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Economic Growth, Inflation and Unemployment. An Empirical Evidence using the ARDL approach from Tunisia, Egypt and Saudi Arabia

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ABSTRACT

This paper investigates the relationship between inflation, unemployment and economic growth in Tunisia, Egypt and Saudi Arabia over the period 1989-2021. This paper attempts to study the effect of inflation and unemployment on short- and long-term economic growth for countries affected by the political upheavals of the Arab Spring such as Tunisia and Egypt, and the example of Saudi Arabia as a country affected by instability in the energy market and the covid 19 pandemic. It begins with the application of Augmented Dickey-Fuller techniques to examine the unit root property of the time series data after which Auto-regressive Distributive Lag Model (ARDL) was used to determine the cointegration or long-run relationship. The existence of the long-term relationship between the variables is validated by the ARDL approach. The results suggest that there is a long-term equilibrium relationship whose growth is explained by un-employment in the case of Tunisia. The results validate the unemployment persistence effect for Egypt. The results also show that unemployment in the previous period constitutes a stimulus for current growth. For the inflation rate, the results show that the relationship is statistically insignificant for Egypt and Tunisia, but it significantly affects the growth of Saudi Arabia, which benefits from increases in commodity prices.

INTRODUCTION

In recent decades, researchers have been preoccupied with re-examining the main factors of economic growth as well as studying certain relationships that have been widely discussed by the different schools of economic theory. In this respect, inflation, unemployment and their impacts on economic growth have been studied considerably as these economic characteristics have explicitly undergone repercussions related to structural and cyclical changes in all developed and developing countries. A better

recognition of the effect of inflation and unemployment on a country's economic growth helps to achieve the goals of more appropriate resource allocation and sustained improvement in welfare.

The Middle East North Africa (MENA) countries have been marked by political shocks triggered by the Arab Spring and combined with a difficult external environment caused by the effects of the covid 19 pandemic that affected all sectors, affecting their economic performance. Economic growth has slowed down and has been accompanied by a continuous increase in unemployment and inflation.

Figures 1, 2 and 3 below show that the instability of economic growth has been more pronounced in recent years, with low or even negative rates. Since then, countries such as Tunisia and Egypt, with political stability problems, and Saudi Arabia, with economic problems linked to instability in the energy market and the covid 19 pandemic, have experienced a sustained weakening of their currencies, leading to inflationary spirals. The reforms undertaken by these countries, which aim to restore macroeconomic stability, are leading to an increase in the rate of inflation and unemployment.

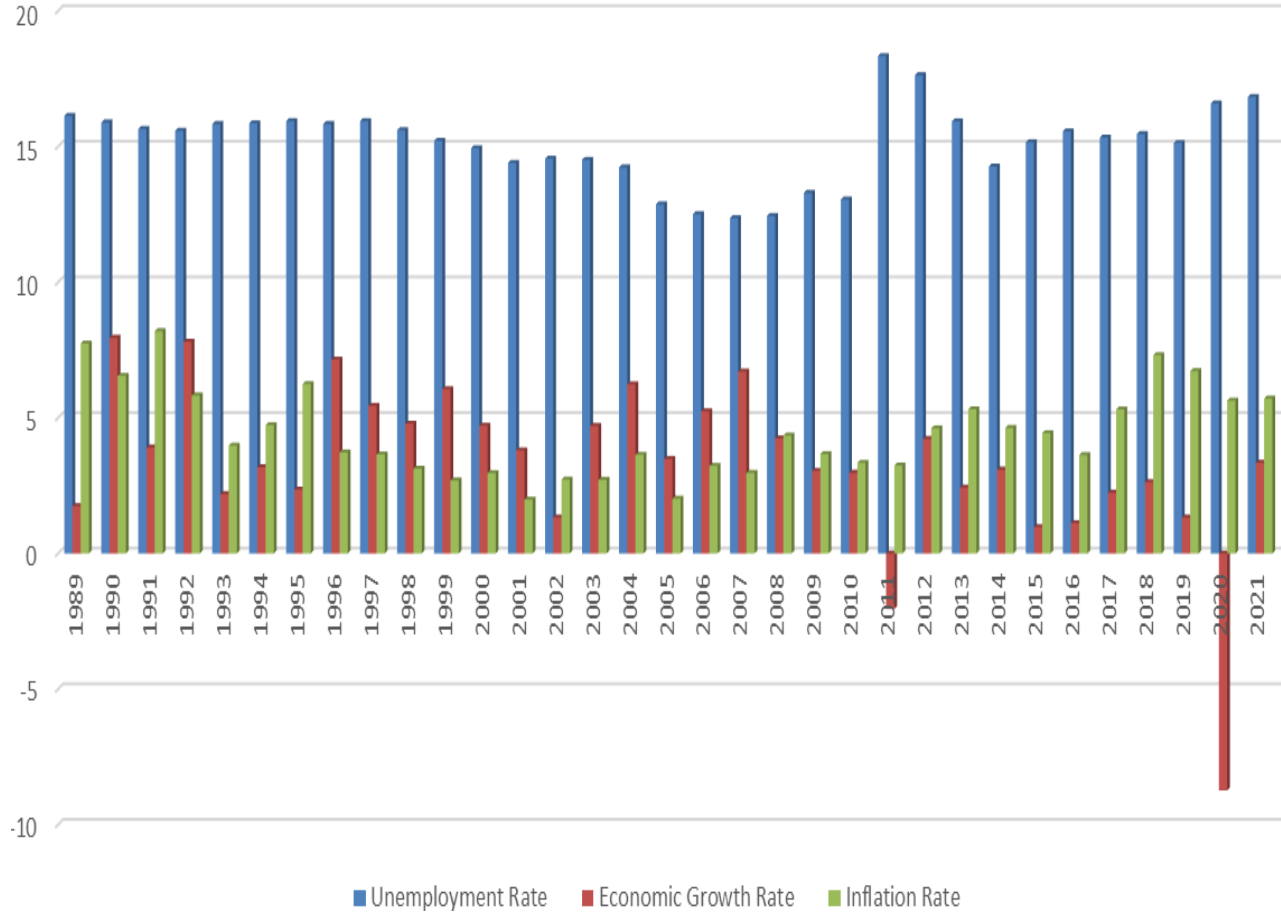

Figure 1. Evolution of the Unemployment Rate, Economic Growth Rate and Inflation Rate in Tunisia between 1989 and 2021.

Source: ILOSTAT, WB, OECD and IMF.

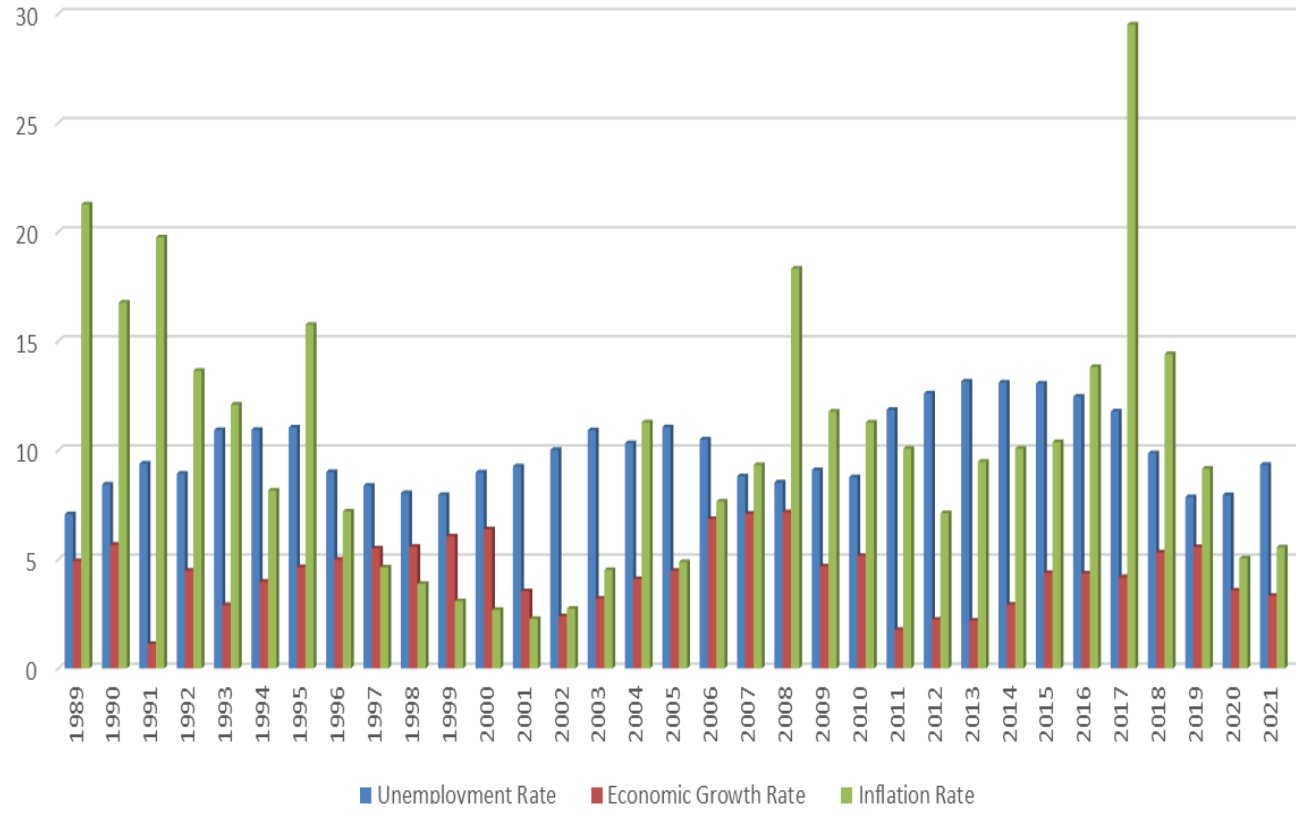

Figure 2. Evolution of the Unemployment Rate, Economic Growth Rate and Inflation Rate in Egypt between 1989 and 2021.

Source: ILOSTAT, WB, OECD and IMF.

Figure 3. Evolution of the Unemployment Rate, Economic Growth Rate and Inflation Rate in Saudi Arabia between 1989 and 2021.

Source: ILOSTAT, WB, OECD and IMF.

This paper attempts to study the effect of inflation and unemployment on short- and long-term economic growth for countries affected by the political upheavals of the Arab Spring such as Tunisia and Egypt, and the example of Saudi Arabia as a country affected by instability in the energy market and the covid 19 pandemic. The article is structured as follows: the first section presents the literature review on the growth-inflation, growth-unemployment and inflation-unemployment relationships. The second section will be devoted to the presentation of the empirical analysis, methodology and results. The last section concludes the paper.

1. LITTERATURE REVIEW

A large theoretical literature has revealed a general interest in the relationships between economic growth, inflation and unemployment. In this section, we review the most important works in this literature. We proceed by presenting three subsections, namely (1) economic growth and inflation; (2) economic growth and unemployment; and (3) inflation and unemployment.

1.1 Relationship Between Economic Growth and Inflation

The relationship between economic growth and inflation has been widely studied in the economic literature with mixed results. Indeed, several works have shown that inflation is a constraint to growth and that this relationship is negative. Others have validated the existence of a threshold effect, that this relationship changes sign above a certain threshold ((Fischer 1983); (Barro 1995); (Gylfason and Herbertsson 2001); (Burdekin et al. 2004); (Gillman, Harris, and Mátyás 2004); (Gillman and Kejak 2005); (Kremer, Bick, and Nautz 2013). However, others indicate that inflation is growth-enhancing ((Mallik and Chowdhury 2001); (Rapach 2003), (Benhabib and Spiegel 2009)). A fourth group of works have shown that inflation has no impact on economic growth ((Wai 1959); (Dorrance 1966); (Sidrauski 1967)).

Gylfason and Herbertsson (2001) used a panel covering 170 countries over the period 1960-1992, to show that inflation negatively affects economic growth. They estimated a theoretical model in which inflation affects economic growth through savings, the real interest rate and the velocity of money.

Fisher (1983) is the first work that proves the existence of a threshold effect. He suggests that there is a non-linear relationship between inflation and economic growth in that low inflation rates argue for increased growth, but as inflation increases, this effect becomes negative.

Bruno and Easterly (1998) confirmed this result, proving the negative effect of high inflation rates but doubting the positive effect of low inflation. They found that for high inflation rates the relationship between inflation and economic growth is negative, but not for low rates. They showed that there is no conclusive evidence of the relationship when inflation rates are very low (Bruno and Easterly 1998).

Gillman and Kejak (2005) showed that when inflation increases, the cost of trading goods increases, which creates a substitution effect of consumption by leisure and thus leads to a negative effect of inflation on economic growth.

Using an Autoregressive Distributed Lag (ARDL) model Mohseni and Jouzaryan (2016) examined the effect of inflation on economic growth in Iran during the period of 1996 to 2012. They showed that inflation significantly and negatively affects economic growth in the long run (Mohseni and Jouzaryan 2016). Similar results were found by Bittencourt (2012), who used time series data for the period between 1970 and 2007 to show that inflation has a negative effect on growth in four Latin American countries (Bittencourt 2012).

1.2 Relationship Between Economic Growth and Unemployment

According to the International Labour Organization (ILO) the unemployed is an economically productive person who is not in work and is seeking employment, including those who have lost or voluntarily left their

jobs (Organization 1998). The unemployment rate is the percentage of people looking for work at a given time (Bank 1998).

The control of inflation and unemployment has an important role in economic development, which has been widely discussed by economists. However, the mechanisms of effectiveness and the short- and long-term effects of inflation and unemployment on economic growth have not been thoroughly examined and are still subject to theoretical and empirical discussion. Indeed, despite the wealth of research on the link between economic growth and unemployment, there is little consensus on the meaning and intensity of the relationship. Okun's law is among the first scientific relationships that link productivity (growth) to unemployment. It is the best-known relationship in macroeconomic theory and has been validated for several countries and even regions, including emerging countries ((Okun 1962); (Lee 2000); (Farsio and Quade 2003); (Christopoulos 2004).

Okun (1962) is theoretically based on the idea that an increase in the labor force would result in an increase in the production of goods and services. Furthermore, he found that when the real growth rate was high, the unemployment rate decreased, whereas it increased when the real growth rate was low or even negative.

According to the same study, when GDP grows exponentially, the unemployment rate falls. When growth is low or negative, the unemployment rate increases and when growth is close to its potential level, the unemployment rate remains constant. In fact, most of the studies on the subject have been carried out to test the validity of Okun's rule.

The relationship between growth and unemployment varies in two directions, on the one hand, growth can be positively related to unemployment in case the high growth rate would accelerate the creative distribution effect. On the other hand, a high rate of growth will lead to a decrease in the capitalization rate from which there will be an increase in the incentive to invest and thus a decrease in unemployment.

Jackman, Pissarides, and Savouri (1990) has analyzed the impact of an increase in productivity on the equilibrium unemployment rate; he suggests that an increase in the growth rate increases the present value of profits generated by the creation of a niche of new jobs leading firms to open more vacancies and therefore probably reduce unemployment. This capitalization effect is not the only consequence of high growth, however (Jackman, Pissarides, and Savouri 1990).

Aghion and Howitt (1990) suggest that when there is an increase in productivity, through creative destruction, low productivity activities would be replaced by higher productivity activities generating an increase in unemployment. This reallocation effect therefore acts in the opposite direction to the capitalization effect (Aghion and Howitt 1990).

Aghion and howitt (1994) show that the reallocation effect dominates in case of high growth, leading to an important relationship between growth and unemployment (Aghion and Howitt 1994).

Examining Okun's law in the case of the Spanish economy over the period 1980-2004, Villaverde and Maza (2008) concluded that it still applies to most Spanish regions and to the country. They showed that there is an inverse relationship between unemployment and output (Villaverde and Maza 2008).

Tiryaki and Özkan (2011) used quarterly data covering the period 1998:1-2010:4 to study the growth-unemployment relationship in Turkey. This study found that there is a unidirectional causality from GDP change to unemployment but less proportional. Furthermore, they found that after periods of recession, the recovery of economic activity did not have the same magnitude in reducing unemployment (Tiryaki and Özkan 2011).

Kemi and Dayo (2014), based on Okun's law (1962), found that unemployment is negatively related to economic growth. They suggest, therefore, that changes in total demand affect agricultural production technology, which in turn affects the demand for labour, thus altering the unemployment situation of a country. Economists have taken note of this model, not only for its high methodological consistency, but also for its importance as a component of macroeconomic construction (MUHAMMAD et al. 2014).

Odo et al (2016) used several econometric techniques (cointegration test vector error correction model (VECM) and the Granger causality test) to investigate the long-run economic growth-unemployment

relationship in Nigeria during the period 1980-2015. The study revealed that unemployment has a negative and significant impact on GDP and that there is a unidirectional relationship between unemployment and GDP with the direction of causality running from economic growth to unemployment (Odo et al. 2016).

However, Conteh (2021) confirmed the existence of the unidirectional causal link between unemployment and economic growth but found that the causality does not have the same direction, going from unemployment to economic growth. They used the (ARDL) and ECMARDL models for annual data from Greece over the period between 1995 and 2015 (Conteh 2021).

1.3 Relationship Between Inflation and Unemployment

The Most studies of the inflation-unemployment relationship have been associated with confounding results associated with the fact that the nature of this relationship is ambiguous. Indeed, although a negative relationship has been found between inflation and unemployment in the theoretical literature, empirical studies have not confirmed this relationship.

Phillips (1958) studied the relationship between unemployment and the rate of change of wages in the UK 1861-1957 and showed that there is an explicit link between unemployment and inflation, when the unemployment rate was high, inflation was low and vice versa (Phillips 1958). This relationship was supported by Samuelson and Solow (1960) in their study of unemployment in the US (Samuelson and Solow 1960). Other studies adopted this Phillips curve relationship which was confirmed by Solow (1970) and Gordon, Brainard, and Juster (1971) who validated this negative relationship between unemployment and inflation in the US, using data before and after 1970 ((Solow 1970) ; (Gordon, Brainard, and Juster 1971)).

This relationship was challenged in the 1960s. Indeed, Friedman (1968) considers that it cannot be valid in the long run because:

- the natural or equilibrium rate of unemployment is determined in relation to structural factors specific to the economy and the labour market.
- expansionary monetary policies are neutral in the long run.

In the short run, these policies only lower the rate of unemployment below its equilibrium level, lead to an inflationary spiral due to the expectations of the economic agents which neutralizes this increase, and thus this policy has an effect on the long run rate of unemployment. It is possible to read the Friedmannian critique as the substitution of a negative relationship between the unemployment rate and the inflation evolution for the usual negative relationship between inflation and unemployment (Friedman 1970).

A renewal of the Phillips curve took place in the mid-1990s thanks to the New Keynesians' analysis of monetary policy. This thinking presents inflation as a phenomenon directly associated with the optimistic behavior of economic agents that is forward-looking.

Karanassou, Sala and Snower (2010) suggest that the interactions between changes in output and unemployment depend on monetary fluctuations and thus on inflationary effects (Karanassou, Sala, and Snower 2010).

Zabihi and Lotfi (2012) examined the relationship between the unemployment rate, inflation and potential output growth. This study is based on the estimation of Okun's law and the Phillips curve using an unobserved component model. In this method, the key unobservable economic variables were recorded as unobserved random processes in a system with three variables: unemployment rate, growth rate and inflation. The results validate the existence of a negative relationship between the variation of the output gap growth and the variation of the unemployment rate with respect to inflation (Zabihi and Lotfi 2012).

Yelwa et al (2015) showed the existence of a negative effect of unemployment and inflation on economic growth for the case of Nigeria over the period 1987-2012. The results lead to the conclusion that the Nigerian government is called upon to improve the effectiveness of economic policy instruments to

further stabilize an economic environment that allows for increased domestic production (Yelwa, David, and Awe 2015).

In a similar study, Mohseni and Jouzaryan (2016) examined the relationship between inflation, unemployment and economic growth in Iran for the period 1996-2012. The results of the study revealed a negative effect of inflation and unemployment on economic growth in both the short and long term (Mohseni and Jouzaryan 2016).

2. EMPIRICAL ANALYSIS, METHDOLOGY AND RESULTS

The aim of this paper is to examine the relationship between economic growth, inflation and unemployment for the two countries most affected by the Arab Spring namely Tunisia, Egypt and the example of Saudi Arabia as a country affected by instability in the energy market and the covid 19 pandemic over the period 1989-2021.

In this article, in addition to the main variables:

- the economic growth rate measured by the growth of GDP per capita in constant dollars.
- the inflation rate measured by the GDP deflator % per year.
- the unemployment rate measured as the percentage of unemployed in relation to the active population.

Data for these variables are taken from the World Bank's World Economic Indicators database and its various sources.

Table 1. The main Variables, Period and Sources.

Variables	*Period*	*Sources*
U: Unemployment rate (% of labour force) (national estimate)	1989-2021	International Labour Organization, ILOSTAT database.
G: GDP growth (annual %)	1989-2021	World Bank national accounts data, and OECD National Accounts data files.
inf_IPC: Inflation, consumer prices (annual %)	1989-2021	International Monetary Fund, International Financial Statistics and data files.

Source: Own study ILOSTAT, WB, OECD and IMF

3. STATIONARITY STUDY AND MODEL SPECIFICATION

The choice of the estimation method and the specification of the form of the model presupposes that the statistical properties of the series are known. Thus, the first step is to examine the stationarity of the series to define their order of integration. This step is crucial, because the use of non-stationary time series will lead to spurious regressions ((Harris and Sollis 2003); (Alimi 2014)). This results in the T-statistics of the coefficients being highly significant and the F-statistic being insignificant, with a very low coefficient of determination (R2), higher than the Durbin Watson (DW) statistic and committing a high frequency of type 1 errors (Granger and Newbold 1974). For this reason, unit root tests are applied, such as the Augmented Dickey Fuller (ADF) test (1979; 1981) ((Dickey and Fuller 1979); (Dickey and Fuller 1981)) and the Phillips Perron (PP) test (1988) ((Phillips and Perron 1988)). This passage also allows us to choose the appropriate estimation techniques in accordance with the level of stationarity of the variables. In this respect, the Augmented Dickey and Fuller ADF (1979) and Phillips and Perron PP (1988) tests have been widely used to determine the level of stationarity of variables.

Table 2. Stationarity study for the case of Tunisia

Variables	*P_value: ADF test*	*Ordre of integration*
U	0.4672	I(1)
G	0.0000	I(0)
INF_PC	0.2916	I(1)

Source: Own study.

Table 3. Stationarity study for the case of Egypt

Variables	*P_value: ADF test*	*Ordre of integration*
U	0.0031	I(0)
G	0.0120	I(0)
INF_PC	0.1152	I(1)

Source: Own study.

Table 4. Stationarity study for the case of Saudi Arabia

Variables	*P_value: ADF test*	*Ordre of integration*
U	0.8937	I(1)
G	0.0044	I(0)
INF_PC	0.0896	I(1)

Source: Own study.

The results of the unit root tests, mainly the ADF (Augmented Dickey-Fuller) test, applied to the variables at table level 1, 2 and 3, show that the variables are of mixed integration order I(0) and I(1). Such results verify the necessary condition for the application of the cointegration technique according to the Pesaran, Shin and Smith (2001) ARDL (Auto Regressive Distributed Lag) model which requires that the dependent variable and the explanatory variables are of mixed integration order to be I(1) or I(0) ((Pesaran, Shin, and Smith 2001)). Therefore, the statistical characteristics of the variables provide information on the existence of a cointegration relationship according to an unconstrained error correction model of Pesaran, Shin and Smith (2001) or ARDL (Auto Regressive Distributed Lag) model.

The ARDL model (autoregressive model with staggered delays) proposed by Pesaran and Shin (1998) (Pesaran and Shin 1998) and Pesaran et al (2001) makes it possible, on the one hand, to test long-term relationships using the bounds test on series which are not integrated of the same order and, on the other hand, to obtain better estimates on small sample sizes (Kumar Narayan* and Narayan 2005). Thus, the ARDL makes it possible to simultaneously process long-term dynamics and short-term adjustments. Compared to other cointegrating approaches, ARDL addresses potential issues of autocorrelation and endogeneity in the model. Moreover, the ARDL approach provides efficient and consistent results when the sample is small. Finally, a dynamic error correction model can be derived from the ARDL method by a simple linear transformation.

4. ESTIMATIONS AND RESULTS

The results of the ADF (Augmented Dickey-Fuller) unit root tests suggest the existence of a long-term equilibrium relationship between the different variables of the model. This results in the possible existence of cointegration relations between them and a stationary combination would exist between the level variables.

The approach generally used to estimate an ARDL consists of the following steps:

- Estimate the chosen model according to the Akaike information criterion,
- Perform the Long-term relationship existence test using the Bound test.
- Estimation of relationship with the error correction term.
- Perform the necessary tests (the CUSUM stability test and CUSUM squares).
- Reject or accept and interpret the model.

So, we will examine the validity of the relationship between economic growth, the unemployment rate and inflation.

The general form of an ARDL, for our model, is written:

$$d(Y_t) = \underbrace{c + \sum_i^p \lambda_i Y_{t-i} + \sum_i^k \beta_i X_{t-i}}_{(a)} + \underbrace{\sum_{i=1}^p a_i\, D(Y_{t-i})}_{(b)} + \underbrace{\sum_{i=0}^k b_i\, D(X_{t-i})}_{(c)} + \varepsilon_t \quad (1)$$

The equation contains three components of which the first (a) is the long-term relationship, the second (b) is the short-term adjustment by the "p" lags of the dependent variable economic growth and the third (c) it is the short-term adjustment by the “k” lags of the explanatory variables.

$$d(growth_t) = c + \sum_i^p \lambda_i G_{t-i} + \sum_i^k \beta_i U_{t-i} + \sum_i^r \beta_i Inf\_PC_{t-i} + \sum_{i=1}^p a_i\, D(Y_{t-i}) + \sum_{i=0}^k b_i\, D(U_{t-i}) + \sum_{i=0}^r c_i\, D(Inf_{t-i}) + \varepsilon_t \quad (2)$$

$$d(U_t) = c + \sum_i^p \lambda_i U_{t-i} + \sum_i^k \beta_i G_{t-i} + \sum_i^r \beta_i Inf\_PC_{t-i} + \sum_{i=1}^p a_i\, D(U_{t-i}) + \sum_{i=0}^k b_i\, D(G_{t-i}) + \sum_{i=0}^r c_i\, D(Inf\_PC_{t-i}) + \varepsilon_t \quad (3)$$

$$d(Inf_t) = c + \sum_i^p \lambda_i Inf\_PC_{t-i} + \sum_i^k \beta_i G_{t-i} + \sum_i^r \beta_i U_{t-i} + \sum_{i=1}^p a_i\, D(Inf\_PC_{t-i}) + \sum_{i=0}^k b_i\, D(G_{t-i}) + \sum_{i=0}^r c_i\, D(U_{t-i}) + \varepsilon_t \quad (4)$$

Where,

- “d” denotes the first difference operator.
- “εt” the error term assumed to be independently and identically distributed. To estimate the parameters of equations (2), (3) and (4).
- P, k and r: optimal delay number.

Once the cointegration has been established, we proceed to estimate the long-term relationship, which will take the following form:

$$growth_t = cte + \sum_i^p \lambda_i G_{t-i} + \sum_i^k \beta_i U_{t-i} + \sum_i^r \gamma_i Inf\_PC_{t-i} + \varepsilon_t$$

The dynamic error correction model which can be derived from the long-term equation resulting from the ARDL model integrates the short-term dynamics with the long-term equilibrium will take the following form:

$$d(growth_t) = cte + \sum_{i}^{p} a_i d(G_{t-i}) + \sum_{i}^{k} b_i d(U_{t-i}) + \sum_{i}^{r} c_i Inf\_PC_{t-i} + \alpha CointEq_{t-1} + \varepsilon_t$$

With {CointEq}_{t-1} represents the lagged error correction term of the long-term cointegrating equation its coefficient which indicates the speed of adjustment towards the long-term equilibrium state must be negative and statistically significant. In this article, we will examine the relationships for the three cases studied, Tunisia first and then the same approach for the case of Egypt and Saudi Arabia.

4.1 The Case Of Tunisia

The null hypothesis of no cointegration is rejected when the calculated F-statistic is greater than the Upper bound. However, we accept the null hypothesis if the calculated F is below the lower bound. Finally, the decision is indeterminate when the value of F is between the lower bound and the upper bound.

Table 5. Results of the ARDL cointegration test for the case of Tunisia Bounds testing to cointegration

Estimated models	*Optimal form*	*F-statistic*	
(1) G/ U, Inf_PC	Selected Model: ARDL(1, 1, 4)	9.616578	
(2) U/ G, Inf_PC	Selected Model: ARDL(1, 0, 0)	4.028727	
(3) Inf_PC/ G, U	Selected Model: ARDL(4, 3, 0)	3.987998	
For T=33			
	Significance	*Lower bound*	*Upper bound*
	1%	4.13	5
	2.5%	3.55	4.38
	5%	3.1	3.87
	10%	2.63	3.35
The optimal shape is obtained based on AIC Akaike Information Criteria			

Source: Own study.

The results in Table 5 show the existence of a cointegration vector between the variables examined. The null hypothesis of no cointegration is rejected at 1% for model (1). The results confirm a long-term relationship between GDP per capita growth, inflation and unemployment. The optimal model according to the SIC criterion is ARDL (1, 1, 4) the relationship contains a single lag for the dependent variable, a single lag for the first explanatory variable and four lags for the second.

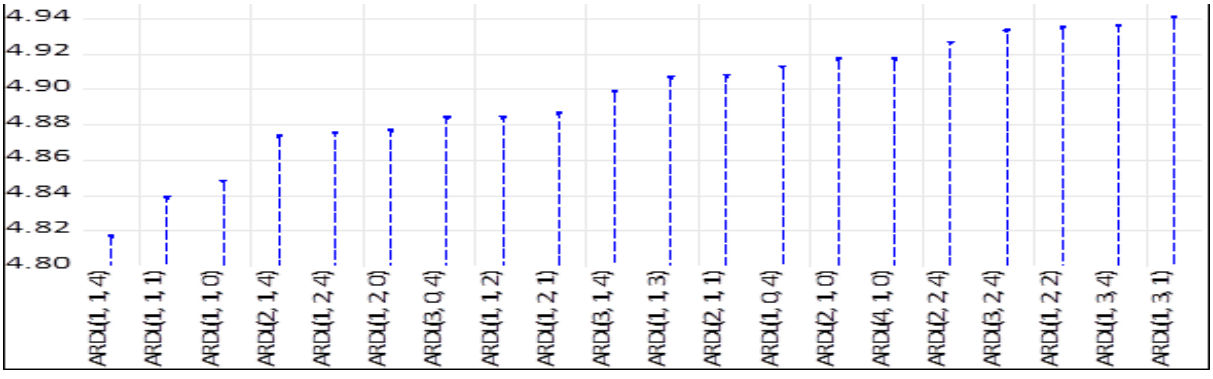

Figure 4. Estimation of the model chosen according to the Akaike information criteria (top 20 models)

Source: The authors

Once the cointegration is established, we proceed to estimate the long-term relationship which will take the following form:

$$G_t = cte + \sum_{i}^{p} \lambda_i G_{t-i} + \sum_{i}^{k} \beta_i U_{t-i} + \sum_{i}^{r} \gamma_i Inf\_PC_{t-i} + \varepsilon_t$$

With, p = 1, k = 1 and r = 4

Table 6. Results for the long-term relationship for the case of Tunisia

Dependent Variable: G			
Method: ARDL			
Sample (adjusted): 1993 2021			
Included observations: 29 after adjustments			
Model selection method: Akaike info criterion (AIC)			
Selected Model: ARDL(1, 1, 4)			
Variable	*Coefficient*	*t-Statistic*	*Prob.**
C	11.95217	1.883433	0.0743
G(-1)	-0.091790	-0.507306	0.6175
U	-1.245682	-2.703411	0.0137
U(-1)	0.866181	1.894101	0.0728
INF_PC	-0.619755	-1.256620	0.2234
INF_PC(-1)	-0.258726	-0.470785	0.6429
INF_PC(-2)	-0.653581	-1.310582	0.2049
INF_PC(-3)	-0.033417	-0.063097	0.9503
INF_PC(-4)	0.853401	1.855792	0.0783
R-squared	0.554873		
F-statistic	3.116376		
Prob(F-statistic)	0.018648		

Source: Own study.

The results for the case of Tunisia Table 5 indicate that in the long-term relationship, a 1% decrease in the unemployment rate will lead to a 1.24% increase in the growth rate. The results also show that for Tunisia the growth of the current year is positively affected by the unemployment rate of the previous period. For the inflation rate, the results show that the relationship is statistically insignificant.

The dynamic error correction model which can be derived from the long-term equation resulting from the ARDL model integrates the short-term dynamics with the long-term equilibrium will take the following form:

$$d(G_t) = cte + \sum_{i}^{p} a_i d(G_{t-i}) + \sum_{i}^{k} b_i d(U_{t-i}) + \sum_{i}^{r} c_i Inf\_PC_{t-i} + \alpha CointEq_{t-1} + \varepsilon_t$$

With {CointEq}_{t-1} representing the lagged error correction term of the long-term cointegrating equation its coefficient which indicates the speed of adjustment towards the long-term steady state must be negative and statistically significant.

Table 7. Short-term dynamics with the error correction coefficient case of Tunisia

ARDL Error Correction Regression Dependent Variable: D(G) Selected Model: ARDL (1, 1, 4) Case 2: Restricted Constant and No Trend Sample: 1989 2021			
Variable	Coefficient	t-Statistic	Prob,
D(U)	-1.245682	-3.353158	0.0032
D(INF_PC)	-0.619755	-1.414037	0.1727
D(INF_PC(-1))	-0.166403	-0.439493	0.6650
D(INF_PC(-2))	-0.819984	-2.104081	0.0482
D(INF_PC(-3))	-0.853401	-2.083113	0.0503
CointEq(-1)*	-1.091790	-6.651034	0.0000
R-squared	0.735284		

Source: Own study.

The recursive residual tests of structural stability (CUSUM) and the test (CUSUM squares). The CUSUM graph showed that the regression equation is stable since the CUSUM test statistic and CUSUM squares do not cross the limits at the 5% significance level.

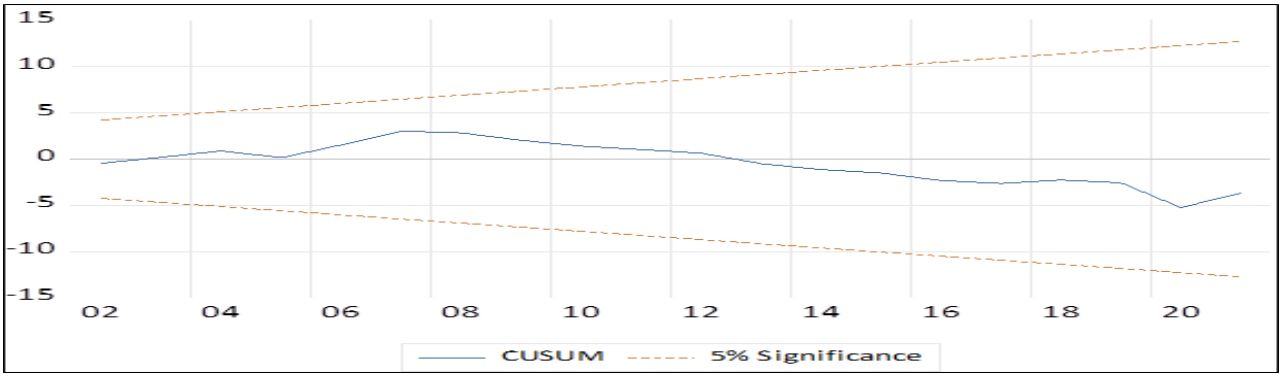

Figure 5. Results of CUSUM stability test. Source: The authors.

For the short-term relationship {CointEq}_{t-1}is negative and statistically significant. The estimated relationship means that the short-term dynamic is very far from equilibrium. Indeed, according to the estimated equation the deviations from the long-term equilibrium are adjusted by more than 109% each year such a result can be explained by the transition period and that the adjustment is made in a way arbitrary by the intervention of the government which has created overstaffed jobs in the public sector (Mahfoudh and Gmach 2021).

4.2 The Case of Egypt

The results in Table 7 show the existence of a cointegration vector between the variables examined. The null hypothesis of no cointegration is rejected at 1% for models (2). The results confirm a long-term relationship between the unemployment rate as a function of the GDP growth rate and the inflation rate.

Table 8. Results of the ARDL cointegration test for the case of Egypt Bound*s testing to cointegration*

Estimated models	*Optimal form*	*F-statistic*	
(1) G/ U, Inf_PC	Selected Model: ARDL(4, 2, 3)	4.956805	
(2) U/ G, Inf_PC	Selected Model: ARDL(1, 0, 1)	9.145780	
(3) Inf_PC/ G, U	Selected Model: ARDL(1, 0, 0)	3.481247	
For T = 33			
	Significance	*Lower bound*	*Upper bound*
	1%	4.13	5
	2.5%	3.55	4.38
	5%	3.1	3.87
	10%	2.63	3.35
The optimal shape is obtained on the basis of AIC Akaike Information Criteria			

Source: Own study.

The optimal model according to the criterion of SIC is ARDL (1, 0, 1) the relation contains a single delay for the dependent variable, zero delay for the first explanatory variable and only one for the second.

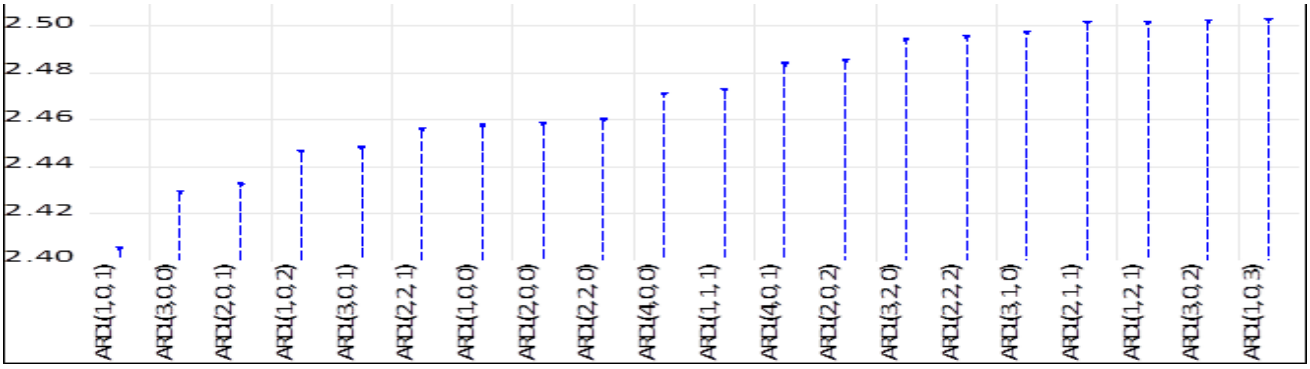

Figure 6. Estimation of the model chosen according to the Akaike information criteria (top 20 models)

Source: The authors.

The cointegration is established, we then proceed to estimate the long-term relationship which will take the following form:

$$G_t = cte + \sum_{i}^{p} \lambda_i G_{t-i} + \sum_{i}^{k} \beta_i U_{t-i} + \sum_{i}^{r} \gamma_i Inf\_PC_{t-i} + \varepsilon_t$$

With, p = 1, k = 0 and r = 1

Table 9. Results for the long-term relationship for the case of Egypt

Dependent Variable: U
Method: ARDL
Sample (adjusted): 1990 2021
Included observations: 32 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): G INF_PC

Selected Model: ARDL(1, 0, 1)

Variable	*Coefficient*	*t-Statistic*	*Prob.**
U(-1)	0.675875	7.957946	0.0000
G	-0.452742	-4.941908	0.0000
INF_PC	0.028456	0.950067	0.3505
INF_PC(-1)	-0.043739	-1.577180	0.1264
C	5.458264	5.533887	0.0000
R-squared	0.806019		
F-statistic	28.04730		
Prob(F-statistic)	0.000000		

Source: Own study.

The results in Table 8 indicate that there is a long-term relationship between the unemployment rate and growth, a decrease of 1% in the growth rate will lead to an increase of 0.45% in the unemployment rate. The results validate the unemployment persistence effect for Egypt, insofar as the unemployment rate of the current period depends on that of the previous period. However, the relationship with inflation is not statistically significant.

The dynamic error correction model which can be derived from the long-term equation resulting from the ARDL model integrates the short-term dynamics with the long-term equilibrium will take the following form:

$$d(U_t) = cte + \sum_{i}^{p} a_i d(G_{t-i}) + \sum_{i}^{k} b_i d(U_{t-i}) + \sum_{i}^{r} c_i Inf\_PC_{t-i} + \alpha CointEq_{t-1} + \varepsilon_t$$

With {CointEq}_{t-1}representing the lagged error correction term of the long term cointegration equation its coefficient which indicates the speed of adjustment towards the long-term equilibrium state must be negative and statistically significant.

Table 10. Short-term dynamics with the error correction coefficient case of Egypt

ARDL Error Correction Regression			
Dependent Variable: D(U)			
Selected Model: ARDL(1, 0, 1)			
Case 2: Restricted Constant and No Trend			
Sample: 1989 2021			
Variable	Coefficient	t-Statistic	Prob,
D(INF_PC)	0.028456	1.204141	0.2390
CointEq(-1)*	-0.324125	-6.375572	0.0000
R-squared	0.578473		
Adjusted R-squared	0.564422		

Source: Own study

The recursive residual tests of structural stability (CUSUM) and the test (CUSUM squares). The CUSUM graph showed that the regression equation is stable since the CUSUM test statistic does not exceed the limits at the 5% significance level.

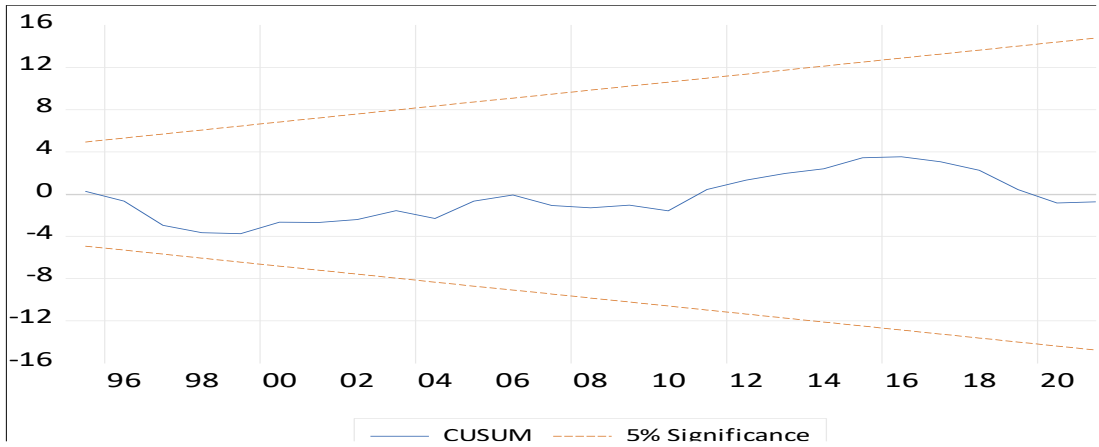

Figure 7. Estimation of the model chosen according to the Akaike information criteria.

Source: The authors.

For the short-term relationship {CointEq}_{t-1}is negative and statistically significant. The estimated relationship shows that the speed of adjustment of deviations from the long-term equilibrium is 32% each year.

4.3 The Case Of Saudi Arabia

The results in Table 11 show the existence of a cointegrating vector between the variables examined. The null hypothesis of no cointegration is rejected at 1% for models (1). The results confirm a long-term relationship between the GDP growth rate as a function of the unemployment rate and the inflation rate.

Table 11. Results of the ARDL cointegration test for the case of Saudi Arabia Bounds testing to cointegration

Estimated models	Optimal form	F-statistic	
(1) G/ U, Inf_PC	Selected Model: ARDL (1, 3, 0)	10.28479	
(2) U/ G, Inf_PC	Selected Model: ARDL (4, 1, 0)	2.919743	
(3) Inf_PC/ G, U	Selected Model: ARDL (2, 0, 0)	1.846180	
For T = 30			
	Significance	Lower bound	Upper bound
	1%	4.13	5
	2.5%	3.55	4.38
	5%	3.1	3.87
	10%	2.63	3.35
The optimal shape is obtained based on AIC Akaike Information Criteria			

Source: Own study

The optimal model according to the criterion of SIC is ARDL (1, 3, 0) the relation contains a single lag for the dependent variable, three lags for the first explanatory variable and a zero for the second.

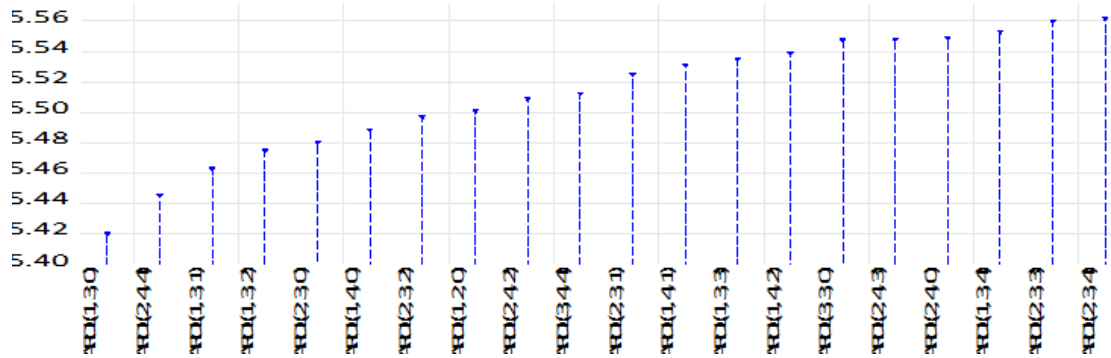

Figure 8. Estimation of the model chosen according to the Akaike information criteria (top 20 models)

Source: The authors.

The cointegration is established, we then proceed to estimate the long-term relationship which will take the following form:

$$G_t = cte + \sum_{i}^{p} \lambda_i G_{t-i} + \sum_{i}^{k} \beta_i U_{t-i} + \sum_{i}^{r} \gamma_i Inf\_PC_{t-i} + \varepsilon_t$$

With, p = 1, k = 3 et r = 0

Table 12. Results for the long-term relationship for the case of Saudi Arabia

Dependent Variable: G			
Method: ARDL			
Sample (adjusted): 1992 2021			
Maximum dependent lags: 4 (Automatic selection)			
Model selection method: Akaike info criterion (AIC)			
Dynamic regressors (4 lags, automatic): U INF_PC			
Selected Model: ARDL (1, 3, 0)			
Variable	*Coefficient*	*t-Statistic*	*Prob.**
G (-1)	0.076961	0.459796	0.6500
U	-2.285629	-1.671427	0.1082
U (-1)	3.964846	2.231174	0.0357
U (-2)	-0.032225	-0.011218	0.9911
U (-3)	-3.456953	-1.504892	0.1460
INF_PC	0.434434	1.761745	0.0914
C	11.97765	2.099112	0.0470
R-squared	0.356164		
Adjusted R-squared	0.188206		
F-statistic	2.120560		
Prob(F-statistic)	0.089870		

Source: Own study.

The results in Table 12 indicate that there is a long-term relationship between the growth rate and the unemployment rate for the same period, a 1% decrease in the unemployment rate will lead to a growth gain of around 2.2%. However, delayed unemployment can lead to an increase in growth in the current period. This can be explained by the volatility of growth and the importance of seasonal work, the effect of which on economic growth depends on the stock of available labour.

Compared to the two cases, the effect of inflation is significantly felt in the case of Saudi Arabia, which is affected by the spectacular increase in basic products.

The dynamic error correction model which can be derived from the long-term equation resulting from the ARDL model integrates the short-term dynamics with the long-term equilibrium will take the following form:

$$d(U_t) = cte + \sum_{i}^{p} a_i d(G_{t-i}) + \sum_{i}^{k} b_i d(U_{t-i}) + \sum_{i}^{r} c_i Inf\_PC_{t-i} + \alpha CointEq_{t-1} + \varepsilon_t$$

With {CointEq}_{t-1} representing the lagged error correction term of the long term cointegration equation its coefficient which indicates the speed of adjustment towards the long-term equilibrium state must be negative and statistically significant.

Table 13. Short-term dynamics with the error correction coefficient for Saudi Arabia

ARDL Error Correction Regression
Dependent Variable: D(G)
Selected Model: ARDL (1, 3, 0)
Case 2: Restricted Constant and No Trend
Sample: 1989 2021

Variable	*Coefficient*	*t-Statistic*	*Prob.*
D (U)	-2.285629	-1.877963	0.0731
D (U (-1))	3.489178	2.929300	0.0075
D (U (-2))	3.456953	1.672155	0.1080
CointEq (-1)*	-0.923039	-6.819468	0.0000
R-squared	0.696024		
Adjusted R-squared	0.660950		

Source: Own study.

The recursive residual tests of structural stability (CUSUM) and the test (CUSUM squares). The CUSUM graph showed that the regression equation is stable since the CUSUM test statistic does not exceed the limits at the 5% significance level.

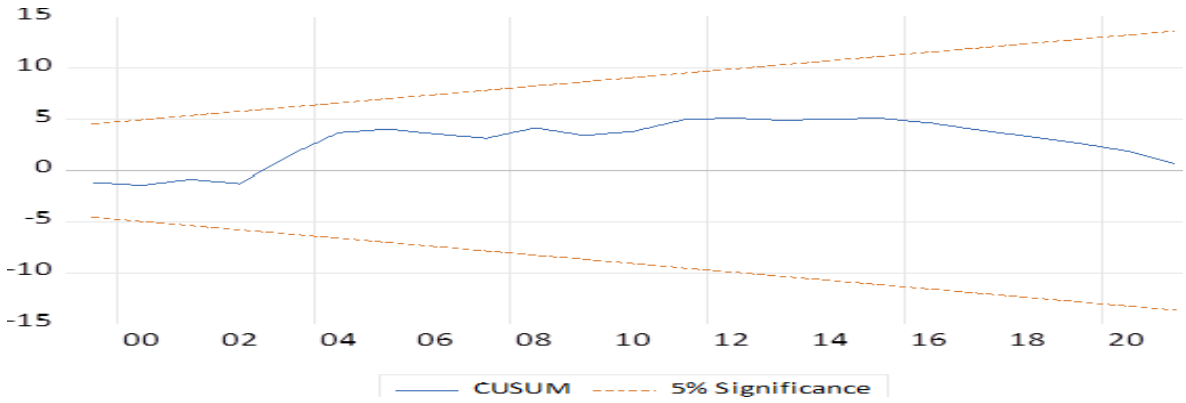

Figure 9. Estimation of the model chosen according to the Akaike information criteria.

Source: The authors.

The short-term relationship displays a negative and statistically significant coefficient {CointEq}_{t-1}. The estimated relationship shows that the speed of adjustment of the deviations from the long-term equilibrium is around 92% each year, which proves the adjustment efforts made by the public authorities and the very significant effect economic conditions on economic activity.

CONCLUSION

This paper examines the relationship between economic growth, inflation and unemployment for three Arab countries over the period 1989-2021. The existence of the long-term relationship between the variables is validated by the ARDL approach. The results suggest that there is a long-term equilibrium relationship whose growth is explained by unemployment in the case of Tunisia. The results also show that unemployment in the previous period constitutes a stimulus for current growth. For the inflation rate, the results show that the relationship is statistically insignificant for Egypt and Tunisia, but it significantly affects the growth of Saudi Arabia, which benefits from increases in commodity prices.

Still for the Tunisian case, the estimated relationship means that the short-term situation is very far from equilibrium. Indeed, according to the estimated equation the deviations from the long-term equilibrium are adjusted by more than 109% each year such a result can be explained by the transition period and that the adjustment is made in a way arbitrary by the intervention of the government which has created overstaffed jobs in the public sector.

These variables are interdependent and therefore the success of macroeconomic policy cannot be ensured by intervening on any one of these variables in isolation.

For the case of the Egyptian economy, the results show a long-term relationship between the unemployment rate as a function of the growth rate of GDP per capita and the rate of inflation. The results validate the unemployment persistence effect for Egypt. However, the relationship with inflation is not statistically significant. The short-term dynamic relationship shows that the speed of adjustment of deviations from the long-term equilibrium is 32% each year.

In the current circumstances of the transitional period the Tunisian and Egyptian governments must develop appropriate economic policies to encourage self-employment and entrepreneurship to overcome the high unemployment rates allowing to achieve stable growth rates to return to a stable and sustainable economic environment.

For the case of Saudi Arabia, there is a long-term relationship between the growth rate and the unemployment rate for the same period. However, delayed unemployment can lead to an increase in growth in the current period. This can be explained by the volatility of growth and the importance of seasonal work, the effect of which on economic growth depends on the stock of available labour.

Compared to the two cases, the effect of inflation is significantly felt in the case of Saudi Arabia, which is affected by the spectacular increase in basic products.

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