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The Effect of Tax Policy on Economic Growth

Introduction

On December 22, 2017, President Trump signed the Tax Cut and Job Act of 2017(TCJA). This act cut the corporate income tax from 35% to 21%, and lowered most individual income tax rates, including the top marginal rate from 39.6% to 37%. Trump stated that the decrease of tax rate would draw more investment back to the U.S. and increase the tax base. It will ensure the government tax revenue while boosting the U.S. economy. However, the joint committee of taxation predicted that the tax cut would only increase U.S. annual growth rate by roughly 0.08 percent. This research focus on developing model to examine the effect of tax revenue on economic growth.

This research includes two analysis on the how tax policy affects economic growth. First, the first method employs a time-series linear regression on real GDP and uses policy dummy variables to detect the effects of those policy. Then it also uses Bai-Perron test to examine whether there is a structural break for each time there is a tax policy change. Second, I used the Structural Vector Autoregression Model to estimate the effects of personal and corporate income tax on real GDP. The model included the 5 benchmark variables (GDP, interest rate, price level, government spending, tax revenue). Through the impulse function, the research would gave analysis on how two targeted variable affects economic growth.

The first section of this research shows that, among the five major tax policy tested, Reagan Tax Cut of 1981, Tax Reduction Act of 1975(temporary) and Trump's recent Tax Cut and Job Act are significant in predicting the real GDP changes. All of these three policies shows a positive influence on real GDP. Furthermore, there are structural breaks presented in real GDP data, but none of them corresponds to tax policy changes. The result indicates that tax policy does not perform a structural changes in how the independent variables in the time-series analysis impacting the real GDP.

Results from the second section does not produce significant results for the effects of corporate income tax and personal income on economic growth. Corporate income tax shock has a short term negative influence on real GDP, but becomes not significantly different from zero after the third quarter. Personal Income tax revenue does not show a significant effects on the economy.

Literature Review

Model

Structural Break

In order to determine whether a policy had significant structural influence on the current trend of GDP, we need to detect whether there is a structural break before and after the enactment of this policy. In other terms, whether there is a significant change in the coefficient or a portion of the coefficient of the independent variable before and after specific dates.

Chow developed a method to detect whether a known exogenous break date would give a structural break based on F-statistics(Chow 1960). Quandt then used the chow test to iterate on all possible break points and enabled detection of structural break even without a known breakpoint by finding the maximum Chow statistics (Quandt 1960). Quandt's method was computationally burdensome and not widely used as the limiting distribution of the test statistic was unknown, until Andrews and Ploberg later advanced the method with an applicable distribution for the test-statistic (Andrews & Ploberg 1994). However, a critique for the previous tests is that they ignore other possible breakpoints that are within data timeframe. Two methods were invented to solve this problem and to detect multiple structural breaks: the joint testing method and the sequential method. The joint testing method would iterate all possible breakpoint options based on the number of breaks, thus when testing for more than 2 breaks, the run time for joint method would be so large and infeasible. However, Bai and Perron's sequential method, based on dynamic programming, is able to detect multiple structural break with unknown break dates, as they separate the sample into subsamples each time the algorithm finds a breakpoint(Bai & Perron 1998, 2003).

Before Bai & Perron's method, researchers could test for multiple structural breaks by trimming the data into different subsamples and then perform the chow test for structural breaks. However, the breakpoints might have potential endogeneity problem. Bai-Perron test successfully solved this problem as it finds the breakpoints sequentially between the selected test dates. Bai-Perron test also has a much efficient run time than other methods, thus this research uses Bai-Perron test for multiple structural breaks.

Structural Vector Autoregression Model

In previous literatures, there are typically four different approaches researchers used VAR model for analyzing fiscal policies, a narrative approach, a sign-restriction on impulse function approach, a mathematical approach (Choleski), and an exploiting decision lags approach. As explored by Perotti(2002), each approach has its distinct advantages and limitation.

The first approach based on the use of dummy variable to construct a narrative of how an exogenous shock affects macroeconomics. For example, Ramey and Shapiro(1998) uses the narrative approach to identify shocks in government spending. They used events, such as the Korean War, Vietnam War, the Carter-Reagan Buildup or 911, that were exogenous to the economy, to model the change in government spending. They found that the increase of government spending would actually decrease consumption and real wages using SVAR model. Burnside, Eichenbaum and Fisher (2004) also adopted this technique and analyzed the response of working hours and real wages to fiscal policy shocks in the U.S. They used military purchase as the exogenous changes and concluded that an increase in government purchase and personal and capital income tax would rise aggregate working hours and reduce real wages.

The second approach impose restrictions on impulse functions instead of restrictions on the variance in reduced form VAR models. This model was traditionally used in monetary policy analysis (Faust, 1998). Mountford and Uhlig (2002) applied this method into fiscal policy. They used sign restrictions to identify a government revenue shock as well as a government spending shock, while controlling for a generic business cycle shock and a monetary policy shock. With this approach, they identified three scenarios where deficit-financed tax cuts promote economic growth.

Another approach focused on a mathematical ways to find recursive ordering using the Choleski factors. Fata and Mihov(2001) used this method to conclude government spending would lead to strong and persistent increases in consumption and employment. However, because it is only a mathematically of solving the recursive ordering by have the upper side of the matrix to be zero. It would add implicit restrictions when applying to actual economics models.

The last approach is the structural VAR model pioneered by Blanchard and Perotti(2002). They focused on exploiting decision lags in fiscal policy and institutional information about the elasticity of variables to economic activities. Blanchard and Perotti(2002) expanded on this method further and found the effects of fiscal policy on economic growth has became smaller in the past years. Arin (2005) also expanded on the same model to explore effects of defense spending , government expenditure and tax revenue on economic growth. Auerbach and Gorodnichenko (2012) also used this method to analyze the size of fiscal multipliers when the economy is in recession.

Effects of Tax on Economy: Other Models

Previous researches have conflicting results on the effects of tax structure on economic growth. Yongzheng Liu and Jorge Martinez-Vazquez researched on the growth-inequality tradeoff based on tax structure and found that income tax led to growth while corporate tax jeopardized it (2015), which contradicts with Lighter and Zhang's finding that raising corporate tax increase GDP the most, whereas increase individual income harms the economy(2015). Akgun, Cournede, and Fournier showed that reducing corporate tax and personal income tax while raising recurrent property and consumption tax could boost GDP growth(2017). Their study echos with Galindo and Pombo's study and Blochliger's study that taxes on corporate or personal income reduce incentives to raise supply; whereas property tax have no disincentive effects (Galindo 2011, Blochliger 2015).

Data

This research uses data from 1960 first quarter to 2018 forth quarter. The research included quarterly data instead of annual data with the assumption that fiscal policy can be adjusted in response to unexpected changes within the year (Blanchard & Perotti ,2002). The data started from 1960 to exclude spike changes in tax revenue resulting from a after war insurance benefit payment from National Service Life to veterans and also the unusual changes in government expenditure during the Korean War (1951-1952).

The data are obtain through two different sources. From the Federal Reserve Economic Data (Fred St.Louis), we obtain data for real GDP, nominal GDP, 3-month Treasury Bill, private investment and CPI index. The GDP deflator is calculated by dividing nominal GDP by real GDP. The other source is Bureau of Economic Analysis, in which I obtained the data for personal and corporate income tax revenue, government expenditure. The CPI index, personal and corporate income tax revenue, investment and government expenditure are all deflated with the GDP deflator to control for inflation. The first section of this research only uses the real GDP data collected, and the second section of this research uses all the data presented.

Section 1 — Structural Break

Method

In this section, the research focuses on detecting structural breaks and also test whether each tax policy has affected the growth of real GDP. Between the timeframe of the data (from

1960Q1 to 2018Q4), there were 4 major tax policies enacted, including Kennedy Tax Reduction Act of 1964(Q2), Tax Reduction Act of 1975(Q2)[temporary], Reagan Tax Cut of 1981 (Q4) and 1986 (1987Q1), and Trump's tax cut in 2017(Q4). If the policy changes have significantly affect the growth rate afterwards, we would expected to see multiple structural breaks. In order to control for the potential endogeneity between each breakpoint, I use the Bai-Perron Test to conduct the research.

First, I constructed a time-series linear regression for real GDP data. Because the model focus on the finding the change in mean, I regress the real GDP data on a constant, a lag, and also a trend. I also create dummy variables for four tax policies changes to check their influence on the trend. Furthermore, I include seasonal dummies to check for seasonality. Because this model allow for serial correlation in the error terms, we specify a quadratic spectral kernel based on HAC covariance estimation using prewritten residuals. The kernel bandwidth would be determined automatically by the Andrews AR(1) method. I select the maximum number of 5 breaks for the data as it is the maximum selection option in Eviews. Then, I conduct the multiple breakpoint tests based on the global information criteria, and also the sequential determined method.

The global optimization procedures aims for identifying the number of multiple breaks and their associated coefficient to minimize the sums-of-squared residuals of the regression model. The detailed procedures for the method are as following. With a pre-specify a maximum number of breakpoint, it first test for the optimal number of breakpoints by finding the number of breakpoints, *m*, that minimize the specified information criteria. Then, it finds the *m* breakpoints sequentially. It begin with the full sample and then perform a test of parameter constancy with unknown break. After finding the first break, it then test for structural breakpoints in breakpoint tests in each subsamples and add breakpoint when the null for non break is rejected. The test then repeat the procedure until it finds *m* breakpoints. The sequential method started like the sequential process in global information method, and then perform a reduction.

Result & Discussion

The statistics for the linear regression of real GDP with a constant, a lag and a trend is shown in Table 1.

Variable	Coefficient	P-value
c	52.07099	0.0011
RGDP(-1)	0.991312	0.0000
Trend	0.839203	0.0699

Table 1: Linear Regression Coefficient

As shown in the table, the lag is significant at 5% level, and trend variable is significant at 10% level. The R-square equals 0.999775, indicating a very good fit for the model. I also regress the model with seasonal dummies. None of the variables were significant, which indicates that this series does not suffer from seasonality. Last, I added policy dummies for the tax changes. Because Tax Reduction Act of 1975 was temporary, I only code the time period affected with 1. The result is shown in Table 2. Reagan Tax Cut of 1981, Tax Reduction Act of 1975 and Trump's recent Tax Cut and Job Act are significant in predicting the real GDP changes. All of these three policies shows a positive influence on real GDP.

Variable	Coefficient	P-Value
Kennedy Tax Reduction Act (1964)	2.967557	0.8495
Tax Reduction Act (1975)[temporary]	33.20466	0.0157
Reagan Tax Cut of 1981	57.56635	0.0287
Reagan Tax Cut of 1986	-5.689579	0.7946
Trump's TCJA in 2017	33.20466	0.0137

Table 2: Tax Policies' Effect on Economic Growth

The results for the multiple breakpoints test for real GDP are shown in Table 3. Both the Schwarz criterion and LWZ criterion indicates that there would be 2 breakpoints. The estimated breakpoints are 1996Q2 and 2008Q4.

Name	# of Breaks	Break dates
Global Information Criteria - BIC	2	1996Q2, 2008Q4
Global Information Criteria - LWZ	2	1996Q2, 2008Q4
Sequential Method	2	1996Q2, 2008Q4

Table 3: Results of Multiple Breakpoint Tests

According to Table 3, none of tax policy changes date seems to correspond to the structural breakpoints identified by multiple break point tests. It means that none of the tax policy changes how the independent variables affect real GDP. Two of the policy dummies are significant indicating that the policy itself might have a positive effect on real GDP after enacted.

A potential problem of this test is that Breusch-Godfrey test indicates the model suffers from serial correlation. The serial correlation problem might potentially result in higher number of structural breaks estimated by the LWZ and Schwarz criterion in the Global Information Criterion method.

The next section of this research focuses on detecting how changes of corporate income tax revenue and personal income tax revenue affect economic growth. As shown in this section, the real GDP variable does have structural breaks over the desired timeframe. Other variables, such as corporate income tax revenue and personal income tax revenue, that are used in Section Two always appears to have structural breaks after the Bai-Perron test.

Thus, the research would uses Structural Vector Autoregressive Model to find the corresponding relationship. The unit root analysis for each variables and their adjustment for the SVAR model will also be presented in the next section.

Section 2 — Structural Vector Autoregression Model

Method

Independent Variable Measuring Tax

The aim for this research is to analyze the effects of tax changes on economic growth. The three current types of data that researchers use to measure tax are stationary tax rate, nominal tax revenue and real tax revenue(adjusted for inflation). Although stationary tax rate and nominal tax revenue are easy to acquire and use, it does not fully captures economic conditions of each year. It also would miss many other factors that would affects the research outcome. Thus, this research choose to use real tax revenue as one of our independent variable.

Why Structural Vector Autoregression Model

The challenges for real tax revenue, however, is that it would be affected by the economic condition of the year, and thus would cause problem of simultaneity with other variables such as real GDP. Thus, we choose to use the Vector Autoregression (VAR) include to the endogenous effects of our targeted variables to each other. As proven in the first section that there is structural break in our real GDP variable and also a few other variables. Thus, I choose to implement the Structural VAR model and use the impulse-response function to analyze how economy reacts to different tax policies.

Furthermore, Structural VAR model is very suitable for conducting fiscal policy analysis. First, output stabilization is rarely a predominant reason explaining changes in fiscal policy; therefore, we can assume there are exogenous fiscal shocks. Second, decision and implementation lags in fiscal policy imply that there is little response of fiscal policy to unexpected movement in economic activity. Thus, one can construct estimates of effects of unexpected movements in activity on fiscal variables and obtain the estimates of fiscal policy shocks (Blanchard & Quah, 2002).

Procedure

1. *Specify the Model Variable*

This research uses the commonly used 5 benchmark criteria based on the Keynesian model to capture the changes in economic growth (GDP). Thus, it includes variables on GDP, interest rate, price level, tax revenue, and government expenditure. The interest rate is included to account for monetary shocks.

2. Test For Stationarity

First, I performed Augmented Dickey Fuller test for all the five variables. Then, we found that all the variables are non-stationary at its original state. All five variables, however, are stationary at first difference, with real GDP being stationary of first difference with trend. As a result, this research would use the difference of each variable in the model. Furthermore, because all variables are integrated for order one, the pre-condition for conducting a VAR model is satisfied. The five variables are also traditionally assumed to be affecting each other, the condition that all variables are endogenous is also fulfilled.

3. Use Schwarz Information Criterion (BIC) To Determine Lag Length

I constructed an unrestricted VAR and found that based on the BIC statistics, including lag till order one is optimal. The intuition of this test is to find a balance between parsimony with the reduction sum of square. Thus, avoiding curse of dimensionality.

4. Estimate Reduced Form VAR Model

I then estimate the basic VAR model using lag 1 on each variable, and then use Wald Test to test for joint significance of the variables, such as whether the two lags for GDP is jointly significant for personal income tax revenue.

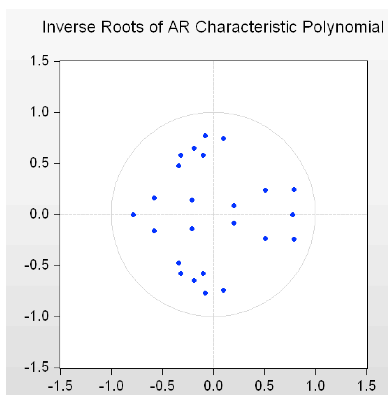
5. Perform Diagnosis tests

I performed the test for autocorrelation LM test to see whether it suffers from serial correlation. It shows that except for lag length 1, the data does not suffer from serial correlation.

VAR Residual Serial Correlation Test

Lag	Probability
1	0.0122
2	0.4247
3	0.7925
4	0.8139

I also checked the stability of the model. As shown in the graph, all the roots lied inside the circle, which means the estimated VAR model is stationary. Otherwise, the impulse response standard error would not be valid.



6. Structural Identification / Add Restriction

For the structural identification, I imposed the long run restriction as suggested in Blanchard & Quah(2002) and (Arin & Koray 2005). Structural identification interprets historically observed variation in data in a way that allows the variation to be used to predict.

7. Use Impulse Function to Model the Effects

Next, I performed the variance decomposition, and then used the impulse functions to capture the effects of shocks to each variables.

Result & Discussion

The IRFs of all model variables to a one-standard deviation shock to real personal income tax, corporate income tax, and real government expenditure are included in Figures 1-3. The solid blue lines indicate the point estimates, and the red lines shows the one standard deviation bands.

Figure 1 presents the IRFs of interest rate, real GDP, real corporate income tax, real persona income tax, price level and real government expenditure to a positive innovation in corporate income tax. The response of GDP is negative before quarter 2 and positive afterwards. However, it is not significantly different from zero after quarter 2, which means it only have a negative influence on GDP in the short term. The response of Corporate income tax is positive and significantly different from zero for some of the first few quarters, but not significantly different from zero for the other parts, which means the innovation is not permanent. The response of price level and government is not significantly different from zero. The response of personal income tax is negative and significant at the first quarter and positive and significant in quarter 5-6, and 7-9, which means corporate income tax would have a negative influence on personal income tax revenue at first, and then it would have a positive influence then no influence. The response of interest rate indicates that increase of corporate income tax would have a negative influence on interest rate only in the short term.

Figure 2 presents the IRFs of interest rate, real GDP, real corporate income tax, real persona income tax, price level and real government expenditure to a positive innovation in personal income tax. Based on this figure, the response of GDP, price level, and government expenditure is not significant. The response of real corporate income tax is positive at first and then become not significant. The response function of interest rate is only significant for a few quarters , and it is positively influenced by increase of personal income tax. The response of personal income tax is not significant, thus the innovation is not permanent.

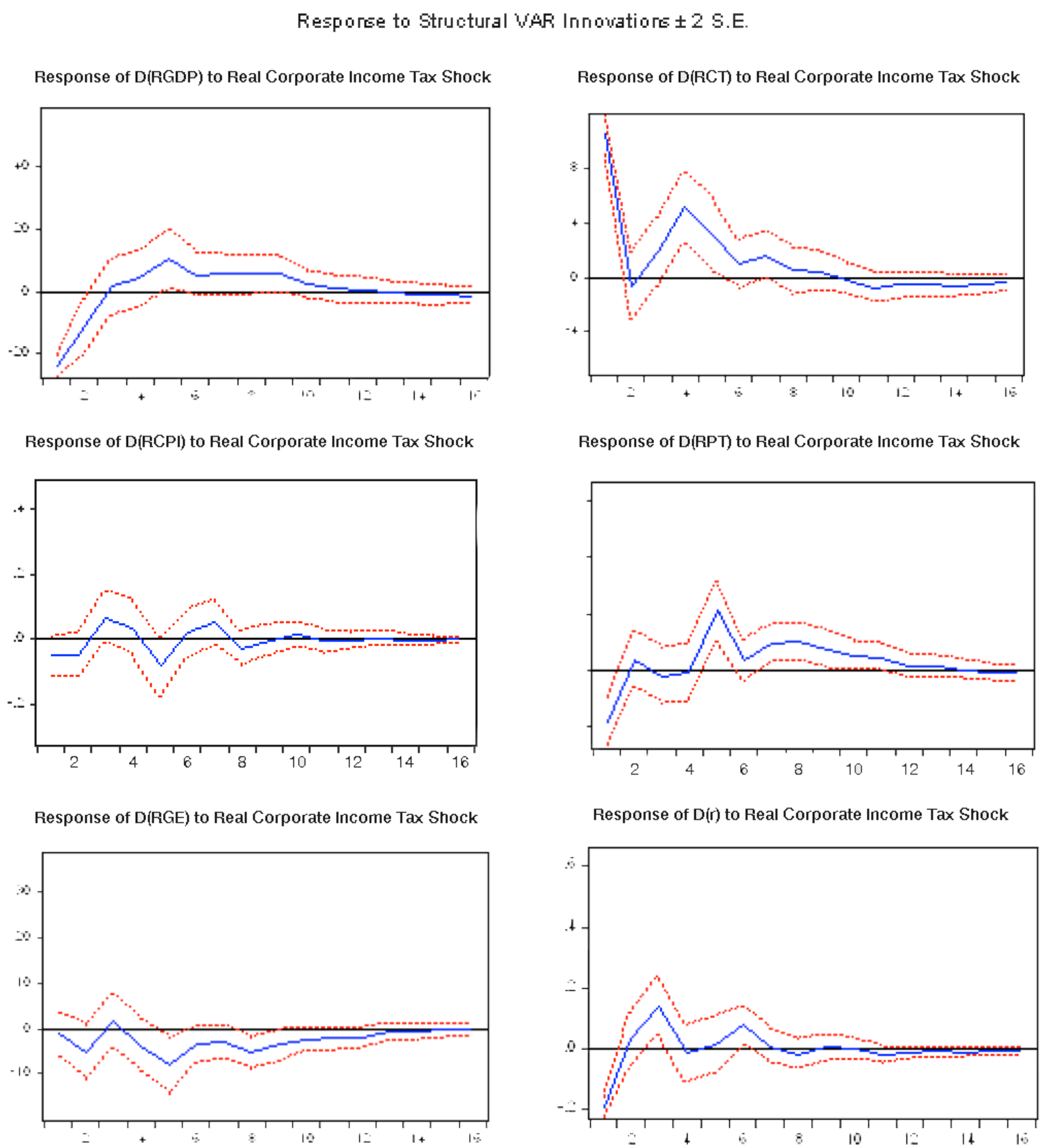
Figure 3 presents the IRFs of interest rate, real GDP, real corporate income tax, real persona income tax, price level and real government expenditure to a positive innovation in government expenditure. The response of GDP is positive and significant at first, and then become insignificant in the longer run. That means that increase of government expenditure would have positive influence on GDP only in the short term. The response corporate income tax is also only significant at the first quarter. The response of price level is positive at first and then become negative. The response of government expenditure is not always significantly different from zero which means the innovation is not permanent.

Conclusion

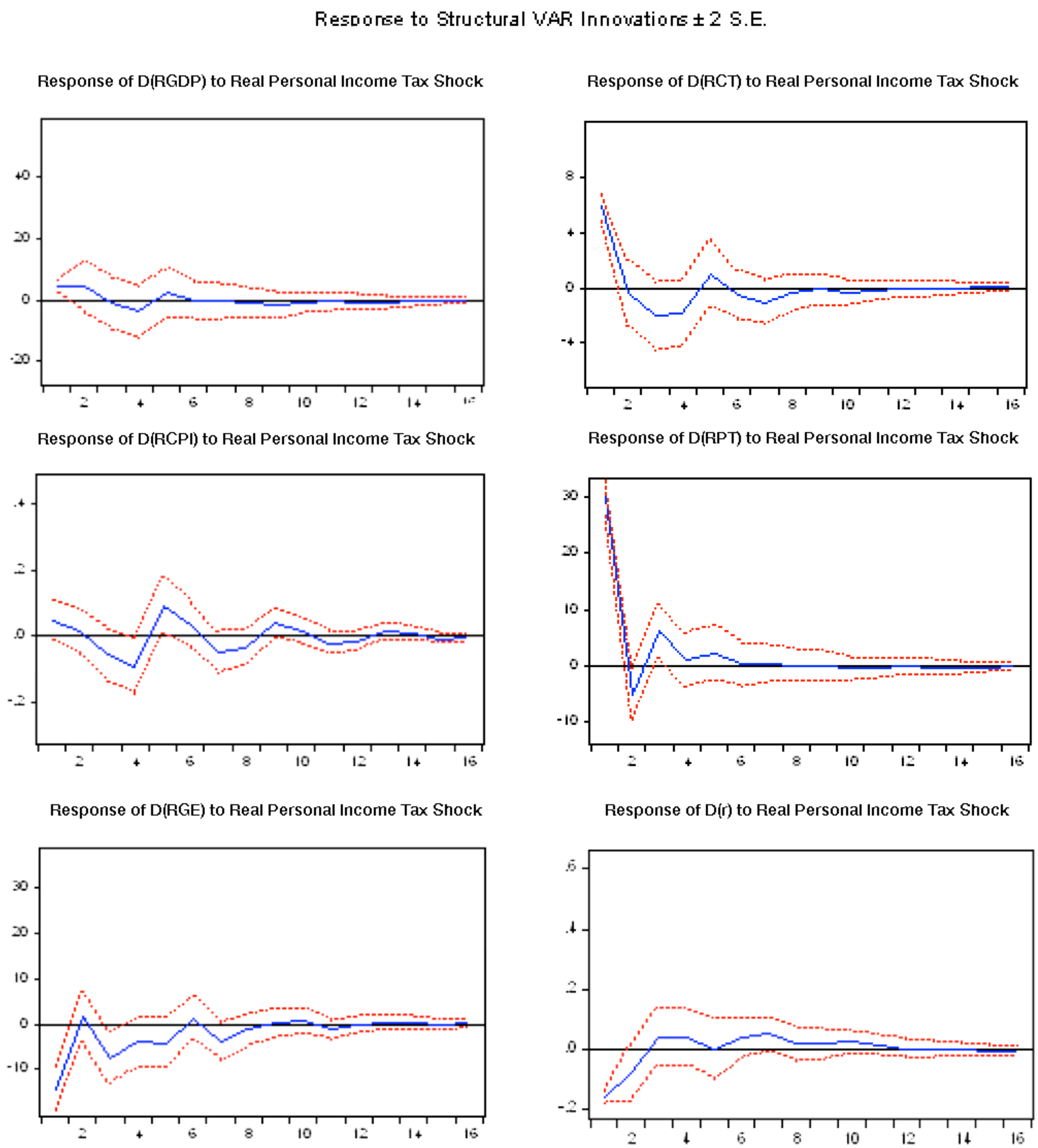
The first section of this research concludes that, among the five major tax policy tested, Reagan Tax Cut of 1981, Tax Reduction Act of 1975(temporary) and Trump's recent Tax Cut and Job Act did have positive influence on economic growth. However, tax policies does not perform a structural changes for GDP, which means it does not change how other variables affect GDP. The results from the second section shows that corporate income tax shock only has a short term negative influence on real GDP, but becomes not significantly different from zero after the third quarter. Personal Income tax revenue does not show a significant effects on the economy.

Graph and Tables

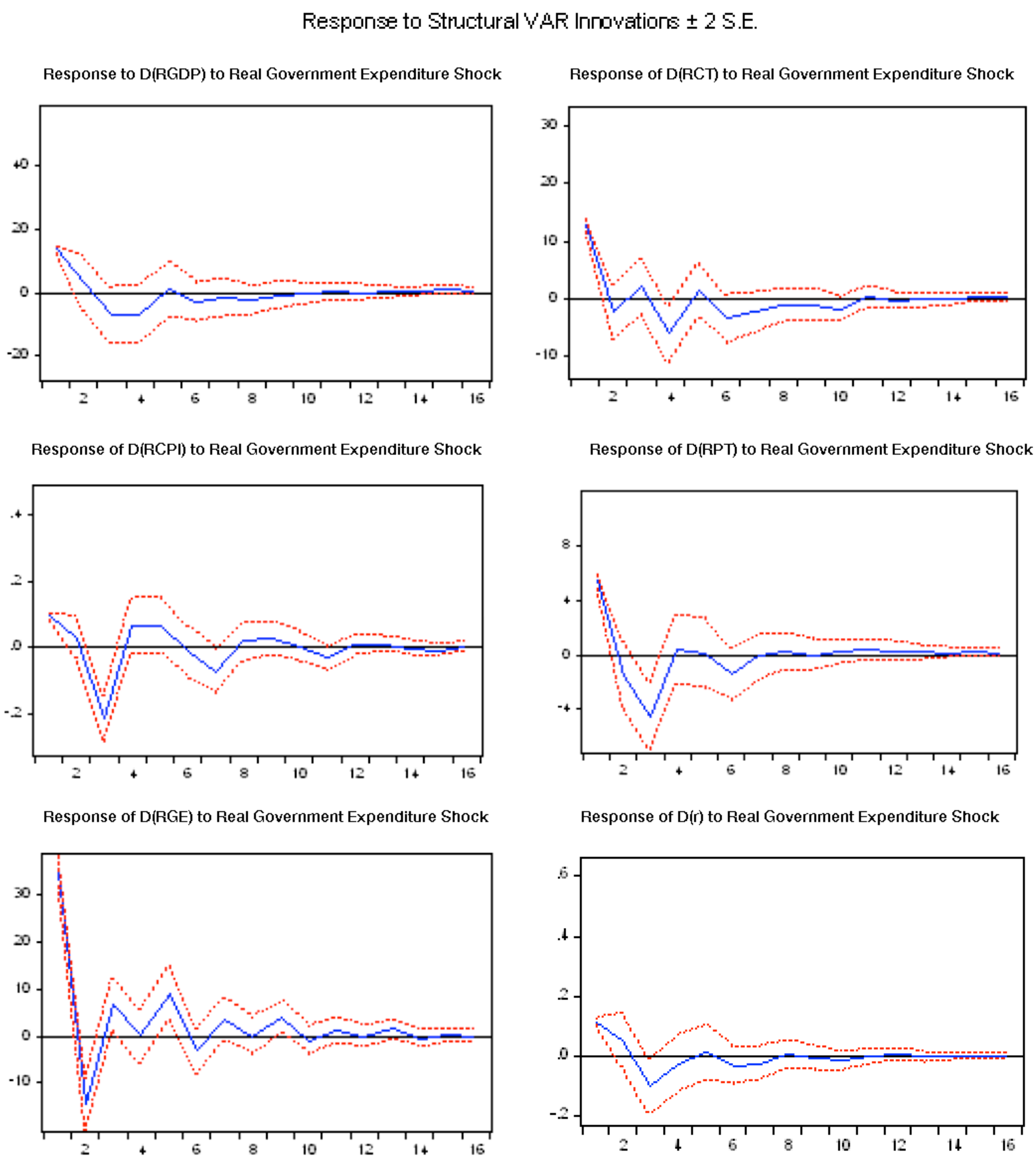
Real Corporate Income Tax (Figure 1)



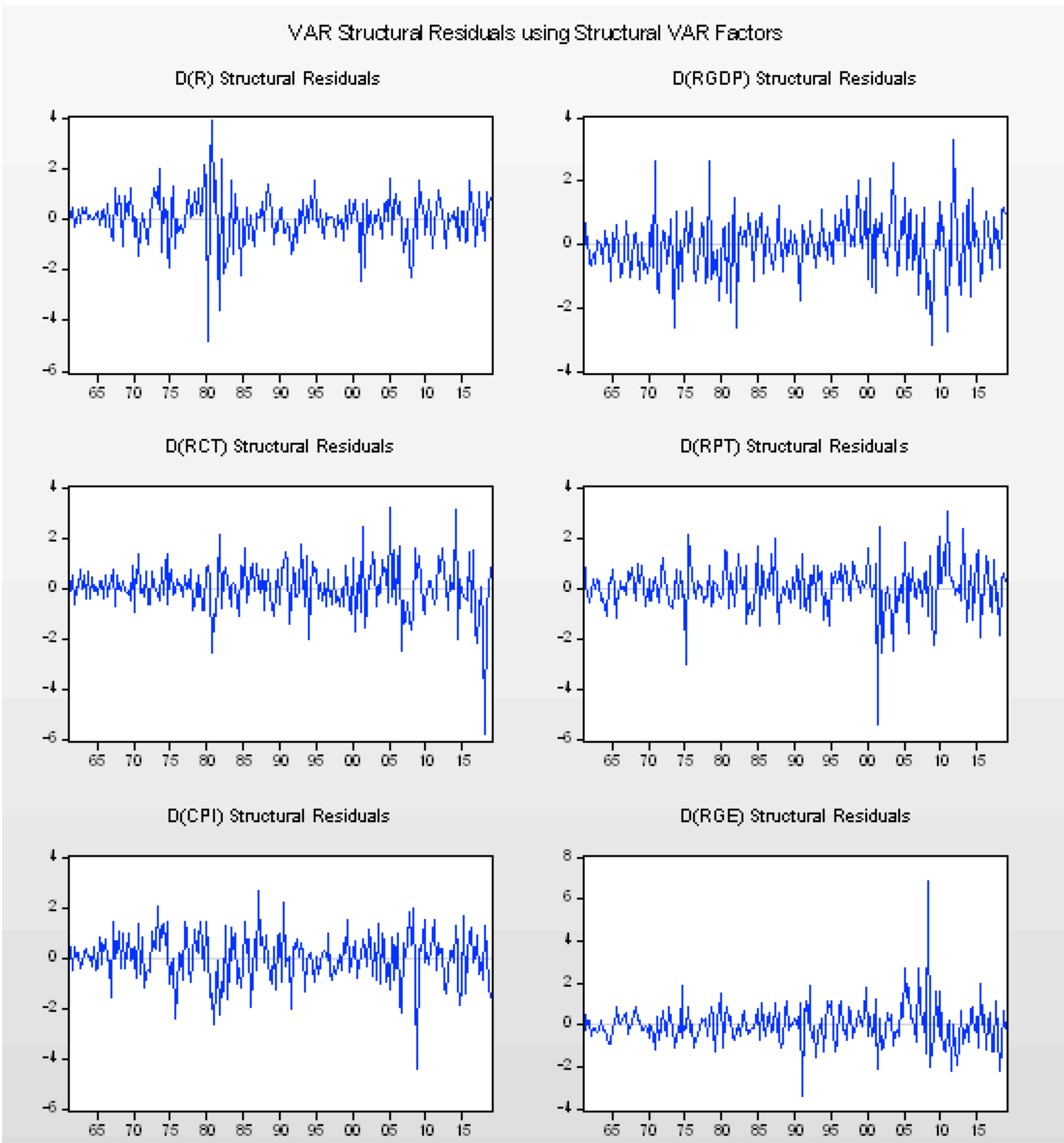
Real Personal Income Tax (Figure 3)



Real Government Expenditure (Figure 1) [1-r; 2-gdp, 3-corpT, 4-persT, 5-CPI, 6-GovtExp]



Residuals


VAR Structural Residuals using Structural VAR Factors
D(R) Structural Residuals
D(RGDP) Structural Residuals
D(RCT) Structural Residuals
D(RPT) Structural Residuals
D(CPI) Structural Residuals
D(RGE) Structural Residuals

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