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The Impact of Predictable and Unpredictable Exchange Rate Shocks on GDP Fluctuations in Iran

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ABSTRACT:
This research aimed to evaluate the impact of predictable and unpredictable exchange rate shocks on GDP fluctuations in Iran. This applied research in terms of its objective is a survey-descriptive study regarding its inference method and a causal-correlational investigation because of its dependence on the relationship between variables and the effect of an independent variable, as well as a post-event study concerning its design. All the statistics and data needed for this research were extracted from the economic reports and the balance sheet of the Central Bank from 2015 to 2016. According to the nature of time series data and the type of study, the effect of predictable and unpredictable exchange rate shocks on GDP fluctuations and the long-term relationship between variables were examined using the autoregression distributed lag (ARDL) model. Data were analyzed using Eviews version 9 software. According to the results, predictable shocks have long-term negative and significant effects on production fluctuations in Iran while unpredictable shocks have a positive and significant effect on production fluctuations in Iran in the long term.

Keywords: Predictable shocks, unexpected shocks, exchange rate, GDP fluctuations

INTRODUCTION:

The economy of Iran is oil-based, and oil-dependent economies are known to be very vulnerable to exchange relationship instability. Based on empirical evidence, the effect of GDP instability is two-fold higher in oil economies. Therefore, the study of the exchange rate effect and its shocks on the domestic economy and the analysis of the exchange rate-GDP interaction can provide useful solutions for economic policymakers in dealing with such shocks. The currency system in Iran has witnessed many changes before and after the revolution. Since the revolution, it has been characterized by a multi-rate system accompanied by currency regulations and controls for imports, and this issue has led to major consequences for the economy and the efficiency of economic policies. During the years before the revolution, the government could stabilize the parity rate of the Rial with other foreign currencies, particularly the dollar, within the framework of the Bretton Woods monetary system due to the high oil revenues and the absence of crises in the balance of payments. However, the establishment of a floating currency system in some countries and the suspension of the Bretton Woods monetary system since 1975, as well as the Rial dependence on the dollar, caused severe fluctuations of the Rial against other currencies, especially the dollar. This means that dollar changes against the currencies of other countries, as a major part of Iran's trade parties, significantly influenced the volume and price of exports and imports in Iran. During the post-revolution years, the Rial value decreased sharply against other currencies in the market because of factors such as the continued dependence on the income from oil exports, capital flight, inflation, political factors, and war. Therefore, it can be seen that the exchange rate has experienced wide fluctuations during the post-revolution years due to the aforementioned reasons. Most importantly, this intensity of exchange rate fluctuations can create an atmosphere of uncertainty in the economy and overshadow macroeconomic variables, such as domestic and foreign investment, domestic production, and price levels, leading to contractionary effects on production (Kazerouni and Feshari, 2010).

Since exchange rate fluctuations affect both the demand and supply sides of an economy, it can be regarded as one of the major variables affecting the macroeconomic variables of a country. The demand side through net exports and changes in foreign exchange reserves and the supply side through imported intermediate goods are influenced by exchange rate fluctuations. On the other hand, the real exchange rate, as a measure of the parity value of a country's national currency against those of other countries, reflects the economic situation of that country compared to the economic conditions of other countries. In an open economy, the real exchange rate accounts for a key variable due to its interaction with other economic variables, which is largely affected by domestic and foreign economic policies and economic developments. In the past years, many studies have investigated the importance and role of the real exchange rate variable in macroeconomics. Nonetheless, these studies have not always yielded the same results, and there is controversy regarding the effect of the exchange rate. The asymmetric effects of exchange rate fluctuations on variables such as production have been reported in recent studies (Kandil, 2008).

The currency plays an undeniable role in economic systems, especially in underdeveloped countries. This results from the fact that underdeveloped countries are dependent on industrialized countries in most of their economic sectors and need more currency for imports. Most manufacturing companies import raw materials, technology, and machinery. If the exchange rate increases because of economic changes and other multiple influencing factors, economic enterprises will have to pay more money for imports. An increase in the exchange rate redoubles the amount of debt, on the one hand, and increases the cost of products and services provided by these companies, on the other hand. An increase in debt leads to liquidity shortage, and firms' liquidity shortage negatively affects profit distribution and the cash return index of stocks. The exchange rate can be deemed as a tool of economic policies to realize the policymakers' goals. Nevertheless, this tool is used in an economy where the exchange rate is not fully floating, that is, the exchange rate is not determined merely through the mechanism of the foreign exchange market. In other words, the mentioned tool can be used in economic systems where the exchange rate is determined as fixed or controlled floating. An increase in the exchange rate is expected to raise the price of imported goods, resulting in a decreased demand for imports. In addition, an increase in the exchange rate will elevate the export of goods due to the depreciation of domestically produced goods in foreign markets. As a result, the increase in exports and decrease in imports should stimulate the production sector to escalate production. However, it is noteworthy that the influence of import and export on the exchange rate is related to demand elasticity for exported and imported goods. In addition, the market share of the mentioned goods will play an important role in increasing the demand for the product, therefore, the production may increase imperceptibly (Azharia et al., 2010).

GDP fluctuations are recurring (repeatable) deviations of the economy from the process in which variables move with each other. Early analysts of GDP fluctuations believed that each cyclical phase of the economy generates the next cyclical phase. An economic boom creates the next economic crisis (recession), the recession generates the next boom, and the economy is forever caught in a self-sustaining cycle. In contrast, modern theories of GDP fluctuations attribute the fluctuations to the cumulative effects of shocks and disturbances that constantly attack the economy. In other words, there are no fluctuations without shocks (Chatterjee, 2000).

This research aims to determine a framework that can be used to understand the relationship between exchange rate shocks concerning GDP fluctuations. Therefore, this research proposes a model that includes a complete definition and description of GDP fluctuations. Based on the related literature, a functional form can be considered for the economy of Iran, in which GDP fluctuations are a function of fluctuations in the exchange rate, inflation, interest rate (short-term interest rate), consumption, and investment.

In this research, real GDP data are separated from their long-term trend to study GDP fluctuations using a filtering method for this purpose. In this article, therefore, the trend is separated from the data using the Hedrick-Prescott (HP) filtering method, and the main characteristics of GDP fluctuations and the affecting variables are examined after detrending. Furthermore, a method for obtaining positive and negative shocks is to use the time series variable of the time trend. By regressing the intended variable on time and comparing the actual values with the values obtained from the trend, the values higher and lower than the trend can be considered positive and negative shocks, respectively. However, this method is correct if the trend of the intended variable is not associated with structural failure, otherwise, structural changes should be introduced into the model. In practice, the conditions and changes of the economic structure in the analysis of currency shocks can be considered using the univariate filtering method, and as denoted above, the HP method is among the most well-known filtering approaches. This research seeks to find answers to the following questions:

1. Do predictable and unpredictable exchange rate shocks affect GDP fluctuations?
2. Does consumption expenses (sum of government and private) affect GDP fluctuations?
3. Does the inflation rate influence GDP fluctuations?
4. Does the interest rate (deposit interest rate) affect GDP fluctuations?

BACKGROUND RESEARCH

Afshari et al. (2013) conducted a study on the evaluation of a neoclassical growth model in explaining Iran's business cycles using the neoclassical growth model. Business cycles in Iran's economy were first extracted from the realized seasonal data of consumption, investment, and government consumption expenses. Then, a neoclassical growth model was generalized to include technological shocks and government consumption expenses. The model parameters were quantified using time series characteristics in the economy of Iran. To evaluate the model, the realized business cycles in Iran were compared with their corresponding items in the simulated model. The results revealed that the model could well regenerate fluctuations in the economy of Iran. The simulation results also show that the main factor of fluctuations in Iran's economy is technological shocks and government shocks slightly contribute to economic fluctuations.

In a study on the effect of exchange rate uncertainty on the import demand of MENA countries, Behrad and Zamaniyan (2014) state that the exchange rate is always regarded as a key economic variable in policy-making. Additionally, the exchange rate fluctuations and uncertainty and their effects on international trade were focused by researchers after the implementation of the floating exchange rate system in the 1970s. Although most business models argue that exchange rate fluctuations increase uncertainty and risk and, consequently, reduce trade flows, including imports, opposite reports are seen in some other studies. The current study investigates the effect of real exchange rate uncertainty on the import demand of five selected MENA countries using annual data from 1980 to 2012. The logarithm of the GARCH variance series (estimation of exchange rate uncertainty) was generated with the EGARCH model, and the model was estimated using the panel data method with random effects. The results indicate the negative effect of the real exchange rate uncertainty variable on long-term real imports. In the long term, an increase in the real exchange rate uncertainty can improve the country's trade balance by reducing import demands; at the same time, industrial production may suffer due to a decrease in the import of capital and intermediate goods. From a political point of view, therefore, it seems necessary to stabilize the real effective exchange rate through major nominal exchange rates.

Goudarzi and Sabouri (2013) evaluated long-term relationships between the exchange rate and non-oil exports in Iran by estimating two separate functions for the demand and supply of Iran's non-oil exports from 1976 to 2009 using the co-aggregation method. The results indicated a long-term relationship between GDP, real effective exchange rate, and non-oil exports. The estimation results of the country's non-oil export demand model, including the variables of the GDP of Iran's trading partners, the real effective exchange rate, and Iran's non-oil exports, show that the demand elasticity of non-oil exports and the income elasticity in this function were equal to 0.303 and 2.409, respectively, compared to the exchange rate. These results indicate that the real effective exchange rate does not have a significant effect on the amount of non-oil exports of the country. On the other hand, the estimated coefficients for the real effective exchange rate and GDP in the country's non-oil export supply function are equal to 0.055 and 1.031, respectively.

Danesh Jafari et al. (2012) studied the effect of exchange rate shocks on the challenges and employment prospects of the Iranian industrial sector, which plays an effective role in employment creation and influences other sectors both directly and indirectly. Given the importance of employment and its role in humans' individual and social destiny, this research investigates the impact of exchange rate shocks on the challenges and employment prospects of the industry sector. In the first part of the study, the exchange rate shock index was calculated using the exponential generalized autoregressive conditional heteroskedastic (EGARCH) model. Then, a vector error correction model was used to estimate during 1959-2011 with the Dickey-Fuller unit root test and the Perron structural failure test. The results show that the exchange rate shock and the money volume have an inverse relationship with employment in the short and long terms. The employment rate of the industrial sector also increases with an increase in revenue and construction expenditures. In the second part of the study, the employment trend of the industrial sector was predictable using the neural network model. Accordingly, employment in the industrial sector will witness an increasing trend in the future. Therefore, relevant planning can be of paramount importance.

Heydari et al. (2012) conducted an empirical investigation on the effect of the real exchange rate uncertainty on the total stock price index in the Tehran Stock Exchange (TSE) market within the framework of the Bounds Testing Approach. The stock price index of the companies listed on the stock exchange is one of the crucial criteria in the evaluation of macroeconomics. The exchange rate uncertainty is a factor affecting the stock price index in any developing country such as Iran, which has a high degree of uncertainty in macroeconomic variables. This article examined the relationship between the real exchange rate uncertainty and the total stock price index in the TSE using monthly data from 1994 to 2009. The uncertainty index of the real exchange rate was calculated using the EGARCH model. The relationship between the real exchange rate uncertainty and the total stock price index was studied using the Bounds Testing Approach. The results show that the exchange rate has a negative and significant relationship with the stock price index in the long and short terms while the variable of the exchange rate uncertainty in the short term is not significantly related to the stock price index, but it negatively affects the stock price. There is a negative and significant relationship between exchange rate uncertainty and the stock price index in the long run. The results of the Granger causality test show that there is a bidirectional causality between the real exchange rate and the real exchange rate uncertainty in the short term while such a bidirectional relationship is not established between other variables in the short term. There is also an indirect Granger causality relationship between exchange rate variables and exchange rate uncertainty to the stock price index in the long term.

Kandil (2008) investigated the asymmetric effects of exchange rate fluctuations on production levels and prices in developing countries. The results of this research confirmed the hypothesis of the existence of asymmetric effects of exchange rate fluctuations on production levels and prices.

The decrease in the domestic currency value (positive exchange rate shocks) affects the cost of imported intermediate goods, thereby reducing the production level and increasing the price level. Moreover, the increase in the domestic currency value (negative exchange rate shocks) reduces the level of production through a decrease in exports, but it does not influence the level of prices.

Alexius and Post (2008) explored the hypothesis of asymmetric exchange rate shocks in countries with small open economies using the structural vector autoregression (SVAR) model. The results of this study indicate that the main reason for exchange rate fluctuations is the exchange rate itself in most cases. Their results also reveal that the exchange rate in the studied countries has stable characteristics, hence the effects of exchange rate shocks are symmetrical. Furthermore, the exchange rate and its fluctuations can be analyzed separately from the whole structure of the economy in these countries.

Sun and Lian (2008) evaluated the selection of the best exchange rate regime in the face of exchange rate shocks to stabilize the exchange rate behavior in East Asian countries using an SVAR model. Their results indicate that a common currency cannot be chosen among these countries to stabilize the exchange rate behavior. On the other hand, there is evidence that the Japanese currency can be used as a shared unit in a small group of these countries.

MATERIALS AND METHODS

Autoregressive Distributed Lag (ARDL) approach

The long-term and short-term relationships between a dependent variable and other explanatory variables of the model can be investigated using the Engel-Granger method, which is not recommended in regressions with more than two variables due to its disadvantages. The other available methods include the Johansen-Juselius maximum likelihood method and error correction models. Due to the limitations of these methods, more suitable approaches have been proposed to analyze long-term and short-term relationships between variables, one of which is the ARDL approach (Boys and Shin, 1997). ARDL estimations are unbiased and efficient as they avoid problems such as autocorrelation and endogeneity (Seddiki, 2000).

In this method, it is not necessary to use the degree of co-integration of variables (which is necessary for the Engel-Granger and Johansen-Juselius method). In addition, this method simultaneously estimates long-term and short-term patterns in the model and solves the problems related to the removal of variables and autocorrelation. The ARDL econometric method is proposed to investigate a long-term co-integrative relationship. This method is widely used due to its many advantages over other similar methods. The main advantage of this method is its usability to investigate the relationships between variables, regardless of whether they are stationary or non-stationary. In addition to calculating long-term relationships between variables, this method allows calculating dynamic and short-term relationships in each period to reach a long-term balance. Another advantage of using this method is that the co-integration relationship between the variables can be examined and achieved regardless of whether the explanatory variables are at the stationary level ($I(0)$) or become stationary by one-time differentiation (Yousofi, 2011).

If the co-integration vector is obtained by applying the ordinary least squares method to an ARDL model with wide interruptions that are well specified, it will be less skewed and more efficient in small samples, in addition to a normal distribution of the least square estimator (Pesaran and Shin 1997). An ARDL model with a wide lag can be estimated as follows. A $ARDL\left(p, q_1, q_2, ..., q_k\right)$ model can be shown as follows (Noferesti, 2018):

$$Q(L,P)Y_t = \sum_{i=1}^{k} \beta_i(L,q_i)X_{it} + \delta W_t + u_t$$

$$Q(L,P) = 1 - Q_1 L - Q_2 L^2 - ...Q_P L^P$$

$$\beta_i(L,P) = 1 - \beta_{i1}L - \beta_{I2}L^2 - ... - \beta_{iq}L^{qi}$$

(1)

In Equation 1, L indicates is the first-order time operator so that $LY = Y_{t-1}$ ، Y_t, and X_{it} denotes the vector of explanatory variables, $q_i = (i = 1,2,...,k)$ shows the number of optimal lags related to each explanatory variable, P is the number of optimal lags related to the dependent variable and W_t specifies the vector of fixed variables such as y-intercept, seasonal variables, time trends, or exogenous variables with fixed lags, and Y is the dependent variable in the model. Macrofit software estimates Equation (7-3) for all possible combinations of $p = 1,2,...,m$, $\bar{R}^2$, $i = 1,2,...,k$ and values, that is, the $(m+1)^{k+1}$ times. The maximum number of lags is determined and estimated in the $t = n,...m+1$ time range, meaning that m number of initial observations are removed in the estimated model during estimation; in other words, they are lost by m number of degrees of freedom (df). Next, the optimal intervals of the model are selected using one of the Akaike Information Criterion (*AIC*), Schwartz Bayesian Criterion (*SBC*), Hannan-Quinn Criterion (*HQC*), or adjusted coefficient of determination ($\bar{R}^2$), which are calculated using the following formulas:

$$AIC = \ln(\hat{\beta}) - k$$
$$SBC = \ln(\hat{\beta}) - \frac{1}{2}k \log(n)$$
$$HQC = \ln(\hat{\beta}) - k[\log\log(n)] \quad (2)$$
$$\bar{R}^2 = 1 - \left[\frac{\ln(\hat{\beta})}{\ln(\beta_0)}\right]$$

where $\hat{\beta}$ is the maximum likelihood estimator of the β coefficient, *k* is the number of freely estimated parameters, and *n* is the sample size. From the above criteria, Pesaran and Shin propose the *SBC* to determine the optimal lag of the model. Due to the small sample size, this criterion saves the number of lags to lose a lower number of df. To detect long-term co-integration, the *t* statistic value can be compared with the critical quantities provided by Banerjee, Dolado, and Mester (1992) (Noferesti, 1999; Pahlavani et al., 2007).

The *ARDL* approach is carried out in two stages, and the presence of long-term relationships between the studied variables is tested in the first stage. To this aim, if the sum of the estimated coefficients for the dependent variable lags is smaller than one, the dynamic pattern tends toward long-term equilibrium. The null and opposite hypothesis for detecting long-term co-integration in the model is defined as follows. Therefore, the co-integration test is necessary for the following hypotheses:

Long-term co-integration does not exist between the model variables $\{H_\circ : \sum_{i=1}^{p} a_i - 1 \geq 0$ (3)

Long-term co-integration exists between the model variables $\{H_1 : \sum_{i=1}^{p} a_i - 1 < 0$

The *t* statistic quantity for testing the long-term co-integration hypothesis is calculated as:

$$t = \frac{\sum_{i=1}^{p} \hat{a}_i - 1}{\sum_{i=1}^{p} S\hat{a}_i}$$

(4)

In this statistic, $\sum_{i=1}^{p} \hat{\alpha}_i$ is the sum of the coefficients of the variables with a lag related to the dependent variable, appearing on the right side of the equation, and $\sum_{i=1}^{p} S\hat{\alpha}$ is the sum of the standard deviations of these coefficients. The H_0 is rejected if the modulus of the calculated quantity is greater than the critical quantity presented by Banerjee, Dolado, and Mester at the intended level of confidence and, as a result, a long-term equilibrium relationship exists between the model variables (Houshmand et al., 2017).

The next step includes the estimation and analysis of long-term coefficients and the deduction of their values. To this aim, one of the equations is first selected using one of the *AIC*, *SBC*, or *HQC*. Usually, the *SBC* is used in samples less than 100 so as not to lose much df. The long-term coefficients of the explanatory variables of the model are calculated from the following formula (Noferesti, 2018).

$$\hat{\theta}_i = \frac{\hat{\beta}(1, \hat{q}_i)}{\hat{\varphi}(1, \hat{p})} = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + \hat{\beta}_{i2} + \ldots + \hat{\beta}_{i\hat{q}i}}{1 - \hat{\varphi}_1 - \hat{\varphi}_2 - \ldots - \hat{\varphi}_{\hat{p}}} \quad (5)$$

where $\hat{q}_{i,} \hat{p}_i (i = 1, 2, \ldots, k)$ represents the values chosen for p, q_i.

Similarly, the long-term coefficients for deterministic and non-random variables are calculated as follows:

$$\hat{\Psi} = \frac{\hat{\delta}(\hat{p}, \hat{q}_1, \hat{q}_2, \ldots, \hat{q}_k)}{1 - \hat{\varphi}_1 - \hat{\varphi}_2 - \hat{\varphi}_{\hat{p}}} \quad (6)$$

in which $\hat{\delta}(\hat{p}, \hat{q}_1, \hat{q}_2, \ldots, \hat{q}_k)$ refers to the δ estimation in the *ARDL* model. An important point in the model is to determine the optimal lags. According to Pesaran and Shin, if suitable lags are determined for this model, the ordinary least squares estimators are consistent for the short-run parameters, and the *ARDL* model estimates are consistent in the long run. The *ARDL* model somewhat lacks the weaknesses of the Engel-Granger model and is the same as the Johansen-Juselius method, all the variables do not need to be *I(1)*, but they can be *I(0)* and *I(1)*. Therefore, the *ARDL* model is the best option to examine the co-integration in these conditions. Another advantage of this model is that it can encompass a sufficient number of lags for the data generation process in a general-to-specific modeling framework (Chowdhury, 2005).

In this study, models are estimated using the *ARDL* method. The existence of co-integration between a set of economic variables underpins the use of error correction models and relates short-term fluctuations (short-term imbalance) of variables to their long-term values. Engel and Granger believe that every long-term relationship has a short-term error correction model that ensures achieving that balance and vice versa (Andres, 1995). As described above, the dynamic model will be as:

$$y_t = \beta_0 + \sum_{h=1}^{p-1} \eta_h y_{t-h} + \sum_{h=1}^{p-1} \lambda_h x_{t-h} + u_t \quad (7)$$

where y_t is the dependent variable, x_t is the vector of independent variables, and u_t is a white lag. According to the above, the model used in this study to examine and evaluate the predictable and unpredictable exchange rate shocks on GDP fluctuations in Iran will be as follows:

LIGDP = F (INF, CONS, IR, PS, UPS) (8)

where INF is the inflation rate, CONS represents the consumption costs (government and private), IR denotes the interest rate, PS is the predictable shocks, and UPS indicates the unpredictable shocks in the country.

As mentioned before, GDP fluctuations (dependent variable) in this research are studied by separating real GDP data from their long-term trends using the filtering method by detrending the data using the HP filter procedure.

HP filtering method

Proposed by Hodrick and Prescott (1989), this single-equation method is more well-known than other filtering methods such as Baxter-King. The logic behind using this method is that it allows separating the observed shocks into permanent and temporary components. This filter is obtained by minimizing the sum of the square deviation of the Y variable from its trend Y_t^{tr}. The values of this trend are the values that minimize the following relationship:

$$\sum_{t=1}^{T}(Y_t - Y_t^{tr})^2 + \lambda\sum_{t=2}^{T-1}[(Y_{t+1}^{tr} + Y_t^{tr}) - (Y_t^{tr} - Y_{t-1}^{tr})]^2 \quad (9)$$

where T is the number of observations, and parameter λ is the balancing factor that determines the degree of trend smoothing; it takes values of 100 and 1600 for annual and seasonal data, respectively. This two-way filter is symmetrical and eliminates the problem of the period phase change, but it faces a problem at the period completion because the future statistics are not available. A greater value chosen for λ indicates the reason for more smoothing, and the time series limit will move toward linearity. However, this filter suffers from inadequacies, for example, the voluntary choice of the λ value, ignoring the structural failure, and overlooking the instability dynamics. Based on the presented method, exchange rate shocks can be defined as follows.

The size of the exchange rate time trend is first extracted based on the HP filter; this size is the predictable or expected shocks. Unpredictable shocks of the exchange rate can be obtained from the difference between the nominal exchange rate and the predictable shocks of the exchange rate. To obtain positive and negative shocks of the exchange rate, the positive shocks are those unpredictable shocks with a positive value, and negative shocks are those unexpected shocks with a negative value. To determine the positive impulses, zero is considered if the unpredictable shock value is a negative number, and if the obtained shock is positive, the same positive value will be determined. The same process is applied to negative shocks but in the opposite way.

All the statistics and information needed for this research were obtained from the economic reports and the balance sheet of the Central Bank from 1981 to 2016. Since the annual time series information of the mentioned variables was provided by the Central Bank of Iran, only this official statistical source of the country was used to homogenize the information.

RESULTS

Reliability test of variables

The non-stationary status in the series used in a model can lead to wrong statistical inferences, resulting in false regression. Evidence indicates that this assumption is incorrect, and most of these variables are non-stationary in the case of many macroeconomic time series. If the time series variables used in estimating the model coefficients are non-stationary while no relationship or concept may exist between the model variables, the obtained R^2 coefficient can be very high, leading to the researcher's wrong deductions about the degree of association between variables. In such a situation, the obtained regressions are not real and are false. In addition, when the model variables are not stationary, the critical values of *t* and *F* statistics are no longer applicable. According to the co-integration theory in modern econometrics, the stationarity of variables should be ensured to avoid the spurious regression problem in regression analysis. The reliability or unreliability and the existence of a unit root of time series in this research were evaluated using the Augmented Dickey-Fuller (ADF) test and determining their co-integration order with Eviews 9 software. The final result for the data level respectively is presented in Table 1.

To test the reliability of the variables, the ADF test for all the variables shows their stationarity at the level. In other words, the H_0 on the existence of a single root in the mentioned time series cannot be rejected at the 10, 5, and 1% levels. Based on Table 1, all variables are zero order or I(0), except consumption, exchange rate, and accumulated interest rate.

Table 1. The results of the Augmented Dickey-Fuller test

Variable	Level				First-order difference			
	Calculation of ADF statistic value	Critical value 1%	critical value 5%	critical value 10%	Calculation of ADF statistic value	critical value 1%	critical value 5%	critical value 10%
Production fluctuations	4.20	3.61	2.93	2.60	-	-	-	-
Inflation rate	3.79	3.60	2.93	2.60	-	-	-	-
Predictable shocks	3.63	3.60	2.93	2.60	-	-	-	-
Unpredictable shocks	3.35	3.62	2.94	2.61	-	-	-	-
Consumption	0.207	3.61	2.93	2.60	3.43	3.61	2.93	2.60

Exchange rate	0.351	3.60	2.93	2.60	6.07	3.61	2.93	2.60
Interest rate	2.33	3.61	2.93	2.60	3.36	3.62	2.94	2.61

Estimation with the ARDL method

Compared to other co-integration methods, a major advantage of ARDL is its ability to estimate long-term and short-term relationships in the conditions that even the variables of a stationary model are not of zero order and are stationary of the first order, offering efficient and consistent estimates.

To ensure the existence of a long-term relationship, the ARDL dynamic model or the lags determined with the SBC by the system are estimated at this stage. This criterion gives 4, 3, 4, 3, and 4 lags to the variables of GDP fluctuations, interest rate, inflation rate, consumption (government and private), predictable shocks, and unpredictable shocks, respectively. After ensuring the existence of a long-term relationship, this co-integration relationship is estimated by the ARDL model with specific lags as follows. The long-term relationship estimation results are shown in Table 2.

Table 2. The estimation results of the long-term ARDL model (4,3,4,3,4,4)

Variable	Estimated coefficients	Standard deviation	t-statistic (probability)
IR	0.62	0.46	-1.35 (0.0024)
INF	0.18	0.16	1.13 (0.0032)
CONS	-1.27	0.78	-1.63 (0.0079)
PS	-0.00006	0.000041	1.57 (0.0007)
UPS	0.0002	0.000079	2.52 (0.0050)
C	-12.28	4.02	3.05 (0.037)

All the coefficients are significant at the 95% confidence level. A coefficient of 0.62 for the interest rate (IR) variable indicates a positive and significant effect of IR on long-term GDP fluctuations in Iran, that is, one unit rise of IR increases production fluctuations by 0.62 in Iran. The coefficient of the inflation rate variable (0.18) reveals a positive and significant effect of the inflation rate on production fluctuations in Iran in the long term, that is, if the inflation rate increases by one unit, the production fluctuations will rise by 0.18 in Iran. The coefficient of the consumption variable (government and private) is equal to −1.27, showing that consumption has negatively and significantly affected production fluctuations in Iran in the long term. This means one unit elevation in consumption decreases production fluctuations by −1.27 in Iran. The predictable shock variable coefficient (−0.00006) shows that predictable shocks have negatively and significantly influenced production fluctuations in Iran in the long run, i.e., if predictable shocks increase by one unit, production fluctuations will decrease by −0.00006. The coefficient of the unpredictable shock variable is equal to 0.00002, suggesting that unpredictable shocks have positively and significantly affected production fluctuations in Iran in the long run. This means a 0.00002 increase in production fluctuations with one unit rise of unpredictable shocks.

ANOVA of production fluctuations

Table 3 shows the ANOVA of model variables according to the estimated model.

Table 3. The reaction of production fluctuations to shocks in the other variables

Period	S.E.	LIGDP	IR	INF	CONS	PS	UPS
1	0.001	100.00	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.003	94.43	0.58	0.01	4.25	0.41	0.29
3	0.006	88.06	0.44	0.20	9.77	0.75	0.75
4	0.011	82.75	0.144	0.185	14.78	0.82	1.30
5	0.017	78.06	0.34	0.091	18.6	0.86	2.02
6	0.025	73.92	1.002	0.048	21.16	1.009	2.84
7	0.033	70.27	1.91	0.069	22.76	1.29	3.68
8	0.042	66.93	2.99	0.15	23.64	1.73	4.53
9	0.050	63.70	4.27	0.320	23.95	2.31	5.42
10	0.056	60.39	5.81	0.58	23.71	3.05	6.43

In Table 3, the first column marked with S.E. shows the prediction error of the relevant variables during different periods. This error increases over time as it is calculated every year based on the previous year's error, and the source of this error is changes in current values and future shocks. The results in the table show the prediction errors of 0.001 and 0.003 in the first and the second periods, with an increase over time. The next columns represent the variance percentage caused by a sudden change or specific shock. The second column indicates that although 100% of the changes in GDP fluctuations result from the variable itself in the first period, the changes in this variable are related to production fluctuations (94.43%), the IR (0.58%), inflation rate shock (0.01%), consumption shock (4.25%), related to predictable exchange rate shock (0.41%), and unpredictable shocks (0.29%) of the country's exchange rate in the second period.

Over time, the country's production fluctuations are caused by the shocks of production fluctuations (60.39%), IR (5.81%), inflation rate (0.58%), consumption (21.73%), predictable shocks (3.05%), and unpredictable shocks (6.43%) of the country's exchange rate.

Instantaneous reaction functions (shock, reaction)

The information in the table of instantaneous reaction functions shows the effect of GDP fluctuations in Iran in the following periods if a shock or a sudden change equal to one standard deviation occurs in the IR, inflation rate, consumption, predictable shocks, and unpredictable shocks.

Table 4. The reaction of production fluctuations to shocks in the other variables

Period	LIGDP	IR	INF	CONS	PS	UPS
1	0.001	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.002	-0.0002	3.63E-05	-0.0006	-0.0001	0.0001
3	0.005	-0.0003	0.0002	-0.001	-0.0005	0.0005
4	0.008	3.73E-05	0.0003	-0.003	-0.0008	0.001
5	0.011	0.0009	0.0002	-0.006	-0.001	0.002
6	0.015	0.0023	-0.0001	-0.008	-0.001	0.003
7	0.018	0.0039	-0.0006	-0.011	-0.002	0.004
8	0.019	0.0056	-0.001	-0.012	-0.004	0.006
9	0.020	0.007	-0.002	-0.013	-0.005	0.007
10	0.018	0.008	-0.003	-0.012	-0.006	0.008

In Table 4, the first column shows that a sudden change or shock of one standard deviation in the variable of GDP fluctuations in the first period increases the production fluctuation index by 0.001 units. In the second season, this effect increased the production fluctuation index by 0.002. In the third period, this effect raised the production fluctuation index by 0.005. The effect of this shock is interpreted in the same manner in the next periods. The second column belongs to the shock effect on the production fluctuation index from the IR variable. If IR increases by one standard deviation, it does not affect the production fluctuation index in the first period, but it increases production fluctuations by −0.002 units in the second period. Here, the effect of this shock is similarly interpreted in later periods. The third column indicates that a sudden change of one standard deviation in the inflation rate does not affect production fluctuations in the first period. A shock on this variable increases production fluctuations in the second period, and similarly, the shock effect of this variable on the production fluctuation index can be interpreted until the end of the period. The fourth column of the table reveals the effect of a shock equal to one standard deviation in production fluctuations from the consumption variable. According to the results in Table 4, the shock that occurred in the first period does not affect production fluctuations. In the second period, this shock reduced production fluctuations by 0.0006 units, and likewise, the impact of this variable on production fluctuations can be interpreted until the end of the period. The fifth column of the table displays the effect of a shock equal to one standard deviation on production fluctuations from the predictable shock variable. According to the results in the table, the incident shock in the first period does not affect production fluctuations. In the second period, this shock reduced production fluctuations by −0.0001 units, and the effect of the shock of this variable on production fluctuations can be interpreted in the same way until the end of the period. The sixth column of the table shows the effect of a shock equal to one standard deviation in production fluctuations from the unpredictable shock variable. According to the results in the table, the shock does not affect production fluctuations in the first period. In the second period, this shock increased production fluctuations by −0.0001 units, and similarly, the effect of the shock of this variable on production fluctuations can be interpreted until the end of the period.

Based on the results in Table 4, it can be deduced that the shock on all the variables, except that on the production fluctuation variable, has started almost from the second period, and its effect is gradually moderated until the end of the period.

Examination of Classical Assumptions

This part examines the establishment of classical assumptions so that the estimates according to the classical assumptions are the best non-distorted estimators (BLUE). Therefore, the classical assumptions are discussed in the following.

The normality of residual sentences

An assumption investigated in the normal OLS method is the normal distribution of the values of estimated residuals. In regression fitting, however, the non-normal distribution of the residual values has no effect on the estimation results when the goal is only to fit the values. Figure 1 presents the residual sentence histogram test and the Jarque-Bera statistic for normality, besides a series of simple descriptive statistics of the residual sentences.

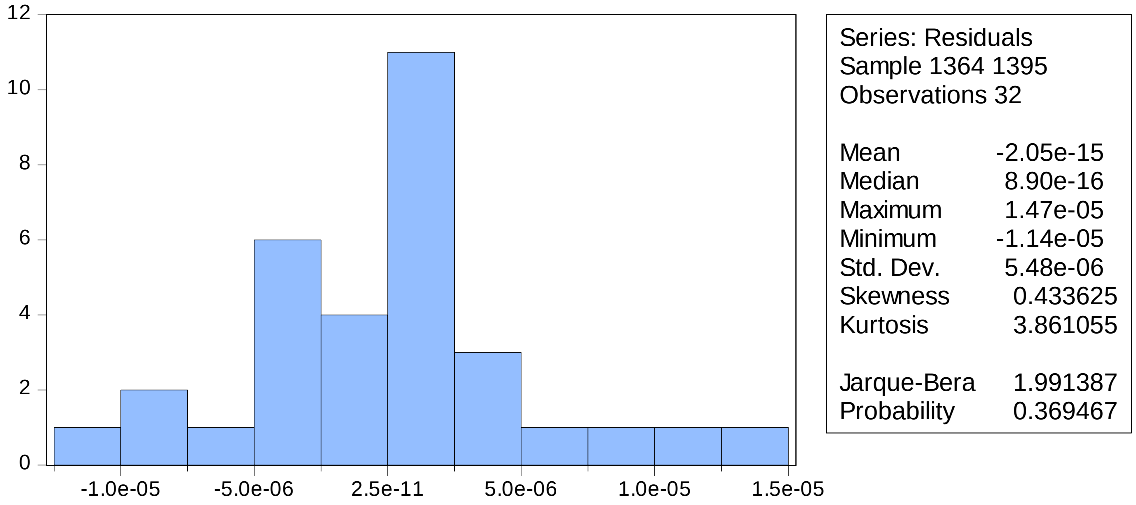

Figure 1. The normality test of the estimated model residuals

The normality test results of the residual sentences (Fig. 1) indicate the normal distribution of the estimated model residuals (the probability of Jarque-Bera statistic is > 0.05).

Heteroskedasticity of variance

Variance heteroskedasticity problems increase the variance of the estimated y-intercept coefficients, and on the other hand, affect the variance of other estimated independent variables, leading to the inefficiency needed for the estimate. The variance heteroskedasticity of the residuals was verified using the Glejser test, and the output results of Eviews9 software for White's test are shown in Table 5.

Table 5. The results of White's test to detect variance heteroskedasticity

Heteroskedasticity Test: White

F-statistic	0.364174	Prob. F(27,4)	0.0510
Obs*R-squared	22.74657	Prob. Chi-Square(27)	0.6985
Scaled explained SS	0.559541	Prob. Chi-Square(27)	1.0000

The results of White's test indicate that the residuals of the fitted model have homogenous variances. Therefore, the estimated model coefficients have the necessary efficiency (the F-statistic probability > 0.05).

Absence of autocorrelation

According to econometrics, the presence of autocorrelation in the residuals leads to incorrect estimations of standard errors, resulting in incorrect statistical inferences for the coefficients of the equation. To avoid such an error, this problem is examined using the Breusch-Godfrey test, the results of which are presented in Table 6, according to Eviews9 software.

Table 6. The results of the Breusch-Godfrey test to examine autocorrelation

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.202014	Prob. F(27,4)	0.0960
Obs*R-squared	18.46128	Prob. Chi-Square(27)	0.8888
Scaled explained SS	0.454127	Prob. Chi-Square(27)	1.0000

In this test, the H_0 on the absence of autocorrelation is accepted according to the probability value in the table, and therefore the test results indicate the absence of autocorrelation in the residuals.

CONCLUSIONS AND RECOMMENDATIONS

Overall, it can be concluded that the currency system in Iran has witnessed many changes before and after the revolution. Since the revolution, this issue has been determined by a multi-rate system, accompanied by currency regulations and controls related to imports, such that this issue has led to crucial consequences for the economy and the efficiency of economic policies. Due to the presence of high oil revenues and the absence of a crisis in the balance of payments during the pre-revolution years, the government could stabilize the parity rate of the Rial with foreign currencies, especially the dollar, within the framework of the Bretton Woods monetary system. However, the establishment of a floating currency system in some countries and the suspension of the Bretton Woods monetary system since 1974, as well as the Rial dependence on the dollar, caused severe Rial fluctuations against other currencies, especially the dollar. This means that dollar changes against the currencies of other countries, as a major part of Iran's trade parties, significantly influenced the volume and price of exports and imports in Iran.

The estimation results of the long-term relationship between the model variables generally indicate that currency shocks significantly influence GDP fluctuations. The effect of currency shocks on production fluctuations corresponds to the theoretical research foundations that emphasize the significant effect of the exchange rate on GDP fluctuations. This result also agrees with international and domestic empirical studies, such as Cottani, Cavallo, and Khan

(1990), Schnabel (2007), Aliyu (2009), Brito et al. (2011), Mousavi (2001), and Halafi (2007).

The positive effect of unpredictable shocks on GDP fluctuations is that unpredictable exchange rate shocks create an unstable and uncertain environment in the economy and the profit resulting from international exchanges, thereby reducing trade, lowering capital flow through a decrease in investment in foreign activities, collapsing the portfolio of financial assets, decreasing the production level. This article concludes with the following suggestions:

- ✓ Given the different effects of positive and negative exchange rate shocks, economic policymakers are suggested to behave differently from each other in facing these shocks and adopt a suitable policy based on the existing conditions to be able to minimize the negative effects of the generated shocks.
- ✓ To control and manage the country's currency fluctuations, it is suggested to avoid adopting emotional strategies and decisions (news of adjustments in the bank interest rate, multiple exchange rates, etc.) that lead to production and capital market fluctuations through industries affected by such decisions.
- ✓ In addition to paying attention to the supply side of the economy (GDP) and creating its booming factors in the economy of Iran, it is suggested to control the demand side, especially the liquidity, and reduce the gap between these two rates with the cooperation of the two sectors, thereby reducing the exchange rate instability and increasing the hope of economic prosperity.
- ✓ One of the main sources of deviation of the real exchange rate from the equilibrium path can be the additional growth of domestic credits particularly because the government has financed its budget deficit by borrowing from the Central Bank in most years, resulting in inflation and elevated levels of domestic prices. Therefore, observing discipline in fiscal policy, using a strong and efficient tax system, and financing the government budget deficit through borrowing from people instead of borrowing from the Central Bank can effectively reduce both the price level and the deviation of the real exchange rate from the long-term equilibrium path.
- ✓ The establishment of a precautionary reserve fund in recent years is an effective step toward reducing short-term exchange rate fluctuations and optimal management of the country's value resources, especially the income from oil and gas exports. Altogether, one of the needs in the future is to establish institutions that can reduce uncertainty.

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