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TESTING THE VALIDITY OF OKUN'S LAW WITH MIXED-FREQUENCY DATA: THE CASE OF TÜRKIYE

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Abstract

Okun's law posits a one-way relationship running from gross domestic product (GDP) to the unemployment rate. According to this law, an increase in GDP beyond its potential level will result in a decrease in the unemployment rate. In practice, potential real GDP is often taken to be the trend GDP, and the difference between actual GDP and potential GDP is termed the real GDP gap. The empirical literature typically estimates potential GDP using a linear trend approach. However, employing a linear trend to estimate potential GDP assumes that these values remain constant over the period under consideration. However, in reality, there are many reasons why potential GDP cannot remain constant over time, but rather can change. In such cases, using a Kalman filter approach instead of a simple linear trend is more appropriate. Furthermore, because the unemployment rate is measured at a higher frequency than GDP, unemployment data are typically not used at their original frequency in empirical analyses. In this study, the validity of Okun's law is tested by utilizing the unemployment rate at its original frequency for the Turkish economy. By employing a restricted reverse MIDAS (RR-MIDAS) model in our analysis, we find that Okun's law holds for the Turkish economy over the period examined.

Keywords: Mixed Data Sampling (MIDAS), RR-MIDAS, Kalman Filtering, Okun's Law

JEL Codes: C22 E24

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INTRODUCTION

According to Okun's law, first proposed by Arthur Okun in the 1960s, there exists a negative and statistically significant relationship between the unemployment rate and real GDP growth. Specifically, when economic growth exceeds its potential level, the unemployment rate is expected to decline. In his seminal study, Okun (1962) estimated that for the U.S. economy, a 1 percentage point increase in real GDP growth above its long-run trend of approximately 2.5 percent would reduce the unemployment rate by about 0.5 percentage points. Following this pioneering contribution, numerous empirical studies have examined the validity of Okun's law across different countries and time periods, with many finding supportive evidence (e.g., Motley, 1984; Weber, 1995; Attfield and Silverstone, 1998).

The policy relevance of Okun's law lies in its ability to provide a simple and intuitive benchmark for policymakers regarding the effectiveness of aggregate demand policies. If robust economic growth systematically leads to reductions in unemployment, policymakers can be more confident in employing expansionary fiscal or monetary measures during downturns. Conversely, a weakening or breakdown of this relationship would imply that growth-oriented policies may not translate into labor market improvements. For this reason, it is crucial to periodically reassess the empirical validity of Okun's law, particularly in different institutional settings and recent economic environments.

According to Okun (1962), potential real GDP refers to the level of output an economy can sustain at full employment. In empirical applications, potential output is typically approximated by a deterministic or stochastic trend, and the deviation of actual GDP from this trend is interpreted as the output gap. Most conventional studies assume that potential GDP follows a constant growth path over time. However, this assumption may be overly restrictive, as structural changes, productivity shocks, and policy regimes can cause potential output to evolve in a time-varying manner. In such cases, state-space models and the Kalman filter provide a more appropriate framework, allowing potential GDP to be treated as an unobservable component that evolves dynamically over time.

Despite the extensive literature on Okun's law, a key empirical limitation remains largely unresolved. Most studies have been unable to utilize unemployment and output data at their original frequencies. This limitation arises because labor market indicators are typically available at higher frequencies than national accounts data. For example, in Türkiye, unemployment statistics have been published on a monthly basis since 2014, whereas real GDP is available only quarterly. As a result, existing studies often aggregate high-frequency unemployment data to match quarterly GDP, potentially obscuring important within-quarter labor market dynamics.

The central research problem addressed in this study is whether Okun's law holds for the Turkish economy when unemployment data are used at their original monthly frequency rather than being artificially aggregated to quarterly observations. To address this problem, the primary aim of the study is to test the validity and stability of Okun's law for Türkiye in recent periods by employing a mixed-frequency econometric framework that preserves the informational content of monthly unemployment data.

To achieve this objective, we employ a Reverse Restricted Mixed Data Sampling (RR-MIDAS) model. This methodology allows variables measured at different frequencies to be jointly modeled without temporal aggregation. In addition to improving estimation efficiency, the RR-MIDAS framework enables us to examine whether the Okun coefficient varies within the quarter-that is, whether the responsiveness of unemployment to output differs across the first, second, and third months of each quarter. This within-quarter heterogeneity cannot be observed in standard quarterly regressions.

Methodologically, this study contributes to the literature by providing a novel mixed-frequency perspective on Okun's law. By exploiting the full granularity of monthly unemployment data for Türkiye, the analysis offers a more timely and detailed assessment of the growth-unemployment relationship and yields new insights into the temporal structure of Okun's coefficient that are relevant for macroeconomic policy design.

LITERATURE REVIEW

Okun's Law was first proposed by Arthur Okun in 1962 and has since been the subject of many empirical studies. In pioneering studies focusing specifically on the U.S. economy, Motley (1984) and Weber (1995) suggested that Okun's law remains consistently valid. Similarly, Freeman (2000) obtained results consistent with the law across eight geographic regions of the U.S., and Wang and Huang (2017) confirmed the validity of Okun's law for the U.S. economy using a nonlinear model.

In the literature, the validity of Okun's law has been shown to vary across countries. For example, Kaufman (1988) conducted an analysis including the United States, Sweden, Japan, Canada, the United Kingdom, and Germany, and found that the cyclical unemployment rate's response to economic growth is sensitive to the structural differences among countries. In a study covering the Germany, the Netherlands, the United Kingdom, and the United States, Knoester (1986) noted that variables such as real wages and investment serve to strengthen the statistical robustness of the Okun relationship. On the other hand, studies focusing on European countries have produced complex findings. Mussida and Zanin (2023) found that, in nine European countries excluding Norway, Okun's law generally holds, although the Okun coefficient exhibits instability over time. Similarly, Sögner and Stiassny (2002) reported that the law is unstable for

Switzerland, Germany, Denmark, Finland, France, United Kingdom, Japan, Netherlands, Norway, and Sweden, whereas a stable relationship is observed for Austria, Belgium, Canada, Italy, and the United States.

There is also empirical evidence that law may exhibit asymmetric behavior during periods of expansion and contraction of economies. Holmes and Silverstone (2006) found evidence of asymmetry during recessions, when unemployment is above its trend, whereas this effect was absent in expansions. Similarly, Huang and Lin (2008) demonstrated that the coefficient in Okun's law can vary over time. Cuaresma (2003) and Silvapulle et al. (2004) showed that, in the U.S. economy, the association between output and unemployment differs between recessionary and expansionary phases.

Empirical research on developing countries presents a more diverse set of findings. For instance, Pehlivanoğlu and Tanga (2016) reported that law is not valid for Türkiye, South Africa, and Brazil, even though it appears valid in Russia, China, and India. In addition, Singh and Nurudeen (2022) found robust evidence supporting the law for China's economy, while Bartolucci et al. (2018) demonstrated that the Okun coefficient is higher for high-income countries, with unemployment rising disproportionately during economic crises. Additional applied studies have further supported the validity of Okun's law across various regions; for example, consistent evidence has been reported for the G7 countries (Moosa, 1997), Latin American countries (Zanin, 2023), the United Kingdom (Attfield & Silverstone, 1998), a panel of sixteen OECD countries (Lee, 2000), Austria (Sögner, 2001), Greece (Apergis & Rezitis, 2003), Canada (Adanu, 2005), Spain (Villaverde, Malezya: Tingi & Lingii, 2011), Jordan (Al-Kasasbeh, 2022), Tunisia (Ben Amor, 2023), 265 European regions (Maza, 2009), and Pakistan (Latif et al., 2021). Conversely, some studies have reported that Okun's law does not hold or has only limited validity. For example, Moosa (2008) found inconsistent evidence for Morocco, Tunisia, Algeria, and Egypt, while Eğri (2018) and Chenini et al. (2023) reached similar conclusions for Egypt and Pakistan, respectively. Furthermore, Christopoulos (2004) observed that only six out of thirteen regions in Greece yielded results that conformed to Okun's law.

Turning specifically to studies on Türkiye, findings have varied according to the period and methodological approach employed. Demirgil (2010) identified a statistically significant inverse association between economic growth and the unemployment rate within the framework of Okun's law in Türkiye, noting that including a productivity variable increased the absolute magnitude of the Okun coefficient. Moreover, in the same study, Demirgil (2010) found that the Okun coefficient changes over time, tending to decrease during expansion phases, and that law does not hold when productivity growth exceeds its average level. In contrast, Barışık et al. (2010) argued that the law holds only during recessionary periods, observing a phenomenon of jobless growth during economic expansions. While Akay et al. (2016)

emphasized the presence of an asymmetric relationship between growth and unemployment, Erkuş et al. (2016) did not detect such asymmetry in their analysis. Apaydın and Taşdoğan (2019) contended that the law is valid for general and cyclical unemployment but not for structural unemployment, whereas Uslu (2020) reported evidence consistent with the law for Türkiye during the period 1923–1971 but noted that jobless growth has dominated from 1972 to 2019. Similarly, Yamak and Yamak (2018) and Kolcu and Yamak (2022) confirmed the validity of the law for Türkiye, although they emphasized that the estimated Okun coefficient can vary depending on the filtering method employed. Finally, Yüksel and Oktar (2017) identified a one-way causality from economic growth to unemployment in Türkiye, although they did not estimate the Okun coefficient.

Distinct from the above studies, Koçak (2021) tested Okun's law for the Turkish economy by employing the original frequencies of both the unemployment rate and economic growth. In his study, which utilized a Mixed-Frequency Bayesian Vector Autoregressive Regression (MFBVAR) model as well as a traditional VAR model, the Okun coefficient was statistically significant only in the MFBVAR model, albeit at a very low magnitude. In a more recent study, Turna (2023) using an ARDL approach for the period 2005–2022, found strong evidence that changes in economic growth led to significant long-run reductions in unemployment. Furthermore, in another study that utilized the original frequency of the unemployment rate, Samut (2024) employed the RR-MIDAS approach and found that the Okun effect in the Turkish economy varies across the individual months within each quarterly period. In Samut's (2024) study, potential GDP was estimated using the Hodrick–Prescott filtering; however, as mentioned before, HP filtering may not fully capture short-term economic shocks, rendering it insufficient for accurately decomposing the high-frequency cyclical component.

Overall, as for many other countries, the empirical literature for Türkiye largely supports the validity of the law. A common feature among nearly all these studies is the use of the same frequency for both the unemployment rate and economic growth data. As noted earlier, in many economies these two variables are published at different frequencies. The present study will test the validity of the law in Türkiye using the original frequencies of both variables. Unlike previous studies such as those by Koçak (2021) and Samut (2024), this study will estimate the potential GDP series using Kalman filtering rather than the HP filter and subsequently estimate Okun's equation employing the RR-MIDAS model.

METHODOLOGY

Okun's law which explains the association between economic growth and the unemployment rate can be formulated within different modeling frameworks. One such model examines the impact of the gap

between actual GDP and potential GDP on changes in the unemployment rate. According to this framework, Okun's equation is given as follows:

$$\Delta u_t = \beta_0 + \beta_1(y_t - y_t^*) + \varepsilon_t \quad (1)$$

In Equation (1), u_t denotes the unemployment rate, Δ is the difference operator, y_t represents GDP, y_t^* represents potential GDP, and β_0 and β_1 are the regression coefficients. For Okun's law to hold, the coefficient β_1 must be statistically less than zero. Since potential GDP is not directly observable, the literature typically employs filtering methods such as the Hodrick–Prescott, Baxter–King, or Christiano–Fitzgerald filtering to extract unobserved component. However, these filtering techniques assume a constant cyclical structure for any time series, whereas economic variables may change dynamically due to unforeseen shocks. The Kalman filter approach models the evolution of unobserved variables over time and updates its estimates with each new observation, thereby enabling a dynamic estimation of latent series. In this study, potential GDP is estimated by applying the Kalman filter to a state-space model. The model, which consists of measurement and transition equations is presented in Equations (2) and (3) below.

$$y_t = Z_t y_t^* + \varepsilon_t, \qquad \varepsilon_t \sim N(0, H_t), \quad y_1 \sim N(y_1, P_1) \quad (2)$$

$$y_{t+1}^* = T_t y_t^* + R_t \eta_t, \qquad \eta_t \sim N(0, Q_t) \quad (3)$$

In this state-space framework, Equation (2) serves as the measurement equation, while Equation (3) outlines the transition equation. Here, Z_t denotes the system matrix in the measurement equation, and ε_t is the measurement noise vector, assumed to be normally distributed with covariance matrix H_t. The matrix T_t governs the time evolution of the state vector y_t and R_t is associated with the transition noise. Meanwhile, the latent state error η_t follows a normal distribution with covariance Q_t. Finally, the notation $y_1 \sim N(y_1, P_1)$ specifies the initial conditions, with P_1 representing the covariance matrix of the initial state. The estimation of the model using the Kalman filter is performed in two steps. In the first step, the covariance $P_{t|t-1}$ is estimated using the updated forecast information from period $t-1$ (denoted by $y_{t|t-1}^*$). In the second step, the model's forecast error is computed by comparing the observable variable y_t with the actual observation for period t, and the updated estimates y_t^* and P_t are obtained accordingly.

In the related literature, the validity of Okun's law has been investigated using different econometric methods for different economies and periods. Multivariate time series models have been generally utilized in these analyses. As is known, in multivariate time series regression models, all included variables must be of the same frequency. However, in testing the validity of law, unemployment rate and GDP have different

frequencies for many economies. For example, in Türkiye the unemployment rate is published monthly, whereas real GDP is reported quarterly. To eliminate this frequency mismatch, the high-frequency variable is aggregated to the frequency level of the low-frequency variable. Such aggregation, however, may result in the loss of some information contained in the high-frequency data. (Zadrozny, 1990, p.1-2; Andreou et al., 2010, p.246; Götz et al., 2016,p.418). To address this shortcoming in time series analysis, Ghysels et al. (2004) developed the Mixed Data Sampling (MIDAS) methodology. With the MIDAS approach, variables observed at different frequencies can be incorporated in the same model without undergoing any frequency conversion. Nevertheless, in the MIDAS framework the dependent variable must be at a lower frequency than the independent variable(s). In contrast, in the case of Okun's equation the dependent variable the unemployment rate is observed at a higher frequency than the independent variable (GDP). In the relevant literature, Foroni et al. (2018) developed the RU-MIDAS model specifically for situations where the dependent variable is at a higher frequency than the independent variable. However, the number of parameters in the RU-MIDAS model depends on the magnitude of frequency ratio between the variables as well as the number of lag terms in the model. To mitigate the burden of estimating numerous parameters, Xu et al. (2021) introduced the Reverse Restricted MIDAS (RR-MIDAS) model. The RR-MIDAS model is presented in Equation (4) below.

$$(\Delta u_t)_{t,j}^{(m)} = \sum_{r=0}^{q-1} \lambda_{j,r} \sum_{s=1}^{m} w_r(\delta_r; s)(\Delta u_t)_{t+j/m-(r+\frac{s}{m})}^{(m)} + \sum_{i=0}^{q} \beta_i (y_t - y_t^*)_{t-i} + \varepsilon_{t,j} \qquad (4)$$

In Equation (4), m denotes the frequency ratio between the low-and high-frequency variables, q represents the number of lags, and β_i are the model parameters. The index j refers to the jth high-frequency interval corresponding to the low-frequency period t of the unemployment rate, while $s = 1, 2, \dots, m$ denotes the high-frequency periods and r represents the low-frequency periods. Moreover, $\lambda_{j,r}$ is the common parameter associated with the high-frequency variable, δ_r is the hyperparameter associated with the rth low-frequency lag order, and $w_r(\delta_r; s)$ represents the weighting function for the past values of the high-frequency variable, as specified in Equation (5).

$$w_r(\delta_r; s) = \frac{\varphi_r(\delta_r; s)}{\sum_{s=1}^{m} \varphi_r(\delta_r; s)} \qquad (5)$$

Xu et al. (2021) proposed incorporating nonlinear functional restrictions into the RR-MIDAS model. Consequently, the RR-MIDAS model can be estimated by nonlinear least squares. In the present study, the high-frequency unemployment rate was weighted using the exponential Almon model prior to estimating the RR-MIDAS model. Ghysels et al. (2005) argued that two parameters are sufficient for the exponential

Almon specification. In the analysis section of this study, the RR-MIDAS model was estimated using a nonlinear least squares approach implemented by Broyden-Fletcher-Goldfarb-Shanno algorithm.

Samut (2024) re-examined Okun's law for the Turkish economy employing a RR-MIDAS model. In that study, potential GDP was estimated using the Hodrick–Prescott (HP) filtering. As is known, the HP filter cannot adequately capture short-term fluctuations or other economic shocks. Therefore, the HP filter is inadequate for decomposing high-frequency cyclical components. On the other hand, Baxter and King (1999) pointed out that the rapidly changing weights of the Hodrick–Prescott filtering toward the end of sample, when applied to quarterly data, can cause substantial distortions in the estimated cyclical component. This approach – which is widely used for potential GDP estimation – may suffer from significant end-of-sample bias. Furthermore, because the smoothing is performed with the same parameter over the entire sample, HP filtering may fail to capture structural breaks or shocks at different frequencies that occur over time in the series. In contrast, the Kalman filter can directly incorporate unobserved latent variables such as potential GDP into the model and can update estimates as new data become available, thereby capturing time-varying dynamics. Thus, the Kalman filter helps resolve the end-of-sample bias and provides a flexible framework that can be integrated with economic theory.

DATA SET

To test Okun's law for the Turkish economy, monthly unemployment rates were obtained from the Central Bank of Türkiye's electronic data delivery system. Meanwhile, the quarterly chain-linked GDP volume index was collected from the Turkish Statistical Institute. Both series were adjusted for seasonal and calendar effects at the source and were subsequently analyzed at their original frequencies. The unemployment rate dataset extends from January 2014 to December 2024, while the chain-linked GDP volume index spans the first quarter of 2014 through the fourth quarter of 2024. Furthermore, the GDP index was transformed using the natural logarithm to stabilize variance and enhance interpretability of the findings. Table 1 summarizes the descriptive statistics for both variables. As seen in the table, the unemployment rate ranges from 10.5 to 14.1, while the GDP volume index lies between 141.1 and 231.3. Notably, both series exhibit right-skewed distributions and demonstrate a platykurtic structure.

Table 1: Descriptive Statistics

Variable	Unemployment	Chain-Linked GDP Volume
Number of Observation	132	44
Frequency	Monthly	Quarterly
Mean	10.948	183.091
Median	10.5	176.55
Maximum	14.1	231.3
Minimum	8.4	141.1
Standard Deviation	1.557	27.752
Skewness	0.483	0.295
Kurtosis	2.253	1.810

Figure 1 depicts the evolution of the unemployment rate over time. As shown, the rate increased from roughly 9% in 2014 to between 10% and 11% by the end of 2015. In 2016, the unemployment rate further rose to 12%, before declining to around 10% by February 2018. Subsequently, the unemployment rate rose sharply, reaching about 14% during the 2019–2020 period. This trend may suggest that both global and domestic economic fluctuations exerted adverse effects on the labor market. After 2020, however, the graph reveals a sustained decline in the unemployment rate, with data indicating that by late 2024, the rate had decreased to around 8%.

Figure 1: Unemployment rate

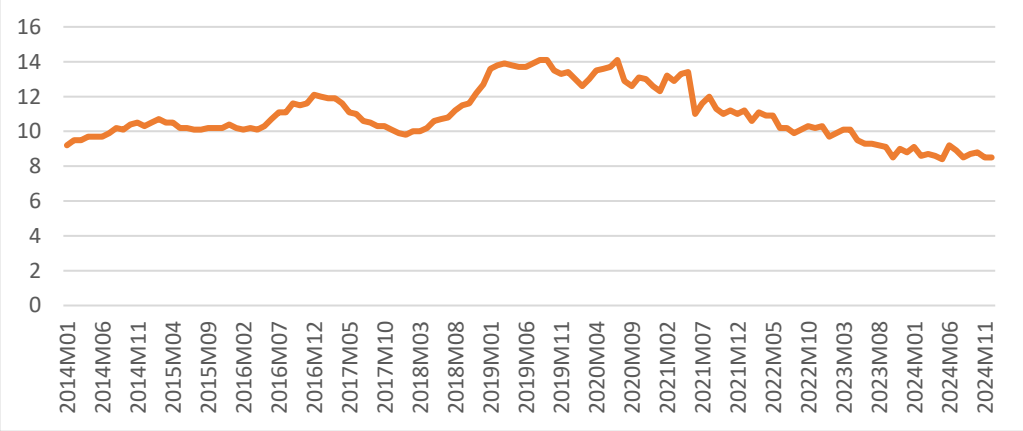
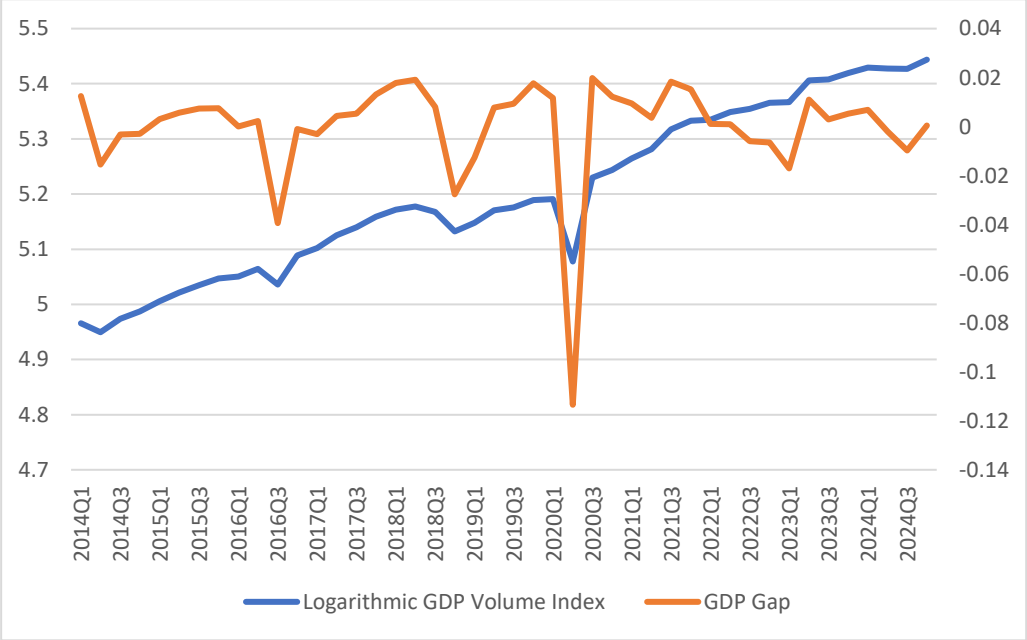


Figure 2 depicts the evolution of the logarithmic GDP volume index and the GDP gap over time, where the GDP gap is defined as the difference between the log-index and its potential value, estimated via Kalman filtering. The chart indicates that the logarithmic GDP volume index followed a steady upward trend until the final quarter of 2018, subsequently experiencing a slight decline. However, after this

downturn, the index resumed its growth trend, despite a sharp drop in 2020 prompted by the pandemic. This decline was subsequently reversed, and by the end of 2024 the GDP volume index had resumed a steady growth trend. In contrast, the GDP gap was positive during the 2014–2015 period but turned negative in the third and fourth quarters of 2016. The graph reveals that the GDP gap generally remained positive until the early part of 2019, although a decline was observed in the fourth quarter of 2018. The most pronounced decrease in the GDP gap occurred in the second quarter of 2020. Notably, during the second and third quarters of 2020, the GDP gap rebounded swiftly, reverting to its earlier path. Throughout the period leading up to 2024, the gap fluctuated, but remained primarily in the positive range.

Figure 2: Logarithmic GDP volume index and GDP gap



FINDINGS

Granger and Newbold (1974) highlighted that in multivariate time series regression models, nonstationary level variables can lead to spurious regression problems. Therefore, the stationarity properties of the variables were assessed before estimating the RR-MIDAS model. As noted in the previous section, Okun's equation is estimated with the cyclical component of GDP, the output gap (actual minus potential GDP), as the independent variable and the first difference of the unemployment rate as the dependent variable. In terms of stationarity tests, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were applied using models without a constant term, and the findings are presented in Table 2.

According to Table 2, the Kalman filter–based cyclical GDP variable is stationary at the 1% significance level, whereas the unemployment rate becomes stationary upon first differencing.

Table 2: Unit root test results

Variable	Frequency	ADF	PP
Cyclical GDP	Quarterly	-7.343***	-9.726***
Δ unemployment Rate	Monthly	-12.034***	-12.013***

Note: ***, *, and * demonstrate significance levels at 1%, 5%, and 10%, respectively. Δ is the first difference operator.

Based on the stationarity tests, neither the first difference in the unemployment rate nor the cyclical GDP (constructed by Kalman filtering) displays a unit root. Hence, no further transformations are required prior to estimation. Given the monthly unemployment data and the quarterly GDP data, the Okun equation is estimated using the RR-MIDAS model described in Equation (4). In this estimation, the high-frequency variable is weighted using the exponential Almon model. Since the exponential Almon model is nonlinear in its parameters, the RR-MIDAS model is estimated through the nonlinear least squares method. Moreover, separate RR-MIDAS model estimations were performed for each month within the quarterly period in order to investigate the potential change in the Okun coefficient across the quarter. The findings of the RR-MIDAS model are summarized in Table 3.

Table 3 presents the model findings, which imply that the estimated Okun coefficient is, as expected, significantly less than zero. Furthermore, the estimates of the Okun coefficient are statistically significant at the 1% level in the first month of the quarter, at the 5% level in the second month, and at the 10% level in the third month, as shown in the table. These results thus support the validity of Okun's law for the Turkish economy. Moreover, the estimates remain robust when new unemployment data are incorporated for each month within the quarter. However, the performance of the law is not uniform across the months within the quarter. According to the findings, economic growth above potential rapidly influences the labor market and leads to a decline in the unemployment rate. Specifically, if GDP increases by 1 percent above its potential value, the unemployment rate is anticipated to decrease by 5.45 percent in the first month of the quarter, by 4.60 percent in the second month, and by 6.41 percent in the third month. The differing monthly outcomes imply that the dynamics influencing the unemployment rate fluctuate across the quarter. Additionally, Table 3 includes tests of whether the estimated Okun coefficients for each month within the quarter are significantly less than zero. The results indicate that the coefficients for all three months are statistically significantly less than zero at the 5% level.

Table 3: RR-MIDAS results of Okun's equation

RR-MIDAS Findings			
	First Month Period	**Second Month Period**	**Third Month Period**
β_1	-5.4537*** (1.8498)	-4.5960** (1.9996)	-6.4105* (3.4208)
$H_0: \beta_1 \geq 0$ (t-statistic)	2.9483	-2.2985	-1.8740
Diognastic Test for RR-MIDAS			
	First Month Period	**Second Month Period**	**Third Month Period**
LM, χ^2 Statistics	0.276	2.234	2.118
Ljung-Box χ^2 Statistics	0.286	2.426	2.078
Glejser t Statistics	0.745	0.868	-0.524
Comparison of RR-MIDAS and OLS Models			
	RR-MIDAS	OLS	
RMSE	0.07038	0.20831	

Note: ***, *, and * demonstrate that the respective coefficient is statistically significant at the 1%, 5%, and 10% significance levels. The t-statistic values reported in the table are for testing the null hypothesis $H_0: \beta_1 \geq 0$, where the alternative hypothesis is $H_1: \beta_1 < 0$. For one-tailed tests, the critical t-values at the 1% and 5% significance levels are 2.423 and 1.684, respectively. RMSE stands for Root Mean Squared Error**.** Across the three month-specific RR-MIDAS equations, the LM χ^2 and Ljung–Box χ^2 statistics indicate no residual autocorrelation, while the Glejser t-statistics indicate no heteroskedasticity at conventional levels. Hence, the residuals are well-behaved and inference from the RR-MIDAS estimates is valid.

As a robustness check and for comparison, Okun's equation was re-estimated using a quarterly aggregation of the unemployment rate. This version of the model incorporates the gap between the GDP volume index and its potential value obtained via the Kalman filter along with the first difference in the unemployment rate. As both series satisfy the stationarity condition, the estimation was performed using the Ordinary Least Squares (OLS) method. To account for autocorrelation in the error terms, Newey-West standard errors were calculated. The OLS estimation resulted in an Okun coefficient of -11.474, which is statistically significant at the 1% level.

Comparing the RR-MIDAS and OLS approaches highlights the advantages of the mixed-frequency method. The RR-MIDAS model, by utilizing the high-frequency (monthly) unemployment data in its original form, preserves information that is lost in the aggregated quarterly OLS model. As a result, the RR-MIDAS approach provides a more nuanced understanding of Okun's law by capturing intra-quarter dynamics and differences in impact from month to month, which the OLS approach cannot discern. In the analyses, the forecasting performances of the RR-MIDAS and OLS models were compared using the Root

Mean Squared Error (RMSE) statistic. For this comparison, the estimations were re-run excluding the final year of observations for both the unemployment rate and the GDP gap. In this way, forecasts for one year's first difference changes in the unemployment rate were produced with both models. In the RR-MIDAS model, the out-of-sample forecasts are tied to the specific high-frequency period used in the estimation. For the first month of the quarter, the forecast values are derived from the estimates of the MIDAS model corresponding to the first high-frequency sub-period within the quarter, while the forecasts for the last two months of the quarter are obtained from the MIDAS models estimated for the respective sub-periods. Consequently, monthly forecast values from the RR-MIDAS model are combined to form a single quarterly forecast. To compare the predictive performance of the RR-MIDAS and OLS approaches, these monthly forecasts were likewise aggregated to a quarterly basis. As shown in Table 3, both models' RMSE statistics imply that the RR-MIDAS model outperforms the OLS model; the RR-MIDAS model's RMSE (0.07038) is much lower than the OLS model's RMSE (0.20831). This indicates that the RR-MIDAS provides a significantly more accurate forecast of changes in unemployment. Hence, it can be concluded that the RR-MIDAS approach provides superior forecasting performance relative to the traditional OLS approach. These findings underscore the benefits of using RR-MIDAS in our context. RR-MIDAS does not only validates Okun's law with higher fidelity but also improves predictive power by fully exploiting the information in high-frequency labor market data.

DISCUSSION

Many previous studies on Türkiye aggregate high-frequency unemployment data to match quarterly GDP, potentially obscuring short-term labor market dynamics. In contrast, this study retains the original monthly frequency of unemployment and employs the RR-MIDAS framework, allowing a more nuanced assessment of the growth–unemployment nexus. By doing so, it uncovers intra-quarter heterogeneity that cannot be identified in conventional low-frequency models.

Three methodological choices are particularly relevant for interpreting the findings. First, preserving the original data frequencies enables the identification of short-run labor market adjustments that are otherwise smoothed out by temporal aggregation. Second, estimating potential output via a Kalman filter mitigates well-known limitations of fixed-parameter trend filters, such as end-point bias and excessive smoothness. Third, the RR-MIDAS specification allows the response of unemployment to cyclical output to vary within the quarter, revealing timing effects that are typically ignored in the literature.

The presence of intra-quarter heterogeneity suggests that labor market adjustments to economic activity are not instantaneous nor uniform over time. Hiring and separation decisions may respond with

short lags to realized demand conditions, while firms may wait for clearer signals about quarterly performance before adjusting employment. Institutional factors, seasonal employment patterns, and the timing of policy implementation may further shape these month-specific responses. This interpretation highlights the importance of considering the temporal structure of labor market reactions when assessing the validity of Okun's law.

The confirmation of Okun's Law in this study aligns with a segment of the literature that supports the existence of a statistically significant negative relationship between output and unemployment in Türkiye. Specifically, the findings are consistent with Akay et al. (2016), who found evidence of a long-run relationship between 1969 and 2014, as well as Demirgil (2010), who documents a strong and time-varying inverse relationship. Similarly, the results are compatible with Turna (2023)'s long-run ARDL evidence. However, they contrast with the "jobless growth" evidence reported by Barışık et al. (2010). This divergence may reflect differences in sample periods, structural changes in the Turkish labor market, or the methodological advantages of mixed-frequency models in capturing short-run dynamics. Consequently, these findings suggest that asymmetries identified in parts of the literature warrant re-examination within a mixed-frequency framework.

Most prior studies on Türkiye utilize the Hodrick-Prescott (HP) filter. However, the literature indicates that Okun's coefficient is highly sensitive to the detrending method; for instance, Yamak and Yamak (2018) found that coefficients varied significantly depending on whether HP, Baxter-King, or Christiano-Fitzgerald filters were used. By utilizing the Kalman filter, this study treats potential output as a latent variable-an approach often considered superior for capturing time-varying structural changes compared to the rigid nature of standard filters.

Furthermore, the use of mixed frequency data (monthly unemployment and quarterly GDP) addresses the loss of information inherent in temporal aggregation. Koçak (2021) also employed a mixed-frequency approach (MFBVAR) for the 2005–2020 period and found the MFBVAR model to have superior forecasting performance compared to classical VAR models. However, unlike the current study, Koçak (2021) found the effect of growth on unemployment to be statistically significant but weak in magnitude. The divergence between Koçak's "weak effect" and this study's "strong effect" may stem from the different specific models or the inclusion of the post-2020 data in the current study, which covers a period of significant economic volatility.

The inclusion of the COVID-19 recession further underscores the cyclical sensitivity of unemployment in Türkiye. Rather than reiterating descriptive outcomes, the key implication is that severe

downturns amplify the responsiveness of unemployment to output gaps, reinforcing the importance of timely counter-cyclical policy interventions during periods of large negative deviations from potential output.

From a policy perspective, the existence of intra-quarter heterogeneity implies that the timing of aggregate demand measures matters. Demand-side policies may yield stronger employment effects when implemented during periods in which the labor market exhibits heightened sensitivity to cyclical conditions. This adds a temporal dimension to stabilization policy design and suggests that policymakers may enhance effectiveness by aligning interventions with periods of stronger labor market responsiveness.

CONCLUSION

This study re-examines the validity of Okun's law in the Turkish economy using monthly unemployment data over the 2014–2024 period within a mixed-frequency framework. By employing the RR-MIDAS model and estimating potential output via a Kalman filter, the analysis avoids information loss associated with temporal aggregation and addresses key limitations of conventional trend-filtering approaches.

Relative to previous studies on Türkiye, this paper contributes to the literature in three main respects. First, it preserves the original frequency of unemployment data rather than relying on temporally aggregated series. Second, it derives potential output using a state-space approach, yielding a more flexible measure of the output gap. Third, it identifies month-specific Okun coefficients, offering new insights into short-run labor market dynamics that are not captured by standard low-frequency models.

The empirical findings provide strong evidence in support of Okun's law for Türkiye. Increases in cyclical output are associated with significant declines in unemployment, and this relationship exhibits clear intra-quarter heterogeneity. The results indicate that the labor market response to economic activity is not uniform across the months of a quarter, highlighting the importance of timing in the growth–unemployment nexus.

During periods of economic contraction, such as the unprecedented downturn in 2020 caused by the COVID-19 pandemic, expansionary policies are vital. Indeed, our analysis reflects that the large negative output gap in 2020 was accompanied by a significant surge in unemployment, consistent with Okun's law. In this regard, expansionary fiscal and monetary tools can help the economy converge toward potential output. However, policymakers must balance this against inflationary risks if unemployment falls below its

natural rate. Therefore, indicators such as output and unemployment gaps should be jointly considered when formulating stabilization policies.

From a policy perspective, the findings suggest that aggregate demand policies can be effective in reducing unemployment when output exceeds its potential, but their impact may vary depending on the timing of implementation within the quarter. This underscores the value of jointly monitoring output and unemployment gaps when designing stabilization policies. Overall, the results emphasize that mixed-frequency approaches provide a richer understanding of labor market dynamics and can enhance the empirical assessment of macroeconomic relationships such as Okun's law.

Finally, the analysis opens several avenues for future research. Future work could extend the mixed-frequency model with productivity, labor-force participation, or capacity-utilization indicators, and allow for asymmetric or regime-dependent Okun coefficients. Additionally, regional RR-MIDAS applications could test whether the intra-quarter patterns identified here generalize across different economic geographies.

AUTHORS' STATEMENT

The authors declare that all contributions to this manuscript were made by the listed authors. The contributions of the authors are as follows: the first author contributed 60%, and the second author contributed 40%. The authors also declare that there are no conflicts of interest.

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