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Effect of U.S. Government Spending on GDP

Our research question is: how does government spending (G) in a given year (t), affect the economic growth (GDP) of that country in the next year (t+1)?

Our hypothesis is that as government spending increases in a given year, the GDP will increase the following year. Our thinking is based on macroeconomics, where the equation for GDP (Y) is: Y = C + I + G + NX. And in this equation, as government spending (G) increases, GDP (Y) increases. We decided to use the next year's data for GDP, because the relationship between G and GDP in the same year is straightforward (G is a part of the GDP equation). We also thought that an increase in government spending may take time to affect an economy, so we decided to look at how federal spending impacts GDP in the following year to account for this potential time lag.

Data

We got our data from the American Presidency Project at UC Santa Barbara (Woolley). This data set contains a table of government spending (receipts and outlays), as well as the GDP, for each fiscal year dating back to 1930. From this table, we added the receipts and outlays to get the government spending for each year, and we compiled this data into our own table alongside the GDP for each year[1]. We decided arbitrarily to use data from 1990 up to 2022. This table gave us complete data for both variables that we were able to translate easily into R later on. This source is highly credible and the authors gathered the data directly from government sources.

Models

Original Model:

$GDP_{t+1} = \beta_0 + \beta_1 G_t + \varepsilon_t$

Where G = Government spending

[1] FederalSpendingandGDP

Differencing/Adjusted Model:

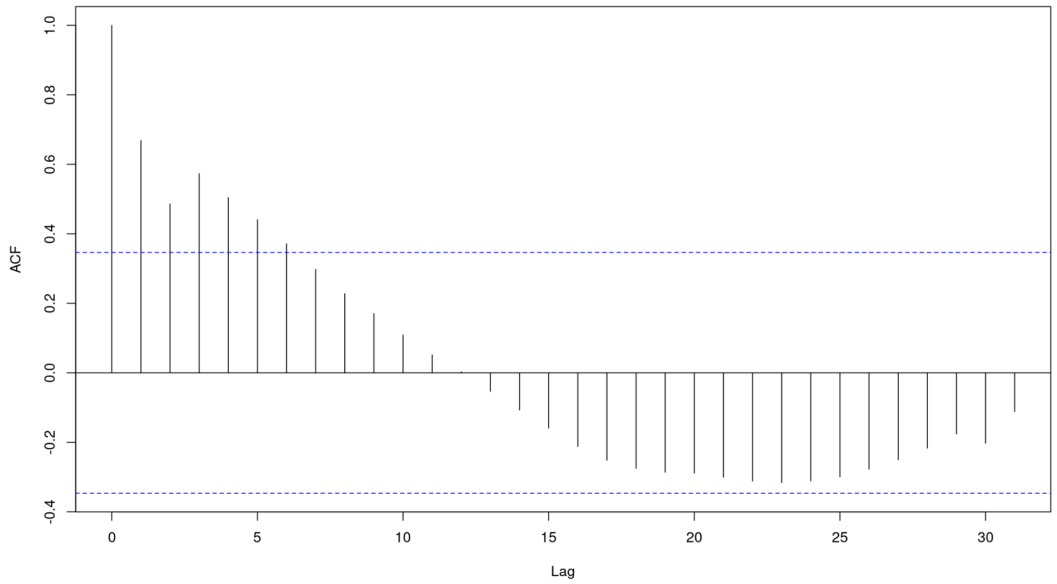
$\tilde{y} = y_t - y_{t-1}$

Where y = GDP, and $\tilde{y}$ = change in GDP (ΔGDP).

$\Delta GDP = \beta_0 + \beta_1 \Delta G_t + \varepsilon_t$

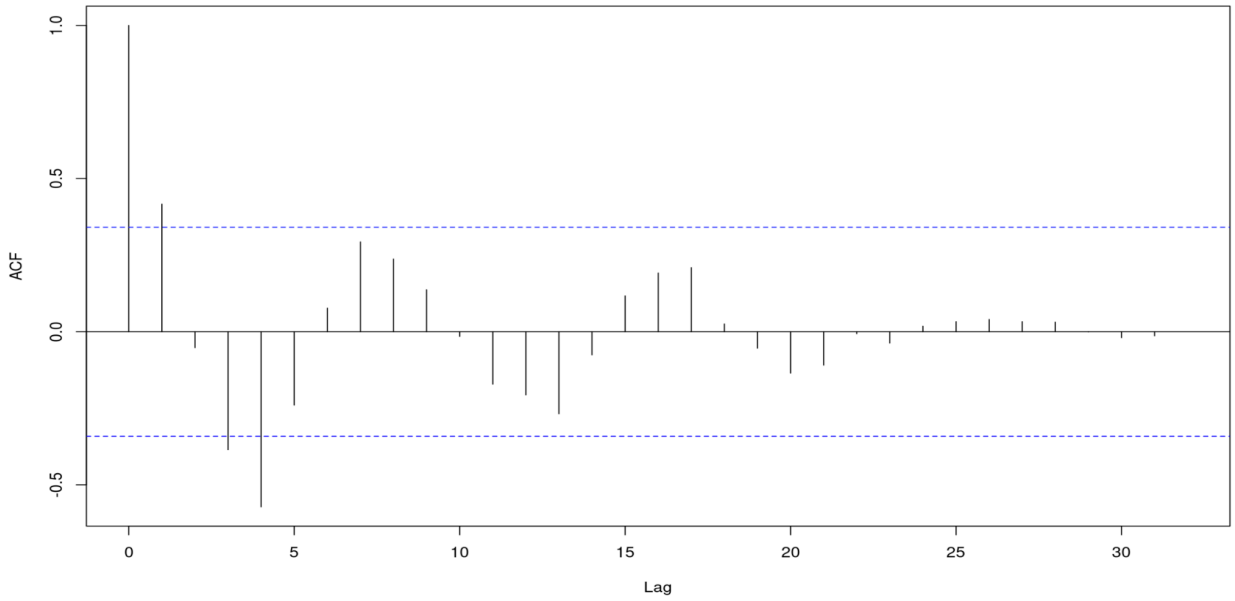
All of the X and Y variables are continuous and quantitative – GDP and change in GDP, Government Spending and change in Government Spending. Our original model is a basic model that estimates the relationship between government spending in a given year, and the GDP in the next year (in the U.S.).

Because we're dealing with time series data, it is possible that we can run into issues of autocorrelation. This could break assumption five of simple linear regression. This assumption says that the covariance between error terms should be zero: $Cov(\varepsilon_t, \varepsilon_j = 0)$. To test for autocorrelation we graphed an autocorrelation function (ACF) in R. In the ACF plot below, we can see that the Time Series is non-stationary, with high correlation in the lag period between 0-12 years and decreasing at a slower rate after that. This suggests a higher level of autocorrelation within the data.



To correct for autocorrelation, we used a differencing model where we instead look at the change in our y variable (GDP) and its relationship to the change in our x variable (government

spending) across time. When we do this, we get rid of a majority of the autocorrelation as shown in the new ACF graph below:



Results

We chose to use a significance level of 0.05 ($\alpha = 0.05$). This significance is the threshold below which we can reject the null hypothesis. If we get a p-value less than or equal to 0.05, then we can reject the null hypothesis and accept the alternative hypothesis. This significance level also means that there is a 5% chance of committing Type I Error – which is rejecting the null hypothesis when the null is actually true.

Original Model:

$GDP_{t+1} = \beta_0 + \beta_1 G_t + \varepsilon_t$

Our null hypothesis for this model is that government spending in a given year has no effect on next year GDP in the U.S.
$H_0: \beta_1 = 0$

Our alternative hypothesis is that government spending in a given year has a positive effect on next year GDP in the U.S.
$Ha: \beta_1 > 0$

When we ran this regression in R we found $\beta_0 = 18.0369310$. This value is saying that when government spending is zero, GDP the next year will be 18.0369 billions of dollars (a very small number for U.S. GDP).
We then found that $\beta_1 = -0.0001816$. This value tells us that with an increase in government spending of 1 billion dollars, GDP decreases by 0.0002 billions of dollars.

It is worth noting that this beta 1 value is negative. This is different from our original hypothesis that beta 1 would be a positive number. This beta tells us that an increase in government spending in one year results in a (very) small decrease in the GDP of the next year. For this regression, we got a p-value of 0.1092. This p-value is not below the 0.05 threshold which means that we cannot reject the null hypothesis at the 0.05 significance level. From this we conclude that government spending has no significant effect on the GDP of the next year in the U.S.

Differencing/Adjusted Model:

$\tilde{y} = y_t - y_{t-1}$
Where y = GDP and $\tilde{y}$ = change in GDP (ΔGDP)
$\Delta GDP = \beta_0 + \beta_1 \Delta G_t + \varepsilon_t$

Our null hypothesis is that a positive change in government spending from year to year has no effect on the change in GDP in the U.S.
H_0: $\beta_1 = 0$

Our alternative hypothesis is that a positive change in government spending from year to year will result in a positive change in GDP from year to year in the U.S.
H_a: $\beta_1 > 0$

We ran the regression in R – after adjusting our x and y variables to reflect the differencing model above. We found that $\beta_o = 0.007264$. This tells us that when there is no change in federal spending year to year, then the change in GDP will be 0.007264 billions of dollars (GDP will increase very very slightly).

We then found $\beta_1 = 0.000008549$. This value tells us that if government spending changes by + 1 billion dollars year to year, the GDP will change by 0.000008549 year to year in the U.S.

P-value is 0.946. Since the p-value is much greater than 0.05, we fail to reject the null hypothesis that there is no significant relationship between a change in federal spending and a change in the GDP. This means that we lack the evidence to say that federal spending has a significant effect on GDP.

Conclusion:

Government spending has no significant effect on GDP in the U.S. This is because the p-values we calculated from both regression models are greater than 0.05. This implies we cannot reject our null hypothesis (H_0: $\beta_1 = 0$). It is important to note here what the government is spending money on. The biggest expenditures by the U.S. government are on social security, military, education, healthcare, and infrastructure. It is possible that some of this government spending spurs economic growth. But it is likely that other factors overshadow the effect of government spending. For example, things like consumer spending, private investment, or monetary policy may have a much greater effect on GDP than government spending. There may be more of a time lag than one year also – it may take longer than one year for government spending to actually impact GDP.

Issues with our Analysis

It is possible that we still have some autocorrelation in our models (definitely in the first model and maybe still in the second model). If there is autocorrelation present, this will bias our standard error for beta 1, which will give us an inflated t-statistic and make us more likely to reject the null hypothesis when it's actually true (Type I error). This was not really an issue in our results, because we ended up rejecting the null in both of our models nonetheless.

A potential variable that we have omitted in our models is the overall state of the economy – whether it's in a recession or not. We could measure this in a couple of ways, the best one may be the unemployment rate. This could be an issue in our model because if the economy is in a recession for example (ie: high unemployment), the government will often decide to increase federal spending (things like stimulus checks). The economy being in a recession will also affect the GDP of the U.S. – it will be lower when unemployment is high. So, there is a clear relationship between the state of the economy – measured by unemployment rate for example – and the x and y variables in our model. We can reasonably assume that there is a positive relationship between the unemployment rate and federal spending. This is because as the unemployment rate increases, the economy moves toward a recession which will result in the government spending more money to try and get out of. If this relationship is positive (which it may not always be as government spending can be decided by outside political factors sometimes), then the bias will be in a positive direction. This means that our estimates for beta 1 are being increased by the bias. This inflated our t-statistic and makes us more likely to commit Type I error.

This is a violation of assumption two of OLS. This assumption says that our x variable is independent of the error term. This means the covariance between x and the error term should be

equal to zero: $Cov(x_t, \varepsilon_t) = 0$. The omitted variable of unemployment rate (which is encapsulated by the error term ε_t) will covary along with federal spending which means that this assumption is being violated and the covariance is not equal to zero. If we were to pursue this research question in the future, we could move to a multiple linear regression model where we add variables like unemployment rate and inflation rate to our model. Taking all these variables into account would give us the most accurate estimate for the coefficient on government spending. We could also implement some sort of different research design like difference in differences to help get rid of bias in our models.

Works Cited

Woolley, John, and Gerhard Peters. “Federal Budget Receipts and Outlays:” *Federal Budget Receipts and Outlays: | The American Presidency Project*, 28 May 2021, https://www.presidency.ucsb.edu/statistics/data/federal-budget-receipts-and-outlays.