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The Inverted Okun's Law: Evidence from France

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This study considers the nonlinear relationship between GDP growth and unemployment in France (1975–2024) using a logistic smooth transition regression (LSTR) model. Findings reveal a threshold unemployment rate of 7.93%, above which the traditional Okun's law holds (GDP growth reduces unemployment). Below this threshold, an inverted Okun's law emerges, where economic growth coincides with rising unemployment. This is explained by technological advancements, skill mismatches, and delayed employment adjustments. The results indicate that macroeconomic policies based on linear assumptions are limited in their capacity to address unemployment challenges effectively. Recognizing these nonlinear dynamics is crucial for designing effective labor market policies that account for asymmetries in economic fluctuations.

Keywords: Okun's Law, GDP Growth, Unemployment, Nonlinear Models, Threshold Regression

JEL Classifications: E23; E24; J64 ; C29

1 Introduction

The relationship between economic growth and unemployment was articulated by Okun in the 1950s. Through this relationship, it is possible to estimate the Okun coefficient, measuring the impact on the unemployment rate of one percentage point of GDP growth above its potential level. Thus, it also allows for determining the potential GDP growth rate at which the variation in the unemployment rate becomes negligible. This relationship has been extensively analyzed and remains a crucial consideration in macroeconomic policy formulation.

Empirical studies show that the Okun coefficient is statistically significant for most OECD countries (Lee, 2000). According to Ball, Leigh, and Loungani (2019), the Okun law was verified in the United States between 1948 and 2012, as well as in most of the twenty developed countries between 1980 and 2012.

Besides, several findings about Okun's law show that the relationship between the unemployment rate and economic growth differs from country to country and is unstable over

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time (Perman and Tavera, 2005). Regarding developing countries, there is an inverse relationship between GDP growth and unemployment rate in most cases. However, this inverse relationship differs among G7 countries (Bod'a and Pozavanova, 2023). For example, Ball, Leigh, and Loungani (2017), using macroeconomic data in quarterly frequencies, assert that this coefficient reaches – 0.37 in France against – 0.52 in Canada, – 0.15 in Japan, and – 0.56 in the USA.

In addition, Okun's law presents structural changes and asymmetries (Villaverde and Maza, 2009; Ball, Leigh, and Loungani, 2017). Indeed, asymmetries in Okun's law are evident as economic contractions tend to increase unemployment more significantly than economic expansions reduce it (Neifar, 2023). In this regard, Christopoulos et al. (2022) use an augmented version of the logistic smooth transition regression (LSTR) to assess the case for asymmetry and non-linearity in Okun's law. They found that the unemployment gap is increasingly associated with a smaller output gap. Notably, whilst the Great Recession accelerated that rise, the bulk of the change occurred beforehand.

This asymmetry is also particularly observed in North African countries, where during economic downturns, the fluctuations in GDP have a more pronounced effect on increasing unemployment compared to their impact on reducing unemployment during economic upturns (Djamal and Brahim, 2025).

Thus, regardless of the level of development of countries, it seems that a nonlinear relationship exists between the unemployment rate and GDP growth rate. So, nonlinear time series models are relevant to characterize the asymmetric evolution of the macroeconomic data. The most famous nonlinear model that analyzes regime-switching is the Smooth Transition Autoregressive (STAR) model. The STAR model was developed in the univariate case by Chang and Tong (1986) and later popularized by Granger and Teräsvirta (1993), Teräsvirta (1994), and Van Dijk et.al. (2002). It is particularly well adapted to capture nonlinear characteristics of business cycle indicators (Skalin and Teräsvirta, 1999). The general specification of this model nets the linear autoregressive model as a special case. It is also more general in comparison to other nonlinear models like the threshold autoregressive (TAR) models, initially developed and discussed by Tong (1983).

Regarding Okun's law, several findings exhibit a positive relationship between the unemployment rate and GDP growth rate. Thus, structural changes in the economy (Gordon,2014), labor reforms (Blanchard and Summers, 1986), productivity and automation (Brynjolfsson and McAfee, 2014 and Acemoglu and Restrepo, 2018), as well as the delay and employment effect (Ball, Leigh, and Loungani, 2017) can explain such a positive relationship.

In fact, an inverted Okun's law appears and shows that a one percent increase in the GDP growth above its potential level entails an increase in the unemployment rate. Therefore, the Okun coefficient, which traditionally signifies the reduction in the unemployment rate following an increase in GDP growth, can be positive up to a certain threshold of the unemployment rate.

For example, France has a historically rigid labor market characterized by high employment protection laws, strong unions, and significant labor costs, even though recent reforms have been carried out to enhance labor market flexibility. Additionally, between 1975 and 2024, the country experienced significant structural changes, including pronounced deindustrialization and a marked decline in the share of industrial employment.

In this analysis, we aim to identify the threshold unemployment rate at which an economy like France may observe two distinct relationships between unemployment and GDP growth: an inverted Okun's law and the traditional Okun's law. To fulfill this objective, we employ threshold regression analysis on quarterly data from the first half of 1975 through the first half of 2024, enabling a comprehensive examination of Okun's law regimes within the context of the French economy.

This paper contains three other sections. Section 2 outlines the Logistic Smooth Threshold Regression (LSTR) model and provides parameter estimates using quarterly French data from the first half of 1975 to the first half of 2024, focusing on the inverted Okun's law. Section 3 discusses aspects of the inverted Okun's law. Section 4 offers conclusions.

2 The Logistic Smooth Threshold Regression model: Estimation on French data

Utilizing the methodology from the logistic STAR model as estimated for the univariate case (Dias, 2003), we conduct the following threshold regression:

$$\Delta U_t = a_0 + a_1 Y_t + (b_0 + b_1 Y_t) G(U, \gamma, s) + \varepsilon_t \tag{1}$$

where $\varepsilon_t \rightarrow iid(0, \sigma_\varepsilon^2)$. ΔU_t is the absolute variation of the unemployment rate, and U is the unemployment in a percentage of the active population. Y_t represents the GDP growth rate.

G is called the transition function. This is a continuous, bounded function between 0 and 1and at least twice differentiable in the sample space.

$$G(U_t, \gamma, c) = (1 + exp[-\gamma(U_{t-1} - s)])^{-1},\ \gamma > 0 \tag{2}$$

It takes two extreme values: $G = 0$ and $G = 1$, with c representing the threshold, e.g., the unemployment rate around which the impact of the GDP growth rate on the unemployment rate is inverted. The transition between these two extreme regimes is allowed to be smooth and is governed by the transition variable. When G equals zero, the relationship between the unemployment rate and GDP growth rate is linear and takes the form of a simple linear regression:

$$\Delta U_t = a_0 + a_1 Y_t + \varepsilon_t \tag{3}$$

From relation (3), we sort the traditional Okun's law, which regresses the variation of the unemployment rate (in the percentage of the active population), ΔU_t, on the GDP growth rate, Y_t.

$$\Delta U_t = -\alpha(Y_t - \beta) + \varepsilon_t \tag{4}$$

$$\varepsilon_t = \rho\varepsilon_{t-1} + v_t \tag{4'}$$

where α (= a_1) < 0 is the Okun coefficient and β (= a_0 / a_1) > 0 is the potential GDP growth rate.

By applying both the ordinary least squares (OLS) method and the Cochran-Orcutt procedure, ensuring that the residuals v_t exhibit white noise, we estimate relations (4) and (4)' and obtain the results in Table 1.

Table 1: Results for equations (4) and (4')

Coefficient	Value	Std. Error	t-Statistic
α	0.08	0.007	10.56***
β	0.23	0.362	0.63
ρ	0.46	0.064	7.29***
N = 195; R^2 = 0.31			
p-value Q-Stat (15) = 0.41			
p-value LM-Stat (Harvey heteroskedasticity test) = 0.25			

*** Significant at 1%

The p-value of the Q (Ljung-Box) statistic (with the number of lags in parentheses) is larger than 5%, which is means that the residuals v_t follow a white noise process. The p-value of the LM Statistic (the Harvey heteroskedasticity test, which is useful in macroeconomic models where volatility may evolve with structural or policy variables) is larger than 5% and shows that the model is homoscedastic.

Regression (4) displays a positive value of the Okun coefficient, which is statistically significant at 1% level. This means a positive relationship between unemployment variation and GDP growth rate occurs. The coefficient of the potential GDP growth rate is not significant.

In its linear form, the traditional Okun's law is not verified in France during the studied period.

When G = 1, this relationship becomes nonlinear. Equation (1) can be rewritten as:

$$\Delta U_t = (a_0 + b_0) + (a_1 + b_1)Y_t + \varepsilon_t \tag{5}$$

In this model, absolute variation of the unemployment rate follows a stationary process and moves more or less smoothly between two extreme regimes characterized by possibly completely different specifications and dynamics, instead of switching abruptly as is assumed in a threshold model. The regime that characterizes the dynamic at each moment is linear and depends on the value of the transition variable U_{t-1}. The choice of this transition variable and its lag was determined by the Luukonen et al. (1988) test, for which the null hypothesis of linearity is rejected. Using the OLS method, we estimate the following relation (6) and perform the test. Both series have been downloaded from INSEE over the 1975-2024 period in quarterly frequencies[1].

Since the logistic transition function G is nonlinear and involves an exponential function, it cannot be estimated directly using OLS. Thus, for testing linearity against nonlinearity, under the null hypothesis ($\gamma = 0$) where the threshold parameter s is not identified, we approximate the transition function by a Taylor function of order 4 around the point $(U_{t-1} - s) = 0$, such as:

$$\Delta U_t = a_0 + a_1 Y_t + b_1 Y_t U_{t-1} + b_2 Y_t U_{t-1}^2 + b_3 Y_t U_{t-1}^3 + b_4 Y_t U_{t-1}^4 + u_t \tag{6}$$

Using the OLS method, with the Newey-West covariance method to remove the autocorrelation and heteroskedasticity problems, we obtain the results in Table 2.

Table 2: Results for equation (6)

Variable	Coefficient	Std. Error	t-Statistic
a_0	0.04	0.032	1.24
Y_t	4.95	2.48	1.99**
Y_tU_{t-1}	-3.40	1.61	-2.101**
$Y_tU_{t-1}^2$	0.84	0.37	2.26**
$Y_tU_{t-1}^3$	-0.09	0.04	-2.39**
$Y_tU_{t-1}^4$	0.003	0.001	2.48**
$N = 195$; $R^2 = 0.26$			

** Significance at 5%

In equation (6), except for the constant, all coefficients are statistically significant at the 5% level.

[1] https://www.insee.fr/en/statistiques/

The null hypothesis of linearity (H0: $b_1 = b_2 = b_3 = b_4 = 0$) is assessed using regression (6), resulting in an F-statistic of 6.58 and a p-value of 0.00. Given that the p-value is significantly below the 5% threshold, the null hypothesis is rejected, providing robust evidence for nonlinearity and thereby justifying the application of the LSTR model instead of a simple linear regression.

The transition function has two forms: logistic and exponential. In this paper, we use the common logistic form:

$$\Delta U_t = a_0 + a_1 Y_t + (b_0 + b_1 Y_t)\,(1 + exp[-\gamma(U_{t-1} - s)])^{-1} + c_1 YL_t + c_2 D + \varepsilon_t \quad (7)$$

$$\varepsilon_t = \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} + v_t \quad (7')$$

This function is monotonically increasing in U_{t-1} so that the two regimes correspond to the threshold value of the transition variable. The threshold value s determines the point at which the regimes are equally weighted, and γ controls the speed and smoothness of the transition. The γ coefficient is the smoothness parameter. It determines the slopes of the logistic function and consequently governs the speed with which the transition takes place between the lower (linear) regime ($G = 0$) and the upper (nonlinear) regime ($G = 1$). If γ is very large, the change from 0 to 1 is abrupt, and, if $\gamma \to\infty$, the logistic STR (LSTR) model becomes equivalent to a two-regime threshold regression model.

In this equation, the variables D (a dummy variable to account for abnormal values during the COVID-19 period) and YL_t (productivity per hour worked) have been added to carry out the omitted variables test.

We estimate equations (7) and (7’) using nonlinear least squares and the Cochran–Orcutt method (so that the residuals v_t follow white noise) and present the results in Table 3.

Table 3: Results for equations (7) and (7')

Variable	Coefficient	Std. Error	t-Statistic
a_0	0.05	0.03	2.00**
Y_t	0.08	0.02	5.12***
a_0	-0.04	0.04	-1.01
Y_t	-0.16	0.05	-2.88**
e_{t-1}	0.22	0.06	3.61***
e_{t-2}	0.29	0.05	5.35***
YLt	-0.02	0.01	-2.76**
D	-0.43	0.12	-3.60***
SLOPE (γ)	3.76	2.11	1.78*
THRESHOLD (s)	7.93	0.22	35.23***
$N = 194$; $R^2 = 0.45$ p-value LR-Stat = 0.00 p-value LM-Stat = 0.25 $s \in [7.48\,; 8.37]$ = 95% confidence interval of the s parameter			

***, **, * Significance at 1%, 5%, and 10%

In this model, the p-value of the omitted variables test (p-value LR-Stat) is below 5%, proving strong evidence against the null hypothesis that the additional set of regressors (dummy variable, D and productivity per hour worked, YL_t) are not jointly significant. So, the coefficients associated with the dummy variable and the variable of productivity per hour worked (YL_t) are significant at the 5% level. Thus, a one percentage point increase in labor productivity leads to a reduction of the unemployment rate variation by 0.02 percentage point.

Given that the model variables are expressed in first differences, an R-squared value of 0.45 indicates a relatively strong level of explanatory power.

The Q (Ljung-Box) Statistic and its p-value (in Appendix) indicate that residuals v_t are white noise. The p-value (larger than 5%) of the LM Statistic (Harvey test of heteroskedasticity) indicates that the model is homoscedastic. We also notice that the value of the γ coefficient is relatively large. This means that there is an abrupt change regarding the impact of GDP growth on the unemployment rate as depicted in Figure 1.

Figure 1: Transition from an inverted Okun's law to the traditional Okun's law

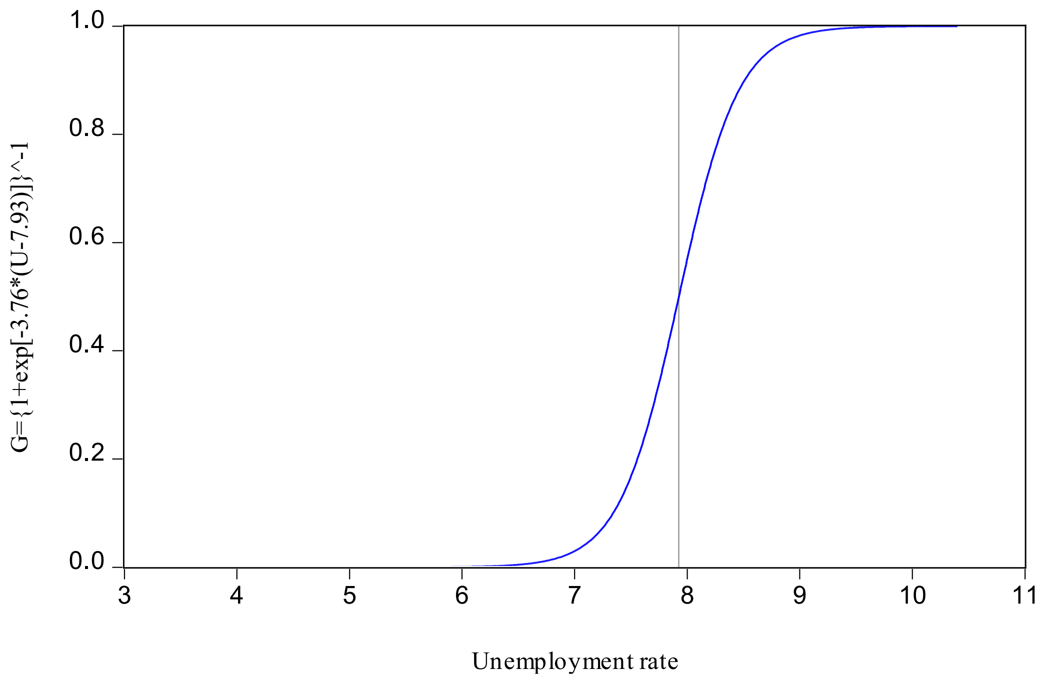


Figure 1 illustrates the transition function derived from relation (7), wherein the transition variable is the unemployment rate lagged by one period. The Y-axis represents the logistic function G as defined in relation (2), which characterizes the nature (whether abrupt or gradual) of transitions between two distinct regimes.

The sigmoid curve shows a relatively abrupt change from 0 to 1 as unemployment increases because the parameter γ (which controls how steep the transition is) exhibits a relatively high value. Thus, a parameter value of 3.76 in the relation (7) implies a relatively quick switch between both regimes (low and high unemployment rate regimes) as unemployment crosses the threshold represented by the vertical line. This line represents the midpoint of the transition (s = 7.93%) with the 95% confidence interval (7.48%; 8.37%), suggesting a reliable identification of the switching point between low and high unemployment rate regimes. When the unemployment rate exceeds this threshold value of 7.93%, the traditional Okun's law applies (a negative relationship between unemployment rate variation and economic growth rate), indicating that the unemployment rate decreases by 0.08 percentage point (0.08 – 0.16) following a one percent increase in GDP growth rate.

In the linear part (when the parameter $\gamma = 0$), there is a positive relationship between GDP growth and the unemployment rate variation. Specifically, a one percentage point increase in GDP growth corresponds to a 0.08 percentage point increase in the unemployment rate (as aforementioned in equation (4)). This observation suggests an inverted Okun's law, where economic growth is associated with an increase in unemployment. There are multiple possible explanations for this result.

3 Comments on the inverted Okun's law

With the AI development in all fields of economic life, we can see the labor market may be shifting towards higher-skilled jobs, leaving lower-skilled workers unemployed.

If economic growth is driven by a sharp increase in productivity rather than job creation, firms can produce more with the same or fewer workers, leading to rising GDP but stagnant or increasing unemployment. (Gordon, 2014). In addition, as economic growth is concentrated in industries requiring specialized skills, but the unemployed workforce lacks those skills, job openings may rise while unemployment remains high. (Pissarides, 2000).

There may be a disconnect between GDP growth and employment creation, as labor market polarization and skill mismatches have been identified as factors contributing to continued unemployment during periods of economic growth.

In other words, the improvement of technical tools, which requires specialized skills, can drive economic growth towards a sharp increase in productivity rather than job creation. Thus, the firms can produce more with the same or fewer workers, leading to rising GDP but stagnant or increasing unemployment (Brynjolfsson and McAfee, 2014).

This improvement of productivity, notably in the industry sector, explains the occurrence of significant changes in sectoral composition in France.

Due to deindustrialization during, notably studied period 1975-2024 (in quarterly data), the proportion of employment in industry declined steadily from approximately 48% in 1975 (2nd quarterly) to 19% in 2024 (1st quarterly) while in the services sector this proportion increases from 49% to 80% during the same period (European Central Bank, 2025)[2]. The proportion of workers in services, where labor productivity is lower compared to industry, has risen notably during the study period, leading to a drop in overall hourly productivity. This shift influences both unemployment rates and GDP growth, as shown by the following model using instrumental variables.

$$YL_t = a_0 + a_1 E_t + \varepsilon_t \qquad (8)$$

$$\mathrm{d}U_t = b_1 Y_t + b_2 YL_t + v_t \qquad (9)$$

$$v_t = \rho v_{t-1} + u_t \qquad (9)'$$

[2] https://data.ecb.europa.eu/search-results?searchTerm=skilled%20in%20France

In this system, YL_t refers to productivity per hour worked, while E_t denotes the ratio of employment in services to employment in industry. ε_t and v_t are idiosyncratic error terms.

To estimate the model, we employ the Two-Stage Least Squares (TSLS) method, using these instruments:

- Lagged labour productivity growth rate (dYL_{t-1}).
- Lagged unemployment rate variation (dU_{t-1}).
- Ratio of employment in services to industry, lagged one period (E_{t-1}).

Using the Cochrane-Orcutt method in regression (9) to remove the residuals autocorrelation, we present the results of equations in Table 4.

Table 4: Results for equations (8), (9) and (9')

Variables	Coefficient	Std. Error	t-Statistic
a_0	1.35	0.33	4.05***
E_t	-0.46	0.12	-3.79***
Y_t	0.13	0.02	6.38***
YL_t	-0.03	0.02	-1.31
v_t	0.46	0.07	6.69***
p-value Q-Stat Portemanteau test = 0.19 $R_{e_t,v_t} = 0.24$ p-value Breusch-Pagan test for diagonal covariance matrix = 0.00 p-value J-Statistic (Sargan test) = 0.13			

*** Significance at 1%

In this model, all coefficients are statistically significant and the p-value of the Portmanteau autocorrelation test (larger than the 5% level) shows no autocorrelation of the residuals.

In addition, the relatively low value of the R_{e_t,v_t} statistic, e.g., the correlation coefficient between residuals of equations (8) and (9), means some link in unobserved shocks between YL_t (labor productivity) and dU_t (unemployment rate variation).

The p-value of the Breusch-Pagan test is below 5%, which indicates that we can reject the null hypothesis of the diagonal covariance matrix. This implies that the residuals of the two equations are not independent; hence, a system approach is justified.

The p-value of the J-Statistic (Sargan test), larger than 5%, indicates the validity of the instruments.

As a result, relation (8) displays that the ratio of employment in services to industry (E_t) exerts a negative effect on labor productivity (YL_t). Specifically, a one-unit increase in this ratio corresponds to a reduction of 0.46 percentage point in labor productivity. This finding suggests that workforce transitions from industry, generally more capital-intensive and associated with higher productivity, to the services sector, which often exhibits lower productivity in traditional segments, may contribute to declines in overall productivity.

Relation (9) indicates a positive association between the GDP growth rate (Y_t) and the change in unemployment rate (dU_t). Specifically, a one percentage point increase in GDP growth corresponds to a 0.13 percentage point rise in unemployment rate variation, considering the effect of labor productivity (YL_t).

This counterintuitive result can have some possible explanations. In France, the GDP growth is seen to be jobless or driven by productivity gains without hiring, and the short-term structural adjustments occur where sectors grow without absorbing labor.

In other words, the model might capture short-run dynamics where output grows without job creation (e.g., due to automation or capital deepening).

Moreover, such a counterintuitive relationship between unemployment rate and GDP growth could reflect measurement issues, lags, or structural changes in the economy (e.g., growth in low-labor-intensive sectors).

On the contrary, labor productivity negatively affects unemployment. Therefore, higher productivity of one unit reduces the unemployment rate by 0.08 percentage point, suggesting that productivity improvements may support employment in the long run, possibly by enhancing competitiveness or reducing costs. Hence, higher productivity may reflect a healthier economy where firms are more competitive and better able to hire. It may imply supply-side improvements, reducing the unemployment rate. However, the coefficient exhibits a small magnitude, suggesting that productivity plays a measurable role in reducing unemployment.

This structural change resulted in reductions in industrial employment, particularly in sectors characterized by lower skill levels and higher unionization, leading to persistent unemployment in regions historically associated with heavy industry, such as the North of France.

Furthermore, France underwent notable political transformations during this era. In the early 1980s, the socialist government introduced nationalizations and expansionary policies, which were subsequently succeeded by liberal initiatives such as privatization and deeper European integration. These liberal reforms persisted between 1993 and 1995, including labor market measures such as early retirement schemes and the imposition of hiring freezes within the public sector. More recently, from the 2010s to 2024, the extension of retirement age, the increased flexibility in layoffs, accompanied by more security for workers, and unemployment assurance reform can explain the reasons why the unemployment rate does not diminish in the short run (Clegg, 2022). In the long-term, labor contract flexibility and skill allocation influence observed decoupling of GDP growth and unemployment dynamics (Cette, Drapala and Lopez, 2023).

These reforms may have reinforced the heterogeneity in labor market outcomes, potentially contributing to the nonlinear relationship between output and unemployment.

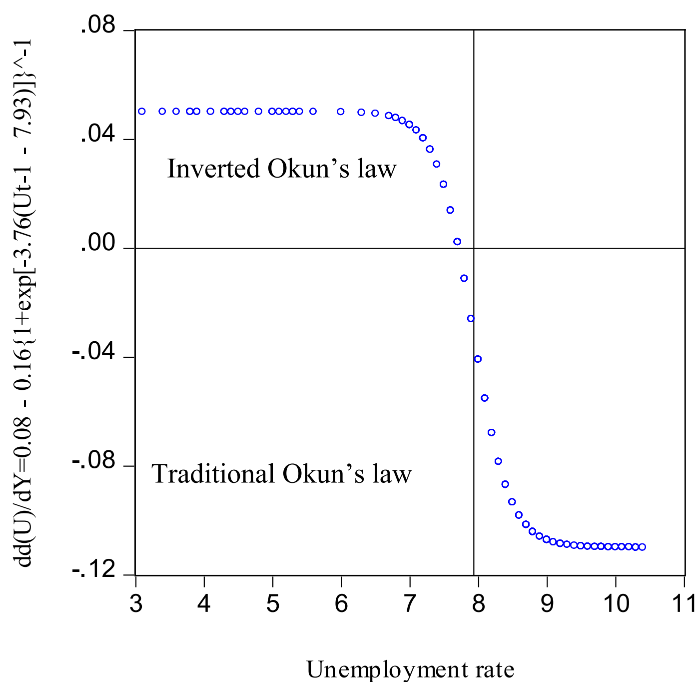
At the macroeconomic level, especially regarding the economic cycle, the firms may wait to hire after a downturn, increasing output first through overtime work and productivity gains before hiring new employees. So, employment adjustments often lag behind GDP growth (Ball et al., 2017). Indeed, in a recession, economic growth may reflect the recovery of financial markets and corporate profits rather than immediate job creation (Reinhart and Rogoff, 2009; Hall, 2011). In fact, after a recession, some industries may disappear, forcing workers to retrain, leading to a temporary increase in unemployment.

Furthermore, a rapid increase in the working-age population (e.g., baby boomers entering the job market, immigration influx) can lead to a temporary rise in unemployment despite economic expansion (Summers, 2014).

Besides, if economic growth is fueled by globalization but jobs are outsourced to other countries, domestic unemployment can rise despite overall GDP growth. (Baldwin, 2016).

Nevertheless, when the unemployment rate is larger than the threshold values of 7.93%, we recover the traditional Okun law, indicating that the elasticity of the unemployment rate variation with respect to the GDP growth is negative, as Figure 2 plots.

Figure 2: Change in unemployment rate elasticity relative to GDP growth



On the Y-axis, the elasticity is calculated from the regression (7):

$$\frac{\partial \Delta U_t}{\partial Y_t} = 0.08 - 0.16\ (1 + exp[-3.76(U_{t-1} - 7.93)])^{-1} \tag{10}$$

On the X-axis, the unemployment rate with one lag is represented.

In the upper section of Figure 2 (above the horizontal line representing zero elasticity), Okun's law appears reversed, as elasticity is positive, as the unemployment rate is between 3.1% and 7.93%. When the unemployment rate goes beyond the vertical line at the 7.93% threshold, elasticity becomes negative (as shown in the lower part of the Figure), indicating that the conventional form of Okun's law associates a decrease in unemployment with increasing GDP growth.

Finally, when the unemployment rate is relatively low, a positive relationship with GDP growth (positive elasticity) occurs. Conversely, when the unemployment rate exceeds 7.93%, there is an inverse relationship with GDP growth (negative elasticity).

4 Conclusions

In France, notably during the 1975-2024 period (in quarterly frequencies), we observe an inverted Okun's law. In this country, the labor market is still relatively rigid, and the decrease in the unemployment rate after the economic growth augmentation, due partially to the technological amelioration, does not occur immediately during a certain period. On the contrary, it continues to increase after a rise in the GDP growth rate. Besides, the high employment protection laws and strong unions create hiring friction, meaning firms hesitate to hire immediately following economic growth. Instead, they often increase productivity and working hours before creating new jobs. This leads to a short-term positive relationship between GDP growth and unemployment, highlighting the inverted Okun's law.

We also notice that the unemployment rate is relatively high, as indicated in the threshold regression model, where the threshold value is close to the mean value of 8.05% over the estimated period. We also observe that when the unemployment rate is high and larger than 7.93% of the active population, the traditional Okun's law appears. However, even in this case, economic growth does not decrease the unemployment rate a lot. Indeed, a one percent increase in GDP growth leads to a reduction in the unemployment rate by only 0.08 percentage point.

Finally, macroeconomic policies based on linear assumptions to combat the unemployment rate are limited. Therefore, considering nonlinear dynamics is essential for effective labor market policies that address asymmetries in economic fluctuations.

Macroeconomic policies based on linear assumptions are constrained in their ability to address unemployment issues. Consequently, it is imperative to incorporate nonlinear dynamics into labor market policies to effectively manage asymmetries in economic fluctuations.

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Appendix: Correlogram of residuals (equation (7))

Lags	AC	PAC	Q-Stat	Prob
1	0.099	0.099	1.9472	0.163
2	0.021	0.011	2.0314	0.362
3	0.091	0.089	3.6876	0.297
4	-0.075	-0.095	4.8266	0.306
5	-0.113	-0.100	7.3827	0.194
6	0.109	0.128	9.7815	0.134
7	-0.030	-0.037	9.9637	0.191
8	-0.114	-0.104	12.610	0.126
9	0.036	0.024	12.873	0.168
10	0.016	0.031	12.928	0.228
11	0.048	0.086	13.416	0.267
12	0.075	0.017	14.591	0.265
13	0.024	-0.007	14.710	0.326
14	0.039	0.064	15.030	0.376
15	0.080	0.069	16.394	0.356
16	-0.049	-0.068	16.900	0.392
17	-0.029	-0.030	17.075	0.449
18	0.019	0.025	17.153	0.513
19	-0.134	-0.098	21.029	0.335
20	-0.075	-0.053	22.265	0.326

The p-values associated with the Q-Stat of Ljung Box are larger than the 5% level for all lags and indicate that the residuals of equation (10) follow a white noise process.