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Impact of exchange rates and inflation on GDP: A data panel approach consistent with data from Iran, Iraq and Turkey

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Abstract

In any country, economic growth and the GDP are among the key most important indicators of progress as well as economic growth/development of that nation. Consequently, it is crucially significant to study and assess factors affecting the GDP. Therefore, the primary objective of this study is to investigate and analyze the impact of exchange rates and inflation on GDP. The objective of this article is to assess and analyze the impact of exchange rates and inflation on the GDPs of Iran, Iraq and Turkey during the period between 2005-2020. This research is descriptive in nature and applied in purpose. The relationships between the variables have been studied utilizing the data panel method compliant with statistical data from Iran, Iraq and Turkey (from 2005-2020). Data from the Central Bank of Iran, as well as the World Bank, were used for collect testing the hypotheses. Findings revealed that the exchange rate has no effect on GDP in these countries, while inflation has a significant/meaningful plus negative relationship with GDP.

Keywords: economic growth, exchange rate, inflation, data panel approach
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1 Introduction

Achieving a high rate of economic growth is a top goal of any economic system. This is inclusive of implementing the right economic policies, the stability of economic policies, as well as a greater comprehension of factors affecting/impacting economic growth. Most economists have arrived at the consensus that economic stability is a requisite condition for robust economic growth, while economic instability is the opposite, thereby limiting/constraining horizons for economic growth [13]. Economic growth provides resources enabling sustainable improvement in human development, and on the other hand, human development and enhancing the quality of manpower and labor in the economy, encourages and boosts economic growth. In other words, more freedom as well as the growth/involvement of capabilities induces greater economic performance and human development plays a crucial role in economic growth [7].

Inflation in general is a harmful and inauspicious economic phenomenon imposing substantial costs/pain on a society. High inflation levels not only disrupts the price system, but also reduces savings, destroys investment incentives and encourages capital flight from the actual/genuine sectors to speculative activities, and ultimately induces slower

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economic growth [20]. Therefore, the relationship between inflation and economic growth is a vital macroeconomic issues, widely discussed in economic literature/published works and has been duly modified compliant with exciting contemporary conditions.

Another element affecting the world economy is the exchange rate. The common globally-traded currency around the world is the US$ [33, 23]. The exchange rate is the intermediary between the domestic and international economies. In a world moving towards free trade and accelerated volume of international exchanges, the exchange rate is among the most significant variables affecting the economic fortunes of countries. The exchange rate translates domestic prices into international ones and vice versa [22].

The objective of this article is to assess and analyze the impact of exchange rates and inflation on the GDPs of Iran, Iraq and Turkey during the period between 2005-2020. First off, the evidence pertinent to the objective and thereafter the experimental research conducted in Iran and other countries are examined and evaluated. Henceforth, the research method and the model are introduced and then the data is analyzed. Finally, the conclusions of this research shall be presented.

2 Review of literature/published works

2.1 GDP

Among the most critical economic objectives of countries is to create the requisite conditions for the expansion of GDP and economic growth [14]. GDP and its rise is a key measure of society's economic performance and the study of factors affecting it has been intensely studied for decades [12]. The GDP index utilized to measure output (return) reflects the increase or decrease of wealth/prosperity in a country [8].

There are several methods for measuring a country's GDP and it is quite essential to know its types and applications.

- Nominal GDP: For example, in 2015, the GDP of the United States was approx. $18 trillion, indicating the nominal US GDP figure; This is a crude estimate and price increases are also included. In the United States, the Bureau of Economic Statistics (BEA) conducts this estimate every three months and reviews and updates it each time it receives new data.
- Real GDP: In order to compare economic output annually, the effect of inflation must be excluded from the calculations. To achieve this, the implicit price index is utilized. This indicator reveals how much prices have changed compared to the base year. By multiplying the implicit price index by the nominal GDP, the real GDP is obtained. In these calculations, three points are considered: a) The income/revenue of companies and individuals living and working abroad is not included in the calculations. Consequently, the effect of exchange rates and trade policies is excluded from the calculations, b) Inflation's impact is excluded from the calculations, and c) Only final products are included in the calculations. For example, if a shoe company does not produce the shoelace itself, only the value of the shoe itself is calculated, not the shoelace.
- GDP Growth Rate: GDP growth rate is the level of increase occuring in a country's quarterly economic output. This rate determines exactly how fast a country's economy is growing. Many countries use real GDP to calculate the growth rate (toward eliminating the impact of the economy on GDP).
- Per Capita GDP: The best way to compare countries in terms of GDP; Because some countries have huge economic outputs and are more populous. To make an accurate comparison, per capita GDP is required. This criterion is obtained by dividing the real GDP by the number of inhabitants of a country, determining the standard of living in a country.

One of the most widely-used methods is the final cost method, wherein Gross Domestic Product is obtained via the following equation (Central Bank Of Iran):

$$Y = CP + CG + I + (X - M). \tag{2.1}$$

In the above equation, Y is Gross Domestic Product, CP is Private Consumption, CG is Government Consumption, I is Gross Fixed Capital Formation (Gross Investment), X is Export and M is Import.

Multiple factors affect GDP (two important ones are detailed hereinafter):

Foreign Direct Investment

Early neoclassical growth models demonstrate that foreign direct investment provides capital formation and increases capital stocks. In these models, the impact of foreign direct investment flow is exactly equal to domestic

investment, where foreign direct investment capital has only a short-term growth effect due to reduced returns. On the other hand, the new growth theory emphasizes technological developments and assumes that foreign direct investment has a positive effect on economic growth in both short-term and long-term [2].

Government expenditures

To examine how government spending affects economic growth in the first place, it should be noted that financing any level of government spending, whether through taxation or government borrowing, leads to the absorption by the public sector of more tangible resources, and from an allocative perspective, induces the algebraic substitution effect [41]. Foolaay stipulates that there are two possible states as to how positive or negative the effect of the created substitution is: The first state: the existence of positive external effects corresponding to the created substitution. If public sector spending leads to increased private sector productivity, then under circumstances where social benefits outweigh the cost of reducing resources available to the private sector, public sector spending can have a positive effect on economic growth. Case 2: No positive external effects as a consequence of the created substitution. If public sector expenditures are made only in the form of consumption and non-productive expenditures, then due to the lower efficiency of the public sector compared to the private sector, it can be stated that the level of production will not increase and in fact decrease [21].

2.2 Exchange rate

Due to the structural relationship between all macroeconomic variables, the exchange rate as one of the most important and effective variables in the economy of any country, can affect macro variables, including trade, in various ways [47]. Macro-monetary and financial variables are among factors affecting the performance of companies. Exchange rates are one of the factors impacting the business relations of economic enterprises with the outside world [39]. The exchange rate in Iran has fluctuated a great deal in recent years due to exchange rate policy (such as exchange rate unification, exchange rate multiplication, etc.) plus external shocks (due to international sanctions and oil price shocks). It appears that due to the import-oriented nature of some domestic products as well as significant imports of consumer goods, these currency changes in the Iranian economy have a significant effect on domestic prices [15].

Excessive exchange rate fluctuations lead to delays in investment decisions and therefore cause economic uncertainty. Uncertainty caused by fluctuations has a negative impact on economic growth by affecting investment and investor confidence, productivity, international trade and capital flows [36]. Numerous studies have been conducted on the factors affecting the exchange rate and most of these studies are limited to a few major and well-known primary factors, some of which are: people's expectations, flight of capital to abroad, size of government, capital inflows and outflows, productivity growth [31] and oil prices [32].

In a general classification, currency theories can be divided into three general sections: Traditional theories, modern theories with a monetary approach, and modern theories with a portfolio balancing approach. In traditional theories, the exchange rate fluctuation factor is elucidated by the theory of purchasing power parity. In this theory, the law of "unitary price" for all goods in the world is the primary basis for interpreting and articulating the strengthening and weakening of the exchange rate, and with changes in the prices of goods and services in countries, exchange rates are adjusted [45].

In modern theories, which themselves are classified into two approaches, monetarist and portfolio balance. The determination of the exchange rate is grounded on principles such as the full and free flow of capital and rational expectations. In the monetarist theory, academics such as Dornbusch, Frankel, Mandel, Fleming, and Gartner have proposed, respectively, theories such as the overshooting, the monetarist, the equilibrium model, and the exchange rate bubble models [21]. Here under, several exchange rates theories are discussed in detail:

Purchasing power parity theory

The theory of purchasing power parity is a theory that considers the exchange rates between two currencies in equilibrium when their purchasing power is the same in both countries. This means the exchange rate between the two countries should be equal to the price level of a fixed basket of goods and services [26]. Perron & Vogelsang stated that the main idea of the purchasing power parity hypothesis is that since commodity arbitrage in the international market must be traded over time, one must expect the real exchange rate to return to a stable equilibrium in the long run. In particular, an unstable exchange rate shows that there is no long-term relationship between the nominal exchange rate and domestic and foreign prices, thus destroying the purchase price parity [25].

Portfolio balancing theory

Gibson states that assuming that economic factors, apart from their national currencies, hold foreign assets, including currency, in their asset composition, the exchange rate in the short run is more affected by the relative price of assets and the possibility of their replacement in the context of rational expectations than trade balance fluctuations [35].

Monetarist theory

Hoontrakul states that this model emphasizes the variables impacting the exchange rate through the domestic money market of countries. The framework of this model is also composed of three markets of money, goods and assets (assuming unequal interest rates). In this model, the exchange rate is strongly correlated with the level of relative money supply [35].

2.3 Inflation

Inflation is among the most serious economic problems in any country inducing the imbalance of macroeconomic indicators such as declining growth rate, rising unemployment and unequal distribution of income. In addition, the uncertainties caused by high inflation rates increase inflation expectations [42]. Excess aggregate demand over supply increases the general level of prices; However, the rise in price levels is referred to as inflation only if it is continuous and self-increasing and has a long-term memory. Economists believe inflation's costs on society can be much more serious than slowing economic growth. High and unstable inflation disrupts the price allocation system as well as income distribution within a society [40].

There are different types of inflation, all of which can be placed under two general criteria. Sometimes inflation is divided according to the social conditions and contexts of origin and in terms of whether it is predictable or not, and at times divided compliant with its intrinsic characteristics. Inflation divided according to conditions is classified into two types:

Predictable Inflation: In this type, before it is fully manifested in a society's economy, its symptoms appear (prices constantly go up and seemingly randomly and in an unstable manner). Hence, an invisible yet tangible anxiety dominates the market.

Unexpected Inflation: This inflation is not predictable and occurs suddenly. Its factors are also varied (coups, wars, unexpected disasters like deadly massive hailstorm, etc.). It is in this context that prices all of a sudden soar and the currency is devalued.

Inflation is divided into three types by economic theories [28]:

Creeping Inflation (Slow or Mild): This type of inflation occurs when a country's inflation increases gradually but steadily. This type of inflation is the most common pattern in a multitude countries. Although the magnitude of this increase is relatively small in the short run, it continues over time and will therefore increase and then rise some more. Severe Inflation (Accelerating or Rapid Inflation): In this type of inflation, the rate of price increase is rapid. This inflation is mainly caused by high government spending (through printing more money due to debt/budget deficit).

Very Severe Inflation (Rampant Inflation, Superinflation Hyperinflation): This type of inflation is the most severe form. Rapid/lightning speed inflation almost impossible to stop or curtail.
There is no consensus among economic experts on various inflation types, hence, it is not possible to provide a fixed criterion for the types of inflation in all places and times; Considering that customs, cultures and rationals of different times and places may exhibit varied reactions to a certain rate, it is even possible that over time a society becomes accustomed (and not exhibit sensitiveness) to a certain rate due to its cultural and other particularities, or it may react to it with delay. Therefore, a certain rate of inflation may be considered severe in some societies and mild in others [46].

There are multiple theories concerning inflation, some of which are as follows:

Monetary Theory: Proponents of monetary theory believe that inflation is a phenomenon exclusively derived from an increase in the money supply. When money supply is controlled by the central bank, the release of extra currency by the central bank (probably ordered by the government), will lead to increased prices [9].

Structural Inflation Theory: Structuralists, in their methodological framework, believe that money supply is often endogenous and passive and is adjusted to the level of economic activity and inflation. Structuralists argue that inflation

is a dual process that inevitably has a monetary dimension. The second dimension entails social contradictions related to input values such as inactivity of resources, market segmentation and the imbalance between supply and demand of the sector and the lack of ability to grow rapidly in the economy are pondered as structural factors of inflation. [43, 38].

Demand Pressure Theory: The main basis of this theory is Keynesian. According to this theory, inflation is the consequence of an increase in aggregate demand relative to aggregate supply in full employment conditions. In this situation, an increase in the general level of prices is inevitable [44].

Cost Pressure Theory: According to this hypothesis, it is not possible to explain inflation without considering how prices and wages are set. Since prices and wages in various market structures are determined by different institutions, the factors that cause inflation are essentially non-economic [9].

2.4 Research background

In his research, Halder revealed that exports and imports have a positive effect on GDP growth rate and there is no significant/meaningful relationship between GDP and exchange rate variables as well as inflation [19]. Ahmed in his study concluded there is a long-term relationship between variables [3]. The short-term relationship showed that only inflation has a negative correlation with the economic growth of Nigeria and furthermore added that the indirect relationship between inflation and economic growth requires the government's immediate attention, because a change in the exchange rate will impact the export and import of goods. Also, services will be hit by inflation, because exchange rate fluctuations induces rising/falling prices. Low and Chan indicated that there is a long-term relationship between macroeconomic variables [30]. A positive relationship was observed between GDP and Forex (exchange rate); While there was a negative relationship between GDP and inflation as well as between GDP and interest rates. In the short run, changes in macroeconomic variables have led to similar behavioral patterns with different effects in terms of shock regulation. Bhat and Laskar mentioned in their research that during the study period, there was a negative relationship between GDP and interest rates and a positive relationship between inflation and India's GDP [11]. Habib & Associates revealed in their research that the increase in the real exchange rate has significantly reduced the annual GDP growth in developing countries more than what was obtained in previous studies [17]. Ahmed and Associates in their research utilizing the ARDL method showed that the reduction of the real exchange rate has an impact on the volume of foreign direct investment and strengthens economic growth in the long run [3]. Apollos and Associates suggested that there is a positive and significant relationship between the GDP, exchange rate and exports [6]. They also stipulated that exchange rate fluctuations impacted Nigeria's economic growth.

Mirani and Associates demonstrated that in the long run, exchange rate fluctuations have a negative effect on GDP [33]. Hosseini-Dolatabadi and Taherifard in their research stated that national currency devaluation shock reduced non-oil sector GDP plus increased prices in comparison to their equilibrium trend in the post currency shock period [22]. Severe dependence of production on imported intermediate and capital inputs in Iran strengthens the exchange rate cost channel (at least in the short run). Abdi and Associates showed that there is a significant relationship between Iran's economic growth and inflation as well as unemployment [1]. Khataee & Gharbali-Moghaddam stated that contrary to many views on the Iranian economy, there is a negative but weak relationship between the real exchange rate and the country's output; Hence, with the devaluation of the national currency (increase of the real exchange rate) the country's production output does not increase. Likewise, an increase in the nominal exchange rate has little effect on an output hike.

3 Methodology

This research is applied in terms of purpose/objective and descriptive-correlational in terms of implementation. In this study, the variable of GDP is considered as a dependent variable. We utilize the data panel method to measure the effect of exchange rates and inflation on GDP. This research has been conducted in three countries: Iran, Iraq and Turkey. Statistical data of Islamic banks of Iran have been prepared from the data of the Central Bank of Iran and other countries from the data reported by the World Bank for the period between 2005 to 2020.

3.1 Econometrics

Econometrics is the application of statistical methods to economic data in order to give empirical content to economic relationships. More precisely, it is "the quantitative analysis of actual economic phenomena based on the concurrent development of theory and observation, related by appropriate methods of inference". An introductory

economics textbook describes econometrics as allowing economists "to sift through mountains of data to extract simple relationships". Jan Tinbergen is one of the two founding fathers of econometrics. The other, Ragnar Frisch, also coined the term in the sense in which it is used today.

A basic tool for econometrics is the multiple linear regression model. Econometric theory uses statistical theory and mathematical statistics to evaluate and develop econometric methods. Econometricians try to find estimators that have desirable statistical properties including unbiasedness, efficiency, and consistency. Applied econometrics uses theoretical econometrics and real-world data for assessing economic theories, developing econometric models, analysing economic history, and forecasting.

Fixed effects model and panel data

In statistics, a fixed effects model is a statistical model in which the model parameters are fixed or non-random quantities. This is in contrast to random effects models and mixed models in which all or some of the model parameters are random variables. In many applications including econometrics and biostatistics a fixed effects model refers to a regression model in which the group means are fixed (non-random) as opposed to a random effects model in which the group means are a random sample from a population. Generally, data can be grouped according to several observed factors. The group means could be modeled as fixed or random effects for each grouping. In a fixed effects model each group mean is a group-specific fixed quantity.

In panel data where longitudinal observations exist for the same subject, fixed effects represent the subject-specific means. In panel data analysis the term fixed effects estimator (also known as the within estimator) is used to refer to an estimator for the coefficients in the regression model including those fixed effects (one time-invariant intercept for each subject).

Qualitative description

Such models assist in controlling for omitted variable bias due to unobserved heterogeneity when this heterogeneity is constant over time. This heterogeneity can be removed from the data through differencing, for example by subtracting the group-level average over time, or by taking a first difference which will remove any time invariant components of the model.

There are two common assumptions made about the individual specific effect: the random effects assumption and the fixed effects assumption. The random effects assumption is that the individual-specific effects are uncorrelated with the independent variables. The fixed effect assumption is that the individual-specific effects are correlated with the independent variables. If the random effects assumption holds, the random effects estimator is more efficient than the fixed effects estimator. However, if this assumption does not hold, the random effects estimator is not consistent. The Durbin–Wu–Hausman test is often used to discriminate between the fixed and the random effects models.

Consider the linear unobserved effects model for N observations and T time periods:

$$y_{it} = X_{it}\beta + \alpha_i + u_{it} \text{ for } t = 1, \dots, T \text{ and } i = 1, \dots, N$$

where

- y_{it} is the dependent variable observed for individual i at time t.
- X_{it} is the time-variant $1 \times k$ (the number of independent variables) regressor vector.
- β is the $k \times 1$ matrix of parameters.
- α_i is the unobserved time-invariant individual effect. For example, the innate ability for individuals or historical and institutional factors for countries.
- u_{it} is the error term.

Unlike X_{it}, α_i cannot be directly observed. Unlike the random effects model where the unobserved α_i is independent of X_{it} for all $t = 1, \dots, T$, the fixed effects (FE) model allows α_i to be correlated with the regressor matrix X_{it}. Strict exogeneity with respect to the idiosyncratic error term u_{it} is still required.

Statistical estimation

Fixed effects estimator

Since α_i is not observable, it cannot be directly controlled for. The FE model eliminates α_i by demeaning the variables using the *within* transformation:

$$y_{it} - \bar{y}_i = (X_{it} - \bar{X}_i)\beta + (\alpha_i - \bar{\alpha}_i) + (u_{it} - \bar{u}_i) \Rightarrow \ddot{y}_{it} = \ddot{X}_{it}\beta + \ddot{u}_{it}$$

where $\bar{y}_i = \frac{1}{T}\sum_{t=1}^{T} y_{it}$, $\bar{X}_i = \frac{1}{T}\sum_{t=1}^{T} X_{it}$ and $\bar{u}_i = \frac{1}{T}u_{it}$. Since α_i is constant $\overline{\alpha_i} = \alpha_i$ and hence the effect is eliminated. The FE estimator $\hat{\beta}_{\mathrm{FE}}$ is then obtained by an OLS regression of $\ddot{y}$ on $\ddot{X}$.

At least three alternatives to the *within* transformation exist with variations. One is to add a dummy variable for each individual $i > 1$ (omitting the first individual because of multicollinearity). This is numerically, but not computationally, equivalent to the fixed effect model and only works if the sum of the number of series and the number of global parameters is smaller than the number of observations [10]. The dummy variable approach is particularly demanding with respect to computer memory usage and it is not recommended for problems larger than the variable RAM, and the applied program compilation, can accommodate.

Second alternative is to use consecutive reiterations approach to local and global estimations [11]. This approach is very suitable for low memory systems on which it is much more computationally efficient than the dummy variable approach. ’

The third approach is a nested estimation whereby the local estimation for individual series is programmed in as a part of the model definition [12]. This approach is the most computationally and memory efficient, but it requires proficient programming skills and access to the model programming code: although, it can be programmed even is SAS [13, 14].

Finally, each of the above alternatives can be improved if the series-specific estimation is linear (within a nonlinear model), in which case the direct linear solution for individual series can be programmed in as part of the nonlinear model definition [15].

First difference estimator

An alternative to the within transformation if the *first difference* transformation, which produces a different estimator. For $t = 2, \ldots, T$.

$$y_{it} - y_{i,t-1} = (X_{it} - X_{i,t-1})\beta + (\alpha_i - \alpha_i) + (u_{it} - u_{i,t-1}) \Rightarrow \Delta y_{it} = \Delta X_{it}\beta + \Delta u_{it}.$$

The FD estimator $\hat{\beta}_{\mathrm{FD}}$ is then obtained by an OLS regression of Δy_{it} on ΔX_{it}. When $T = 2$ the first difference and fixed effects estimators are numerically equivalent. For $T > 2$, they are not. If the error terms u_{it} are homoskedastic with no serial correlation, the fixed effects estimator is more efficient than the first difference estimator. If u_{it} follows a random walk, homever, the first difference estimator is more efficient [16].

Equality of fixed effects and first difference estimators when $T = 2$

For the special two period case ($T = 2$), the fixed effects (FE) estimator and the first difference (FD) estimator are numerically equivalent. This is because the FE estimator effectively “doubles the data set” used in the FD estimator. To see this, establish that the fixed effects estimator is:

$$\mathrm{FE}_{T=2} = [(x_{i1} - \bar{x}_i)(x_{i1} - \bar{x}_i)' + (x_{i2} - \bar{x}_i)(x_{i2} - \bar{x}_i)']^{-1}[(x_{i1} - \bar{x}_i)(y_{i1} - \bar{y}_i) + (x_{i2} - \bar{x}_i)(y_{i2} - \bar{y}_i)]$$

Since each $(x_{i1} - \bar{x}_i)$ can be re-written as $\left(x_{i1} - \frac{x_{i1}+x_{i2}}{2}\right) = \frac{x_{i1}-x_{i2}}{2}$, we'll re-write the line as:

$$\begin{aligned}
\mathrm{FE}_{T=2} &= \Big[\sum_{i=1}^{N} \frac{x_{i1}-x_{i2}}{2}\frac{x_{i1}-x_{i2}}{2}' + \frac{x_{i2}-x_{i1}}{2}\frac{x_{i2}-x_{i1}}{2}'\Big]^{-1} \\
&\quad \Big[\sum_{i=1}^{N} \frac{x_{i1}-x_{i2}}{2}\frac{y_{i1}-y_{i2}}{2} + \frac{x_{i2}-x_{i1}}{2}\frac{y_{i1}-y_{i2}}{2} + \frac{x_{i2}-x_{i1}}{2}\frac{y_{i2}-y_{i1}}{2}\Big] \\
&= \Big[\sum_{i=1}^{N} 2\frac{x_{i2}-x_{i1}}{2}\frac{x_{i2}-x_{i1}}{2}'\Big]^{-1}\Big[\sum_{i=1}^{N} 2\frac{x_{i2}-x_{i1}}{2}\frac{y_{i2}-y_{i1}}{2}\Big] \\
&= 2\Big[\sum_{i=1}^{N}(x_{i2}-x_{i1})(x_{i2}-x_{i1})'\Big]^{-1}\Big[\sum_{i=1}^{N}\frac{1}{2}(x_{i2}-x_{i1})(y_{i2}-y_{i1})\Big] \\
&= \Big[\sum_{i=1}^{N}(x_{i2}-x_{i1})(x_{i2}-x_{i1})'\Big]^{-1}\sum_{i=1}^{N}(x_{i2}-x_{i1})(y_{i2}-y_{i1}) = \mathrm{FD}_{T=2}
\end{aligned}$$

Chamberlain method

Gary Chamberlain's method, a generalization of the within estimator, replaces α_i with its linear projectiononto the explanatory variables. Writing the linear projection as:

$$\alpha_i = \lambda_0 + X_{i1}\lambda_1 + X_{i2}\lambda_2 + \cdots + X_{iT}\lambda_T + e_i$$

this results in the following equation:

$$y_{it} = \lambda_0 + X_{i1}\lambda_1 + X_{i2}\lambda_2 + \cdots + X_{it}(\lambda_t + \beta) + \cdots + X_{iT}\lambda_T + e_i + u_{it}$$

which can be estimated by minimum distance estimation [17].

Hausman-Taylor method

Need to have more than one time-variant regressor (X) and time-invariant regressor (Z) and at least one X and one Z that are uncorrelated with α_i. Partition the X and Z variables such that

$$X = \begin{bmatrix} X_{1it} & \vdots & X_{2it} \\ {\scriptstyle TN\times K1} & & {\scriptstyle TN\times K2} \end{bmatrix}$$

$$Z = \begin{bmatrix} Z_{1it} & \vdots & Z_{2it} \\ {\scriptstyle TN\times G1} & & {\scriptstyle TN\times G2} \end{bmatrix}$$

where X_1 and Z_1 are uncorrelated with α_i. Need $K1 > G2$. Estimating γ via OLS on $\widehat{di} = Z_i\gamma + \varphi_{it}$ using X_1 and Z_1 as instruments yields a consistent estimate.

Generalization with input uncertainty

When there is input uncertainty for the y data, δy, then the χ^2 value, rather than the sum of squared residuals, should be minimized [18]. This can be directly achieved from substitution rules:

$$\frac{y_{it}}{\delta y_{it}} = \beta\frac{X_{it}}{\delta y_{it}} + \alpha_i\frac{1}{\delta y_{it}} + \frac{u_{it}}{\delta y_{it}},$$

then the values and standard deviations for β and α_i can be determined via classical ordinary least squares analysis and variance-covariance matrix.

Testing fixed effects (FE) vs. random effects (RE)

We can test whether a fixed or random effects model is appropriate using a Durbin-Wu-Hausman test.

$$H_0 : \alpha_i \perp X_{it}, Z_i$$
$$H_a : \alpha_i \not\perp X_{it}, Z_i$$

If H_0 is true, both $\hat{\beta}_{\mathrm{RE}}$ and $\hat{\beta}_{\mathrm{FE}}$ are consistence, but only $\hat{\beta}_{\mathrm{RE}}$ is efficient. If H_a is true, $\hat{\beta}_{\mathrm{FE}}$ is consistence and $\hat{\beta}_{\mathrm{RE}}$ is not

$$\hat{Q} = \hat{\beta}_{\mathrm{RE}} - \hat{\beta}_{\mathrm{FE}}$$
$$\widehat{HT} = T\hat{Q}'[\mathrm{Var}(\hat{\beta}_{\mathrm{FE}}) - \mathrm{Var}(\hat{\beta}_{\mathrm{RE}})]^{-1}\hat{Q} \sim \chi^2_K \text{ where } K = \dim(Q).$$

The Hausman that is a specification test so a larger test statistic might be indication that there might be errors-in-variables (EIV) or our model is misspecified. If the FE assumption is true, we should find that $\hat{\beta}_{\mathrm{LD}} \approx \hat{\beta}_{\mathrm{FD}} \approx \hat{\beta}_{\mathrm{FE}}$. A simple heuristic is that if $|\hat{\beta}_{\mathrm{LD}}| > |\hat{\beta}_{\mathrm{FE}}| > |\hat{\beta}_{\mathrm{FD}}|$ there could be EIV.

3.2 Research Hypotheses

Hypothesis 1: There is a significant/meaningful relationship between exchange rate and GDP.

Hypothesis 2: There is a significant/meaningful relationship between inflation and GDP.

3.3 Research models and variables

In order to assess the effect of exchange rate and inflation on GDP, we utilized the following models:

The first model: The impact of exchange rates on GDP via the following equation:

$$\ln \mathrm{GDP}_t = \beta_0 + \beta_1 \ln \mathrm{EXC}_t + \beta_2 \ln \mathrm{SAR}_t + \beta_3 \ln \mathrm{Open}_t + \beta_4 \ln \mathrm{DOMCR}_t + \beta_5 \ln U_t + \varepsilon_{it}$$

where:

Gross Domestic Product (GDP): Gross domestic product is the monetary value of goods and services produced within a country's geographical borders. GDP at fixed/constant 2005 prices (based on World Bank statistics) is provided in billions of dollars [16]. Average Annual Exchange Rate (EXC): All foreign exchange data are denominated in US$ toward taking into account exchange rate effects and enabling facile comparison among countries.

Inflation Rate (INF): Obtained from changes in the Consumer Price Index (CPI) or modifications in the price index of consumer goods and services and is one of the macroeconomic control variables. The base year is 2005 [16].

Savings Rate (SAR): Indicates the share of savings in the banking industry from GDP [is a % of GDP] [10].

Level Of Free Trade (OPEN): Obtained from ratio of total exports and imports to GDP [24].

Monetary Volume Of Domestic Credit Granted to Private Sector (DOMCR): This variable consists of the monetary figure provided by the banking sector to the private sector [expressed as a % of GDP] [34].

Unemployment Rate (U): This variable is derived at via the difference and percentage/number of employees from the total active population divided by the total active population. The number of employees over 15 years of age was utilized [data on existing capital stock was extracted from the World Bank and employment data from the International Labor Organization (ILO)] [5].

4 Research findings

The classical linear regression model is funded on a few simple assumptions and this research can utilize linear regression if there are no issues/problems in terms of dependent variable normality, linearity test, mania and variance homogeneity test. Due to the fact that the residual normality of the model is among of the primary assumptions of regression models, the GDP dependent variable was normalized via the Johnson Test (using the Minitab 17 software) to establish this assumption.

Since one of the assumptions of utilizing causal relations is the absence of multiple alignment relationship between variables, before performing causal analysis, it is requisite to evaluate the alignment between independent variables

in the research toward confirming the absence of multiple common linear relationship between variables. For this goal/purpose, the variance inflation factor (VIF) index was utilized to review/assess multiple alignment between independent variables. Regarding the VIF index, values less than 5 are considered desirable for this index [18]. In other words, as displayed in Table 1, there is no multiple alignment between the independent variables.

Table 1: Alignment between research variables analysis

Variables	Inflation Factor Variance
INF	1.225
SAR	1.492
EXC	1.523
OPEN	1.474
DOMCR	1.569
U	1.304

Toward ensuring the findings of the research, the non-artificial relationships in regression as well as the significance of the variables, the Mana Test was performed and the unit root of the research variables was calculated in the models by Levin, Lin & Chu [29]. The findings of the unit root test for the variables of the final models are described in Table 2. In the case of variables that were not Mana, first- and second-order differentiation was utilized.

Table 2: Mana test findings

Variable	Levin, Lin & Chu Test; Attempt/Stage (0) I		Test Result
INF	Stat	Probability	Unreliable
SAR	1.121−	0.131	Unreliable
EXC	0.618	0.731	Unreliable
OPEN	3.468	0.999	Unreliable
DOMCR	0.239	0.594	Reliable
U	02.780	0.002	Unreliable
Variable	1.237	0.892	Unreliable
INF	0.246	0.597	Test Result
SAR	Levin, Lin & Chu Test; Attempt/Stage (1) I		Reliable
EXC	Stat	Probability	Reliable
OPEN	8.620−	0.000	Unreliable
DOMCR	1.828−	0.033	Reliable
U	1.510−	0.065	Reliable
Variable	4.173−	0.000	Reliable
EXC	3.083−	0.001	Test Result
	3.710−	0.000	
	Levin, Lin & Chu Test; Attempt/Stage (2) I		
	Stat	Probability	
	10.132−	0.000	Reliable

Variance homogeneity is among of the most key assumptions of the linear regression model. Hence, the components of the e_{it} disorder that appear in the regression function of the community possess the same variance. If this assumption is unmet, there will be heterogeneity of variance. In this research, the variance heterogeneity test was conducted and the findings of this test for the research model are shown in Table 3. Due to the heterogeneity of variance, the Generalized Least Squares (GLS) are utilized to eliminate it.

Initially, it is required to determine which of the approaches (pool or panel) is suitable for model implementation via using the F-Limer Test (Chow Test). The pool approach is utilized when the F-Limer test demonstrates that

Table 3: Output of variance heterogeneity test of research models

$\text{Model 1} : \ln \text{GDP}_t = \beta_0 + \beta_1 \ln \text{EXC}_t + \beta_2 \ln \text{SAR}_t + \beta_3 \ln \text{Open}_t + \beta_4 \ln \text{DOMCR}_t + \beta_5 \ln U_t + \varepsilon_i$			
Test Methods	Degree Of Freedom	Test Stat	Level Of Significance
Bartlett	5	14088.92	0.000
Levin	(5.465)	124.74	0.000
Brown-Forsythe	(5.465)	73.60	0.000
$\text{Model 1} : \ln \text{GDP}_t = \beta_0 + \beta_1 \ln \text{EXC}_t + \beta_2 \ln \text{SAR}_t + \beta_3 \ln \text{Open}_t + \beta_4 \ln \text{DOMCR}_t + \beta_5 \ln U_t + \varepsilon_i$			
Test Methods	Degree Of Freedom	Test Stat	Level Of Significance
Bartlett	5	14902.53	0.000
Levin	(5.466)	125.06	0.000
Brown-Forsythe	(5.466)	73.79	0.000

there are no individual differences between sections and courses/cycles. The panel approach is utilized when the F-Limer test points out that there are significant individual differences between sections or courses/cycles. In other words, each of the sections or courses/cycles includes effects that impact the results, however, can not be observed accurately. This approach is adopted when the F-Limer statistic is significant/meaningful (the probability is less than the significance/meaningful level of 0.05).

The findings of the L-test (Chao) Model is delineated in Table 4. Taking into account that the test statistic is greater than the critical point (95% confidence level), or in other words, the probability value (statistical significance level) is less than 0.05, therefore, the hypothesis (based on the utilization of the integrated model) is rejected. Consequently, the panel data method should be utilized to estimate/project the models.

Table 4: Research model's of F-limer test output

Redundant Fixed Effects Tests $\text{Model 1} : \ln \text{GDP}_t = \beta_0 + \beta_1 \ln \text{EXC}_t + \beta_2 \ln \text{SAR}_t + \beta_3 \ln \text{Open}_t + \beta_4 \ln \text{DOMCR}_t + \beta_5 \ln U_t + \varepsilon_{it}$			
Test Impact	Stat	Degree Of Freedom	Level Of Significance
Cross-Section F	31.50	(2.64)	0.000
Redundant Fixed Effects Tests $\text{Model 2} : \ln \text{GDP}_t = \beta_0 + \beta_1 \ln \text{INF}_t + \beta_2 \ln \text{SAR}_t + \beta_3 \ln \text{Open}_t + \beta_4 \ln \text{DOMCR}_t + \beta_5 \ln U_t + \varepsilon_{it}$			
Test Impact	Stat	Degree Of Freedom	Level Of Significance
Cross-Section F	9.33	(2.64)	0.000

A point that necessitates reminding is this study analyzed data from three countries: Iran, Iraq and Turkey. Due to the limited number of panels, it was only possible to use the fixed effects method (random effects method was not significant). The findings of estimating/projecting the research model for the first research hypothesis utilizing the fixed effects method and considering the variance heterogeneity and fixing/repairing it via utilizing the Generalized Least Squares (GLS) are stipulated in Table 5. As can be observed, consistent with the findings of estimating the research model, compliant to the significance level of F statistic, it was determined/confirmed that the model has a 99% confidence level. Watson's stats are also in the range of $1.5 - 2.5$ with a value of 1.679, indicating a lack of auto-correlation between errors. Moreover, the adjusted coefficient of variables determination utilized in the model shows that in total, these variables explain 91.2% of the dependent variable's variance in the research sample.

Regarding the second hypothesis, the inflation rate variable, with respect to the significance level of less than 5 percent, and the value of t greater than 1.96 (at 95% significance level) has a meaningful and negative relationship with GDP and the hence the second hypothesis is confirmed. It can be interpreted that with a hike inflation, there is a dip in GDP. The findings of this model reveal a positive and significant relationship between savings rate variables, the degree of free trade (openness) and GDP.

Furthermore, the findings of estimating the research model for the second hypothesis of the research using the fixed effects method and considering the heterogeneity of variance and fixing it utilizing Generalized Least Squares (GLS) are displayed in Table 6. As can be observed, based on the estimation results of the research model, according to the

Table 5: Test findings; research's first model

Dependent Variable: GDP 3 Countries (Iran, Turkey, Iraq) From 1992-2019 Total Observations: 84					
Result	Significance Level	T-Statistic	Standard Deviation	Variable Coefficient	Variable
Rejected	0.265	1.124−	90753.32	102061.4−	INF
Approved	0.000	11.538	2.10e09+	2.42e10+	SAR
Approved	0.000	6.993	8110.535	56722.43	OPEN
Approved	0.000	3.987	4678.684	18655.39	DOMCR
Rejected	0.131	1.529	1.46e08+	2.23e08+	*U*
Approved	0.000	4.908	3.56e10+	1.75e11+	*C*
F-Stat *F*-Stat Probability Total Remaining	95.636	Modified R2 R2 *D*-Watson Stat	0.903		
0.000	0.912				
0.048	1.679				

significance level of F statistic, it is determined that the model is confirmed (99% confidence). Moreover, the value of Watson's ??? is in the range of $1.5 - 2.5$ with a value of 1.644, indicating a lack of auto-correlation between errors. In addition, the adjusted coefficient of determining of the variables utilized in the model indicates that in total these variables explain 93.4% of the variance of the dependent variable in the research sample.

Regarding the second hypothesis, the inflation rate variable with respect to the significance level less than 5 percent and the value of t greater than 1.96 at the 95% significance level has a meaningful and negative relationship with GDP and the second hypothesis is confirmed. It can be interpreted that with the rise of inflation, GDP will fall. The results of this model show a positive and significant relationship between GDP and the savings rate variables plus the degree of open/free trade.

Table 6: Initial model of the research's test findings

Dependent Variable: GDP 3 Countries (Iran, Turkey, Iraq) From 1992-2019 Total Observations: 84					
Result	Significance Level	*T*-Statistic	Standard Deviation	Variable Coefficient	Variable
Approved	0.000	4.411−	4.67e08+	−2.06e09+	INF
Approved	0.000	10.458	1.97e09+	2.06e10+	SAR
Approved	0.000	3.880	25192.73	97757.69	OPEN
Rejected	0.563	0.580	19557.29	11351.20	DOMCR
Rejected	0.016	2.472−	9.41e08+	−2.33e09+	*U*
Approved	0.147	1.465−	3.51e10+	5.14e10+	*C*
F-Stat *F*-Stat Probability Total Remaining	130.096	Modified R2 R2 *D*-Watson Stat	0.927		
0.000	0.934				
0.032	1.644				

5 Discussion and conclusion

Gross domestic product, per capita income and economic growth rate are the most crucial macroeconomic performance indicators. Simultaneous with the level of production and per capita income indicating the average economic welfare/financial status of individuals in society, the rate of economic growth plus GDP's rate of increase or decrease demonstrate how people in a society are doing as well as the rate/speed of improvement or decrease in their level of welfare/well-being [27]. Due to the importance of production and economic growth in any society, achieving enhanced productivity has always been a priority for governments [37]. Therefore, identifying factors affecting GDP is among

the most important aims of economic planners around the globe. For this precise reason, in this study, we sought to examine the impact of exchange rates and inflation on GDP.

As discussed in the statistical analysis of the first hypothesis, the annual average exchange rate variable at the 95% significance level has no meaningful relationship with GDP and the first hypothesis is therefore not confirmed. In fact, the exchange rate has no effect on GDP in selected countries. The findings additionally indicate a positive and significant relationship between GDP and savings rate variables, the level of free/open trade, the volume of credit provided to the private sector, etc. In relation to the second hypothesis, the inflation rate variable at the 95% significance level has a meaningful and negative relationship with GDP and the second hypothesis is confirmed. Consequently, it can be interpreted that with inflation rise, a GDP drop was detected in the selected countries. Consistent with the findings of the second model, a positive meaningful/significant correlation exists between GDP and savings rate variables plus the degree of free/open trade.

With respect to the fact that the inflation rate negatively affects GDP, it is recommended that in order to reduce inflation, the factors impacting it should be controlled. Liquidity control is one way to keep inflation in check. The government can implement various solutions to prevent a large increase in liquidity and reduce inflation. By doing so, it will strengthen the competitiveness of the economy as well as boost the production/manufacturing sectors. Furthermore, it will forestall a rise in production costs, and foster GDP growth.

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