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TESTING THE VALIDITY OF OKUN'S LAW IN ALGERIA: IS THERE A DIFFERENCE BETWEEN MAKI'S COINTEGRATION AND QUANTILE'S REGRESSION RESULTS?

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Abstract

Research background: This paper examines the existence of Okun's law in Algeria over the period of 1970–2020 using both the gap and differences model.
Purpose: The main objective of this paper is to econometrically examine, explore and test the nexus among unemployment rate and economic growth, in order to have a clear explanation about unemployment in Algeria.
Research methodology: Firstly, the Kapetanios unit root test and Maki cointegration test are employed for the gap model to deal with the structural breaks than the estimation of the coefficients in this case,

secondly, the quantile regression is used for the differences model; finally, three categories of causality tests are used in this research.
Results: The findings revealed that unemployment rates are not affected by output over the period of study both in the gap and differences model. Hence, Okun's law is not held in Algeria.
Novelty: The study focused on Okun's law in different ways. This latter carries out structural breaks in both the unit root and co-integration analysis. On the other hand, the study uses the quantile regression for the first time in the examination of Okun's law. In the same line of thought, this research introduces an asymmetric analysis in the Maki cointegration and quantile regression.

Keywords: Okun's law, Unemployment, Output growth, Maki cointegration, Asymmetric causality tests, Quantile regression

JEL classification: C32, E23, E24

Introduction

Since the pioneering study of the American economist, Arthur Malvin Okun (1962) appeared and his famous finding that an increase in output of 3% is linked to a decrease in the unemployment rate of 1% (Okun, 1962). Since Okun's discovery, many studies have verified the validity of Okun's Law in the economies of many countries, and different versions of this law have been used. However, the two most famous models of Okun's Law are; the first one known as the difference version of Okun's Law, which relates changes in output to changes in unemployment. The second model is the gap version that explains the relationship between the changes in the unemployment rate and the gap between actual output and potential output; also, it enjoys significant empirical support.

Algeria, like many countries, has long suffered from the symptoms of the "Dutch disease" and fluctuating oil prices, which is its main resource (Ayad, 2021). This is what most countries that acquire oil and export oil in their crude suffer from (Aissa, Ayad, 2022). This form has contributed to the weakening of other economic sectors, especially industrial and agricultural sectors, with improved oil prices on international markets during the new millennium (Djedaiet, Ayad, 2022). The country's economic situation has improved.

The first challenge for the Algerian economy is achieving steady and sustainable economic growth. If there is no sustainable growth, then it is impossible to talk about any effective strategy to reduce unemployment, but when the economy becomes dynamic and grows at a high rate, this becomes possible. Nevertheless, the problem remains how such growth can be achieved.

For a long time now, unemployment has become the most important form of imbalance in the labour market in Algeria. Studying this subject in-depth and detail has become an urgent necessity to determine the results, analyse them, and then formulate the appropriate policies to deal with the problem of unemployment. The descriptive study of the evolution of unemployment rates and economic growth in Algeria over the study period is also important to realize the connection between these two variables.

During the first half of the 1980s, despite a slowdown of the investment rate (33% against 40 to 45% on average during the 1970s), according to the National Economic and Social Council (CNES) it has created approximately 140,000 jobs per year. This evolution led to a significant decline in the unemployment rate. It passed from 32.9% in 1966 to 22% in 1977 then to 16.3% and 13.1% in 1982, and 1983 respectively (Attouchi *et al.*, 2019). Even though, the decrease in oil prices recorded in 1986 reduced the speed of employment, this led to high unemployment rates after the second oil crisis in 1986 and economic reforms implemented by the government in the early 1990s harmed the performance of the overall economy and labour market. Then, since 1999, Algeria benefited from its external financial position due to the accumulation of oil revenue. This recovery allowed for improving labour market indicators, particularly unemployment rates. Algerian total unemployment rates have declined considerably since 2000 (Dahmani, Rakrek, 2015). During the period 2010–2013, the unemployment rate remained within 10%, which signifies the minor peak, this reduction in unemployment is caused by the evolution of oil prices that have improved since 2010 (moving from an average of 80 $ to 105 $ for a barrel of crude oil by the end of 2013). In addition, in the same phase, it has seen a steadiness in economic growth rates (3% as average) (Attouchi *et al.*, 2019). Total unemployment was cut in half, from 29.9% in 2000 to 10.6% in 2014. Between 2016 and 2017 the Algerian unemployment rate increased by 1.79% because of the difficult situation of some oil-producing countries, such as Algeria; knowing that in February 2016, oil prices rebounded to $ 50 at the end of 2016 and those prices were held between $ 50 and $ 60 until the fourth quarter of 2018, and the unemployment rate remained at an average proportion of 11.5% until 2020.

Through this study, we will try to test Okun's relationship and make sure it is valid with the Algerian economy to estimate the growth rates needed to reduce unemployment and define the suitable economic strategies to provide efficient public employment policies.

Our research differs from previous studies in two aspects. The first contribution is that we will use the cointegration technique in the existence of multiple structural fractures (Maki cointegration test) for the gap model and then estimate it using the FMOLS and DOLS methods.

Secondly, while the majority of studies on Okun's law investigate how changes in unemployment respond to economic growth with linear models (Symmetrical effects), we will attempt to test the validity of the gap model using the asymmetric causality of J-Hatemi and also estimate the difference model using the asymmetric effects of the GDP via Quantile regression approach.

The rest of the paper is organized as follows: Section. 1 describes the brief literature review relating to Okun's Law; Section 2 explores the theoretical background of Okun's Law; Section 3 discusses the data and methodology; Section 4 provides the empirical findings, explores these results, and provides some policy analytics. Finally, Section 5 delivers some concluding interpretations and policy suggestions.

1. Literature review

A wide range of research has been examining the link between GDP and unemployment rate, as any variation in economic growth can directly affect the macroeconomic variables especially the unemployment rate. We begin our literature survey by having a closer examination of the empirical studies of renowned scholars which could help to uncover the relationship between these variables. After Okun's study (1962) was conducted, several macroeconomists have studied this link using different approaches (e.g. Thirlwall, 1969; Smith, 1974; Knoester, 1986; Prachowny, 1993; Lee, 2000; Apergis, Rezitis, 2003; Knotek II, 2007; Lal, 2010; Elshamy, 2013; Dixon, 2017; Huang, 2020; Gelfer, 2020; Bod'a, Považanová, 2021).

Louail and Riache (2019) verified the existence of Okun's law in Algeria over the period 1991–2019 depending on the ARDL model. The results depending on the gap version of the hypothesis revealed the existence of Okun's law in the Algerian economy but in a very small manner. Whereas, a 1% decline in economic growth will upsurge unemployment by 0.053% in the long-run term.

Latif *et al*. (2021) tried to study the relationship among the two variables in Pakistan over the period 1972–2019 using the ARDL model. As a result, the outcomes concluded to the existence of the inverse linkage but with a very low intensity of association. In addition, the Granger causality test discovered a unidirectional causation running from unemployment to GDP in contract of Okun's law suggesting where the causal link is from GDP to unemployment.

Neifar, M. (2020) investigated the association between GDP and unemployment in some Arabic countries from the MENA zone (Morocco, Tunisia, Oman, Jordan, Lebanon and Egypt) over the period 2000:1–2014:4. On the one hand, empirical results from the linear model

confirmed an inverse linkage concerning unemployment-output nexus, except of Oman. On the other hand, the nonlinear study results using the NARDL model showed that the positive shock effects of economic growth on unemployment were larger than the negative shocks in Tunisia, Egypt, Morocco and Lebanon; in contrast of Oman and Jordan where the opposite is held (Neifar, 2020).

Bande and Martín-Román, (2017) investigated the relationship in Spain at the regional level (17 regions). Particularly, they used regional data for the period 1980–2015. Therefore, their results show a significant asymmetric behaviour in the link, with higher parameters in absolute values for growing periods than for declining periods.

Amor and Hassine, (2017) tried to identify and determine the dynamic connection among unemployment and economic growth in Saudi Arabia using annual data covering the period 1980–2015 depending on the ARDL model. Their results showed that the expected long-run elasticity shows that the effect of real GDP on unemployment is more obvious for the gap model than for the difference model. Hence, in the gap model, the results indicated that any rise in the real GDP by 1% will automatically lead to a decline in unemployment rates by 0.54%. Passing to the difference model, any improvement in output by 1% will lead to a decline in unemployment rates by only 0.33%.

Nurudeen (2017) employed the Auto-Regressive Distributed Lag model (ARDL model) to investigate the existence of the law in Nigeria during the period 1970–2014 considering oil prices. Notably, the results revealed the existence of a co-integration relationship between the two variables in the presence of oil price. Furthermore, the unemployment rate had a long-term negative and significant effect on the economic growth, whereas, the coefficient indicated that any increase by 1% in unemployment reduces the GDP by 0.18% in the long-run term. Therefore, the increase of unemployment rate in Nigeria means that individuals who are jobless cannot buy many goods or use services and subsequently production will decline in the long-run term.

2. Theoretical background of Okun's Law

The GDP-unemployment nexus were first formulated in the economic literature by Arthur Melvin Okun in 1962, the American economist who filled in as chairman of the U.S. Council of Economic Advisers during a specific period (Abubakar, Nurudeen, 2019). This famous relationship became well-known as Okun's law. For this reason, the revision of the association between the two variables in Algeria requires examining the existence

of the Okun hypothesis. This last one suggests the existence of an inverse relationship between unemployment and production. If production increases, unemployment rates will decrease, and vice versa, because a decrease in production volume increases unemployment rates. Our model for exploring Okun's law could be presented as (Widarjono, 2020):

$$\Delta Unem_t = \beta \Delta rgdp_t + e_t \tag{1}$$

where $\Delta Unem_t$ shows the variation in the unemployment rate, $\Delta rgdp_t$ is the variation in real GDP, and e_t is an error term. The parameter of Okun is stated by β ($\beta < 0$), where β is the Okun coefficient, which measures some changes in production that cause changes in the unemployment rate (Perman *et al.*, 2015). Accordingly, two relevant models of Okun's law have become quite widespread in the economic literature. The first model is identified as the "gap model", and the second is the "difference model" (Bande, Martín-Román, 2018).

2.1. The gap version of Okun's Law

The gap equation reflects the link between the output gap and changes in unemployment. As the potential output is related to full employment, this version can be showed empirically as follows:

$$Unem - Unem_N = \alpha + \beta \left(\frac{rgdp - rgdp^*}{rgdp^*} \right) + e \tag{2}$$

$$U_gap_t = \alpha + \beta G_gap_t + e \tag{3}$$

where: *rgdp*: Real GDP, $rgdp^*$: Potential GDP, *unem*: The Unemployment Rate (Actual Unemployment), $unem_N$: The Natural Unemployment Rate.

Also, in this version there are some complications involved in computing the natural rate of unemployment and the potential output that can be computed using various methods (Akram *et al.*, 2014). The primary argument in using the gap version is that it explains the unemployment-GDP link compared to the other versions.

2.2. The difference version of Okun's Law

This version is created depending on the following regression, which shows the simultaneous relationship among GDP and variations in the unemployment rates from one time to the next (Chamberlin, 2011). The difference version can be presented as follows:

$$Unem_t - Unem_{t-1} = \gamma + \delta\left(\frac{rgdp_t - rgdp_{t-1}}{rgdp_{t-1}}\right) + \epsilon_t \tag{4}$$

$$U_dif_t = \gamma + \delta G_dif_t + \epsilon_t \tag{5}$$

In this case, the parameter δ is called the Okun's coefficient and is expected to have a negative sign.

3. Data and Methodology

This study uses annual data over the period 1970–2020 to examine the short-run and long-run interactions between the two variables, and investigate the validity of Okun's law in Algeria. All these data were obtained from different institutions and official sources.

Table 1. Information about the data

Variable	Abr.	Clarification	Source
Unemployment	$unem_t$	Unemployment rate (%)	ONS
Real Gross Domestic Product	GDP_t	GDP in Constant Prices	WB
The Cyclical Unemployment Rate	U_gap_t	The difference between the observed unemployment rate and the natural rate	Authors' calculations
The GDP gap	G_gap_t	The difference between actual GDP and potential GDP	
The change in the unemployment rate	U_dif_t	The difference between $unem_t$ and $unem_{t-1}$	
The change in real GDP	G_dif_t	The difference between GDP_t and GDP_{t-1}	

ONS: National Bureau of Statistics in Algeria.

Source: authors' compilation.

Recent economic literature has shown that traditional co-integration tests may perform poorly due to their neglect of structural breaks (Iorember, 2020). Henceforth, it is essential and crucial to take the structural breaks when testing the time series cointegration as in unit root tests (Yildirim, Orman, 2018). In this research, we apply unit root tests, a Maki cointegration analysis (Maki, 2012), and causality tests to examine the existence of Okun's law in Algeria. Specifically, the Maki test could detect the long run association between variables in light of five possible structural changes. Notably, the Algerian economy over the period of study experienced several shocks and changes, such as the transformation from a socialist economy to a hybrid economy. The empirical study subsists four steps. Firstly, stationary variables are examined with unit root

tests (NG-Perron and Kapetanios). Accordingly, the unit root tests such as the NG-Perron test provides us solutions to deal with the integration order of the series in order to avoid spurious regressions. Moreover, the previous unit root test failed to detect the structural changes in the series, and since our period is long, it is important to examine more than just one break using the Zivot-Andrews test, especially in light of various shocks that have affected the Algerian economy like oil prices shocks, the black decade from 1990–1999. Secondly, we considered the long-run connection between our variables using a co-integration test under structural breaks. Thirdly, long-run coefficients are estimated using dynamic ordinary least (DOLS) and fully modified OLS (FMOLS). Particularly, these procedures allowed us to detect the long run elasticities in the presence of co-integration behaviour among our variables. Finally, we examined the causality link to explore the direction of causality among variables for the gap model. On the other hand, we employed the Quantile regression Koenker and Bassett (1978) for the difference equation of Okun's Law.

4. Empirical Results and Discussion

4.1. The gap model of Okun's Law

Unit root results

Before proceeding to the cointegration tests, it was necessary to study the time series stationarity. In this regard, we used the NG-Perron unit root test (Ng, Perron, 2001) and the Kapetanios test (Kapetanios 2005) with a maximum of five breaks to avoid any counterfeit results in the order of integration long-run estimations after checking the cointegration relationship. The stationarity tests result in the levels show that the two series are not conclusively stationary in their levels, where the findings of the Kapetanios test results show the existence of at least five structural breaks on the variables. Hence, the series had to differ; accordingly, the results in Table 2 confirm that the two variables are stationary after their first differences in the NG-Perron test and the Kapetanios test. Consequently, we rejected the null hypothesis of non-stationary for the two variables of our study. The estimated results concluded that the our variables are integrated in order (1), which means that all of the co-integration tests especially the Maki (2012) test, can be applied with the used series.

Table 2. Stationarity test results

NG-Perron test								
series	MZ_a		MZ_t		MSB		MPT	
	statistic	5% CV	statistic	5% CV	statistic	5% CV	statistic	5% CV
U_gap_t	–7.731	–17.30	–1.955	–2.910	0.252	0.168	11.811	5.480
G_gap_t	–3.975	–17.30	–1.409	–2.910	0.354	0.168	22.915	5.480
$\Delta(U_gap_t)$	–23.40**	–17.30	–3.418**	–2.910	0.146**	0.168	3.904**	5.480
$\Delta(G_gap_t)$	–18.19**	–17.30	–2.987**	–2.910	0.164**	0.168	5.185**	5.480
Kapetanios test								
series	statistic		break years				5% CV	
U_gap_t	–5.817		1977–1988–1994–2000–2006				–8.343	
G_gap_t	–6.638		1983–1990–1996–2002–2008				–8.343	
$\Delta(U_gap_t)$	–10.840**		/				–8.343	
$\Delta(G_gap_t)$	–9.041**		/				–8.343	

** Significant at $p < 0.05$; Δ denotes the first difference operator. CV denotes critical values.

Source: own calculations.

Co-integration test results

After confirming that all the variables are integrated of order one, we proceeded the co-integration analysis to test the long run relationship between the two gaps in our study, and dissimilar to the prior studies we used the modern test proposed by Maki (2012) given the implication of the structural breaks in the co-integration investigation. This test allowed us to detect the existence of several breaks (five breaks) (Ayad, Belmokaddem, 2020). The results are described below in Table 3, and it is clear that the absolute values of the test statistic in the four equations are more significant than the absolute values of the critical values obtained from the original paper of the test. Hence, the null hypothesis of no co-integration is strongly rejected, this outcome reveals the long run connection between unemployment and GDP gaps under five structural breaks, and it is important to know that these break dates are consistent with the Algerian economy especially with the oil price movements and the black decade between 1990 and 2000. In this case, we used the results of the last equation (trend and regime shifts model) that has six elements including intercept, intercept dummy, trend, trend dummy, independent variable and independent variable dummy to estimate the long run elasticities using FMOLS and DOLS estimations.

Table 3. Maki co-integration test results

Models	Statistic	Break years	1% CV	5% CV
Equation (01) level shifts model	–9.962**	1980–1985–1992–1997–2013	–5.959	–5.426
Equation (02) level shifts with trend model	–10.147**	1977–1982–1989–1997–2009	–6.193	–5.699
Equation (03) regime shifts model	–10.131**	1983–1989–1998–2007–2013	–6.915	–6.357
Equation (04) trend and regime shifts model	–11.248**	1977–1987–1995–2001–2013	–8.004	–7.414

** Significant at $p < 0.05$ levels using CV available in Maki (2012) while K = 1.

Source: own calculations

Long run estimations

After detecting the long-run association between the two variables with five structural breaks, we analysed the cointegration estimators to obtain the long-run coefficient of Okun's law. In this case, we used the FMLOS and DOLS estimation. Depending on the Maki test results, we estimated the trend and regime shifts model by taking into account the five structural breaks (1977, 1987, 1995, 2001, and 2013) with all the components of the equation as we described it above (intercept, intercept dummy, trend, trend dummy, independent variable, and independent variable dummy[1]). The outcomes are shown in Table 4. It is clear from the two estimation methods that the GDP gap's effect on the unemployment gap is not significant at a 5% significance level (neither in 10% for the DOLS estimator). This means that Okun's law is not held in Algeria's long run throughout the study.

Table 4. Long run estimation results

Variables	FMOLS estimation		DOLS estimation	
	parameters	probability	parameters	probability
1	2	3	4	5
G_gap_t	–0.009563	0.9571	–0.493000	0.2271
D_{1977}	–340.107100	0.7546	–662.309700	0.5396
D_{1987}	–920.326000	0.3359	–550.180200	0.5723
D_{1995}	–499.063800	0.7008	–996.057200	0.4545

[1] Intercept and intercept dummy denotes the constant term and the change on. Trend and trend dummy denotes the introduction of the trend variable in addition to the dummy variable of the effect of the structural change on the trend. Furthermore, Independent variable, and independent variable dummy represents our independent variables and the dummy variables of the association between these last and the structural changes as clarified in Table 4.

1	2	3	4	5
D_{2001}	4045.861000	0.0008	4308.878000	0.0004
D_{2003}	–3957.935000	0.0000	–4055.400000	0.0000
$G_gap_t * D_{1977}$	0.193520	0.5856	0.519436	0.2361
$G_gap_t * D_{1987}$	–0.899951	0.0767	–0.946224	0.0611
$G_gap_t * D_{1995}$	0.588195	0.6416	0.463147	0.7111
$G_gap_t * D_{2001}$	–0.796893	0.5222	–0.530661	0.6689
$G_gap_t * D_{2003}$	1.038676	0.1518	1.010966	0.1580
$T * D_{1977}$	0.170976	0.7562	0.334276	0.5408
$T * D_{1987}$	0.466256	0.3327	0.279963	0.5680
$T * D_{1995}$	0.253137	0.6972	0.501793	0.4519
$T * D_{2001}$	–2.024038	0.0007	–2.155433	0.0004
$T * D_{2003}$	1.968700	0.0000	2.016973	0.0000
C	6.632923	0.0022	6.148163	0.0060
T	–0.546259	0.2531	–0.618339	0.1925

Source: own calculations.

Causality analysis

The following step is to look at the causal relationship between the two variables of the study. For this reason, we used different tests to account for different cases of causality; the first test is Hacker-Hatemi-J symmetric test with critical bootstrap values, the second is Hatemi-J test with an asymmetric causal relationship. The last test is the Breitung-Candelon test in a frequency domain analysis to deal with both short and long-run terms (Ayad *et al.*, 2019). The results are reported in Table 5 (for Hacker-Hatemi-J and Hatemi-J tests) and Figure 1 (for Breitung-Candelon test). There is no evidence of any causation between the two variables at any significance level with the two-time domain tests. Noticeably, all the statistics are lower than the critical values at a 5% significance level, meaning that there is no 5% evidence of any causation among our variables. This latter means that we do not have enough proof to conclude that the GDP gap (unemployment gap) does not cause the unemployment gap (GDP gap) both with the normal, positive or negative components. The same result is obtained with the frequency domain analysis where there is no causal link among the two variables at any frequency level from 0 to π.[2]

[2] The variables are in first differences to remove the unit roots and structural breaks using the stationary series to avoid any spurious results.

Table 5. Causality analysis tests

Causality direction	Statistic	1%	5%	10%
U_gap_t to G_gap_t	0.390	9.636	6.217	4.715
G_gap_t to U_gap_t	14.495	30.255	16.824	12.318
$G_gap_t^+$ to U_gap_t	0.910	48.034	21.351	15.486
$G_gap_t^-$ to U_gap_t	11.760	34.050	18.080	13.169
$U_gap_t^+$ to G_gap_t	5.585	15.666	10.299	8.129
$U_gap_t^-$ to G_gap_t	2.365	17.125	11.367	7.265

Source: authors' calculations.

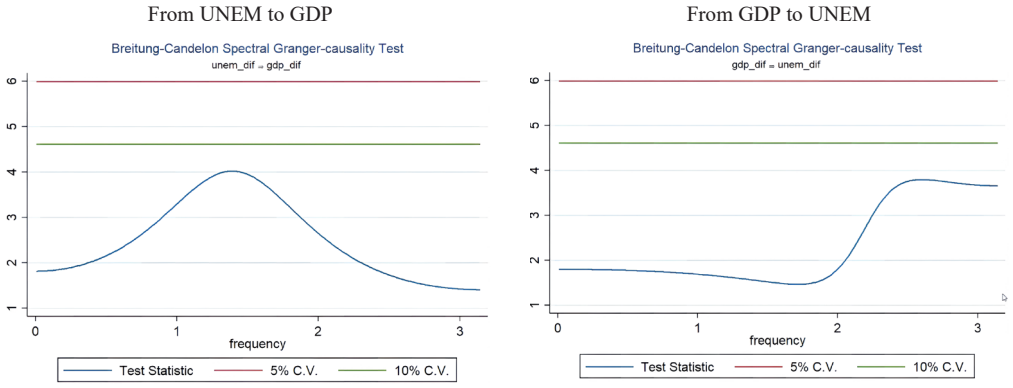


Figure 1. Frequency domain causality results

Source: authors' calculations

4.2. The difference version of Okun's Law

Unit root test

Usually, the stationarity circumstances in the time series leads to spurious results in both the co-integration analysis and the estimation results. Thus, we used the ADF and PP tests to inspect the stationary behaviour of the variables without structural breaks. Besides, we depended on the Kapetanios test to verify the existence of structural breaks. The results inspired from Table 6 illustrate that both variables are stationary at their levels without any structural break nor unit-roots. These findings mean that the two differences series are integrated in order (0) and there is no long run connection between them. Thus, we used the quantile regression in the following step.

Table 6. Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Unit Root Tests

Variables	ADF		PP	
	statistic	probability	statistic	probability
U_dif_t	–6.145***	0.000	–6.352***	0.000
G_dif_t	–12.791***	0.000	–24.033***	0.000
$G_dif_t^+$	–6.973***	0.000	–6.989***	0.000
$G_dif_t^-$	–16.478***	0.000	–11.525***	0.000
Variables	Kapetanios test			
	statistic	5% critical value	breaks	
U_dif_t	–10.840***	–8.343	1977–1983–1991–2000–2006	
G_dif_t	–9.950***	–8.343	1981–1988–1994–2001–2009	
$G_dif_t^+$	–12.226***	–8.343	1977–1985–1993–2000–2006	
$G_dif_t^-$	–28.902***	–8.343	1978–1984–1992–1998–2005	

*** Significant at $p < 0.01$.

Source: own calculations.

Quantile regression analysis

Considering the absence of the long run association between the series and related to some recent studies (Albulescu *et al.*, 2019; Zmami, Ben-Salha, 2020). We used the Quantile estimation presented by Koenker and Bassett (1978) using the robust estimator developed by

Table 7. OLS and quantile regression results

Symmetric effects of G_dif										
Varia	OLS	10^{th}	20^{th}	30^{th}	40^{th}	50^{th}	60^{th}	70^{th}	80^{th}	90^{th}
C	–0.21 (–0.69)	–2.53** (–2.89)	–1.76** (–2.82)	–0.68** (–1.61)	–0.29 (–0.65)	0.01 (0.02)	0.41 (1.48)	1.00** (3.77)	1.33** (3.66)	1.69** (3.72)
G_dif	0.03 (1.06)	0.08 (1.83)	0.06 (0.77)	0.03 (0.21)	0.02 (0.42)	0.01 (0.10)	0.005 (0.79)	–0.009 (–0.38)	–0.018 (–0.37)	–0.005 (–0.02)
Asymmetric effects of GDP										
C	–1.788 (–1.148)	–4.75 (–1.68)	–5.15 (–1.63)	–3.922 (–1.29)	–1.57 (–0.54)	–0.17 (–0.06)	1.07 (0.47)	3.02 (1.24)	4.30 (1.51)	2.925 (0.744)
$G_dif_t^+$	0.065* (1.844)	0.090 (1.985)	0.098 (0.890)	0.077 (1.186)	0.037 (0.758)	0.013 (0.279)	–0.007 (–0.16)	–0.040 (–0.55)	–0.06 (–0.41)	0.03 (0.24)
$G_dif_t^-$	0.063* (1.99)	0.08 (0.93)	0.08 (0.77)	0.06 (1.18)	0.03 (0.99)	0.014 (0.42)	–0.001 (–0.04)	–0.03 (–0.44)	–0.04 (–0.30)	0.05 (0.37)

(·) denotes the Student's t statistic. Significant at: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.; 10^{th}, 20^{th}, …, 90^{th} are the quantiles.

Source: authors' calculations.

Koenker and Zhao (1994) and OLS estimation to compare the two different types of estimation. The results are presented in Table 7. The OLS estimator reveals that the coefficients were statistically non-significant both for the symmetric and asymmetric estimation. The quantile estimators confirmed these results for both symmetric and asymmetric estimation in all of the quantiles. For this reason, we can conclude that Okun's law is not valid in the Algeria economy throughout the study for both the gap model and difference model.

Conclusion remarks and policy implications

Focusing on annual data covering the period between 1970 and 2020 in the Algerian context, and using a set of new econometric approaches, this study examined the presence of Okun's law in the Algerian economy. As a result, the study tested both the gap model and differences model depending on the structural breaks analysis for the first model by applying the NG-Perron and the Kapetanios unit root tests with structural breaks and the Maki (2012) co-integration test with five breaks. On the other hand, in the second model, and since our series were integrated into order 0 we performed the OLS estimation and the quantile regression presented by Koenker and Bassett (1978). Consequently, the paper's main contribution is the use of symmetric and asymmetric analysis for the two models to test the hidden causality for the gap model and examine the asymmetric effects of negative and positive output changes on unemployment in the difference model.

The outcomes revealed that Okun's law is not valid in the Algerian economy for the two models. Despite the long-run association between the gaps obtained from the two series with five structural breaks, there was no evidence of any significant effects from output to unemployment neither for both a symmetric and an asymmetric causal relationship between them. The same results were obtained from the difference model, where there was no significant effect from output to unemployment at any quantile. These results suggest that Algeria's output and unemployment are unrelated, and economic growth gains do not translate to a shrinkage in the unemployment rates.

The invalid Okun's law in Algeria is not a surprising result due to many reasons. Firstly, Algeria's unemployment is not cyclical and is neither correlated with the economic cycles and recessions nor economic prosperity. Whereas, we can say that unemployment in Algeria is structural and frictional rather than cyclical, which means that jobless people are unemployed because of the nonexistence of job opportunities not because of recessions. This is mainly because of the absence of employed sectors such as industry, tourism, and services (the latter

remains very limited). Secondly, Algeria's main source of jobs is the public sector, with the almost full absence of the private one in the labour market. In this case, the jobs are safe and protected by the labour laws and by the government's regulation unlike in developed countries such as the USA, European countries, Japan, Australia, and many others. In these countries, the private sector plays a dominant role in the labour market and it can easily make workers redundant in the case of a recession. It can provide many jobs in economic prosperity. Finally, the Algerian economy is a uni-sectorial economy where the oil sector is the dominant sector with more than 30% of GDP, 60% of budget revenues, and with approximately 95% of export income. For this reason, the oil-exporting countries cannot offer many job opportunities counter to multi-sectorial economies where we found a high Okun coefficient as confirmed in several studies.

Within this framework, given the nullification of Okun's law in Algeria and giving the results obtained in the present paper, several implications are suggested:

1. Algeria should search for new sources of growth through relying on the contribution of private investment to improve the maintainable growth rates of the economy;
2. It is necessary for the government in Algeria to review its various policies to draw more attention to create small and medium enterprises and deliver incentives to reduce dependency on imports;
3. Decision-makers need to pay attention and to introduce knowledge-intensive services in some labour-intensive sectors such as agriculture, tourism and service sectors;
4. It is also suggested to rethink the monetary and fiscal policies with well-defined objectives aimed particularly at decreasing public debt and promoting GDP growth in the country;
5. The Algerian policy makers have to re-orientate the government expenditure to stimulate job creation and respond to the requirements of the labour market.

Appendix A

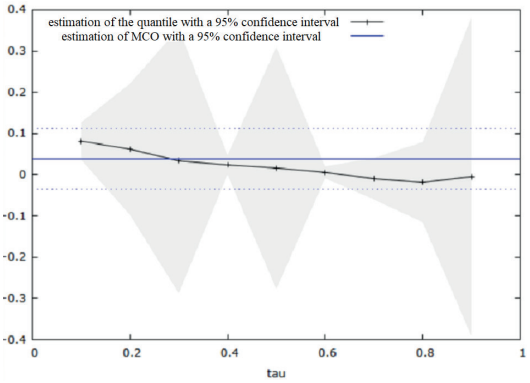


Figure A1. The symmetric impact of GDP on UNEM across quantiles

Source: own elaboration.

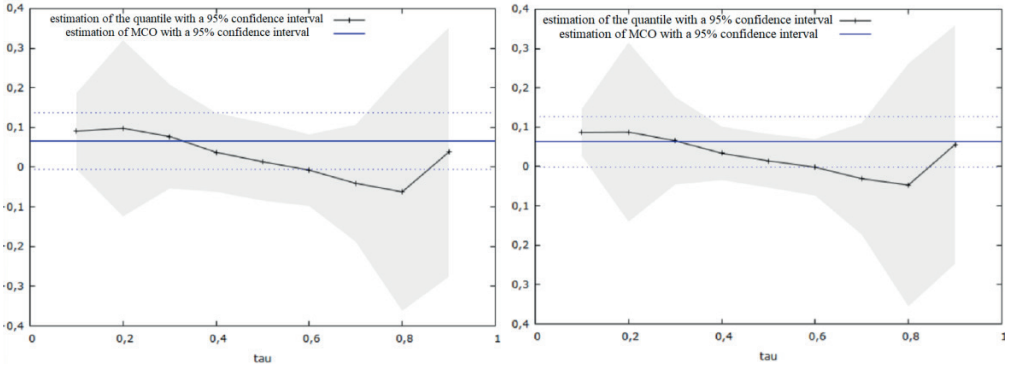


Figure A2. The asymmetric impact of GDP on UNEM across quantiles (GDP positive and negative)

Source: own elaboration.

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