INVESTIGATING OKUN'S LAW IN USA

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Introduction

Gross Domestic Product (GDP) is a macroeconomic indicator that has been heavily scrutinized by researchers, economists, government officials etc. in order to evaluate economic performance for many decades. Real GDP, i.e. GDP adjusted for inflation is the most significant indicator to measure the economic growth of a nation over time. A key relationship discovered by economists in their study of Real GDP is the inverse relationship between changes in real GDP and the unemployment rate, otherwise referred to as the Okun's law. It is an empirically observed relationship between unemployment in an economy and the nation's GDP. According to Okun's law, the unemployment level in the economy is negatively related to the country's GDP.

Motivation

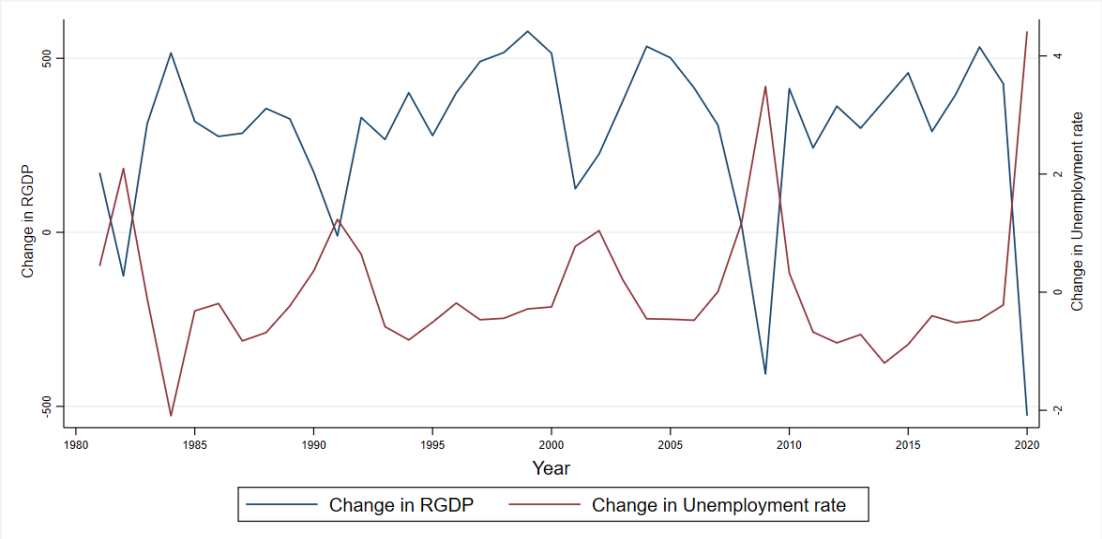


Figure 1.1 Changes in RGDP and Unemployment rate from 1980 – 2020

From figure 1.1 we can see that Okun's law relationship is not always true. For example, from around 2012 onwards till 2019, changes in the unemployment rate are mirroring changes in RGDP.

Thus, our project will investigate the viability of Okun's Law in the USA, from the year 1980 to 2020.

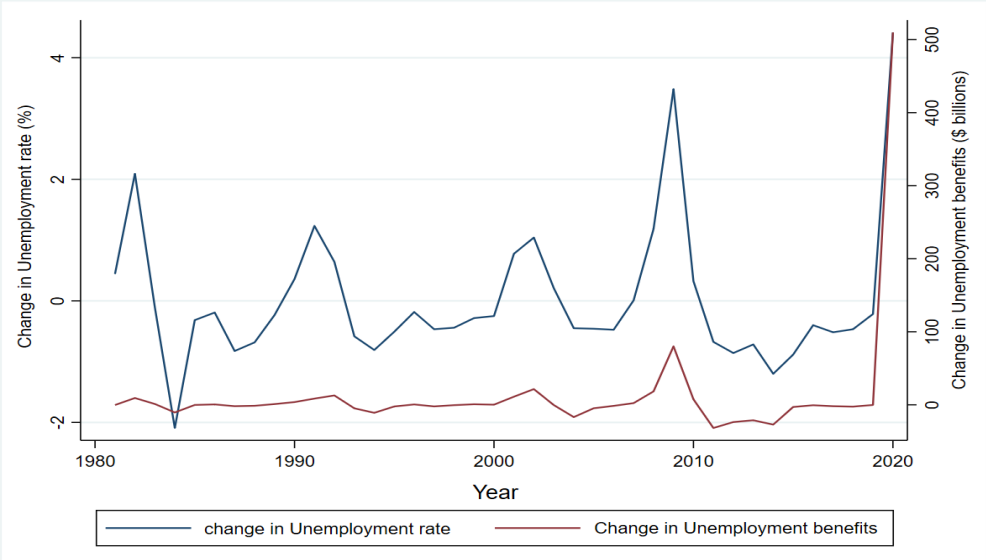


Figure 1.2 changes in unemployment rate and benefits from 1980 – 2020

If we look at figure 1.2, we can clearly see that annual unemployment insurance has generally increased or decreased following the changes in the level of the unemployment rate. This leads us to believe that the contradiction in Okun's law might be a result of other factors, such as unemployment benefits, which affect the labor market and Real GDP. Furthermore, we think unemployment benefits might have the highest effect on Okun's Law relationship. This is because a common consensus among economists exists that high unemployment benefits lead to lower worker participation as workers have no incentive to work which can lead to higher unemployment rates. However, since unemployment benefits let the unemployed retain their consumption power, we expect the RGDP to maintain its positive growth despite what Okun's law relationship states. Thus, our goal is to analyze why are there deviations from Okun's law relationship and if unemployment benefits play a role in this regard. Thus, our research question is "Do unemployment benefits affect the relationship between unemployment and real GDP in the USA?"

Literature Reviews

1. Lu, Jiayong, "*On the Impact of Social Spending on Long term Economic Performance in the USA*"(2022).Undergraduate Honors Theses.William & Mary

This study focuses on the effects of social spending such as social security, unemployment insurance etc. and how it affects the economy in the US. Overall, the study finds that social spending increases private savings and unemployment rate. Due to its dominant distortionary effects on the labor market, social spending decreases GDP. These effects are mostly short-term effects. The economic effects of the different social spending programs on the economy are similar in direction but different in magnitude.

2. Levine, L. L. (2013). *Economic growth and the unemployment rate*. Library of Congress, Congressional Research Service.

This paper focuses on the relationship between economic growth and unemployment rate. Unemployment rate is seen as a lagging indicator for economic growth. What appears to matter for a reduction in the unemployment rate is the rate of actual output (economic) growth compared with the rate of potential output growth. Potential output is a measure of the economy's capacity to produce goods and services when resources (e.g., labor) are fully utilized. The growth rate of potential output is a function of the growth rates of potential productivity and the labor supply when the economy is at full employment.

3. Roberto Dell'Anno & Offiong Helen Solomon (2008) *Shadow economy and unemployment rate in USA: is there a structural relationship?* An empirical analysis, Applied Economics.

Over the past two decades, the scale of the US shadow economy is thought to have decreased. This paper provides evidence that the shadow economy (SE) and the unemployment rate in the US have a structural link. Their finding shows a strong positive correlation between the official GDP growth rate and inflation. A decline in the official growth rate of the formal economy may be a reflection of increased production in the SE. This is due to the fact that during a recession, resources including labor and capital are transferred from the formal sector to the SE. According to Arimah (2001), there are forward links between the two in Nigeria. The SE's existence contributes to the expansion of the official economy, not hinders it. The income distribution in society is improved via underground manufacturing, which also increases competitiveness and enables the labor market to be more flexible. The SE is distinguished by extremely cheap labor costs and greater freedom of entry and departure.

4. Claudia Foroni, Francesco Furlanetto (2022) *Explaining deviations from Okun's law.*

Despite its stability over time, as for any statistical relationship, Okun's law is subject to deviations that can be large at times. In this paper, the authors provide a mapping between residuals in Okun's regressions and structural shocks identified with a SVAR model by inspecting how unemployment responds to the state of the economy.

5. Jr., T. H. (2020, April 9). *How many recessions you've actually lived through and what happened in every one*. CNBC.

This article helps us better contextualize the deviations in Okun's Law. We are already familiar with the idea that the Okun's law seems to not hold up during economic shocks. This article provides us a summary of the recessions which took place since the beginning of the 20th Century. The ones most relevant to our study are the dot com recession and the Great Recession of 2008 which occured at the end of a subprime mortgage crisis.

6. Juan M. Sánchez and Constanza S. Liborio (2012), "*The Relationships Among Changes in GDP, Employment, and Unemployment: This Time, It's Different*," Economic Synopses.

The findings of this study show that the GDP growth and the unemployment rate have changed recently. In the past, a 1% drop in GDP has been linked to an increase in unemployment of almost a 2% percentage points. Apparently, Okun's law has evolved since the start of the Great Recession. A small rise in GDP was accompanied by a decline in unemployment that was much larger than what the relationship before the Great Recession would have predicted.

7. Edward Knotek (2007) *How useful is Okun's law?* Economic Review

This paper provides us information on when the Okun's Law may not hold up and under which circumstances. As a relationship between changes in the unemployment rate and economic growth, Okun's law predicts that growth slowdowns typically coincide with rising unemployment. The recent experience of 2006 shows, however, that this is not always the case. This article has documented several reasons for this. First among these is that Okun's law is not a tight relationship. There have been many exceptions to Okun's law, or instances where growth slowdowns have not coincided with rising unemployment. This is true when looking over both long and short time periods. This is a reminder that Okun's law—contrary to connotations of the word "law"—is only a rule of thumb, not a structural feature of the economy. This article has also documented that Okun's law has not been a stable relationship over time. Part of this variation is related to the state of the business cycle: The relationship between output and unemployment is different in recessions and expansions, and recent expansions have been longer than average. Additionally, the data suggest that a weakening of the contemporaneous relationship between output and unemployment has coincided with a stronger relationship between past output growth and current unemployment. This finding favors versions of Okun's law that are less restrictive in the timing of this dynamic relationship. These findings have practical applications.

8. Sabia, Joseph J. *Do minimum wages stimulate productivity and growth?*

It is believed that minimum wage increases are likely to stimulate economic growth through higher worker productivity and motivation. However, this study shows how there is little empirical evidence supporting this claim and that the effect of a minimum wage increase on economic growth is ambiguous. An increase in minimum wage can go two ways; it can increase a firm's labor costs which may lead to an increase in product prices and therefore a reduction in output, employment and GDP. On the other hand, there might be an increase in the marginal propensity to consume of the workers who are able to retain their job and this might lead to higher consumption spending and therefore GDP. The relationship depends on several other exogenous factors. "Simple correlational evidence on the relationship between minimum wage increases and

GDP is not dispositive. For instance, the US government enacted federal minimum wage increases in 1990−1991 and 2007−2009, which were periods of sharp declines in real GDP growth. On the other hand, there was strong economic growth during the period when the federal minimum wage was raised in 1996−1997 and during a recession in the early 2000s, when the real value of the minimum wage declined."

Dataset

For our research project, we have gathered data from St. Louis Fed FRED Economic Data website: Federal Reserve Economic Data | FRED | St. Louis Fed (stlouisfed.org). Below are variables that our dataset includes and their definitions.

1. Annual Real Gross Domestic Product in Billions of USD
2. Annual Unemployment rate in Percentage
3. Annual Personal Consumption Expenditure in Billions of USD
4. Annual Unemployment Benefits in Billions of USD
5. Annual Labor Compensation Share in GDP in proportions
6. Annual Minimum Wage per Hour in USD
7. Recession as a dummy variable

Our dependent variable is Real Gross Domestic Product (RGDP), the measure of economic growth/performance of the USA.

We have included total personal consumption as an independent variable in our model because it is one of the largest components of aggregate demand in the macroeconomic equation.

The inclusion of unemployment rate is due to the Okun's Law relationship whereas, the inclusion of unemployment benefits is because of our hypothesis and research question.

Our literature review suggests that structural factors, such as worker bargaining power may have an effect on unemployment rates in an economy. In order to take into account this effect, we included minimum wage per hour as an estimate of the magnitude of workers' bargaining power. The higher the minimum wage/hour, the higher might be the bargaining power because higher minimum wages may be a result of stronger trade union groups contributing to more bargaining power.

Capital accumulation and the role of technology also have an impact on a country's GDP apart from other factors. In order to see how much of the US GDP is coming from capital contribution and labor contribution, we are including labor compensation share as a proportion of GDP. We have attempted to also use this method as a way to estimate worker bargaining power, i.e. higher labor compensation share as a proportion of GDP means greater proportion of GDP is going to the labor force which shows stronger worker bargaining power. However, the issue with this approach is that people belonging to the higher income class enjoy very high income while the lower income group earns very low. Therefore, a higher percentage of labor compensation in GDP will not necessarily mean higher worker bargaining power as most of it will probably be going to the top 1% of the income group, for example.

We have included recession as a dummy variable to take into account the shocks that the US economy had experienced over the course of these 40 years. Years when there was recession are labeled as 1 and those with normal economic activity are labeled as 0.

Table 1 below represents the summary statistics of our dataset.

Table 1: Summary Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
observation_date	41	14,610	4,375	7,305	21,915
RGDP	41	12,686	3,839	6,764	19,036
unemploymentrate	41	6.246	1.679	3.675	9.708
consumption	41	7,216	3,922	1,751	14,393
realconsumption	41	8,483	2,786	4,251	13,092
UnemploymentbenefitsUSDbillio	41	49.03	83.49	13.35	537.4
MinWageperhour	41	5.123	1.529	3.100	7.250
laborcompensationshareinGDP	40	0.609	0.0129	0.588	0.640

Methodology

Okun's Law Mathematical Equation:

ΔUnemployment rate = b(Real quarterly output growth)

b = factors relating changes in unemployment with changes in output

Our null and alternative hypothesis are:

$$H_0 : Unemployment\ benefits\ do\ not\ affect\ the\ Okun's\ Law\ relationship$$

$$H_a : Unemployment\ benefits\ affect\ the\ Okun's\ Law\ relationship$$

Our Models

Our very first model was as follows:

$$RGDP = \beta_0 + \beta_1\ unemployment\ rate + \beta_2\ unemployment\ benefits + \beta_3\ consumption + \varepsilon$$

This initial model had many problems with it; we had lesser observations (20 years of macroeconomic data), multicollinearity and heteroscedasticity. We believe that this was due to the omitted variable bias and the presence of outliers. Moreover, our model was also suffering from endogeneity which occurs when an independent variable is correlated with the error term. We proceeded on the following steps to progress to our final model.

The theoretical equation for our first updated model and its regression results are given below:

$$real\ GDP = \beta_0 + \beta_1\ unemployment\ rate + \beta_2\ unemployment\ benefits + \beta_3\ consumption + \beta_4\ minimum\ wage + \beta_5\ labor\ share + \beta_6\ i.recession + \epsilon$$

VARIABLES	Real GDP
Unemployment rate	-284.2***
	(64.4)
Consumption	0.949***
	(0.0667)
Unemployment benefits billion $	17.25***
	(2.979)
Minimum wage per hour	-113.92
	(148.7)
Labour compensation share in GDP	17216.35**
	(5878.1)
i.recession	-220.43
	(117.01)
Constant	-2874.128
	(3845.8)
Observations	40
Adj-rsquared	0.9944

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Even though we have significant results for some of our betas, we realize that this model might be suffering from multicollinearity and therefore we ran a test to check the VIF of our independent variables. The table below shows the outcome of the test. We see how minimum wage and consumption have very high multicollinearity between them and therefore, this needs to be fixed.

Variables	VIF	1/VIF
Unemployment rate	6.270	0.160
Consumption	34.850	0.029
Unemployment benefits	4.210	0.237
Min wage	27.210	0.037
Labor compensation share	3.090	0.324
Years with recession	1.420	0.705
Mean VIF	12.840	

Furthermore, we also ran the White's test to check for heteroskedasticity in the residuals and the results are shown below. For the white's test, our chosen significance level is 5% and the results show that we cannot reject the null. Therefore, homoskedascity assumption is reasonable in this model.

White's test

H0: Homoskedasticity

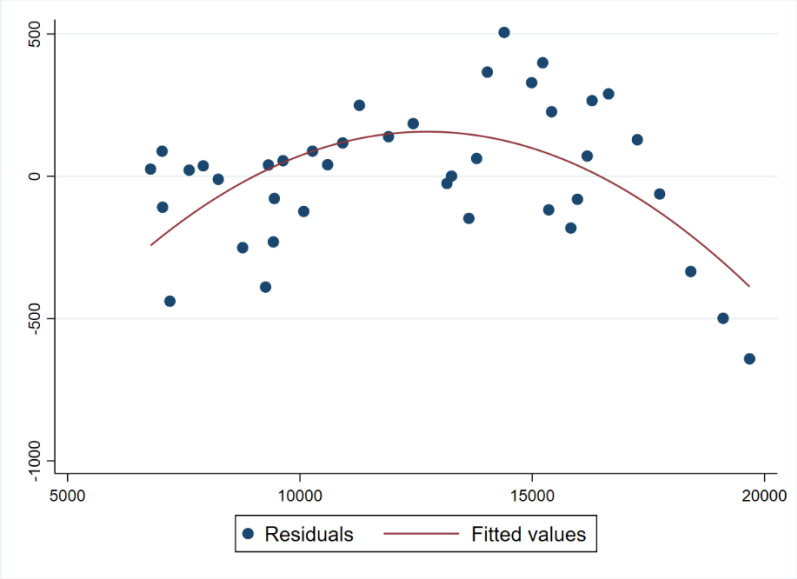
Ha: Unrestricted heteroskedasticity

chi2(26) = 36.84

Prob > chi2 = 0.0772

Cameron & Trivedi's decomposition of IM-test

However, from the rvfplot given below we see that our model might have a non-linear relationship between the independent and dependent variables and this is why we move on to our second updated model.



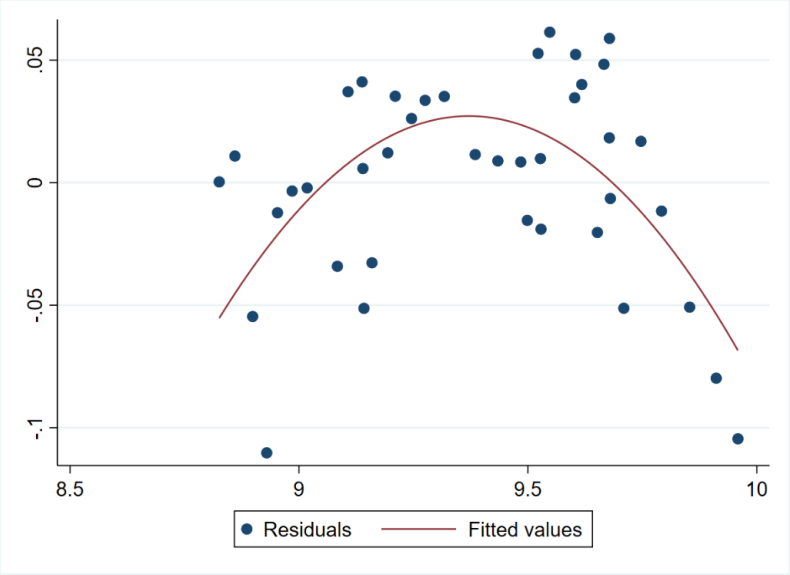
The theoretical equation for our second updated model and its regression results are given below. We decided to change our measurements to fix any issues with establishing significance or patterns in the rvfplot. To do so we decided to use log RGDP and see if the limitations of our model were fixed.

$$logreal\ GDP = \beta_0 + \beta_1\ unemployment\ rate + \beta_2\ unemployment\ benefits + \beta_3\ consumption + \beta_4\ minimum\ wage + \beta_5\ labor\ share + \beta_6\ i.recession + \epsilon$$

VARIABLES	logReal GDP
Unemployment rate	-0.0557***
	(0.011)
Consumption	0.000064***
	(0.0000115)
Unemployment benefits billion $	0.00324***
	(0.00051)
Minimum wage per hour	0.0000591
	(0.255)

Labour compensation share in GDP	1.6766
	(1.009)
i.recession	-0.0325
	(0.0200)
Constant	8.150***
	(0.660)
Observations	40
Adj-rsquared	0.9791

From the above regression, we see that the Adjusted R-squared is still unusually high and now the labor share of GDP and recession years have also become insignificant alongside minimum wage. Thus, we decided to use the white's test and the rvfplot to check for our model validity.



White's test

H0: Homoskedasticity

Ha: Unrestricted heteroskedasticity

chi2(26) = 35.75

Prob > chi2 = 0.0963

Cameron & Trivedi's decomposition of IM-test

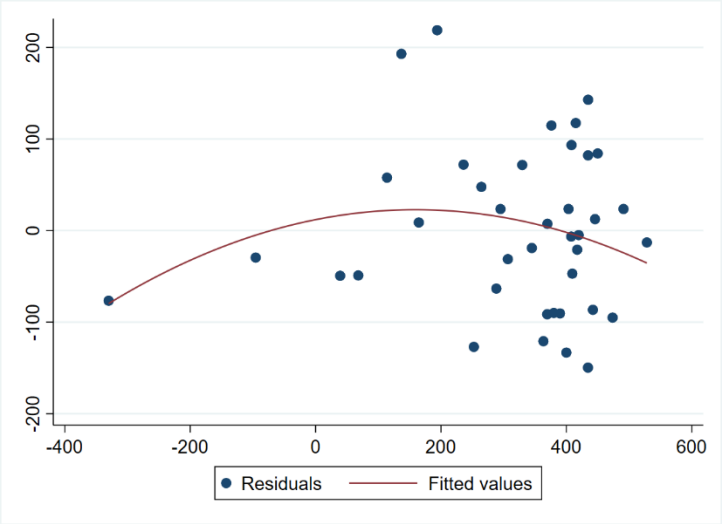
From the figure above we can see that the problem of non-linearity or a curved pattern of residuals is still not fixed despite there being evidence of homoscedasticity from the white's test. We further checked to see if the problem of multi-collinearity was fixed through the VIF test reported below and we observed that the model still had high multicollinearity between consumption and unemployment rate this time.

Variables	VIF	1/VIF
Unemployment rate	34.850	34.850
Consumption	27.210	27.210
Unemployment benefits	6.270	6.270
Min wage	4.210	4.210
Labor compensation share	3.090	3.090
Years with recession	1.420	1.420
Mean VIF	12.840	

After reviewing the literature again, we realized that our model coefficients may not be accurate as according to economic theory, the Okun law's relationship links change in unemployment with change in RGDP. Statistically, this also made sense as the time lag, i.e. the delay of effect due to time taken by the dependent variable to reflect changes from its relationship with the independent variable, was not accounted for in our model. In practical terms, a rise or fall in the unemployment rate in a particular year and its impact is on RGDP is observed in next year's RGDP. This is because of the time it takes for firms to adjust their production systems in accordance with the shortage of labor supply. Thus, we tried a third model that links change in real GDP and change in unemployment. The regression results are shown below.

VARIABLES	Change in RGDP
Change in Unemployment rate	-134.8***
	(28.83)
Consumption	0.0188
	(0.18)
Unemployment benefits billion $	-0.145
	(0.967)
Minimum wage per hour	-18.39
	(50.75)
Labour compensation share in GDP	4679.1***
	(1630.7)
i.recession	-119.90**
	(55.68)
Constant	-2553.1**
	(1009.8)
Observations	40
Adj-rsquared	0.7489

From the regression results we immediately noticed the change in adjusted R-squared from our previous models. The decrease in the value of adjusted r-squared led us to believe that some of the problems of our model might have been fixed. From the figure below, we can observe that our residuals vs fitted plot no longer had a curved relationship despite a clustering of data points between 200 and 600. Furthermore, our model no longer had heteroskedasticity at 5% or 10% levels.



However, the issue of high multicollinearity was still not resolved in our model with consumption and minimum wage still having high multi-collinearity with the rest of the independent variables. Moreover, since the adjusted r-squared was less than the r-squared we realized that this model also needed to be improved.

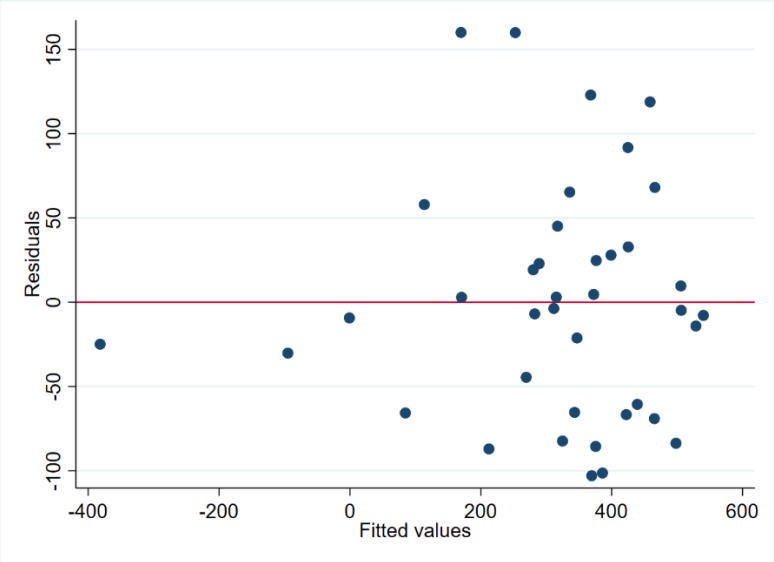
For our last model, we went through a theoretical analysis of our model and realized another measurement error within our previous models. We realized that the reason why most of our results were non-significant might be due to high standard errors. By analyzing our variables again, we realized that the argument of the time lag for transforming RGDP and Unemployment rates to changes in RGDP and Unemployment rates applied to consumption and unemployment benefits too. This is because consumption takes time to change if unemployment benefits increase. Similarly, the level of unemployment benefits does not change instantaneously as a recession starts rather such a government measure needs to be voted upon in Congress before it can be implemented. In order to test our theory we first tried a model with a change in consumption and then we did a regression of another model which included both changes in consumption and change in unemployment benefits. The results are shown below:

VARIABLES	Change in RGDP
Change in Unemployment rate	-89.06**
	(25.01)
Change in Consumption	0.633***
	(0.151)
Unemployment benefits billion $	0.437
	(0.717)
Minimum wage per hour	-23.18
	(17.82)
Labour compensation share in GDP	2400.3*
	(1371.5)
i.recession	-121.10**
	(45.49)
Constant	-1229.3
	(866.5)
Observations	40
Adj-rsquared	0.8323

VARIABLES	Change Real GDP
Change in Unemployment rate	-127.94***
	(30.94)
Change in Consumption	0.664***
	(0.136)
Change in Unemployment benefits billion $	2.859**
	(0.1393)
Minimum wage per hour	-17.744
	(13.839)
Labour compensation share in GDP	2249.5*
	(1280.9)
i.recession	-106.5**
	(43.4)
Constant	-1166.6
	(809.6)
Observations	40
Adj-rsquared	0.8501

From the regression results, we find evidence for our theory. The adjusted r-squared increase with each addition of the change variable. Moreover, by using the change transformation our results also become significant. Significant results for consumption and unemployment benefits were crucial for our model as according to the literature both variables have a positive and significant effect on RGDP. Moreover, other variables also followed general economic theory. For example, years with a recession are supposed to have a negative relationship with RGDP according to economic theory (relationship present in our results). Similarly, the labor compensation share of GDP is also supposed to have a positive relationship with RGDP as that means most of the output produced is by the labor i.e. most of the incomes are gone towards paying workers and not to the maintenance/buying of machinery in the economy. Thus, if workers have higher incomes, then they buy more demand for goods and services which leads to high RGDP. However, we are still unsure about the numerical coefficient of labor compensation share as it is likely that the data might be leading due to the high incomes of the top 1% and top 10% which may distort the actual proportion of income that goes to the rest of the labor force. Furthermore, the labor share compensation ratio may be very different for states with higher rural areas than for states with higher urban areas. This is because of high mechanization and also the higher average income level of urban areas. Thus, the beta relationship between RGDP and labor share compensation ratio might be different if we further control for these factors. Similarly, it also makes sense that the minimum wage per hour was insignificant as the variable itself may not accurately account for worker bargaining power. This is because 30 U.S. states have a minimum wage above the federal minimum wage, five states have no minimum wage, and Georgia and Wyoming have a minimum wage below the federal wage. Thus, the data for this variable does not take these differences into account and only shows the federal minimum wage.

Theoretically, the last model was the best model of all the other models however we wanted to check if this model had overcome the problems of multi-collinearity and of patterned residuals of models 1 and 2. The results below show that the model is free of these problems and is in line with Guass Markov assumptions. One potential reason for the concentration of data points between 200 and 600 fitted values is the number of observations of the data set. It is likely that with quarterly data the number of observations might have increased and the residuals may be more evenly spread. This is due to the fact that Annual figure are an average of quarterly or monthly figures. However, often times there is steady growth or fall during a year which is captured by the quarters before a year with recessions or booms is observed. Thus, higher frequency of data can capture the building changes within a year which could have led to a more scattered spread of the residuals.



Variables	VIF	1/VIF
Change in Unemployment rate	5.81	0.172
Change in Consumption	2.84	0.352
Change in unemployment benefits	3.78	0.264
Min wage	2.86	0.349
Labor compensation share	1.80	0.556
Years with recession	2.29	0.436

Mean VIF	3.23

Conclusion

From our final regression results, we observe that change in unemployment rate has a negative relationship with change in real GDP as described by the Okun's Law. Therefore, the Okun's Law relationship stands in our model. However, while minimum wage still remains insignificant, we were able to find evidence showing labor compensation share and change in unemployment benefits also have an effect on change in real GDP. This should mean that we have evidence against our null hypothesis for now. However, we feel more research needs to be done in this area with better parameters and methodology to be able to fully accept or reject the hypothesis.

Works Cited

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