



Okun's Law amidst Crisis: Analyzing Morocco's Experience during COVID-19

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Abstract: Our study delves into the far-reaching impact of the COVID-19 pandemic on Morocco's economic growth and labor market. Our investigation centers on the examination of Okun's law, to assess the validity of this law in the context of Morocco, we employ both traditional OLS and an M-robust estimator. By comparing estimates before and after incorporating statistical observations associated with the COVID-19 pandemic, we gain valuable insights into how this unprecedented global crisis has affected the country's labor market dynamics, and within a rolling regression framework, we explore the stability (or lack thereof) of Okun's coefficient over time. This dynamic approach allows us to capture the evolving relationship between economic growth and unemployment during different phases of the business cycle. Our research substantiates the validity of Okun's law in the Moroccan context, indicating that the well-established principle continues to hold significance. However, our findings also reveal a noteworthy aspect - the instability of the Okun's coefficient over time in Morocco. This instability suggests that the association between changes in unemployment and economic growth in the country is subject to shifts and fluctuations, likely influenced by various economic and policy factors. One crucial discovery from our study is the identification of asymmetries in the trends and shocks associated with the magnitude of the Okun's coefficient. Specifically, when accounting for the most recent major economic slowdown caused by the COVID-19 pandemic, we observe distinct patterns that deviate from the norm. This insight can provide critical information for policymakers and economists in devising targeted strategies to address unemployment concerns during challenging economic times.

Keywords: Okun's law; Covid-19; GDP growth; Unemployment rate; Robust linear model; Rolling regression.

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1 Introduction

In recent decades, the world has witnessed two significant external shocks that have had detrimental effects on countries worldwide. The first major downturn stemmed from the 2008 financial crisis, which originated in the United States due to the housing bubble and a contraction of liquidity in the global financial markets (Andrew G. Haldane, 2009; Stijn Claessens et al, 2013). This crisis had far-reaching consequences, causing economic

disruptions in numerous countries. The second and most substantial downturn resulted from the COVID-19 pandemic's impact. In response to the need to contain the spread of COVID-19, reduce fatalities, and alleviate pressure on healthcare systems, many governments opted to implement national or local lockdowns. However, this policy choice had severe negative ramifications on the local and national economies of numerous countries, as well as the global economy, given the interconnectedness of firms operating across different nations (e.g., Mandel and Veetil, 2020; Bonadio et al, 2021; PlzÁková and Smeral, 2022).

An economic shock represents a significant shift in macroeconomic variables. Economists strive to comprehend the characteristics and societal impacts of these events on the productive system and labor market, recognizing that not all recessions and recoveries are the same (Schmidhuber and Qiao, 2020; Gelfer, 2020; Donayre, 2022). Understanding these dynamics is vital for devising effective policies to mitigate downturn effects, restore economic growth, and promote job creation.

The very robust response of the Moroccan labor market to the sharp economic downturn in 2020 due to the Covid-19 crisis, as it experienced no such increase in the unemployment rate since 2003, invokes discussion on the functional connection between economic output and labor market developments. In this regard, Okun's law (Okun, 1962) provides some intriguing insights, revealing an inverse connection between unemployment and a country's productivity, offering valuable guidance for policymakers.

The underlying logic behind Okun's law is that when an economy is growing rapidly, businesses are expanding, investing, and hiring more workers. This increased economic activity reduces the number of unemployed individuals seeking jobs, leading to a decline in the unemployment rate. Conversely, during economic downturns or recessions, businesses tend to scale back their operations, resulting in layoffs and higher unemployment rates. It's important to note that Okun's law is an empirical relationship and is subject to certain limitations and variations across different countries, time periods, and economic conditions. The applicability of Okun's law can be influenced by various factors, including structural characteristics of the labor market, policy interventions, technological advancements, demographic factor, and external shocks. While Okun's law provides a useful framework for understanding the relationship between GDP growth and unemployment, it does not capture all the complexities of the labor market. Nevertheless, it remains a widely cited concept in macroeconomic analysis and helps policymakers assess the potential impact of economic growth on unemployment levels.

In this study, our focus revolves around scrutinizing the validity and stability of Okun's coefficient within the Moroccan economy over time, particularly during the period spanning from 1992 to 2022, which also encompasses the years impacted by the recent global pandemic, Covid-19. Our analysis delves into a comparison of the state of the Moroccan economy before and during the pandemic, encompassing the significance and magnitude of Okun's coefficient. Additionally, we explore how this coefficient was perturbed or permanently affected by the crisis.

We employ the first-difference model to estimate Okun's coefficient. To ensure robustness, we utilize two distinct estimation approaches: ordinary least squares (OLS) and the M-robust estimator proposed by Menezes et al. in 2021. To comprehensively examine the impact of Covid-19 on the relationship between Okun's coefficient and the Moroccan economy, we conduct two sets of estimations. Initially, we estimate the model using the entire sample period, followed by a specific analysis focused on the period preceding the Covid-19 pandemic. To account for the cyclical nature of economic data, we employ a rolling regression framework with a window size of 15 terms, aiming to encompass at least one business cycle, as advised by Moosa (1997), Knotek (2007), and Zanin and Mussida (2022). A novel aspect of our approach is the application of the robust estimator, which addresses potential outlier patterns within time series data that might influence OLS estimates. By implementing the robust estimator, we aim to segregate influential observations from the rest of the data, thus reducing the impact of outlier events on our analysis. We estimate Okun's coefficient accurately relying on reliable time series data for the unemployment rate and real GDP growth, obtained from the World Bank (2023).

When evaluating Okun's coefficient across the entire period of analysis (1992–2022) and comparing the outcomes from analyzing the period before COVID-19 (1992–2019), no statistically significant deviations are observed in the inferred relationship. We also find that incorporating a robust estimator aids in mitigating the impact of certain outlier patterns. Upon delving into the results of rolling regression analyses, the instability of Okun's coefficient over time becomes evident. Notably, there is an upswing in the magnitude (measured in absolute terms) of Okun's coefficient during the early 2000s, attributed to various government policies. Specifically, labor market enhancements, such as the establishment of The National Agency for the Promotion of Employment and Competencies (ANAPEC) in 2000, along with the development and publication of the Moroccan Labour Code in

2004, have substantially shaped the labor market's operation. Following this trend, two important perturbations in the coefficient's magnitude are detected during 2015–2016 and 2020–2021 (attributed to the COVID-19 pandemic). More precisely, the first perturbation in the trend led to a reduction (in absolute terms) of Okun's coefficient magnitude, causing the estimated parameter's statistical significance to diminish. Conversely, the economic slowdown induced by COVID-19 resulted in an amplified magnitude (measured in absolute terms) of the coefficient, all while retaining its statistical significance.

In the broader context, the reactions of unemployment to alterations in output do not exhibit uniformity when confronted with external shocks, and a similar diversity characterizes the recoveries from economic downturns. While some insights can be gleaned about whether Okun's coefficient has encountered a structural or transitory shock, or whether the financial crisis has yielded a noteworthy change in magnitude, drawing definitive conclusions remains hasty when considering estimates that encompass the COVID-19 period.

Morocco has taken measures to address the economic challenges posed by the pandemic, including a reduction in its key interest rate to 1.5% and the allocation of 3.3 billion dollars. The nation has also expeditiously implemented job-retention programs to safeguard workers from potential waves of job losses. These initiatives have effectively mitigated the immediate impact of the pandemic on employment and GDP growth, albeit within a temporary timeframe. As these (temporary) strategies reach their conclusion, the potential exists for the connection between the labor market and economic growth to have undergone noteworthy changes; a return to its pre-COVID condition could be anticipated. However, this notion is based on conjecture, and the validation of this hypothesis hinges on forthcoming research in the years ahead.

The subsequent sections of this paper are structured as follows: The first section elucidates the theoretical backdrop, followed by the second section delving into the empirical context. Thereafter, the third section presents key observations concerning Morocco's stylized facts, while the fourth section outlines the conceptual framework employed to estimate Okun's coefficient. Progressing, the fifth section accentuates the primary empirical findings and ensuing discussions, culminating in the final section where the principal conclusions are presented.

2 Theoretical Background

Amidst the emergence of the COVID-19 pandemic in 2020 and the subsequent disruptions to labor markets worldwide, there has been a renewed focus on the varying degrees of strength within Okun's relationship. Okun's law serves as a crucial bridge connecting the market of goods and services with the labor market. It is reasonable to assume that the impact of economic growth on labor market performance is positive. Nevertheless, this effect may be delayed over time due to the necessary duration for employers to identify and onboard new personnel. Additionally, firing workers and hence giving up or losing (company-specific) human capital is another reason for time lags, as employers might hesitate with dismissals. Factors such as employment protection legislation and anticipations regarding the duration of economic downturns must also be considered.

Many economic studies consider the relationship between economic growth and labor market development but in the center of this vast literature is Arthur M. Okun's pioneering article (1962) " Potential GNP & Its Measurement and Significance " which defines the foundations of the concept of potential output, the purpose of the American economist's research was to provide the USA's decision-makers with a tool to predict the impact of the labor programme on output growth (Okun 1962).

Okun is known for the law that bears his name: OKUN's law, also referred to as the OKUN coefficient. It is an empirical established relationship between change in cyclical unemployment and GDP growth. This law was the origin of the tax reduction program that was initiated by President J. Kennedy. Okun believed that the potential output should not be defined as the maximum output the economy could (unconditionally) produce. Instead, he argued that the potential should be measured at full employment, which he characterized as the level of employment absent inflationary pressures, or the level of the non-accelerating rate of unemployment (NAIRU). Consequently, at the business cycle frequency the deviations of unemployment from a level such as the NAIRU could be correlated with the deviations of output from its trend.

Using quarterly data from the second quarter of 1947 through the fourth quarter of 1960 from the American economy, Okun manages to show that there is a difference between the unemployment rate at its natural level and the growth rate of the gross national product (GNP) concerning its potential level in the context of cyclical fluctuations a simple inverse linear relationship of approximately 1:3, i.e. a one percent increase in the unemployment rate would decrease the real output growth by approximately three percent and conversely (a negative correlation between changes in the unemployment rate and changes in output growth). This relationship captures how output growth varies simultaneously with changes in the unemployment rate and it can be empirically described as follows:

$$\Delta U_t = \alpha^d + \beta^d \Delta Y_t + \varepsilon_t^d \quad (1)$$

Where ΔU_t stands for change in unemployment from the previous to current period at time t , ΔY_t stands for change in GNP growth from the previous to current period at time t , α is the intercept that can be defined as unemployment change when the GDP growth remains zero from the previous period, β is the Okun's coefficient, how unemployment reacts to changes in GDP growth, ε is the error term that detects all other effects, and because we consider alternative specifications later in the article, the superscript **d** indicates that these coefficients are specific to "the difference" specification.

In addition to equation (1), Okun estimated "the gap" version that relate two components: the gap between the actual unemployment rate and the non-accelerating inflation rate unemployment (NAIRU) as the explained component, and the gap between potential and actual output, as an explanatory component, for a quarterly sample from the first quarter of 1953 to the fourth quarter of 1960:

$$U_t = \alpha^g + \beta^g (Y_t - Y_t^n) + \varepsilon_t^g \quad (2)$$

Where Y_t is real GNP, Y_t^n is potential GNP ($Y_t^g = Y_t - Y_t^n$) is the output gap).

Based on the sample period considered, he reported that a three percent negative deviation of output from its trend is associated with a one percent increase in the unemployment rate. In this case, the constant represents the natural rate of unemployment—the rate at which the output gap is zero.

Okun's relationships arise from the observation that more labor is typically required to produce more goods and services within an economy. More labor can come through a variety of forms, such as having employees work longer hours or hiring more workers. To simplify the analysis, Okun assumed that the unemployment rate can serve as a useful summary of the amount of labor being used in the economy.

3 Empirical background

A vast amount of empirical research since the seminal paper of Okun (1962) and Smith (1976) has investigated the relationship between GDP growth and changes in the unemployment rate in different countries and historical periods, using several estimation approaches. Whether it is about studies that suggest that Okun's coefficient exhibits asymmetric patterns when comparing recession and expansion periods. Others suggest that the coefficient varies in magnitude over time and across countries and by the age and gender of the unemployed. Other studies have instead focused on the sensitivity of Okun's law in the presence of macro shocks, without neglecting those who suggest that not all downturns and recoveries are equal and that investment and financial shocks affect the labor market more than shocks to productivity.

The simple empirical relationship has come under fire for its lack of a theoretical foundation. Plosser and Schwert (1979) show that the standard interpretation of the textbook specification of Okun's law has faulty econometric foundations. They show that inverting of Okun's law (switching the dependent and independent variables) does not necessarily yield reversible results. Consequently, with simple algebra, the authors show that the inversion of the slope coefficients is valid only when the variables GDP growth and changes in the unemployment rate are perfectly correlated—that is, if the relationship between the two variables is deterministic.

Okun's law was formulated in the heydays of Keynesian economics, with the focus of this relationship being on Keynesian unemployment (Knoester, 1986). Which means the examining of Okun's law takes in consideration the traditional Keynesian assumption that output supply is primarily driven by output demand in the short-run. This seems to be the basic idea and hence the implicit assumption behind Okun's emphasis on the indirect or induced effects.

Several studies have attempted to provide some analytical framework to Okun's law, in this sense Knoester (1986) and Kaufman (1988) provided the early evidence on cross-country differences in the Okun's coefficient. In his empirical study Knoester in 1986 investigated the validity of Okun's law for some economies and stated that the law was not enough to explain the high rates of unemployment in Europe, especially after the 1970s. Kaufman (1988) estimated the cyclical responses of unemployment rate to output shocks among six industrial countries by testing the Okun's law before and after the 1970s oil shocks. He concluded that the output elasticity of employment significantly increased after the outbreak of the oil crisis. He also pointed to the role of institutional and related features of the labor market and the goods market as potential reasons for the instability of Okun's law across time and country.

Moosa (1997) reexamined Okun's law for the G7 countries. He examines the cross-country differences by extracting the cyclical components of unemployment and output, testing for an individual structural break in 1973 and examining the behavior of the rolling Okun's coefficient. The author concludes that employment is more responsive to economic growth in the USA than in the European countries. Which can be explained by the institutional differences that determine the flexibility or rigidity of a country's labor market.

In 2008, Moosa tested the validity of Okun's law in four Arab countries: Morocco, Algeria, Egypt and Tunisia. He found that output growth does not translate into employment gains for the four countries, which means that Okun's coefficient turns out to be statistically insignificant due to structural unemployment and the rigidity of the labor market and that a policy oriented to the promotion of professional and vocation training, and the fight against the rigidities within the labor market, are needed to reduce the unemployment.

Lee (2000) tried to investigate the existence of the Okun's law, and to measure its intensity and robustness, in 16 OECD countries (Organization for Economic Co-operation and Development), on post-war data (1955-1996). Its results were in favor of the validity of the Okun's law in this set of countries. However, the author noted a decrease in its intensity relatively to the results reported by a later study of Okun (1970). He also noted the sensitivity of the found results to the methods of estimation and of decomposition (point also made by Weber (1995)).

At the regional level using Baxter King Band pass filter (which is "a recent development in trend-cycle decomposition of economic time series" that helps smooth business cycle fluctuations), Freeman (2000) tested the Okun's law for the eight US regional economies during the period 1958-1998. Its goal was to analyze regional differences with regard to the effect of production growth on unemployment reduction. The author finds that interregional differences in how unemployment reacts to output are not significant and that pooled estimates of regional data are consistent with the national estimates that are obtained from aggregate data. The authors stressed, however, a certain sensitivity of the results to the methods of decomposition of growth and unemployment series. In addition, he showed that some indicators such as the presence of more flexibility within the labor market, the qualification level of the workforce, and the non-manufacturing sectors share in total employment affect the value taken by the Okun's coefficient in each State.

Freeman (2001) tested Okun's law for ten industrial countries (US, UK, Japan, Canada, Germany, Italy, France, Netherlands, Sweden, Australia) including new developments with trend decomposition and found that Okun's coefficient which was originally three points is now only less than two point's growth in GDP for every one percent change in unemployment rate for selected countries. Freeman (2001) and Furceri et al (2020), further support the conclusion that unemployment tends to be much more reactive to output shocks in the US than in Europe.

In his working paper *How Useful is Okun's Law?* Knotek (2007) investigated the usefulness of Okun's law for economists and policymakers by representing all the available data for the USA during the time period 1948 to 2007 and then examining the regression between the GDP rate and unemployment rate. Knotek pursues to answer two questions. Is Okun's law a reliable and stable relationship? Is the law a valuable forecasting tool? Using the dynamic version of the law that originally proposed by Okun, knotek came to the conclusion that the law is not a structural feature of the economy but only a rule of thumb (a statistical relationship). According to Kontek (2007) Okun's law is not a tight or a stable relationship since it is partly connected to the business cycle and the relationship between GDP growth and unemployment rate is different during economic expansions and recessions. He meant that there had been many instances where GDP growth slowdowns have not coincided with rising unemployment rate. Knotek documents that the estimates underlying Okun's law varied over time and over the business cycle. He associates changes in Okun's coefficient with business cycles in the United States: The coefficient is, on average, smaller (in absolute value) in expansions than during recessions pointing to the fact that unemployment responses differently to economic growth during different phases in the business cycle. The researcher also finds that the contemporaneous correlation has decreased over time, while the dynamic correlation with the lagged values of output growth measures has increased. Furthermore Knotek explained that, to keep the unemployment rate constant the GDP growth had to reach four percent and established that zero growth of output concurred with an increase in unemployment rate of zero-point three percent. Knotek's (2007) study also shows that Okun's law can be a useful forecasting tool but that its instability has to be taken into account.

The study of Ezzahidi and El Alaoui (2014) highlights the connection between employment and economic growth, particularly in the long term. It emphasizes that boosting growth is essential for reducing structural unemployment. Any approach aimed at lowering unemployment should be well-informed about the job-creating potential of economic growth. The paper employs concepts like Okun's law, arc point elasticity, and a basic econometric model to analyze the relationship between economic growth and unemployment in Morocco. Okun's law supports the idea that economic growth in Morocco corresponds to a decrease in the unemployment rate. However, different sectors vary in their ability to generate jobs, leading to inconsistent outcomes. By assessing elasticity over the period 1999-2009, the study reveals that several sectors experienced a net loss of jobs. Overall, while the connection between growth and employment is positive, the employment's responsiveness to growth is moderate. El Aynaoui and Ibourk in 2016, tested how unemployment reacts to economic growth in 46 African countries. The study focuses on estimating and validating the Okun's coefficient, which quantifies this relationship, and evaluating its strength. The results indicate that, in most of the countries examined, there is a weak or no significant connection between GDP growth and unemployment. This contrasts with findings from advanced economies where the Okun's law tends to hold (ball et al, 2013). The diverse economic structures and labor market configurations of these countries explain these differences. The study also seeks to uncover the factors behind the variability of the Okun's coefficient in Africa, finding that demographic factors, domestic market competition levels, and the rule of law

play significant roles. In the case of Morocco, growth volatility emerges as an important factor. The study emphasizes the importance of considering growth structure, creating composite indicators to measure inadequacy, understanding the informal sector, identifying suitable proxy variables, and testing the linearity of the Okun's law for future research and methodological advancements.

In recent study, Ball et al. (2017) analyze the stability of Okun's law and the adaptability of short-term unemployment in the United States and in 20 advanced economies (OECD). They used the HP filter as a filtering technique also included two lags of the output term. They assume the output-unemployment relationship to be only short-run and hence do not test for more than two lags (e.g. the gestation period of the output shock is less than one year). Ball et al. (2017) conclude that the output unemployment nexus is relatively strong and stable in most countries over time, as well as that this relationship does not fundamentally change due to crises. They note that the Okun's coefficient is larger in recessions than during expansions. This evidence is seen as consistent with standard models in which fluctuations in unemployment are driven by aggregate demand shocks.

Recently in his paper "Re-evaluating Okun's Law: Why all recessions and recoveries are 'different'", Gelfer (2020) using a structural DSGE model and a data-rich estimation approach analyzed the impact of different economic shocks on the relationship between GDP and unemployment. According to the results he obtained, a decrease in investment as a component of GDP by 1% increases unemployment by about 0.5%, while productivity shocks of 1% increase unemployment by about 0.15%. Which, according to him, implies that not all downturns and recoveries are equal and that investment and financial shocks have larger effects on employment growth and the unemployment rate (the labor market) when compared to productivity and other supply-side shocks. The researcher suggests that macroeconomic shocks are an important cause when observing the relationship between GDP and unemployment.

In 2021 using data for the US and instrumental variables regressions method, Ziegenbein studies the effects of six types of macroeconomic shocks (government spending, tax, monetary policy, financial, technology, and oil shocks) on Okun's elasticity, put differently how much the unemployment rate falls when output increases by one percentage point because of a specific macroeconomic shock. He finds that the Okun elasticity is largely stable across shocks, but subtle differences emerge: the elasticity is larger for financial shocks and the speed at which unemployment adjusts relative to output depends on the shock driving fluctuations. A major conclusion is that while GDP and employment declined with similar speed during a recession, output recovered faster than employment, thus giving rise to the term "jobless recovery".

Finally, in their article 'Asymmetry and (in-)stability of Okun's coefficients in some European countries', Mussida & Zanin (2022) investigated the behavior of the unemployment/GDP relationship due to the shocks produced by the COVID-19 virus pandemic in some European countries from 1981 to 2021. They compared estimates using traditional OLS and an M-robust estimator within a rolling regression framework to explore the (in-) stability of the coefficients over time. The research confirmed the validity of Okun's law and its instability over time in the investigated countries, except for Norway, where the relationship between changes in the unemployment rate and GDP growth is relatively stable. They noted some asymmetries in the trends across countries, reflecting differences in labor markets and productive systems. They also find some asymmetries and (temporary) shocks in the magnitude of the coefficient when including the most recent major economic slowdowns in the analysis, namely the Great Recession and the COVID-19 pandemic.

Mussida & Zanin (2022) concluded, that the shock in Okun's coefficient caused by the pandemic and the reduction of economic activity was most pronounced in the economies that had the largest decline in real GDP. However, this did not manifest itself through a significant increase in unemployment due to the programs that were undertaken.

4 Stylized facts

The Moroccan economy is a diverse and evolving landscape that reflects a blend of traditional sectors and modernization efforts. Morocco, boasting a population of 37 million, maintains a mixed economy that incorporates aspects of both market-oriented policies and government intervention. It is classified as a middle-income country with a per capita income of \$3528. The economy is characterized by a significant agricultural sector, which employs a large portion of the population (nearly 35%) and contributes to both domestic consumption and exports. The industrial and services sectors have been growing, with a focus on manufacturing, tourism, and financial services.

Morocco has pursued an open trade policy, with trade accounting for a substantial portion of its GDP. The country has entered into various trade agreements, including with the European Union (EU) – its primary trading partner, accounting for 49% of Morocco's trade in goods in 2022. Additionally, Morocco has sought to attract foreign direct investment (FDI) through incentives and economic reforms.

Despite its progress, Morocco faces several challenges. These include high unemployment rates, particularly among youth and women, income inequality, and a need for improved education and skills training. The country also grapples with water scarcity and climate-related vulnerabilities.

In recent years, Morocco has been actively pursuing economic diversification, digitalization, and sustainability as part of its long-term development goals. The government's commitment to economic reforms, investment in key sectors, and engagement with the international community continue to shape the trajectory of the Moroccan economy.

We sketch out the most relevant facts behind the evolution of annual GDP growth and changes in the unemployment rate over the 2000-2022 period in the country investigated Morocco. Figure 1 shows the plots of the time series.

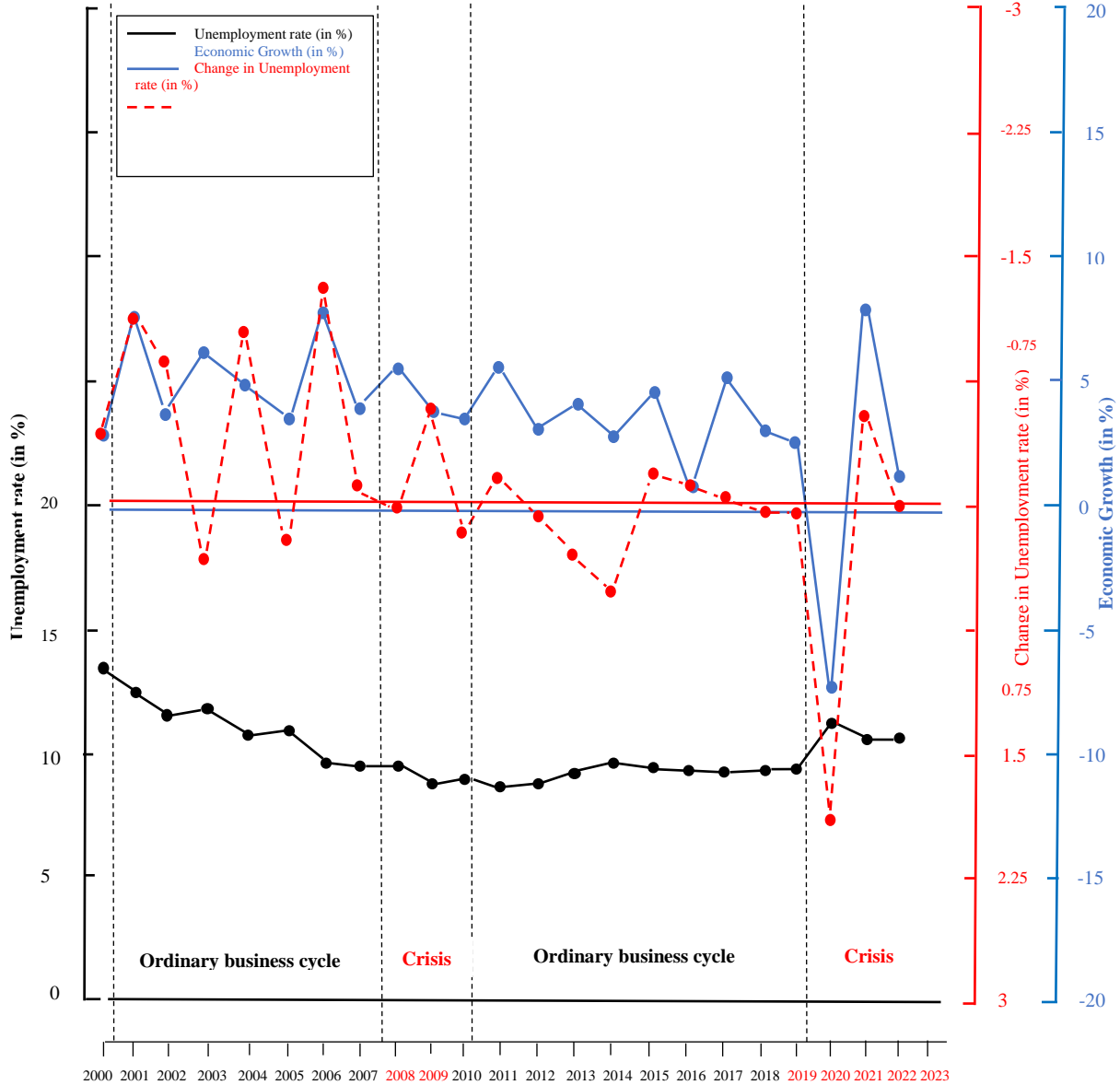


Figure 1. The evolution of annual GDP growth and the unemployment rate over the 2000-2022 period in Morocco.

Source: Authors

Despite the deteriorating financial situation in the US and Europe during the 2008 Great Recession, Morocco's economy displayed resilience. The banking credit in Morocco was still growing, the stock market was expanding, the economic growth was high and driven by domestic demand and public infrastructure and unemployment was declining, registering an increase of 2.24% in real GDP and of 0.01% in the unemployment rate. This positive trajectory was underpinned by a solid banking sector, a thriving local investor-dominated stock market, and controlled capital flow.

However, the post-recession period from 2011 to 2014 saw a rise in unemployment, escalating from 8.9% to 9.7%. The upturn only began in 2015, persisting until 2020, in the backdrop of moderate yet erratic economic growth. The year 2020 witnessed a significant setback, as the COVID-19 pandemic triggered a 7.2% GDP contraction due to external dependencies (European growth, insertion into global value chains, rainfall...) and confinement

measures. This was a more severe downturn than the one experienced in 1995 (5.4%). Correspondingly, a 1.9 percentage point surge in the unemployment rate ensued, attributed to governmental measures aimed at safeguarding workers from the virus.

As the economy rebounded with a 7.9% surge in 2021, the unemployment rate saw a decline of 0.6 percentage points. This trend continued into 2022, with the unemployment rate further dropping by 0.05 percentage points when it reached 1.1%.

5 Conceptual Framework

5.1 Data

To investigate the labor market response by means of unemployment rates in relation to economic output measured in real GDP growth, a data set with annual values from the year 1992 to 2022 is employed to include periods of economic growth and contractions of Morocco.

Regarding the source of the data used in our study, the World Development Indicators (WDI) database of the World Bank were processed to construct the real GDP growth and unemployment rate series for the economy of Morocco.

To control for differences in data history, we divide the period of investigation that we are looking at in our paper into two datasets, and observe the movement of Okun's coefficient:

- **Dataset A:** the first observation period is the entire data from 1992 to 2022, which includes data from the first year of the COVID-19 pandemic till the year of 2022. Accordingly, 2020 represent the start of economic downturn, i.e. the “Crisis”, in our analysis.
- **Dataset B:** the second observation period is from 1992 to 2019 and characterize this period as approximating a normal business cycle because Morocco remained relatively immune vis-à-vis the global financial crisis throughout 2008, in the same time a pre-crisis (COVID-19) period.

The time series of annual real GDP growth and changes in the unemployment rate are presented partially in Figure 1 and discussed as stylized facts previously. In general, the plots of Figure 1 allow comparing the magnitude of recessions and recoveries and the relative changes in the unemployment rate. In particular, we can note the deepest economic slowdown in Morocco of the last decade as being associated with the COVID-19 pandemic, to which government responded with different policy proposals aimed at supporting families and productive systems (e.g., Costa Dias et al., 2020).

To help further understand our datasets, Table 1 displays the summary statistics of the variables of interest.

Table 1. Summary Statistics.

Data / Statistics	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Sum	Sum Sq. Dev.	
Dataset A n=31	cUR	-0.07	-0.05	1.87	-1.34	0.60	0.49	5.24	7.78	0.02	-2.23	10.94
	GDPg	3.46	3.50	12.37	-7.18	4.11	-0.44	3.76	1.74	0.41	107.31	507.72
Dataset B n=28	cUR	-0.12	-0.03	0.61	-1.34	0.50	-0.85	3.13	3.39	0.18	-3.48	6.84
	GDPg	3.76	3.61	12.37	-5.40	3.68	-0.08	3.74	0.67	0.71	105.48	366.22

Source: Authors, Eviews

It emerges from this table that the variable changes in the unemployment rate (cUR) in dataset A is not normally distributed (Prob. JarqueBera < 5%) and in dataset B is normally distributed (Prob. JarqueBera > 5%), while the variable real GDP growth (GDPg) in both datasets A and B is normally distributed (Prob. JarqueBera > 5%).

5.2 The Empirical Model

The validity of Okun's law has been confirmed to a large extent, however, as we have already stated, there are significant differences that certain authors have confirmed when it comes to the universal validity of the law and its application.

The purpose of the research is to reveal the impact of the COVID-19 pandemic on Okun's law in the Moroccan context. The econometric model proposed to investigate the behavior of the Okun's coefficient through the pre-crisis period, and the observed period as a whole is the first difference model of the law (equation 1), despite the gap model because it was assessed that this method provides more accurate results and more suitable for empirical analysis using actual data.

The level of employment in an economy is closely intertwined with its growth trajectory. During the peak of the global Covid-19 pandemic in Morocco during 2020, the unemployment rate surged to its highest point in the past two decades. This surge in unemployment during the Covid-19 crisis is not coincidental, given the strong interdependence between economic activity and joblessness. Indeed, economic growth and unemployment are akin to two sides of a coin: heightened economic activity results in increased overall production, necessitating a larger workforce to meet the elevated demand for goods and services. Conversely, during periods of economic downturn, businesses tend to curtail their workforce, leading to an uptick in unemployment. This reciprocal relationship denotes that unemployment is countercyclical, meaning it rises during periods of low economic growth and vice versa. However, the reduction of unemployment doesn't directly mirror an upswing in growth. Typically, businesses initially strive to enhance productivity before recruiting new employees, which delays the decline in unemployment until after a robust economic recovery is underway. This phenomenon functions in reverse during the onset of a downturn, with businesses often opting to decrease work hours or implement pay cuts before resorting to layoffs. Consequently, a rise in unemployment materializes only when the downturn is protracted. Due to the time lag between unemployment and growth, the former is regarded as a lagging indicator of economic activity. This observation prompts the question of whether the assumptions underpinning Okun's law hold true in the Moroccan context. Additionally, it raises the issue of how resilient this relationship is in the face of economic crises.

The following table provides a specification of the variables used in the research:

Table 2. The Estimated Variable Sign Based on the theory.

Dependent Variable	Independent Variable	Expected Relationship Based on the Theory
changes in the unemployment rate	real GDP growth	-

5.3 Method

The initial phase of the analysis involves the estimation of equation (1) using the basic ordinary least squares (OLS) regression method for both datasets. This aims to capture the fundamental relationship between changes in Morocco's unemployment rate and its economic growth rate. This step serves a dual purpose: firstly, it validates data accuracy, and secondly, it establishes a benchmark against which partial outcomes can be compared with previous literature.

However, it's widely recognized that the classic ordinary least squares method may yield suboptimal results when confronted with outliers within the studied relationship. Notably, an outlier pattern surfaced in Moroccan data during the 2020 COVID-19 pandemic, as illustrated in Figure 1, showcasing a sharp decline in real GDP coupled with a spike in unemployment rates. To counteract the potential impact of these outlier patterns on estimates, equation (1) is reestimated using a robust linear model known as the M-estimator for both datasets. This methodology helps mitigate the influence of influential observations, as detailed in Menezes et al.'s work from 2021.

The subsequent stage of the analysis aims to capture potential variations in the Okun's coefficient magnitude over time. This is achieved through the application of equation (1) within a rolling regression framework, utilizing both the classic OLS method and the robust M-estimator. The core idea is to assess the parameter of interest across fixed time observation windows (k) of length δ . Following the examples set by Moosa (1997), Knotek (2007), Zanin and Marra (2012), and Zanin and Mussida (2022), δ is set to 15 to ensure coverage of at least one business cycle within each estimation window. When the estimated magnitudes of the Okun's coefficients are relatively consistent, it suggests a stable relationship over time. Conversely, if they exhibit variability, the relationship is deemed unstable.

Preceding this two-part analysis, a thorough evaluation of the underlying data properties is imperative to accurately specify model components. The stationarity of the data warrants initial attention, and the Augmented Dickey-Fuller (ADF) test – a robust method – is employed for this purpose. Proposed by Said and Dickey in 1984, the ADF test is rooted in an autoregressive process and tests the hypothesis that when the absolute value of an estimated parameter interacting with the measured variable over time equals or surpasses 1, the series lacks stationarity and demonstrates a time-relative trend. This test is conducted for all variables featured in this study, namely the change in the unemployment rate and economic growth rate of datasets A and B. The analysis was conducted using the Eviews 10 software package.

6 Empirical results and Discussion

Before embarking on the estimation of a model aimed at examining the viability and robustness of Okun's law in the Moroccan context, both prior to and subsequent to the impact of the Covid-19 pandemic, it is imperative to lay the foundation by scrutinizing the stationarity of the time series encompassing the fluctuations in the Unemployment Rate and Economic Growth Rate of Morocco.

When working with time-series data, a fundamental procedural step involves subjecting the variables within a regression model to unit root testing. This procedure, as emphasized by Uwakaeme (2015), is paramount in ensuring the stability of these variables. It is important to underscore that attempting a regression analysis with non-stationary variables may lead to spurious regression outcomes and inconclusive results. Consequently, any conclusions derived from such analyses would likely lack substantive meaning.

In order to ascertain the stationarity of our datasets, a unit root test is employed. Specifically, the Augmented Dickey-Fuller (ADF) test is utilized to ascertain the degree of integration inherent in the various series. In cases where a series displays structural breaks, the ADF unit root test tends to substantiate the presence of a unit root within the series. Summarizing the outcomes of the unit root test to evaluate the stationarity of the alterations in "change in the unemployment rate" and "real GDP growth", we present the findings in Table 3.

Table 3. Summary of Unit Root Test for model variables.

Data	Variables	Level		First difference		Selected model	Order of co-integration
		t-statistics	p-value	t-statistics	p-value		
Augmented Dickey-Fuller test							
Dataset A n=31	cUR	-6.2022	0.0000	–	–	Model (1) DS without drift	I(0)
	GDPg	-10.3196	0.0000	–	–	Model (2) DS with drift	I(0)
Dataset B n=28	cUR	-5.4928	0.0000	–	–	Model (1) DS without drift	I(0)
	GDPg	-11.5342	0.0000	–	–	Model (2) DS with drift	I(0)

Source: Authors, Eviews

Based on the information presented in Table 3, it becomes evident that both datasets A and B exhibit a distinct characteristic: all variables demonstrate stationarity at the level by default. This notable feature, indicating an integration order of zero for all variables, has significant implications. Specifically, it obviates the necessity to conduct a co-integration test, which is relevant solely for non-stationary series. Consequently, we arrive at the compelling conclusion that there exists no enduring, long-term relationship between the two variables within both datasets A and B.

This absence of a sustained, long-term relationship paves the way for our focus on estimating solely a short-run model. In practical terms, this implies that over a defined timeframe in the future, at least one input parameter remains constant, while the others exhibit variability.

Turning our attention to Table 4, we delve into the results of estimating Okun's coefficient through two distinct approaches: the conventional linear model and an alternative robust linear model using the M-estimator technique. Our empirical investigation commences by applying equation (1) across the entire span of the observation period. Subsequently, we narrow our scope to the period preceding the onset of the Covid-19 pandemic.

Table 4. The estimation results.

Model/ Data	OLS					RLM					
Dataset A n=31	Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	z-Statistic	Prob.	
	GDP	-0.100357	0.019894	-5.044573	0.0000	GDP	-0.072038	0.019589	-3.677460	0.0002	
	C	0.275462	0.105946	2.600030	0.0145	C	0.209857	0.104321	2.011644	0.0443	
	R-squared	0.467379	Mean dependent var		-0.071935	Robust Statistics					
	Adjusted R-squared	0.449013	S.D. dependent var		0.603901	R-squared	0.210991	Adjusted R-squared		0.183784	
	S.E. of regression	0.448267	Akaike info criterion		1.295484	Rw-squared	0.390208	Adjust Rw-squared		0.390208	
	Sum squared resid	5.827345	Schwarz criterion		1.387999	Akaike info criterion	47.44728	Schwarz criterion		50.42479	
	Log likelihood	-18.08000	Hannan-Quinn criter.		1.325641	Deviance	4.514631	Scale		0.321946	
	F-statistic	25.44772	Durbin-Watson stat		2.379141	Rn-squared statistic	13.52371	Prob(Rn-squared stat.)		0.000236	
	Prob(F-statistic)	0.000022									

Dataset B n=28	Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	z-Statistic	Prob.
	GDP	-0.075261	0.022382	-3.362534	0.0024	GDP	-0.051491	0.015410	-3.341399	0.0008
C	0.159234	0.116883	1.362328	0.1848	C	0.230018	0.080474	2.858301	0.0043	
R-squared	0.303073	Mean dependent var	-0.124286	Robust Statistics						
Adjusted R-squared	0.276268	S.D. dependent var	0.503487	R-squared	0.201695	Adjusted R-squared	0.170991			
S.E. of regression	0.428329	Akaike info criterion	1.210898	Rw-squared	0.465162	Adjust Rw-squared	0.465162			
Sum squared resid	4.770106	Schwarz criterion	1.306056	Akaike info criterion	57.40543	Schwarz criterion	60.53335			
Log likelihood	-14.95258	Hannan-Quinn criter.	1.239989	Deviance	2.530179	Scale	0.216724			
F-statistic	11.30664	Durbin-Watson stat	2.270839	Rn-squared statistic	11.16495	Prob(Rn-squared stat.)	0.000834			
Prob(F-statistic)	0.002401									

Source: Authors, *Eviews*

Our empirical inquiry rests upon a meticulous comparative analysis of the estimation outcomes derived from datasets A and B. A comprehensive delineation of these results is meticulously documented within Table 4 and visually presented in Figure 2, facilitating a comprehensive understanding of the dynamics under scrutiny.

As we inspect the yielded outputs, a conspicuous pattern emerges: the Okun's coefficient during the entire observation period (dataset A) exhibits a greater magnitude in absolute terms compared to the coefficient observed prior to the Covid-19 crisis (dataset B). This increment in the absolute value of the Okun's coefficient, particularly noteworthy when encompassing the pivotal years 2020, 2021, and 2022, suggests that amid the tumultuous phase of Covid-19, the labor market displayed a modest adjustment of employment patterns in response to shifts in productivity.

Widening our perspective, the overarching trend in Morocco regarding the magnitude of the Okun's coefficient remains relatively subdued. This finding stands in contrast to the spectrum of values commonly documented in the existing literature. Evidently, the unemployment rate demonstrates a marginal reaction to fluctuations in real GDP during economic slowdowns and recovery phases.

Integral to our investigation, the estimated coefficient assumes a consistently negative and statistically significant character across both datasets A and B, a facet discerned through the application of OLS regression and RLM estimator techniques. The p-values consistently fall below the widely acknowledged alpha threshold of 0.05, a confluence that aligns harmoniously with the tenets expounded in existing literature.

In a bid to gauge the efficacy of the two modeling methodologies (OLS and RLM), we embark upon a comparative assessment of their predictive prowess using the mean absolute error (MAE) metric. The conclusion reached indicates that the M-estimator outperforms OLS in predictive accuracy within our datasets. Notably, the disparities in MAE are not significantly different, albeit slightly lower values emerge from the application of the robust linear model, a phenomenon underscored by the presentation in Table 5.

Table 5. Testing the predictive accuracy of the two approaches OLS and RLM within our datasets using (MAE).

Model/ MAE of the data	OLS	RLM
MAE of Dataset A	0.344611	0.327840
MAE of Dataset B	0.326125	0.303384

Source: Authors, *Eviews*

This outcome indicates that Okun's Law is valid in Morocco, consistent with the findings of Ezzahidi and El Alaoui in 2014, as well as El Aynaoui and Ibourk in 2016, therefore an increase in GDP by 1 percent leads to a decrease in unemployment by 0.05 point and up to 0.07 point when including the most recent observations affected by COVID-19. Moreover, when engaging the Z-test as a detector of statistical outliers, we found that there is no statistically significant differences in the estimated coefficient magnitude in the period preceding and following the advent of the COVID-19 crisis, as elaborated in Table 6.

Table 6. Detection of statistical outliers using Z-test.

Model/ Z-test	OLS	RLM
Z value	- 0.8416	- 0.829
P(Z<z)	0. 20045	0.20611

Source: Authors Calculation

Ultimately, it is deduced that the pandemic, coupled with the policies deployed by the Moroccan government to contain its repercussions and alleviate its economic toll, has not elicited statistically significant perturbations within the estimated relationship. The elevation observed in the Okun coefficient's magnitude subsequent to the integration of COVID-19-affected years potentially reflects the inherent instability of Okun's law within the Moroccan context. In a noteworthy convergence, our findings showed an empirical support to the insights articulated by Knotek (2007) and Ball et al. (2017), positing that the estimated coefficient tends to exhibit larger absolute values during recessions in contrast to expansionary phases. This dynamic nuances our understanding of how unemployment reacts differentially to economic growth across the business cycles.

In order to thoroughly investigate the temporal stability or potential variability inherent in Okun's law, we estimate equation (1) within a rolling regression framework involves employing a fixed observation window of 15 years, a period that enables us to examine the dynamics at play rigorously. Figure 2 is the graphical representation encapsulates the outcomes derived from both the OLS estimator and the M estimator, encapsulating the effects of the rolling regression procedure.

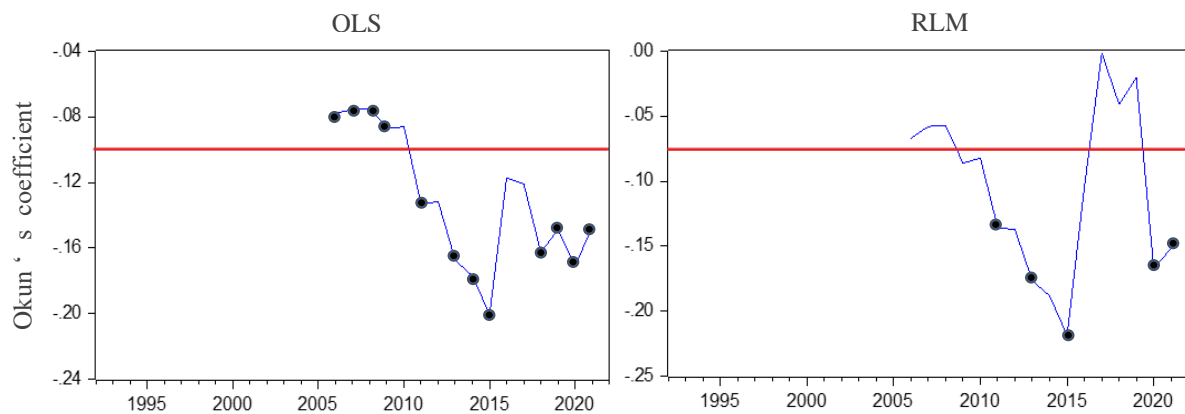


Figure 2. Okun's coefficients estimated using a rolling regression

Source: Authors, Eviews

Regarding the (in)stability of the estimated coefficient over time, the outcomes reveal - when both the M and OLS estimator are used - a gradual increase (in absolute terms) in the magnitude of Okun coefficient starting from the time window covering the period 2008-2015, suggesting a heightened responsiveness of the unemployment rate to shifts in productive activity, this may be due to the growth model pursued by Morocco in recent decades which relies mainly on the expansion of domestic demand, supported by the expansion of consumption (itself fueled by wage increases linked to the minimum wage adjustments) and high levels of investment public, mainly through state-owned enterprises (which have contributed to the expansion of private investment through a complementary effect). This pattern was interrupted in 2016 and 2020, and is even more pronounced when employing the M estimator which showcases slightly improved predictive accuracy within our sample. The perturbation observed in 2016 manifests as a significant decline in the absolute value of the Okun coefficient—a noteworthy anomaly amidst the prevailing trend. The second, more recent perturbation, coinciding with the onset of the COVID-19 pandemic, unveils a significant increase (in absolute terms) in magnitude and then a reversion to a higher level in 2021. These deviations underscore the intricate interplay between economic dynamics and external shocks.

In sum, the observed fluctuations lead us to the following inference: the instability of the estimated coefficient over time within the Moroccan context. This observation resonates with the seminal work of Knotek (2007), who highlighted the utility of Okun's law as a predictive tool while cautioning against its susceptibility to instability. The multifaceted nature of Morocco's economic landscape, coupled with the reverberations of global events, underscores the dynamic interplay that shapes the intricate relationship between unemployment and GDP growth.

Note:

The year reported on the x-axis is the last year of each rolling regression. The black circles indicate that the relationship in the estimation window is statistically significant at a confidence level of 5%. The red horizontal line represent the magnitude of Okun's coefficient estimates over the 1992–2022 period obtained by applying the OLS and RLM regression.

7 Conclusion

Economics, psychology, and politics are three interwoven disciplines that together embody the dual aspects of a single entity. Therefore, one must consider that Covid-19, which has been portrayed as a lethal virus, might alternatively be a fleeting seasonal influenza strategically employed for political or psychological motives. This manipulation could favor certain countries or specific groups of individuals over others. Regardless of its true nature, Covid-19 has undeniably exerted considerable influence on the economy and people's mental health. In delving into the economic impact, the focal points encompass production and the labor market. The primary objective of this article is to delve into the intricate relationship between the inverse fluctuations in real GDP growth and changes in the unemployment rate spanning the period from 1992 to 2022 in Morocco.

We conduct a comprehensive analysis by comparing outcomes derived from the application of traditional Ordinary Least Squares (OLS) and M-robust estimation methods. This evaluation is performed across two distinct periods: the complete sample timeline and the period preceding the onset of the Covid-19 pandemic. Additionally, we extend our examination by employing a rolling regression framework, adhering to a 15-year window, inspired by the methodologies of Moosa (1997), Knotek (2007), and Zanin and Mussida (2022).

Our analytical findings reveal slight disparities in the goodness-of-fit between models when OLS and M-estimators are employed, focusing on in-sample mean absolute error. Furthermore, we affirm the applicability of Okun's law in the context of Morocco, both during the pre-pandemic era (1992-2019) and the entire sample duration, which encompasses years affected by the pandemic. Importantly, we identify no statistically significant perturbations in our estimates after the pandemic.

Upon adopting the rolling regression framework, our estimations point towards temporal instability in Okun's coefficient. Notably, this instability is accompanied by asymmetric unemployment responses to productivity shifts, particularly in relation to the significant and recent economic deceleration – the Covid-19 pandemic. Unlike the Great Recession, which does not appear to trigger a structural alteration in Okun's coefficient magnitude, the Covid-19 pandemic does bring about a meaningful, albeit possibly temporary, change. This observation supports existing literature on how not all recessions and recoveries are alike (e.g., Gelfer 2020).

For economists and policymakers alike, our discoveries offer valuable insights into the dynamic and time-varying connection between fluctuations in the unemployment rate and real GDP growth. However, while these findings enrich the understanding, we urge caution when interpreting Okun's coefficient, especially if Okun's law is considered a simplistic predictive instrument for the unemployment rate.

It's important to acknowledge that this relationship might face challenges when dealing with lower-frequency data. The absence of quarterly data, particularly in developing and less developed countries, often necessitates reliance on annual frequency data. This limitation could compromise the accuracy of identifying short-term business cycle oscillations and hinder the generation of robust projections and clear insights into the varied unemployment responses occurring within quarters of the same year.

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