Estimating the Government Consumption and Investment Multipliers Using SVAR Method on the US Data from 1966 to 2020.

Abstract

Government spending, one of the major components of Gross Domestic Product (GDP), is composed of government consumption, investment, and transfer payments. A change in government spending during recessionary periods can generate an increase in GDP greater than the increase in spending. This is called the "multiplier effect". Accurate estimation of government spending multiplier is important because fiscal policy has been used to stimulate a flagging economy. Many recent studies have focused on identifying parts of economy that responds more to a stimulus under variety of circumstances. I use the US dataset from 1966 to 2020 and a linear Vector Auto Regression (VAR) model assuming standard identification method (Blanchard & Perotti 2002) to estimate the multipliers. I include private consumption, private investment in the model and control for forecasted government spending, interest rate, Consumer Price Index (CPI), export, import, and level of public debt. I find the investment multipliers to be positive for the first five quarters and larger than one around impact whereas consumption multiplier is not significantly different than zero. It is because an increase in public consumption crowds out private investment whereas an increase in public investment does not crowd out private consumption or investment. In addition, much of the positive and prolonged effects of public investment shock on GDP are seen during the expansionary periods. Surprisingly, both these results are not consistent with the traditional theories or findings from prominent literature on this topic.

Introduction

Government spending, one of the major components of Gross Domestic Product (GDP), is composed of government consumption, investment, and transfer payments. Fiscal stimulus is additional government spending e.g., beyond typical spending to stimulate economic activity. A change in government spending during recessionary periods can generate an increase in GDP greater than the increase in spending. This is called the "multiplier effect". Accurate estimation of government spending multiplier is important because fiscal policy has been used to stimulate a flagging economy. For example, if fiscal multiplier is positive and larger than one, then additional spending may be effective. Increasing numbers of empirical studies have reported larger multipliers in recessions than in expansions (e.g., Ramey and Zubairy 2018; Auerbach and Gorodnichenko 2012). In addition, consumption multipliers have been found to be larger than the investment multipliers for a temporary increase in spending (e.g., Perotti 2004; Boehm 2020). I try to connect the behavior of the multiplier between recessions and expansions with work on disaggregated multipliers. First, I estimate separate multipliers for government consumption and investment using linear Vector Auto Regression (VAR) models on quarterly US data from 1966 to 2020. Then I split the dataset and estimate both multipliers for recessions and expansions separately.

Most studies have found multipliers to be modest and often smaller than one. If multipliers are much smaller than one and close to zero, they find that government spending increases do not stimulate the aggregate demand (Ramey & Zubairy, 2018). Private investment has generally been found to be ‘crowded out’ after increases in the aggregate government spending (e.g., Ramey and Shapiro, 1998; Blanchard and Perotti 2002; Mountford and Uhlig, 2009; Ramey 2011b). But, when the economy is in recession and unemployment is high, crowding out is found to be smaller (Michaillat, 2014).

However, it is not the aggregate spending multiplier that has been a focus of recent studies. The productivity enhancement of public capital makes the longer run investment multipliers higher than the consumption multipliers (Baxter & King,1993). In response to disaggregated spending shocks, private investment gets crowded out more than that of private consumption (Perotti 2004; Boehm 2020). Boehm (2020) estimated consumption multiplier to be larger than the investment multiplier for a transitory shock. He argues that private investment is more inter-temporally substitutable than the private consumption. Hence, a short-lived government investment shock generates a bigger crowding out effect to private investment than that a short-lived government consumption shock does to private consumption. In addition, private investment does not get crowded out after a public consumption shock.

Therefore, it is inaccurate to estimate aggregate multiplier directly because composition of total purchase is not constant. Since aggregate multipliers are approximately weighted average of disaggregated multipliers, a change in the composition of spending may lead to a change in aggregate multiplier. So, it is better to estimate an aggregate multiplier for total spending as a weighted average of the disaggregated multipliers (Boehm, 2020).

Auerbach & Gorodnichenko (2012) estimated much larger multipliers in recessions using regime switching non-linear VAR. This study ignored the possibility that the business cycle can respond to government spending shock. Ramey and Zubairy (2018) used similar method but allowed for the business cycle to be endogenous and showed that the multiplier gets reduced to be around unity. Ramey and Zubairy (2018) also used a local projection method to estimate multipliers to be below unity during recessions. However, the evidence still suggests that multipliers are larger during recessions because of very small or close to zero multiplier size in expansions.

There are other studies that have focused on identifying parts of the economy that respond more to a stimulus under a variety of circumstances i.e., monetary policy is restricted by zero lower bound (Christiano et al. 2011; Eggertsson 2011), high public debt (Favero, 2007), government spending is financed with cash (Gali, 2020). However, most studies have measured multipliers for aggregate government spending whereas government consumption and investment multipliers are different. The few studies that estimated separate multipliers either used smaller United States datasets or did not control for forecasted government spending. For example, Perotti (2004) estimated both the consumption and investment multipliers for quarterly US data from 1960 to 2000 but did not control for the anticipated component of government spending. Ilzetzki et al. (2013) used a panel dataset for OECD countries with 2,500 observations from 10 years, but it does not fully represent the US context. Both these studies did not control for the business cycle.

Similarly, Boehm (2020) used OECD panel data that also does not fully represent the US context. Ramey and Zubairy (2018) used larger US dataset and controlled for slack periods but estimated aggregate spending multiplier. Auerbach and Gorodnichenko (2012) used quarterly US data from 1947 to 2008 to estimate separate consumption and investment multipliers for both recessions and expansions using non-linear VAR. However, regime switching VAR models are complicated and their results are sensitive to the criteria used to delineate the recessionary periods from the expansionary periods. Also, they did not add private consumption, investment, interest rate, and debt level in their model. So, it is difficult to explain the underlying mechanism other than just reporting the results.

In my research, I use forecasted government spending, private consumption, private investment, Export, Import, interest rate, Consumer Price Index (CPI), and GDP in the VAR. In addition, I include the level of public debt which is rarely done in the literature but an important variable to control for the endogenous component of government spending shock. Because I have larger dataset and it allows for greater Degree of freedom, I simply split the dataset into recession and expansion samples based on a continuous recession probability indicator developed by Auerbach and Gorodnichenko (2012). Then I use linear VAR on both samples to estimate separate multipliers for government consumption and investment. I find the investment multipliers to be positive for the first few quarters and larger than one on impact whereas consumption multiplier is not significantly different than zero. It is because an increase in public consumption crowds out private investment whereas an increase in public investment does not crowd out private consumption or investment. In addition, much of the positive and prolonged effects of public investment shock on GDP are seen during the expansionary periods. Surprisingly, both these results are not consistent with the traditional theories or findings from prominent literature on this topic.

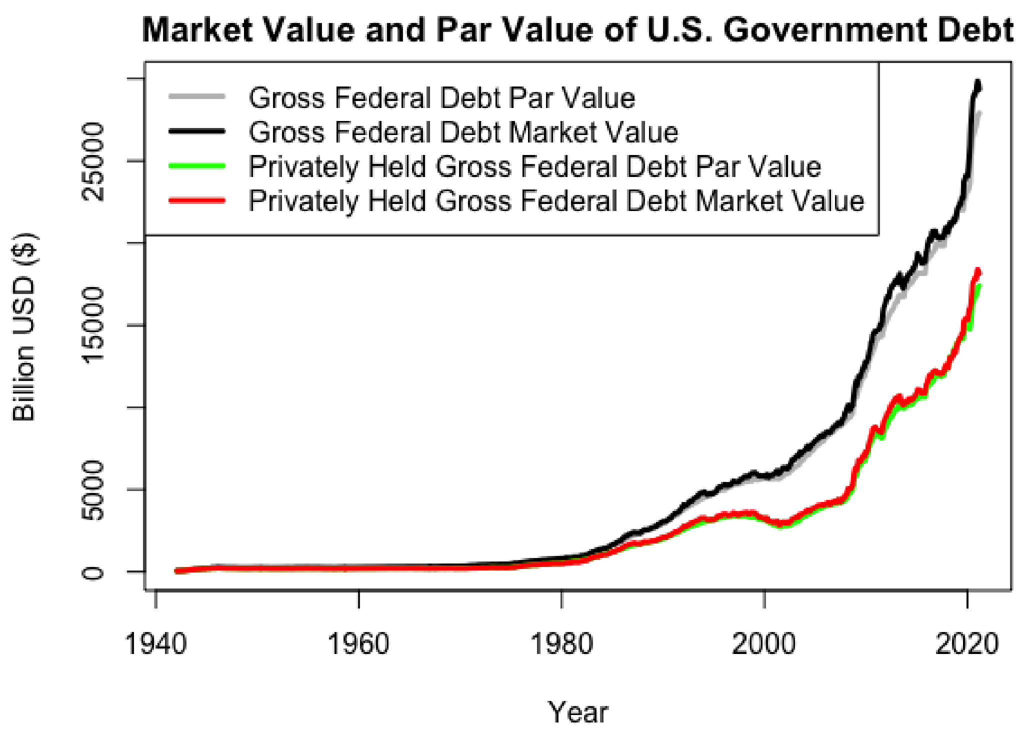
Data

I collect seasonally adjusted Private consumption (C), Private investment (I), Export (Ex), Import (IM), GDP, Government consumption (GC), Government investment (GI), and Tax revenue (TR) data from the US Bureau of Economic Analysis (BEA). These macro aggregates are available for the period 1947: Q1 to 2021: Q1 on table 1.5.5 and table 3.2 at the BEA website.[1] All variables are converted in real terms using the price index from table 1.5.4 for Private consumption (C), Private investment (I), Export (Ex), Import (IM), GDP, Government consumption (GC), Government investment (GI) where base index for the year 2012 price is considered 100.[2] I use GDP price index to convert Tax revenue (TR) in real terms. I construct a continuous recession probability variable 'F_Z' following Auerbach & Gorodnichenko (2012) and use this variable to split recession sample from the expansion sample instead of NBER dates.

I use mean Forecasted Government Spending (FGS) data from Survey of Professional Forecasters for the period 1981: Q4 to 2020: Q2.[3] Then I stack the data of forecasted government spending from Auerbach & Gorodnichenko (2012) for the period 1966: Q4 to 1981: Q3. I use market value of public debt (D) instead of par value. Market value of debt captures the actual debt burden to the government as it accounts for changing interest rate. This data is available at the website of Federal Reserve Bank of Dallas for the entire study period.[4]

[1] https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2#reqid=19&step=2&isuri=1&1921=survey
[2] https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2 - reqid=19&step=2&isuri=1&1921=survey
[3] https://www.philadelphiafed.org/surveys-and-data/rslgov
[4] https://www.dallasfed.org/research/econdata/govdebt.cfm#tab3

Figure 1: Market Value and Par Value of U.S. Government Debt



I use the interest rate (i) from effective federal funds rate for the period before 2009 and shadow interest rate for the period after 2009 to control zero lower bound (ZLB) environment. Shadow interest rate estimate by Wu and Xia (2016) matches with effective federal funds rate for the non-ZLB period (before).[5] Consumer Price Index (CPI) data are collected from FRED website and data are available for the entire sample period.[6]

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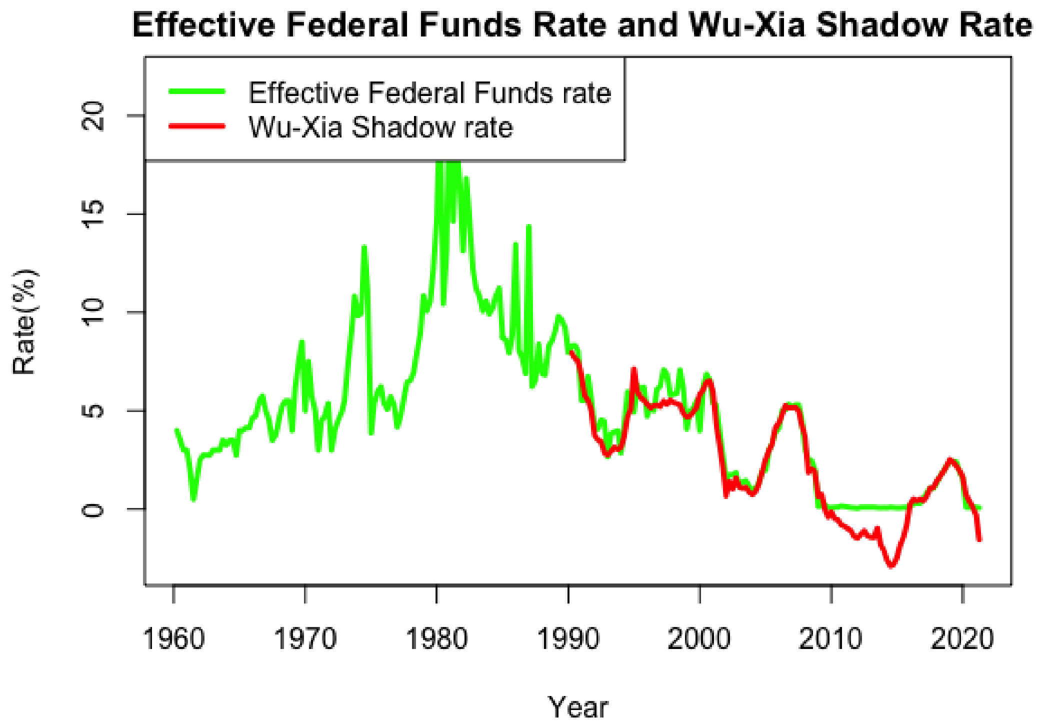
[5] https://www.atlantafed.org/cqer/research/wu-xia-shadow-federal-funds-rate?panel=2

[6] https://fred.stlouisfed.org/series/CPIAUCSL

Figure 2: Effective Federal Funds Rate and Wu-Xia Shadow Rate



Model

Private consumption (C), Private investment (I), Export (Ex), Import (IM), GDP, Government consumption (GC), Government investment (GI), Tax revenue (TR), and Debt (D) are log linearized. I use impulse responses from log-linearized VAR (1) model to compute the multipliers. Most data are available for the entire period from 1947: Q1 to 2020: Q4. However, forecasted government spending (FGS) data is available for only the period 1966: Q4 to 2020: Q4. Since it is clear from the literature that government expenditures are anticipated by the private sector, I truncate the entire dataset to match the forecasted spending variable. Also, I remove the last three quarters from 2020 because businesses and activities got disrupted due to COVID-19 pandemic which is different from other recessions.

Identification: Endogenous variables can affect each other contemporaneously. I assume standard identification strategy following Blanchard & Perotti (2002) that fiscal variables do not respond to macro variables within the same quarter. Hence, I put fiscal variables at the top of the Cholesky decomposition matrix followed by macro aggregates Private Consumption (C), Private Investment (I), and GDP. B & P (2002) also says that the order of the fiscal variables doesn't matter. However, the order of the macro aggregates can matter. So, I also estimated my model with an alternative order of macro variables i.e., GDP followed by Private Consumption (C) and Private Investment (I). To choose the lag order for the VAR, I use Schwarz Criterion (SC) to choose the number of lags.[7] Exogenous variables are lagged to avoid simultaneity bias.

[7] For full sample period AIC, HQ, and FPE suggest 6, 2, and 5 lags respectively. Since I have 6 endogenous variables in the VAR, using higher number of lags can significantly reduce the degree of freedom. However, I perform robustness check with other lag choices up to 6 and the results seem to be similar.

$\boldsymbol{Model\ 1}$: $\boldsymbol{Structural\ VAR\ (1)\ Equation(Full\ Sample)}$: $\boldsymbol{Y_t = Y_{t-1} + X_{t-1} + U_t}$

Y_t= Endogenous variables [GC GI TR C I GDP] ´ ordered accordingly for Cholesky Decomposition.

Y_{t-1} = Lagged variables.

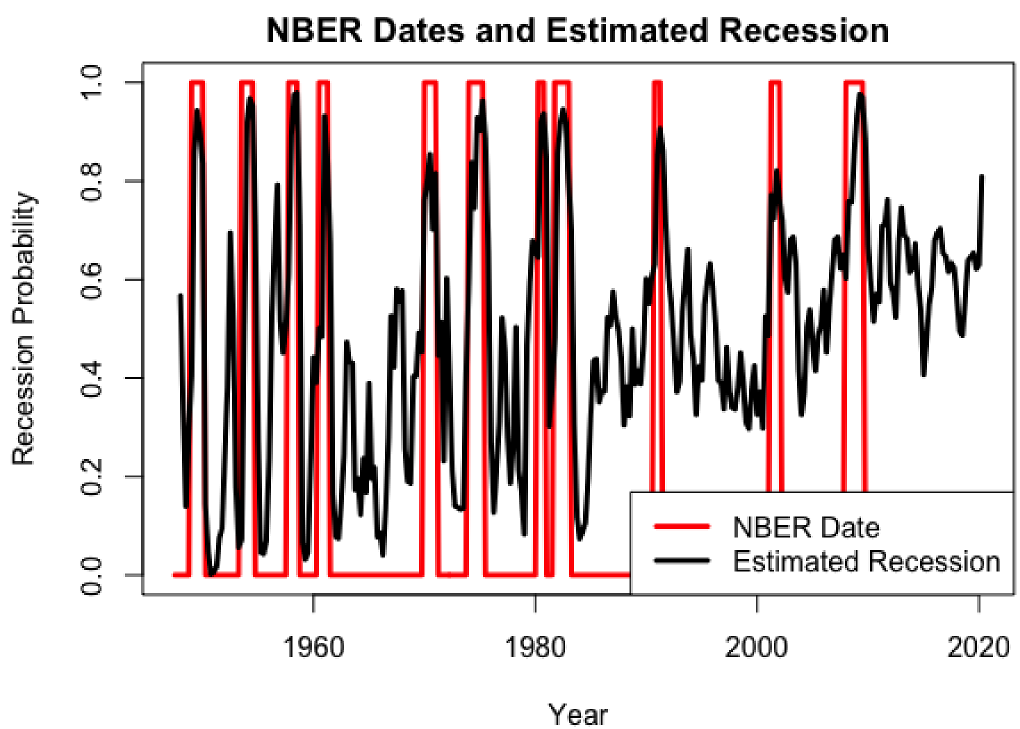
X_t= Exogenous variables [i CPI FGS EX IM D] ´

U_t = Error $[u_t^{GC}\ u_t^{GI}\ \ u_t^{TR}\ \ u_t^{C}\ u_t^{I}\ \ u_t^{GDP}]$ ´

I compute a new index variable 'z' which is three quarter moving average of GDP growth rate. Then I use this index variable to estimate recession probability for each observation following Auerbach and Gorodnichenko (2012). This continuous recession probability variable (F_Z) is constructed as following:

$F\_Z = \frac{\exp(-g*z)}{(1+\exp(-g*z))}$; where g=1.5

Figure 3: NBER dates and Estimated Recession Probability



I simply split the dataset into recession and expansion samples using this new recession probability variable F_Z (i.e., if F_Z>0.5, then sample is recession). This is useful because National Bureau of Economic Research (NBER) announced dates have a small number of recession observations and VAR results tend to be less stable with smaller sample size. I also use F_Z>0.6, F_Z>0.7, and F_Z>0.8 as recession criteria to complete the robustness check. If F_Z>0.7 or F_Z>0.8 criteria are used, there will be small number of observations for recession sample, but it would be more consistent with NBER announced recession periods. Then I use VAR (1) on both the recession and expansion samples to estimate separate multipliers for government consumption and investment.

$\boldsymbol{Model\ 2: Structural\ VAR\ (1) Equation\ (Recession\ Sample): Y_t = Y_{t-1} + X_{t-1} + U_t}$

Y_t= Endogenous variables [GC GI TR C I GDP] ´ ordered accordingly for Cholesky Decomposition.

Y_{t-1} = Lagged variables.

X_t= Exogenous variables [i CPI FGS EX IM D] ´

U_t = Error $[u_t^{GC}\ u_t^{GI}\ \ u_t^{TR}\ \ u_t^{C}\ u_t^{I}\ \ u_t^{GDP}]$ ´

$\boldsymbol{Model\ 3: Structural\ VAR(1)\ Equation(Expansion\ Sample): Y_t = Y_{t-1} + X_{t-1} + U_t}$

Y_t= Endogenous variables [GC GI TR C I GDP] ´ ordered accordingly for Cholesky Decomposition.

Y_{t-1} = Lagged variables.

X_t= Exogenous variables [i CPI FGS EX IM D] ´

U_t = Error $[u_t^{GC}\ u_t^{GI}\ \ u_t^{TR}\ \ u_t^{C}\ u_t^{I}\ \ u_t^{GDP}]$ ´

Impulse responses produced from these VAR (1) models are in percentage terms. So, I scale them holding the first impulse as one percent. Then I convert the GDP responses from percentage terms to USD equivalent for one dollar increase in government consumption or investment. I estimate it by multiplying the scaled percentage responses of GDP with average GDP per government consumption/investment.

$$\frac{\Delta GDP}{\Delta GC} = Elasticity * \frac{GDP}{GC}$$

Where $Elasticity = \frac{\log(GDP)}{\log(GC)}$

Similarly,

$$\frac{\Delta GDP}{\Delta GI} = Elasticity * \frac{GDP}{GI}$$

Where $Elasticity = \frac{\log(GDP)}{\log(GI)}$

To estimate the cumulative multiplier over the horizon, I take sum of the responses of government consumption or investment in USD from its own impulse of 1 USD. Then I divide the cumulative responses of GDP in USD by the cumulative responses of government consumption or investment in USD.

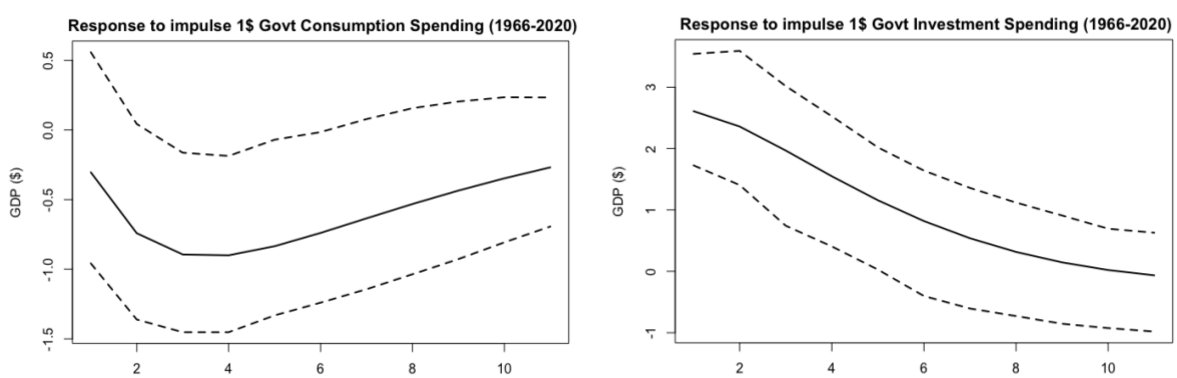
$$Cumulative\ Multiplier\ for\ Government\ Consumption = \frac{\sum GDP}{\sum GC}$$

$$Cumulative\ Multiplier\ for\ Government\ Investment = \frac{\sum GDP}{\sum GI}$$

Results

Government consumption and investment multipliers are significantly different from each other. In the literature, consumption multipliers are often reported positive and larger than the investment multipliers for the US and the OECD countries. In my research, I find the opposite. Investment multipliers are often positive and larger than the consumption multipliers. Figure-4 shows that government investment spending has significant positive effects on output for the first five quarters whereas government consumption spending has no significant positive effects on output. Instead, public consumption spending has significant negative effects on GDP after second quarter. Furthermore, government investment multiplier is significantly larger than one for the first two quarters.

Figure 4: GDP responses to $1 impulse using full data 1966-2020 (90% Bootstrap CI, 1000 runs)



Boehm (2020) concludes that investment multiplier is smaller because private investment is more intertemporally substitutable than private consumption. Hence, private investment gets crowded out more by a public investment shock than private consumption gets crowded out after a public consumption shock. This own crowding out effect is known to be most important and reported to produce smaller multipliers for public investment. However, this paper finds evidence on the contrary.

Figure 5: Responses of $1 increase in government consumption (90% Bootstrap CI, 1000 runs)

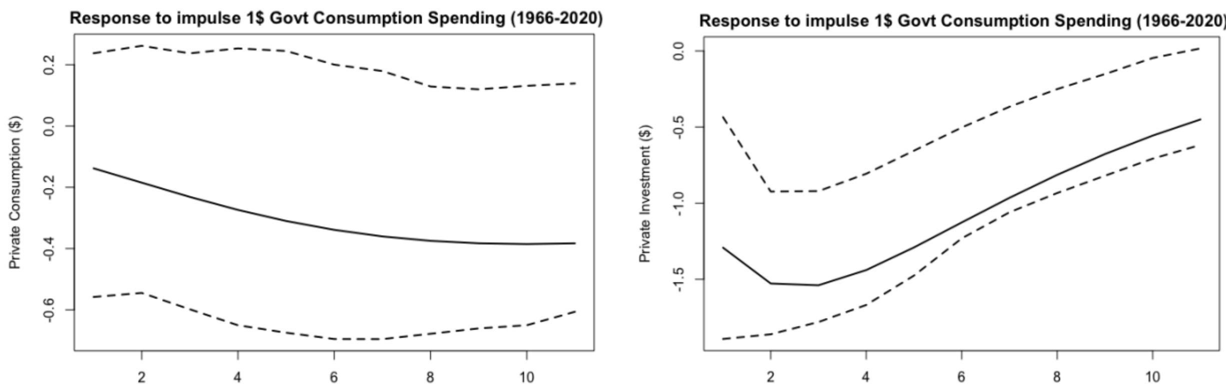
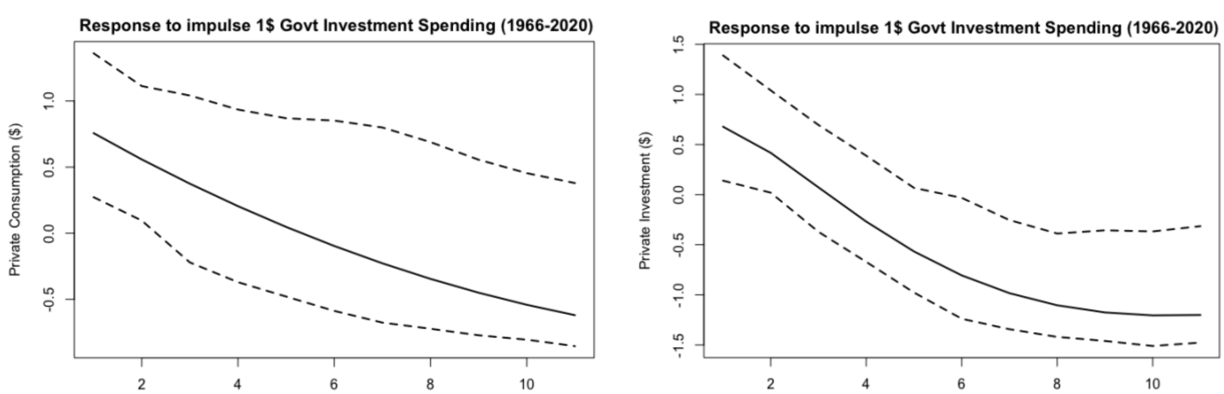


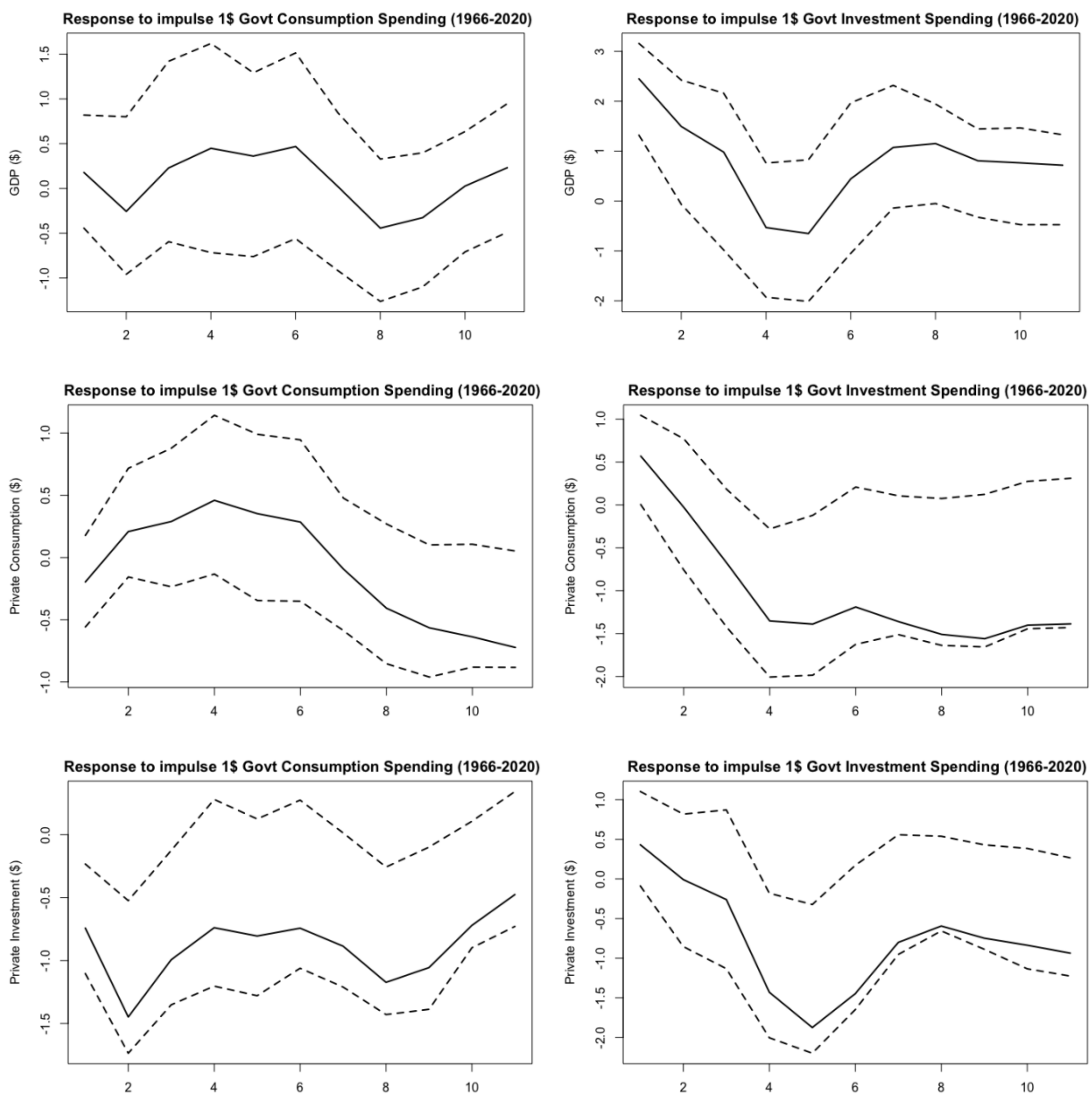
Figure-5 shows that public consumption shock crowds out private investment, but it has no significant effects on private consumption. On the other hand, public investment shock does not crowd out private consumption rather it has significant positive effects on private consumption for the first few quarters. Also, increase in government investment spending has significant positive effects on private investment in the beginning, but it starts to have significant negative effects of private investment after the six quarters. Regardless, cross effects are seen to be more active since cross 'crowding out' effect is producing smaller or negative consumption multipliers and cross 'crowding in' effect is producing larger and positive investment multipliers. (Figure-6)

Figure 6: Responses of $1 increase in government investment (90% Bootstrap CI, 1000 runs)



I choose higher number of lags in the VAR to estimate the IRFs and results remain similar (Figure-7). Cross effects are still present and producing positive and larger multiplier for government investment around the impact. However, magnitude and duration of the effects become smaller than before. Also, public investment shock crowds out private consumption and investment around fourth quarter, but it is still not enough to create any significant negative effects on GDP.

Figure 7: Responses of 1$ increases in gov spending from VAR (6) **(90% Bootstrap CI)**



I divided the recession sample from the expansion sample using the continuous recession probability criteria (F_Z>0.5). Figure-8&9 show the results from VAR (1) that both the consumption and investment spending have significantly positive and larger effects on GDP during recessions. I don't see any significant positive effects on GDP during expansions rather significant negative effects are observed. I use higher lag choices to confirm this result (Figure-10). Also, investment spending has larger effects on GDP than the consumption spending. Figure-8 shows that 1 USD increase in government investment spending adds at least 2 USD in GDP around impact whereas similar increase in government consumption spending creates at least 1 USD in GDP. With higher lag choices, 1 USD increase in government investment spending during recessions has stronger effects on GDP than that of consumption spending (Figure-10). Also, investment spending during expansion has significant positive effects on GDP around the impact (Figure-10).

Figure 8: GDP responses to \$1 impulse during recession VAR (1) (F_Z>0.5) **(90% CI)**

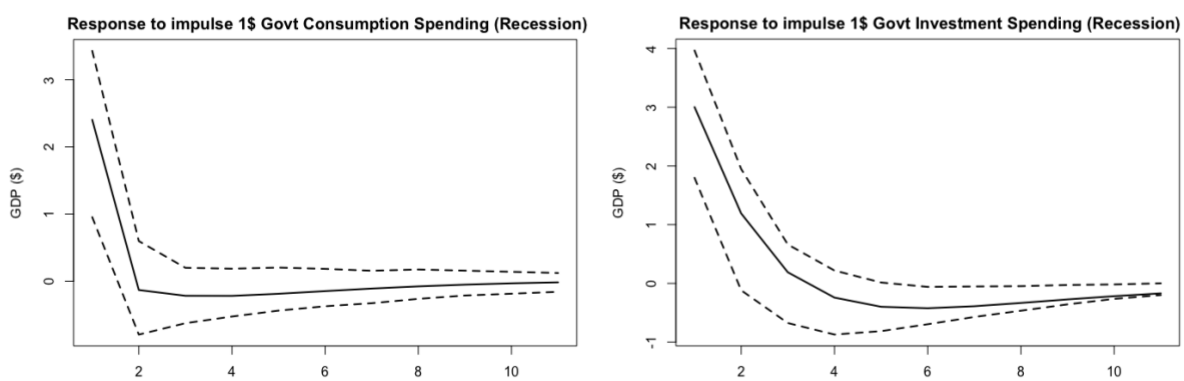


Figure 9: GDP responses to \$1 impulse during expansions VAR (1) (F_Z<0.5) **(99% CI)**

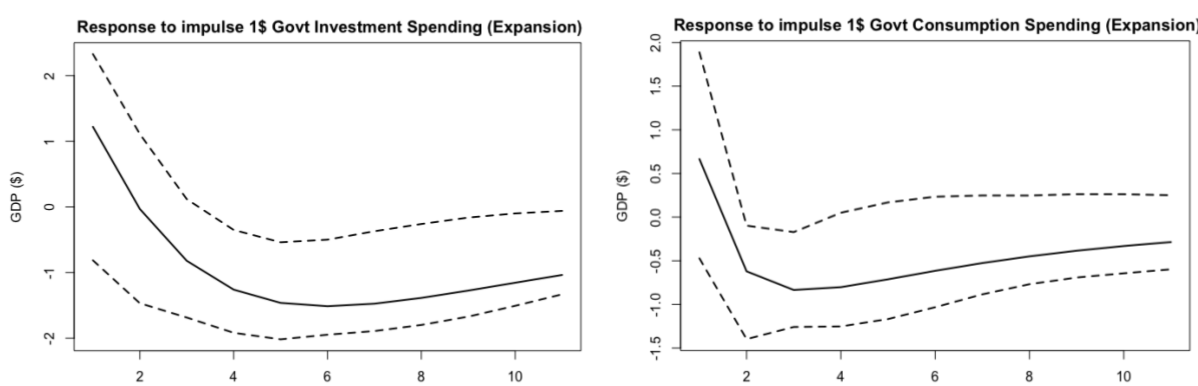
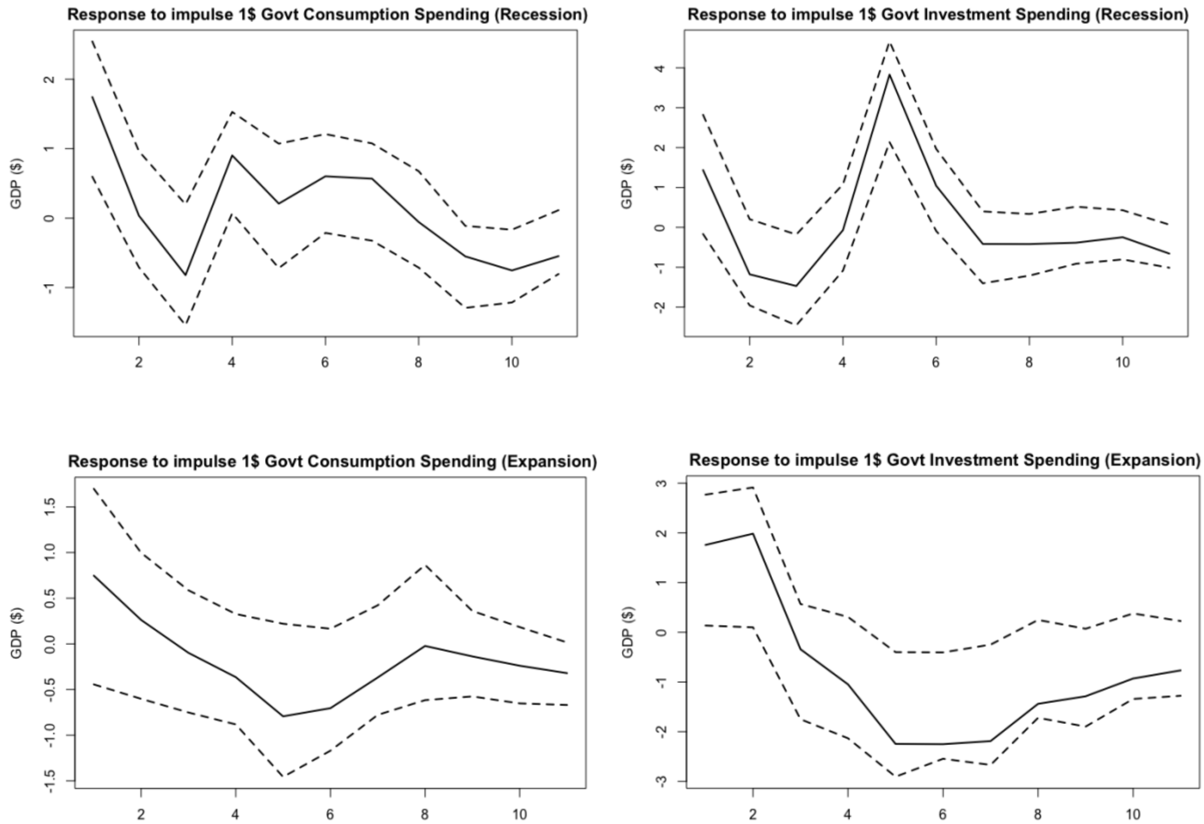
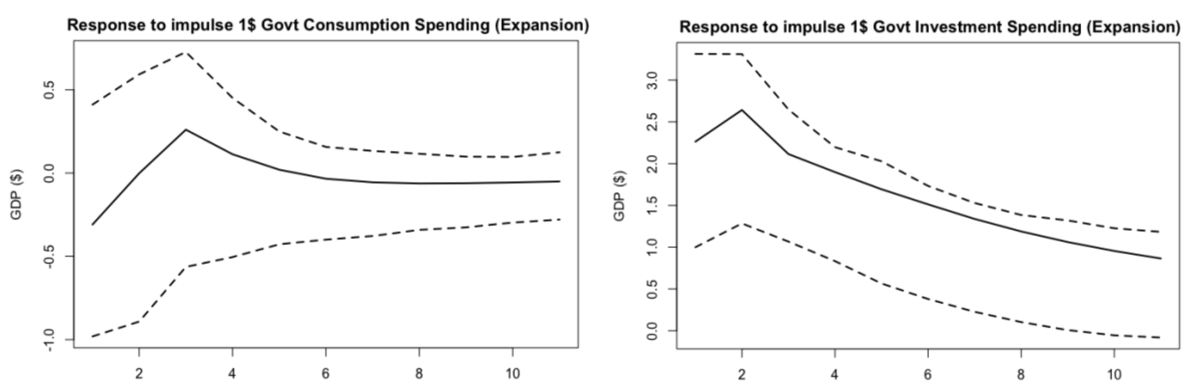


Figure 10: GDP responses to $1 impulse from VAR (4) (F_Z<0.5) (90% CI)



Results start to change when I use stricter recession criteria (F_Z>0.6) to split the sample. Positive effects on GDP during recessions become weaker and positive effects during expansions get stronger especially for the investment spending. If higher probability cut-off is used to split recession sample, it will produce smaller sample size that are more comparable to NBER announced recession dates. For example, if (F_Z> 0.8) criteria is used, it approximately includes NBER announced recession observations (Figure-3). However, impulse responses using small number of observations may not be stable. But expansion sample using the same criteria should be stable as it has more observations, and it is consistent with the NBER announcements. Figure-11 shows that investment multiplier is positive during expansion for the entire period and positive effects on GDP are found to be larger than one for the first three quarters whereas consumption multiplier is not significantly different than zero.

Figure 11: GDP responses of 1$ impulse during expansions VAR (2) (F_Z<0.8) (90% CI)



Conclusion

Using US data from 1966 to 2020, investment multipliers are found to be positive and larger than the consumption multipliers. Cross effects (both crowd out and crowd in) are more important and generating smaller multipliers for consumption. Significantly positive and prolonged effects of investment spending on GDP are seen during the expansionary periods. Surprisingly, these results are contradicting traditional theories or empirical findings from prominent literature on this topic. However, there are limitations of this research. I have used linear VAR models to estimate the effects. Parametric linear models ignore nonlinearity in the data, assumes symmetry, and are often vulnerable to misspecification. Also, I have used lagged control variables to avoid simultaneity problem in the model and contemporaneous control variables are ignored which can create omitted variable bias in the model.

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