and economic growth. Specifically, these fluctuations substantially raise production costs, and as a result, firms—under financial pressure—may refrain from expanding production or may even cut back output. This, in turn, negatively impacts not only individual firms as well as the general expansion of the nation's economy. Numerous empirical studies support these relationships. For example, Erceg et al., (2000) found that exchange rate fluctuations can increase production costs and ultimately reduce gross domestic product. These findings suggest that exchange rate volatility impacts import costs directly and indirectly leads to a reduction in local production and as well as the expansion of the economy. (Akiba, 2024).

Variations in currency values exert substantial effects on the demand side of the economy, particularly in the areas on international trade. When the domestic currency weakens, it immediately lowers the prices of domestically produced goods in global markets while increasing the prices of foreign goods. These changes can enhance a country's export competitiveness and reduce domestic consumers' inclination to purchase imported goods. Consequently, demand for domestic products rises, exports improve, and this process can help narrow the output gap, ultimately contributing positively to economic growth. From a theoretical perspective, these effects are explained in various economic models, including the Marshall-Lerner condition (1923) and the J-curve model. According to the Marshall-Lerner theory, for exchange rate fluctuations enhancing the trade surplus requires a crucial prerequisite, which is that the combined responsiveness of export and import demand to price changes needs to be greater than unity. In other words, a weakening of the currency may enhance the trade balance only if the demand reactions to

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fluctuations in international and local prices involve sufficiently strong and elastic. If this condition is not met, currency fluctuations may have adverse consequences, such as a decline in GDP or even a worsening trade deficit. Furthermore, Magee (1973) illustrated the effects of currency value changes analyzed through the J-curve model. According to this model, currency depreciation may initially lead to a worsening of the trade balance in the short term but eventually results in improved exports and a better trade balance in the long term. The J-curve clearly demonstrates the asymmetry in short- and long-term responses to exchange rate changes (Gayweh, 2024).

Monetary Authority's Role in Managing Currency Value Variations

In many countries, exchange rate flexibility is possible. However, due to the concerns of monetary policymakers about to manage currency fluctuations, monetary authorities engage in the forex market through the purchase and sale of foreign assets to prevent extreme fluctuations caused by supply and demand. If a managed under a flexible currency regime, the monetary authority acts whenever shifts in the internal variations in the monetary base that influence currency values take place. In this context, according to Tanner's (2001) study, the monetary model in terms of money demand is represented by equation (10).

$$m_t = \frac{\Delta M_t}{M_{t-1}} - \pi_t \quad (10)$$

In which: m_t: represents the real growth rate of the monetary base, M_t: is the nominal monetary base, and π_t: is the inflation rate. On the other hand, π_t^*: domestic inflation is related to global inflation, ex_t : through the face value of the currency exchange rate and the theory of equal buying power[1].

$$ex_t = \pi_t - \pi_t^* + z_t \quad (11)$$

In equation (11), ε_t: represents the deviation from purchasing power parity. However, equation (12) refers to the supply side.

$$\frac{\Delta M_t}{M_{t-1}} = \frac{(\Delta F_t + \Delta D_t)}{M_{t-1}} = r_t + \delta_t \quad (12)$$

In equation (12), F_t: represents the central bank's holdings of international currencies and assets, D_t: reflects internal lending, r_t: is the share of external monetary assets in the monetary base, and δ_t: is the proportion of internal lending within the money supply. It is presumed that, given worldwide

[1] The domestic currency is valued against the US dollar.

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inflation levels of zero, purchasing power parity holds, as indicated by $\pi_t^* = z_t = 0$, in equation (11). Therefore, equations (10) and (11) are substituted into (12), resulting in equation (13).

$$EMP_t = ex_t - r_t = \delta_t - m_t \quad (13)$$

According to equation (13), the difference regarding currency values and their fluctuations in foreign reserves are equal to the growth of credit (δ_t) and money demand (m_t). Therefore, in a currency regime with pegged exchange rates ($ex_t = 0$), and under floating exchange rates ($r_t = 0$), considering that Iraq's currency regime operates under a controlled flexible exchange rate, equation (14) applies.

$$ex_t - r_t = \delta_t - \mathrm{m_t} \quad (14)$$

In this context, δ_t: represents the share of the monetary base controlled by monetary policymakers. If real money demand is constant ($m_t = 0$), and the monetary authority's strategy for influencing currency values and the proportion of internal lending within the monetary base move in the same direction, the central bank may alter the share of domestic credit in the monetary base by adjusting interest rates. In this regard, contractionary monetary actions widen the gap between local and international interest rates, resulting in capital inflows and reducing currency market intervention (Abbasi et al., 2021).

Central bank policy intervention in the output gap

The Taylor Rule (1993), as a basic and essential concept within the field of monetary affairs policy, opened a new horizon for economic policymakers. With clear and logical reasoning, this rule advises central banks for identifying the face value of the interest rate not based on subjective preferences or political pressures, but on a scientific and well-defined foundation comprising two key economic indicators: the gap between observed inflation and the central bank's goal, and the difference between real economic performance and its maximum sustainable level. That is, when price levels surges, the monetary regulator is expected to curb market overheating by raising interest rates; conversely, in times of economic slowdown and declining output, it should inject vitality into the economy by lowering interest rates. However, despite its appealing simplicity, the implementation of this rule faces several limitations. Firstly, its exclusive focus on just two variables—inflation and the output gap—offers an incomplete picture of complex economic realities. Central banks, particularly in open and dynamic economies, are compelled to

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consider a broader range of indicators such as exchange rates, asset prices, capital flows, and even market expectations. Secondly, structural changes within the economy can destabilize the optimal coefficients prescribed by the rule, necessitating frequent recalibrations. Moreover, the academic community has not reached a definitive agreement about the precise magnitude of these coefficients. From Taylor (1993) to Clarida et al., (1999) and Rudebusch and Svensson (1999), each study has proposed different calibrations tailored to specific national contexts. Brainard (1967) insightfully reminds us that under conditions of uncertainty, central banks tend to act with greater caution, avoiding aggressive parameter values. This prudence reflects their deep understanding of the intricate and evolving nature of the global economy (Güney, 2016).

In the intricate and often ambiguous realm of monetary policy, one of the most persistent challenges confronting economic policymakers is the issue of the output gap—and the inherent difficulties in accurately estimating it. A fundamental concept in macroeconomics, the output gap represents the difference between an economy's actual output and its potential capacity. It serves as a mirror reflecting how efficiently an economy is utilizing its resources. Yet, this mirror is rarely clear: at times, it is fogged by ambiguity; at others, it reflects distorted images.

Within the framework of the Taylor Rule (1993)—a seminal guideline for setting interest rates still widely followed by central banks—the output gap, alongside the inflation rate, stands as one of two core variables in monetary decision-making. However, serious complications arise from the challenges associated with estimating the gap. Data used to calculate this crucial variable often arrives with a delay and is frequently subject to substantial revision. As a result, policymakers must often rely on information that is not only incomplete but potentially misleading.

A substantial body of literature—including studies by Smets (2002), Peersman and Smets (1999), and Rudebusch (2001)—has shown that in the face of such uncertainty, central banks tend to avoid overreacting to changes in the output gap. This caution is not born of indifference, but of prudence. When data is unreliable, a forceful policy response can generate unintended consequences—like a medicine that creates new symptoms rather than curing the disease.

Aoki (2003) reinforces this view, emphasizing that during periods of heightened uncertainty, policymakers must adopt a more deliberate and measured approach. Careful steps and meticulous calculations are essential—particularly during times of economic turbulence or structural crisis, when

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rash actions can destabilize fragile equilibria and send shockwaves through financial and monetary systems.

Thus, in striving to stabilize the economy, central banks must deploy more sophisticated analytical tools and refine their estimation methods to minimize measurement error. This does not imply an abandonment of monetary intervention, but rather a shift toward intentional, data-informed, and flexible strategies. In today's complex economic landscape, rigid, one-size-fits-all solutions are no longer viable.

A central bank is much like a captain steering a ship through stormy seas—one eye fixed on the stars of economic data, the other watching the turbulent waves of the future. In this role, precision, foresight, and realism become the essential principles of navigation. The output gap, while a necessary metric, can become a hidden trap in times of volatility; if misjudged or misunderstood, it can easily lead policymakers astray.

It follows, then, that in managing the output gap and the uncertainty surrounding its measurement, central banks must remain firmly committed to their core mandates—price stability and sustainable economic growth—while embracing a broader and more nuanced understanding of this variable's role. In doing so, monetary policy can move beyond a mechanical function and evolve into a sensitive, adaptive art—one that contributes constructively and calmly to the economic environment.

Ultimately, during periods of elevated uncertainty, monetary interventions must be executed with greater caution, accuracy, and strategic restraint to avoid negative consequences and avert crises. Central banks must account for structural changes and specific economic conditions when calibrating the weights assigned to the output gap and inflation in their policy rules. Above all, they must avoid aggressive decisions that risk provoking financial instability (Anjaly & Deo, 2025).

2.2 Previous Research

Hmod et al., (2024), in a study titled "The Impact of the Interaction of Fiscal and Monetary Policies on Exchange Rates in Iraq from 1980 to 2022" using the ARDL method, concluded that various policies and their instruments have different effects on exchange rate fluctuations and the value of the Iraqi dinar against the US dollar. They also found that the interaction between fiscal and monetary policies can neutralize or reduce each other's impacts.

Teacher (2024), in a study regarding "The Efficiency of Monetary and Fiscal Measures Tools in Enhancing Financial Stability in Iraq," found that

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the compatibility between monetary and fiscal policy tools can help rebuild Iraq's economy and achieve financial stability.

Atiyabi et al., (2023) analyzed the impact of Central Bank interventions on the profitability of commercial banks using the Smooth Transition Regression model. The results showed that central bank intervention reduced market pressure by 24% on average.

Zolfaghary et al., (2023), in their article titled "The Impact of Exchange Rate Shocks and Central Bank Monetary Policy on the Output Gap in Business Cycles from March 1980-June 2019 ," used the Nonlinear Threshold Time Series Model approach. According to statistical tests for model specification, the exchange rate shock is a threshold variable, and findings indicated that monetary authority actions and fluctuations in oil prices exert a stronger influence on the disparity between actual and potential output.

Haghighat et al. (2022), examined the nonlinear effect of financial risk, with central bank policy intervention and market pressure, on banking stability in the country using Smooth Transition Regression. According to the Girton and Roper (1977) model, in 26 out of 33 years, market pressure increased, and the average central bank policy intervention was 0.79. Between 1986 and 2018, 79% of central bank intervention policies were inconsistent, and the Smooth Transition Regression model showed that the threshold transition variable is 6.55. When central bank intervention exceeds this threshold, policymakers focus more on controlling the exchange rate, which increases liquidity and credit risks, decreasing banking stability. Capital adequacy and economic growth have a positive effect, while central bank intervention, liquidity risk, credit risk, and inflation have a negative impact on banking stability.

Rajae et al., (2020), this study examined the impact of lasting and short-term currency fluctuations on the difference between actual and potential output within Iran’s economy from 1974 to 2017. The output gap was first calculated using the Hodrick-Prescott filter, and a Structural Vector Autoregressive (SVAR) model was employed to examine how sudden changes in currency values affect the economy. Blanchard and Quah technique (1988) was applied to separate currency disturbances into long-lasting and temporary components. The findings show that temporary fluctuations in exchange rates exert a temporary impact on the output gap, lasting for four periods, after which the immediate effects disappear and only cumulative effects persist in the long term. In contrast, permanent exchange rate shocks initially adversely affect production levels gap, but their accumulated effect turns positive over the long term. During the brief term,

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temporary shocks are dominant, while in the long run, permanent shocks play a more significant role in output gap fluctuations.

Katusiime & Agbola (2018), This study investigates how actions taken by the central bank in the foreign exchange market have influenced both the value and fluctuations of the Uganda shilling against the US dollar (UGX/USD) under an inflation-targeting policy framework. The analysis relies on daily observations spanning from 1 September 2005 to 31 December 2015. A GARCH-based econometric model is used to estimate the effects. Findings suggest that these interventions have produced varied outcomes in terms of exchange rate volatility. The results show that foreign exchange interventions have a mixed impact on exchange rate volatility. Inflation targeting is found to play a useful role in stabilizing brief exchange rate shocks. While order flow reduces volatility, an increase in the operating target rate (7-day interbank rate) tends to increase volatility. These findings are robust to alternative model specifications. The study concludes that inflation targeting is a useful monetary policy tool for managing exchange rate volatility of central bank intervention in influencing the direction, volatility, and misalignment of the exchange rate.

Trivedi and Srinivasan (2016) examined the effectiveness the role of monetary authority actions in affecting the movement, fluctuations, and deviations of the currency exchange rate in India's managed float regime, characterized by consistent intervention conducted by India’s central monetary authority. This research employs the event study methodology to analyze the clustered and non-stochastic nature of interventions. The results indicate that direct intervention, through the sale or purchase of foreign currency, does not play a major role in determining the trajectory of exchange rates movement or volatility, as shown by both monthly and daily data. The findings suggest that central bank intervention in this context has not managed to accomplish the intended outcomes regarding currency values dynamics.

3 Research Methodology

The research method is of a causal-correlational type, based focusing on the examination of sequential data points. The objective of this study is to present a macroeconomic model, considering the conditions of Iraq. The data for this research were collected through library and documentary methods from the World Bank database for the period of 2008-2022 for Iraq. The research model has been developed using the LSTR (Logistic Smooth Transition Regression)

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approach[1]. The study first introduces the index of central bank policy intervention and then interprets the research model.

3.1 Central Bank Policy Intervention Index

Many studies emphasize the function of local organizations in shaping monetary policy, particularly concerning the self-governance and clarity of central banks. In general, the autonomy of the central bank reduces the fluctuations caused by currency value disturbances. Nevertheless, the efficiency of economic reform policies cannot be understood without considering political economy. Therefore, countries with a good political environment experience fewer negative effects from exchange rate shocks due to strong institutions (Aisen & Veiga, 2005). On the other hand, policymakers intervene directly within the currency trading arena (purchasing and offloading currencies) to achieve stability in the currency exchange value, and this index of central bank intervention reflects its response to exchange rate volatility, as presented in equations (15) to (16). Within a pegged currency framework, market interventions occur without restrictions to maintain the exchange rate. Thus, ρ tends to infinity. In a floating exchange rate system, policymakers do not intervene in the foreign exchange market ($\rho = 0$).

$$\Delta r_t = -\rho e_t \tag{15}$$

However, within a controlled flexible currency regime, the foreign exchange market Pressure Index (EMP) is defined as:

$$EMP = \Delta e_t + \eta \Delta r_t \tag{16}$$

In relation (16), EMP: represents the exchange market pressure, Δe_t: denotes the changes in the currency exchange value, η is the currency exchange value elasticity with respect to foreign reserves, and Δr_t: represents the changes in foreign reserves. Equation (16) is adjusted depending on the

[1] The Logistic Smooth Transition Regression (LSTR) approach is a nonlinear regression model used to analyze phenomena whose behavior gradually shifts between two or more distinct regimes over time or under specific conditions. Unlike discrete regime-switching models such as the Markov-switching model, the LSTR model allows for smooth and continuous transitions between states. A key component of the LSTR model is the transition variable, which governs how the model's coefficients evolve gradually in response to changes in this variable. The transition function is typically a logistic function, which controls the speed and intensity of the regime shift. This feature makes the LSTR model particularly suitable for examining economic relationships that behave differently under varying conditions—for example, the response of output to exchange rate fluctuations during periods of economic stability versus instability.

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type of actions taken by the monetary authority within the currency exchange market. For example, if the monetary authority, in order to control the exchange rate and influence the foreign exchange market, uses not only the tools of currency exchange value and foreign reserve adjustments but also an additional tool called changes in the domestic lending by the central bank, and utilizes indirect tools such as banking interest rates, part of the currency market stress decreases through the internal composition of the monetary base In this case, the exchange market pressure is derived using the following equation:

$$EMP = \Delta e_t + \eta[\lambda \Delta d_t + \Delta r_t] \quad (17)$$

Δd_t: represents the changes in the domestic lending by the central bank, and λ indicates the percentage of the changes in domestic credit that is due to indirect intervention. The policy index for the actions taken by the central bank in the forex market are described as the part of currency market stress that is neutralized through its intervention (Weymark, 1995). Depending regarding approaches to how various nations' central banks implement intervention strategies in their currency markets, the policy intervention index is divided into two parts: the 'direct intervention index' and the 'direct and indirect intervention index.

$$I_t = \frac{\eta \Delta r_t}{EMP} \quad (18)$$

$$I_t = \frac{\eta[\lambda \Delta d_t + \Delta r_t]}{EMP} \quad (19)$$

Equation (18) represents the direct intervention index, and equation (19) represents the direct and indirect intervention index For the purpose of preserving equilibrium in the forex market and protect it from traders and speculators, policymakers in the monetary system of countries always strive to keep exchange rate fluctuations within a desired range by applying appropriate policy tools (Tabatabaie Nasab & Afshari, 2013). However, due to the limited availability of data from the monetary system of Iraq, this study uses the direct intervention policy index of the central bank.

3.2 Model Specification

After introducing the policy intervention index of the central bank, to complement the discussion, and following the study by Zolfaghary et al.,

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(2023)[1], with the aim of explaining the impact of exchange rate fluctuations and central bank policy intervention on the output gap in Iraq, the smooth transition regression approach is applied using equation (20).

$$GDP_{gap,t} = \alpha_0 + \alpha_1 INT_{i,t} + \alpha_2 LOGOIL_{i,t} + \alpha_3 EX_{i,t} + \alpha_4 LOGM_{i,t} + \alpha_5 DMEX_{i,t} + \alpha_6 DEP_{i,t} + U_t \quad (20)$$

In which: $GDP_{gap,t}$: represents the output gap, calculated using the Hodrick-Prescott filtering method, functioning as a signal of national economic activity cycle. $INT_{i,t}$: indicates the metric reflecting central bank intervention activities. $LOGOIL_{i,t}$: is the logarithm of oil income. $EX_{i,t}$: captures currency volatility, calculated using the logarithmic difference in exchange rate values at the close of captures currency volatility, calculated using the logarithmic difference in exchange rate values at the close of the rate of exchange observed at the end of period t divided by its value at the conclusion of period t−1. $LOGM_{i,t}$: refers to the logarithmic form of the available money in the economy. $DMEX_{i,t}$: is a dummy variable representing the critical conditions of the ISIS war years (2014 to 2017). $DEP_{i,t}$: is the logarithm of the inflation-adjusted interest rate, calculated by subtracting the inflation rate from the nominal rate.

4 Research Findings

4.1 Trend of Variable Changes in the Mode

Next, before presenting the quantitative descriptions reflecting how changes have evolved in the research variables has been examined. Accordingly, in Figure 1, the trend of changes in the Gross Domestic Product (GDP) gap, based on the Hodrick-Prescott method, is shown.

[1] It is worth noting that the present study demonstrates several notable innovations compared to the research conducted by Zolfaghary et al(2023). First, there is a clear difference in the temporal and geographical scope: while Zolfaghary et al's study(2023) focuses on the Iranian economy, the current research is centered on the Iraqi economy. Second, Zolfaghary et al's(2023) work emphasizes oil and exchange rate shocks, whereas this study specifically examines fluctuations in Iraq's oil revenues alongside exchange rate volatility. Third, the choice of dummy variables also distinguishes the two studies; Zolfaghary et al's(2023) research considers oil sanctions against Iran as the dummy variable, while the present study incorporates the outbreak of the ISIS war as a critical economic shock. Fourth, in terms of both subject matter and methodology, this research is unprecedented in the context of Iraq, thereby representing a novel contribution to the existing literature on exchange rate fluctuations in the region.

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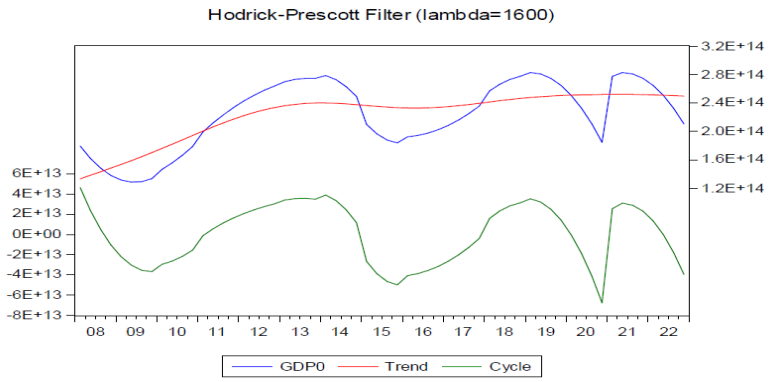

Figure 1. Trend of Changes in the Gross Domestic Product Gap Based on the Hodrick-Prescott Method
Source: Research Findings

According to the results of the Hodrick-Prescott filter in Iraq, four periods of economic recession occurred during the following intervals: four separate spans of economic downturn were identified: starting early in 2008 and lasting through Q3 2009; between Q2 2014 and Q3 2015; from Q3 2019 until the close of 2020; and again, from Q4 2021 through the end of 2022. In contrast, growth phases were detected during three timeframes: Q4 2009 to Q1 2014, Q4 2015 to Q1 2019, and Q3 2020 to Q1 2021.

On the left side of Figure 2, the trend of changes in the real interest rate is depicted. The real interest rate fluctuated sharply downward from 2008 to 2011, marked by significant volatility. It then followed a sharp upward trend from 2012 to the third quarter of 2018. From the fourth quarter of 2018 to the end of 2019, the rate decreased gradually, then increased slowly from 2020 to the third quarter of 2021, and rose again from the fourth quarter of 2021 to the end of 2022.

The right panel of Figure 2 illustrates the pattern of oil revenue changes. Between 2008 and 2022, Iraq's oil earnings experienced notable volatility with an overall downward trend. Increases in oil income were recorded in the years 2009, 2012, 2015, 2019, and 2022, whereas decreases occurred in 2008, 2010, 2014, 2017, and 2021.

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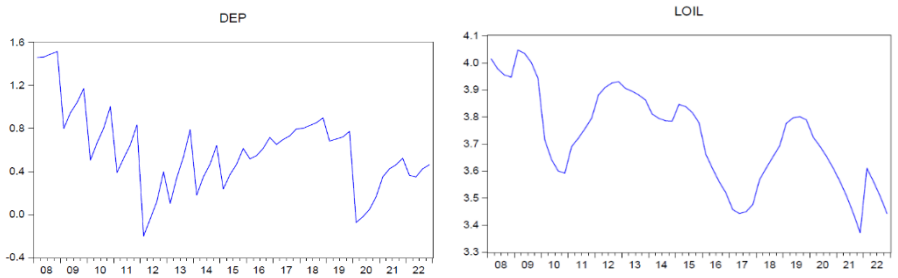

Figure 2. Trend of Changes in the Real Interest Rate and Oil Income
Source: World Bank

On the left section of Figure 2 displays the progression of changes in the inflation-corrected interest rate is shown. The real interest rate experienced a sharp downward trend from 2008 to 2011, marked by significant volatility. From 2012 to the third quarter of 2018, it followed a sharp upward trend, again with notable volatility. From the fourth quarter of 2018 to the end of 2019, it decreased gradually. Between 2020 and the third quarter of 2021, the rate increased modestly, and from the fourth quarter of 2021 to 2022, it continued to rise.

On the right side of Figure 2, the trend of changes in oil income is shown. Iraq's oil income during the study period, from 2008 to 2022, began with fluctuations and gradually decreased. Positive increases in oil income occurred in 2009, 2012, 2015, 2019, and 2022, while negative declines were observed in 2008, 2010, 2014, 2017, and 2021.

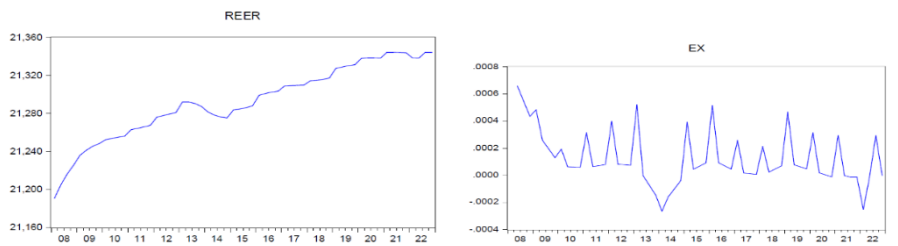

Figure 3. Trend of Changes in the Real Exchange Rate and Exchange Rate Fluctuations
Source: World Bank

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In Figure 3, The left portion of the figure illustrates the pattern of variations in the real exchange rate, whereas the right side depicts the volatility in exchange rates. From 2003 until 2020, Iraq's government and monetary authorities employed the exchange rate mechanism as a tool for economic management, leading to GDP expansion and a rise in exports, which subsequently caused fluctuations in the exchange rate. Following December 19, 2020, the country transitioned to a managed floating exchange rate regime, which helped stabilize the exchange rate and strengthen the Iraqi dinar, preventing large-scale surges. According to the methodology section, Table 1 presents the Exchange Market Pressure (EMP) along with the central bank's policy intervention index derived from exchange rate volatility (It), with Figure 4 providing a visual representation of these results.

Table 1
Exchange Market Pressure (EMP) and the Central Bank's Policy Intervention Index (It) Based on Exchange Rate Fluctuations

Year	EMP				I_t			
	(Season 1)	(Season 2)	(Season 3)	(Season 4)	(Season 1)	(Season 2)	(Season 3)	(Season 4)
2008	0.00660	0.000662	0.000548	0.000435	0.002702	0.002721	0.001993	0.000887
2009	0.000481	-0.000258	0.000194	0.000130	-0.005312	-0.000533	-0.000245	0.001793
2010	0.000193	-6.36E-05	-6.19E-05	-5.97E-05	0.002446	0.009117	0.011995	0.015152
2011	0.000316	-6.53E-05	-7.31E-05	-8.13E-05	0.002646	0.020244	0.021563	0.022488
2012	0.000401	-8.42E-05	-7.99E-07	-7.56E-05	0.007253	0.023738	0.024025	0.024347
2013	0.000523	-1.20E-01	-3.70E-07	-0.000146	0.005949	-0.000461	-0.007175	-0.000591
2014	-0.000266	-0.000159	-9.89E-05	-4.05E-05	0.004377	0.007104	0.015686	0.049314
2015	0.000389	-0.000025	-0.000067	-0.000095	-0.010791	-0.051171	-0.028576	-0.018106
2016	0.000513	-0.000916	-0.000686	-0.000555	-0.003592	-0.009928	-0.006536	-0.000294
2017	0.000259	-0.000178	-0.000136	-0.000840	0.001904	0.052102	0.101704	0.218128
2018	0.000218	-0.000259	-0.000286	-0.000137	0.019065	0.076505	0.034679	0.019493
2019	0.000468	-0.000383	-0.000303	-0.000478	0.001836	0.011435	0.011022	0.010350
2020	0.000314	-0.000179	-0.000271	-0.000125	0.000941	0.005370	-0.038171	-0.024261
2021	0.000293	-0.000171	-0.000146	-0.000142	-0.001033	0.177743	0.007075	0.007309
2022	-0.000251	-0.000125	-0.000293	-0.000151	-0.003241	-0.002426	-0.001033	-0.068578

Source: Research Findings

Within a managed floating exchange rate framework, the central bank's actions vary along a scale ranging from zero to one ($0 < I_t < 1$). When the $I_t$value is negative, it reflects a synchronized intervention approach, where monetary officials act in alignment with the movement of the exchange rate in the forex market. In contrast, a positive $I_t$value represents a counter-cyclical strategy, with the central bank taking actions contrary to the direction of exchange rate changes. This typically involves supplying foreign currency to the market to dampen extreme fluctuations and promote stability.

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According to the findings presented in Table 1 and the left panel of Figure 4, between 2008 and 2022, the central bank's actions aligned with exchange rate movements during six distinct intervals: the first and second quarters of 2009, the second and third quarters of 2013, from early 2015 through the third quarter of 2016, the third quarter of 2020, the first quarter of 2021, and both the first and third quarters of 2022. Outside these periods, the central bank adopted a counter-cyclical stance. On average, the central bank's intervention rate was 0.0233%, successfully offsetting roughly 97% of the pressures faced in the foreign exchange market

A positive value of Exchange Market Pressure (EMP) signals forces pushing for a depreciation of the local currency, causing the exchange rate to climb, which can trigger inflation and lure speculative activity. On the other hand, a negative EMP reflects a strengthening currency, with its value maintained through a falling exchange rate. Based on data in Table 1 and the right section of Figure 4, prior to the fourth quarter of 2020, the EMP mostly pointed to downward pressure on the dinar relative to the dollar, aside from two exceptions during Q2 2019 and from mid-2013 through the end of 2014. From late 2020 through 2022, the EMP shifted to negative territory, indicating that the Central Bank of Iraq, in its effort to curb inflation, permitted a gradual increase in the exchange rate while prioritizing the dinar's stability .

Three specific intervals—Q1 of 2009, the span from early 2015 through Q3 of 2016, and the period between Q3 2020 and Q1 2021—were characterized by a negative, aligned intervention stance from the central bank alongside upward exchange market pressure. In response, authorities devalued the dinar and allowed the exchange rate to rise, reinforcing market dynamics. Conversely, in Q3 2009, Q2–Q3 2013, and Q3 2022, despite the central bank maintaining a similarly negative and aligned policy, the exchange market pressure was downward. During these times, policymakers acted to appreciate the dinar and lower the exchange rate, even as market conditions suggested strength in the national currency.

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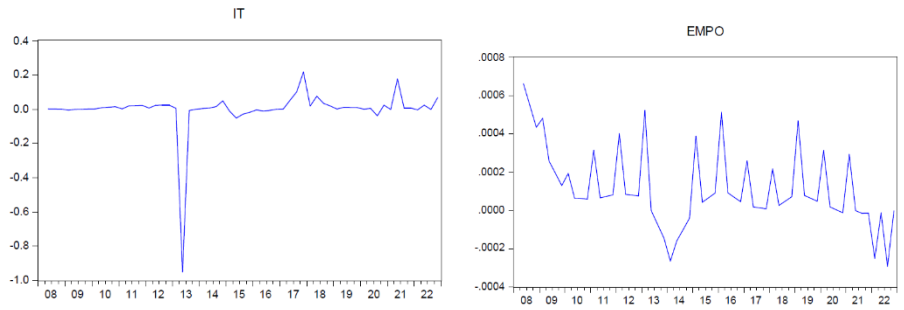

Figure 4. shows the trend of exchange market pressure (EMP) and the central bank's policy intervention index in relation to exchange rate fluctuations (I_t)

Source: Research Findings

4.2 Descriptive Statistics of Variables

Three specific intervals—Q1 of 2009, the span from early 2015 through Q3 of 2016, and the period between Q3 2020 and Q1 2021—were characterized by a negative, aligned intervention stance from the central bank alongside upward exchange market pressure. In response, authorities devalued the dinar and allowed the exchange rate to rise, reinforcing market dynamics. Conversely, in Q3 2009, Q2–Q3 2013, and Q3 2022, despite the central bank maintaining a similarly negative and aligned policy, the exchange market pressure was downward. During these times, policymakers acted to appreciate the dinar and lower the exchange rate, even as market conditions suggested strength in the national currency.

Descriptive statistics serve as a preliminary tool for uncovering structural patterns within the dataset and form the analytical groundwork for exploring inter-variable relationships in this study. Among the measures of central tendency, the arithmetic mean plays a pivotal role, capturing the general magnitude of each variable. For instance, Iraq's GDP averaged approximately 2.24×10^{14} dinars over the analysis period, suggesting that most values clustered around this level. The standard deviation, which quantifies dispersion, indicates that the money supply exhibited the highest variability among the variables assessed. Regarding distributional shape, the skewness and kurtosis indicators help assess deviations from normality. Notably, the central bank's policy intervention index demonstrated the greatest degree of peakedness (kurtosis). As for asymmetry, the money supply, exchange rate

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fluctuations, and real interest rate were positively skewed, while the remaining variables tended to display left-skewed distributions.

Table 2
Descriptive Statistics of the Research Variables

Variable	Index	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
GDPt	Gross Domestic Product	2.24×10^{14}	2.83×10^{14}	1.29×10^{14}	4.80×10^{13}	-0.49	2.05
GMt	Money Supply	3.23×10^{15}	1.22×10^{16}	5.9×10^{12}	4.46×10^{15}	0.837	2.06
OILt	Oil Revenue	7.91×10^{15}	1.29×10^{16}	2.60×10^{13}	4.03×10^{15}	-0.699	2.53
It	Central Bank Policy Intervention Index	0.000233	0.218	-0.95	0.133	-6.26	46.37
DEP	Real Interest Rate	0.581	1.515	-0.198	0.359	0.383	3.58
EX	Exchange Rate Volatility	0.000122	0.0007	-0.0003	0.00019	0.769	3.23

Source: Research Findings

4.3 Stationarity Test of the Research Variables

Before estimating the model, it is crucial to test the stationarity of the variables. The process for testing the stationarity of seasonal data differs from that of other types of data, and the typical approach to address non-stationarity is through seasonal differencing. To test the stationarity of the variables, the Augmented Dickey-Fuller (ADF) test is used, as presented in Table 3.

Table 3
Results of the Stationarity Test for Variables

Variable	Index	Statistic	Significance Level	Unit Root Test Results
dGDPt	GDP Gap	-3.722	0.003	I(0)
LGMt	Log of Money Supply	-7.95	0.000	I(0)
LOILt	Log of Oil Income	-3.71	0.006	I(0)
It	Central Bank Intervention Index	-6.91	0.000	I(0)
DEP	Real Interest Rate	-3.64	0.000	I(0)
EX	Real Exchange Rate Volatility	-3.98	0.001	I(0)

Source: Research Findings

The results in Table (3) show that all variables in the research model are stationary. This confirms the validity of using the LSTR method for data analysis.

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4.4 Diagnostic Tests

After performing the unit root test, which confirms the stationarity of the research variables at the level, the next step is to select the transition variable from among the research variables. The hypothesis of linearity is tested, and typically, the variable that rejects the linearity hypothesis is chosen as the transition variable. In this study, exchange rate volatility, which prompts the central bank's policy intervention to mitigate market pressure on GDP, is selected as the transition variable. According to the results in Table 4, exchange rate volatility is confirmed as the transition variable in the research model, and the linearity hypothesis is rejected, thereby validating the use of the LSTR model.

Table 4
Linearity Test, Transition Variable Selection, and Model Type

Transition Variable	F Statistic	2F Statistic	3F Statistic	4F Statistic	Research Model
LSTR	0.518	0.429	0.789	0.562	Exchange Rate Volatility

Source: Research Findings

In addition to the diagnostic tests, serial correlation and heteroscedasticity tests were conducted. The estimation results in Table 5 indicate the presence of serial correlation in the residuals of the study. Moreover, the results of the heteroscedasticity test in Table 6 show the absence of heteroscedasticity. Therefore, with no serial autocorrelation in the residuals and no heteroscedasticity, the model estimation using the LSTR method is confirmed.

Table 5
Serial Correlation Test of Residuals of the Model

Lag	F Statistic	Probability
1	0.877	0.3798
2	0.326	0.7498
3	0.397	0.6932

Source: Research Findings

Finally, two additional diagnostic tests were conducted: one for the absence of nonlinearity in the residuals and another for parameter stability across different regimes. According to the results in Table 6, the absence of nonlinearity in the residuals confirms that all nonlinear behaviors present in the model are appropriately accounted for. Furthermore, the results of the

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parameter stability test across different regimes indicate that the null hypothesis of parameter stability is rejected. This suggests that the explanatory variables differ across regimes and that the effects on the production gap in trade cycles are asymmetric. Therefore, based on the results of the diagnostic tests, the LSTR model is deemed suitable for analyzing the behavior of the model estimates, and the estimation results are considered reliable for interpretation.

Table 6
Diagnostic Tests of the Model

Test	F Statistic	Probability Value
Heteroscedasticity	0.128	0.9432
Nonlinearity of Residuals	1.267	0.5932
Stability of Parameters in Different Regimes	1.347	0.4632

Source: Research Findings

4.5 Model Estimation Results

An LSTR model was employed, incorporating exchange rate volatility as the transition variable, to construct a response function that captures the influence of both exchange rate fluctuations and central bank intervention on the output gap across different phases of the business cycle. Therefore, the threshold value of the transition variable and the slope parameter were selected. Then, using these initial values and applying the Newton-Raphson algorithm, the parameters of the model were determined using the maximum likelihood estimation technique. Table 7 displays the findings from the parameter estimation process.

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Table 7
Estimation Results of the Research Model Using the LSTR Method

Variable	Indicator	Coefficient	Standard Deviation	t-Statistic	Significance Level
Linear Model Estimation					
It	Central Bank Policy Intervention Index	-0.004496	0.001271	-3.536895	0.0053
EX	Real Exchange Rate Volatility	1.976305	0.456400	4.330185	0.0049
LOILt	Log of Oil Revenue	-0.036265	0.008423	-4.305584	0.0001
LGMt	Log of Money Supply	-0.025535	0.006126	-4.168364	0.0002
DEP	Real Interest Rate	-0.003487	0.002530	-1.378392	0.1766
DMEX	Dummy Variable for ISIS War Occurrence	0.001635	0.000672	2.426416	0.0204
C	Intercept	0.004200	0.002094	2.567673	0.0525
Non-Linear Model Estimation					
It	Central Bank Policy Intervention Index	-0.004175	0.001192	-3.503825	0.0188
EX	Real Exchange Rate Volatility	2.070128	0.459236	4.507875	0.0063
LOILt	Log of Oil Revenue	-0.015912	0.003451	-4.610674	0.0015
LGMt	Log of Money Supply	-0.027628	0.006417	-4.305696	0.0001
DEP	Real Interest Rate	-0.000719	0.002592	-1.247245	0.2204
DMEX	Dummy Variable for ISIS War Occurrence	0.000529	0.000184	2.875001	0.0051
C	Intercept	-0.003216	0.002166	-1.484801	0.1463
THRESH	Threshold (c)	5.589545	0.150833	37.05765	0.0000
Slope	Slope Parameter (γ)	0.443130	0.165244	2.681666	0.0075
Coefficient of Determination (R^2): 0.82					

Source: Research Findings

The Central Bank's Policy Intervention Index exhibited a statistically significant and negative effect on the output gap throughout trade cycle phases, as evidenced by both linear and nonlinear model results. Conversely, The transfer index of exchange rate volatility demonstrates a meaningful and positive influence on the output gap across both linear and nonlinear modeling approaches. This suggests that fluctuations in the exchange rate play a role in expanding the output gap, fostering inflationary expectations and price increases within the economy. In this context, during the study period, the Central Bank implemented a positive, counter-cyclical intervention strategy, demonstrating how monetary authorities utilized the currency window to manage exchange rate volatility and alleviate market pressure.

The impact of oil revenue on the output gap has been negative and significant in both linear and non-linear estimations. As oil revenues increase, leading to higher foreign reserves for when the central bank acts, pressure on the exchange rate lessens, and the national currency strengthens. This results in a decline in the competitiveness of non-oil export products, causing imports

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to exceed exports. However, imports of consumer goods, intermediate products, and production inputs increase, which in turn boosts production and private sector investment. In the long run, this helps reduce the output gap.

Similarly, the impact of the money supply on the output gap during trade periods has been negative and significant in both linear and non-linear estimations. As the money supply grows, stimulating production, the output gap narrows. However, when implementing expansionary monetary policy, it is essential for the central bank to consider the real output requirements and avoid excessive money supply growth, which could lead to inflation.

How changes in the real interest rate affect the output gap during business cycles, both under linear and nonlinear estimation, has been negative and statistically insignificant. This indicates that interest rate–based monetary policy has limited effectiveness in the Iraqi economy and cannot, on its own, stimulate production or curb recession. The inefficiency of this policy tool is largely due to weaknesses within the process through which monetary policy influences the economy, especially in a context of underdeveloped financial markets, high uncertainty, and low institutional trust.

The impact of the ISIS war on the output gap during trade periods has been positive and significant in both linear and non-linear estimations. In other words, the war caused significant destruction to Iraq's infrastructure and production capacity, resulting subsequently in a rise in the output gap.

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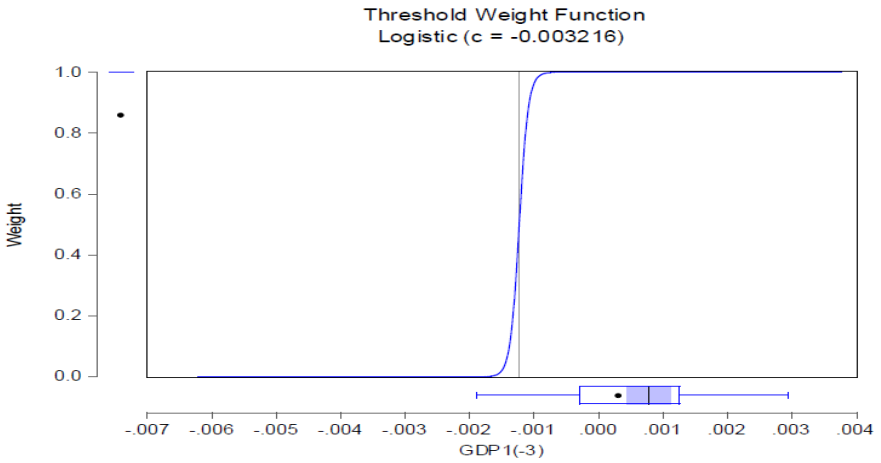

Figure 5. shows how explanatory variables impact the dependent variable, influenced by the exchange rate volatility transition in the LSTR model.
Source: Research Findings

Based on the values of the transition variable, the coefficients in both linear and nonlinear regimes are compared, determining the transition variable, transfer function, and the resulting regime. When the transition variable exceeds the threshold, two distinct regimes are formed. Based on the estimation outcomes shown in Table 7, the identified threshold is 5.589, exceeding the exchange rate volatility coefficient that acts as the transition variable, resulting in both linear and nonlinear regimes. Consequently, once exchange rate volatility goes beyond 5.589, monetary authorities' reactions to these fluctuations intensify markedly. Given that Iraq employs a managed floating exchange rate regime, the central objective of monetary policy is to limit excessive exchange rate fluctuations and maintain stability within a targeted band, which necessitates more active intervention by the central bank. The dynamic transition of exchange rate volatility across different phases is illustrated in Figure 5.

5 Conclusion and Recommendations

Exchange rate volatility significantly influences economic variables such as inflation, production, exports, and imports. Moreover, the central bank's approach to implementing monetary policies aimed at controlling inflation and managing exchange rate fluctuations under varying economic conditions

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warrants further analysis. Therefore, the primary objective of this study is to assess the impact of exchange rate volatility and central bank intervention on the output gap within the business cycle in Iraq. To test the research hypotheses, the study utilizes the LSTR approach, with the model estimated using data from 2008 to 2022.

Within the framework of macroeconomic theory, central bank policy interventions—particularly in the management of the foreign exchange market—are essential in reducing economic fluctuations and fostering stability within the broader economic environment. In the face of external disturbances impacting the economy, such as severe exchange rate fluctuations, the central bank can utilize tools such as direct intervention in the currency market to contain instability and support a smoother path toward economic growth. The present study employs the Logistic Smooth Transition Regression (LSTR) model to examine the impact regarding the influence of central bank actions in the foreign exchange market on the output gap throughout various stages of economic expansion and contraction. The findings derived from the model estimation—both in linear and nonlinear regimes—indicate that the intervention index exerts a negative and statistically significant effect on the difference separating real output from its potential level. During other words, higher levels of intervention are associated with a narrowing of the disparity between what the economy is capable of producing and what it actually produces. This result underscores the role of proactive central bank interventions in lessening the depth of recessions and supporting economic rebound during downturn phases. During the studied period, the central bank predominantly intervened by supplying foreign currency to the market and influencing exchange rate levels. These interventions were aimed at curbing inflation expectations, strengthening the confidence of economic agents, and enhancing predictability within the market. As a result of these actions, relative exchange rate stability was achieved, which in turn created a more favorable environment for investment, production activities, and economic planning. Ultimately, the first hypothesis of the study—that central bank interventions have a significant effect on reducing the output gap—is confirmed. This underscores the importance of intelligent and targeted exchange rate policies in managing business cycle fluctuations and improving macroeconomic performance, especially in developing economies such as Iraq, which are often more vulnerable to internal and external shocks.

Moreover, the findings are consistent with previous empirical studies that have investigated the impact of foreign exchange policy interventions across

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various countries, including Weymark (1995), Tabatabaie Nasab and Afshari (2013), Katusiime and Agbola (2018), and Zolfaghary et al., (2023). This alignment with the existing literature further strengthens the credibility and robustness of the study's conclusions.

Based on the results obtained from the estimation of the model using the Smooth Transition Regression (LSTR) method, it was found that exchange rate volatility, in both linear and nonlinear regimes, has a positive and statistically significant impact on the output gap during business cycles. This finding indicates that increased instability in exchange rates is associated with a widening gap between potential and actual output, ultimately leading to disruptions in macroeconomic performance. From a theoretical standpoint, exchange rate fluctuations are considered one of the key channels through which external shocks are transmitted to the domestic economy. Such volatility affects import prices, production costs, and the overall price level, thereby fueling inflationary expectations among economic agents. The formation of these expectations—especially in economies with weak institutional structures and high dependency on imported goods—creates an environment of uncertainty, undermines investment confidence, and weakens productive activity. As a result, the level of economic output declines, deviating further from its potential, thus expanding the output gap. In this context, the findings of the present study on Iraq's economy also confirm that intense exchange rate volatility—particularly during periods marked by political or external shocks—has exacerbated macroeconomic instability and increased the output gap. This underscores the crucial importance of maintaining relative stability in the foreign exchange market as a necessary condition for macroeconomic balance and preventing a decline in national output. Overall, the results suggest that controlling exchange rate fluctuations, particularly in vulnerable economies, through targeted and transparent monetary and exchange rate policies, can be an effective step toward reducing the output gap and enhancing economic stability. Accordingly, the second hypothesis of the study, which posits a positive and significant relationship between exchange rate volatility and the output gap during Iraq's business cycles, is not rejected. These findings are consistent with previous studies, including those by Weymark (1995), Tabatabaie Nasab and Afshari (2013), and Zolfaghary et al., (2023), all of which highlight the critical role of exchange rate policies in mitigating macroeconomic fluctuations.

Considering the positive impact of exchange rate volatility on the output gap during business cycles, as well as the significant negative effect of central

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bank policy interventions in reducing this gap, the following practical recommendations are outlined:

- **Strengthening targeted currency market actions:** considering the favorable impact of central bank measures in lessening the output gap, these interventions should be implemented intelligently, using predictive models and market trend analysis. Interventions should not be merely short-term or reactive but should be based on data analysis and aligned with broader macroeconomic goals.
- **Establishing a stable and transparent exchange rate policy framework:** developing a clear framework for an exchange rate strategy that integrates a managed float framework with predetermined fluctuation margins can be effective in curbing excessive exchange rate instability, provide assurance to economic actors, and ultimately reduce the output gap.
- **Increasing foreign exchange reserves to enhance intervention capacity:** increasing foreign exchange reserves, particularly during periods of high oil revenue, provides the necessary tools for effective central bank intervention in times of crisis and helps prevent sudden exchange rate fluctuations.
- **Developing hedging instruments for exchange rate volatility:** creating forward currency markets and financial hedging instruments for importers and exporters may assist in minimizing the adverse effects of exchange rate fluctuations on economic output and international trade.
- **Managing inflation expectations through effective policy communication:** the central bank should strengthen its communication tools and provide clear policy information to manage inflation expectations, thus reducing the psychological effects of exchange rate fluctuations on production and investment decisions.
- **Enhancing central bank autonomy and technical expertise:** enhancing the operational and decision-making the central bank's autonomy and strengthening its technical expertise would enable more effective implementation in shaping monetary and currency strategies, strengthening the influence of interventions in reducing the output gap.
- **Diversifying foreign exchange income sources and reducing oil dependence:** decreasing dependence on petroleum revenues while encouraging growth in non-oil export sectors, as well as attracting foreign investment, can create greater stability in foreign exchange supply and make exchange rate fluctuations more manageable.

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- **Designing an early warning system for exchange rate volatility:** establishing analytical and data-driven early warning systems will enable enabling the central bank to act proactively ahead of exchange rate crises and prevent their negative impact on the output gap.

However, the primary limitation of this study was the absence of monthly data availability in Iraq. Therefore, the EViews software was used to seasonally adjust the data in order to mitigate this issue to some extent.

6 Conflict of Interests Statement

The authors have no relevant financial or non-financial interests to disclose.

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