Decreasing Output while Decreasing Unemployment in the US

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From January 2020 to now, the United States has been affected by the COVID-19 pandemic. The pandemic has had a significant impact on the U.S. economy and people's standard of living. The number of people affected by COVID-19 is still growing, even though President Biden declared the pandemic is over in September of 2022. In response, the U.S. government has made both fiscal policy and monetary policy changes.

In general, during the recession, there is decreasing output while increasing unemployment, which is proved by Okun's law. Okun's law was proposed by American economist Arthur Okun (1962) to describe the alternating relationship between unemployment rate and potential GDP in an approximate way. It reads that for every 1% above the natural rate of unemployment, the real GDP falls below the potential GDP by 2%.

During the financial crisis of 2008, many companies began to lay off a large number of employees in order to reduce labor costs and restructure their internal organization. When the number of people who can work decreases, output increases. However, we find that at this particular stage, which is from the 2nd quarter of 2021 to now, unemployment and output are positively correlated. This relationship has never been seen before the pandemic; therefore, it is an important and worthwhile stage to study.

Although unemployment and GDP have been studied for decades in different regions, they still need to be updated due to the time-specific nature of their explanatory relationship. This paper is dedicated to investigating the effect of COVID-19 on the relationship between the two variables. Specifically, it is divided into three specific questions: whether the relationship has indeed changed, what factors may cause the relationship to change when generalized from a historical perspective, and whether these factors have played an important role in COVID-19.

To answer the above doubts, this paper will first build the theoretical foundation for the subsequent research exposition by reviewing the literature in related fields; and then make appropriate analytical adjustments in light of the current economic situation. Subsequently, the feasibility of data sources is considered comprehensively, such as time series data during the pandemic may be encountered as too short. This paper attempts to explain the change in the relationship by examining the change in the OLS regression results of the Okun coefficients for the normal ten-year economic cycle and the ten-year economic cycle that includes the pandemic. Further, referring to the selection of explanatory variables by other scholars, this paper does separate OLS regressions for output and unemployment in the normal decadal economic cycle and tries to find the significant variables that would turn them into an indirect relationship. The study will conclude with a summary of shortcomings and an outlook.

Literature Review

This paper studied how the COVID-19 pandemic influenced the relationship between output and unemployment. Okun's Law states that there is an inverse correlation between real GDP growth and change in the rate of unemployment, which was first proposed by Okun (1962). Okun's coefficient indicates the anticipated change in unemployment resulting from a 1% rise in GDP. Okun estimated it for the US economy for the period 1947-1960 to be around 0.3. This figure varies across countries and over time, as revealed by numerous studies throughout history. Moosa (1997) employed OLS, rolling OLS, and SUR to calculate Okun's coefficient for the G7 nations and explained the comparison result by variations in labor market rigidities. Rolling OLS results showed that the coefficients' absolute values grew with time, which was accounted for by labor market reform. Soylu et al. (2018) used the panel data method to investigate the association between economic growth and unemployment in Eastern European countries from 1992 to 2014.

After testing panel OLS, they concluded that a 1% increase in GDP would result in a 0.08% drop in the unemployment rate.

Empirical research observed violations of Okun's Law around economic downturns. Balakrishnan et al. (2010) applied Okun's Law to produce estimates for a few developed countries during recessions and recoveries. Factors that caused the anomalies were analyzed. Owyang and Sekhposyan (2012) reviewed the "difference," "gap," and "dynamic" specifications of Okun's models. They inspected the output-unemployment connection in the United States and found evidence of deviations from Okun's Law around recessions. Utilizing the first-difference model, Mussida and Zanin (2022) examined the evolution of the unstable Okun's coefficient as well as the effects of the COVID-19 pandemic in certain European countries. They discovered a reduction in Okun's coefficient with the pandemic, which was mainly due to the significant decline in GDP and the lower-than-expected increase in the unemployment rate.

The link between output and unemployment has been a classic topic. Although it has been studied for decades in different regions, it still needs to be discussed and updated due to the time-specific nature of the explanatory relationship between the two variables. We will try to explore the changes in this relationship after the emergence of the COVID-19 pandemic.

Data

To answer the research questions, we decided to construct two regression models based on time series data to analyze. The first model estimates and compares Okun's coefficients in pre-COVID, post COVID and after government intervention period to figure out whether the relationship between output and unemployment has changed after the pandemic. And the second model analyzes the variables that influence unemployment rate and output to change in the same

direction. The data used for analysis are revised data at a quarterly frequency. Because of data availability, the focus of the analysis is on quarterly data over the period 2010: Q1-2022: Q3.

For the first model, the dependent variable is the unemployment rate, and the independent variable is the output gap. And there are some other variables used to estimate the change in unemployment rate and output gap, which are natural rate of unemployment, real GDP, and real potential GDP.

For the second model, the dependent variables are unemployment rate and output. And for independent variables, we include the variables representing the monetary policies as the money supply and federal funds rate, and variables representing the fiscal policies as the subsidy and unemployment insurance. We also include the participation rate which measures the proportion of people who intended to work over all population.

The data of unemployment rate and participation rate are average quarterly data sourced from U.S. Bureau of Labor Statistics. The data of real GDP, subsidies, and unemployment insurance are quarterly data sourced from U.S. Bureau of Economic Analysis. The data of natural rate of unemployment and real potential GDP are unemployment rate and output measured in the long-run level by U.S. Congressional Budget Office. The data of money supply and federal funds rate are quarterly data sourced from the Board of Governors of the Federal Reserve System.

Empirical Strategy

1st Stage Empirical Strategy- Revisiting the Relationship of Okun's Law

To answer the main question, we construct the first model to revisit the Okun's Law for pre and post Covid period.

Okun's law is an empirical correlation and is not a causation estimation. Generally speaking, there is no theoretical basis in the data, and it is not always strictly observed. Because

the relationship is based on correlation rather than causality, within different sample period, the coefficient of Okun's law appears to be different. But the unusual volatility of the Okun's coefficients still make sense in analyzing the relationship between output growth and unemployment rate. According to Okun's seminal paper in 1962, Okun regressed the change in the unemployment rate on the change in the output growth, which is always shown as:

$$\Delta U_t = \alpha + \beta \Delta Y_t + \epsilon_t$$

According to the quarterly data in US from 1947: Q2 to 1960: Q4, Okun derives the empirical relationship between unemployment rate and output growth. He figures out that a 3 percent decrease in the growth of GDP is accompanied with a 1 percent increase in the unemployment rate.

Thus, we construct the first model as follows:

$$\Delta U_t = \alpha + \beta \Delta Y_t + \epsilon_t$$

Here we measure ΔU_t as the difference between unemployment rate and the unemployment level in the long run level which is also known as the natural rate of unemployment. That is $\Delta U_t = U_t - U_t^*$. Also, we measure ΔY_t as the difference between real GDP and GDP predicted in the long run level which is also the real potential GDP. That is $\Delta Y_t = Y_t - Y_t^*$.

To be more specific, we also construct a secondary regression model adding two lags. With quarterly data, if we add two lags of the output term, the fitness of regression will be improved because the policy and the economic condition don't take effect at once. It takes time for the market to react. Firms need to adjust employment strategy and households need to decide whether they should exit labor force. Thus, we construct the secondary model as:

$$\Delta U_t = \alpha + \beta_0 \Delta Y_t + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta Y_{t-2} + \epsilon_t$$

To do the regression, we focus on 3 different time windows of the same length. Period 1, which we call the pre covid period: from the 1st quarter in 2010 to the 1st quarter 2020. Period 2, the post covid period, in which we include the outbreak of covid: that is from the 2nd quarter in 2011 to 2nd quarter in 2021. Period 3, we call it the post Covid period with government intervention because we include the period after the outbreak of covid and a great deal of implementation of monetary and fiscal policies. From the 3rd quarter in 2012 to the 3rd quarter in 2022. And the results are as follows.

Table 1

Regression Results of Okun's Coefficient

	(1) Change in Unemp rate	(2) Change in Unemp rate	(3) Change in Unemp rate	(4) Change in Unemp rate	(5) Change in Unemp rate	(6) Change in Unemp rate
Output gap	-1.405***	-1.025***	-.902***	-.775***	-.898***	-.798***
	(.108)	(.073)	(.065)	(.271)	(.065)	(.062)
L. output gap				-.021	-.262***	-.217***
				(.408)	(.07)	(.067)
LL. output gap				-.671*	-.075	-.042
				(.332)	(.065)	(.062)
_cons	-1.965***	-1.245***	-1.094***	-2.23***	-1.776***	-1.426***
	(.283)	(.223)	(.176)	(.271)	(.221)	(.184)
Observations	39	39	39	39	39	39
R-squared	.82	.841	.84	.86	.902	.888

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1*

Columns (1)-(3) show the result of the regression of the original Okun's coefficient estimation model in these 3 periods, and columns (4)-(6) show the results of the model with lags in these periods. As we can see, The Okun's coefficient in Period 3 is always higher than in Period 2. Especially for the model with lag adjusted to exclude the time variation, the Okun's coefficient decreases sharply for the outbreak of covid period and recovers after the intervention of the government for some time. From Okun's Law, we know that an increase in unemployment rate

must be associated with a decrease in real output growth. But here the results show that the Okun's Law was weakened during the recovery of the US economy after Covid. Which means, there might exist some periods after the 2nd quarter in 2021 when there is decreasing output while decreasing unemployment. And we want to figure out the reason.

2nd Stage Empirical Strategy-OLS Regression

After proving Okun's law was weakened during in covid-19, this paper aims to find significant variables that influence output and unemployment rate in the same direction. To make data and results meaningful, this article chooses data from 1st quarter of 2010 to 4th quarter of 2019 to gain enough observations of regression. The relationship between dependent variables and independent variables are stable no matter covid-19 happened, which means the signs of coefficients before the break happened are still useful for our research.

Government intervention is the most important part for the weakened effect of Okun's law and the independent variables are chosen mainly concerned with two parts of government effects. One effect is monetary policy, and another effect is fiscal policy. For monetary policy, this paper chooses M2 and federal funds effective rate (DFF) as two representatives. M2 inludes all forms of money that can become real purchasing power. Nowadays, M2 was taken by many countries as the target of money supply regulation. DFF is the rate for banks to borrow funds from each other, and it is more suitable for our model than real interest rate, because it is the central interest rate in the U.S financial market and it can indirectly influence long-term interest rates such as mortgages, loans, and savings. For fiscal policy, this article uses subsidies provided by the government and unemployment insurance to show how the government uses their expenditure to promote economic growth. Also, labor force participation rate is added in this model, which is the proportion of labor force in the whole population.

First regression

This article runs 2 OLS regression models. Firstly, unemployment is the dependent variable, 5 variables mentioned above and real GDP as the index of output are the independent variables.

$$unemployment\ rate = \beta_0 + \beta_1 real\ GDP + \beta_2 M2 + \beta_3 unemployment\ insurance + \beta_4 labor\ force\ paricipation\ rate + \beta_5 subsidy + \beta_6 federal\ funds\ effective\ rate$$

Second regression

Then, real GDP is used as the dependent variable, unemployment rate with 5 other variables are independent variables.

$$real\ GDP = \beta_0 + \beta_1 unemployment\ rate + \beta_2 M2 + \beta_3 unemployment\ insurance + \beta_4 labor\ force\ paricipation\ rate + \beta_5 subsidy + \beta_6 federal\ funds\ effective\ rate$$

Table 2.

The Results of Model 2

	(1) Unemployment rate	(2) Real GDP
Real GDP	-11.381***	
	(3.248)	
M2	-3.885**	.254***
	(1.694)	(.071)
Unemployment insurance	5.209	2.145
	(51.209)	(2.313)
Participation rate	.491*	-.001
	(.244)	(.012)
subsidy	210.808***	6.931**
	(60.102)	(2.987)
DFF	.325**	.024***
	(.122)	(.005)
Unemployment rate		-.024***
		(.007)
_cons	-22431.577	15480.178**

	(162945.73)	(6953.595)
Observations	40	40
R-squared	.994	.996

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

For the first regression, real GDP has negative sign, which follows Okun's law. M2 also has negative sign, because when the government increase money supply, which usually depreciate the demand for money, and it will lead to inflation. Due to Phillips curve, when inflation rate is high, unemployment rate will be low. Thus, we can get the negative relationship between M2 and unemployment rate. For unemployment insurance, its coefficient sign is positive. Since this kind of subsidy can reduce the incentive for unemployed workers to find a job, more unemployed workers may spend less effort on the job finding and the unemployment rate will increase. Subsidy provided by government has a positive relationship with the unemployment rate, from practical experience, this is largely due to the fact that policy formulation generally occurs after a decline in unemployment has already begun. After the unemployment rate decreases, the amount of subsidy will decrease too. Therefore, their relationship is always positive. Sign of federal funds effective rate is positive, because, in general, when the interest rate is high, company have little willingness to borrow money to expand their firm size. Thus, the unemployment rate will increase.

For the second regression, M2 and federal funds' effective rate are positively related to real GDP, since they are both tools that the government used as monetary policy to promote economic growth. Moreover, in context, unemployment insurance and subsidies have a positive relationship with real GDP in large part because the government wants to use those expenditures as fiscal policy to improve output.

Checking for the p-value, this article can find out that real GDP, M2, labor force participation rate, subsidy and federal funds effective rate are significant for unemployment. M2,

subsidy, federal funds effective rate and unemployment rate are significant for real GDP. Consequently, 4 variables except unemployment insurance are the factors that we want to find out to answer our secondary question,

Conclusion

Output and unemployment are two important variables to measure whether an economy is in recession. Because of the time-specific nature of the interpretation of these two variables, this relationship still needs to be constantly updated by researchers. This paper is dedicated to examining the impact of the COVID-19 pandemic on the relationship between the two variables. In this paper, three OLS regressions are conducted for three time periods, 2010:Q1-2020:Q1, 2011:Q2-2021:Q2, and 2012:Q3-2022:Q3, respectively, to verify the change in the Okun coefficient in a normal ten-year economic cycle versus a ten-year economic cycle that includes a pandemic. It can be concluded that the relationship between output and unemployment did change during the pandemic, specifically, that the decline in unemployment in the United States is accompanied by a decline in output during the latter part of the pandemic(2021:Q2-2022:Q3). Taking into account the actual situation and macroeconomic theory, it is reasonable to assume that this is a result of the impact brought about by the implementation of a series of policies. Thus, we then introduce the second model to verify the key explanatory variables in causing output and unemployment to change in the same direction. To be specific, real GDP, M2, labor force participation rate, subsidy, and federal funds effective rate are significant for unemployment. M2, subsidy, federal funds effective rate, and unemployment rate are significant for real GDP.

Since, as we proved, the interpretation of output and unemployment is significantly influenced by monetary and fiscal policies, the Federal Reserve and the federal government should implement more prudent regulatory measures to promote macroeconomic stability or risk entering

a recession. To be more specific, probably through easy monetary policy and expansionary fiscal policy during the pandemic, M2 rose, and so do subsidy and unemployment insurance. This could be what led to the sharp rise in inflation and the fall in the labor force participation rate.

Limitation and Further Research

This paper is limited by the fact that the time series data during the pandemic period are too short to do an empirical study to analyze the changes in the explanatory variables obtained in the second model during the latter part of the pandemic and the impact on output and unemployment at this time. Therefore, this paper can only make the following theoretical speculations on the connection between output and unemployment based on the facts. In response to policies, the unemployment rate spiked abruptly in 2020:Q1 and, in 2020:Q2, began to decline toward its pre-crisis level at a rate slower than the recovery of GDP, making the negative relationship between the unemployment rate and output less visible. At this time, it can be further postulated based on the existing reality that the labor supply and demand are not yet cleared. 2021:Q2, GDP declines again, possibly as a result of the macro-control backlash, causing the short-term correlation between output and unemployment to turn positive. In a follow-up study, the researcher could attempt to test this part of the paper's conjecture that is prevented by the current data limitations. Further, subsequent studies could also attempt to make predictions about whether the U.S. will enter the next Great Recession in this hyperinflation and to what extent the world economy will be affected.

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