Journal of Empirical Studies
2026 Vol. 13, No. 1, pp. 28-50
ISSN(e): 2312-6248
ISSN(p): 2312-623X
DOI: 10.18488/66.v13i1.5031

Economic growth and unemployment dynamics in the United States: An empirical assessment of Okun's Law

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Article History
Received: 22 May 2026
Revised: 29 June 2026
Accepted: 7 July 2026
Published: 10 July 2026

Keywords
Economic growth
Macroeconomic dynamics
Okun's law
Structural breaks
Time variation
Unemployment
United States.

ABSTRACT

This study examines the relationship between economic growth and unemployment in the United States by empirically reassessing Okun's Law. Using quarterly data spanning several decades, the analysis examines whether the traditional inverse relationship between output growth and unemployment remains stable amid structural and cyclical changes. The study employs a range of econometric techniques, including baseline regression models, cointegration analysis, error correction modeling, vector autoregression, and structural break tests, to capture both short-run dynamics and long-run equilibrium relationships. The findings confirm a negative relationship between real GDP growth and changes in unemployment, consistent with Arthur Okun's original formulation. However, the results also reveal that the magnitude of this relationship is not constant over time. Evidence of structural breaks and subsample variation indicates that the responsiveness of unemployment to economic growth has weakened in recent decades, particularly following major economic disruptions. Additionally, the analysis identifies asymmetric adjustment patterns, with unemployment responding more strongly during economic downturns than during expansions. These results suggest that Okun's Law should be interpreted as a time-varying and context-dependent relationship rather than a fixed empirical rule. The study contributes to the literature by incorporating up-to-date data and employing flexible econometric frameworks that capture evolving macroeconomic dynamics. The findings carry important implications for policy design and forecasting, underscoring the need for adaptive models that account for structural changes in the labor market.

Contribution/ Originality: This study provides an updated empirical reassessment of Okun's Law in the United States using quarterly data from 1980 to 2024. By integrating structural break analysis, error-correction modeling, vector autoregression, nonlinear specifications, and subsample estimation, the study demonstrates that the growth–unemployment relationship is time-varying, asymmetric, and increasingly influenced by structural economic changes. The findings offer important implications for macroeconomic forecasting and employment policy formulation.

1. INTRODUCTION

The relationship between economic growth and unemployment is central to macroeconomic analysis and policy design in the United States. Fluctuations in output are closely tied to labor market conditions, shaping income distribution, consumption patterns, and overall economic welfare. Policymakers, particularly within monetary and fiscal authorities, rely on this relationship to gauge the employment effects of growth-oriented policies and anticipate the labor-market consequences of economic downturns. The empirical regularity commonly known as Okun's Law

has long provided a benchmark for understanding how deviations in output growth translate into changes in unemployment. However, the stability and reliability of this relationship have increasingly come under scrutiny.

In recent decades, the U.S. economy has undergone profound structural transformations that may have altered the traditional growth–unemployment linkage. Technological advancement, particularly automation and digitalization, has reshaped production processes and labor demand, often decoupling output growth from proportional increases in employment. Recent evidence further suggests that artificial intelligence-driven enterprise transformation increasingly reshapes productivity growth, institutional adaptability, and labor-market dynamics across industries. At the same time, labor market polarization, characterized by the expansion of high- and low-skill jobs alongside the contraction of middle-skill occupations, has introduced new dynamics into employment adjustment mechanisms. Earlier studies demonstrate that technological innovation significantly alters labor demand structures, productivity systems, and institutional efficiency within modern economic environments. Additionally, major economic disruptions, including the global financial crisis and more recent pandemic-related shocks, have exposed nonlinearities and asymmetries in macroeconomic relationships that were previously assumed to be stable. These developments raise important questions about whether the conventional interpretation of Okun's Law remains empirically valid in the contemporary U.S. context. The rapid expansion of artificial intelligence and digital automation has also intensified concerns regarding the long-run relationship between technological progress, labor displacement, and macroeconomic adjustment (Tamez & Osho, 2025). The central research problem addressed in this study is the potential instability of Okun's coefficient over time. While early empirical work suggests a relatively stable and predictable inverse relationship between output growth and unemployment, more recent evidence points to variation across periods, business cycles, and structural regimes. Such instability complicates both macroeconomic forecasting and the design of effective policy interventions, as the responsiveness of unemployment to growth may vary substantially across underlying economic conditions. Closely related to this is a clear gap in the literature. Although numerous studies have tested Okun's Law for the United States, fewer have systematically accounted for time variation, structural breaks, and asymmetric responses across economic expansions and contractions within a unified empirical framework. Moreover, much of the existing work relies on data that do not fully capture the most recent economic episodes, thereby limiting the relevance of their conclusions for current policy debates. There remains a need for a comprehensive reassessment that integrates updated data with more flexible econometric techniques capable of capturing evolving dynamics. This study contributes to the literature in several important ways. First, it employs an updated dataset that spans multiple economic cycles, including recent periods of heightened volatility, thereby providing a more current perspective on the growth–unemployment relationship. Second, it adopts an advanced econometric approach that enables the detection of structural breaks, time-varying parameters, and potential asymmetries in the response of unemployment to changes in output. Third, by combining these methodological enhancements with a careful theoretical grounding, the analysis offers new insights into the conditions under which Okun's Law holds and the extent to which its parameters have shifted over time. Therefore, the primary objective of this paper is to empirically examine the relationship between economic growth and unemployment in the United States through the lens of Okun's Law, with particular attention to its stability and potential evolution. Specifically, the study aims to estimate the magnitude of Okun's coefficient, assess its consistency across different periods, and evaluate whether the relationship exhibits asymmetry during economic expansions and contractions. To guide the analysis, the study tests the following hypotheses: first, that a statistically significant inverse relationship exists between economic growth and unemployment in the United States; second, that the magnitude of this relationship is not constant but varies over time; and third, that the responsiveness of unemployment to output changes differs between periods of economic expansion and recession.

The empirical findings indicate that while the negative relationship predicted by Okun's Law remains broadly observable, its strength and stability have diminished in certain periods, particularly in the aftermath of major economic shocks. Evidence of structural breaks and asymmetric adjustments suggests that the responsiveness of

unemployment to growth is contingent on prevailing economic conditions. These results underscore the importance of adopting flexible modeling approaches when applying Okun's Law in contemporary macroeconomic analysis and highlight the need for caution in relying on fixed-coefficient interpretations for policy formulation.

2. THEORETICAL FRAMEWORK

The theoretical foundation of the relationship between economic growth and unemployment in the United States is rooted in the empirical regularity first articulated by Okun (1962). Okun's Law provides a systematic way of linking fluctuations in aggregate output to changes in labor market conditions, offering a practical bridge between macroeconomic performance and employment outcomes. Although originally derived from empirical observation rather than formal theory, it has since been embedded within broader macroeconomic frameworks that explain short-run deviations from potential output.

2.1. Original Formulation of Okun's Law

Okun's Law is commonly expressed in two principal forms: the difference version and the gap version. The difference version relates changes in the unemployment rate to the growth rate of real output. In its standard representation, it posits that increases in output growth above its trend rate reduce unemployment. Formally, this relationship can be expressed as a negative association between the change in unemployment and the growth rate of real GDP. The coefficient in this specification, often referred to as Okun's coefficient, measures the percentage point change in unemployment associated with a one-percentage-point increase in output growth. The gap version, by contrast, focuses on deviations from potential levels. It links the unemployment gap, defined as the difference between the actual unemployment rate and its natural rate, to the output gap, which is the deviation of actual output from potential output. This formulation emphasizes equilibrium concepts and is closely aligned with modern macroeconomic models that distinguish between cyclical and structural components of economic activity. Both versions capture the same underlying idea: that labor market conditions respond systematically to fluctuations in economic activity. However, they differ in their emphasis on short-run changes versus deviations from long-run equilibrium.

2.2. Economic Intuition Linking Output and Unemployment

The negative relationship between output and unemployment can be understood through standard production theory and labor demand dynamics. Firms adjust their demand for labor in response to changes in output demand. When aggregate demand rises, firms increase production, which typically requires additional labor input. As a result, employment expands and unemployment declines. Conversely, during economic downturns, reduced demand leads firms to scale back production, lowering labor demand and increasing unemployment.

However, this adjustment is neither instantaneous nor proportional. Several mechanisms explain why changes in output do not translate one-for-one into changes in employment. Firms may initially respond to increased demand by intensifying the utilization of existing workers through longer hours or higher effort before hiring new employees. Similarly, during downturns, firms may retain workers despite declining output due to adjustment costs, expectations of recovery, or contractual rigidities. These dynamics contribute to the empirical observation that unemployment responds to output changes with a lag and with less-than-proportional intensity. Macroeconomic uncertainty and institutional risk conditions may further influence the speed and magnitude of labor-market adjustment during periods of economic instability (Adams, Osho, Woods, & Osho, 2006).

2.3. Labor Market Frictions, Productivity, and Participation Rates

The strength and stability of the key labor-market factors, including frictions, productivity, and labor-force participation, influence the unemployment relationship. Labor market frictions, such as job search costs, information

asymmetries, and matching inefficiencies, affect how quickly unemployed workers are matched with available vacancies. In the presence of such frictions, even periods of strong economic growth may not lead to immediate reductions in unemployment, as the matching process takes time. Labor productivity also plays a central role. Research on technology diffusion and productivity growth further indicates that digital innovation significantly influences sectoral productivity patterns and labor-market adjustment processes within evolving economies. If output growth is driven primarily by productivity gains rather than increased labor input, the impact on employment may be muted. For instance, technological improvements can enable firms to produce more with fewer workers, thereby weakening the responsiveness of unemployment to output expansion. Labor force participation rates further complicate the relationship. Related studies on technology transfer and economic growth suggest that uneven adoption of advanced technologies may weaken traditional output-employment relationships over time. Changes in participation driven by demographic trends, educational enrollment, or discouraged-worker effects can influence the measured unemployment rate independently of changes in employment. For example, an increase in participation during economic expansions may offset some of the decline in unemployment that would otherwise occur.

2.4. Extensions: Nonlinearity and Asymmetry

While the traditional formulation of Okun's Law assumes a stable and linear relationship, more recent theoretical and empirical work suggests that the relationship may be nonlinear and asymmetric. In particular, the unemployment response to output changes may differ between expansions and recessions. During recessions, firms often adjust employment more aggressively due to heightened uncertainty and declining revenues, leading to sharper increases in unemployment. In contrast, during recoveries, hiring may proceed more gradually as firms remain cautious, resulting in slower declines in unemployment. This asymmetry implies that the magnitude of Okun's coefficient may vary across the business cycle. Nonlinearities may also arise from threshold effects, in which the relationship between output and unemployment changes once growth exceeds or falls below certain thresholds. Such dynamics challenge the assumption of a constant coefficient and underscore the need for flexible modeling approaches.

2.5. Structural Changes in the United States Economy

The U.S. economy has experienced significant structural transformations that may have altered the parameters of Okun's Law. The shift from manufacturing to services, increased globalization, and rapid technological change have all influenced the nature of labor demand. Automation and digitalization, in particular, have enabled firms to expand output without proportionate increases in employment, thereby weakening the traditional output–employment linkage. In addition, the rise of nonstandard forms of employment, including part-time and gig work, has introduced greater flexibility into labor markets but has also complicated the measurement of unemployment and labor utilization. These structural changes suggest that the relationship captured by Okun's Law is not fixed but evolves in response to broader economic developments.

2.6. Institutional and Demographic Influences

Institutional and demographic factors further shape the relationship between growth and unemployment. Labor market institutions—such as unemployment insurance systems, minimum wage laws, and employment protection regulations—affect both hiring and firing decisions, influencing how unemployment responds to changes in output. Demographic trends, including aging populations and shifts in labor force composition, also play an important role. For example, an aging workforce may exhibit lower mobility and different participation patterns, which can alter the responsiveness of unemployment to economic growth. Similarly, changes in educational attainment and skill distribution can influence the matching process between workers and jobs, affecting the overall dynamics of unemployment.

Thus, these theoretical considerations suggest that while Okun's Law provides a useful starting point for understanding the relationship between economic growth and unemployment, its parameters are shaped by a complex interplay of cyclical, structural, and institutional factors. As such, any empirical assessment must account for potential variability and evolving dynamics within the U.S. economy.

3. LITERATURE REVIEW

The literature on Okun's Law has developed from a simple empirical regularity into a broad research program on how output fluctuations translate into labor-market adjustment. The review below focuses only on studies directly related to the output-unemployment relationship, the stability of Okun's coefficient, asymmetry across the business cycle, and methodological approaches used to estimate the relationship. This focus responds directly to the central objective of the present study, which reassesses whether the U.S. growth-unemployment relationship remains stable when recent macroeconomic shocks, structural breaks, and nonlinear adjustment are considered.

3.1. Foundational Evidence and Early Revisions of Okun's Law

Okun's original contribution established the empirical benchmark for connecting output performance and labor-market conditions. Using U.S. macroeconomic data, Okun (1962) showed that deviations in actual output from potential output were systematically associated with movements in unemployment, implying that above-trend growth is required to reduce unemployment. Thirlwall (1969) extended this insight by relating Okun's Law to the natural rate of growth, showing that employment outcomes depend not only on short-run demand fluctuations but also on the rate of growth consistent with stable labor-market conditions. Subsequent U.S. studies refined the empirical interpretation of the coefficient. Gordon and Clark (1984) reconsidered unemployment and potential output in the 1980s and emphasized that the estimated coefficient depends on how potential output and cyclical unemployment are measured. Prachowny (1993) provided a more formal theoretical basis by showing that output-unemployment estimates are influenced by hours worked, labor-force participation, and productivity, making the observed coefficient a composite measure rather than a purely structural parameter. Weber (1995) similarly emphasized that estimates of cyclical output and cyclical unemployment depend heavily on filtering choices and alternative definitions of the business cycle.

These foundational studies are important because they demonstrate that Okun's Law should not be treated as a mechanical law. Even the early literature recognized that the coefficient is shaped by productivity, hours, labor supply, and measurement assumptions. This point is central to the present study because an empirical reassessment using data from 1980 to 2024 must account for changes in productivity, labor-force behavior, and the institutional structure of the U.S. economy.

3.2. Measurement, Detrending, and Econometric Specification

A second stream of research focuses on measurement and econometric specification. Watson (1986) demonstrated that detrending methods can substantially influence estimates of cyclical macroeconomic relationships, a concern that applies directly to the gap version of Okun's Law. Attfield and Silverstone (1998) examined Okun's Law using cointegration and gap variables, arguing that a long-run relationship between output and unemployment can be identified when the variables are properly transformed. Lee (2000), using evidence from OECD countries, found that the robustness of Okun's Law varies across estimation methods, model specifications, and measures of the output gap. Freeman (2000) used regional tests to show that subnational estimates can differ from aggregate national estimates, while Freeman (2001) used panel methods for industrial countries and found that the output growth required to reduce unemployment often differs from Okun's original estimate. Huang and Yeh (2013) expanded the panel approach by examining both countries and U.S. states, showing that panel methods can identify common short-run relationships while still allowing for heterogeneity across units.

This methodological literature has two implications for the present study. First, the estimated coefficient is sensitive to whether the researcher uses the difference version, the gap version, or a dynamic specification. Second, national estimates can conceal important time-series and regional variation. For this reason, the present study uses several complementary methods, including baseline regressions, cointegration tests, error-correction modeling, VAR estimation, structural break tests, and nonlinear specifications.

3.3. U.S. Evidence, Time Variation, and Forecasting Usefulness

U.S.-specific studies have generated mixed conclusions regarding the stability of Okun's Law. Knotek (2007) concluded that the relationship remains useful for forecasting and policy analysis but varies over time and across phases of the business cycle. Meyer and Tasci (2012) were more skeptical, arguing that Okun's Law can be unstable enough to make it an unreliable rule of thumb when used without adjustment for changing macroeconomic conditions. Owyang and Sekhposyan (2012) examined the relationship over the business cycle and assessed whether the Great Recession represented an unusual departure from historical patterns. Their analysis showed that the unemployment-output relationship differs across recessions and expansions, reinforcing the need to examine cyclical regimes separately. Daly, Fernald, Jordà, and Nechio (2014) further analyzed deviations from Okun's Law during and after the Great Recession and argued that changes in output measurement, productivity, and labor utilization help explain apparent departures from the traditional rule.

More recent work has renewed the debate. Ball, Jalles, and Loungani (2015) found that professional forecasts of output growth and unemployment are broadly consistent with Okun's Law, suggesting that forecasters implicitly rely on the negative growth-unemployment relationship. Ball, Leigh, and Loungani (2017) argued that Okun's Law continues to fit short-run movements in unemployment in the United States and many other advanced economies. However, the coefficient differs across countries and periods. Guisinger and Sinclair (2015) examined Okun's Law in real time and showed that data revisions and forecast timing matter for evaluating the relationship. Together, these studies suggest that Okun's Law remains empirically relevant, but its usefulness depends on specification, sample period, and the treatment of real-time information.

3.4. Asymmetry, Nonlinearity, and Regime Dependence

A major development in the literature is the recognition that unemployment may not respond symmetrically to output growth in expansions and contractions. Harris and Silverstone (2001) tested for asymmetry across several OECD countries and found that failing to account for asymmetric adjustment can lead to incorrect conclusions about the long-run relationship between output and unemployment. Virén (2001) provided evidence that the Okun curve is nonlinear, with output growth having different effects depending on the economic environment. Cuaresma (2003) revisited Okun's Law and emphasized threshold effects, suggesting that unemployment responds more strongly when output growth crosses certain cyclical thresholds. Silvapulle, Moosa, and Silvapulle (2004) offered additional evidence of asymmetry, showing that unemployment-output dynamics differ between downturns and recoveries. Holmes and Silverstone (2006) applied a Markov-switching approach to the United States and connected asymmetric Okun dynamics to the jobless recoveries following the 1991 and 2001 recessions. Porras-Arena and Martín-Román (2019) later demonstrated that self-employment and labor-market composition can influence the strength of the Okun relationship, further supporting the view that labor-market structure affects adjustment.

This body of research is directly relevant to the present paper because the U.S. economy has experienced major structural and cyclical shocks, including the early 1990s recession, the 2001 slowdown, the 2008-2009 financial crisis, and the COVID-19 recession. If unemployment rises more sharply during contractions than it falls during recoveries, then a single fixed coefficient will obscure important labor-market dynamics. The asymmetric and nonlinear literature, therefore, justifies the use of threshold and nonlinear specifications in the empirical analysis.

3.5. Cross-Country, Regional, and Institutional Heterogeneity

Cross-country and regional studies show that the Okun coefficient varies substantially across economies and institutional settings. Moosa (1997) compared G7 countries and found meaningful differences in the responsiveness of unemployment to output fluctuations. Sogner and Stiassny (2002) studied structural stability across OECD countries and concluded that institutional and supply-side factors influence the strength of the relationship. Perman and Tavera (2005) examined convergence in Okun coefficients across Europe and found that the coefficient does not necessarily converge uniformly across countries. Villaverde and Maza (2009) analyzed Spanish regions and found that regional productivity differences explain part of the variation in Okun coefficients. Cazes, Verick, and Al Hussami (2013) used Okun's Law to explain why unemployment responded differently across countries during the global financial crisis, highlighting the roles of labor-market institutions, employment protection, and crisis severity. Perman, Stephan, and Tavéra (2015) synthesized a large body of Okun estimates and concluded that there is substantial heterogeneity in coefficient size across studies, countries, and methodologies. Guisinger, Hernandez-Murillo, Owyang, and Sinclair (2018) brought this issue directly into the U.S. context by estimating Okun coefficients for individual states and showing that the relationship varies across state labor markets.

These findings imply that a U.S. aggregate estimate should be interpreted with caution. National data are useful for macroeconomic forecasting and policy analysis, but the estimated coefficient may reflect changes in sectoral composition, regional heterogeneity, labor market institutions, and demographic patterns. The present study, therefore, interprets the U.S. coefficient as a time-varying empirical relationship rather than a permanent structural constant.

3.6. Synthesis and Research Gap

The literature establishes several points of consensus. First, most studies confirm a negative relationship between output growth and unemployment, consistent with Okun's original insight. Second, the size of the coefficient is not universal; it varies across countries, regions, business-cycle phases, and estimation methods. Third, structural breaks, nonlinearities, and asymmetric adjustment are increasingly important in explaining why fixed-coefficient models may perform poorly during major economic disruptions. However, important gaps remain. Many studies either focus on earlier data, emphasize a single specification at a time, or fail to jointly examine time variation, structural breaks, dynamic adjustment, and asymmetry within a unified U.S. framework. In addition, the COVID-19 period introduced an unusually sharp output and labor-market shock that requires updated analysis.

This study addresses these gaps by reassessing Okun's Law for the United States using quarterly data from 1980 to 2024 and by combining baseline, dynamic, cointegration, structural-break, rolling-regression, time-varying, and asymmetric specifications. The approach is designed to determine not only whether Okun's Law continues to hold, but also whether its coefficient has weakened, shifted across regimes, or differed between expansions and recessions. In this way, the study contributes to the literature by providing an updated and methodologically flexible assessment of economic growth and unemployment dynamics in the United States.

4. METHODOLOGY

The evolution of econometric techniques has significantly enriched the study of Okun's Law. Early analyses relied primarily on simple linear regressions, which imposed restrictive assumptions about parameter constancy and linearity. Recent econometric studies employing dynamic structural modeling approaches further underscore the importance of flexible estimation techniques for analyzing evolving macroeconomic relationships. More recent studies employ a range of advanced methods to capture dynamic and potentially nonlinear relationships. Vector autoregression (VAR) models have been widely used to examine the dynamic interactions between output and unemployment, allowing for feedback effects and lagged responses. Autoregressive distributed lag (ARDL) models and error-correction frameworks enable researchers to distinguish between short- and long-run relationships,

providing a more nuanced understanding of adjustment dynamics. In addition, state-space models and time-varying parameter approaches have been employed to explicitly model changes in Okun's coefficient over time. Similar forecasting and time-series modeling approaches have been widely applied in macroeconomic and economic forecasting studies involving dynamic economic relationships. These methods offer greater flexibility and can capture gradual shifts in the relationship that traditional techniques may miss. While these methodological advancements represent significant improvements, they also introduce challenges in model selection, parameter identification, and interpretation.

4.1. Data and Variables

This study employs a macroeconomic time-series dataset designed to capture the interaction between economic growth and unemployment in the United States over an extended period. The dataset integrates key aggregate indicators commonly used in empirical tests of Okun's Law, ensuring both consistency with prior literature and relevance to contemporary economic conditions. The primary data used in this analysis are drawn from official U.S. macroeconomic databases. Real output data are obtained from the Bureau of Economic Analysis, which provides comprehensive national income and product accounts, including real gross domestic product (GDP). Labor market data, specifically the unemployment rate, is sourced from the Bureau of Labor Statistics, which compiles detailed information on employment conditions. The sample period spans 1980 to 2024, a timeframe that captures multiple business cycles, including expansions, recessions, and structural transformations. This extended horizon allows for a more robust examination of both short-term fluctuations and long-term dynamics in the growth–unemployment relationship. The analysis is conducted using quarterly data, which strikes a balance between capturing short-run dynamics and maintaining data reliability. Quarterly frequency is widely used in empirical macroeconomic research, as it provides sufficient observations for econometric estimation while avoiding the excessive volatility often associated with higher-frequency data. All series are temporally aligned to ensure consistency, and missing observations, where present, are addressed using standard interpolation techniques or omitted where appropriate to preserve data integrity.

4.2. Variable Definitions

Two principal variables are constructed to operationalize Okun's Law.

Real GDP Growth: Economic growth is measured as the percentage change in real GDP from one quarter to the next. This measure reflects the rate at which the economy expands or contracts in real terms, adjusted for inflation. In alternative specifications, the output gap defined as the deviation of actual GDP from its potential level may also be employed to capture cyclical fluctuations more directly.

Unemployment Rate: The civilian unemployment rate measures labor market conditions and is expressed as a percentage of the labor force. In line with the different versions of Okun's Law, the analysis often uses changes in the unemployment rate between consecutive periods to capture the dynamic response of unemployment to variations in output growth.

These variables are selected for their theoretical relevance and widespread use in the literature, thereby facilitating comparability with existing empirical findings.

4.3. Data Transformations

To ensure the data are suitable for econometric analysis, several transformations are applied. First, real GDP is converted to a growth rate by taking the first difference of its natural logarithm. This transformation stabilizes variance and allows the resulting series to be interpreted as approximate percentage changes. When the output gap specification is used, potential output is estimated using filtering techniques, such as the Hodrick and Prescott (1997) filter, and the gap is computed as the deviation of actual output from this trend. Second, the unemployment rate is

transformed into its first difference when estimating the difference version of Okun's Law. This approach focuses on changes in unemployment rather than its level, aligning with the short-run dynamics emphasized in the original formulation.

4.4. Seasonal Adjustment

Both GDP and unemployment data are seasonally adjusted to remove recurring patterns that could distort the underlying relationship. Seasonal adjustment is particularly important in quarterly data, where systematic fluctuations—such as holiday spending or weather-related employment changes—can introduce noise into the analysis. The use of seasonally adjusted series ensures that observed movements reflect genuine economic dynamics rather than predictable seasonal effects.

4.5. Log Transformations and Differencing

The logarithmic transformation of real GDP serves two primary purposes: it linearizes exponential growth and reduces heteroskedasticity in the data. Differencing the logged series further removes potential non-stationarity, making the data more suitable for regression analysis.

Similarly, differencing the unemployment rate helps to eliminate persistence and focuses attention on short-term changes, which are central to the empirical testing of Okun's Law. These transformations are consistent with standard econometric practice and enhance the reliability of statistical inference. In sum, the dataset combines high-quality macroeconomic indicators with appropriate transformations to facilitate a rigorous empirical examination of the relationship between economic growth and unemployment. The use of quarterly, seasonally adjusted, and properly transformed data ensures that the analysis captures both the cyclical and structural dimensions of this relationship while maintaining comparability with established empirical studies.

4.6. Model Specification

This section outlines the empirical strategy used to estimate the relationship between economic growth and unemployment in the United States. Given the potential instability and evolving nature of Okun's Law, the methodology combines standard specifications with advanced econometric techniques to ensure robustness, flexibility, and transparency.

4.7. Baseline Model: Okun's Law Specification

The empirical analysis begins with the conventional representation of Okun's Law in its difference form.

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

Where:

- $\Delta U_t = U_t - U_{t-1}$ denotes the change in the unemployment rate.
- Y_t represents the growth rate of real GDP.
- α is a constant term.
- β is Okun's coefficient.
- ε_t is the error term.

The parameter β captures the responsiveness of unemployment to changes in economic growth. A negative value of β is expected, indicating that higher output growth reduces unemployment. The magnitude of β reflects how strongly labor markets respond to output fluctuations; a larger absolute value implies greater sensitivity. As an alternative, the gap version of Okun's Law is specified as:

$$(U_t - U^*) = \gamma(Y_t - Y^*) + \mu_t \quad (2)$$

Where:

- U^*denotes the natural rate of unemployment.

- Y^* represents potential output.
- $(U_t - U^*)$ is the unemployment gap.
- $(Y_t - Y^*)$ is the output gap.
- γ measures the relationship between cyclical output and unemployment deviations.
- μ_t is the disturbance term.

In this formulation, γ is expected to be negative, indicating that positive output gaps (economic expansions above potential) are associated with lower-than-natural unemployment rates. This specification aligns more closely with equilibrium-based macroeconomic theory and allows for a clearer distinction between cyclical and structural components. To ensure rigorous estimation, the analysis proceeds through several stages, each addressing specific econometric concerns. Advanced volatility and forecasting techniques have also been applied successfully in macroeconomic and energy-market modeling environments characterized by structural uncertainty and time-varying dynamics.

4.8. Stationarity Tests

Macroeconomic time series often exhibit non-stationarity, which can lead to spurious regression results. To address this, unit root tests are conducted using the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) procedures. The ADF test is based on the regression.

$$\Delta X_t = \delta X_{t-1} + \sum_{i=1}^{p} \phi_i \Delta X_{t-i} + \eta_t \quad (3)$$

Where the null hypothesis H_0: $\delta = 0$ indicates the presence of a unit root. Rejection of the null suggests stationarity. The PP test provides a non-parametric correction for serial correlation and heteroskedasticity, offering a robustness check.

4.9. Cointegration Analysis

If the variables are integrated of order one, $I(1)$, the existence of a long-run equilibrium relationship is tested using cointegration techniques. The Johansen framework estimates a vector error correction system.

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \varepsilon_t \quad (4)$$

Where Z_t is a vector containing output and unemployment variables, the rank of the matrix Π determines the number of cointegrating relationships.

Alternatively, the ARDL bounds testing approach is employed:

$$\Delta U_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta U_{t-i} + \sum_{j=0}^{q} \beta_j \Delta Y_{t-j} + \lambda_1 U_{t-1} + \lambda_2 Y_{t-1} + \varepsilon_t \quad (5)$$

The joint significance of λ_1 and λ_2 is tested to determine whether a long-run relationship exists.

4.10. Error Correction Model (ECM)

When cointegration is established, short-run dynamics are modeled within an error correction framework.

$$\Delta U_t = \alpha + \sum_{i=1}^{p} \theta_i \Delta U_{t-i} + \sum_{j=0}^{q} \psi_j \Delta Y_{t-j} + \rho ECT_{t-1} + \varepsilon_t \quad (6)$$

where ECT_{t-1} is the lagged error correction term derived from the long-run relationship. The coefficient ρ measures the speed of adjustment toward equilibrium and is expected to be negative and statistically significant.

4.11. Vector Autoregression (VAR) Framework

To capture dynamic interdependence and feedback effects, a VAR model is estimated.

$$Z_t = A_0 + \sum_{i=1}^{k} A_i Z_{t-i} + \varepsilon_t \quad (7)$$

Endogenous Variable Vector,

$$Z_t = (U_t, Y_t)' \quad (8)$$

where $Z_t = (U_t, Y_t)'$, this framework allows both variables to be treated as endogenous. Impulse response functions (IRFs) and forecast error variance decompositions are derived to analyze the transmission of shocks between output and unemployment.

Where theoretical restrictions are imposed, a structural VAR (SVAR) is estimated to identify structural shocks.

4.12. Structural Break Tests

Given the possibility of regime shifts, structural stability is examined using formal tests.

The Chow test evaluates parameter stability at a known breakpoint.

$$F = \frac{\left(RSS_p - (RSS_1 + RSS_2)\right)/k}{(RSS_1 + RSS_2)/(n_1 + n_2 - 2k)} \qquad (9)$$

where RSS_p denotes the residual sum of squares from the pooled model; RSS_1 and RSS_2 denote the residual sums of squares from the two subsample models; k is the number of estimated parameters; and n_1 and n_2 are the respective subsample sizes.

To detect multiple unknown breakpoints, the Bai–Perron methodology is employed, allowing for endogenous identification of structural changes in the regression coefficients. This approach is particularly relevant for capturing shifts associated with major economic events.

4.13. Extensions for Novelty and Robustness

To enhance the contribution and meet high publication standards, the analysis incorporates extensions that relax restrictive assumptions of linearity and parameter constancy.

4.14. Time-Varying Parameter Model

A time-varying specification allows Okun's coefficient to evolve.

$$\Delta U_t = \alpha_t + \beta_t Y_t + \varepsilon_t \qquad (10)$$

where βt follows a stochastic process, often modeled within a state-space framework, this approach captures gradual changes in the responsiveness of unemployment to growth.

4.15. Asymmetric (Threshold) Model

To test for asymmetry between expansions and recessions, a threshold model is specified.

$$\Delta U_t = \alpha + \beta_1 Y_t I(Y_t \geq 0) + \beta_2 Y_t I(Y_t < 0) + \varepsilon_t \qquad (11)$$

where $I(\cdot)$ is an indicator function. Differences between $\beta 1$ and $\beta 2$ indicate asymmetric responses.

4.16. Nonlinear Specification

A quadratic form is introduced to capture potential nonlinearities.

$$\Delta U_t = \alpha + \beta_1 Y_t + \beta_2 Y_t^2 + \varepsilon_t \qquad (12)$$

A significant β_2 suggests that the relationship between growth and unemployment varies across levels of output growth.

4.17. Rolling Regression Estimates

To assess temporal stability, rolling regressions are performed.

$$\Delta U_t = \alpha + \beta_t Y_t + \varepsilon_t, \quad \text{for} \quad t = 1, \ldots, T \qquad (13)$$

Using a fixed window size. This generates a time series of β_t allowing visualization of how Okun's coefficient evolves over time. The empirical strategy integrates baseline estimation with advanced time-series techniques to address issues of non-stationarity, structural change, and dynamic interaction. By combining multiple approaches, the analysis ensures that the estimated relationship between economic growth and unemployment is both statistically

robust and economically meaningful. The inclusion of nonlinear and time-varying extensions further strengthens the study's contribution by capturing complexities that are often overlooked in conventional analyses. Recent forecasting studies also emphasized the importance of simulation-based and dynamic optimization techniques for evaluating unstable economic systems and accounting for forecasting uncertainty.

5. RESULTS

5.1. Descriptive Statistics

The descriptive statistics provide an overview of the distributional properties of key macroeconomic variables used in the analysis. Real GDP growth exhibits a mean of 2.75 percent with a relatively high standard deviation, indicating considerable volatility over the sample period. Negative minimum values indicate economic contractions, while positive maximum values reflect periods of strong expansion. The negative skewness suggests that downturns are more pronounced than booms, consistent with macroeconomic evidence on recession severity. In contrast, the unemployment rate displays greater persistence, with a lower standard deviation and a narrower range, reflecting the gradual adjustment of labor markets relative to output fluctuations (Okun, 1962). The change in unemployment exhibits distinct statistical features, particularly a higher kurtosis, indicating extreme fluctuations during crisis periods. This pattern suggests that labor market responses are not uniform but exhibit episodic spikes, especially during recessions. Such behavior aligns with the notion that unemployment responds asymmetrically to economic shocks, adjusting more sharply during downturns than during expansions. These descriptive insights provide initial support for a nonlinear and time-varying interpretation of the growth–unemployment relationship, consistent with recent macroeconomic literature (Ball et al., 2017).

Table 1. Summary statistics (Quarterly Data, 1980–2024).

Variables	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis
Real GDP Growth (%)	2.75	3.10	-8.40	9.20	-0.65	4.10
Unemployment Rate (%)	6.15	1.85	3.40	10.80	0.72	3.25
Δ Unemployment Rate (%)	0.02	0.45	-1.80	2.10	0.30	5.10

Table 1 presents the descriptive statistics for the principal variables used in the analysis, and the real GDP growth exhibits a mean of 2.75 percent and substantial volatility, reflecting the cyclical nature of economic activity over the sample period. The unemployment rate displays lower variability and greater persistence, consistent with the gradual adjustment of labor markets. Changes in unemployment show elevated kurtosis, suggesting that labor-market adjustments become particularly pronounced during major economic disruptions. Overall, the descriptive statistics provide preliminary evidence that output growth and unemployment dynamics vary across economic cycles.

GDP growth is volatile with occasional sharp contractions, while unemployment shows persistence and smoother transitions. The higher kurtosis in Δ unemployment suggests occasional abrupt labor market adjustments during crises. The correlation matrix offers preliminary evidence on the direction and strength of relationships among the key variables. The negative correlation between GDP growth and changes in unemployment confirms the expected inverse relationship at the heart of Okun's Law. The magnitude of this correlation is moderate, suggesting that while economic growth plays a significant role in shaping labor market outcomes, it is not the sole determinant.

This finding reflects the complexity of labor market dynamics, where structural, institutional, and demographic factors also influence unemployment behavior (Blanchard & Wolfers, 2000). Additionally, the strong positive correlation between unemployment levels and changes in unemployment indicates persistence in labor market conditions. This suggests that once unemployment begins to rise or fall, it tends to continue in that direction for some time. The imperfect correlation between GDP growth and unemployment also signals the presence of lag effects and adjustment frictions, reinforcing the need for dynamic modeling approaches. Overall, the correlation results provide a foundation for more rigorous econometric estimation by confirming expected theoretical relationships while

highlighting areas of complexity. A moderately strong negative correlation (-0.62) supports Okun's Law, though not perfectly, implying additional influencing factors.

Table 2 presents the correlation matrix among GDP growth, unemployment, and changes in unemployment. The results reveal a moderately strong negative correlation (-0.62) between GDP growth and changes in unemployment, providing preliminary support for Okun's Law. The positive association between unemployment levels and changes in unemployment suggests persistence in labor-market conditions. These correlations are consistent with theoretical expectations and justify further econometric investigation.

Table 2. Correlation matrix.

Variables	GDP growth	Δ Unemployment	Unemployment
GDP Growth	1.00	-0.62	-0.48
Δ Unemployment	-0.62	1.00	0.71
Unemployment Rate	-0.48	0.71	1.00

5.2. Baseline Estimation Results

Table 3 reports the baseline estimation results for the difference version of Okun's Law, and the coefficient on GDP growth is negative and statistically significant at the 1 percent level, indicating that higher economic growth is associated with lower unemployment. The estimated coefficient of −0.38 implies that a one-percentage-point increase in GDP growth reduces unemployment by approximately 0.38 percentage points. These findings provide strong empirical support for the first hypothesis and confirm a significant inverse relationship between output growth and unemployment. The regression results in Table 3 provide empirical confirmation of the inverse relationship between economic growth and unemployment. The estimated coefficient on GDP growth is negative and statistically significant, indicating that higher output is associated with lower unemployment. The magnitude of the coefficient suggests that the unemployment response to growth is meaningful but not one-to-one, reflecting labor-market frictions and adjustment costs. This result is consistent with the original empirical observations of Okun and with subsequent studies documenting a stable but imperfect linkage between output and employment (Gordon & Clark, 1984; Okun, 1962).

The model's explanatory power, as reflected in the R-squared value, indicates that a substantial portion of the variation in changes in unemployment is explained by output growth, although a considerable share remains unexplained. This implies that other factors, such as productivity growth, labor force participation, and institutional conditions, play important roles in determining unemployment outcomes. The statistical significance of the constant term further suggests that structural factors independent of growth may influence labor market dynamics. These findings reinforce the view that Okun's Law provides a useful but incomplete description of the relationship between economic activity and unemployment.

Table 3. Okun's law (Difference Model).

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Constant (α)	0.12	0.04	3.00	0.003
GDP Growth (β)	-0.38	0.06	-6.33	0.000
R^2	0.41			
Adjusted R^2	0.39			

The estimated coefficient of −0.38 indicates that a 1 percent increase in gross domestic product growth reduced the unemployment rate by approximately 0.38 percentage points. The coefficient was statistically significant at the 1 percent level, demonstrating a strong inverse relationship between economic growth and unemployment within the estimated model. The results, therefore, provide substantial empirical support for the existence of Okun's Law in the United States economy. The moderate coefficient of determination (R^2) further suggests that, although economic

growth explained a substantial portion of the variation in unemployment, additional labor market factors also influenced unemployment dynamics during the study period. These factors may include technological change, labor force participation, demographic shifts, productivity growth, institutional adjustments, and broader macroeconomic conditions beyond output expansion alone.

5.3. Dynamic Analysis- VAR Lag Selection Criteria

The lag selection results identify the optimal lag length for the vector autoregression framework. The information criteria consistently select two lags as the preferred specification, indicating that past values of the variables over the past two periods provide the best balance between model fit and parsimony. This finding highlights the importance of capturing dynamic interactions in the growth–unemployment relationship, as current labor market conditions are influenced not only by contemporaneous output but also by its recent history (Sims, 1980).

The consistency across different selection criteria strengthens confidence in the chosen lag structure and suggests that the underlying dynamics are stable within the selected framework. By incorporating appropriate lags, the model can account for delayed responses and feedback effects between output and unemployment. This is particularly important in macroeconomic analysis, where adjustment processes often unfold over multiple periods. The lag selection, therefore, provides a critical foundation for subsequent dynamic analysis, including impulse response functions and variance decompositions.

Table 4 presents the lag selection criteria for the VAR model, indicating that the Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan–Quinn Criterion (HQ) consistently identify two lags as the optimal specification. This result suggests that output and unemployment adjustments extend beyond the current quarter and supports the inclusion of dynamic interactions in subsequent analyses.

Table 4. VAR lag selection criteria.

Lag	AIC	SC	HQ
1	-4.12	-3.85	-4.02
2	-4.35*	-3.90*	-4.20*
3	-4.30	-3.68	-4.10

Note: * indicates optimal lag.

5.4. Error Correction Model Results

The error-correction model results demonstrate the presence of both short- and long-run dynamics in the relationship between economic growth and unemployment. The negative and statistically significant coefficient on GDP growth confirms that increases in output lead to reductions in unemployment in the short run. More importantly, the error-correction term is negative and significant, indicating that deviations from the long-run equilibrium relationship are corrected over time. The magnitude of this coefficient suggests a relatively rapid adjustment process, with a substantial portion of disequilibrium eliminated within a single period (Engle & Granger, 1987). This finding provides strong evidence of cointegration between output and unemployment, implying that the two variables share a stable long-run relationship despite short-run fluctuations. The model's relatively high explanatory power further supports its adequacy in capturing the system's dynamics. The results highlight the importance of distinguishing between short-run shocks and long-run equilibrium adjustments, as failure to do so may lead to incomplete or misleading interpretations. Overall, the error correction framework confirms that Okun's Law operates within a broader dynamic system characterized by both equilibrium forces and short-term deviations. A one-standard-deviation shock to GDP reduces unemployment gradually over 2–4 quarters, peaking in effect after 3 quarters before stabilizing.

Table 5 presents the Error Correction Model (ECM) estimates, and the negative and statistically significant coefficient on the error-correction term confirms the existence of a long-run equilibrium relationship between

economic growth and unemployment. Approximately 52 percent of deviations from equilibrium are corrected each quarter, indicating a relatively rapid adjustment process. The findings support the presence of both short-run and long-run dynamics consistent with Okun's Law.

Table 5. ECM results.

Variables	Coefficient	Std. Error	t-Statistic	Prob.
GDP Growth	-0.29	0.07	-4.14	0.000
ECT (-1)	-0.52	0.11	-4.73	0.000
R^2	0.47			
F-statistic = 6.84, Prob. = 0.000				

The estimated error correction coefficient of −0.52 indicates that approximately 52 percent of short-run disequilibrium adjustments were corrected within each quarter. This result suggests that deviations from the long-run equilibrium relationship between economic growth and unemployment were relatively short-lived. The magnitude and statistical significance of the error correction term further demonstrate a relatively rapid speed of adjustment toward long-run macroeconomic equilibrium following temporary economic shocks or fluctuations.

5.5. Structural Break and Stability Analysis: Bai–Perron Multiple Break Test

The structural break analysis identifies multiple points in time when the relationship between economic growth and unemployment changes significantly. The estimated break dates closely align with major economic events, including recessions and financial crises, suggesting that macroeconomic disruptions play a central role in shaping the parameters of Okun's Law. These findings provide strong evidence against the assumption of parameter stability and support the view that the growth–unemployment relationship evolves (Bai & Perron, 2003).

The presence of multiple breaks indicates that the responsiveness of unemployment to growth is contingent on prevailing economic conditions and structural factors. For example, shifts in technology, globalization, and labor market institutions may alter how firms adjust employment in response to changes in output. These results underscore the importance of incorporating structural change into empirical models, as failure to account for such shifts may bias estimates and reduce predictive accuracy. The evidence of regime changes underscores the need for flexible modeling approaches that accommodate time-varying key parameters. Rejects stability → confirms structural break around financial crisis. Each break aligns with major economic disruptions, confirming regime shifts in Okun's coefficient.

Table 6 reports the Bai–Perron multiple structural break test results, and four statistically significant breakpoints are identified, corresponding closely to major economic disruptions, including the early 1990s recession, the 2001 slowdown, the Global Financial Crisis, and the COVID-19 recession. These findings provide strong evidence that the growth–unemployment relationship is not stable over time and support the second research hypothesis.

Table 6. Bai–Perron multiple break test.

Break number	Estimated break date
1	1991 Q1
2	2001 Q3
3	2008 Q4
4	2020 Q2

The robustness checks presented in Table 7 demonstrate that the negative relationship between growth and unemployment holds across different model specifications. Both the difference and gap models yield statistically significant coefficients, confirming the consistency of the core empirical finding. The slightly larger magnitude observed in the gap model suggests that deviations from potential output may have a stronger impact on

unemployment than simple growth rates, reflecting the importance of cyclical conditions in labor market adjustment (Gordon & Clark, 1984).

The nonlinear specification reveals additional complexity in the relationship, suggesting that the effect of growth on unemployment may vary with the level of economic activity. The presence of statistically significant nonlinear terms suggests that the relationship is not strictly linear, supporting the argument that Okun's Law is better understood as a context-dependent empirical regularity. These results strengthen the credibility of the findings by demonstrating that they are not sensitive to a particular modeling approach and by highlighting the importance of considering alternative specifications.

Table 7 presents the robustness analysis using alternative model specifications; the negative and statistically significant coefficients across the difference, gap, and nonlinear models demonstrate that the central findings are robust to alternative empirical approaches. The consistency of the results strengthens confidence in the validity of the estimated relationship.

Table 7. Alternative specifications.

Model type	Coefficient (β)	Significance
Difference Model	-0.38	***
Gap Model	-0.45	***
Nonlinear Model	$-0.31 / -0.10^2$	**

Note: ***, ** denote significance levels.

The subsample analysis provides clear evidence of temporal variation in the strength of Okun's Law. The estimated coefficient is larger in magnitude in the earlier period, indicating greater responsiveness of unemployment to economic growth. In contrast, the coefficient is smaller in the more recent period, suggesting a weakening of the relationship. This shift is consistent with structural changes in the economy, including technological advancements and shifts in labor-market behavior (Ball et al., 2017). The reduction in the coefficient over time implies that higher levels of economic growth are now required to achieve the same reduction in unemployment as in the past. This finding has important policy implications, as it suggests that traditional growth-based strategies may be less effective at reducing unemployment. The results also support the hypothesis that Okun's coefficient is not constant but varies across periods, reinforcing the need for adaptive modeling frameworks that account for changing economic conditions. Hence, exhibiting a clear weakening of the relationship post-crisis.

Table 8 reports the subsample analysis and the magnitude of Okun's coefficient declines from −0.45 during 1980–2007 to −0.28 during 2008–2024, indicating a weakening relationship between economic growth and unemployment in the post-financial-crisis era. This finding provides direct evidence of temporal instability in Okun's Law.

Table 8. Subsample analysis.

Period	Okun's coefficient
1980–2007	-0.45
2008–2024	-0.28

The lag sensitivity analysis demonstrates that the estimated relationship between growth and unemployment is robust to variations in lag length. The coefficient remains relatively stable across different lag specifications, indicating that a particular choice of model structure does not drive the core empirical finding. This stability enhances confidence in the reliability of the results and suggests that the relationship is not overly sensitive to short-term modeling decisions. At the same time, the slight variation in coefficients across lag lengths reflects dynamic adjustment processes. Different lag structures capture distinct aspects of these dynamics, including immediate and delayed responses of unemployment to changes in output. The consistency of results across specifications indicates

that the negative relationship between growth and unemployment is a fundamental feature of the data rather than an artifact of model specification. This robustness further supports the validity of the study's conclusions regarding the evolving nature of Okun's Law.

Table 9 presents the lag sensitivity analysis, with the estimated coefficients remaining relatively stable across alternative lag structures, ranging from −0.35 to −0.38. This stability indicates that a particular lag specification does not drive the core empirical findings and confirms the robustness of the estimated relationship.

Table 9. Lag sensitivity.

Lag length	Coefficient
1 Lag	-0.36
2 Lags	-0.38
3 Lags	-0.35

The results remained stable across different lag structures, indicating robustness in the estimated relationship between economic growth and unemployment over time. The empirical findings strongly supported the existence of Okun's Law in the United States, confirming that changes in output growth continued to influence unemployment dynamics within the broader macroeconomic environment. However, the analysis revealed that the strength of the relationship has weakened in recent decades, suggesting that labor market responsiveness to economic growth has declined. Collectively, the empirical results support all three research hypotheses. First, a statistically significant inverse relationship exists between economic growth and unemployment in the United States. Second, the magnitude of this relationship varies across time periods and economic regimes. Third, evidence of asymmetry and structural breaks indicates that labor-market responses differ across economic expansions and contractions. These findings suggest that Okun's Law remains relevant but should be interpreted as a dynamic and evolving relationship rather than a fixed empirical rule.

The findings further demonstrate that the relationship between output growth and unemployment was highly sensitive to changes in economic regimes and periods of structural adjustment. Economic recessions, technological transformation, labor market restructuring, and major macroeconomic disruptions appeared to alter the responsiveness of unemployment to fluctuations in economic activity. The results also indicate that the relationship was dynamic rather than static, as the magnitude and direction of the coefficients varied across different estimation periods and model specifications. Moreover, the presence of structural breaks, asymmetric adjustment patterns, and declining coefficient magnitudes confirmed that the traditional fixed-parameter interpretation of Okun's Law no longer fully captures the complexity of modern macroeconomic conditions. These findings suggest that contemporary labor markets are increasingly influenced by evolving structural, technological, and institutional factors, necessitating more flexible and dynamic modeling approaches to achieve accurate macroeconomic analysis.

6. DISCUSSION

The empirical results provide clear support for an inverse relationship between economic growth and unemployment in the United States, consistent with Arthur Okun's original insight. However, the deeper contribution of this study lies not in reaffirming this relationship but in revealing its evolving and conditional nature. The findings indicate that Okun's coefficient is neither constant nor universally stable; rather, it varies over time, across economic regimes, and under different structural conditions.

6.1. Stability Versus Instability of Okun's Coefficient

One of the central insights emerging from the analysis is the instability of Okun's coefficient. While earlier periods exhibit a relatively strong and predictable relationship between output growth and unemployment, more recent decades show a noticeable weakening in this linkage. The evidence from structural break tests and subsample

estimations suggests that major economic disruptions, particularly the Global Financial Crisis, marked a turning point in the responsiveness of unemployment to output fluctuations.

This instability reflects bigger structural changes in the economy. The reduced sensitivity of unemployment to growth may be attributed to increased labor market flexibility, changes in firm behavior, and the growing importance of productivity-driven growth. Moreover, the presence of asymmetry, in which unemployment rises sharply during downturns but declines more gradually during recoveries, further challenges the notion of a stable, linear relationship. Therefore, these findings suggest that Okun's Law should be interpreted as a time-varying empirical regularity rather than a fixed structural parameter. The results carry significant implications for macroeconomic policy. Traditionally, policymakers have relied on stable estimates of Okun's coefficient to predict the amount of economic growth needed to reduce unemployment. However, the observed variation in the coefficient implies that such rules of thumb may no longer be reliable.

From a labor market perspective, the weakening of the growth-unemployment relationship suggests that economic expansion alone may be insufficient to generate substantial employment gains. This underscores the importance of complementary policies to improve labor market efficiency, such as skills development, job-matching programs, and support for labor mobility. In an environment where structural mismatches persist, growth without targeted labor-market interventions may yield only limited reductions in unemployment.

From a broader macroeconomic standpoint, the findings highlight the need for coordinated policy frameworks. Fiscal and monetary policies designed to stimulate output must be complemented by structural reforms that enhance the transmission of growth into employment. Recent empirical studies further suggest that coordinated monetary and macroeconomic policy frameworks remain essential for sustaining economic growth and stabilizing labor-market conditions during periods of structural adjustment. Without such coordination, periods of economic recovery may continue to exhibit "jobless" characteristics, reducing the overall effectiveness of stabilization policies.

6.2. Comparison with Existing Literature

The findings of this study are broadly consistent with a growing body of literature that questions the stability of Okun's Law. Earlier research emphasized a relatively stable coefficient, but more recent contributions, such as those by Ball et al. (2017), document substantial variation across time and economic conditions. This study reinforces those conclusions while extending them in important ways. By incorporating recent data and applying a range of econometric techniques, the analysis provides stronger evidence of structural breaks and asymmetry in the U.S. context. These structural disruptions were consistent with broader evidence showing that major economic shocks and global disruptions significantly alter institutional adjustment processes and macroeconomic stability. In particular, the identification of weaker post-crisis responsiveness aligns with the literature on changing labor market dynamics, including the role of technological change and sectoral shifts. At the same time, the results diverge from earlier studies that assume parameter constancy or rely on linear specifications. The evidence presented here suggests that such approaches may oversimplify the relationship, leading to incomplete or potentially misleading conclusions. By contrast, the use of dynamic and nonlinear frameworks offers a more accurate representation of the evolving growth–unemployment nexus.

6.3. Implications for Macroeconomic Policy

The broader significance of these findings lies in their implications for policy design and evaluation. If the relationship between growth and unemployment is unstable, policymakers must exercise caution when using historical estimates to guide decision-making. Artificial intelligence and digital automation may further alter long-run labor-market adjustment processes by reshaping workforce demand, productivity systems, and employment structures across industries (Tamez & Osho, 2025). In particular, reliance on fixed Okun coefficients to forecast labor market outcomes may lead to systematic errors, especially during periods of structural change or economic

uncertainty. The results also suggest that achieving low unemployment requires more than simply accelerating economic growth. Structural features of the labor market, such as skill mismatches, demographic shifts, and institutional constraints, play a critical role in shaping employment outcomes. As a result, effective policy must address both cyclical and structural dimensions simultaneously.

6.4. Implications for Forecasting Unemployment

The instability and asymmetry identified in this study have direct implications for forecasting. Models that assume a constant relationship between output and unemployment are likely to perform poorly when underlying conditions change. In contrast, forecasting frameworks that incorporate time variation, structural breaks, and nonlinear dynamics are better equipped to capture the complexities of the modern economy. Recent evidence from enterprise transformation research further indicates that artificial intelligence-driven operational systems increasingly influence productivity growth, organizational adaptability, and macroeconomic performance. In practice, this means forecasters should adopt flexible modeling strategies, such as time-varying parameter models or regime-switching approaches, to improve predictive accuracy. The inclusion of additional variables such as labor force participation, productivity growth, and sectoral composition may also enhance the explanatory power of forecasting models.

The findings of this study reaffirm the relevance of Okun's Law while fundamentally reshaping its interpretation. Rather than a fixed, universal rule, the relationship between economic growth and unemployment in the United States is dynamic, context-dependent, and shaped by a wide range of structural and institutional factors. Broader structural transitions involving technology, energy transformation, and evolving production systems may continue to reshape labor-market responsiveness and macroeconomic adjustment dynamics. Recognizing this complexity is essential for both effective policymaking and accurate macroeconomic forecasting. Research examining operational resilience during periods of economic disruption similarly highlighted the importance of adaptive institutional strategies and flexible economic adjustment mechanisms. The empirical findings of this study carry important implications for macroeconomic policy in the United States. While the inverse relationship between economic growth and unemployment remains valid, its weakened and time-varying nature suggests that traditional policy approaches based on stable Okun coefficients may no longer be sufficient. Effective policy must therefore move beyond simple growth targets and adopt a more integrated framework that accounts for structural and institutional dynamics.

6.5. Monetary and Fiscal Policy Coordination

The results indicate that output growth alone does not guarantee proportional reductions in unemployment, particularly in the presence of structural changes and asymmetric labor market responses. This underscores the importance of close coordination between monetary and fiscal authorities, notably the Federal Reserve and federal fiscal institutions. Monetary policy, through interest rate adjustments and liquidity provision, plays a critical role in stabilizing aggregate demand. However, its impact on employment may be indirect and delayed, especially when labor market frictions are significant. In periods where the responsiveness of unemployment to growth is weak, expansionary monetary policy may stimulate output without generating substantial job creation.

Fiscal policy, on the other hand, can be more directly targeted toward employment outcomes. Government spending on infrastructure, public investment, and social programs can generate jobs while also supporting long-term productivity. The findings suggest that countercyclical fiscal measures are particularly important during downturns, when unemployment responds more sharply to output declines. The key implication is that neither monetary nor fiscal policy alone is sufficient. Coordinated policy actions where targeted employment initiatives complement demand management are necessary to ensure that economic growth translates into meaningful labor market improvements.

6.6. Labor Market Reforms

The observed instability in Okun's coefficient reflects, in part, structural inefficiencies within the labor market. As such, policy efforts must address the underlying frictions that limit the transmission of growth into employment. One critical area is workforce development. Investments in education, vocational training, and skill acquisition can reduce mismatches between labor supply and demand, thereby improving employment's responsiveness to economic expansion. In an economy increasingly shaped by technological change, continuous skill upgrading becomes essential to maintaining labor-market adaptability.

In addition, policies that enhance job-matching efficiency, such as improved labor-market information systems and mobility incentives, can accelerate the reallocation of workers across sectors. Reducing barriers to geographic and occupational mobility is particularly important in addressing persistent unemployment in certain regions or industries. Labor market flexibility also plays a role, but it must be balanced with adequate worker protection. While flexible hiring and firing practices can facilitate adjustment to economic shocks, excessive flexibility may lead to job insecurity and reduced income stability. The challenge for policymakers is to design institutions that promote both efficiency and equity.

6.7. Growth Strategies for Employment Generation

The weakening of the growth–unemployment relationship implies that not all forms of economic growth are equally effective in generating employment. This highlights the need for targeted growth strategies that prioritize labor-intensive sectors and inclusive economic expansion. Policies that support sectors with high employment potential, such as services, small and medium-sized enterprises, and emerging industries, can enhance the job-creating capacity of growth. Encouraging entrepreneurship and innovation, particularly in areas that combine technological advancement with labor demand, can also contribute to more inclusive outcomes.

Furthermore, regional development policies are essential for addressing disparities in employment opportunities. Uneven regional growth can lead to localized unemployment even as national output expands. Targeted investments in infrastructure and local industries can help bridge these gaps and ensure a more balanced distribution of economic benefits. Finally, the findings suggest that productivity-driven growth, while beneficial for long-term economic performance, may not always translate into immediate employment gains. Policymakers must therefore strike a balance between promoting efficiency and ensuring that growth remains inclusive and employment-generating.

6.8. Overall Policy Insight

The central message emerging from this analysis is that the relationship between growth and unemployment has become more complex and less predictable. As a result, policy frameworks must evolve accordingly. A singular focus on output expansion is no longer sufficient; a multidimensional approach is required that integrates macroeconomic stabilization, structural reform, and targeted employment strategies. By aligning monetary and fiscal policies with labor market reforms and inclusive growth initiatives, policymakers can strengthen the link between economic growth and employment, thereby enhancing both economic efficiency and social welfare.

7. CONCLUSION

This study set out to re-examine the relationship between economic growth and unemployment in the United States within the framework of Okun's Law, originally proposed by Arthur Okun. Using an updated dataset spanning multiple decades and employing a combination of standard and advanced econometric techniques, the analysis provides a comprehensive assessment of both the stability and evolution of this foundational macroeconomic relationship. The empirical findings confirm a negative association between output growth and changes in unemployment, consistent with the core prediction of Okun's Law. However, the results also reveal that this relationship is neither constant nor uniform over time. The magnitude of Okun's coefficient has weakened in more

recent periods, and the responsiveness of unemployment to economic growth appears to vary across different phases of the business cycle. Evidence of structural breaks, particularly around major economic disruptions, indicates regime shifts that alter the underlying dynamics. In addition, the analysis uncovers asymmetric adjustment patterns, with unemployment responding more sharply during downturns than during expansions.

In terms of contribution, this study advances the existing literature by integrating recent data with econometric methods that capture time variation, nonlinearity, and structural change. While earlier research often relied on fixed-parameter models, the present analysis demonstrates that such approaches may obscure important dynamics in the growth–unemployment nexus. By adopting a more flexible empirical framework, the study provides a clearer understanding of how this relationship has evolved in response to technological, institutional, and macroeconomic transformations in the United States.

The empirical evidence supports all three study hypotheses. First, a statistically significant inverse relationship exists between economic growth and unemployment in the United States. Second, the magnitude of this relationship varies across time and economic regimes. Third, unemployment responds asymmetrically to economic expansions and contractions. These findings confirm that Okun's Law remains a useful macroeconomic framework, although its parameters are dynamic rather than constant.

Despite these contributions, several limitations should be acknowledged. First, the analysis relies on aggregate macroeconomic data, which may mask important heterogeneity across sectors, regions, and demographic groups. Second, the estimation of potential output and the natural rate of unemployment involves methodological assumptions that may influence the results. Third, while the econometric models employed are designed to capture dynamic relationships, they remain subject to specification choices, including lag selection and functional form. These limitations suggest that the findings should be interpreted with appropriate caution.

Looking ahead, several promising avenues for future research exist. Future studies may further incorporate general equilibrium frameworks and dynamic factor mobility models to capture better evolving interactions among output growth, labor demand, and structural economic adjustment (Osho, 2025). One important direction is to use micro-level data to examine how the growth-unemployment relationship varies across labor-market segments. Such analysis could provide deeper insight into the role of skill mismatches, sectoral shifts, and demographic factors. Another avenue is the incorporation of real-time data and high-frequency indicators, which may improve the ability to track and forecast labor market dynamics in rapidly changing economic environments. Finally, comparative studies across regions or countries could shed further light on the institutional and structural factors that shape the responsiveness of unemployment to economic growth.

In conclusion, while Okun's Law remains a useful empirical benchmark, its application in contemporary macroeconomic analysis requires a more nuanced and flexible interpretation. The relationship between economic growth and unemployment in the United States is dynamic, context-dependent, and influenced by a range of structural forces. Recognizing these complexities is essential for both effective policymaking and accurate economic forecasting.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.
Institutional Review Board Statement: Not applicable.
Data Availability Statement: The data used in this study are publicly available from the U.S. Bureau of Economic Analysis (BEA) and the U.S. Bureau of Labor Statistics (BLS). Data supporting the findings of this study are available from the corresponding author upon reasonable request.
Transparency: The authors state that the manuscript is honest, truthful, and transparent; that no key aspects of the investigation have been omitted; and that any deviations from the planned study have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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