# The effect of economic stationary variables on the growth in per capita income in Iraq for the period (1990 - 2021) by using the autoregressive distributed lag (ARDL) model

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**Abstract—** This research is work to measure the effect of the economic stability variables represented by unemployment, inflation, economic growth and the Iraqi balance of payments on the growth of individual income by using the autoregressive distributed lag (ARDL) model after conducting a series of tests to ensure that the model is free from standard problems and to ensure the stability of the series Such as unit root tests based on Philip-Perron test and tests of homogeneity, serial correlation and normal distribution of data (Jarque-Bera), and the study concluded that there is a long-term logical equilibrium relationship depending on the impact test of Bounds Test, and there is a correction relationship from the short to the long term At a speed of 22.6%, that is, complete equilibrium will occur within a period of approximately four and a half years, as the study showed that both inflation and the unemployment rate have a negative impact on the individual income rate and that the magic square of the role in the Iraqi economy is completely far from the ideal that I assumed as the role, especially in what The unemployment indicator.

**Keywords—**Autoregressive distributed lag model (ARDL) , Stationary , (ADF) Test , (P P) test , (AIC) & SIC Criterions **.**

## 1 Introduction

Measuring the wealth of a country does not depend only on the gross domestic product of any country, but the per capita income of that country must be taken and considered as a measure of the wealth of society. The United Nations reports, and in general, the Iraqi per capita income was usually fluctuating, as it witnessed a boom at the end of the eighties and then decreased rapidly during the second Gulf War, and at the beginning of 2012 Iraq witnessed a significant increase in income as a result of the rise in oil imports and then decreased significantly with the spread of the Corona pandemic and the decline the world economy's demand for oil imports, Which led to a decrease in the gross domestic product and consequently the per capita share of it, and since this indicator is a measure of the wealth of society, this study attempted to show the impact of the economic stationary variables represented by the magic square of the role in the growth of individual income.

## 2 The importance of Research

Per capita income is an economic indicator that measures the degree of economic development in a country and has significant effects.

## 3 The problem of Research

The variables of unemployment, economic growth, inflation, and the balance of payments are the variables of stability economic that I suppose as the role to achieve an ideal economy, and therefore these variables will have a significant impact by affecting, negatively or positively, the rate of individual income.

## 4 The Aim of Research

The study aims to investigate the impact of economic stability variables (economic growth - unemployment - the general level of prices represented by the inflation rate - balance of payments) on the growth of individual income.

## 5 The Hypothesis of Research

The study assumes that the economic stability variables that it assumes as the role are not ideal in the Iraqi economy, and therefore the rate of inflation and unemployment have a negative impact on the growth rates of individual income, while the balance of payments and growth in the gross domestic product have a positive negative effect.

## 6 The Theoretical side

### 6.1 Define time series

The time series is defined as a sequence of observations of a specific measurable phenomenon that is arranged according to the time parameter t, if the time series can be measured intermittently or continuously according to the phenomenon it represents, and that the study of the time series is important in knowing the changes that occur in the studied phenomenon, which are changes in the values of the observations For this phenomenon, as each observation is expressed by a continuous or discontinuous random variable, and the mathematical model must reflect those changes, and the most important characteristics of the mathematical model that represents a time series is stationary .

### 6.2. Stationary Tests

Subjecting economic variables to static tests is an urgent necessity because of the random trends of the series, as the presence or absence of a unit root helps determine some of the advantages of the process of generating the basic data of the series. In the case of a unit root, the time series do not tend to return to the long-term deterministic path, i.e. the variance of the series depends on time, and the non-stationary series suffers from permanent effects of random shocks, and thus the series follows a random movement, and if the series is not stable and the first difference in it is constant The string contains a unit root, (John and other, 2007,6), stationary in time series can be defined as a change in the value of variance from one time period to another, that is, the time series have different averages from each other at different points during a time period that are adopted in the estimation, and their variance increases with the size of the sample that it does not take a certain direction and that its random errors accumulate Over time, and then the general trend of the series results in a strong correlation between the values of the same variable over time (Gujarati, 2011, 208).

There are many statistical methods that are used to test stationary, and we will rely on one of them, which is considered one of the most effective and widespread methods, which are unit root tests, as the goal of unit root testing is to examine the properties of time series for all study variables to ensure their stability during the time period of observations and then determine The order of integration for each variable alone. When the series is stable in its original value, it is integrated from the zero order I (0), meaning that it does not carry a unit root. When the series is stable after taking the first difference, this series is integrated from the first order I (1) and the series is stable from The second rank I (2) after taking the second difference (Rad and Eslami, 2012, 15) and there are many tests to achieve this goal as follows:

**First:Augmented Dickey Fuller Test (ADF)**

This test allows the treatment of deviations in the autocorrelation of random errors with high accuracy by measuring the deviations in them and finding treatments for the auto-correlation problem by introducing the coefficient of time slowing down for the independent variables, and this test takes three forms as follows (Gujarati, 2003, 817):

$$\Delta Y_1 = \alpha Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad (1)$$

$$\Delta Y_1 = \alpha_o + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad (2)$$

$$\Delta Y_1 = \alpha_o + \alpha_1 Y_{t-1} + \alpha_{2t} \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad (3)$$

The first equation refers to the test without the cutoff limit as well as without the time trend, while the second equation refers to the test with the cutoff limit and without time trends as well, while the third equation indicates the presence of the cutoff limit with the time trend and the numbers of time lag periods were tested to ensure that there is no correlation Random errors with each other actually, for example, if we take the difference $\Delta y_{t-1} = y_{t-1} - y_{t-2}$ and it becomes clear to us that the autocorrelation problem has disappeared, we will be satisfied with this difference, but if this problem does not disappear We will resort to the second difference, and so on, this test uses a set of criteria to test the optimal time lag period that leads to the cancellation of sequential or self-correlation in random errors (Zou, 2006, 1259) and these criteria are:

**1- Akaike Information Criterion (AIC) :** This criterion was proposed in 1974 by the scientist Akaike to test the rank of the optimal model among the models presented, and that the optimal model is the model that has the lowest value and is expressed as follows (Tsay, 2005).

$$AIC(B) = \frac{-2}{ln}(\sigma_\beta^2) + \frac{2B}{n}$$

Where B = number of model parameters ,n = number of observations , $\sigma_{(\beta)}^2$ = the amount of error variance.

**2- Schwarz Criterion (SIC) :** This criterion was proposed in 1978 by the scientist Schwarz to test the optimum model rank as well, and it is written in the following form (Makridakis, S., Wheelwright, S. C., & Hyndman, 2008).

$$SIC = n \ln(\sigma^2{}_\beta) + LIn(n)$$

Where L = the number of model parameters, n = sample size, $\sigma_{(\beta)}^2$ = The amount of variance of the residuals of the matching model.

**Second: Philip-Perron (P.P) Test**

This test uses a non-parametric correction method to get rid of the autocorrelation problem, because it calculates the unit root of the regression equations, and then transforms the statistical results to cancel the effects of the serial correlation of the random error distributions resulting from the statistical tests in order to transform the corrective test results accordingly. The standard we use the following equation:

$$S_1^2 = \frac{1}{N}\sum_{t-1}^{N} \hat{e}_t^2 + 2/N \sum_{s=1}^{L} \bar{\omega}\ (s, L) \sum_{t=s+1}^{N} \hat{e}_t\, \hat{e}_{t-s} \quad (4)$$

Whereas, L represents the optimum deceleration period coefficient needed to cancel the sequence correlation in random errors, which is one of the most important basic requirements necessary for the success of stationary tests in time series data (Enders, 2004, 64).

### 6.3 Estimation of the Autoregressive Distributed Lag (ARDL) Model

Co-integration means that there is a long-term relationship between the variables for two or more variables, while there is no equilibrium relationship in the short term for the variables of the study, then the imbalances must be corrected in the short term according to the so-called error correction model, and it is worth mentioning that there are several models for studying the co-integration between the variables, including Engle and Grager in 1987, which is considered one of the limited methods because it is based on the assumption that the study is based on only two variables and that the two variables are of the same rank. 1(0) or Also, this method has several characteristics, the most important of which is that it deals with long time series. When the sample size is small, it is difficult to find a joint integration between the variables and also takes a sufficient number of slowdown periods to obtain the best set of data among the study variables (Nkoro and kelvin, 2016, 76).

And this model is used in the analysis of time series, where it combines the slowing variables as internal variables with an external variable that is affected by it in the autoregressive model, and it is called the distributed slowing autoregressive model and is written in the following formula:

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{p} \sum_{i=1}^{n} \beta_{ji} x_{jt-i} + \varepsilon_t \quad (5)$$

where $\varepsilon_t$ is white noise, $y_t$is the response variable, which is an endogenous variable of time t, $y_{t-i}$slows variables form endogenous variables, $x_{jt-i}$slows variables for exogenous variables, $\alpha_0$, $\alpha_i$, $\beta_{ji}$are model parameters, There are special cases for this model, when the autoregressiveness of the first order of the internal variable as well as the distributed slowness of the external variable of the first order is symbolized by ARDL(1,1) and written in the following form (Nkoro and Kelvin, 2016, 83):

$$y_t = \propto_0 + \propto_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + \varepsilon_t \quad (6)$$

$\varepsilon_t$is the term of the random error, and it is normally distributed with the variance of | $\alpha_2$| <1, $\sigma^2$and mean zero.

$$E(y_t) = \alpha_0 + \alpha_1 E(y_{t-1}) + \beta_0 E(x_t) + \beta_1 (x_{t-1}) \quad (7)$$

$$y_t^* = E(y_t) = E(y_{t-1}) \; and \; x_t^* = E(x_t) = E(x_{t-1}) \quad (8)$$

$$y_t^* = \frac{\alpha_0 + (\beta_0 + \beta_1) x_t^*}{(1 - \alpha_1)} = k_0 + k_1 x_t^* \quad (9)$$

$K_1$is the long-run multiple of y with respect to x

Co-integration is tested using the linkage test method developed by (Pesaran et al, 2001), where the auto regression and the distributed model are integrated in this model. Tests the hypothesis of co-integration of the variables against the existence of co-integration to discover a long-run equilibrium relationship between the variables, as follows, based on the following assumptions:

$H_0: C_{11} = C_{12} = C_{13} = C_{14} = 0$

$H_1: C_{11} \neq C_{12} \neq C_{13} \neq C_{14} \neq 0$

The null hypothesis (the null hypothesis) is rejected when compared because it is the calculated F value with the tabular values of the critical limits proposed by (Pesaran et al, 2001). Among the variants (Moawad, 2019, 628).

After confirming the existence of a co-integration relationship between the variables based on the boundary test, the error-correction model is estimated to diagnose and analyze the error-correction speed coefficient, and this

coefficient confirms the existence of a co-integration relationship between the variables, provided that the significance and negativity are achieved, and it can be formulated as follows:

$$\Delta Y_t = \propto + \sum_{i=1}^{p-1} y_i \Delta Y_{t-i} + \sum_{j=1}^{K} \sum_{i=0}^{q-1} \beta_{ij} \Delta X_{j,t-1} - \varphi ECT_{t-1} + \varepsilon_t \qquad (10)$$

Where $ECT_{t-1}$represents the random error variable that results from estimating the relationship in the long run with a time delay of one year, which is the coefficient of adjustment speed (Narayan, 2005, 6).

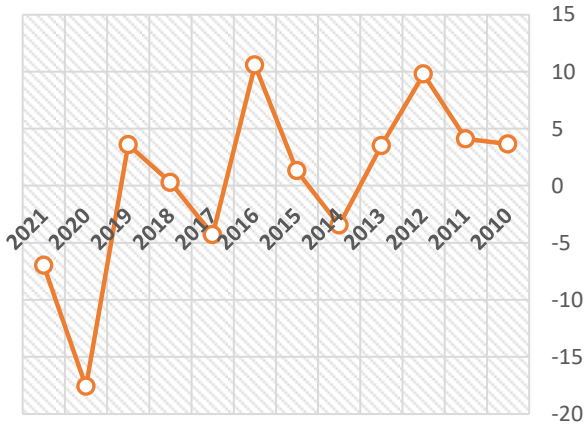
# 7 Applied Side

## 7.1. Growth in per capita income

It is defined as the average per capita GDP, after dividing the GDP at current prices by the population. International organizations use multiple measures to measure the economic development of the countries of the world. The per capita GDP is one of those measures, and this indicator expresses the individual's ability to obtain it. On consumer goods and services, the importance of the per capita GDP indicator is that it is one of the indicators of measuring the level of social well-being of the citizens of the country. The per capita GDP is usually used to compare between one country and another. growth (General Authority for Statistics, 2017, 2) and that growth in it leads to a rise in individual spending, which is considered a measure of the standard of living. The state's economic level (Barihi and Radi, 2018, 175).

It is worth noting that Iraq is one of the countries that witnessed record growth in the average per capita income after 2007 due to the significant increases in oil export revenues. The growth rate in 2007 and 2008 was approximately 31% and 28%, respectively (Abdul Karim and Wahbiah, 2013, 13 The following figure shows the growth rate of the GDP share for the last ten years, as follows:

**Figure (1) GDP per capita**




**The source was prepared by the researcher based on the data of the World Bank**

It is clear from the above figure that at the beginning of the year 2020, and coinciding with the spread of the Corona virus in Iraq, there was an unprecedented drop in oil prices and a sharp deterioration in Iraq's revenues from oil

exports on which Iraq relies almost completely, amounting to 95% in financing its general budget, and thus a decrease in The gross domestic product leads to a decrease in per capita share (Al-Zubaidi and others, 2020, 15).

### 7.2 .Model description and results

The model consists of a simple linear regression equation of square variables such as the role (balance of payments - inflation rate - unemployment rate - growth rate) as independent variables and the growth rate in individual income as a dependent variable, and the model includes the random variable and it represents all other variables that were not included in the model It was not mentioned and it has an impact on the growth rate of per capita income and it can be expressed standardly as follows.

$$PIG_t = B_0 + B_1 GDP + B_2 INF + B_3 U + B_4 BOP + \varepsilon_t \qquad (11)$$

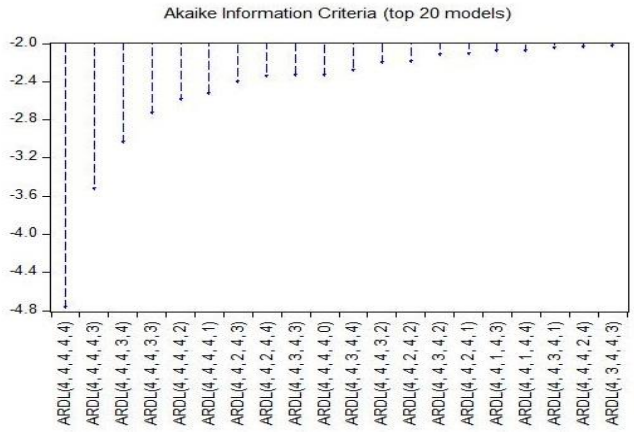
Where is $PIG_t$ the growth in per capita income, BOP is the balance of payments, U is the unemployment rate, INF is the inflation rate, GDP is the growth in GDP, $\varepsilon_t$is the random variable, and the annual data was obtained from the World Bank and below is the statistical information for the study variables.

**Table (1) Descriptive statistics for the study variables**

| greatest value | smallest value | standard deviation | Median | Sample mean | Views | Variables |
|---|---|---|---|---|---|---|
| 53.9748 | -64.992 | 21.6185 | 3.55566 | 4.43387 | 32 | PIG |
| 448.500 | -16.117 | 109.129 | 9.72568 | 53.2299 | 32 | INF |
| 57.8178 | -64.047 | 22.2509 | 5.80181 | 7.36895 | 32 | GDP |
| 14.1920 | 7.96000 | 1.78918 | 8.85900 | 9.64323 | 32 | U |
| 21.6088 | -6.6768 | 7.71695 | 6.78157 | 6.89713 | 32 | BOP |

**First - Determining the optimal deceleration period for the study variables according to the Akaike criterion, as follows in the following figure.**

**Figure (2) shows the optimal deceleration period for the model**




It is clear from the figure that Akaike's criterion chooses the rank (4,4,4,4,4) as the best slowdown period among 20 models, and accordingly, this period will be relied on in the distributed autoregressive distribution model.

**Second: stationary tests**

**Table (2) Unit Root Test**

| Augmented Dickey-Fuller Unit Root Test | | | |
|---|---|---|---|
| Variables | No Trend | Trend | Rank |
| GDP | -8.602609<br>(-2.960411) | -8.630194<br>(-3.562882) | I(0) |
| INF | -5.247495<br>(-2.963972) | -5.164543<br>(-3.568379) | I(1) |
| BOP | -7.668640<br>(-2.963972) | -7.829148<br>(-3.568379) | I(0) |
| U | -3.103700<br>(-2.991878) | -3.723829<br>(-3.612199) | I(1) |
| PIG | -8.714047<br>(-2.960411) | -8.731701<br>(-3.562882) | I(0) |
| Philip- Perron Unit Root Test | | | |
| GDP | -8.730283<br>(-2.960411) | -10.15161<br>(-3.562882) | I(0) |
| INF | -8.199955<br>(-2.963972) | -8.826284<br>(-3.568379) | I(1) |
| BOP | -5.248008<br>(-2.960411) | -6.565867<br>(-3.562882) | I(0) |
| U | -4.883083<br>(-2.963972) | -5.748124<br>(-3.568379) | I(1) |
| PIG | -9.016578<br>(-2.960411) | -11.06200<br>(-3.562882) | I(0) |

- Source: Prepared by the researcher based on the statistical program "10" EViews
- The program EViews "10" calculates the tabular value (τ=t) at the level of significance (5%) placed between the brackets.

The table shows us that the variables of unemployment and inflation are unstable in their initial state, but after taking the initial differences, the series becomes stable and integrated, while the growth rate of individual income, gross domestic product and balance of payments stabilizes in its initial state "Level" and at a level of significance of 5%, whether by including constant or Constant and direction, meaning the null hypothesis that states the existence of a unit root will be fulfilled, because the value (τ) is smaller than the tabular value.

**Third - Results of the test for homogeneity, serial correlation and normal distribution**

In order to ensure that the standard model used in the study is free of standard problems, diagnostic tests (Normality test, LM Test, Breusch-Pagan-Godfrey) must be performed.

**Table (3) Diagnostic tests**

| | | | |
|---|---|---|---|
| Breusch-Godfrey Serial Correlation LM Test | | | |
| F-statistic | 8.063231 | Prob. F | 0.2416 |
| Obs*R-squared | 0.2416 | Prob. Chi-Square | 0.5200 |
| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
| F-statistic | 9.565537 | Prob. F | 0.4340 |
| Obs*R-squared | 27.63882 | Prob. Chi-Square | 0.2756 |
| Scaled explained SS | 0.235582 | Prob. Chi-Square | 1.0000 |
| Histogram Normality Test | | | |
| Jarque-Bera | 0.363701 | Probability | 0.833726 |

• Source: prepared by the researcher based on the statistical program "10" EViews

The results indicate that the value of Jarque-Bera is higher than the value of the significance level set at 5%, and therefore that the data follow a normal distribution, as well as that the model is free from the problem of the existence of a serial correlation and heterogeneity because the probability values for both tests amounted to 0.2 and 0.4, respectively, which are greater than the values of F Therefore, the null hypothesis cannot be rejected, and the study model does not suffer from sequential autocorrelation and variation in errors.

**Fourth- Estimation of the Distributed Deceleration Autoregressive Distribution Model (ARDL)**

**Table (4) Limit test and estimate the long- and short-term relationship**

| Test Statistic | Value | I(0) | I(1) | K | Sig* |
|---|---|---|---|---|---|
| F-Bounds Test | 4.71314 | 2.86 | 4.01 | 4 | 5% |
| t-Bounds Test | -4.631089 | -2.86 | -4.36 | 4 | 5% |
| ARDL Long Run | | | | | |
| Variable | Coefficient | Std. E | t-Statistic | | Prob |
| BOP effect on PIG | -0.010878 | 0.047736 | -0.227868 | | 0.8344 |
| GDP effect on PIG | 0.953769 | 0.006702 | 142.3187 | | 0.0000 |
| INF effect on PIG | -0.005757 | 0.000732 | -7.860605 | | 0.0043 |
| U effect on PIG | -0.555037 | 0.095918 | -5.786584 | | 0.0103 |

It is clear from the value of the F-Bounds Test that there is a long-term relationship. When comparing the statistical value of F with the values of the boundary limits, we find that the statistical F value of 4.7 is greater than the critical values at I(0) and I(1) at the level of significance of 5%, and this It confirms the existence of a long-term equilibrium relationship between the variables of the study, which requires rejecting the null hypothesis and accepting the alternative hypothesis. logical relationship.

The high rates of inflation in the Iraqi economy led to a negative impact on the per capita income, as the rise in the general level of prices led to a decrease in the purchasing power of the local currency and thus affected the per capita income in a negative way, as it appears from the results that economic growth is strongly correlated with per capita income. The rate of economic growth by one unit leads to a rise that leads to a rise in per capita income by 95%. As for the unemployment rate, it is inversely related to per capita income. Whenever the unemployment rate rises, this will lead to a significant decrease in the average per capita income.

**Table (5) Short-term test and error correction**

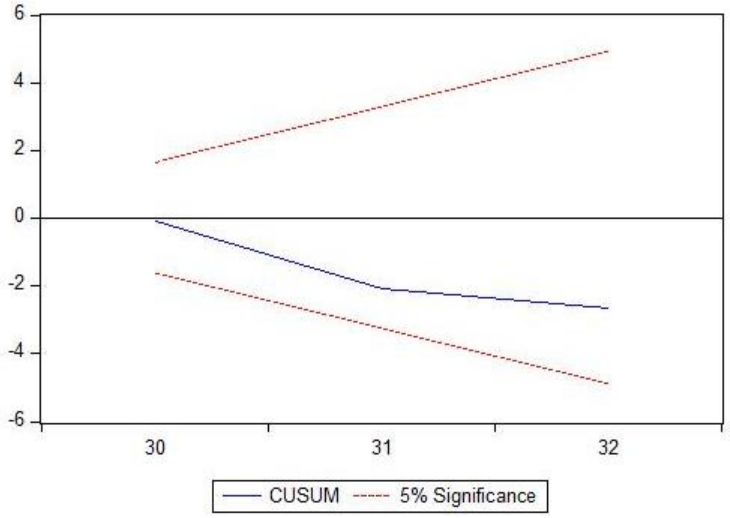
| Variable | Coefficient | Std. Error | t-Statistic | Prob . |
|---|---|---|---|---|
| C | -1.569426 | 0.070644 | -22.21611 | 0.0002 |
| D(PIG(-1)) | 0.990015 | 0.066716 | 14.83928 | 0.0007 |
| D(PIG(-2)) | 0.570633 | 0.128810 | 4.430034 | 0.0214 |
| D(PIG(-3)) | -1.042605 | 0.088516 | -11.77870 | 0.0013 |
| D(INF) | 0.000161 | 8.55E-05 | 1.888445 | 0.1554 |
| D(INF(-1)) | 9.47E-05 | 6.34E-05 | 1.492854 | 0.2323 |
| D(INF(-2)) | 0.000642 | 5.58E-05 | 11.50524 | 0.0014 |
| D(INF(-3)) | 0.000512 | 6.20E-05 | 8.249646 | 0.0037 |
| D(GDP) | 0.973910 | 0.000243 | 4011.022 | 0.0000 |
| D(GDP(-1)) | -0.958603 | 0.065106 | -14.72372 | 0.0007 |
| D(GDP(-2)) | -0.550650 | 0.125216 | -4.397585 | 0.0218 |
| D(GDP(-3)) | 1.017830 | 0.086531 | 11.76254 | 0.0013 |
| D(BOP) | 0.017093 | 0.000951 | 17.97323 | 0.0004 |
| D(BOP(-1)) | 0.013472 | 0.001437 | 9.376711 | 0.0026 |
| D(BOP(-2)) | 0.009911 | 0.000753 | 13.17005 | 0.0009 |
| D(BOP(-3)) | 0.017461 | 0.001494 | 11.69063 | 0.0013 |
| D(U) | -0.130317 | 0.014840 | -8.781416 | 0.0031 |
| D(U(-1)) | -0.294790 | 0.015635 | -18.85421 | 0.0003 |
| D(U(-2)) | -0.225569 | 0.015428 | -14.62074 | 0.0007 |
| D(U(-3)) | -0.105341 | 0.013635 | -7.725868 | 0.0045 |
| CointEq(-1) | -0.226047 | 0.010179 | -22.20733 | 0.0002 |
| F-sta(Prob) | | 204(0.000) | $R^2$ | 0.97 |
| D-Watson | | 266731 2. | Akaike | -5.04 |

The value of the error correction coefficient appeared negative and significant, and this indicates the existence of a correction relationship from the short to the long run at a speed of 22.6% of the imbalance in the previous year is due to equilibrium in the current year, and this means that we will obtain the balance in the short term completely within a period of about Approximately four and a half years, the ratio of the coefficient of determination shows us that 97% of the effects on economic growth rates are due to the effect of economic stability variables (inflation, economic growth, unemployment, balance of payments), and this is a very large percentage of it, only 3% of changes in Growth rates are due to the effects of other variables that were not included in the study model.

It is also clear from the table that the value of D-Watson It is located in the acceptance region and therefore we accept the null hypothesis which says that there is no linear autocorrelation between random errors and we reject the alternative hypothesis which states that there is a linear autocorrelation between random errors, and the value of F appears at a significant level of significance and this means that the estimated model as a whole is significant and statistically acceptable.

After testing the error correction factor from the long term to the short term, the cumulative sum of the follow-up residuals (CUSUM) is applied to show the structural stability of the model parameter (Dizaji, 2012, 28) as in the following figure:

**Figure (3) Structural stability test results**




The figure shows the fulfillment of the morality condition to test the structural independence of the model parameters in the UECM format for the ARDL model, as the CUSUM value lies within the critical limits and at a significant level of 5%, which is the economically acceptable limit, and this means that the model is structurally stable.

## 8 Conclusions & Suggestions

**First: Conclusions**

1- The negative impact of both the unemployment rate and inflation on the per capita income rate, and therefore effective policies must be developed to address these two variables, and this hypothesis of the study is achieved.

2- The existence of a long-term relationship between the variables of economic stability and the growth rate of individual income.

3- It is clear from the limit test according to the ARDL model that the long-run equilibrium relationship is a logical relationship.

4- We reach full equilibrium within a period of approximately four and a half years according to the error correction factor.

**Second: Suggestions**

1- Addressing unemployment by diversifying the structure of the productive economy and not relying on oil revenues only as a source of state funding, drawing up a new economic policy and making structural changes.

2- Take all necessary measures to address inflation and work to raise economic growth rates because of its significant impact on per capita income.

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