Is the Okun's law valid in Tunisia?

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Is The Okun's Law Useful in Tunisia?

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Abstract —The central focus of this paper was to check whether the Okun's law in Tunisia is valid or not. For this purpose, we have used quarterly time series data during the period 1990Q1-2014Q1. Firstly, we applied the error correction model instead of the difference version of Okun's Law, the Engle-Granger and Johansen test are employed to find out long run association between unemployment, production, and how error correction mechanism (ECM) is used for short run dynamic.

Secondly, I used the gap version of Okun's law where the estimation is done from three band pass filters which are mathematical tool used in macro-economic and especially in business cycles theory. The finding of the study indicates that the inverse relationship between unemployment and output is verified in the short and long term, and the Okun's law holds for the Tunisian economy, but with an Okun's coefficient less than required. Therefore, our empirical results have important implications for structural and cyclical policymakers in Tunisia to promote economic growth in a context of lower unemployment growth.

Key-words—Okun's law, Validity, unit root, cointegration, error correction model and bandpass filters.

I. INTRODUCTION

TUNISIA is an economy strongly supported by the government. Thanks to a priority given to education; it has produced a lot of graduates. However, in the last two decades, the labor market was unable to absorb this flow of young university graduates, and the situation has worsened in recent years after the revolution, unfortunately in a country that had so much invested in education. Nowadays, the world faces this major economic problem of increasing unemployment rate and insufficient growth.

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"Why?" and "How to get out?" are potential questions of all countries that have such circumstances.

This complication lies in the center of our study, which push us to discover the "Okun's law" which associates the products and labor markets. The policy makers are monitoring this linkage as it creates a clear picture about the economic development of a country.

Moreover, "Okun's law[1]" is an important "Keynesian" concept in macroeconomics both theoretical and empirical (Blinder (1997))[5], where it has proved one of the most enduring relationships in macroeconomics modern (Viviane, Naimy (2005))[31] and has been held for several countries mainly the developed ones (Lee (2000) [19], Freeman (2001) [10]). Moreover, the Federal Reserve Bank of St. Louis has concluded that "Okun's law can be a useful guide for monetary policy, but only if the natural rate of unemployment is properly measured".

The logic behind this law is very simple, it tries to explain us how much a country's gross domestic product (GDP) may be lost when the unemployment rate is above its natural rate of unemployment, which leads to the conclusion that we need an average of GDP growth over than 3% to lower unemployment by 1%, below this threshold it increases at a constant elasticity (Okun, (1970) [24]). This threshold varies between countries, since it results from the factors of the evolution of the active population and labor productivity (Blanchard and Cohen (2006) [4].

It is well known that the Okun's coefficient is different across countries, where it may have a high coefficient if the institutions of the labor market in the country are relatively flexible. In fact, several factors which affect the Okun's coefficient are basically statistical methods adopted in the identification of cyclical fluctuations in order to detrend GDP and unemployment rate (Lee, 2000) [19], (Knotek, 2007) [18]. Therefore, according to Samuelson and Nordhaus[2], Okun's ratio of three points decrease in GDP with one point increase in unemployment (3:1) is found to be inaccurate since two points to one point (2:1) are likely to be more precise recently.

The objective of this paper is to add to the current stand of literature on the linear relationship between unemployment and economic growth "Okun's law" for developing countries by using different band pass filters for Tunisia in the period 1990Q1 to 2014Q1, to shine a light on the existing collective knowledge concerning this issue.

Therefore, this study aims to estimate empirically the Okun's law ans to verify itstability for the Tunisian economy. To analyze its coefficient, it makes use of two initial versions of Okun such as the difference and the gap versions, considering both, the short term and the long term possible relationship. This paper concludes by discussing policies and recommendations on this phenomenon.

[1] was first proposed by Arthur Okun (1962)

[2] Paual.A. Samuelson and W. D. Nordhaus, Macroeconomics,17th ed. McGraw-Hill,New York,2001,324

The rest of paper is organized as follows: the second section reviews the existing literature on Okun's law, the third presents the different versions focusing on this law, a forth section will describe the econometric methodology. The fifth section will set out the available data, and a sixth section will discuss the empirical results. Finally a conclusion will summarize the results.

II. LITTERATURE

In practice, several economists followed Okun (1962) [23] by testing the relationship between unemployment and economic growth and mostly revealed the validity (Lee (2000), Harris and Silverstone (2001)[11], Moosa. I(1997) [21], Villarde, Maza (2007) [29]). Starting with Lee (2000), who tried to evaluate the robustness of the Okun's relationship based on post-war data from 1955 to 1996 for 16 OECD countries, which are found generally favorable to the validity of this law, but not as robust as the original results Okun (1970) [24]. Quantitative estimates of Lee differ significantly between countries according to diverse methods of decomposition (trend-cycle): Hodrick-Prescott(H-P)filter, Beveridge-Nelson decomposition, and the Kalman filter based on the NAIRU.

We also find the use of H-P filter in Dritsaki.C Nikolaos.D (2009) [8] and Caraiani Petre (2006) [6]. The firsts have tried to estimate the Okun's coefficients for four European Union Mediterranean countries through annual data for the period 1961-2002 using the variation and correlation for both variables. The results confirmed the Okun's law and showed that the cost of unemployment related to the loss of real GDP is larger for Italy (-0,024) and lowest in Greece (-0.007). Also Caraiani Petre concluded that Okun's law was held in Korea in last decades by using two different estimates (the first quarterly data on GDP and employment from 1970 to 2004) (and the second on monthly data from 1984 to 2004).

Also, the Spanish economist Villarde Maza (2007) [29] also used the HP filter, besides quadratic trend and the Baxter-King filter to validate the Okun's law for the Spanish regions during the 1980-2004 periods, but with regional differences detected due to the diversity of the quantitative values of Okun's coefficients. Again, and using the Kalman filter, Moosa (1997) [21] estimated the Okun's coefficient from quarterly US data covering the period 1947: 1-1992: 2 which was around the order of 0,38 regardless of the model used is static or dynamic, whatever the length of delays were in the dynamic model. He also tested Okun's law for G7 countries and extracted cyclical output and unemployment rate using Harvey's structural time series model. The empirical results indicate that Okun's coefficient is higher in North America and lower in Japan.

The Okun's relationship has long been considered a fairly stable pattern in industrialized countries, but it's not the same for some studies focusing on developing countries. Moosa (2008) [22] tried the estimation of Okun's law in four Arab countries(Algeria, Egypt, Morocco, Tunisia) with the two initial versions of Okun. His results concluded that cyclical components of unemployment and GDP which calculated by applying (H-P) filter are unrelated in Algeria, Egypt, Morocco and Tunisia, and he deduced that Okun's law doesn't hold for these four countries. Contrarily to Khan et al..(2013)[17] who have used time series annual data during the period 1976 to 2010 for Pakistan and used unit root test, Hodrick–Prescott filter and least square method to find that a rise of one percentage point of unemployment is associated significantly with a decline of 0.36 percentage point of real GDP growth.

III. THE DIFFERENT VERSIONS OF OKUN'S LAW

Empirical estimates of the Okun's coefficient are sensitive to model specification formulated by Okun, which may take the form of static and dynamic models. The first relationship is named the difference version of Okun's law captures the contemporaneous correlation between output growth and movements in the unemployment rate. If the desired Okun's coefficient is negative so that fast output growth is associated with a decrease in unemployment rate, and slow or negative output growth is associated with rising unemployment rate. This relationship is based on accessible macroeconomic statistics.

The second version is named the gap version, which connects the gap between real unemployment rate to its potential and the gap between actual outputs to its potential. Here, another problem arises concerning the choice of the method of decomposition (trend-cycle) method because it can produce different estimates of the unobservable trends and cycles.

Many economists use a dynamic version of Okun's law (Moosa (1997) [21], Holmes (2001) [13], Huang and Lin (2007) [14]), which have partly based their suggestion that certain pertinent variables were omitted from the right part of the equation. A common form for the dynamic version of Okun's Law would have the growth of real output current, past actual production as well as past changes in the unemployment rate as dependant variables on the right side of the equation. Finally, a version of the production functions of Okun's law which is initially introduced by Prachowny (1993) [26]. It generally combine a theoretical production function (labor, capital and technology merge in order to perform production (GDP)) with the gap version based on Okun's law.

IV. Methodology of analysis

We will limit our methodology of Okun's law estimation on the basis of the specifications initially suggested by Okun (1970) the pioneer on this economic phenomenon: the difference and gap model.

A. *The Difference Model*

This method connects the real production (y_t) and the rate of unemployment (U_t) in first differences:

$$\Delta Yt = \beta 0 + \beta 1 \Delta Ut + \varepsilon t \quad t = 1, \ldots . T, (1)$$

ΔY_t: is the growth rate of output (GDP) in per cent between the current time period and the previous which is considered a proxy of the activity.

β_0: is the intercept that captures the average growth rate

β_1: is commonly known by the Okun's coefficient which it is the percentage point change in the unemployment rate for a one percentage point change in the output growth.

ΔU_t: represents the changes in unemployment rate between current and previous period

ε_t: is the residual term

Although, in a number of empirical research criticizing the difference version, several authors stress that if "output" and "unemployment" are cointegrated, then the version of difference will be poorly specified (Attfield and Silverstone (1997) [1]). From this point of view, we will estimate the Okun's coefficient directly from the error correction method (ECM) which takes into account the co-integration relations.

As a first step, we will verify stationarity of data, as it may cause a spurious regression. Most macroeconomic variables are non-stationary, so the differentiation of variables could be a solution to demonstrate that Y_t and U_t are stationary and integrated in the same order(d) and denoted I (d). The Augmented Dickey-Fuller (ADF) which is known by the unit root test and Phillips Perron (P-P) are used to test stationarity in our sample. The results are obtained in Table 1.

$$\Delta Yt = \alpha + \beta\, \Delta Yt - 1 + \beta j \sum \Delta Yt - j + \mu t \quad t = 1, \dots, T \ (2)$$

The null hypothesis of unit root existence is $\beta = 0$ (GDP growth is not stationary) against $\beta = 1$ (GDP growth is stationary). If a variable is found not stationary in level, it will be tested in first difference.

Consequently, if each variable is obtained stationary, we can proceed to the next step which is the cointegration methodology in two step procedure. The two main methods for testing co-integration are: Engle–Granger two-step method and Johansen test. For Engle-Granger method, we will check if this regression's residuals ε_t are stationary, if so, the UG and OG variables will be co-integrated. However, if these residuals are not stationary, it is concluded that there are no long-term relationship (no cointegration). For the Johansen test, it is checking for cointegration in the regression that allows for more than one cointegrating relationship, unlike the Engle–Granger method.

Thus if the variables are cointegrated, the long-term cointegration exist. The final step is to estimate the corresponding error correction method, based on long-term cointegrating relationship to observe the short run dynamics (Engle,Granger(1987)) as follows in equation (3):

$$\Delta Z_t = \mu + \Pi Z_{t-1} + \sum \Delta Z_{t-i} + \varepsilon_t \quad t=1,\dots,T \ (3)$$

Where Z_t = [y, U], μ is a 2x1 vector intercepts, ε_t t is a vector 2x1de disturbances.

Π is a matrix that captures the long-term relationships. The rank of Π indicates the number of cointegration vectors Z_t.

Empirically this can be done as describe equation (4):

$$\Delta Y_t = \alpha + \beta_1 \Delta U_t + \beta_2 u_{t-1} + \varepsilon_t \quad t=1,\dots,T \ (4)$$

Where: $u_{t-1} = Y_{t-1} - \sigma_0 - \sigma_1 U_{t-1} - \sigma_2 T$

U_{t-1} and Y_{t-1} are regressors with one period lagged for unemployment rate and economic growth, respectively. T is the trend variable, whereas u_{t-1} is the one period lagged value of the error from the cointegration equation.

Equation (4) states that ΔY_t depends upon both ΔU_t and u_{t-1}.

If u_{t-1} is different from zero then there will be disequlibrium.

In ECM, we check the significance of coefficient U_{t-1} (if it is negative or positive), which displays the dynamics of the short-term model. Technically, the error correction method measures the speed of adjustment to return to cointegrated relations. The ECM assumes that a force affects the integrated variables to return to their long term relationship when they deviate from the equilibrium.

B. *The Gap Model*

The second approach to estimate Okun's law is based on the difference between the outputgap and unemployment gap:

$$y_t - y_t^* = \beta_1 (U_t - U_t^*) + \varepsilon_t \quad t=1,\dots,T \ (5)$$

where ($y_t - y_t^* = y_t^c$) corresponds to the cyclical output (output gap), y_t^* is the potential output. ($U_t - U_t^* = U_t^c$) corresponds respectively to the cyclical unemployment (unemployment gap), and U_t^* is the natural rate of unemployment.

We will take into consideration the presence of stochastic trends y_t^* and U_t^*, not deterministic because this may lead to misleading results since in most cases both variables are integrated.

This version uses unobservable variables, where there is no single accepted method for detrending these variables. Among them I chose univariate band pass filters which are mechanical methods (typically non-parametric) based on filtering techniques. The principal smoothing methods used are mainly Baxter-King, Hodrick-Prescott, Christiano-Fitzgerald filters.

The Hodrick and Prescott (HP) filter is a a smoothing method that isolates the movements of time series situated between an upper limit and a lower limit of a frequency or duration, as it eliminates movements outside the desired frequency band. Indeed, The HP filter supposes that any series X is decomposed into a trend and a cycle:

$$Xt = Tt + Ct \quad t = 1, \dots, T \ (6)$$

Theorically,it's a parametric estimation method to obtain a smooth trend "T" component via the solution to the minimization of a loss function for a fixed (known) λ penalty parameter. For quarterly data Hodrick & Prescott (1997) suggest to be 1600.

$$\min_{X_t^*} \sum_{t=1}^{N} \left((X_t - T_t)^2 + \lambda (\Delta T_{t+1} - \Delta T_t)^2 \right)$$

The second (B-K) filter is an approximation of an ideal band pass filter. As time series can be decomposed into various frequency components, the ideal band pass filer extracts frequencies within predetermined ranges and eliminates all other frequencies. Hence, this filter is a linear filter which eliminates trend components and high frequency irregular components while it aims to retain the intermediate cyclical components which are passed through a predetermined lower and upper bond " the periods 6 and 32 quarters".

The third is Christiano and Fitzgerald filter (C-F). It is like the (B-K) filter as an approximation of an ideal band pass filter and has therefore basic similarities with it. (B-K) assumes a symmetric moving average while in order to approximate an

ideal band pass filter the CF on the other hand assumes that the time series y_t , follows a random walk without drift. Furthermore, we note that the CF filter puts different weights to each observation and hence the filter is not symmetric, Haug & Dewald (2004). A contrast to the BK is that the BK assumes the weights are fixed regardless of the number of observations. Besides, the CF is consistent compared to the BK as it converges to an ideal band pass filter as the sample size, T, increases.

Once trends "y^*_t" and "U^*_t" are extracted from the H-P, the B-K and the C-F filters, we can calculate the Okun's coefficient β1 from the equation (7):

$$y^c_t = \beta_0 - \beta_1 U^c_t + \varepsilon_t \quad (7)$$

V. DATA

Our data sample is provided by the National Institute of Statistics of Tunisia (NIS), with a monthly availability of the variable 'actual GDP' over the period 1990Q1-2014Q1. The available data on unemployment are only annual observations available for the years 1989-1994 and 1997 and for all years from 1999 to 2009 and which are published by the (NIS). So, in order to obtain an infra annual frequencies, we used extra information from the ANETI (National Employment Agency and self-employment) and researched on additional requests and job creation available in monthly frequency.

Therefore, we can disapprove the results of certain papers studying about Tunisia such as Moosa (2008) who used the interpolation method in order to make quarterly data from 1990 to 2005. Such a method is simple, fast and easy but it lacks precision that's why the empirical results achieved are not sufficiently verified and significant.

VI. EMPIRICAL RESULTS

This section represents the estimated results by the two versions of the Okun's law. Firstly, the approach of Augmented Dickey-Fuller (ADF) and Phillips Perron (P-P) has been applied for the two variables "GDP" and "unemployment" and found non-stationary. Hence, we test them in first difference (as shown in Table I), where both variables are integrated of order 1(I (1)) and become stationary after differentiation.

TABLE I
STATIONARITY TESTS

Variables	ADF in level	ADF at first difference	P-P in level	P-P at first difference
(Y_t)	-1.266745	-8.957357*** (intercept)	-1.171065	-9.019713*** (intercept)
(U_t)	-2.271647	-6.810716*** (None)	-2.006171	-6.766774*** (intercept)

Note: This table reports the author's calculations of ADF and P-P in levels and in first difference respectively. ***, ** and * indicate significance at the respective significance levels 1%, 5% and 10%.

A. *Empirical Results of Difference Version (Error Correction Model)*

This section displays the estimation results of the Okun's coefficient within error correction method (ECM). As a first step, the co-integration test will be used to determine the long-term relationship between the variables. There are several co-integration tests; the first step is the Engle and Granger test.

TABLE II
ENGLE GRANGER TEST

Variables	ADF at 1st difference		
	Coef (t-value)	P-Value	Decision
U_t	-9.0262623***	0.0000	Co-integrated

Note: Table II reports the unit root test of the residuals of the difference version in level. ***, ** and * indicate significance at the respective significance levels 1%, 5% and 10%.

Building on the table II, our estimated model is not spurious. We reject the null hypothesis that that the residuals are integrated and the two variables "lngdp" and "Un" have long run causality, named co-integrated.

TABLE III
JOHANSEN TEST

	Eigenvalue	Trace statistic	Critical value	Prob
None ***	0.186547	36.02618	20.26184	0.0002
At most1***	0.172566	17.23773	9.164546	0.0013

Unrestricted Cointegration Rank Test (Trace)

	Eigenvalue	Max-Eigen statistics	Critical value	Prob
None**	0.186547	18.78846	15.89210	0.0170
At most 1 ***	0.172566	17.23773	9.164546	0.0013

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

D(Yt)	D(Ut)	C
1.0000000	-1.406812 (0.61209)	0.010123 (0.00159)

Normalized cointegrating coefficients (standard errors in parentheses)
Note: Table III reports the analysis of trace and the maximum eigen value. ***, ** and * indicate significance at the respective significance levels 1%, 5% and 10%.

The second step is the Johansen test. The analysis of the trace and the maximum eigen value reveals (from table III) two co-integration relationship at the 0.01 level.

Thus, the normalized relationship is

$$dYt = -1.406812 * dUt + 0.010123 \quad (8)$$

The results show that an increase of 1% of GDP above the critical value (mean of output growth) in the long term would

lead to a 1.4% decline in the unemployment rate in Tunisia. Subsequently, the value of the Okun's coefficient is "β = 1.4". As the co-integration relationship has been established, we can then estimate the Okun's coefficient in an error correction framework (ECM) (equation (9)) for correcting the short term.

$$D(Yt,2)=c(1)*(D(Y(t-1))+21.3350*D(Ut(-1))-0.01253) +c(2)*D(Yt(1),2)+c(3)*D(Yt(2),2) +c(4)*D(Ut(-1),2)+c(5)*D(Ut(2),2)+c(6) \quad (9)$$

We shall use Wald statistics to check short run causality (table IV) where we have rejected the null hypothesis (c (4) =c (5) = 0), hence there is a short run causality running from unemployment to GDP.

TABLE IV
WALD TEST

Test Statistic	Value	Df	Probability
F-statistic	2.430477	(2, 87)	0.0939
Chi-square	4.860953	2	0.0880

Note: Table IV reports the checking of short term causality between our variables basing on the chi-squared distribution.

B. *Empirical Results of Gap Version*

This section represents the estimation results of the Okun's coefficient in the gap version. The 3 filters are applied to quarterly data to extract the cyclical components of output and unemployment. The fig1, fig2 and fig3 show the cyclical components of unemployment and production established on the same scale via the H-P filter, the B-K filter and C-F filter respectively.

Fig. 1 Cyclical GDP and cyclical unemployment

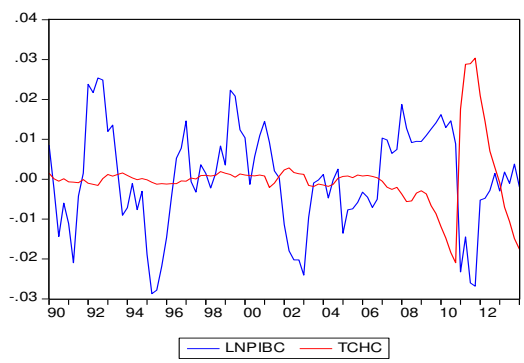


Fig. 2: Cyclical GDP and cyclical unemployment

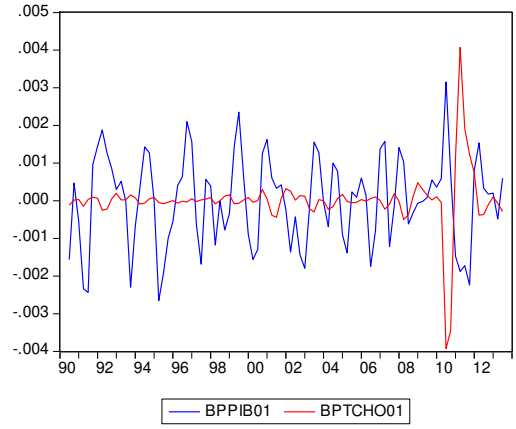
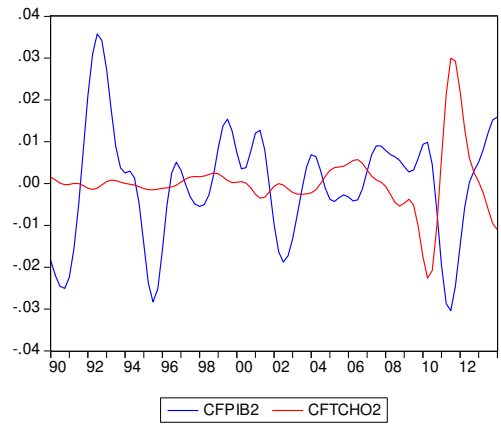


Fig. 3: Cyclical GDP and cyclical unemployment



Graphically, there is a little negative correlation between the cyclical components of unemployment and output from 1990 to 2000, but in the period after 2000 and mainly the period of political transition (2010-2014) we can detect clearly the inverse relationship of the two variables studied with the three filters. This provides us some evidence for the validity of Okun's law.

Empirically, through (the table V), the Okun's coefficient extracted from the C-F filter is the highest. The estimation of equation (7) yields these results found in equation (10):

$$yct = 0.00126 - 0.75804Uct + \varepsilon t \quad t = 1 \ldots\ldots T \quad (10)$$
$$(-1.282258) \quad (-4.342448)$$

As seen in the equation (10), the gradient of unemployment in Okun's law is around -0.758 and potential GDP growth is around 0.126 percentage points in the period 1990-2014. A possible explanation leads to conclude that in order to achieve sustainable improvement in standards of living, the small percentage of GDP growth compared to its natural level, the policy makers will come to a decision that they may promote the creation of new jobs intensively without generating inflation.

What's also noticeable is that the Okun's coefficient of U^c which is around -0.758" is statistically significant. Meaning that the variables are negatively correlated as predicted by the

theory, hence any increase of 1 point of growth above the critical level (mean of potential output), Tunisia will have a decline of 0.75% in unemployment rate. Therefore, based on our findings, we believe that Okun's law holds for Tunisia.

As can be seen that the empirical results are satisfactory, but we observe that the Okun's coefficient is less than required, and the calculated adjusted R-squared does not confirm a very strong relationship between the two variables. A variety of approaches have been explored in order to ameliorate the measurements problems related to Okun's law, starting from the inclusion of other explanatory variables in the equation, to the application of regressions that allow non-linear changes in the relationship between output and unemployment. It will be a future research on non linearity in the Okun's law for Tunisia in order to check if there will be some amelioration in our results.

TABLE V
GAP MODEL

Variable	H-P filter		
	C(2)	t-statistic	R^2
(U-U*)	-0.699680***	2.93E-10	0.3833

Variable	B-K filter		
	C(2)	t-statistic	R^2
(U-U*)	-0.6174***	-4.0197	0.3507

Variable	C-F filter		
	C(2)	t-statistic	R^2
(U-U*)	-0.75804***	-4.3424	0.4156

Table V reports the results of the estimation of the gap version with the three filters H-P, B-K and C-F. ***, ** and * indicate significance at the respective significance levels 1%, 5% and 10%.

VII. CONCLUSION

This manuscript focuses on the validity of Okun's law. It seeks to examine the relationship between the unemployment rate and GDP growth in the short term and long term in Tunisia.

We applied the error correction model instead of the difference version of Okun's law and found a negative relationship between the two variables involved in the long term with a value of the Okun's coefficient of -1.4, which assumes that an increase of 1% of GDP in the long term would lead to a 1.4% decline in the unemployment rate in Tunisia.

First, the Dickey-Fuller test is applied to prove stationarity of unemployment and GDP growth using random walk with drift and stochastic trend, and we found two non-stationary variables. As both variables are integrated of order 1, I (1), we applied the Johansen test and found that the two variables have a long-run equilibrium relationship. Then, the error correction model (ECM) is applied and we have found that there is a short run causality running from unemployment to GDP.

For the second version, we found a statistically significant Okun's coefficient around -0.75 using the C-F filter. This negative value confirms the inverse relationship between the two variables, and has provided evidence of validity of Okun's law in Tunisia.

In summary, this study attempts to predict the nature of the relationship between unemployment and output, where economic policy should focus on the big problem of increasing unemployment. Mainly after the revolution the major problem of the Tunisian economy is its chronic inability to generate enough jobs, which basically resulted from chronic mismatch between supply and demand in the labor market.

Thus, the present state regime should focus on labor market needs through trying to increase the efficiency and flexibility of the Tunisian labor market, and adopting priority on promoting sectors with high added value.

There is also a need to immediate actions in order to accelerate economic growth. Firstly, through favoring efficient investment relatively to GDP, secondly by supporting industrial policy in order to better the competitive strategy and finally via encouraging national Tunisian integration such as international integration.

According to these recommendations, the Okun's coefficient would probably increase. Nowadays, unemployment is not only an economic problem; it is also a political problem. Today, we need to clarify a lot of things before embarking on the implementation of a strategy to remedy this situation.

Finally, this paper contributes to an important debate on the linear relationship between unemployment and economic Growth, however it has left some measurement problems aside, which will gives the motivation to continue on this topic applying other versions of Okun's law, or testing many other difficulties cited.

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