Parameter Instability, Expectations, Exogenous Fiscal Shocks, and the Relationship between Taxes and Government Spending

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Abstract

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This dissertation focuses on the US government spending and taxes relationship. Chapter 2 considers the empirical relationship of taxes and spending using Granger causality test robust to parameter instability. The results show that revenues cause expenditures and expenditures cause revenues, as the fiscal synchronization suggests, only after taking into account parameter instability, using Rossi's (2005) test. Chapter 3 considers impulse response functions to see whether decreases in newly and already legislated taxes decrease government spending, as the "starve the beast" hypothesis suggests. Results show that these two shocks affect government spending in different ways. News about future tax cuts decrease government spending before these cuts are implemented, supporting the "starve the beast" hypothesis. Likewise, newly legislated tax cuts create a fiscal illusion, leading voters to demand higher government spending. Finally, Chapter 4 examines the behavior of the average tax rates following the present value of government war spending changes. Using impulse response functions, the point estimates suggest that a spending increase of 1% of GDP increases the average tax rate 0.2% on average, supporting the tax smoothing idea.

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DEDICATION

to my dear wife, Flor Karina and

to my two lovely daughters, Ana Paula and Ema Sofia

Chapter 1

INTRODUCTION

The empirical relationship between government expenditures and revenues is key to comprehending the future path of the budget deficit and to understand how policymakers make spending and tax decisions. Nowadays, the debate of this empirical relationship has reemerged mainly in response to the growing concern over the increase in government deficit and debt in the US and most developed countries. According to the International Monetary Fund (IMF)[1], the Major Advanced[2] Economies' government deficit averaged 7.14% of GDP in the last four years. Moreover, the last US debt ceiling debate has also emphasized the importance of the relationship between government spending and taxes in decreasing the fiscal deficit.

In the public finance literature, there are different theories that explain how spending and revenues are related. First, Friedman (1967) and Buchanan and Wagner (1977) argue that governments make tax decisions first and then adjust government spending according to those tax changes. Specifically, Friedman (1967) explains that the most effective way to reduce the size of the government is to "starve the beast" by reducing taxes. Buchanan and Wagner (1977) argue that decreases in tax revenues lead to increases in government spending through a "fiscal illusion". They argue that individuals demand higher government spending whenever the government lowers the price of those spendings, taxes. That is, individuals do not have a full knowledge of the government budget and these individuals do not associate higher government spending with higher taxes needed to meet the government constraint. Barro (1979) argues that the path of government expenditure is taken to be exogenously given, and taxes are adjusted to minimize distortions while the budget is balanced intertemporally. Musgrave (1966) argues that revenues and expenditure

[1]World Economic Outlook, October 2014.

[2]The countries included are: Canada, France, Germany, Italy, Japan, United Kingdom, and United States.

decisions are made simultaneously while Wilddavsky (1988) recognizes that the allocation of government expenditures are independent from the decision on taxation.

The empirical studies that look at the US spending and revenues relationship have produced a variety of results supporting one of the previous theories using mostly a Vector Autoregression (VAR) model and the concept of Granger-causality. Examples of these studies include Anderson, Wallace and Warner (1986), Furstenberg, Green and Jeong (1986), Ram (1988), Islam (2001), Auerbach (2000, 2003), Ewing, Payne, Thompson and Al-Zoubi (2006) and Young (2008). However, these previous studies have not paid attention to three important issues. First, these studies have ignored the presence of parameter instability in the government spending and taxes relationship. Most of this empirical literature uses a long span of the variables and has not put attention to the presence of parameter instability. In fact, data covering a long time span are susceptible to structural breaks. Stock and Watson (1996) find strong evidence that parameter instability is a persistent fact in the empirical relationship of time series data.

In Chapter 2, I consider Rossi's (2005) test that is robust to parameters instability with an unknown break in order to deal with this issue. This test jointly tests for both parameter instability with an unknown break point and Granger-causality. This technique also has the advantage of using the full sample data instead of using different subsample data for before and after the break period. First, using Andrews' (1993) stability test with an unknown break point, I find strong evidence of parameter instability in the tax and spending relationship around the late 1990's and early 2000's, which is consistent with the graphical evidence. These results may be explained by the PAYGO regime enacted by the Budget Enforcement Act of 1990 that compels new spending or tax changes not to add to the federal deficit. The results for traditional Granger-causality tests, ignoring parameter instabilities, find evidence of unidirectional causality from expenditures to revenues; however, I find strong evidence of bidirectional causality between revenues and expenditures after, and only after, controlling for the instabilities. This result provides support to the idea that the revenues and spending decision are determined simultaneously.

Second, past studies have not paid attention to expectational effects of tax changes and spending. According to economic theory, individuals make their decisions based on current and future information. That is, policymakers should make policy decisions whenever they have new information about changes in taxes and spending and not wait until these changes actually occur. Third, these previous studies have used impulse response functions based on shocks associated with aggregate government spending and revenues that are not exogenous given and do depend on the state of the economy. Therefore, the results based on these shocks may be plagued by issues of endogeneity. In Chapters 3 and 4, I look at the government spending and taxes relationship using exogenous tax changes and government spending changes that do not depend on the state of the economy. Specifically, in Chapter 3, I estimate the impact of exogenous tax shocks on government expenditure using newly and already legislated tax changes proposed by Mertens and Ravn (2009). I find empirical support in favor of the "starve the beast" hypothesis before the legislations are implemented. An already legislated tax cut is associated with pre-implementation drops in government spending. The cumulative impact of an already legislated tax cut of 1% of GDP decrease spending by around 5% 4 quarters after the tax changes are pre-announced. Likewise, a newly legislated tax cut increases government spending in all of the quarters. The point estimates of a tax cut of 1% of GDP suggest an increase of government expenditure of around 2% after 12 quarters. This result finds evidence of the fiscal illusion idea.

In Chapter 4, I test the tax smoothing hypothesis using Ramey's (2009) spending news shocks. Ramey's (2009) spending shock measures the expected discounted value of future government spending due to foreign political events. This is the type of spending that affects the tax rates according to Barro's (1979) tax smoothing idea. The results show that there is a positive link between government war spending shocks and the average tax rates. An increase in government spending increases the average tax rate. The point estimates associated with the cumulative impulse response function are always significant at a 90% of confidence. These point estimates suggest that a spending increase of 1% of GDP increases the average tax rate 0.2% on average, suggesting a tax smoothing effect. The results seems to be quite robust to different tests.

Chapter 2

CAUSATION, SPENDING AND REVENUES: SOME EVIDENCE ROBUST TO PARAMETER INSTABILITY

2.1 Introduction

The empirical relationship between government expenditures and revenues is fundamental to understand the course of the budget deficit. Nowadays, the debate of this empirical relationship has reemerged mainly in response to the growing concern over the increase in government deficit and debt in developed countries. According to the International Monetary Fund (IMF)[1], the fiscal deficit for the Advanced[2] Economies averaged 7.14% of GDP in the last four years. Moreover, US debt[3] ceiling debate during 2013 also emphasized the importance of the relationship of government receipts and spending in decreasing the fiscal deficit. Congressional Republicans, using the debt limit vote, proposed significant cuts in federal spending to reduce annual government deficits. The discussion ended with an increase of the debt ceiling and a reduction on future government spending.

In the public finance literature, there are different theories that explain how spending and revenues are related. First, Friedman (1967) and Buchanan and Wagner (1977) argue that government makes revenue decisions first which leads to future government spending changes (revenues cause spending). Barro (1979) argues that the path of government expenditure is taken to be exogenously given, and the taxes are adjusted to minimize distortions while the budget is balanced intertemporally (spending cause revenues). Musgrave (1966) argues that revenues and expenditure decisions are made simultaneously (the case of mutual causation) while Wilddavsky (1988) recognizes that the allocation of government expenditures are

[1] World Economic Outlook, October 2014.

[2] The countries included are: Canada, France, Germany, Italy, Japan, United Kingdom, and United States.

[3] Before that debate, the debt ceiling stood at 14.3 trillion and represented the maximum amount of money the federal government was authorized to borrow in order to pay off its expenses.

independent from tax decisions (the case of no causal linking).

The empirical literature on the evidence of the government revenues and spending to support any of the previous theories has produced a range of results, due in part to differing methodological approaches, model specification and the time periods examined. The most common approach used within the Public Finance literature is some variation of the spending on lagged revenues and revenues on lagged expenditure or both using a Vector Autoregression (VAR) model and the concept of Granger-causality; examples of this approach include Anderson, Wallace and Warner (1986), Furstenberg, Green, Jeong (1986), Ram (1988) and Islam (2001). More recent studies with a sophisticated versions of this methodology include Auerbach (2000, 2003) and Ewing, Payne, Thompson and Al-Zoubi (2006)[4]. Auerbach (2000) analyzes the formation of the fiscal policy over the past twenty five years for the US economy, centering his analysis on how revenues and expenditures adjusts to the government deficit. Instead of using current revenues and spending for a specific year, he uses the sum of current and subsequent five fiscal years legislated tax and spending changes relative to GDP from 1984 to 1999. Ewing, Payne, Thompson and Al-Zoubi (2006) propose Threshold Autoregression (TAR) and Momentum Threshold Autoregression (MTAR) models to address the empirical link between revenues and expenditures, allowing budget surpluses or deficit to have asymmetric effects on the dynamic behavior of expenditures and revenues (see also Young, 2008). The mixed results of this literature has left the empirical debate unsettled.

Most of this empirical literature uses long span of the variables and has not put attention to the presence of parameter instability. In fact, data covering a long time span are susceptible to structural breaks. Stock and Watson (1996) find strong evidence that parameter instability is a persistent fact in the empirical relationship of time series data. I argue that the empirical results of the revenues and expenditures relationship of previous studies may not be consistent in the presence of parameter instability leading to incorrect inferences in regards to this relationship. Therefore, this paper revisits the discussion on the validity of

[4]This studies also includes Romer and Romer (2009) and Luna (2014b, 2014c). However, these studies focus on either the effects of spending shocks on the average tax rate or the effects of tax shocks on real spending using exogenous shocks based on narrative documents.

all tax-spend theories by incorporating in the econometric analysis parameter instability as an alternative explanation of this unsettled evidence.

I am not the first to propose parameter instability in the government expenditures and revenues empirical relationship. Furstenberg al et (1986), Hoover and Sheffrin (1992), and more recently Islam[5] (2001), Niskanen (2006) and New (2009) have argued the presence of a structural breaks due to military actions, tax reduction acts, among others. However, these papers have carried out separately parameter instability test with known and unknown point breaks and causality tests for the relationship of revenues and spending before and after the break. None of these studies have used a Granger-causality test that takes into account parameter instability for the full sample data.

In order to solve this problem, my approach uses Rossi's (2005) test that is robust to parameters instability with unknown break. She suggests an optimal test for model selection between two nested models in the presence of underlying parameter instability. This optimal test jointly tests for both parameter instability with unknown break point and Granger-causality. This technique also has the advantage of using the full sample data instead of using different subsample data for before and after the break period.

The main results of this chapter can be summarized as follow: First, using Andrews' (1993) stability test with unknown break point, I find strong evidence of parameter instability around the late 1990's and early 2000's, which is consistent with the graphical evidence. These results may be explained by the PAYGO regime enacted by the Budget Enforcement Act of 1990 that compels new spending or tax changes not to add to the federal deficit.

Second, the traditional Granger-causality, ignoring parameter instabilities, finds evidence of unidirectional causality from expenditures to revenues; however, I find strong evidence of bidirectional causality between revenues and expenditures after, and only after, controlling for the instabilities. This result provides support to the idea that the revenues and spending decision are determined simultaneously.

Third, I carried out different robustness tests such as different lag structure in the econometric tests, different sample sizes, additional explanatory variables and different economet-

[5]Specifically, Islam (2001) finds strong evidence of parameter instability in both government variables using annual data when performing unit root tests.

ric techniques. Overall, these robustness tests support the evidence from the baseline results suggesting that government makes spending and tax decisions simultaneously.

The rest of the chapter is organized as follows: The next section discusses the background of the empirical relationship between government revenues and expenditures and the graphical evidence. Section 2.3 presents the tests considered in this chapter. Section 2.4 reports the empirical results using the traditional Granger-causality test, Andrews' (1993) test and Rossi's (2005) Granger-causality test robust to parameter instability under different assumptions. Section 2.5 concludes.

2.2 Background

Within the public finance literature, there is a huge literature discussing several alternative theories to explain the empirical causality between government expenditures and revenues. The tax-spend idea argues that changes in government revenues lead to changes in government spending. Friedman (1978) and Buchanan and Wagner (1977) support this idea but with a different perspective. Specifically, Friedman (1978) argues that the most effective way to reduce the size of the government is the "starve the beast" hypothesis by reducing tax revenues. That is, decreasing tax revenues will only lead to decreases in government expenditures. The "starve the beast" hypothesis implies that government revenues and expenditures have a positive relationship. Alternatively, Buchanan and Wagner (1977) argue that decreases in tax revenues may lead to increases in government expenditures through fiscal illusion. They argued that individuals have an incomplete knowledge of taxes and government spending overtime. The benefits of high government spending and low taxes are clear and noticeable, while the cost of lower future spending and higher future taxes that are needed to satisfy the government budget constraint are unnoticeable. Therefore, individuals will "demand" more government spending when the government reduces taxes which are the price associated with this spending.

The tax smoothing hypothesis proposed by Barro (1979) establishes that the path of government expenditure is taken to be exogenously given, and the taxes are adjusted to minimize distortions while the budget is balanced intertemporally. Under the tax smoothing the government decides the current tax rate based on current and future government spending. Under this perspective, higher expenditures would lead to higher taxes[6]. Other economists (Musgrave, 1966 and Melzer and Richard, 1981) propose a different alternative, arguing that governments make expenditures and revenues decision simultaneously. That is, the government synchronizes spending and taxing decisions. Another possible mechanism is that decisions on taxation are independent from the government expenditure determination (Wildavsky 1988, Baghestani and McNown 1994). There is no consensus among economist regarding the empirical causality between expenditures and revenues.

The empirical literature of the relationship between government spending and revenues focuses mainly on the concept of casualty in the spirit of Granger[7]. In the context of Granger-causality, Friedman (1978) and Buchanan and Wagner (1977) version of tax-spend hypothesis are supported if unidirectional causality goes from revenues to expenditures. However, the relationship between government revenues and spending is different under these two perspectives. While the “starve the beast” hypothesis assume a positive relationship between government revenues and expenditures, the fiscal illusion idea assumes a negative relationship between revenues and expenditures.

The tax smoothing hypothesis is supported if unidirectional causality is evidence from expenditures to revenues[8]. The fiscal synchronization hypothesis is supported if bidirectional causality between revenues and expenditures exits whereas the absence of causality between revenues and expenditures shows support to the institutional separation hypothesis. Table 2.1 summarizes the implication of theses theories.

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[6]This result holds under specific assumptions about the function of government spending. Sarget (1987) proposes a stochastic process for the government spending. Specifically, he proposes the following stochastic process: $G = g + g(L)\epsilon_t$. Where g(L) is a polynomial in the lag operator (L) and ϵ is a white noise process. Sargent (1987) shows that the tax rate is a function of lag values of spending under this assumption.

[7]Although, some economists question the concept of Granger-causality, the Granger-causality tests are essentially tests of the incremental predictability content of the respective time series.

[8]Note that this result holds only assuming the following government spending stochastic process: $G = g + g(L)\epsilon_t$. Where g(L) is a polynomial in the lag operator (L) and ϵ is a white noise process.

2.3 Data and Econometric Tests

The question of how revenues affect government spending should be investigated empirically. In this chapter, therefore, I use quarterly nominal government revenues, expenditures and NGDP from the Bureau of Economic Analysis (BEA). I analyze quarterly data[9] because the collection of taxes and government spending occur throughout the year. Government revenues and expenditures are expressed as the log of the percent of nominal GDP (NGDP), and denoted henceforth by r_t and x_t, respectively.

Figure 2.1 shows government revenues and expenditures as percent of nominal GDP (NGDP). Looking at this graph, two features are remarkable to point out. First, the two series appear to mirror each other from 1947 through out the mid 1990's. Secondly, these government variables appear to have a negative relation only after the beginning of the 1990's. That is, these two features suggest the presence of parameter instability in the revenues and expenditure relationship. In the following section, I explore further the presence of structural break and how this evidence may change the conclusion about the revenues and spending relationship.

In order to find which theory of the revenues and spending relationship is supported empirically, I consider the traditional Granger-causality test, Andrews' (1993) parameter instability test, and Rossi's (2005) Granger-causality test robust to parameter instability. These tests focus on testing a hypothesis on a parameter vector β as follow:

- *Granger-Causality Test.* Traditional Granger-casualty regressions assume that parameter of interest is constant over time. The Granger-causality test is then implemented by the following $Wald$ test:

$$W_T = T(\hat{\beta} - 0)\hat{V_\beta^{-1}}(\hat{\beta} - 0) \tag{2.1}$$

Where $\hat{V}_\beta = S_{xx}^{-1}\hat{S}S_{xx}^{-1}$ is a consistent estimate of the covariance, and $S_{xx} \equiv \frac{1}{T-1}\sum_{t=1}^{T-1} x_{t-1}x'_{t-1}$, and $\hat{S} = \frac{1}{T}\sum_{t=2}^{T} x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_t x'_{t-1}$. If there is serial correlation in the data, $\hat{S}$ is given by:

[9] Even though the political budgetary cycle is an annual decision-making process.

$$\hat{S} = \left(\frac{1}{T}\sum_{t=2}^{T} x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_t x'_{t-1}\right) + \sum_{t=2}^{T-1}\left(1 - \left|\frac{j}{T^{\frac{1}{3}}}\right|\right)\left(\frac{1}{T}\sum_{t=j+1}^{T} x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_{t-j}x'_{t-1-j}\right)$$

Where $\hat{\varepsilon}_t \equiv y_t - x'_{t-1}\hat{\beta}$ and $\hat{\beta}$ is the full-sample OLS estimator:

$$\hat{\beta} = \left(\frac{1}{T}\sum_{t=1}^{T-1} x_{t-1}x'_{t-1}\right)^{-1}\left(\frac{1}{T}\sum_{t=1}^{T-1} x_{t-1}y_t\right)^{-1}$$

Under the null hypothesis of no Granger-causality ($\beta = 0$), W_T is a chi-square distribution with p degrees of freedom, which corresponds to the number of restrictions. If all the coefficients are statistically significant different from zero, then there is evidence of Grander-causality.

- QLR_T[10] *Parameter Instability Test.* Andrews (1993) proposes a test for parameter instability and structural change with unknown change point in nonlinear parametric models. The proposed test is designed for a one-time change in the value of a parameter vector, but is shown to have power against more general forms of parameter instability. The test is given by the following equation:

$$QLR_T = \max_{\tau\in[\tau_{min},\tau_{max}]} F_T(\tau) = \frac{[\hat{\varepsilon}'_{1,T}\hat{\varepsilon}_{1,T} - (\hat{\varepsilon}'_{1,\tau}\hat{\varepsilon}_{1,\tau} + \hat{\varepsilon}'_{\tau+1,T}\hat{\varepsilon}_{\tau+1,T})]/k}{(\hat{\varepsilon}'_{1,\tau}\hat{\varepsilon}_{1,\tau} + \hat{\varepsilon}'_{\tau+1,T}\hat{\varepsilon}_{\tau+1,T})/(T-2k)} \quad (2.2)$$

  Where k number of parameters.

  Distribution of QLR_T is non-standard and depends on the number of variables k and the trimming parameters τ_{min} and τ_{max}. Critical values for various values of trimming parameters are given in Andrews (1993) Table 2.1.

- *Granger-Causality Test Robust to Parameter Instability.* One of the key assumptions[11] of the traditional Granger-causality test is parameter stability. Under parameter instability, Rossi (2005) shows that Granger-causality tests may fail. She suggests an optimal tests for model selection between two nested models in the presence of underlying parameter instability. This optimal test jointly test for both parameter instability

[10] QLR_T is also known as Andrews' $Sup - F$ statistic.

[11] The Granger-causality tests is valid under the following assumptions: a) $\{y_t, x_t\}$ are stationary and ergodic, b) $E(x_t x_t)$ is non-singular, c) $E(x_t\varepsilon_t) = 0$. This condition allows the data to be serially correlated, but rules out endogeniety. d) $\{x_t\varepsilon_t\}$ satiesfies Gordin's condition and its lon run variance is non-singular.

and a null hypothesis on the parameter. The test statistic is given by the following equations:

$$Exp - W_T^* =$$

$$\frac{1}{T}\sum_{\tau=[0.15T]}^{[0.85T]}\frac{1}{0.75}exp\left(\frac{1}{2}\right)\Big((\hat{\beta}_{1,\tau}-\hat{\beta}_{2,\tau})'(\frac{\tau}{T}\hat{\beta}_{1,\tau}+(1-\frac{\tau}{T})\hat{\beta}_{2,\tau})'\Big)\hat{V}^{-1}\begin{pmatrix}(\hat{\beta}_{2,\tau}-\hat{\beta}_{2,\tau})\\ \frac{\tau}{T}\hat{\beta}_{1,\tau}+(1-\frac{\tau}{T})\hat{\beta}_{2,\tau}\end{pmatrix} \tag{2.3}$$

Where $\hat{\beta}_{1,\tau}$ and $\hat{\beta}_{2,\tau}$ denote the OLS estimators before and after the time of the shift.

$$\hat{\beta}_{1,\tau} = \left(\frac{1}{\tau}\sum_{t=1}^{\tau-1}x_{t-1}x'_{t-1}\right)^{-1}\left(\frac{1}{\tau}\sum_{t=1}^{\tau-1}x_{t-1}y_t\right)^{-1}$$
$$\hat{\beta}_{2,\tau} = \left(\frac{1}{T-\tau}\sum_{t=\tau}^{T-1}x_{t-1}x'_{t-1}\right)^{-1}\left(\frac{1}{T-\tau}\sum_{t=\tau}^{\tau-1}x_{t-1}y_t\right)^{-1}$$

$$\hat{V}^{-1} = \begin{pmatrix}\frac{\tau}{T}S'_{xx}\hat{S}_1^{-1}S_{xx} & 0\\ 0 & \frac{T-\tau}{T}S'_{xx}\hat{S}_2^{-1}S_{xx}\end{pmatrix}$$

$$\hat{S}_1 = \left(\frac{1}{\tau}\sum_{t=2}^{\tau}x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_t x'_{t-1}+\sum_{j=2}^{\tau-1}\left(1-\left|\frac{j}{\tau^{1/3}}\right|\right)\left(\frac{1}{\tau}\sum_{t=1+j}^{\tau}x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_t x'_{t-1-j}\right)\right)$$
$$\hat{S}_2 =$$
$$\left(\frac{1}{T-\tau}\sum_{t=\tau+1}^{T-\tau}x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_t x'_{t-1}+\sum_{j=\tau+1}^{T-\tau}\left(1-\left|\frac{j}{T-\tau^{1/3}}\right|\right)\left(\frac{1}{T-\tau}\sum_{t=1+j}^{T-\tau}x_{t-1}\hat{\varepsilon}_t\hat{\varepsilon}_t x'_{t-1-j}\right)\right)$$

Under the joint null hypothesis of no Granger-causality and no time variation in the parameters, $Exp - W_T^*$ has a distribution whose critical values are given in Rossi (2005) Table B[12].

[12]If there is no serial correlation in the data, only the first component of $\hat{S}_1$ and $\hat{S}_2$ is relevant.

2.4 Empirical Results

In this section, I examine first the empirical relationship between government expenditures and revenues using the traditional Granger-causality procedure. Then, I estimate Andrews' (1993) QLR test for parameter instability since there are some empirical and theoretical concerns that the revenues and expenditure relationship may show structural breaks. Finally, I estimate Rossi's (2005) test for both parameter instability and causality between revenues and spendings.

2.4.1 Baseline Results

The tax-spend argument proposes that changes in government revenues lead to changes in government expenditures. This argument implies that government revenues must Granger-cause government expenditures. That is, I should reject the null hypothesis that the coefficient associated with the revenue variable, β, is zero in the following Granger-causality regression:

$$\Delta x_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta r_{t-i} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} \tag{2.4}$$

Table 2.2 (fourth row, third column) shows the results based on the above equation. These estimations are heteroskedasticity and serial-correlation consistent. The table reports the p-value for the test. A number below 0.10, 0.05 and 0.01 implies evidence in favor of Granger-causality at the 10, 5 and 1% level respectively. The $Wald$ test does not reject the null hypothesis that all parameters in the model are jointly equal to zero at 5%, finding no evidence for revenues Granger-causing expenditures[13].

As I discussed above, there are some empirical and theoretical concerns that the revenues and expenditure relationship may show structural breaks. In order to check for the presence of parameter instability, I estimate Andrews' (1993) QLR parameter instability test. Table 2.3 (fourth row and third column) shows the result from this test for the Granger-causality regressions. This test finds evidence of structural breaks in the relationship between revenues

[13] I consider 4 lags as the AIC suggests. However, in the next subsection, I assume different lag length as a robustness test.

and expenditures around the second Quarter of 2001[14]. One of the reasons that may explain the instability of the revenues and spending relationship is the enactment of the PAYGO[15]. In order to take into account parameter instability, I propose the following Granger-causality regression that takes into account parameter instability.

$$\Delta x_t = \alpha + \sum_{i=1}^{p} \beta_{i,t} \Delta r_{t-i} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} \tag{2.5}$$

Table 2.5 (fourth row third column) reports the results robust to parameter instability[16]. This result shows that Rossi's (2005) test does reject the null hypothesis that all revenues parameters in the model are jointly equal to zero. This test of Granger-causality indicates strong evidence for revenues Granger-causing expenditures. This result is consistent with the tax spend idea that changes in revenues lead to changes in spending.

Rossi's test performs a causality test taking into account breaks using the full sample size. However, the empirical studies that consider structural breaks look at the causality between revenues and expenditures before and after the breaks. In order to check whether the results from Rossi's (2005) test are consistent, I estimate the Granger-causality test before and after the break suggested by the Andrews test. Table 2.6 (fourth row, third column and seventh row, third column) shows the p-value for the $Wald$ test before and after 2001Q2. This test shows no evidence for revenues Granger-causing expenditures before or after the break using 4 lags. However, these results change as I increase the number of lags in the next subsection.

Similarly, the tax smoothing theory argues that changes in government spending lead to changes in government revenues. This argument implies that government spending must Granger-cause government revenues. That is, I should reject the null hypothesis that the coefficient associated with the spending variable, δ, is zero in the following Granger-causality

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[14]As a robustness check, I also estimate Bai and Perron (2003) parameter instability that allows more than one break. However, I find no evidence of more than one break in the spending and revenues relationshipship.

[15]First enacted as part of the Budget Enforcement Act of 1990, PAYGO required all increases in direct spending or revenue decreases to be offset by other spending decreases or revenue increases.

[16]I also allow the intercept to be a time variant parameter in the econometric tests. However, the results are very similar to the ones of the baseline specification.

regression[17]:

$$\Delta r_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta r_{t-i} + \sum_{j=1}^{p} \delta_j \Delta x_{t-j} \tag{2.6}$$

Table 2.2 (fifth row, third column) shows the results based on the above equation. The *Wald* test associated with the spending coefficients does reject the null hypothesis that all parameters in the model are jointly equal to zero at 5%, finding evidence for expenditures Granger-causing revenues. This result is consistent with the tax smoothing argument. However, this traditional Granger-casualty regressions assume that the parameter of interest is constant over time and the graphical evidence suggests the presence of parameter instability. In order to check for the presence of parameter instability, I also estimate Andrews' (1993) *QLR* parameter instability tests for the delta coefficients of equation 4.6. Table 2.4 (fourth row and third column) shows the results from this test for the Granger-causality regression. This test finds evidence of structural breaks in the relationship between revenues and expenditures around the second quarter of 2001. Therefore, I propose the following Granger-causality regression that takes into account parameter instability.

$$\Delta r_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta r_{t-i} + \sum_{j=1}^{p} \delta_{j,t} \Delta x_{t-j} \tag{2.7}$$

Table 2.5 (fifth row third column) reports the results robust to parameter instability assuming four lags of the independent variables. This result shows that Rossi's (2005) test does reject the null hypothesis that all spending parameters in the model are jointly equal to zero. This test of Granger-causality indicates strong evidence for revenues Granger-causing expenditures. These results are similar to the ones associated with the *Wald* test before and after the break point presented in Table 2.6.

In addition with the findings from the spend-tax equation 2.4, this result suggests evidence of the fiscal synchronization idea. That is, the results robust to parameter instability shows evidence that the government makes spending and taxes decisions simultaneously since spending Granger-cause revenues and revenues Granger-cause spending. This is contrary to the findings looking at the traditional causality. These results show the importance

[17] Here I also consider 4 lags as the AIC suggests.

of considering parameter instability in the econometric analysis since the conclusion of the revenues and expenditure relationship change using a test robust to instabilities. While the traditional causality test finds strong evidence that the tax smoothing hypothesis holds, Rossi's (2005) test supports the idea of fiscal synchronization.

2.4.2 Additional Lags

In the previous section, the baseline analysis was based on 4 lags of the revenues and spending variables as the AIC criteria suggests. However, the tax-spend debate does not make any predictions about the exact timing of how government spending responds to revenues and how revenues respond to spending. Therefore, I change the number of lags of the revenues and spending variables to allow for the possibility that the response of spending to revenues and revenues to spending may be gradual. Therefore, I estimate the traditional Granger-causality test, the parameter instability tests and the Granger-causality test robust to parameter instability using 3, 5 and 6 lags of the independent variables.

Using the traditional Granger-causality test, I find evidence that revenues does not cause expenditures and evidence that expenditures does cause revenues using 3, 5 and 6 lags. This is consistent with the baseline results. Likewise, I find strong evidence of parameter instability around 2001 according to Andrews' (1993) test for all the different lag structures. Therefore, Rossi's (2005) test of the null hypothesis of no Granger-causality and no time variation in the parameters is appropriate. Table 2.5 Rows Four and Five show the p-value associated with this test for 3, 5 and 6 lags. Rossi's (2005) test finds strong evidence that revenues cause spending and spending cause revenues supporting the fiscal synchronization argument.

In order to see if these findings are consistent, I also estimate the traditional Granger-causality test before and after the break for different lag structures. Table 2.6 Columns Two, Four and Five show the $Wald$ test for the Granger-causality regressions associated with the tax-spend and tax smoothing theories. Using only 3 lags, the Granger-causality test suggests that revenues does not cause spending but that spending does cause revenues before and after the break. However, the p-value linked to the $Wald$ tests with more than

4 lags shows evidence of bidirectional causality between revenues and expenditures which is consistent with the findings associated with Granger tests robust to parameter instability. These results suggest that the government synchronizes spending and tax decisions.

Andrews' test suggests the presence of parameter instability in the late 1990's and the early 2000's. During that period, the major institutional change was the PAYGO regime. However, these rules were in effect from 1991 to 2002. To check the importance of this regime, I estimate the traditional Granger-causality test using data from 1947 to 1990. The last two rows of Table 2.6 show the $Wald$ test for the spend-tax regression and the tax smoothing regression. These results support the idea of fiscal synchronization using 5 lags. Most of these results are similar to the ones associated with the 1947-2001 data sample, with the exception of the results using 6 lags. Using 3, 4 and 5 lags, the results finds evidence of unidirectional causality from spending to revenues.

2.4.3 Different Subsamples

The baseline results are based on data from 1947 to 2011. However, recent studies (Romer and Romer, 2009, and Luna, 2014b) show that increasing or decreasing the sample size strengthens or weakens the empirical evidence of the revenues and spending relationship[18]. Therefore, I reduce the sample size to exclude the Korean War and increase the sample size to include the Second War World (WWII) in the analysis using different lag structures.

- Excluding the Korean War. Blanchard and Perotti (2002) and Romer and Romer (2010) argue that fiscal policy was very unusual during the Korean War period. In order to exclude this period, I shorten the sample size from 1957Q1 to 2011Q3. Table 2.2 shows the $Wald$ test for the relationship between revenues and spending for this subsample. These tests find no evidence of unidirectional Granger-causality from revenues to spending. These results are similar to the baseline results presented in Section 2.4.2. Using 5 and 6 lags, the $Wald$ test for the null hypothesis of no Granger-

[18]Specifically, Romer and Romer (2009) show that considering only the post Korean War sample weakens the evidence for a perverse effect of tax cuts on spending. Likewise, Luna (2014c) shows that including Second War Wold data strengthen the evidence of the tax smoothing hypothesis. It is important to point out that these studies differ from mine since they use narrative tax shocks and spending in their analysis.

causality from spending to revenues fails to reject this hypothesis. This result is contrary to ones using 2 or 3 lags.

Table 2.3 and Table 2.4 shows Andrews' test for parameter instability. Similar to the baseline, these tests suggest strong evidence of parameter instability around 2002[19]. Since traditional $Wald$ test for granger causality fails in the present of instabilities, I estimate Rossi (2005) test for the Post-Korean period. This test shows strong evidence of fiscal synchronization for all of the lag lengths. These results are very consistent with the baseline results.

- Including the Second World War. During WWII, there were a lot of defense spending increases, which are the type of government spending that increases revenues according to Barro (1979)[20]. In order to consider these spending changes, I expand the sample size to include the WWII from 1939Q1 to 2011Q3. Nonetheless, the BEA currently reports only annual receipts and expenditure data from that period. Thus, I construct quarterly data for the 1939 to 1946 period using a 1954 BEA publication. This publication reports estimates of quarterly nominal components of GDP back to 1939. Using these components, I estimate government current receipts and expenditures[21].

  Table 2.2, 2.3, 2.4 and 2.5 show the traditional Granger-causality tests, Andrews' (1993) test and Rossi's (2005) test including WWII and different lag structures. Looking at the $Wald$ test, I find evidence of the fiscal synchronization since there is a bivariate causality between revenues and expenditures with the exception of the $Wald$ test 3 lags. Similar to baseline result, Table 2.3 and 2.4 find evidence of parameter

[19] Andrews tests for the granger-causality regression with spending as dependent variable suggests a break in 2002Q1 while the Granger-causality regression with revenues as dependent variable suggest a break in 2002Q4. These results are slightly different from the baseline since in the baseline both regression suggest a break in the same time period (2001Q2).

[20] Specifically, the tax smoothing hypothesis states that government deficit arises when government spending is expected to change. One of the most obvious source of predictable changes in the government expenditures are wars.

[21] From 1939 to 1946, Government spending is the sum of Government Purchases of Goods and Services and Government Transfer Payments, Net Interest Paid by Government, and Subsidies less Current Surplus of Government Enterprises. Government Receipts is the sum of Personal Tax and Non Tax Payments, Corporate Profits Tax Liability, and Indirect Business Tax and Non Tax Liability.

instability around 1999Q4. Finally, using Granger-causality test robust to parameter instability, I find that revenues Granger cause spending and spending Granger-cause revenues, which is consistent with the baseline result.

2.4.4 Additional Variables

In all of the specifications discussed so far, I have used only two variables: government revenues and expenditures. Previous studies (Baghestani and Mcnown, 1994; Ross and Payne, 1998; Romer and Romer, 2009; Luna, 2014a and 2014b) have incorporated RGDP and inflation in to the analysis. In order to take into the account these variables, I estimate all of the tests from the baseline sections including RGDP, inflation and both in the Granger-causality regression analysis.

- Real GDP. Cyclical downturns decrease the receipts of federal government. This should not means that spending should fall to match this decline in revenues. In order to abstract from the cyclical downturns, I include RGDP in the econometric tests[22]. For consistency, I include RGDP in all Granger-causality regressions (equations 2.4, 2.5, 2.6 and 2.7). Table 2.7 presents the $Wald$ test, Andrews test and Rossi test using data from 1947 to 2011. This table also shows all test results for different lag length. Overall, the earlier conclusions are quite robust under this specification. The traditional Granger-causality for the tax-spending regression finds no evidence in favor of Granger-causality ignoring structural breaks while the $Wald$ test does finds evidence in favor of Granger-causality for the tax smoothing regression. Rossi (2005) test for parameter instability and Granger-causality finds strong evidence of bidirectional causality between revenues and expenditures which is consistent with the fiscal synchronization theory.

- Inflation. One obvious concern is the role that inflation may play in the revenues and expenditures relationship. In order to include the effects of prices, I use inflation

[22] I include first differences of the logarithm of RGDP in the regressions. RGDP data was taken from the BEA.

as a control variable[23]. As I did with previous analysis, I estimate the traditional Granger-causality test, the parameter instability test and the Granger-causality test robust to parameter instability. These results are shown in Table 2.8. The $Wald$ test associate with the Granger-causality finds no evidence in favor of Granger-causality from revenues to spending but finds strong evidence of casualty from spending to revenues. However, Andrews' test shows substantial evidence of instabilities in such a regression around 2001. When such instability is taken into account, I find strong evidence in favor of Granger-causality in both direction.

- RGDP and Inflation. In order to see the effect of both inflation and RDGP, I also include both variables in the analysis as a robustness check. Table 2.9 presents the results from all the tests consider in this chapter. The traditional Granger-causality test finds only evidence of causality from spending to revenues using more than 3 lags. Similar to all previous results, I find strong evidence of parameter instability in the early 2000's. Likewise, Rossi's (2005) test robust to parameter inability shows evidence of bidirectional causality test when I include RGDP and inflation into the analysis.

2.4.5 Impulse Response Function

In addition to Granger-causality tests, some of the empirical studies such as Furstenberg al et (1986), Romer and Romer (2009) and Luna (2014a and 2014b) use impulse response function analysis to see how government revenues respond to increases in government spending and how government spending respond to increases in government revenues. Consequently, I also estimate the implied response of total expenditure to an increase in government revenues and the implied response of total revenues to an increase in government spending for the whole data sample. The first column of Figure 2.2 presents the cumulative impulse response function of the expenditure series to revenue innovations of 1% of GDP along with the 90% confidence interval using different lag structures. This column shows the impulse response function for a forecast horizon of 12 quarters. Consistently with the previous results, there is

[23]The inflation rate was estimated using the first difference of the logarithm of GDP Deflator from BEA.

no evidence of the "starve the beast" hypothesis or "fiscal illusion". The cumulative effect is negative after the change in revenues for four quarters. After that, the estimated cumulative effect is positive at every horizon as the "starve the beast" suggests. However, the point estimates are not significant for any of the 4 lag length scenarios, which is consistent with the Granger-causality test of the previous sections.

Similarly, the second column of this figure shows the cumulative impulse response function of the revenue series to spending innovations of 1% of GDP, along with the 90% confidence interval using different lag structures. The cumulative effect is always negative after the change in spending for all of the forecast horizon quarters. However, the point estimates are only significant at 90% confidence for the first four quarters using 4, 5 and 6 lags in the VAR model and for all of the quarters using 3 lags in the model. This result is consistent with the evidence of unidirectional causality from spending to revenues found in the previous section. However, the result suggest evidence of a type of "fiscal illusion" since increases in government spending decrease government revenues and not increase government revenues as the tax smoothing hypothesis suggests[24].

As the Andrews' (1993) test and the graphical evidence suggest, there is strong evidence of parameter instability around 2001. Therefore, I estimate the response of total expenditure to an increase in government revenues and the response of total revenues to an increase in government expenditures before and after the structural break[25]. The left column of Figure 2.3 shows the cumulative impulse response function of the expenditure series to revenue innovations of 1% of GDP before the break point. The cumulative response function is negative for the first quarters but positive after quarter 4. The point estimates are always significant during the first two quarters for all of the lag structures scenarios. For the lag 6 scenario, the point estimates are significant after quarter 4 as well.

The right column of Figure 2.3 shows the implied cumulative response function of revenues to spending before the break. The cumulative response is always negative and sig-

[24]The tax smoothing hypothesis argues that government spending increases lead to fiscal deficits and future tax increases.

[25]The results estimated in this section takes 2001Q2 as the break point. I also estimate the impulse response functions to see the importance of the PAYGO in the analysis. These results are not included in this document since they are very similar to the results presented in this section.

nificant for the first four quarters of the horizon forecast. For the lag 3 scenario, the point estimates are always negative and significance at 10% confidence. Similarly to the response function for the whole data sample, this result suggests a type of "fiscal illusion", since increases in government spending lead to decreases in government revenues. However, the combination of the response functions of revenues and spending support the idea of fiscal synchronization since government revenues and spending response to increases in spending and revenues, respectively.

Figure 2.4 presents the impulse response functions of revenues and spending after the break point. Specifically, first column of this figure shows the impulse response function of spending to revenues. Contrarily to the previous results, an increase of % in revenues decreases government spending during all of the horizon forecast. The point estimates of the response function are never significant using 3 and 4 lag length in the VAR model. However, some of the point estimates are significant after 4 quarters using 5 and 6 lag structures. These results are consistent with the traditional Granger-causality results after the break presented in Table 2.6. The cumulative impact of the response function support evidence in favor of the fiscal illusion since tax reductions lead voters to ask for a greater spending.

The right column of Figure 2.4 shows the cumulative response function of revenues to spending. The cumulative impact is always negative and only significant during the first four quarters. These results suggest a "fiscal illusion" effect between spending and revenues. However, the combination of the results of the two columns finds evidence of the fiscal synchronization idea since revenues response to increases in spending and spending response to increases in revenues. The conclusions based on the results after and before the break point are consistent with the ones from Rossi's (2005) test robust to parameter instability.

2.5 Conclusions

The literature on the tax-spend debate has focused on the inter-temporal relationship between revenues and expenditures in the generation of the budget deficits. The empirical literature on this debate has produced a variety of empirical results, due in part to differing econometric techniques, lag length structure and the time periods examined. However, only a few studies have discussed or incorporated the possibilities of regime shifts in regards to key legislation and political events that may have altered the policy makers decision making process.

This chapter investigates the empirical relationship between government revenues and expenditures taking into account the presence of parameter instability. Specifically, I propose Rossi's (2005) optimal test for model selection between two nested models in the presence of underlying parameter instability, which is a different approach from previous studies. My findings show that failure to recognize parameter instability leads to incorrect inferences in regards to the relationship between revenues and expenditure decisions. Specifically, my results show strong evidence of unidirectional causality from spending to revenues as the tax smoothing hypothesis suggests, using traditional Granger-causality. However, I find strong evidence of bidirectional causality as the fiscal synchronization argument suggest using Rossi's (2005) test since there is evidence of parameter instability in this relationship in the late 1990's and early 2000's. These results seem to be consistent using different sample sizes, lag length and additional variables. Likewise, these results are consistent using impulse response function as an alternative analysis to support the findings using the concept of Granger-causality.

Although the results emphasizes the importance of considering parameter instability in the spending and revenues relationship, there are two issues that are important to be explored in future research. First, it is necessary to include exogenous tax and spending shocks that do not depend on the state of the economy to avoid reverse causation problem. Second, the fiscal variables of the econometric analysis presented in this paper do not take into the account expectation. According to economic theory, economic agents make decision based on current information about the factors relevant to their decision problems. This implies that policymakers make fiscal policy decisions based on news about current and future government spending and taxes. I deal with these two issues in the following two chapters.

Table 2.1: Summary of the Granger-Causality Implication According to Different Theories

Theory	Granger Causality Implications	Revenues and Expenditures Relationship
Starve the Beast	Revenues GC* Expenditures	Positive Relationship
Fiscal Illusion	Revenues GC Expenditures	Negative Relationship
Fiscal Synchronization	Revenues GC Expenditures and Expenditures GC Revenues	No Specific Relationship
Tax Smoothing	Expenditure GC Revenues	Positive Relationship
Institutional Separation	No Granger Causality	

* GC refers to "Granger-Cause"

Table 2.2: Bivariate Granger-Causality Test: Different Sample Sizes: Wald Test

	Number of Lags			
	3	4	5	6
Sample: 1947-2011				
Ho. r does not cause x	0.36	0.47	0.17	0.24
Ho. x does not cause r	0.00***	0.00***	0.00***	0.00***
Sample: 1939-2011				
Ho. r does not cause x	0.26	0.10*	0.05**	0.06*
Ho. x does not cause r	0.67	0.00***	0.00***	0.02**
Sample: 1957-2011				
Ho. r does not cause x	0.54	0.60	0.29	0.16
Ho. x does not cause r	0.06*	0.10*	0.18	0.23

Note: Asterisks indicate evidence of Granger-causality at 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.3: Andrew's (1993) Stability Test for $H_0 : \beta_{1,t} = 0$ in $\Delta x_t = \beta_0 + \beta_{1,t}\Delta r_{t-1} + \delta_1 \Delta x_{t-1}$

	Number of Lags			
	3	4	5	6
	Sample: 1947-2011			
QLR	0.03**	0.00***	0.00***	0.00***
Break Date	2001.2	2001.2	2001.2	2001.2*
	Sample: 1939-2011			
QLR	0.04**	0.03**	0.00***	0.00***
Break Date	1999.4	1999.4	1999.4	1999.4
	Sample: 1957-2011			
QLR	0.00***	0.00***	0.00***	0.00***
Break Date	2002.1	2002.1	2002.1	2002.1

Note: Asterisks indicate evidence of Parameter Instability at 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.4: Andrew's (1993) Stability Test for $H_0 : \delta_{1,t} = 0$ in $\Delta r_t = \beta_0 + \beta_1 \Delta r_{t-1} + \delta_{1,t} \Delta x_{t-1}$

	Number of Lags			
	3	4	5	6
	Sample: 1947-2011			
QLR	0.00***	0.00***	0.00***	0.00***
Break Date	2001.2	2001.2	2001.2	2001.2*
	Sample: 1939-2011			
QLR	0.00***	0.00***	0.00***	0.00***
Break Date	1999.4	1999.4	1999.4	1999.4
	Sample: 1957-2011			
QLR	0.01***	0.00***	0.00***	0.00***
Break Date	2002.4	2002.4	2002.4	2002.4

Note: Asterisks indicate evidence of Parameter Instability at 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.5: Bivariate Granger-Causality Test: Different Sample Sizes: Rossi's (2005) $EXP - W_T$ Robust to Parameter Instability

	Number of Lags			
	3	4	5	6
Sample: 1947-2011				
Ho. r does not cause x	0.06*	0.00***	0.00***	0.00***
Ho. x does not cause r	0.00***	0.00***	0.00***	0.00***
Sample: 1939-2011				
Ho. r does not cause x	0.10	0.03**	0.00***	0.00***
Ho. x does not cause r	0.00***	0.00***	0.00***	0.00***
Sample: 1957-2011				
Ho. r does not cause x	0.06*	0.00***	0.00***	0.00***
Ho. x does not cause r	0.00****	0.00***	0.00***	0.00***

Note: Asterisks indicate evidence of Granger-causality at the 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.6: Bivariate Granger-Causality Test Before and After Structural Break, and Before the PAYGO Regime: Wald Test (Full Sample: 1947-2011)

	Number of Lags			
	3	4	5	6
Sample: 1947-2001				
Ho. r does not cause x	0.25	0.31	0.06*	0.10*
Ho. x does not cause r	0.03**	0.00***	0.00***	0.00***
Sample: 2001-2011				
Ho. r does not cause x	0.42	0.35	0.05**	0.01***
Ho. x does not cause r	0.00***	0.00***	0.00***	0.00***
Sample: 1947-1990				
Ho. r does not cause x	0.30	0.35	0.06*	0.12
Ho. x does not cause r	0.00**	0.00***	0.00***	0.00***

Note: Asterisks indicate evidence of Granger-causality at the 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.7: Granger-Causality Test, Andrew's Stability Test and Rossi's Causality Test Robust to Parameter Instability: Results including RGDP as Explanatory Variable

	Number of Lags			
	3	4	5	6
Tests	Dependent Variable: Spending			
Wald Test	0.35	0.48	0.16	0.33
Andrews Test	0.00***	0.00***	0.00***	0.00 * **
Break	2001.1	2001.1	2001.1	2001.1
Rossi Test	0.00***	0.00***	0.00***	0.00***
	Dependent Variable Revenues			
Wald Test	0.03**	0.00***	0.00***	0.00***
Andrews Test	0.40	0.13	0.00***	0.00***
Break	2000.4	2000.4	2000.4	2000.4
Rossi Test	0.00***	0.00***	0.00***	0.00***

Note: Asterisks indicate evidence of Granger-causality at the 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.8: Granger-Causality Test, Andrew's Stability Test and Rossi's Causality Test Robust to Parameter Instability: Results including Inflation as Explanatory Variable

	Number of Lags			
	3	4	5	6
Tests	Dependent Variable: Spending			
Wald Test	0.46	0.65	0.49	0.59
Andrews Test	0.00***	0.00***	0.00***	0.00***
Break 2001.1	2001.1	2001.1	2001.1	
Rossi Test	0.00***	0.00***	0.00***	0.00***
	Dependent Variable Revenues			
Wald Test	0.03**	0.00***	0.00***	0.00***
Andrews Test	0.23	0.16	0.00***	0.00***
Break	2000.4	2000.4	2000.4	2000.4
Rossi Test	0.00***	0.00***	0.00***	0.00***

Note: Asterisks indicate evidence of Granger-causality at the 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 2.9: Granger-Causality Test, Andrews' Stability Test and Rossi's Causality Test Robust to Parameter Instability: Results including RGDP and Inflation as Explanatory Variables.

	Number of Lags			
	3	4	5	6
Tests	Dependent Variable: Spending			
Wald Test	0.51	0.68	0.57	0.60
Andrews Test	0.00***	0.00***	0.00***	0.00***
Break	2001.1	2001.1	2001.1	2001.1
Rossi Test	0.00***	0.00***	0.00***	0.00***
	Dependent Variable Revenues			
Wald Test	0.37	0.00***	0.00***	0.00***
Andrews Test	0.01***	0.00***	0.00***	0.00***
Break	2000.4	2000.4	2000.4	2000.4
Rossi Test	0.00***	0.00***	0.00***	0.00***

Note: Asterisks indicate evidence of Granger-causality at the 1% (***), 5%(**) and 10%(*) confidence, respectively.

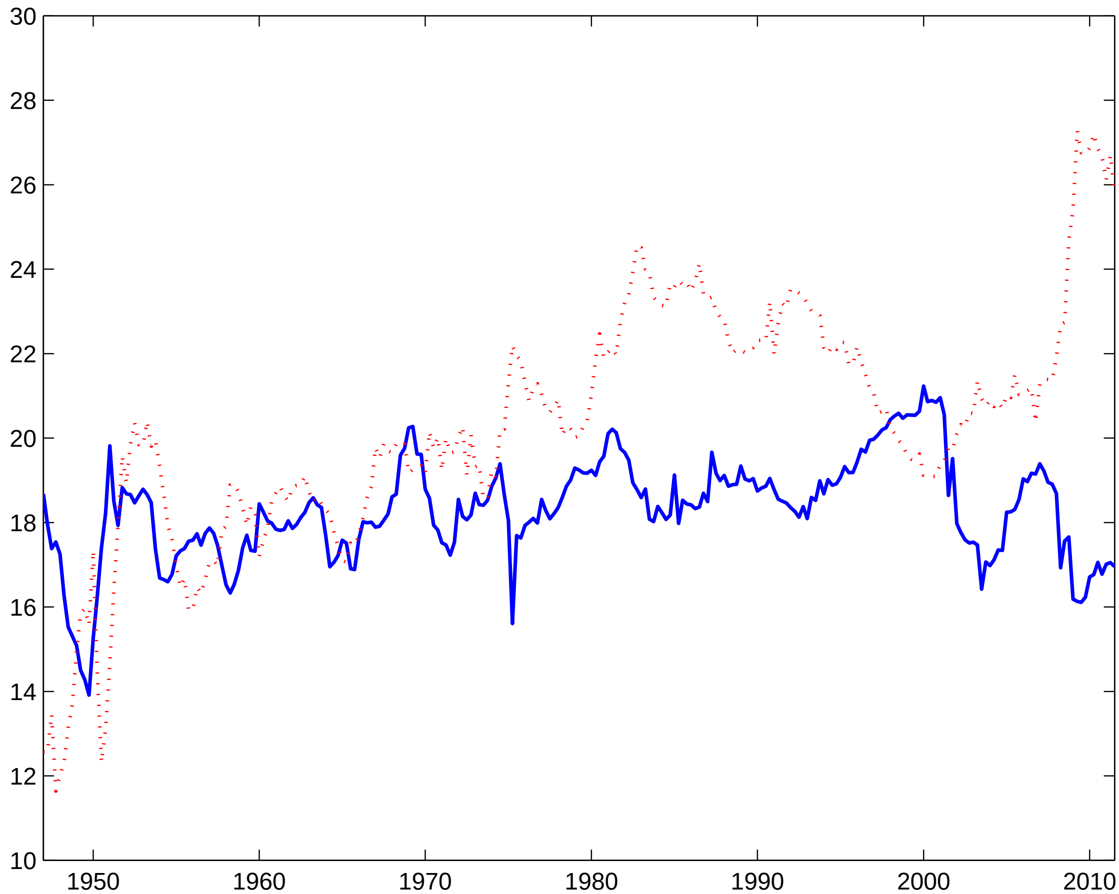

Figure 2.1: Government Revenues and Expenditures as Percent of GDP. Dotted line represents Government spending while solid line represents government revenues . The sample period is from 1947Q1 to 2011Q3

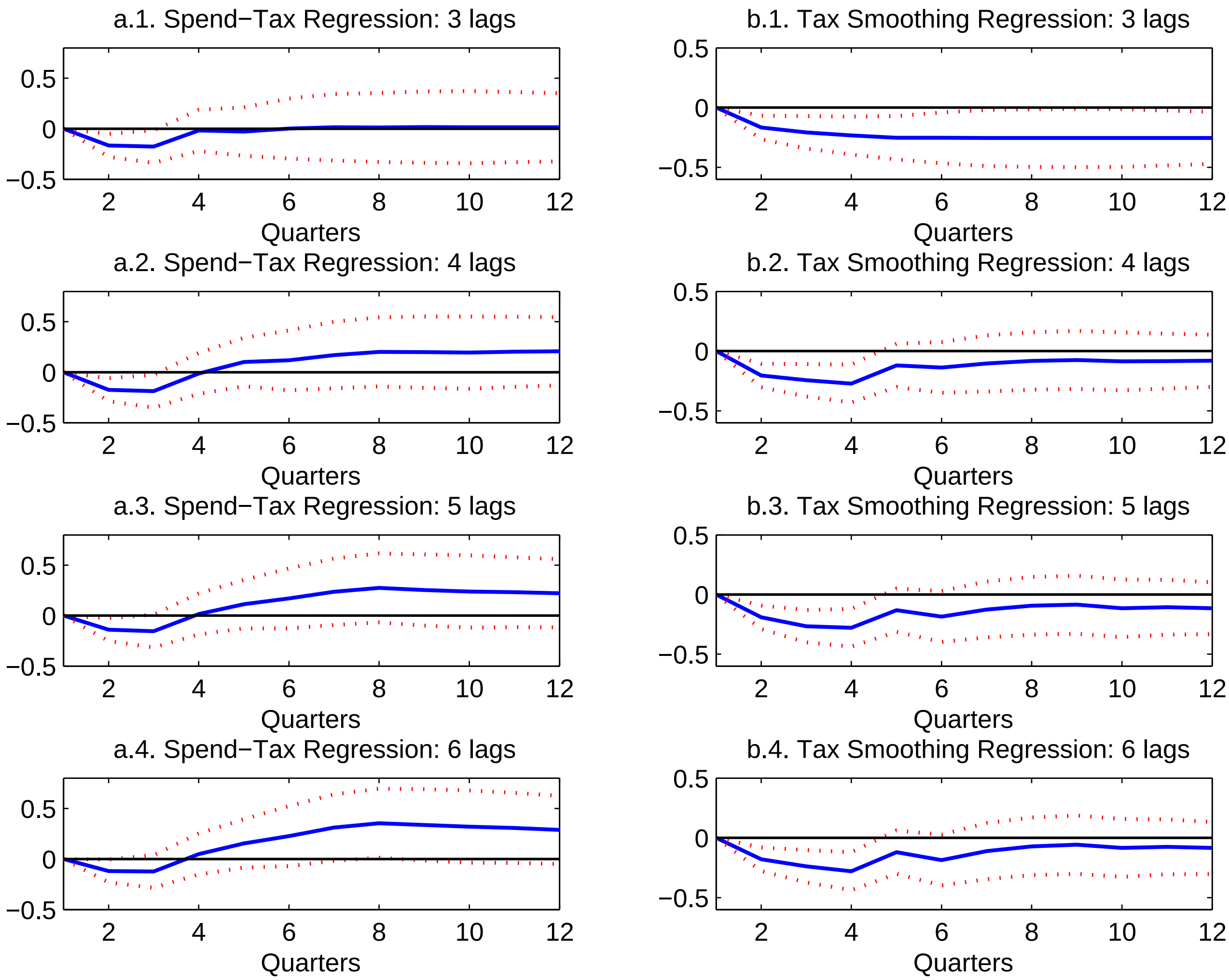

Figure 2.2: Cumulative Response Functions for the Full Sample Data. Panel a Shows the Estimated Cumulative Impact of a 1% Increase in Revenues on Spending. Panel b Shows the Estimated Cumulative Impact of a 1% Increase in Spendings on Revenues.

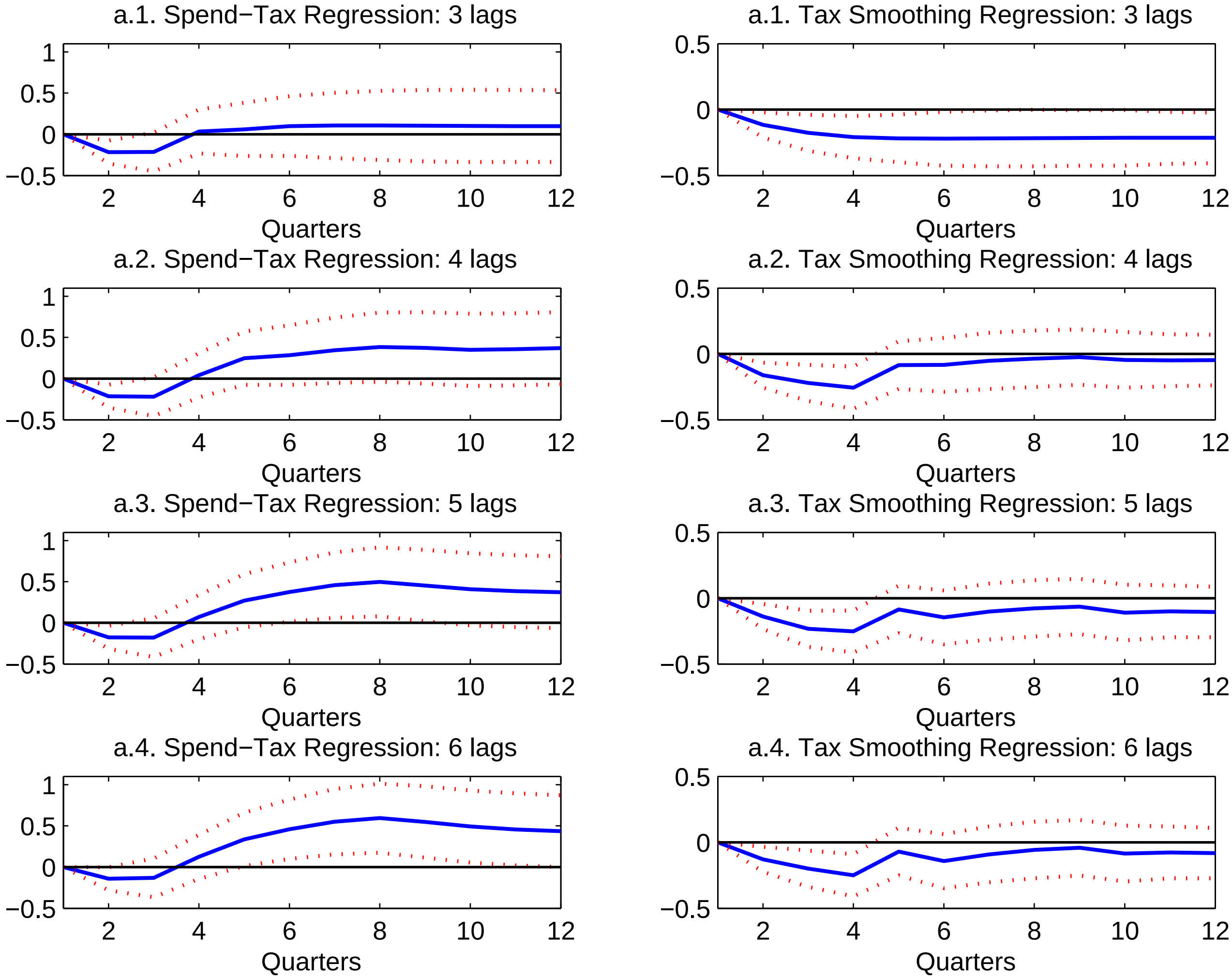

Figure 2.3: Cumulative Response Functions Before the Break Point. Panel a Shows the Estimated Cumulative Impact of a 1% Increase in Revenues on Spending. Panel b Shows the Estimated Cumulative Impact of a 1% Increase in Spendings on Revenues.

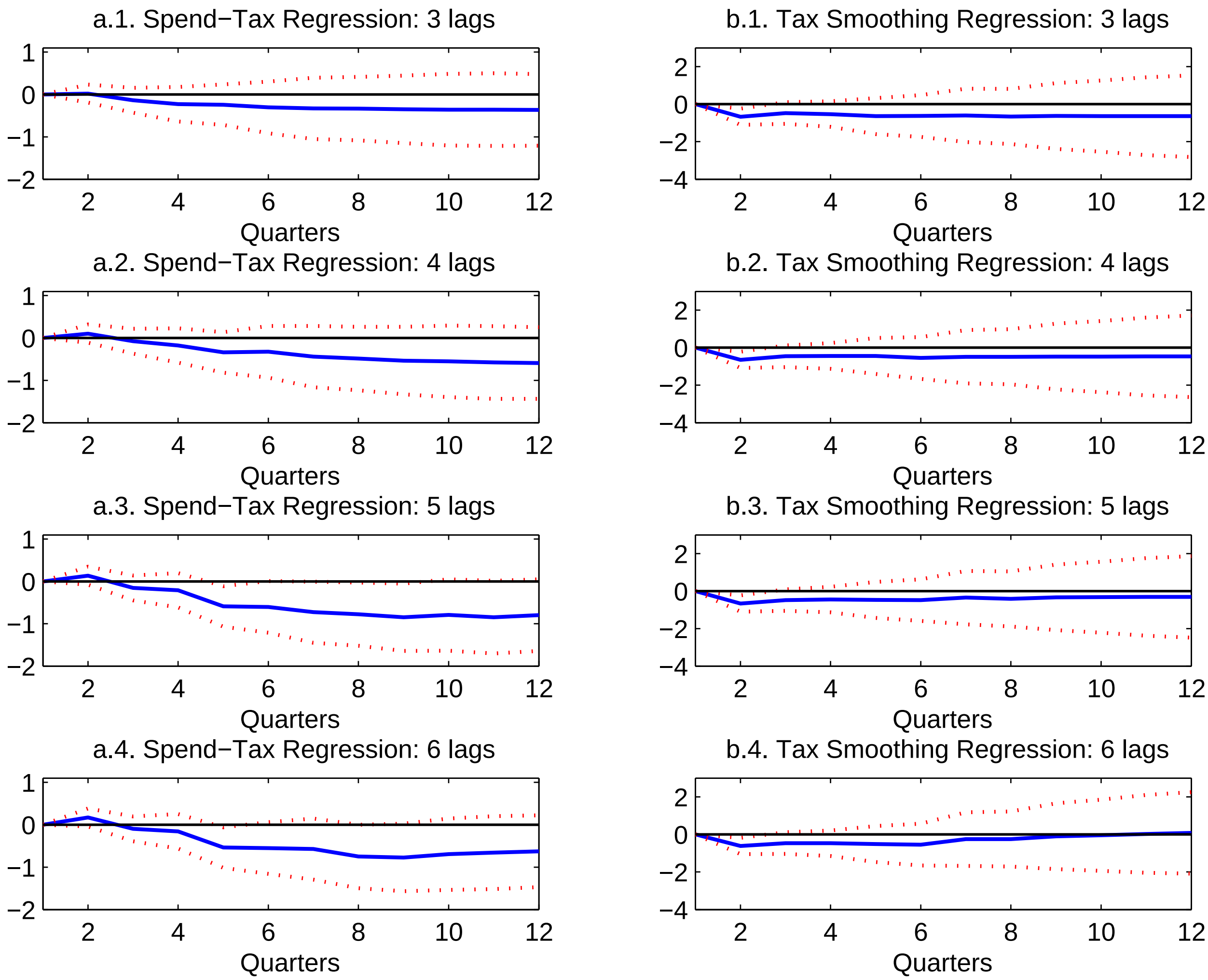

Figure 2.4: Cumulative Response Functions After the Break Point. Panel a Shows the Estimated Cumulative Impact of a 1% Increase in Revenues on Spending. Panel b Shows the Estimated Cumulative Impact of a 1% Increase in Spendings on Revenues.

Chapter 3

DO ALREADY AND NEWLY LEGISLATED TAX POLICY CHANGES "STARVE THE BEAST"?

3.1 Introduction

How does government expenditure respond to tax changes? According to the "starve the beast"[1] hypothesis, tax reductions lead to a decrease in future government spendings. That is, there is a positive relationship between tax rates and spending. A tax cut will increase the budget deficit, forcing policy makers to reduce government spending. John Kenneth Galbraith (1962) was the first economist defending this idea by arguing that the tax cuts of the Kennedy administration would become a ceiling on spending; however, prominent economists have also supported this idea. For example, Milton Friedman (1978) made his point in a column in Newsweek magazine writing "I have concluded that the only effective way to restrain government spending is by limiting government's explicit tax revenue, just as a limited income is the only effective restraint on any individual's or family's spending".

The "starve the beast" hypothesis is not the only explanation of how tax cuts affect government spending. Buchanan and Wagner (1977) propose a "fiscal illusion" effect where taxes cuts may lead to increases in government expenditures. They argued that individuals have an incomplete knowledge of taxes and government spending overtime. The benefits of high government spending and low taxes are noticeable, while the cost of lower future spending and higher future taxes that are needed to meet the government budget constraint are unnoticeable. Therefore, individuals will "demand" more government spending when the price associated with these spending, taxes, are lower. Under this approach, tax rates and government spending have a negative relationship. Other economists (Musgrave, 1966 and Melzer and Richard, 1981) propose a different alternative, arguing that governments make expenditures and revenues decision simultaneously. That is, the government synchronizes

[1]The term "beast" refers to the government size and the programs it funds.

spending and taxing decisions. Another possible mechanism is that decisions on taxation are independent from the government expenditure determination (Wildavsky 1988, Baghestani and McNown 1994). That is, there is no relationship between tax rates and spending decision[2].

An alternative explanation of the relationship between taxes and government spending is the tax smoothing hypothesis proposed by Barro (1979). Under this approach, government spending is exogenous given while tax decision is endogenous. The idea of Barro's (1979) model is that steady tax rates are preferable to alternating periods of big and low tax changes since taxes create a distortion cost and this cost increases more than proportionally with the tax rate. This implies that the government will increase taxes during war to reflect the higher present value of government expenditures and lower taxes during peace time. However, this increase in the tax rate during wartime will not perfectly equalize the rise in expenditures since government spendings are expected to decrease after the conflict. Thus, the government will also use budget deficits and surpluses to smooth the path of taxes.

Whether cutting taxes decreases or increases government spending is crucial for our understanding of the current and the future path of the government deficit and its long run implications, especially in countries with high levels of government deficit. In the last years, the US federal government have run a large budget deficit every year, with the average deficit from 2001 to 2012 exceeding 5%. In fact, the average deficit of the last four years was 10.3%[3]. Likewise, the discussion of the debt ceiling to finance operations for 2012 and the rest of the 2013 fiscal year, and the"fiscal cliff" debate that included tax increases through out the expiration of the Bush Administration tax cuts and spending cuts under the Budget Control Act of 2011 at the beginning of last year raised several concerns about the sources and effects of the budget deficits on the economy. According to the Congressional Budget Office (CBO), the "fiscal cliff" would have decreased GDP by 0.5% and situated the unemployment rate at 9.1. Similarly, if taxes and government spending are positively related as the "starve the beast" hypothesis suggests, the Buffett rule[4] proposed by President

[2]Table 3.1 summarizes the relation between revenues and spending according to these different theories.

[3]IMF (2012) "World Economic Outlook"

[4]The Buffett Rule is a tax increase plan that would apply to individuals earning more than $1 million

Obama a couple of years ago would have had a small impact on the reduction of the US deficit in the long-run. The effect of tax changes on government spending is also important for knowing how tax decisions today may limit or not future administrations' spending decisions. For example, Paul Krugman (2008) argued that "the tax cuts enacted by the Bush administration were, in effect, a fiscal poison pill aimed at future administrations" making it hard for the next president to change the country's direction.

The question regarding the effects of revenues on expenditures is clearly an empirical one. Within the public finance literature there have been several papers investigating this relationship empirically using mainly two econometric approaches. The most common approach is some variation of the spending on lagged revenues, revenues on lagged expenditure or both using a VAR model with different control variables such as output gap, inflation, unemployment, among others (Anderson, Wallace and Warner 1986; Furstenberg, Green and Jeong 1986; Ram 1988; Bohn 1991; Auerbach 2000; Romer and Romer 2009b). Alternatively, some studies have proposed a vector error correction model since the government budget constraint imposes theoretical restrictions on the relative movements of the government revenues and expenditures. This constraint can be interpreted as as a long-run equilibrium between these time series variables (Miller and Russek 1990; Baghestani and Mcnown 1994; Ross and Payne 1998; Ewing, Payne, Thompson and Al-Zoubi 2006; Young 2008). All these papers have yielded mixed results without settling the issue of how expenditures response to decreases in taxes. However, the results of these studies suffer from reverse causation and omitted variable bias problems[5].

Likewise, neither the VAR models nor the cointegration models have paid much attention to expectational effects of tax changes. According with economic theory, individuals make their decisions based on all available information. Announcements of future tax changes may affect policy makers' spending plans even before these tax changes take place. That is, already legislated tax changes may affect government expenditures decisions ahead of their implementation, while newly legislated tax changes may affect government spending when

per year in order to reduce the US Deficit.

[5]Notable exception is Romer and Romer (2009b).

these tax changes are implemented[6].

Another problem with previous literature, that relates to the reverse causation, using aggregate government revenue and spending variables, is the fact that these studies cannot distinguish between spending shocks and tax shocks from each other. The ability to distinguish between government spending shocks and tax shocks is very important, considering that tax smoothing and "starve the beast" arguments share the same implications. Under these two approaches, government spending and taxes have a positive relationship. However, the adjustment process is different. Under the "starve the beast" hypothesis, government spending adjust to exogenous tax reductions while under the tax smoothing hypothesis tax rates adjust to government spending shocks[7]. This is why it is very important to distinguish between tax shocks that are not related to spending decisions. For example, if policy makers raise taxes to finance a new military action as the tax smoothing suggests, a regression of aggregate revenues on spending will show a positive correlation. This result will show evidence of the "starve the beast" hypothesis. However, the causation runs in the opposite direction yielding to biased estimates of the effect of taxes changes on spending.

In order to deal with these issues, I estimate the impact of exogenous tax shocks on government expenditure using Mertens and Ravn's (2009) anticipated and unanticipated tax shocks to test the "starve the beast" hypothesis. This approach is similar to Romer and Romer's (2009b)[8] with the added feature that I distinguish between already legislated and newly legislated fiscal shocks to take into account expectational effects. My main results can be summarized as follows.

First, with regard to the linkage among the surprise tax cuts and government spending,

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[6]This idea that already legislated policy shocks impact the economy prior to their implementation has been already explored. Hall (1971), Auerbach (1989), Yang (2005), House and Shapiro (2006) and Mertens and Ravn (2009) have studied the impact of already legislated tax changes on per capita real output, consumption, investment and real wages prior to the tax implementation. However, there are no studies that use this approach to directly explore whether tax cuts decrease expenditures and provide evidence that the "starve the beast" hypothesis holds empirically.

[7]Some of the studies that focus on testing the tax smoothing hypothesis includes: Kochin, Banjamin and Meador (1982), Furstenberg, Green and Jeong (1986), Anderson, Wallace and Warner (1986), Barro (1990), Islam (2001) and more recently Auerbach (2000, 2003), Aiyagari, Marcet, Sargent and Seppala (2002), Ewing, Payne, Thompson and Al-Zoubi (2006), among others.

[8]In fact, Mertens and Ravn's (2009) tax shock are based on Romer and Rmer (2009) tax liability changes.

my analysis shows a positive link between these two fiscal variables. A newly legislated tax cut increases government spending in all of the quarters. The point estimates of a tax cut of 1% of GDP suggest an increase of government expenditure of around 2% after 12 quarters. This result finds evidence of the fiscal illusion idea. This implies that non-preannounced tax cuts without associated spending cuts weaken the link in individuals minds between government spending and taxes and surprise voters leading them to demand greater spending. This result is in line with recent empirical research using exogenous tax changes, which has found that tax cuts increase expenditures; see, e.g., Romer and Romer (2009b).

Second, in contrast with preexisting studies (Ewing, Payne,Thompson and Al-Zoubi, (2006); Young, A. T., (2008); Romer and Romer, (2009b)), I find empirical support in favor of the "starve the beast" hypothesis before the legislations are implemented. An already legislated tax cut is associated with pre-implementation drops in government spending. The cumulative impact of an already legislated tax cut of 1% of GDP decrease spending by around 5% 4 quarters after the tax changes are pre-announced. After the tax change is implemented, the cumulative impact is associated with an increase in spending during the first quarters and a decrease in expenditures after 7 quarters. This result shows the importance of the implementation period in the decision process of policy makers and suggests that there is no lack of foresight on the part of policy makers and households. That is, policy makers do adjust spending plans and voters do recognize the extent of the tax cuts costs in terms of future lower spending as soon as news of future tax changes are announced.

These results are shown to be very robust. I carried out an extensive robustness analysis. First of all, I allow government spending to have a more complicated and dynamic model. Specifically, I increase the number of lags of the tax change variables, I allow the spending variable to depend on its lags as well as on the tax liability changes and I estimate a VAR with key variables in addition to the tax changes variables. I find evidence of the "starve the beast" hypothesis during the implementation and, in some cases, after the already legislated tax changes are implemented.

Secondly, I ask whether the base line results are contaminated by the lack of control for political variables and for exogenous spending shocks which, might be an important issue in small samples. My results become even stronger when I control for government spending shocks. The evidence of the “starve the beast” hypothesis is present during and after the implementation period. However, the results are very similar to the baseline’s results when I control for political variables.

Finally, I aggregate the quarterly already legislated and newly legislated tax changes to construct a fiscal year measure along with official budget government spending in order use a model closely tied to policy makers’ decisions. Even though the number of observations are significantly reduced, I find stronger evidence of the “starve the beast” hypothesis related to already legislated tax shocks.

The remainder of the chapter is structured as follows: the next section discusses the definition of already legislated and newly legislated tax shocks and data. Section 3.3 presents the econometric model and the baseline results. Section 3.4 presents the robustness analysis and Section 3.5 concludes.

3.2 Definition of Legislated Tax Shocks and Data

One of the problems of previous literature (Miller and Russek 1990; Baghestani and Mcnown 1994; Ross and Payne 1998; Ewing, Payne, Thompson and Al-Zoubi 2006; Young 2008) that attempt to test the “starve the beast” hypothesis is the fact that these studies cannot distinguish between spending shocks and tax shocks from each other, since these studies use aggregate tax and spending data. The inability to distinguish between government spending shocks and tax shocks could arise reverse causation and observational equivalence problems, considering that tax smoothing and “starve the beast” arguments share the same implications. Under these two approaches, government spending and taxes have a positive relationship. However, the adjustment process is different. Under the “starve the beast” hypothesis, government spending adjust to exogenous tax reductions, while under the tax smoothing hypothesis, tax rates adjust to government spending shocks. This is why is very important to distinguish between tax shocks that are not related to spending decisions. For example, if policy makers raise taxes to finance a new military action as the tax smoothing suggests, a regression of revenues on spending will show a positive correlation. This result will show evidence of the “starve the beast” hypothesis. However, the causation runs in the opposite direction, yielding to biased estimates of the effect of taxes changes on spending. Therefore, I use exogenous tax rate changes based on narrative sources to avoid these problems. The following two subsections describe the definition of the exogenous tax shocks and the additional data used in this chapter.

3.2.1 Definition of Already and Newly Legislated Tax Shocks

I use Mertens and Ravn's (2009) anticipated and unanticipated[9] long run and deficit tax shocks. These tax modifications focus on tax liability changes that Romer and Romer (2009a) classify as exogenous, since the changes were not motivated by current or projected economic conditions. These changes include tax liability changes that were introduced without any concern about the current state of the economy, "long-run tax changes", and tax liability changes that were introduced to address inherited budget deficits, "deficit tax changes" [10]. Table 3.2 briefly describes the classification and motivations for all legislated tax changes in the postwar period suggested by Romer and Romer (2009a)[11].

For each of the tax liabilities, Mertens and Ravn (2009) distinguish two dates: the announcement date and the implementation date. The announcement date is the date at which the tax legislation was signed by the president and became law. Similarly, the implementation date is the date at which the tax liability changes were introduced. Mertens and Ravn (2009) define the difference between the announcement date and the implementation date as the implementation lag. When these dates are no longer 90 days apart, I entitle

[9]In order to avoid confusion about the terms "unanticipated" and "anticipated", I rename each of the tax shocks in this document.

[10]In order to see whether these tax shocks are really exogenous variables and to avoid the reverse causality problem, I carried out Granger-causality tests between the government spending variable and the different tax changes proposed by Romer and Romer (2010). I find that government spending does not Granger-cause newly legislated tax or already legislated tax changes. I also find that already legislated and newly legislated tax changes do Granger-cause spending which is consistent with previous literature that use Granger-causality approach to test the "starve the beast" hypothesis. Likewise, I carry out Granger-causality tests between government spending and spending tax changes and counter-cyclical tax changes, the two legislated tax changes that are not included in the already legislated and newly legislated tax changes. Not surprisingly, I find that spending Granger-cause spending-tax changes and spending-tax changes Granger-cause spending. Similarly, I find that spending does Granger-cause counter-cyclical tax changes and that these tax changes do not Granger-cause spending.

[11]A detail explanation and description of each of the four legislated tax changes are explain in Romer and Romer (2009a).

the corresponding tax liability change as implemented or newly legislated tax shocks[12]. For example, the Revenue Act of 1948, that reduced tax rates for all tax payers and increase personal exemptions, was signed and passed over President Truman's veto in April of 1948 and was effective and implemented during the second quarter of 1948. That is, the announcement date and the implementation date are within the same quarter, less day 90 days apart. Thus, the tax change is classified as "newly" legislated tax change. That is, there is no implementation lag since the legislation was effective within less than 90 days of the announcement date.

Similarly, non-implemented or already legislated tax shocks are those changes in taxes for which the announcement date and the implementation date differ by more than 90 days[13]. For example, the Social Security Amendments of 1947, that proposed an increase in the combined Social Security tax rate from 2% to 3%, was signed in August of 1947. However, the legislation was implemented until January 1 of 1950. Therefore, this tax change is classified as already legislated since the announcement date, August of 1947, and the implementation date, January of 1950, are more than 90 days apart. That is, there is an implementation lag period between the announcement date and the date the tax changes were implemented.

The top panel of Figure 3.1 shows the newly legislated tax liability changes and the bottom panel shows the already legislated tax liability changes dated by the quarter of implementation. This figure shows that 36 out of the 70 of the tax liability changes are already legislated while 34 tax liability changes are defined as newly legislated tax shocks. Likewise, Figure 3.2 shows the implementation lags of the already legislated tax liability changes. The median implementation lag in the data is 6 quarters while the longest implementation lag is 27 quarters, associated with the Social Security Amendments of 1983 signed by President Reagan.

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[12]Mertens and Raven (2009) classify this type of shock as unanticipated.

[13]Mertens and Ravn (2009) classify this type of tax shock as anticipated.

3.2.2 Additional Data

In addition with the newly and already legislated tax liability changes as a percentage of GDP, I use quarterly nominal government expenditures deflated by GDP deflator from the National Income Accounts and Product Account (NIPA). I use the same definition as Romer and Romer (2009b) for the government expenditures: total expenditures plus depreciation minus interest payment on government debt[14].

The data on quarterly already legislated and newly legislated tax changes is from 1945Q1 to 2007Q4 while the data on quarterly government expenditure is from 1947Q1 to 2007Q4. Thus in the baseline specification, where I include 12 lags of the newly legislated and already legislated tax variables and 6 leads of the already legislated tax variable, the earliest starting date is 1948Q1 while the latest ending date is 2006Q2.

3.3 Estimating the Impact of Tax Liability Changes on Expenditures

Given the different already legislated and newly legislated tax changes, I estimate the impact of tax changes on expenditure using the following regression model:

$$\Delta E_t = \alpha + \sum_{p=0}^{P} \beta_p \tau^u_{t-p} + \sum_{p=0}^{P} \delta_p \tau^a_{t-p} + \sum_{k=1}^{K} \theta_k \tau^a_{t+k} + e_t \tag{3.1}$$

where ΔE_t is the change in the logarithm of real government expenditure, τ^u_t is the newly legislated tax liability changes in percent of current price GDP at the implementation date t, τ^a_t is the already legislated tax liability changes in percent of current price GDP at the implementation date t and τ^a_{t+k} is the already legislated tax liability changes in percent of current price GDP known at time t + k and implemented at time t. The anticipation effects of the already legislated tax changes are introduced through the θ terms. That is, these coefficients estimate the path of the government spending from when tax changes are announced.

[14]This definition of government expenditures does not included two components that the NIPA aggregates in its government expenditures variable. The first component is the deduction for the consumption of fixed capital. Romer and Romer (2009b) argue that this component reflects spending decisions in the distant past and so can not show "starve the beast" response. The second component is the interest payment on government. Romer and Romer (2009b) explain that for a given interest rate, interest payments increase with the amount of debt. As a result, any tax cut that increases deficit will increase interest payment.

3.3.1 Baseline Results

Table 3.3 shows the results of estimating the baseline equation 1 for total expenditures using the full sample size. Given the availability of the data and the number of coefficients to be estimated, I assume 12 lags of the newly legislated tax shock and 12 lags of the already legislated tax shock. I also assume 6 leads of the already legislated tax change variable since this value corresponds to the median implementation lag[15]. The coefficient estimates for the individual lags and leads of the tax shocks fluctuate between positive and negative. Some of these individual coefficients are statistically significant. The overall fit of the regression (R^2) is 0.27.

Figure 3.3 reports the impulse response functions to a 1% decrease in tax liability changes along with 90% confidence interval. I discuss first the impact of newly legislated tax cut shown in the upper row of Figure 3.3. Panel a shows the impulse response function for a forecast horizon of 12 quarters for newly legislated tax liability shocks. A surprise tax cut sets off an increase in government spending which is consistent with Romer and Romer's (2009b) findings. That is, there is no evidence of the "starve the beast" effects from newly legislated tax shocks. The cumulative effect[16] is always positive at every horizon and the t statistics are significant at 90% of confidence between horizon 4 and 8 and after 12 quarters. The point estimates suggests that a tax cut of 1% of GDP increases spending by 2% after quarter 12, suggesting a "fiscal illusion" effect.

Panel b of Figure 3.3 illustrates the implied response of total expenditure to an already legislated tax cut of 1 % of GDP 6 quarters before its implementation to 12 quarters after. A decrease in already legislated taxes reduces government expenditures before these taxes are implemented up to quarter 3 after the implementation period but then reduces it again. The point estimates reach its minimum point 2 quarters before the taxes are actually implemented. These estimates indicate that a 1% of already legislated tax cut

[15] In the next sections, I expand the number of lag variables and the number of lead variables included in the base line equation.

[16] The cumulative impact of a surprise shock after n quarters is just the negative of the sum of the coefficient on the contemporaneous value and first n lags of the newly legislated tax shocks. Similarly, the cumulative impact of a pre-announced shock is the sum of the coefficients on the contemporaneous value and leads and lags of the already legislated tax shocks.

decreases spending by 6%. The point estimates associated with reductions in spending are always significant at 90% of confidence. Contrary to previous recent studies (Ewing, Payne, Thompson and Al-Zoubi, (2006); Young, A. T., (2008); Romer and Romer, (2009b)), these results provide evidence of the “starve the beast” hypothesis during the implementation period and between horizon 7 and 11 after the taxes are implemented.

These results have some important implications about voters and policy makers decisions. First of all, voters do not associate surprise tax cuts with lower future spending that are needed to satisfy the government budget. This lack of foresight leads voters to demand greater government spending since the “price” of this spending, taxes, have decreased. Contrarily, pre-announced tax cuts help voters to recognize the cost of these cuts in terms of future lower spending, inducing individuals to ask for lesser spending. Secondly, policy makers make decision based on current information adjusting spending plans as soon as news of future tax cuts are pre-announced. In fact, pre-announced future tax cuts affects policy makers’ spending plans before these cuts are implemented.

3.3.2 Different Anticipation Horizons

The baseline regression equation 3.1 assumes that the already legislated tax changes affect government expenditures 6 quarters before the new legislation is implemented. However, some of the legislations have an implementation lag that is greater than this median anticipation lag. Figure 3.4 shows the effect of already legislated tax cut of 1% on government expenditure using different anticipation horizon, from 4 quarter to 10 quarters, and 12 lags of the newly legislated and already legislated tax variables. An already legislated tax cut of 1% reduces government spending during the implementation period and at some point after the 9th quarter, regardless of the assumed anticipation horizon. It is also important to point out that the reduction in government spending increases when the anticipation horizon increases during the implementation period while the opposite occurs during the post implementation period. These results show the importance of the implementation period since taxes that are pre-announced do have an impact on spending even before these taxes take place[17].

3.3.3 Implementation Lag of Newly Legislated Tax Liability Changes

Mertens and Ravn (2009) use a timing definition to identify already legislated versus newly legislated tax changes based on the difference between the implementation of the new legislation date and the date of the new legislation's signature. If this definition is right, there should not be any effect of the newly legislated tax changes on spending before the implementation date[18]. In order to test whether these tax changes are really surprise tax shocks, I modified the baseline model and estimate the following model:

$$\Delta E_t = \alpha + \sum_{p=0}^{P} \beta_p \tau^u_{t-p} + \sum_{p=0}^{P} \delta_p \tau^a_{t-p} + \sum_{k=1}^{K} \theta_k \tau^a_{t+k} + \sum_{k=1}^{K} \lambda_k \tau^u_{t+k} + e_t \tag{3.2}$$

where the anticipation effects of the newly legislated tax liability changes are introduced through the λ_k terms.

Figure 3.5 shows the cumulative response of government spending to a newly legislated tax cut of 1% of GDP for 6 quarters before the tax implementation and 12 quarters after the implementation along with 90% confidence interval. There is no evidence that a newly legislated tax cut has an impact on government expenditures before these tax changes are implemented. The cumulative effect is always close to zero and the t-statistics of the point estimates are always non significant. However, after the post implementation period, there is strong evidence of the fiscal illusion hypothesis which is consistent with the results from the baseline model. These results suggest that the newly legislated tax changes are in fact surprise tax shocks, contrasting with the the results that already legislated tax shocks have an effect on spending before the new legislations are implemented.

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[17] Mertens and Ravn (2009) also estimate the impact of anticipated tax changes on output using different lead structure.

[18] Mertens and Ravn (2009) also include lead in the regression analysis of unanticipated tax changes and output.

3.3.4 Effects of Newly Legislated and Already Legislated Tax cut on Future Revenues

The analysis presented in the previous subsection finds evidence of the "starve the beast", at least using already legislated tax changes. The idea of the "starve the beast" implies that tax cuts increase the fiscal deficit, forcing policy makers to reduce government spending. That is, the government budget adjusts to tax cuts, though out government spending cuts. However, if the "starve the beast" hypothesis holds, already legislated tax cuts today should not increase future taxes since the budget adjustment process is throughout spending cuts under this idea.

Similarly, I also find evidence that newly legislated tax cuts lead to increases in government spending. That is, there is evidence in favor of the fiscal illusion idea. This idea should imply that tax cuts today will increase future taxes in order to adjust the government budget. The government budget should adjust to tax cuts through out future tax increases which means that newly legislated tax cuts today should increase taxes in the future. In order to see how revenues and policy makers respond and adjust to already legislated and newly legislated tax changes, I estimate the impact of already legislated and newly legislated tax changes on both tax legislation and tax revenues.

I re-estimate equation 3.1 using different types of definitions for tax revenues as a dependent variable and same lag and lead structure as the base equation. I measure revenues using three different approaches. First I use federal total receipts, deflated by the price index for GDP from NIPA. Second, I use only tax receipts and deflated by the price index. Third, I estimate the average tax rates using tax revenues as a share of GDP.

Figure 3.6 shows the implied cumulative response of total receipts to a tax cut of 1% of GDP along with the 90% confidence interval. Panel a shows the response of revenues to newly legislated tax-cuts. A tax cut decreases total revenues the first 6 quarters. However, the estimates of the first couple of quarters are not statistically significant. Then, receipts increase after 8 quarters, which could imply that policy makers use future tax increases to finance tax cuts. Panel b shows the response of revenues to a already legislated tax cut. As expected, an already legislated tax cut has not impact on total revenues during the implementation period. Total revenues decline strongly in the short run in response to a tax cut right after the tax cut is implemented. Likewise, total receipts remain below their pretax cut path for almost two years. After this period receipts then recover.

Figure 3.7 and 3.8 show the response of tax revenues and average tax rates to a newly legislated and already legislated tax cut of 1%. The results form these exercises are very similar to the last findings. In both figures, tax revenues and the average tax rate follow the same path as total receipts. Under the newly legislated case, tax revenues and tax rates declines the first quarters and then rise after 8 quarters. The already legislated scenario is also very similar to my previous findings. Already legislated tax cuts have no effect on the tax rates and tax revenues during the implementation period. After these period, tax rates and revenues decline first and then recover after 11 quarters.

All these findings seems to support the results from previous subsection. Already legislated tax cuts do "starve the beast" while newly legislated tax cut create a fiscal illusion. In order to further see whether or not these tax cuts have an effect on future taxes, I estimate the impact of already legislated and newly legislated tax changes on the other tax liabilities changes proposed by Romer and Romer (2009). I use this approach to see if tax cuts affect policy makers' tax decisions. That is, I want to see whether policy makers legislate tax increases to adjust the government budget. The empirical framework is the same as in equation 1, with the difference that the dependent variable is now a measure of legislated tax changes. I use 6 leads and 20 lags for the already legislated case and 20 lags for the newly legislated case to see the full impact on legislated tax changes.

Figure 3.9 shows the estimated impact of a tax cut of 1% of GDP on tax changes of various types[19] along with the 90% confidence interval. Panel a shows the response of legislated tax changes to newly legislated tax cuts. A newly legislated tax cut has no impact on tax changes during the the first 8 quarters. However, after this time, tax changes of different types increase. The point estimates are statistically significant, suggesting that newly legislated tax cuts tend to be followed by tax increases. This result is consistent with the idea of fiscal illusion where policy makers need to increase future taxes after tax cuts to balance the fiscal budget constraint.

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[19]These types include counter cyclical and spending tax changes.

Panel b shows the estimated impact of an already legislated tax cut on legislated tax changes. Similarly to my last findings, an already legislated tax cut has no impact on tax changes of different types during the implementation time. After this time period, there is also no impact of an already legislated tax cut on tax changes of various type[20] either. That is, already legislated tax cuts today are not financed with future taxes. This results is consistent with the idea of the "starve the beast". Tax cuts today reduce government spending and has no effect on future tax.

3.4 Robustness Analysis

This section contains a detailed robustness analysis[21]. Specifically, I examine the robustness of the findings by specifying a more complicated and dynamic model, controlling for political variables and for exogenous spending shocks and assuming a model closely tied to policymakers decisions.

3.4.1 Richer Dynamics

The baseline results suggest that there is evidence of the "starve the beast" hypotheses during the implementation period and also at some point after the new legislations have been implemented. However, the baseline estimates are based on a simple regression model. Here I consider several approaches to allow for more complicated dynamics.

Additional Lags

The first approach is to allow the already legislated and newly legislated tax shocks to have a longer lasting effect on spending by increasing the number of lags in equation 3.1. The baseline analysis was based on 12 lags of the tax shock variables. However, the "starve the beast" hypothesis does not make any predictions about the exact timing of how government spending responds to revenues. Therefore, I increase the number of lags of the already

[20]This result also provides evidence that the tax smoothing hypothesis may hold too. Under this idea, only future government spending affect current and future tax rates. However, it would be necessary additional results to provide full evidence of this hypothesis.

[21]This analysis is similar to Romer and Romer (2009b). However, I incorporate the newly and already legislated tax shocks into the analysis.

legislated and newly legislated variables to allow for the possibility that the response of spending to revenues may be delayed or gradual. Figure 3.10 shows the results of including 20 lags of already legislated and newly legislated tax changes along with 6 leads of the already legislated tax shocks. For horizons beyond 12 lags, the estimated cumulative impact of a surprise tax cut of 1% of GDP on total expenditure is always positive and significant. Likewise, the estimated cumulative impact of a already legislated tax cut of 1% is for the most part negative for almost all horizons and significant during the implementation period and between quarters 5 and 11. Thus, this specification provides evidence of the “starve the beast” hypothesis associated with already legislated tax shocks and fiscal illusion associated with newly legislated shocks which is consistent with the baseline results.

Spending Lags

In order to allow longer-lasting dynamics, I estimate equation 3.1 allowing the spending variable to depend on its own lags as well as on the tax liability changes. This approach also allows for dynamics beyond the number of lags of the tax variable that are included. Therefore, the regression equation takes the following form:

$$\Delta E_t = \alpha + \sum_{q=1}^{Q} \gamma_q \Delta E_{t-q} + \sum_{p=0}^{P} \beta_p \tau^u_{t-p} + \sum_{p=0}^{P} \delta_p \tau^a_{t-p} + \sum_{k=1}^{K} \theta_k \tau^a_{t+k} + e_t \quad (3.3)$$

where the lags of the government expenditure variable are introduced through the γ_q terms.

Panel a and b of Figure 3.11 shows the impulse response function to a 1% decrease in newly legislated and already legislated tax shocks respectively for a forecast horizon of 20 quarters. I assume 4 lags[22] of the spending variable, 12 lags of the already legislated and newly legislated tax shocks and 6 leads of the already legislated shock. This figure shows that the estimated response of spending to an innovation of -1% of GDP of the surprise and announced spending shocks is similar to the results of the baseline specification. The point estimates suggest that an already legislated tax shock “starve the beast” during the implementation period and around the 8th horizon quarter after the implementation date.

[22]The results are robust by allowing for more lags of the spending variable.

Likewise, the point estimates suggest that a newly legislated tax shock has a fiscal illusion effect on spending.

Vector Autoregression (VAR)

Another way that the baseline results could change is if already legislated and newly legislated tax shocks affect other variables that may affect government spending. Thus, I consider VAR models with additional variables. Rather than include a long list of variables that could be relevant, I consider a combination of the following relevant variables.

- Real Government debt. I include this variable since government tax cuts may pressure reduction in government spending through increases in government debt.

- Real GDP. Some studies (Romer and Romer 2010) suggests that tax cuts have short-run effect on output that could have effects on the dynamics of government spending and tax changes.

- Real Government Revenues. In order to include both sides of the government budget, I include government revenues in the VAR model.

- Nominal interest rate and inflation. The inter-temporal government budget constraint includes not only the government spending and revenues but also interest rates and inflation. Thus, these two variables might affect the government spending and tax shocks relation. The VAR-7 that I propose includes these two variables.

  Given these variables in addition with the exogenous already legislated and newly legislated tax shocks, the VAR estimates of the impact of the tax shocks on spending come from the following regression model:

$$\Delta X_t = \alpha + \sum_{q=1}^{Q} \gamma_q \Delta X_{t-q} + \sum_{p=0}^{P} \beta_p \tau^u_{t-p} + \sum_{p=0}^{P} \delta_p \tau^a_{t-p,0} + \sum_{k=1}^{K} \theta_k \tau^a_{t+k,i} + e_t \tag{3.4}$$

  where X_t is a vector of endogenous variables[23].

[23] The real revenues and real GDP variables enter in equation 4 in log terms.

Similar to the baseline specification, equation 3.4 assumes 12 lags of the already legislated and newly legislated tax shocks, 6 leads of the anticipation shocks and 4 lags of the endogenous variables[24]. Figure 3.12 shows the cumulative impact of already legislated and newly legislated tax cut on expenditures using different VAR specifications. Panel i.a and i.b show the cumulative impact of a newly legislated and already legislated tax cut shocks on government spending respectively using a VAR 2 model with spending and government debt as endogenous variables. Panel ii.a and ii.b show the impact of a decrease of newly legislated and already legislated tax changes on government spending respectively using a VAR 3 model with spending, government debt and real GDP as endogenous variables. Row: iii.a and iii.b illustrates the results of a VAR 3 using government spending, debt and revenues as endogenous variables while the lower panel shows the results of a VAR 6 using spending, real debt, revenues, GDP, interest rate and inflation.

All the results associated with newly legislated tax shocks of Figure 3.12 consistently fail to support the "starve the beast" hypothesis. However, the results associated with the already legislated tax cut show support in favor of the "starve the beast" argument. Adding debt to the VAR model in fact moves the estimates further in line with the "starve the beast" hypothesis during the implementation period and in most of the horizon quarters after the tax changes are implemented. These results are similar to the ones of the VAR-3 model with real GDP as an endogenous variables and the VAR-3 with revenues as an endogenous variable. In the 6-variable regressions, the "starve the beast" hypothesis holds only during the implementation period and there is evidence of the fiscal illusion associated with already legislated tax shocks after horizon quarter 10 of the post-implementation period. In all of 4 of those system, the reduction in spending after already legislated tax cuts reaches the maximum value at quarter 2 before the new legislations are implemented.

[24]The results are robust by allowing for more lags of the endogenous variable.

3.4.2 Korean War

Romer and Romer (2010) explain that fiscal policy was very unusual during the Korean War period. Figure 3.13 illustrate the results of the baseline model after reducing the sample size to exclude the years of Korean War. The post Korean War sample results suggest that a surprise tax cut increases government spending all horizon quarters. The cumulative increase in government spending after 12 quarters reaches 4%. These results are similar to the ones associated with the already legislated tax cuts at least after the implementation period. A decrease in pre-announced tax changes reduce government size before the changes are implemented, reaching the maximum reduction at horizon quarter -2.

3.4.3 Omitted-variable Bias

Omitted-variable bias occurs when a model is underspecified. That is, the estimated model incorrectly leaves out one or more key causal factors, causing OLS estimator to be biased and inconsistent. One of the conditions that must hold for omitted-variable bias to exist in linear regression is that the omitted variable must be correlated with one or more of the included independent variables[25]. If political variables and exogenous spending shocks variables play a crucial role in the government spending and tax changes liabilities relation and if such as variables are correlated with the tax shocks, the baseline regression could suffer from omitted variable bias. For this reason, I include political variables and government spending into the regression equation 1.

Political Variables

Usually democrat politicians are seen as supporters of bigger government and higher tax rates while republican politicians as supporters of smaller government and lower tax rates. If this hypothesis holds, it is possible that the party of the president might play a key role on government spending decisions. For this reason, I added a political variable into equation 3.1. Figure 3.14 illustrates the effect of a newly legislated and already legislated tax liability

[25]The second condition is that the omitted variable must be a determinant of the dependent variable.

cut on spending when a dummy variable for democratic administrations[26] is included in the regression. This figure shows that a surprise tax cut increases spending in all horizon quarters which is consistent with my previous findings. Panel b of Figure 3.15 illustrates that the cumulative point impact of already legislated tax cut on spending is negative during the implementation period and at some point after the taxes are implemented. Nevertheless, the cumulative impact after the implementation period is never significant at 90% confidence. In line with my previous findings, these results find evidence of the "starve the beast" hypothesis during the implementation period.

Government Spending Shocks

Romer and Romer (2009b) argue that many of the long run tax changes were followed by wars. These wars could have caused government expenditure to increase. To test for this possibility and to consider government spending shocks, I include Ramey (2011) military action variable in the base line regression. Similar to Romer and Romer (2009a) tax shocks, Ramey (2011) suggests a list of exogenous military actions from narrative sources. Specifically, Ramey (2011) constructs a set of exogenous government spending shocks associated with war periods. The shocks are combine in a dummy variable for changes in federal military spending associated with the Korean war, the Vietnam war, the Carter-Reagan military actions and the terrorist attacks of September 11. This war dummy variable is equal to zero at all dates, apart from 1950Q3, 1965Q1, 1980Q1 and 2001Q3.

The estimated equation 3.1 takes the following form:

$$\Delta E_t = \alpha + \sum_{p=0}^{P} \beta_p \tau_{t-p}^{u} + \sum_{p=0}^{P} \delta_p \tau_{t-p}^{a} + \sum_{k=1}^{K} \theta_k \tau_{t+k}^{a} + \sum_{p=0}^{P} \sigma_p w_{t-p} + e_t \tag{3.5}$$

where w_t is Ramey (2011) exogenous military actions.

Similar to the baseline model, I assume 12 lags of the spending tax shocks. Figure 3.15 panel a and b shows the estimated impact of newly legislated and already legislated tax cut of 1% of GDP on government expenditures respectively. A newly legislated tax cut of 1%

[26] I also include a variable for unified government into the analysis. However, the results are similar to the results of Figure 3.14.

of GDP reduces government spending after and before the implementation date with the exception of horizon quarter 6. The point estimates of the pre-announced period are always significantly different from zero at 90% confidence. Likewise, the point estimates between horizon quarter 7 and 11 after the implementation date are always significant and negative.

Contrarily, a decrease in newly legislated tax cut increases government expenditures before horizon quarter 8 and after horizon quarter 10. Between these two horizons, the cumulative impact of a tax cut decreases government spending favoring the "starve the beast" argument. However, these point estimates are not statistically significant. These results suggest stronger evidence of the "starve the beast" hypothesis associated with the already legislated shocks.

3.4.4 Different Definitions of the Government Spending Variable

In the previous sections, I use real government spending to see whether a tax change affects the spending decisions of policy makers. Previous literature (Anderson, Wallace and Warner 1986; Furstenberg, Green and Jeong 1986; Ram 1988; Bohn 1991; Auerbach 2000) use government spending as a share of GDP in order to test the "starve the beast" hypothesis. That is, these studies argue that policy makers could make spending decision based on the ratio of government spending to GDP and not based on the level government spending[27]. In order to be consistent with previous literature, I use this alternative definition of government spending.

First, I use real government spending scale potential GDP[28]. I use potential GDP to try to avoid the short run fluctuation that a tax cut could have on GDP. That is, a temporality tax cut may increase output, reducing government spending as a share of GDP, creating a biased estimation in favor of the "starve the beast". Secondly, I use real government spending scale by GDP since most of the literature use GDP.

Figures 3.16 and 3.17 show the results of these two applications. Panel a shows the impact of a newly legislated tax cut on spending as a share of GDP and panel b shows the

[27]However, under this approach, a tax cut could lead to an decrease on the government spending by changing output and not changing legislators' spending decisions.

[28]I use Potential GDP from the CBO

impact of a newly legislated tax cut on spending as a share of GDP. The results of these two exercises are very similar. A newly legislated tax cut of 1% of GDP generally raises the share of spending in GDP and Potential GDP. The estimated maximum effect is large, around 2% and statistically significant. Thus, the results again fail to support the "starve the beast" hypothesis, and provide support for the fiscal illusion. Likewise, an already legislated tax cut of 1% of GDP decreases the share of spending in GDP and Potential GDP. The decrease on government spending as a share of GDP occurs during the implementation process and after the tax changes occur. The point estimate during the decrease in government spending is statistically significant, proving evidence in favor of the "starve the beast" idea. These results are consistent with the base results presented above.

3.4.5 Budget Government Spending

The baseline specification and all of the robustness results of the previous sub-sections use quarterly data. However, policymakers usually determine how much to spend and not to spend on federal programs annually. In order to check whether policy makers' decisions affect the tax and spending relationship, I aggregate the quarterly already legislated and newly legislated tax changes to elaborate an annual tax variable. Then, I estimate the baseline model using the annual already legislated and newly legislated tax shocks along with the budget-based real expenditures measure from the budget of the United States Government.

In order to be consistent with the baseline, I assume 3 lags of already legislated and newly legislated tax shocks and 2 leads of the already legislated shocks. Figure 3.18 upper row presents the results. Once again, there is no support for the "starve the beast" hypothesis. The response of budget spending to newly legislated tax cuts is quite similar to that using quarterly spending data. However, there is an even stronger evidence of the "starve the beast" hypothesis associated with already legislated shocks. A decreases in already legislated taxes, decreases expenditures through out all the quarters. The point estimates suggest that a pre-announced tax cut of 1% reduces government spending around 5%. This point estimates are statistically significant at 90% of confidence.

The budget process distinguishes between two types of federal spending: entitlement and discretionary spending. While discretionary spending is optional, entitlement spending refers to funds for programs for which funding levels are automatically set. This kind of spending is authorized by permanent laws. It includes entitlements like Social Security, Medicare, and Food Stamps programs through which individuals receive benefits based on their age, income, or other criteria. Spending levels in these areas are dictated by the number of people who sign up for these benefits, rather than by Congress. Since discretionary spending can be adjusted more quickly than entitlement by policymakers, I also examine the response of discretionary spending[29] to a decrease of already legislated and newly legislated tax changes.

Panel 2 of Figure 3.18 shows the cumulative impact of surprise and pre-announced shocks on annual discretionary expenditure. The point estimates of a newly legislated tax cut on discretional spending show an increase in discretionary spending yet these estimates are not significant. Panel ii.b shows a stronger effect of already legislated tax changes on discretionary spending. The cumulative effect is negative in the quarter of the tax cut and the subsequent quarters, as the "starve the beast" predicts. Specifically, an already legislated tax cut of 1% of GDP reduces discretional spending by around 10%.

3.5 Conclusions

The "starve the beast" hypothesis suggests that reduction in taxes decreases or at least limits the size of government. This paper investigates the empirical relationship between US government exogenous tax shocks and expenditures in order to test the "starve the beast" hypothesis. Previous studies have attempted to show that this hypothesis holds empirically. However, these studies suffer from reverse causality, endogeneity of the tax variable and the lack of attention of expectational effects. In order to deal with these problems, I use Mertens and Ravn's (2009) exogenous already legislated and newly legislated tax changes. These tax changes allow us to estimate separately the effect of already legislated and newly legislated

[29]Discretionary spending is only available after 1962. I estimate discretionary spending as total spending minus the sum of social security, income security, veterans benefits and services, agriculture, commerce and housing credit net interest and undistributed offsetting receipts. This is also the approach that Romer and Romer (2009b) follow.

tax shocks on spending and to see how news about taxes affect spending even before these taxes change.

My results provide direct empirical evidence of the"starve the beast" hypothesis and emphasizes the importance of expectation. I find that already legislated tax cuts reduce government expenditures before the new legislations are implemented and in some cases during the post-implemented period. These results hold even under different implementation lags. In fact, I find that the longer the assumed maximum anticipation horizon, the deeper is the pre-implementation spending reduction. Likewise, I show that the results are very robust since they do not derive from specific assumptions, nor that they are by endogeneity of the tax changes or by missing control for other important variables.

The results regarding the presence of anticipation effects have important implications. First, it provides empirical evidence towards the importance of distinguishing between newly legislated and already legislated shocks. My results show that these two shocks affect government spending in different ways. While announced future tax changes affect spending even before these changes are implemented, newly legislated tax changes affects spending right after the changes are implemented. Second, it provides some empirical evidence towards the importance of rational expectation in spending decisions. My results illustrate that policy makers make spending decision whenever they have news about future tax changes and do not wait until these tax changes are implemented. Third, pre-announced tax cuts help voters to recognize the cost associated to these cuts, leading them not to demand greater spending as the fiscal illusion idea suggests.

Table 3.1: Summary of the Relationship Between Taxes and Spending According to Different Theories.

Theory	Taxes and Spending Relationship
Starve the Beast	Positive Relationship
Fiscal Illusion	Negative Relationship
Fiscal Synchronization	No Specific Relationship
Tax Smoothing	Positive Relationship
Institutional Separation	No Relationship

Table 3.2: Romer and Romer's (2009a) legislated tax changes classified by motivation

Legislated tax change	Motivation
Long-run tax changes	These tax changes include those made to amend the efficiency and equity of the tax system and to boost incentives increasing long-run growth.
Deficit-driven tax changes	These tax changes consist of those made to reduce an inherited budget deficit.
Countercyclical tax changes	These tax changes include those made because policy makers believe that economic growth in the near future will be above or below its normal path.
Spending-driven tax changes	These tax changes are motivated by contemporaneous changes in spending. When policy makers introduce a new program, social benefit or a new spending, policy makers raise taxes to pay for it.

Romer, C. D. and D. H. Romer (2009a), "An Narrative Analysis of Postwar Tax Changes",
University of California Berkley

Table 3.3: Estimated Impact of an Already Legislated and Newly Legislated Tax Cut on Expenditures.

Regressor	Coefficients	Standard Errors
Constant	0.09	(0.20)
τ_t^u	-0.45	(0.52)
τ_{t-1}^u	-0.79	(0.55)
τ_{t-2}^u	-0.64	(0.54)
τ_{t-3}^u	-0.62	(0.53)
τ_{t-4}^u	-0.60	(0.53)
τ_{t-5}^u	-0.07	(0.53)
τ_{t-6}^u	0.94	(0.54)
τ_{t-7}^u	-2.06	(0.53)
τ_{t-8}^u	1.19	(0.54)
τ_{t-9}^u	2.24	(0.54)
τ_{t-10}^u	-0.18	(0.54)
τ_{t-11}^u	-1.09	(0.54)
τ_{t-12}^u	-1.33	(0.53)
τ_{t+6}^a	0.15	(1.33)
τ_{t+5}^a	0.86	(1.36)
τ_{t+4}^a	1.43	(1.32)
τ_{t+3}^a	1.94	(1.34)
τ_{t+2}^a	1.28	(0.98)
τ_{t+1}^a	-1.39	(1.14)
τ_t^a	-1.19	(1.10)
τ_{t-1}^a	-1.56	(0.98)
τ_{t-2}^a	-1.04	(0.97)
τ_{t-3}^a	-1.85	(0.97)

Continued on next page

Table 3.3 – continued from previous page

Regressor	Coefficients	Standard Errors
τ^a_{t-4}	-0.27	(0.98)
τ^a_{t-5}	1.20	(1.01)
τ^a_{t-6}	-1.58	(1.02)
τ^a_{t-7}	2.14	(1.01)
τ^a_{t-8}	2.28	(0.99)
τ^a_{t-9}	0.58	(0.99)
τ^a_{t-10}	-0.10	(1.08)
τ^a_{t-11}	-1.42	(1.13)
τ^a_{t-12}	-0.48	(1.02)
R^2	0.27	
DW	1.81	

Expenditures is defined as Gross Total Expenditures less interest payments.

The sample period is 1948Q1-2007Q4.

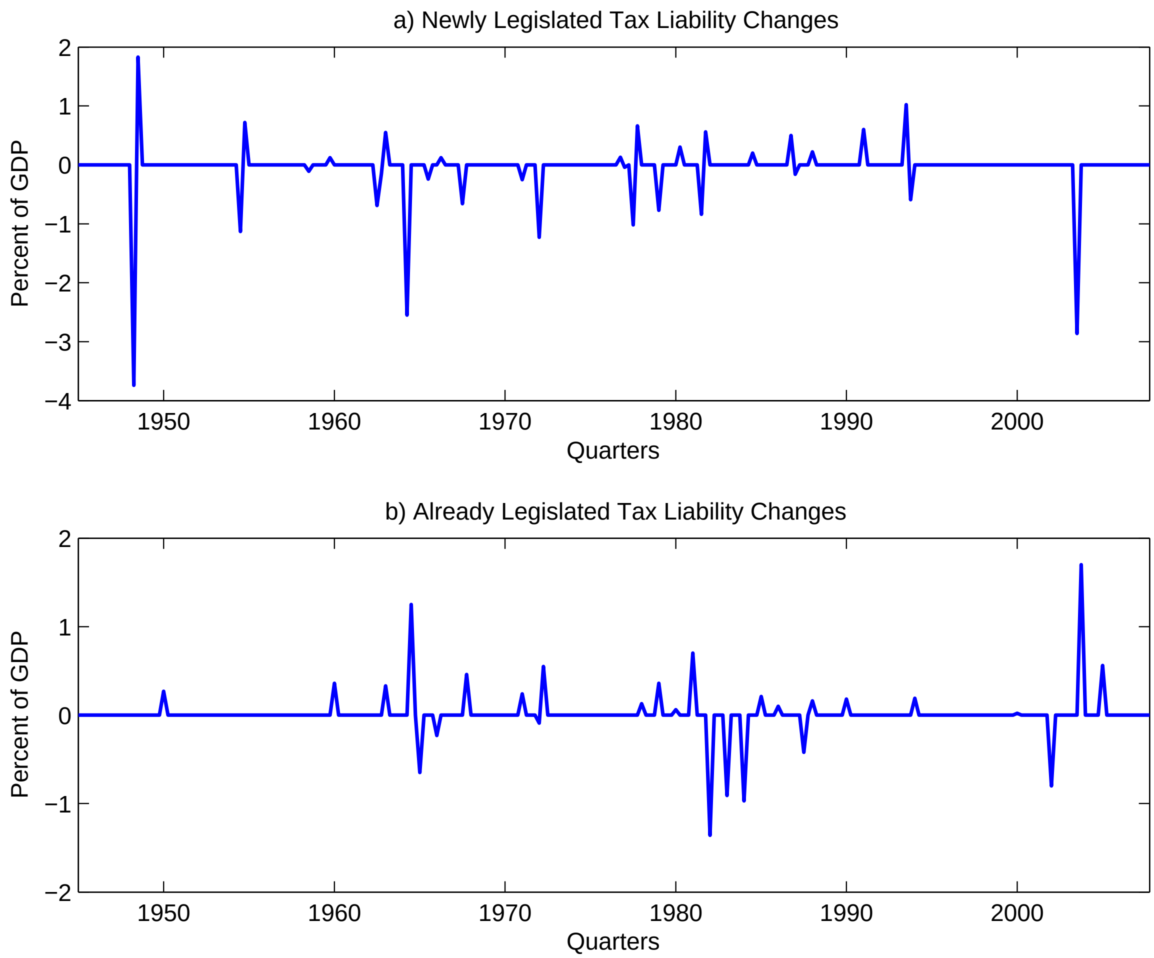

Figure 3.1: Tax Liability Changes as % of Current Price GDP. Source: Mertens and Ravn (2009), "Empirical Evidence on the Aggregate Effects of Unanticipated and Anticipated U.S. Tax Policy Shocks".

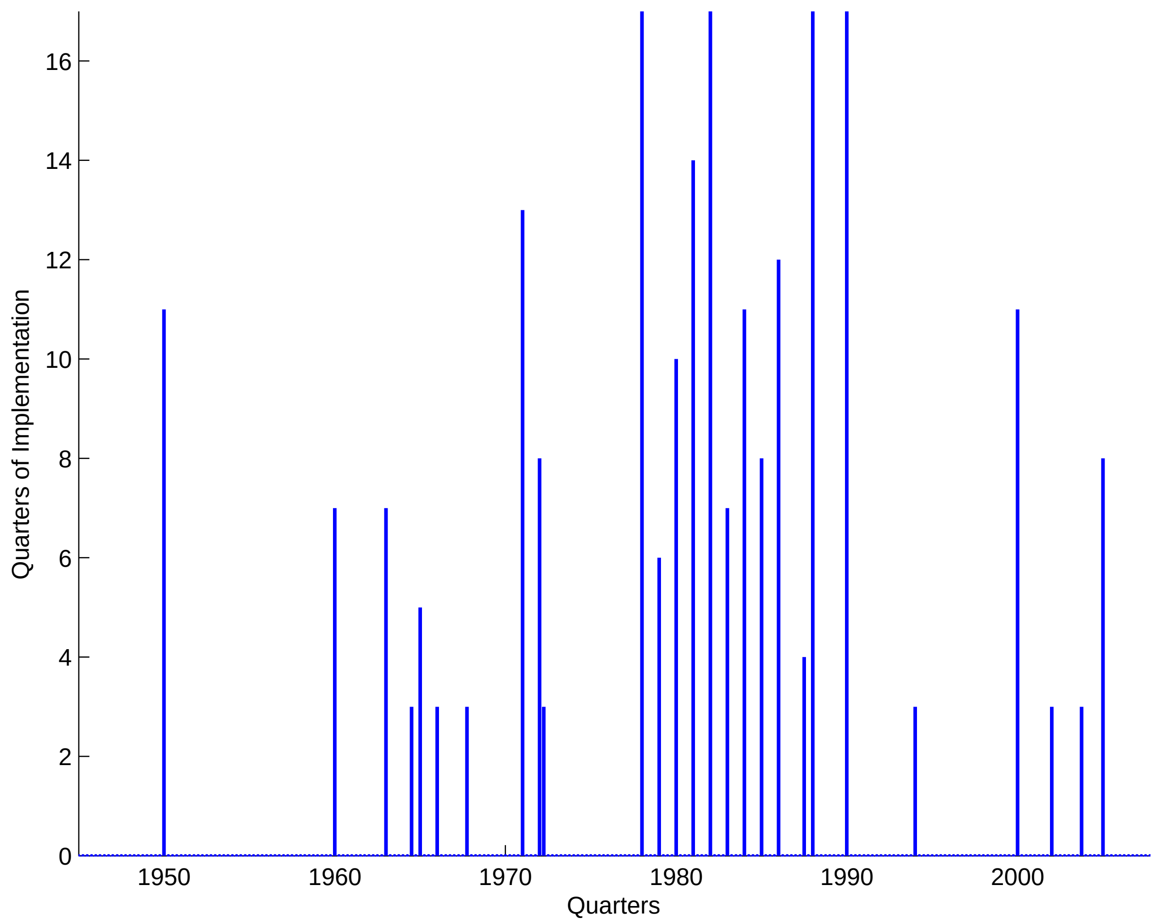

Figure 3.2: Tax Liability Anticipation Horizon.Source: Mertens and Ravn (2009), "Empirical Evidence on the Aggregate Effects of Unanticipated and Unticipated U.S. Tax Policy Shocks".

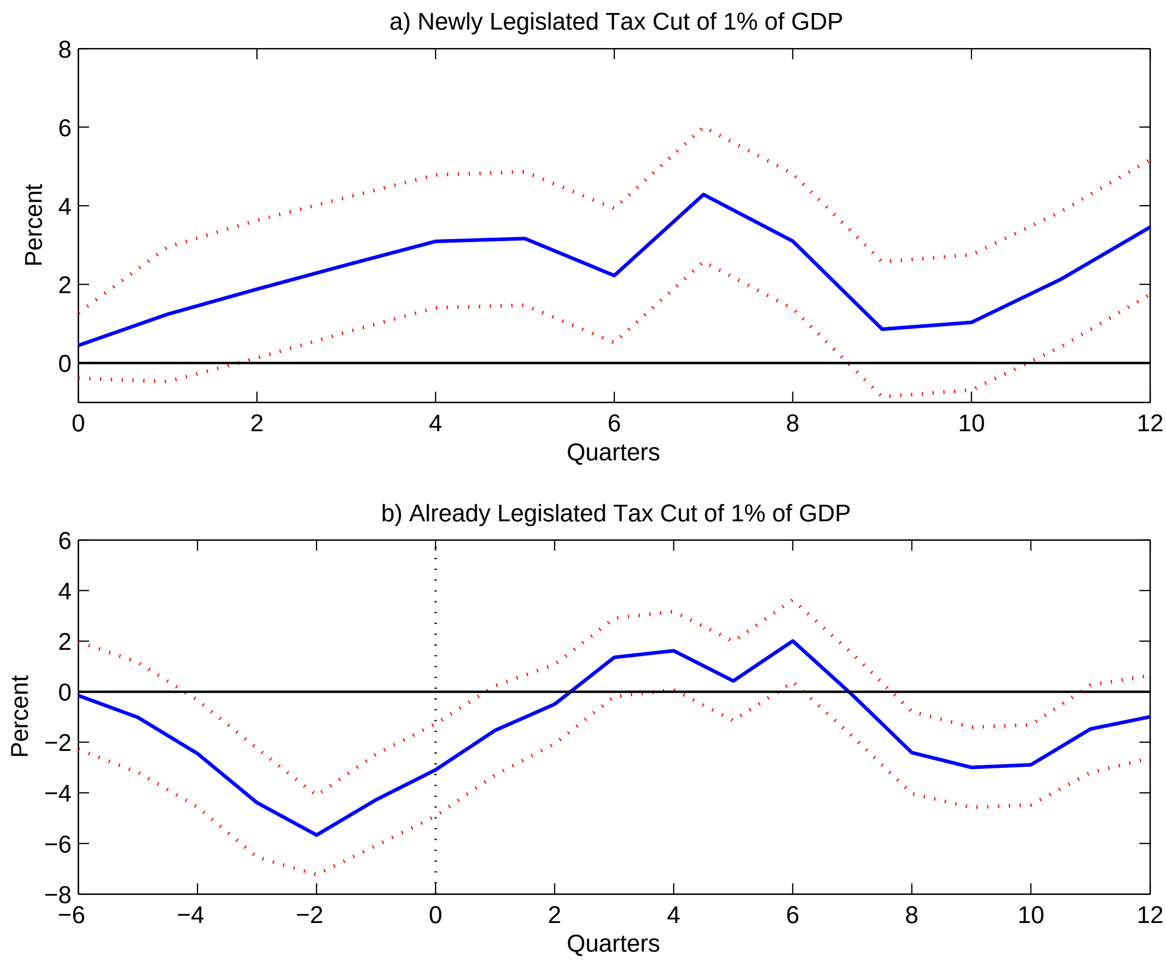

Figure 3.3: Estimated Cumulative Impact of a Newly Legislated and Already Legislated Tax Cuts on Expenditures. Baseline Specification (12 Lags and 6 Implementation Horizon).

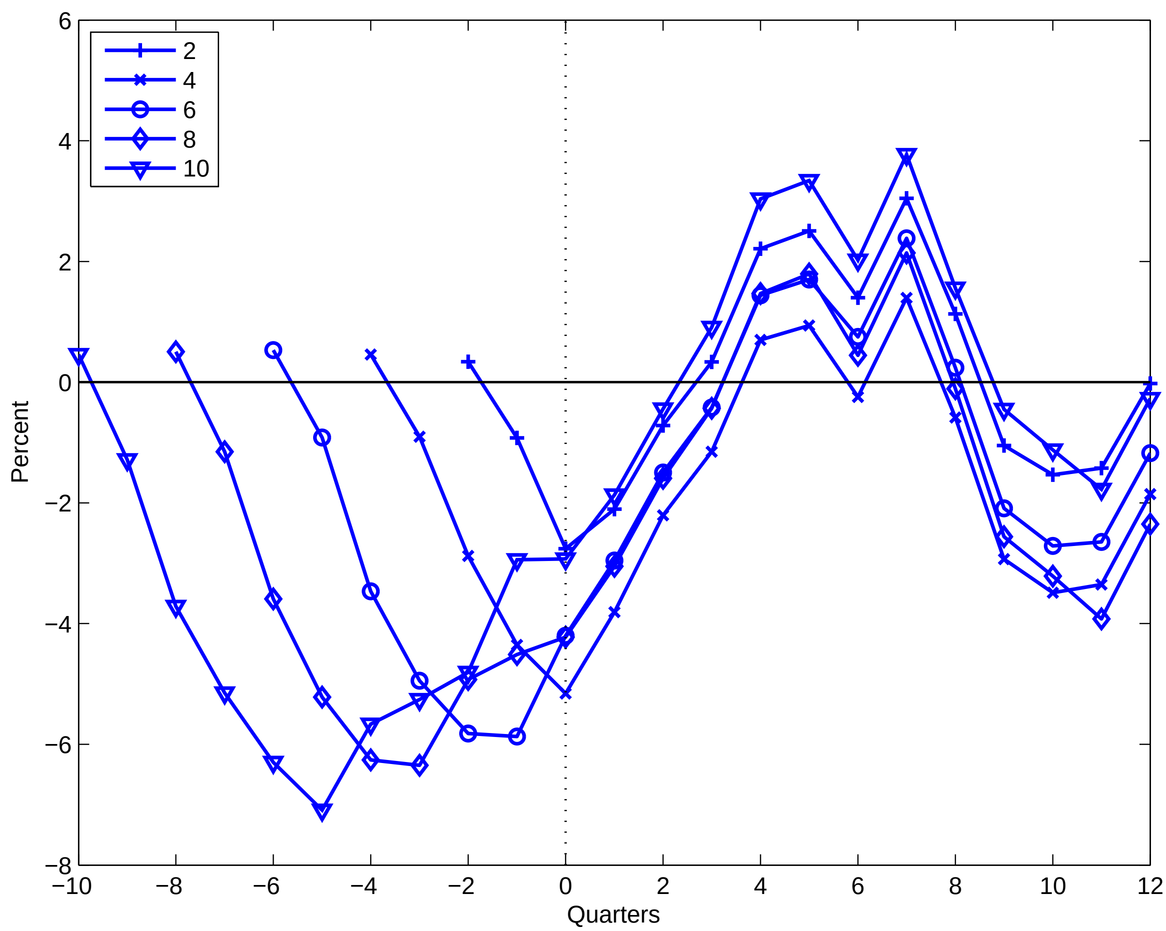

Figure 3.4: Estimated Cumulative Impact of an Already Legislated Tax Cut on Expenditure for Different Anticipation Horizon (12 Lags).

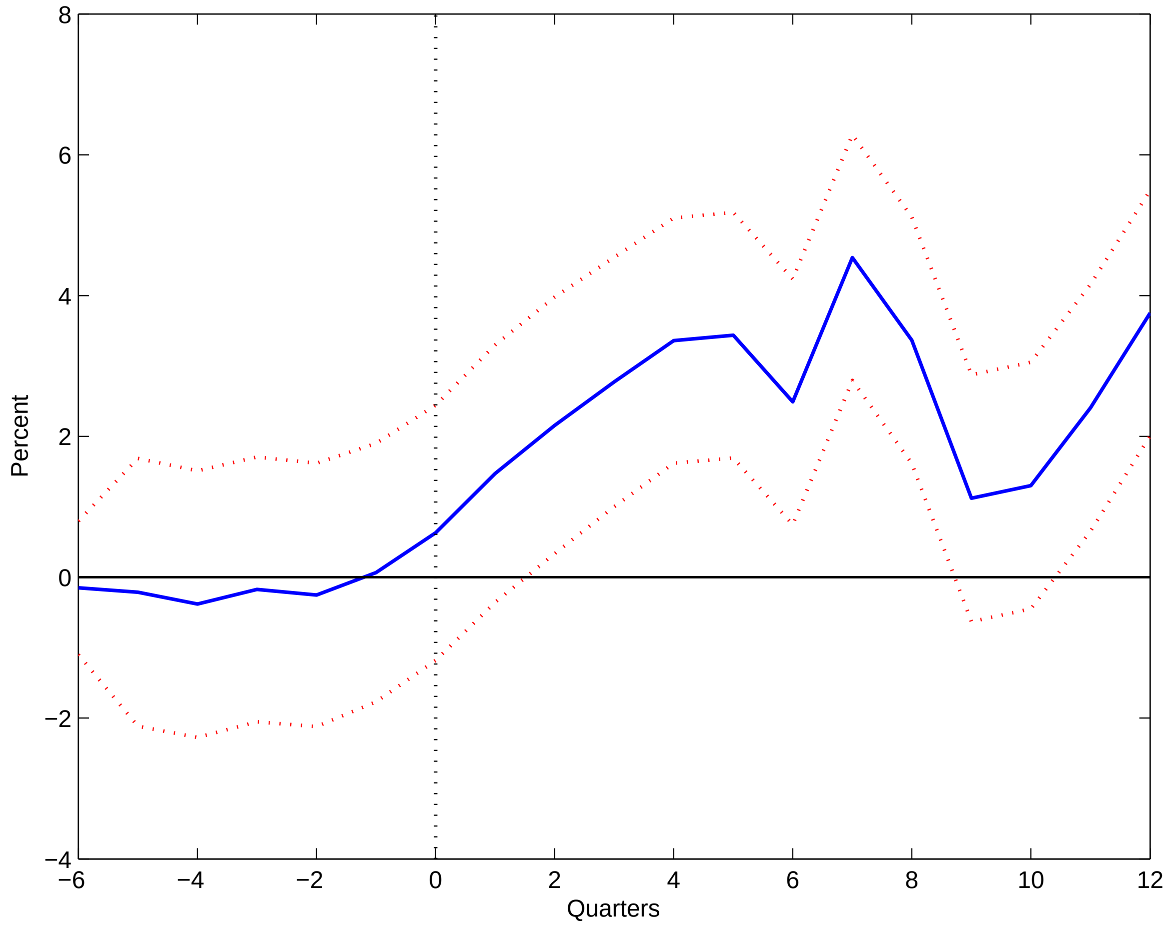

Figure 3.5: Estimated Cumulative Impact of a Newly Legislated Tax Cut on Expenditure (12 Lags and 6 Implementation Horizon).

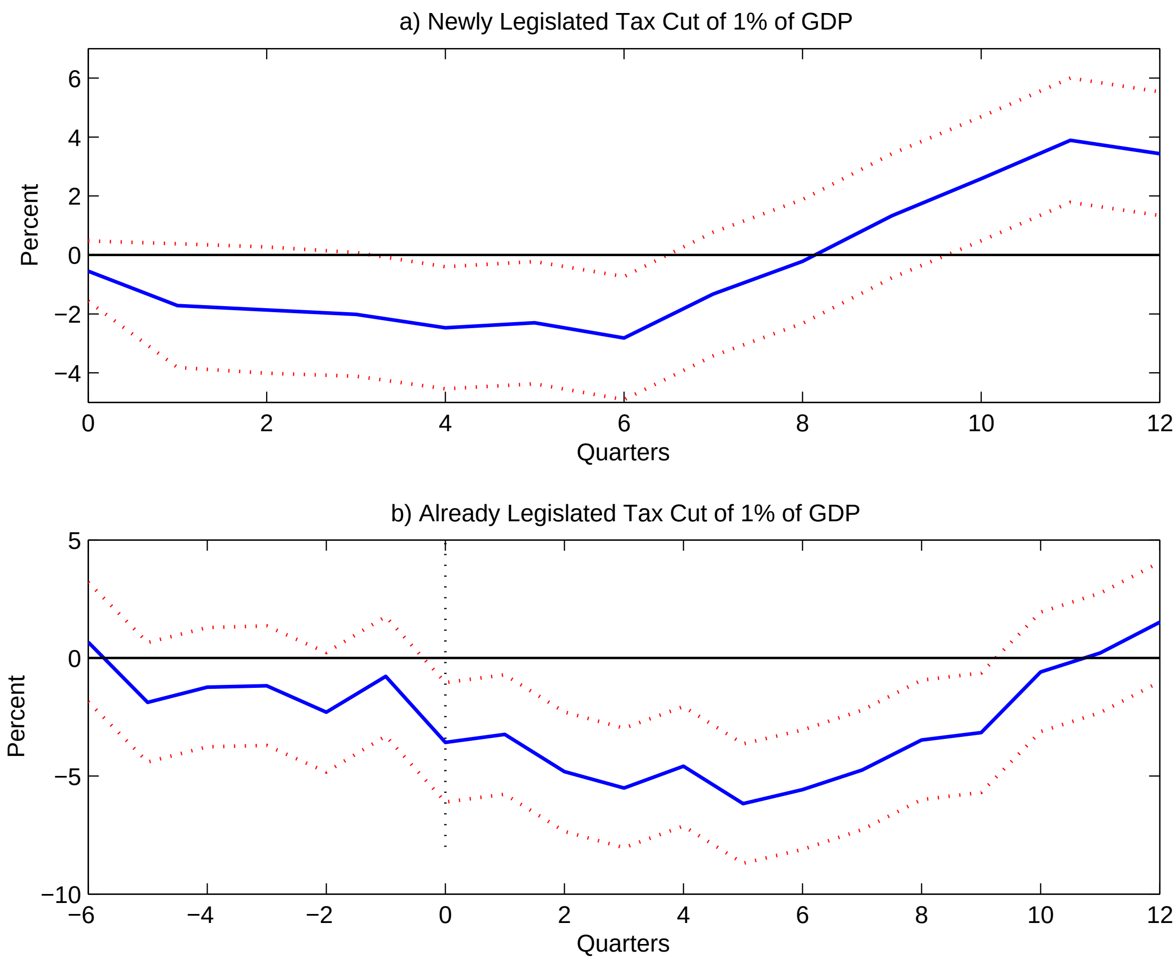

Figure 3.6: Estimated Cumulative Impact of a Newly legislated and already legislated tax cut on total government revenues (12 Lags and 6 Implementation Horizon).

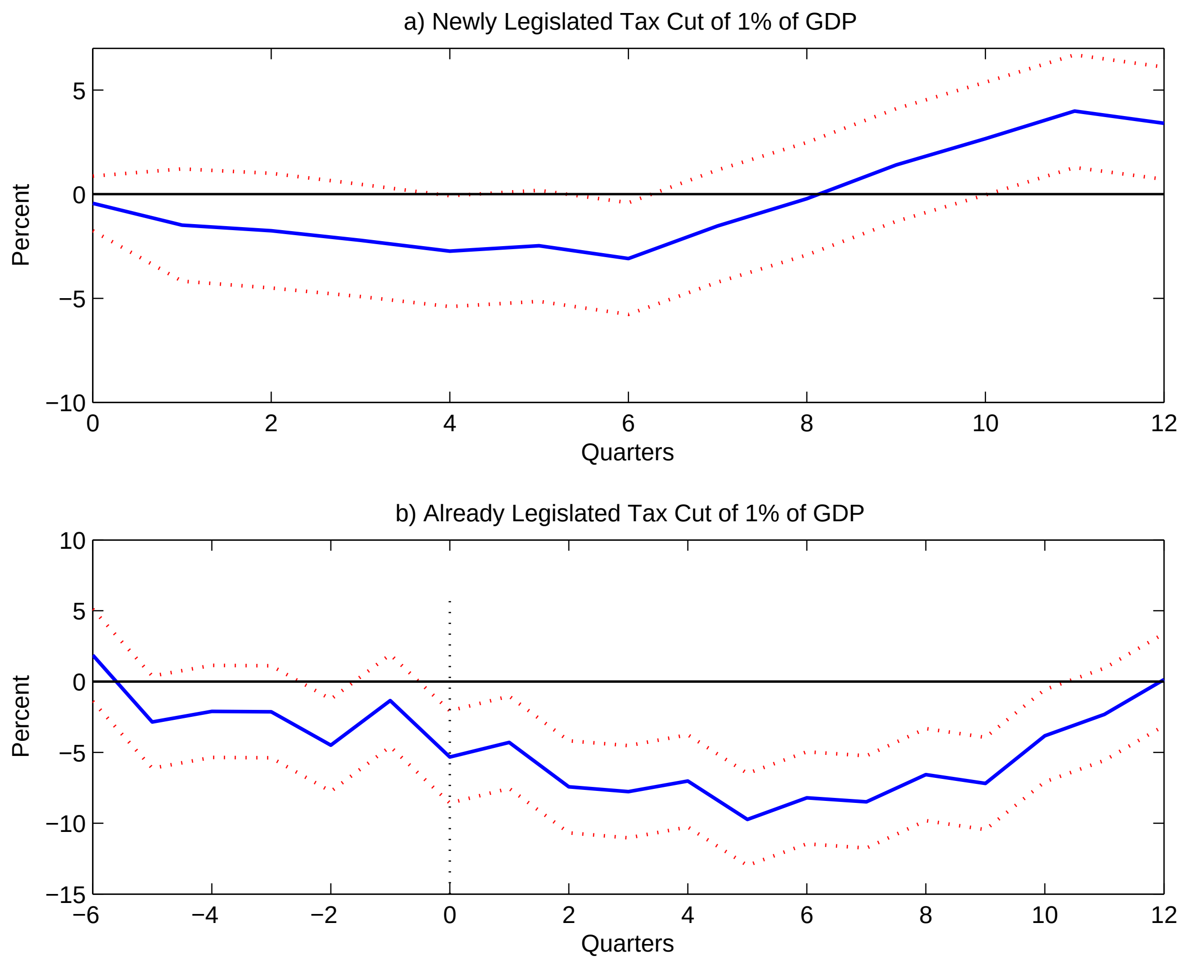

Figure 3.7: Estimated Cumulative Impact of a Newly Legislated and Already Legislated Tax Cut on Tax Revenues (12 Lags and 6 Implementation Horizon).

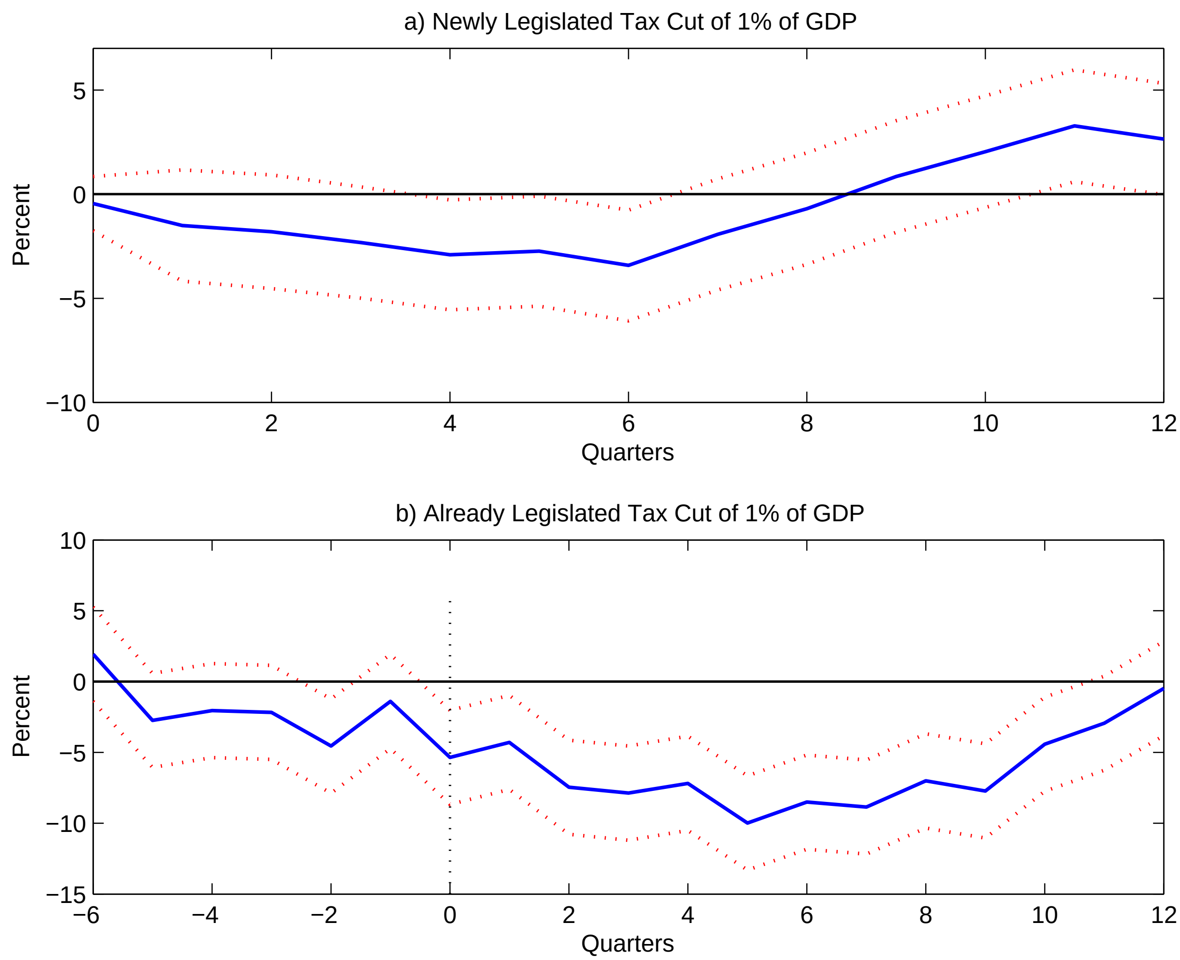

Figure 3.8: Estimated Cumulative Impact of a Newly Legislated and Already Legislated Tax Cut on the Average Tax Rate (12 Lags and 6 Implementation Horizon).

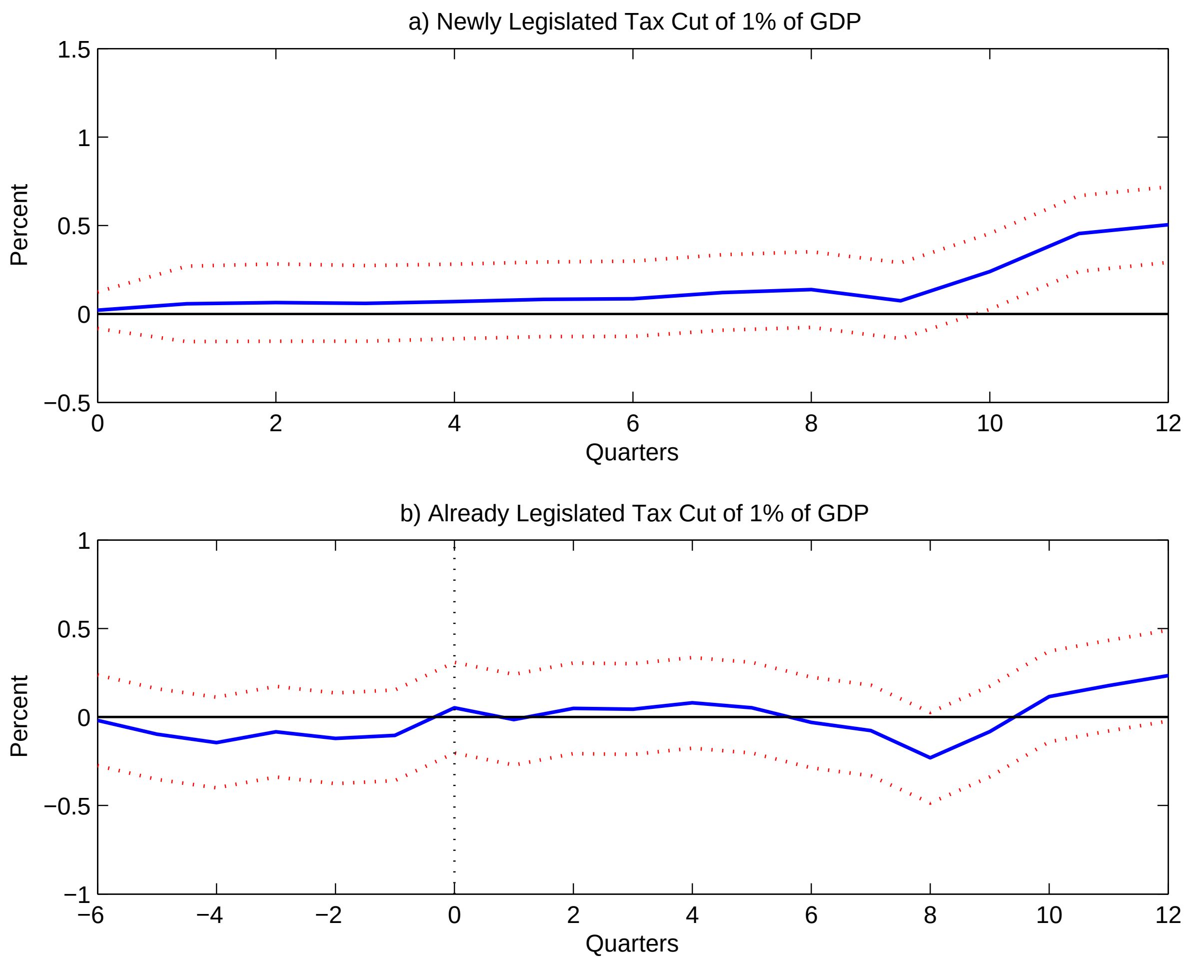

Figure 3.9: Estimated Cumulative Impact of a Newly Legislated and Already Legislated Tax Cut on Tax Changes of Different Types (20 Lags and 6 Implementation Horizon).

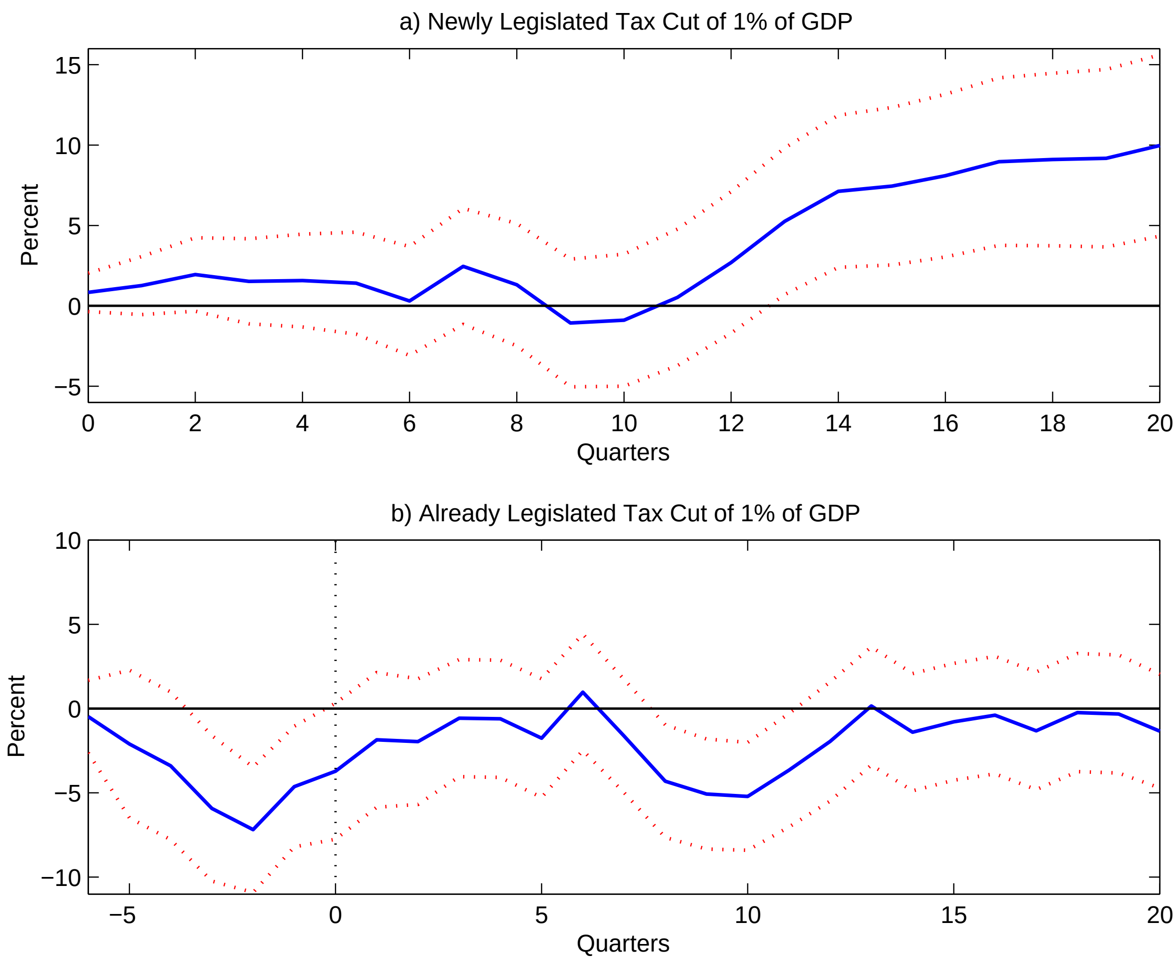

Figure 3.10: Estimated Cumulative Impact of a Newly Legislated and Already Legislated Tax Cut on Expenditure (20 Lags and 6 Implementation Horizon).

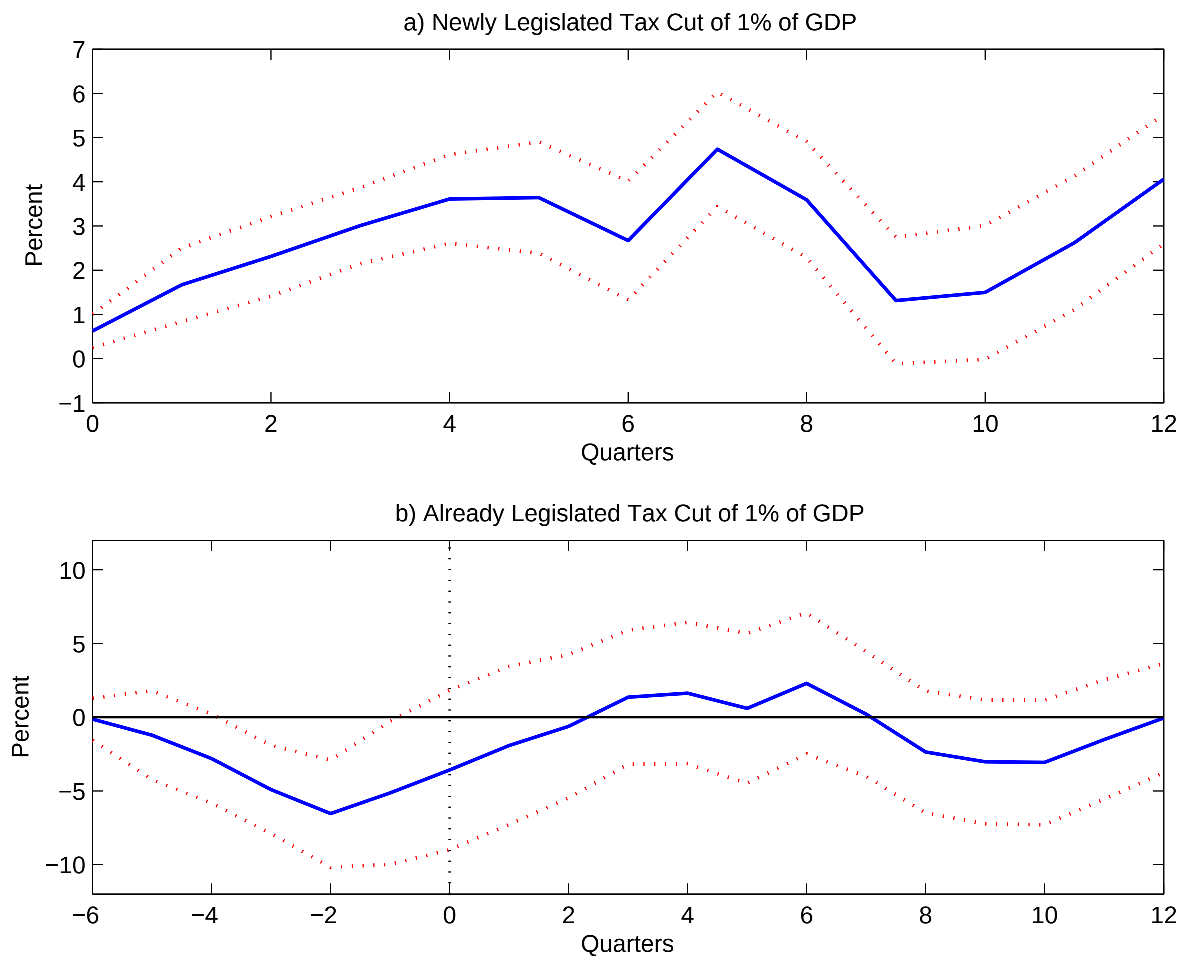

Figure 3.11: Estimated Cumulative Impact of a Newly legislated and Already Legislated Tax cut on Expenditure, including expenditure lags.

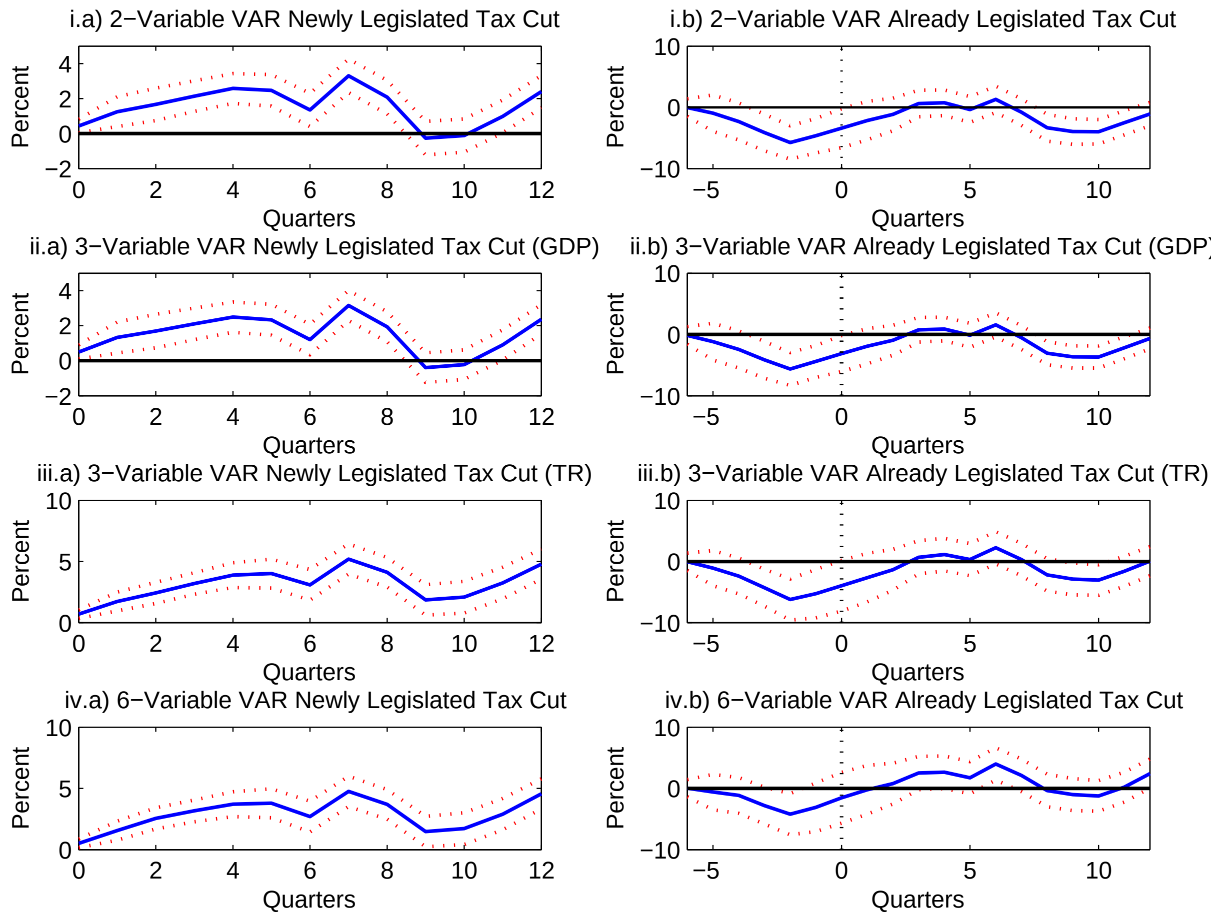

Figure 3.12: Estimated Cumulative Impact of an Already Legislated and Newly Legislated Tax Cut on Expenditure. Multiple VAR Models.

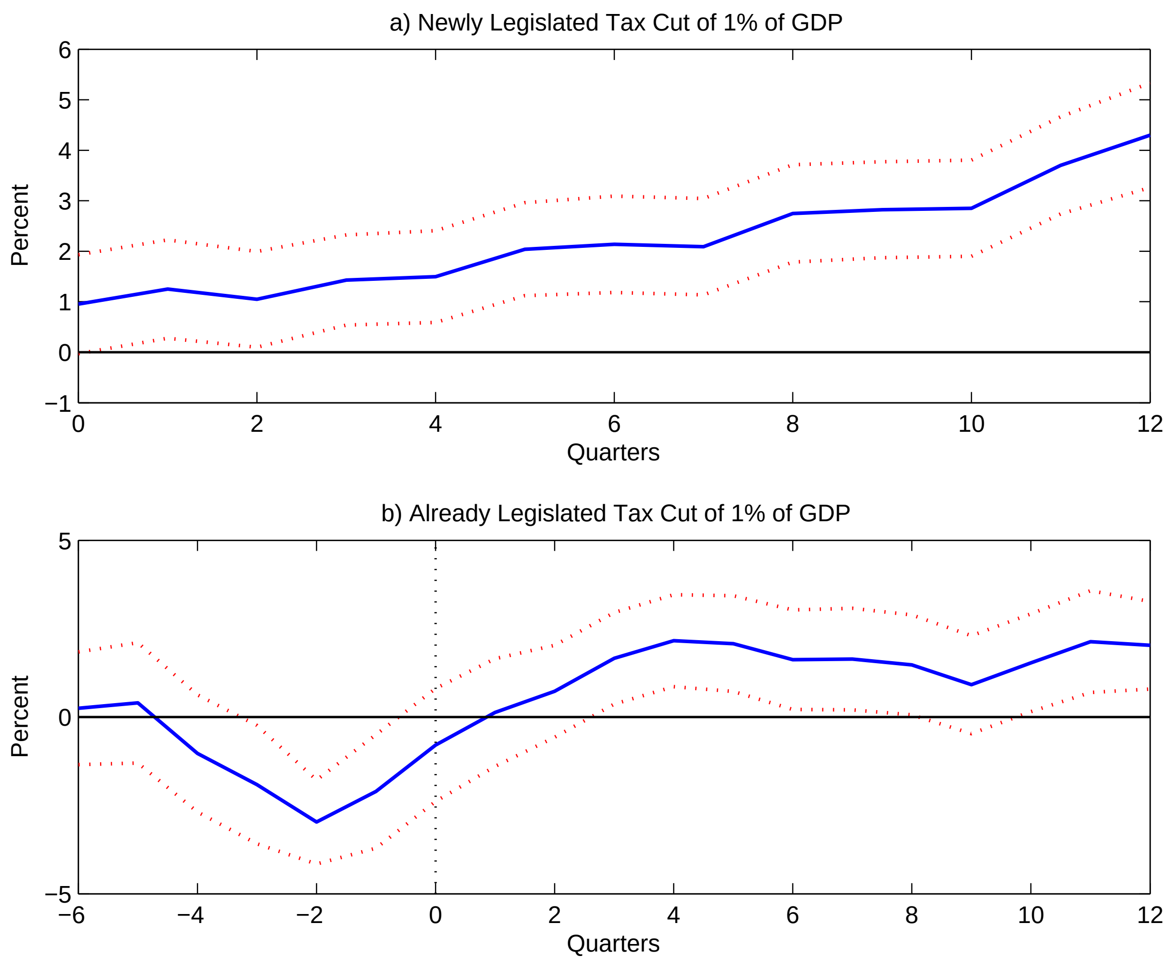

Figure 3.13: Estimated Cumulative Impact of an Already Legislated and Newly Legislated Tax Cut on Expenditure Excluding the Korean War Period.

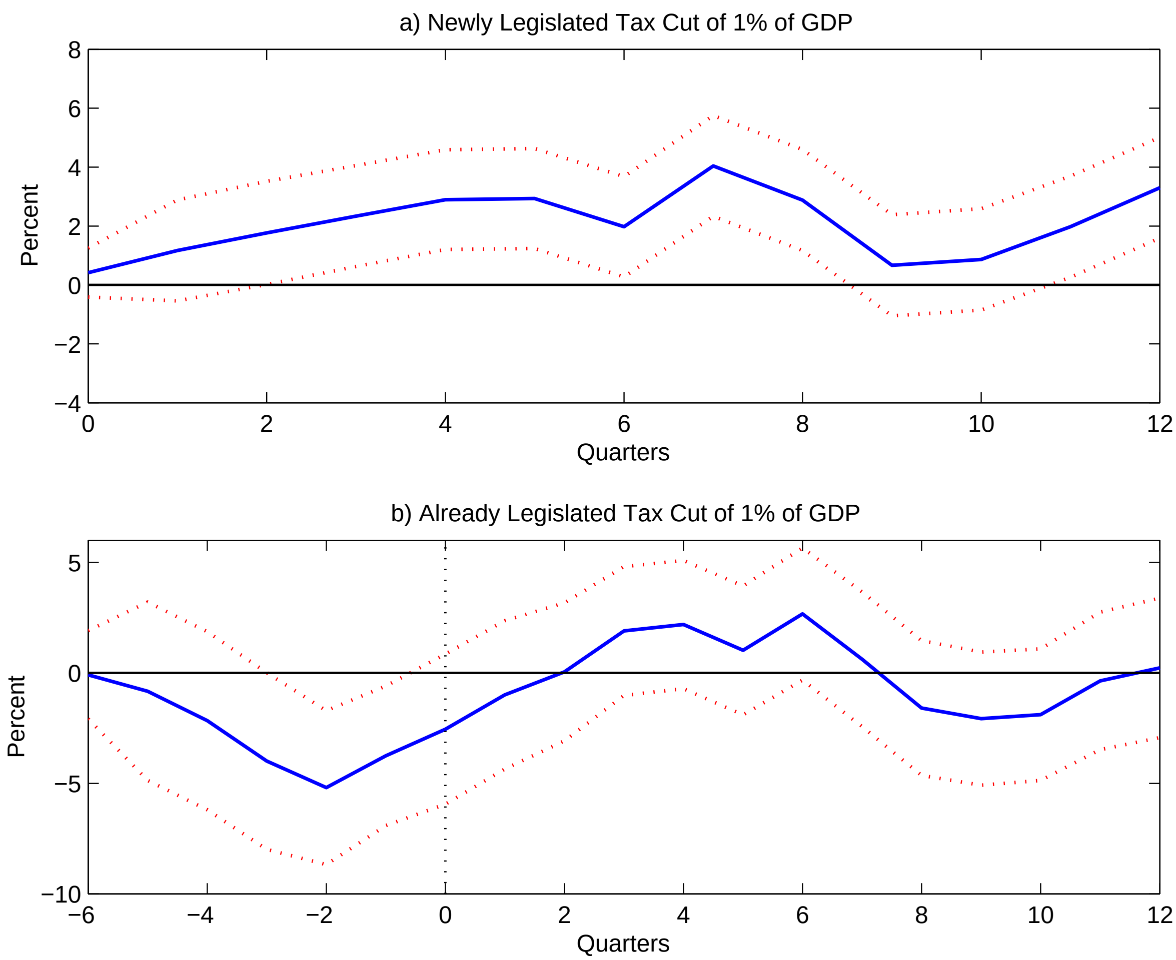

Figure 3.14: Estimated cumulative impact of an already legislated and newly legislated tax cut on expenditure controlling for political variables.

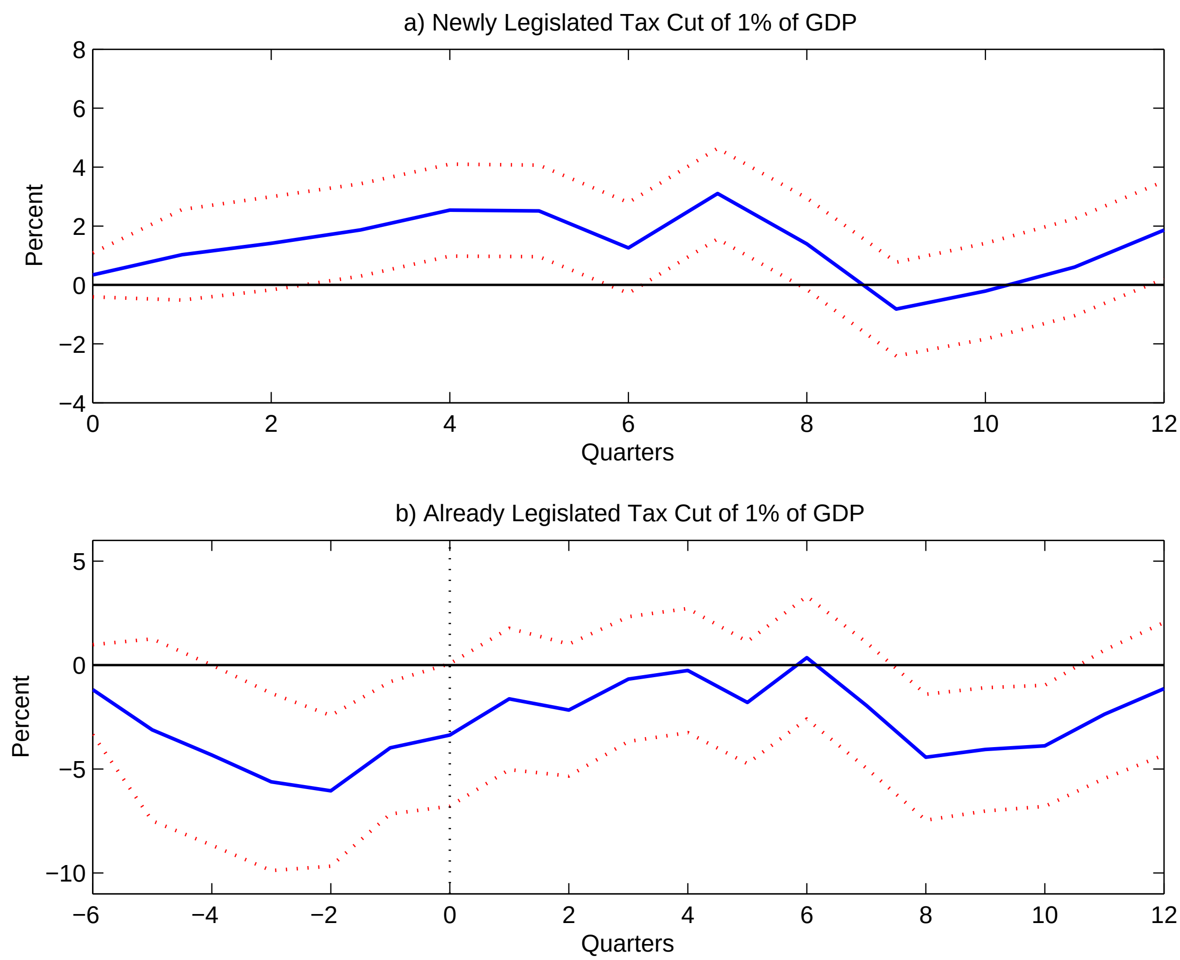

Figure 3.15: Estimated Cumulative Impact of an Already Legislated and Newly Legislated Tax Cut on Expenditure Controlling for Spending Shocks.

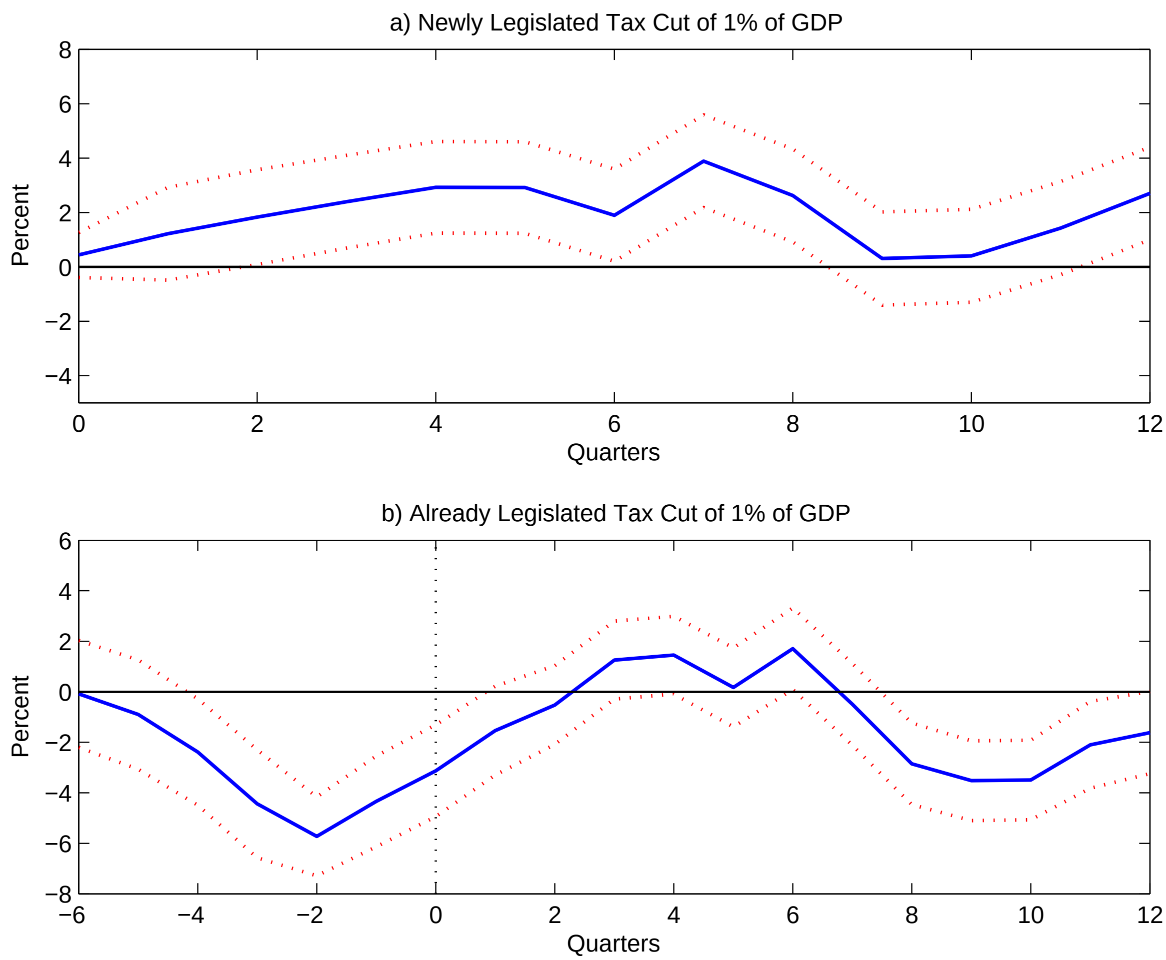

Figure 3.16: Estimated Cumulative Impact of an Already Legislated and Newly Legislated Tax Cut on Expenditure as a Share of Potential GDP.

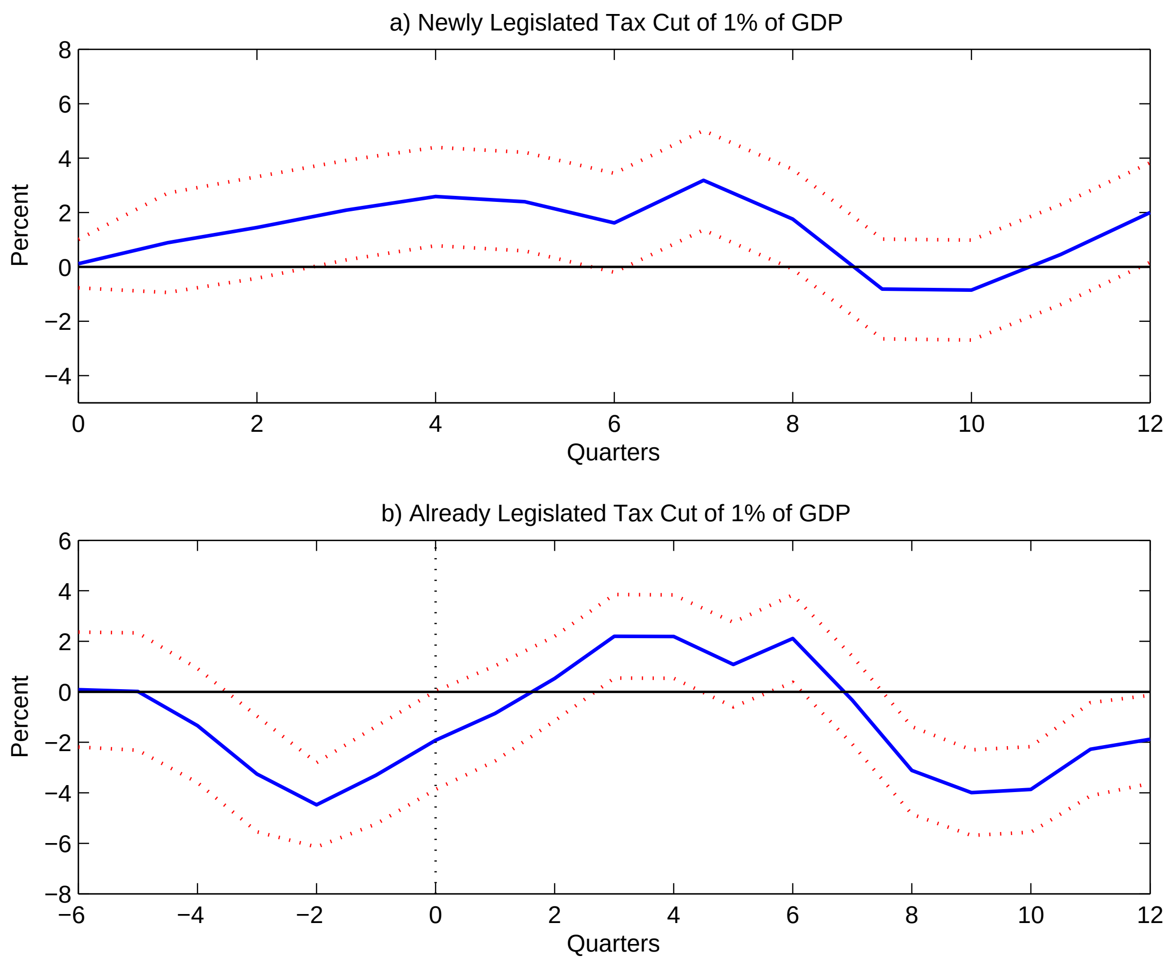

Figure 3.17: Estimated Cumulative Impact of an Already Legislated and Newly Legislated Tax Cut on Expenditure as a Share of GDP.

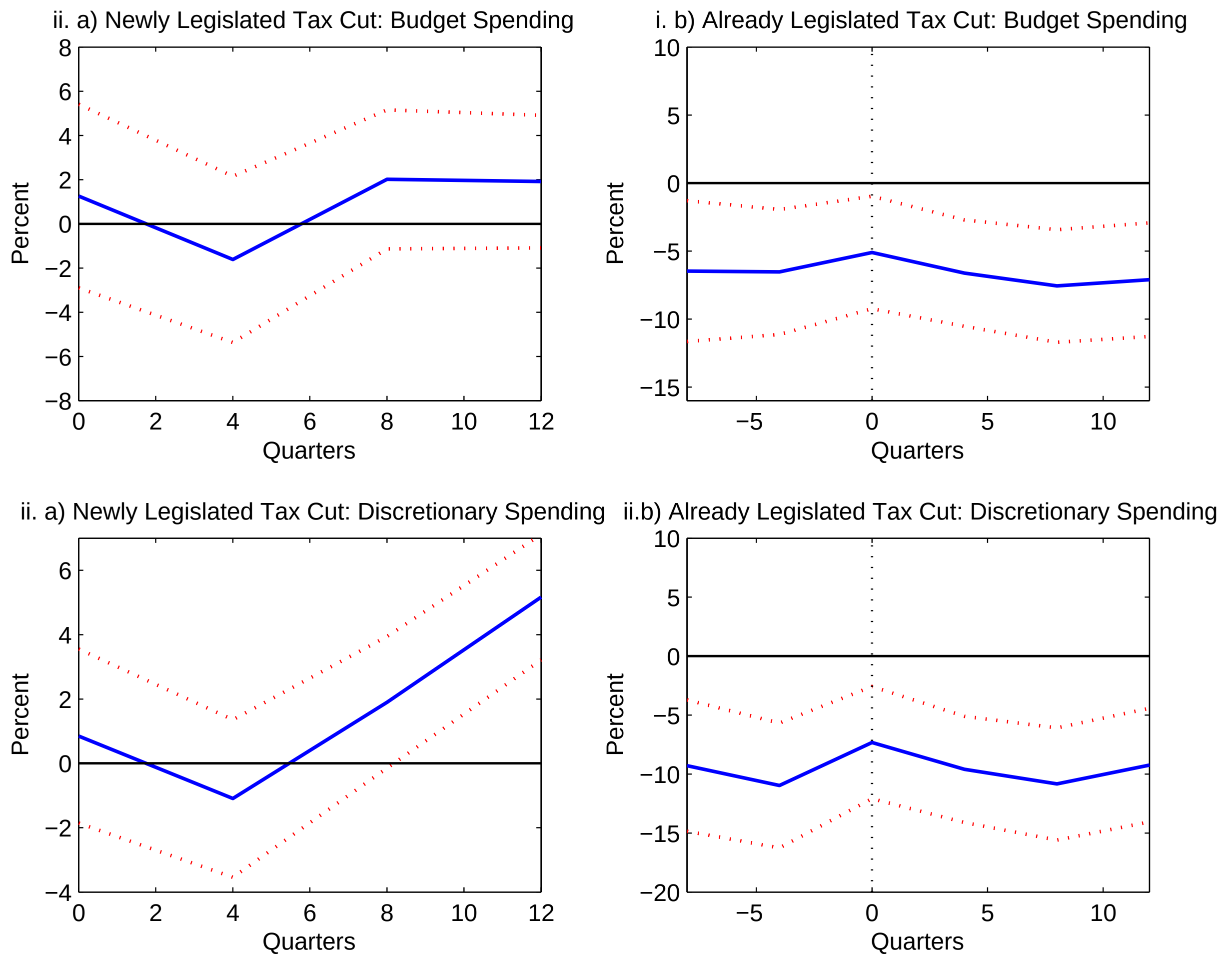

Figure 3.18: Estimated Cumulative Impact of an Already Legislated and Newly Legislated Tax cut on Budget Spending and Discretionary Spending .

Chapter 4

DOES THE TAX SMOOTHING HYPOTHESIS HOLD? EVIDENCE USING EXOGENOUS GOVERNMENT SPENDING SHOCKS

4.1 Introduction

How do tax rates respond to increases in government spending? According to the tax smoothing hypothesis, unexpected spending increases lead to higher tax rates. Barro (1979) argues that the path of government expenditure is taken to be exogenously given, and taxes are adjusted to minimize distortions while the budget is balanced inter-temporally. Taxation under the tax smoothing requires that the government decides the current tax rate based on current and future government spending. If expenditures are uncertain, the government attempt to forecast those expenditures and decides a tax rate congruent with those expenditures. One potential source of unexpected movements in government spending is war conflicts. According to the tax smoothing hypothesis, government will increase taxes during war to reflect the higher present value of government expenditures. This increase in the tax rate during wartime will not perfectly equalize the rise in expenditures since government spendings are expected to decrease after the conflict. Therefore, the government will run fiscal deficits during war time and surpluses during peace time.

Of course, this is not the only point of view of the spending and taxes relationship. Musgrave (1966) argues that tax and expenditure decisions are made simultaneously. This idea proposes that voters compare the marginal benefits and the marginal cost of government programs when deciding the appropriate level of government expenditure and taxes. That is, this strategy would imply that policy makers will forgo a tax cut by forgoing a spending increase. Wilddavsky (1988) proposes the institutional separation hypothesis. He argues that the decision on taxation is independent from the government spending decisions. That is, government taxation is determined with no regards to expenditure, and thus does not response to spending changes.

Whether government spending has an effect or not on the tax rate is important for the understanding of the current and the future path of the government deficit. In fact, the discussion of the US debt ceiling[1] in 2012 included cuts in government spending in order to reduce the fiscal deficit. The discussion ended with a reduction of government spending and an increase of the debt ceiling[2]. The government spending and tax rates relationship is also important for comprehending the impact of "stimulus packages" and war spending on the deficit and on the current and future tax rates. In 2009, President Obama signed a $787 billion stimulus package, entitled the American Recovery and Reinvestment Act (ARRA) of 2009, in order to help the economy to recover from the 2008 financial crisis. This spending increased the U.S. deficit by 3.6%, overall, in 2010.

In the public finance literature, there are different studies that attempt to test the tax smoothing hypothesis. Furstenberg, Green and Jeong (1986), Anderson, Wallace and Warner (1986), Ram (1988), Islam (2001) and more recently Auerbach (2000, 2003), Ewing, Payne, Thompson and Al-Zoubi (2006) and Luna (2011b)[3] propose a VAR model with government spending and revenues as percent of GDP as endogenous variables[4]. These studies have produced a wide variety of results supporting one of the three explanations of the tax and spending relationship. However, these previous studies have not dealt with two important issues. First, the results of these studies suffer from reverse causation problem. Most of these studies have focused on the impact of aggregate spending on taxes using government revenues and lag values of expenditures. This expenditure variable is not exogenous given since this spending depend on the state of the economy. Second, these studies pay little attention to the role of expectation in the tax decision process. Specifically, the spending

[1]Before the discussion, the debt ceiling was $14.3 trillion

[2]The discussion also resulted with the credit-rating agency Standard & Poor's downgrading the credit rating of U.S. government bond for the first time in the country's history.

[3]These recent studies proposed a more sophisticated version of the VAR model. For example, Ewing, Payne, Thompson and Al-Zoubi (2006) propose a Threshold Autoregression (TAR) and Momentum Threshold Autoregression (MTAR) models to address the empirical link between revenues and expenditures, allowing budget surpluses or deficit to have asymmetric effects on the dynamic behavior of expenditures and revenues.

[4]Other studies such as Kochin, Banjamin and Meador (1982), Barro (1990) and Aiyagari, Marcet, Sargent and Seppala (2002) have focussed on the stationary properties of the tax rates in order to show that the tax smoothing hypothesis holds.

shocks associated with the VAR models using current expenditure estimate their impact on the average tax rates when these shocks actually change and not when these shocks are expected to change, leaving aside the role of expectations.

In order to deal with these issues, I examine the effect of exogenous spending shocks on the average tax rate using Ramey's (2009)[5] spending news shocks to check whether the tax smoothing hypothesis holds. These spending shocks have some advantages over the spending shocks associated with VAR models using current government spending. First, the spending news shocks are considered exogenous. These shocks are based on narrative sources and are not motivated by current or projected state of the economy. Second, Ramey's (2009) shocks take into the account expectations of current and future government war spending at the time. Specifically, these shocks measure the expected discounted value of government spending due to foreign political events.

My main results can be summarized as follow: First, my results show that there is a positive link between government war spending shocks and the average tax rates. An increase in government spending increases the average tax rate in all of the horizon quarters. The point estimates associated with the cumulative impulse response function are always significant at a 90% of confidence. These point estimates suggest that a spending increase of 1% of GDP increases the average tax rate 0.2 on average, suggesting a tax smoothing effect. These results contrast with the ones using current government shocks associated with VAR models.

Second, my findings show that failure to recognize the importance of expectations leads to incorrect inferences in regards to the relationship between government spending and taxes. The results using spending shocks based on a VAR model using current expenditure, that do not pay attention to expectation, find no evidence of the tax smoothing hypothesis, while the results using the present value of war spending based on narrative approach find support in favor of the tax smoothing argument. In fact, delaying the news spending shocks 3 quarters provides the same results as the VAR model, showing evidence that the spending shocks associated with current government expenditure were already anticipated.

[5]Ramey (2011) uses these tax shocks to analyze the effect of government spending on real per capita output, interest rate, wages, investment, among others variables.

Third, the results seem to be very robust to different frameworks. I carried out an extensive robustness analysis. First of all, I allow the average tax rate to have a more complicated and dynamic model. Specifically, I increase the number of lags of the spending news variable, I allow the average tax to depend on its lags as well as on the spending shocks and I estimate some VAR models with key variables in addition to the spending news variable. Secondly, I control for political variables and for exogenous spending shocks in oder to avoid omitted bias problem which might be an important issue in small samples. Thirdly, I use different definitions to calculate the tax variable and different exogenous government spending shocks. Finally, I aggregate the quarterly defense spending to construct a fiscal-year measure along with official budget government revenues in order use a model closely tied to policy makers decisions.

The remainder of the chapter is structured as follows: the next section explains the tax smoothing hypothesis and data. Section 4.3 presents the econometric model and the baseline results. Section 4.4 presents the robustness analysis. Section 4.5 concludes.

4.2 Background and Data Description

In the spend-tax literature, there are some theories that explain how government spending affects taxes. The fiscal synchronization theory (Musgrave, 1966) argues that tax and spending decision are made simultaneously while institutional separation argument (Wildavsky, 1988) explains that spending and tax decisions are independent. The spend-tax theory that this chapter wants to assess is that in which changes in government spending lead to changes in tax rates. Barro (1979) argues that government purchases are exogenous given and the government chooses the path of taxes to satisfy its budget constraint while minimizing the present value of the cost of the distortions created by taxes[6]. That is:

$$\min_{\{T_{t+s}\}_{s=0,1\ldots}} E_t[\sum_{s=0}^{\infty} \frac{1}{(1+r)^s} C_t] \tag{4.1}$$

subject to:

[6]This presentation of Barro (1979) model is based on Romer David (2011), Advanced Macroeconomics.

$$\sum_{s=0}^{\infty} \frac{G_{t+s}}{(1+r)^s} + (1+r)B_t = \sum_{s=0}^{\infty} \frac{T_{t+s}}{(1+r)^s} \tag{4.2}$$

where $C_t = Y_t f(\frac{T_t}{Y_t})$ is the cost of distortion in period 1[7], T_t is the path of taxes, G_t is path of government spending, Y_t is the path of output and r is the interest rate.

Given all the relevant information available, Barro's (1979) Euler equation for optimal taxation implies that the current tax rate is an unbiased predictor of future tax rates.

$$\frac{T_t}{Y_t} = E_t\left[\frac{T_{t+s}}{Y_{t+s}}\right]; \qquad \forall s \geq 0 \tag{4.3}$$

where $\frac{T_t}{Y_t}$ is the ratio of taxes to income.

This Euler equation implies that the marginal benefit (MB) and the marginal cost (MC) have to be equal. While the source of the marginal benefit originates from the decrease in taxes at period t, the source of the marginal cost originates from the increases in taxes at period t+1, needed to meet the government budget constraint. These marginal cost and marginal revenues arise from the fact that the cost of distortion is an increasing function of the tax rate. The condition for MC equals MB requires that $\frac{T_t}{Y_t} = \frac{T_{t+1}}{Y_{t+1}}$.

Given the following government intertemporaly budget constraint and substituting equation 4.3 into the intertemporaly budget constraint of the government, efficient plans for taxation are given by the following equation:

$$\tau_t = \frac{r}{1+r}\left(\sum_{s=0}^{\infty} \frac{E_t g_{t+s}}{(1+r)^s} - (1+r)b_t\right) \tag{4.4}$$

where $\tau_t = T_t/Y_t$, $g_{t+s} = G_{t+s}/Y_{t+s}$ and $b_t = B_t/Y_t$, G_t is government purchases, B_t outstanding government debt..

Equation 4.4 has some key implications for efficient taxation. Under certainty, the tax rate will be constant over time ($\frac{T_t}{Y_t} = \frac{T_{t+1}}{Y_{t+1}}$). That is, predictable variations of future spending will be financed by budget deficits or surpluses in order to smooth taxation. However, temporary and unpredictable changes in future government spending will result in tax

[7]The distortion cost is a quadratic function and the cost rise more than proportionally with taxes relative to output i.e. $f(0) = 0, f'(\bullet) > 0$ and $f''(\bullet) > 0$.

changes ($\frac{\Delta \tau_t}{\Delta E_t g_{t+s}} = \frac{r}{1+r} \frac{1}{(1+r)^s} < 1$). That is, the government will forecast future expenditures rationally and decide the tax rates at a level consistent with those forecast about the future. As a result, only sources of unpredictable movements in the spending will induce changes in the tax rates. One potential source of unpredictable movements in government spending is war, since military purchases are usually temporary high during war. According to the tax smoothing hypothesis, government will increase taxes during war to reflect the new higher present value of government expenditures. The increase in the tax rate during wartime will not perfectly equalize the rise in expenditures ($\frac{\Delta \tau_t}{\Delta E_t g_{t+s}} < 1$) since government spending are expected to decrease after the war. Therefore, the government will run fiscal deficits during wartime and surpluses during peace time. Finally, unexpected permanent government spending increases will induce government to increase taxes in every period $\left(\frac{\Delta \tau_t}{\{\Delta E_t g_{t+s}\}_{s=0}^{\infty}} = \frac{r}{1+r} \sum_{s=0}^{\infty} \frac{1}{(1+r)^s} = 1 \right)$. That is, the increase in the tax rate after a permanent spending shock will perfectly equalize the rise in expenditures. Under tax smoothing, deficits and surpluses will be a constant pattern to reflects the increase in government spending as share of income.

In order to test this hypothesis empirically, I use Ramey's (2009) exogenous measure of defense news. Previous studies (Furstenberg, Green and Jeong, 1986; Anderson, Wallace and Warner, 1986; Ram, 1988; Islam, 2001; Ewing, Payne, Thompson and Al-Zoubi ,2006; among others) use a VAR model with aggregate and current government spending and revenues as key variables. However, these studies cannot distinguish between spending shocks and tax shocks from each other. The ability to distinguish between government spending shocks and tax shocks is very important, considering that tax smoothing and starve the beast arguments share the same implications. Under these two approaches, government spending and taxes have a positive relationship. However, the adjustment process is different. Under the "starve the beast" hypothesis, government spending adjust to exogenous tax reductions while under the tax smoothing hypothesis tax rates adjust to government spending shocks. This is why it is very important to distinguish between tax shocks that are not related to spending decisions. For example, if policy makers reduce government spending due to a tax-cut as the "starve the beast" hypothesis suggests, a regression of spending on taxes will show a positive correlation. This result will show evidence of the tax smoothing hypothesis. However, the causation runs in the opposite direction yielding to biased estimates of the effect of spending changes on taxes.

Likewise, Barro (1979) argues that the government sets the current tax rates based on current and future government spending. Under this approach, the government will forecast current and future spending, estimate the discounted present value of those spending as a share of income and set a tax rate that is consistent with those spending forecasts. That is, only expected discounted value of future spending changes as percent of income will change current tax rates. Ramey's (2009) spending shocks not only measure the type of spending that is consistent with Barro's (1979) model but also deal with the problem of endogeinity. Ramey's (2009) spending shocks measure the expected discounted value of future government spending due to foreign political events. That is, these spending shocks should be viewed as an approximation to the changes in expectations at the time.

Ramey (2009) constructs this defense news variable by examining Business Week magazine, the New York Times and the Washington Post. In order to calculate the net present value, Ramey (2009) uses the 3-year Treasury bond rate prevailing at the time. However, before the 1950's Ramey (2011) uses the long-term government bond rate since the other rate was not available. For example, Ramey (2009) estimates a spending shock of $179 billions for the third quarter of 1950[8]. The Business Week on July 1st, 1950, reported that "We are no longer in peacetime economy. Even if communist should back down in Korea, we have had a warning of what can happen any time in all of any of the Asiatic nations bordering on the URSS. The answer will be more money for allies". On August 5th, Business Week reported that the military spending before the Korean conflict was around $15 billion. However, due to the critical circumstances, military spending increase to $33 billion. This increase was expected to last three years. This spending shock is reported in the fourth row of Table 4.1. The spending shock is dated within the third quarter of 1950 to measure the change in future government spending, when the new defense spending was announced and not when the spending was implemented. In order to estimate all of the the forecasting spending shocks of the third quarter of 1950, Ramey (2011) uses all of

[8]This examples is described in Ramey, V. (2009), "Defense News Shocks, 1939-2008: Estimates Based on News Sources". For a full description of all the spending shocks see Ramey, V. (2009)

the forecasting military spending estimates for the current year and future years reported on the New York Times, Washington Post, and Business Week within the third quarter of 1950. Table 4.1 provides the estimates reported on these sources.

Using the information from the table above, Ramey (2009) estimates the average expected defense spending for each year. Then, Ramey (2009) calculates the change in the present value of all of the future spending as the PDV of the sum of the last row minus the first rows. This estimate is then dated as third quarter of 1950. The interest rate used to estimate the PDV in this example is 2.3%.

Ramey (2009) spending shock variable was not relied on official sources since the information was not released in time. If the shocks occurred in the last days of the specific quarter, Ramey (2009) dated it as the next quarter. It is also important to point out that these shocks are considered as exogenous[9] since the shocks were not motivated by current or projected economic conditions.

The Ramey's (2009) spending shock variable includes the the following five main foreign political episodes: Second World War (WWII), Korean War, Vietnam War, Cater-Reagan Buildup and September 11th. The Desert Storm Operation was the only military operation considered that did not require any increase in military expenditures as a percentage of GDP. In fact, it took place during the long reduction in military spending as a percentage of GDP that accompanied the end of the Cold War as Ramey (2009) explains.

Figure 4.1 panel a shows the news spending shocks as a percent of the previous quarter's nominal GDP. This panel shows that the WWII episode was the biggest war spending shock while the Korean War was the second. Figure 4.1 panel b shows federal government spending as percent of GDP in order to compare this spending with Ramey (2009) measure of defense news. This panel shows that relative to the size of the economy, government defense expenditure has become smaller over time which is similar to Ramey (2009) defense news where the size of the shocks get smaller over time. Similar to the defense news shocks, government defense spending was bigger during the WWII and Korean War than in any

[9]In order to test whether the spending news shocks are exogenous, I carry out a granger causality test between the average tax rate and the spending news shocks. I find that the average tax rate does not granger cause the spending news shocks using different lag length.

other foreign political event. It is also important to point out that the timing of the defense news shocks and the increases or decreases of the defense spending is different, since the former not only capture the size of each military build-up but also the change in build-up expectations.

In addition with the government spending shocks, I use average tax rates. Specifically, I use quarterly nominal current tax receipts scaled by GDP[10] from 1947 to 2008 from the U. S. Bureau of Economic Analysis (BEA) National Income and Product Account (NIPA) data. However, the news spending shocks covers data from 1939.1 to 2008.4 and the BEA currently reports only annual tax-receipts data from that period. Thus, I construct quarterly data for the 1939 to 1946 period using a 1954 BEA publication. This publication reports estimates of quarterly nominal components of GDP back to 1939. Using these components, I estimate government current receipts and expenditures[11]. It is important to point out that I use quarterly data[12] since Ramey (2011) emphasizes the importance of the timing of the exogenous shocks. Specifically, Ramey (2011) shows that the impact of spending shocks on output, investment, consumption and real wage change considerably if the spending shocks are delated. Figure 4.1 panel c presents the path of the average tax rates from 1939 to 2008. This panel shows that average tax rates increased around the military dates with the exception of 11/9 terrorist attacks episode where spending shocks were followed by tax-cuts.

4.3 Does the Tax Smoothing Hypothesis Hold?

In order to the test the tax smoothing hypothesis, I first check whether the tax rates follow a random walk process as suggested by Barro (1979), using unit root tests and in-sample predictive content. Then, I estimate the impact of a surprise spending war shocks on taxes using Ramey (2011) spending news shock to see whether unexpected government increases

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[10]I exclude non-tax items and social security contributions since the tax smoothing hypothesis involves only tax rates. However, I include all of these items in the robustness analysis.

[11]From 1939 to 1946, Government spending is the sum of Government Purchases of Goods and Services and Government Transfer Payments, Net Interest Paid by Government, and Subsidies less Current Surplus of Government Enterprises. Government Receipts is the sum of Personal Tax and Non tax Payments, Corporate Profits Tax Liability, and Indirect Business Tax and Nontax Liability.

[12]I use annual data in the robustness section.

induce changes in the tax rates. The following subsection shows the results of these exercises.

4.3.1 Testing the Random Walk Hypothesis for the Tax Rates

One of the results of Barro's (1979) model is that the tax rates follow a random walk. That is, the current tax rate is an unbiased predictor of future tax rates. This implies that there is not any other economic indicator that predicts better the future tax rates than current tax rates. The tax smoothing hypothesis is very similar to the so-called model "random walk" for the stock prices. This hypothesis states that the stock market prices behaves according to a random walk and cannot be predicted. It is also consistent with the efficient market idea. In order to see whether the tax rates follow a random walk process, I first examine whether the average tax rate follows a random walk process as Barro (1979) suggests, using unit root tests. Specifically, I use the unit root tests proposed by Dickey-Fuller (1981) and Phillips-Perron (1988). The equations associated with these techniques test for the null hypothesis of a random walk (unit root) against a stationary alternative. If this result holds, the average tax rate can be expressed using the following equation:

$$\frac{T_t}{Y_t} = \rho \frac{T_{t-1}}{Y_{t-1}} + u_t \tag{4.5}$$

In order to test that $\frac{T_t}{Y_t}$ follows a random walk process ($\rho = 1$), Dickey and Fuller (1988) suggest a statistical test for the unit root (random walk hypothesis) in the time series data. Specifically, they propose a regression model associated with the above AR(1) process that is given by the following equation:

$$\Delta \frac{T_t}{Y_t} = (\rho - 1) \frac{T_{t-1}}{Y_{t-1}} + u_t = \delta \frac{T_{t-1}}{Y_{t-1}} + u_t \tag{4.6}$$

Under the null hypothesis, τ_t is integrated of order one or non stationary ($\rho = 1$, $\delta = 0$). This result implies that under the null τ_t also follows a random walk.

Table 4.2 shows the p-value associated with the Augmented Dickey-Fuller and the Phillips-Perron unit root tests for the average tax rate. Using different assumptions about the intercept, the p-values associated to both tests fail to reject the null hypothesis of non-stationary. These results suggest that the average tax rate follows a random walk process

(I(1) process), which is consistent with the tax smoothing argument[13]. Likewise, the last two rows of Table 4.2 show the p-values for the first difference of the average tax rates. The p-values for both tests suggest that $\Delta\tau_t$ is a stationary (I(0)) process.

Second, I also test whether economic indicators can explain future movements in the tax rate using in-sample predictive content. Under the random walk results, the current tax rate is an unbiased predictor of future tax rates. This implies that there is not any other economic indicator that predicts better the future tax rates than current tax rates. This idea should implies that economic indicators must not Granger-cause the change in tax rates. In other words, I should not reject the null hypothesis that $\beta = 0$ in the following regression:

$$E_t \Delta \frac{T_t}{Y_t} = \alpha + \beta \Delta z_{t-1} \tag{4.7}$$

where z_t is a economic indicator variable[14].

Table 4.3 reports the results based on the above causality regression. The table reports the p-values for the tests[15]. A number above 0.05 implies evidence in favor of the random walk result. I note that overall, the test finds evidence of the random walk model using most of the variables. There is only one exception of these results that involves Ramey's (2009) spending shocks. I find strong evidence against of the random walk result using this spending exogenous variable. This result can be explained by the fact it may take policy makers some time to incorporate news since Ramey's (2009) spending shocks is a measure of defense news. That is, this spending shock measures the expected discounted value of future government spending due to foreign political events[16].

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[13]I also used the Variance Ratio Test proposed by Lo and MacKinlay (1988, 1989) to test the random walk hypothesis. The results of this test are also consistent with the tax smoothing argument.

[14]The set of indicators that are use are: government spending, defense spending, inflation, debt, among others. The source of these indicators are explained in the VAR sub-section of the robustness tests

[15]The estimations are heteroskedasticity and serial correlation consistent. Even though I include one lag independent variable, the results are consistent adding additional lags.

[16]Sarget (1987) argues that under certain assumptions about the function of the government sending, this result could provide evidence of the tax smoothing idea. Sarget (1987) proposes a stochastic process for the government spending. Specifically, he proposes the following stochastic process: $G = g + g(L)\epsilon_t$. Where g(L) is a polynomial in the lag operator (L) and ϵ is a white noise process. Sargent (1987) shows that the tax rate is a function of lag values of spending under this assumption.

4.3.2 Estimating the Impact of Spending War Shocks on Taxes: Baseline Results

Although I find evidence against the tax smoothing hypothesis using the Granger-causality test between the Ramey's (2009) spending shock and the tax rates, previous literature (see for example Furstenberg, Green and Jeong, 1986) have use impulse response functions instead, since the concept of Granger-causality is not a forecastability in a deep sense of the word[17]. Therefore, I also use impulse response functions to see whether or not the tax smoothing hypothesis holds. Given the government spending war shocks, I estimate the impact of war shocks on taxes using the following regression model:

$$\Delta\frac{T_t}{Y_t} = \alpha + \sum_{p=0}^{P}\beta_p\omega_{t-p} + e_t \tag{4.8}$$

where $\Delta\frac{T_t}{Y_t}$ is the change in the logarithm of government tax receipts as a share of GDP and ω_t is the exogenous spending news shocks. The effects of spending shocks are introduced through the β terms. These terms directly provide the dynamics of the average taxes from when the war shocks are announced.

Table 4.4 reports the results of estimating the baseline equation 4.8 for the average tax rate using the full sample size[18]. I assume 16 lags[19] of the spending shocks which implies that the earliest starting date for the regression is 1943Q1. The coefficient estimates for the individual lags of the spending shocks fluctuate between positive and negative. Some of these individual coefficients are statistically significant. The overall fit of the regression, R-square, is 0.25.

Figure 4.2 shows the cumulative impulse response function of the average tax rate to a 1% increase in government spending as percent of GDP along with 90% confidence interval. This cumulative impact of a spending shock after n quarters is just the sum of the coefficients on the contemporaneous value and the n lags of the news spending shock. The baseline

[17] In fact, studies that test the random walk hypothesis of the exchange rate use out-of-sample tests instead of the Granger-causality tests. See for example Chen, Rogoff and Rossi (2010),"Can Exchange Rates Forecast Commodity Prices?", Quarterly Journal of Economics.

[18] The Durbin-Watson statistic is also reported in this table. The statistic is around 2, which indicates no serial correlation in the error.

[19] In the next subsection, I also assume additional lags in order to have a longer lasting effect of government spending shocks on the average tax rate.

results based on equation 4.8 assumes 16 lags of the war shock variable, which implies a forecast horizon of 16 quarters. A spending increase sets off an increase in the average tax rate in all of the 16 quarters. That is, there is strong evidence of tax smoothing hypothesis. The cumulative effect is always positive and the t-statistics are always significant at 90% of confidence at every horizon. The point estimates suggests that a spending increase of 1% of GDP increases the average tax rate 0.2% on average, suggesting a tax smoothing effect. The fact that the rise in taxes does not fully match the increase of spending is also consistent with the tax smoothing argument since government spending are expected to decline after the war. This implies the presence of budget deficits during war time and surpluses during peace time.

Comparison of Impulse Response Functions

The tax smoothing hypothesis argues that policy makers forecast increases in expenditures and set a tax rate that is congruent with those forecast about spending. That is, policymakers make tax decision ahead of when actual spending changes take place. However, previous studies (Furstenberg, Green and Jeong, 1986; Anderson, Wallace and Warner, 1986; Ram, 1988; Islam, 2001; Luna, 2014a) have not paid attention to the role of expectation in the analysis. Specifically, these studies have attempted to prove that the tax smoothing hypothesis holds estimating government shocks using a VAR model with current government spending. These spending shocks are used to estimate their impact on the average tax rates when government spending actually changes and not when this spending is expected to change, leaving aside the role of expectations. One of the advantages of using the news spending variable in the baseline model is that this variable emphasizes expectational effects since it measures the moment policymakers' expectations of government spending change.

In order to compare the results from the baseline shocks[20] with the ones resulting from using measures of spending consistently with previous studies, I estimate three VAR model. These models are estimated using different measures of government spending. The VAR model is given by the following model:

[20]Ramey (2011) also compares the results of the dummy spending war variable on RGDP with the results of other types of spending shocks on RGDP.

$$\Delta X_t = A(L)\Delta X_{t-1} + U_t \tag{4.9}$$

where X_t is a vector of endogenous variables, $A(L)$ is a vector of polynomial in the lag operator and U_t is a vector of the reduced form errors. The vector of endogenous variables consists of the log average tax rate and a measure of government spending. The measure of government spending that I use to estimate the first VAR model is the news defense spending shocks. The second measure is the log of total expenditure as percent of GDP from the National Income and Product Account (NIPA). This measure includes not only defense spending but also non-defense spending such as education spending. The third measure that I use is defense spending since war is one source of expected movements in government spending. Specifically, I use the log of defense spending as percent of GDP from NIPA.

Figure 4.3 shows the impulse response function implied by the there VAR models[21]. The standard error bands shown are 95% bands based on Monte Carlo standard errors. The first panel shows the effects on the tax rate from the war news shock while panel b and c show the effects from the total spending and defense spending shocks, respectively. The effect of a 1% increase of the spending news shock on the average tax rate is always positive and significant, which is very similar to the baseline results. That is, there is evidence in favor of the tax smoothing. Contrary, the effect of a 1% increase of total government spending and defense spending as percent of GDP on the average tax rate is negative the first 7 quarters. The cumulative effect is always positive after the 7th quarter using total government spending shocks and after the 10th quarter using only defense spending shocks. However, the estimates are not significant at 95% confidence, finding no evidence of the tax smoothing using traditional spending shocks. The spending news shock and the current spending shocks provide different results regarding the tax smoothing hypothesis, suggesting the key role that expectations plays in the tax decision process. The following section provides empirical evidence that may explain these different results.

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[21]The results here are slightly different from the baseline since here the war shock enter in lag term. Under the baseline equation, the war spending is allowed to have a contemporaneous and delayed effect on the tax rate.

The Importance of Expectations

One of the concerns with the previous results from the VAR models using current total spending and defense spending is that the "shocks" associated with this current spending may be already anticipated. At the beginning of military conflicts, policymakers spend some time studying the optimum military strategy for the conflict, analyzing the type of military equipment that is needed according to the characteristics of the military action and the type of providers needed to start the military build-up process. After all this process is done, military spending start increasing slowly over time. In fact, during the main war conflicts, there are long delays between the decision to change defense spending and the actual changes as the Ramey (2009) narrative records explain[22].

In order to see if changes in expectation are key in the tax decisions, I delayed three quarters the spending news shocks. I choose three quarters for two reasons. First, the time difference between the new spending shocks and the actual changes in defense spending is three quarters on average. Second, Mertens and Ravn (2009) argue that the median implementation lag associated with tax decision is six quarters. That is, there is a six quarter lag difference between the enactment of a new tax legislation and the introduction of the tax change. I consider this implementation lag as the maximum for spending decisions since war spending requires a quicker response than tax enactments. Therefore, I assume three quarters of implementation lag for military spending which correspond with the middle point between no implementation lag and the maximum implementation lag[23].

Figure 4.4 shows the cumulative response function of the average tax rate to an increase of government spending, delaying the news shock variable. The delayed news shocks now have no effect on the average tax rate which is similar to the results presented in the previous subsection using current spending shocks. That is, an increase of 1% of GDP in spending does not change the average tax rate. This evidence points at the importance of expectation and the timing of the spending shocks. This confirms that expectations of future government spending are key in the tax decision process of policymakers and that

[22]Ramey (2011) also delays the dummy war spending variable to see the effects of this spending variable on RGDP.

[23]The results are similar if I delayed the news spending shock even more quarters than three.

these policymakers make tax decision base on current and future government spending as the tax smoothing hypothesis suggest.

4.4 Robustness Tests

This section contains a detailed robustness analysis[24]. Specifically, I examine the robustness of the findings by specifying a richer dynamics, a more complicated model, controlling for political variables and tax shocks, using different government revenues items and spending shocks, and assuming a model closely tied to policymakers decisions.

4.4.1 Richer Dynamics

The baseline results presented in the previous subsection suggest that there is a tax smoothing effect over a four year horizon. However, the baseline equation (4.8) test the tax smoothing hypothesis in a very simple approach. In this subsection, I consider a more complex and dynamic model to allow for more delayed effects of the spending shock variable on the average tax rate.

Additional Lags

The first approach to considering whether government spending shocks have important effects at a longer horizon is to allow for additional lags in the baseline equation 4.8. Under the baseline results, I assume 16 lags of the spending shock variable. In order to see if the baseline results are consistent with the incorporation of more lags, I reestimate equation 4.8 using 24 lags of the spending shock variable. Panel a of Figure 4.5 shows the impulse response function of the average tax rate to a positive spending shock for a forecast horizon of 24 quarters. The estimated cumulative impact of a war spending increase of 1% on the average tax rate is alway positive. However, only the first 13 point estimates are significant at 90% confidence. These results provide evidence of the tax smoothing idea which is consistent with the baseline results.

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[24]These robustness tests are similar to the ones provided in Romer and Romer (2009b).

Lags of the Average Tax Rate

The second approach is to estimate the baseline regression equation 4.8, allowing the average tax rate variable to depend on its own lags and the spending exogenous shocks. This approach not only permits to have longer lasting dynamics but also dynamics beyond the number of lags of the spending shocks that are included in the regression.

$$\Delta\frac{T_t}{Y_t} = \alpha + \sum_{q=1}^{Q} \delta_q \Delta\frac{T_{t-p}}{Y_{t-p}} + \sum_{p=0}^{P} \beta_p \omega_{t-p} + e_t \tag{4.10}$$

where δ_t captures the dynamics associated to the lags of the average tax rate.

Panel b of Figure 4.5 shows the impulse response function of a 1% increase in government spending shock for a forecast horizon of 16 quarters. This figure shows that the estimated response of the average tax rate to an innovation of 1% of GDP of the spending shock is similar to the results of the baseline specification. For all the horizons, the estimated cumulative impact of a spending increase is always positive and significant with the exception of quarter 14. Thus, this specification provides evidence of the tax smoothing associated with the news spending shock.

4.4.2 Vector Autoregression (VAR) Model

One way the baseline results may change is if government spending shocks affect other variables that may affect average tax rates. Therefore, I consider different VAR models with additional key variables. I consider a combination of variables that are included in the government constraint. In particular, the variables that I consider in this VAR analysis are:

- Government Spending. In order to include both sides of the government budget, I include government spending in the VAR model. For consistency, I include this variable as percent of GDP.

- Real GDP. During recession periods, government spending seek to have an effect on output int the short run. This effect on output could also have effects on the dynamics of government spending and tax changes.

- Nominal interest rate and inflation. The inter-temporal government budget constraint includes not only the government spending and revenues but also interest rates and inflation. Thus, these two variables might affect the government spending and tax relation.

Given this set of variables, the VAR model that I propose is the following:

$$\Delta X_t = \alpha + \sum_{q=1}^{Q} \lambda_q \Delta X_{t-q} + \sum_{p=0}^{P} \beta_p \omega_{t-p} + e_t \tag{4.11}$$

where X_t is a vector of endogenous variables[25]

Equation 4.11 also assumes 16 lags of the exogenous variable and 8 lags of the endogenous variables[26]. Figure 4.6 shows the cumulative impact of a government news spending shock on the average tax rate along with the 90% bands based on bootstrapping standard errors, using different VAR specifications. Panel a shows the cumulative impact of spending increase on the average tax rate using a VAR-2 model with the average tax rate and RGDP as endogenous variables. The second row of Figure 4.6 presents the cumulative impact of spending increase on the average tax rate using a VAR-2 model, including the average tax rate and government spending as endogenous variables. Panel c shows the results using a VAR-3 with the average tax rate, government spending and RGDP as endogenous variables. Panel d shows the results using a VAR-4 with average tax rate, RGDP, government spending and inflation as endogenous variable. Finally, the last row of this figure illustrate the cumulative response of the average tax rate using the average tax rate, government spending, RGDP, inflation and interest rate as endogenous variables.

All the results of this figure consistently shows evidence of the tax smoothing hypothesis. However, adding RGDP to the VAR model makes the point estimate after 14 quarters non significant. In the 6-variable regression model, the tax smoothing idea holds only during the first 8 quarters since the point estimates are significant at 90% confidence. Adding government spending, VAR-3 model, has very similar results as the one from the baseline.

[25] The results presented in this subsection do not change even if I include the exogenous news spending variable as an endogenous in the VAR model.

[26] The results are similar using more lags of the endogenous variable.

In all the five VAR models, the increase of the tax rate reaches the maximum value at quarter 13.

4.4.3 Exogenous Tax Shocks

Fiscal policy implies not only changes in government spending but also changes in taxes. In fact, the post-war period have been characterized for having tax increases and decreases in oder to increase long-run economy growth, reduce the fiscal deficit, finance additional government spending and to keep the economy away from recession and inflation periods. One concern that may affect the baseline results presented in the previous section is the possible correlation of the spending news shocks with other fiscal shocks. Specifically, it is possible that the results are sensitive to in-sample correlation with shocks to fiscal taxation. In order to address this issue, I include an exogenous tax shocks in two different ways.

Romer and Romer (2009b) Tax Shocks

The baseline results are affected by the lack of control for tax shocks. Therefore, I control directly for tax changes shocks by including Romer and Romer (2009b) exogenous tax liability changes. Similarly to Ramey's (2009) news spending shocks, Romer and Romer (2009b) propose a tax change variable based on narrative sources. They constructed a new exogenous measure of US tax liability changes variable by examining policy documents, such as presidential speeches, the Economic Reports of the President, the reports of the House Ways and Means Committee to identify all significant legislated tax changes in the postwar era. Then, they classified this tax variable into contemporaneous changes in spending, countercyclical, budget deficit and long-run growth according to the motivation of every tax policy change[27]. However, I only include the long-run growth tax changes since these changes were not motivated by current or projected economic conditions[28]. Similar to the

[27]Romer and Romer (2009) provide a more detail explanation of these tax changes shocks.

[28]Clearly, the countercyclical and Deficit-driven tax changes were motivated by the current conditions of the U.S. economy and deficits. Likewise, the spending-driven tax changes were motivated by contemporaneous changes in spending. That is, spending-driven changes include tax increases that finance new programs or social benefits at about the same time to pay for it. The inclusion of this tax changes may incorporate reverse causation into the regression analysis. For these reasons I do not include these tax changes in the regression analysis.

spending shocks, I include the present value of the tax liability changes to take into the account expectations of future tax changes using the following regression:

$$\Delta\frac{T_t}{Y_t} = \alpha + \sum_{p=0}^{P} \gamma_p \tau_{t-p} + \sum_{p=0}^{P} \beta_p \omega_{t-p} + e_t \tag{4.12}$$

where τ is Romer and Romer (2009) present value of the long-run tax liability changes variable as percent of GDP.

Similar to the baseline, I include 12 lags of the tax and spending exogenous shocks. However, the tax liability changes variable is available from 1945 to 2007, leaving the WWII out of the sample size. Therefore, I extend the tax shock variable to include this conflict[29]. Figure 4.7 panel a shows the estimated impact of a spending increase of 1% of GDP on the average tax rate. The point estimates are always positive which is similar to the baseline results. Likewise, all the point estimates are significant at 90% confidence[30]. These results are very similar to the results from the baseline.

Government Spending and Tax Shocks

A common approach to test whether the tax smoothing hypothesis holds is using government spending and tax revenues shocks using a VAR model (see for example Furstenberg, Green and Jeong, 1986; Anderson, Wallace and Warner, 1986; Ram, 1988; Islam, 2001; and more recently Luna, 2011b). In oder to be consistent with the previous literature, I propose a VAR model[31] that includes government spending and average tax rate as endogenous variables and Ramey (2009) exogenous news spending shocks and Romer and Romer (2009b) exogenous tax changes using the following equation:

$$\Delta X_t = \alpha + \sum_{q=1}^{Q} \Delta X_{t-q} + \sum_{p=0}^{P} \gamma_p \tau_{t-p} + \sum_{p=0}^{P} \beta_p \omega_{t-p} + e_t \tag{4.13}$$

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[29] Similar to Romer and Romer (2009b), I check government reports to estimate and classify the the legislated tax changes from 1939 to 1945.

[30] The R square associated with the regression analysis is 0.32.

[31] This VAR model differ from the ones presented in the previous subsection since the model presented here includes not only the spending shocks variable but also the tax shocks variable.

where X_t is a vector of endogenous variables that includes government spending and tax receipts as percent of GDP and τ is the exogenous tax shocks.

Figure 4.7 panel b shows the average tax rate response to a 1% increase of government spending as percent of GDP. Similar to the previous results, all of the point estimates are positive. However, adding the tax shocks in a VAR model makes some estimates non significant. The point estimates of quarter 7 and 13 are now non significant at 90% confidence, contrasting with the results from the previous subsection.

4.4.4 Different Definition of the Tax Rate.

The baseline results present evidence that government spending shocks increase taxes. That is, there is evidence that the tax smoothing hypothesis holds. However, the baseline equation (4.8) test the tax smoothing hypothesis using the average tax rate. In this subsection, I consider different definitions of the dependent tax variable.

Marginal Income Tax Rate

The baseline analysis uses the average tax rates; however, the tax smoothing hypothesis involves marginal tax rates. In order to check whether the average tax rate is a good proxy variable for the marginal tax rates, I use Barro and Redick (2010) average marginal income tax rate[32]. These authors provide an update version of the Barro and Sahasakul (1983) average marginal tax rate series from 1912 through 2006. This tax rate is based on the Statistics of Income, Individual Income Taxes publication from the Internal Revenue Service (IRS) and the TAXSIM program[33] from the National Bureau of Economic Research (NBER). The annual tax series are converted to quarterly assuming that the tax rate in each quarter of the year was equal to the annual rate for that year.

Figure 4.8 shows the cumulative impact of a spending increase of 1% of GDP on the

[32]The original marginal rate includes also the marginal state income tax rate. However, I do not considered this state marginal rate since federal defense spending only affects federal tax decision. For consistency with the measure of the average tax rate, I also exclude the Social Security Payroll Tax included in the original Barro and Redick (2010) marginal income tax rate.

[33]The Taxsim is a collection of programs and data sets that implements a microsimulation model of the U.S. federal and state income tax systems

average marginal income tax rate. The results are very similar to the baseline results. An increase in government spending increases the marginal income tax rate as the tax smoothing hypothesis argues. However, the R-square using the marginal tax rates is reduced to 0.18. These results provide evidence that the average tax rate is a good proxy of marginal tax rates. In fact, one of the advantage of the average tax rate over the marginal income tax rate is that the average rate includes not only income tax rates but also corporate tax rates, excise tax rates, excess profits tax rates, among others.

Tax Liabilities Changes

Another way to test the tax smoothing hypothesis is to see whether the spending news shocks affect the tax liabilities of legislated taxes. That is, I check whether government spending shocks induce policymakers to legislate tax increases that translate into liability changes. The empirical framework is again identical to that in equation 4.4, except that the dependent variable is the aggregate measure of the legislated tax liability changes from Romer and Romer (2009). Specifically, I combine all four liability changes proposed by these authors to have an aggregate measure of all tax liability changes[34]. I also assume 16 lags of the independent variable. As before, I estimate the cumulative impact on the tax liability as percent of GDP of a government spending increase of 1% of GDP. Figure 4.8 panel b shows that the impact of the tax liability changes as percent of GDP is positive and highly statistically significant, suggesting that the tax smoothing hypothesis holds.

Different Government Receipt Components

The average tax rate variable used to estimate the baseline results was constructed using only tax receipt components since the tax smoothing argument explains that expected spending changes leads to changes on the tax rates. This tax rate variable excludes other government receipts items such as the contribution for government social insurance, income receipt of assets, current transfer receipts, among others. It may be possible that other tax receipts can be also affected by government spending shocks. For this reason, I construct

[34]Romer and Romer (2009b) estimate and distinguish four liability changes according to its motivation: long-run, deficit, contemporaneous changes in spending and cyclical liabilities.

three alternative tax variables to test the tax smoothing hypothesis. First, I add social insurance contribution to the tax receipts component since social security have some wealth redistribution effects and therefore these payments should be treated as taxes. Second, I add income receipts on assets to the tax receipt component. I add this component since it is the third largest non-transfer receipts component of total government revenues. Finally I include all items of government receipts as percent of GDP to the tax variable since most of the previous studies (see for example Islam, 2001; Ewing, Payne, Thompson and Al-Zoubi, 2006; and Luna, 2011b) use total receipts instead of tax receipts. Figure 4.9 shows the impact of a spending increase on the different measures of government revenues as percent of GDP. Similar to the baseline results, there is strong evidence of the tax smoothing argument using even different measures of government revenues to construct the average tax rate.

4.4.5 Excluding the WWII and Korean War

The baseline results are based on data from 1939 to 2008, including all five key political events. However, recent studies (Blanchard and Perotti, 2002 and Romer and Romer, 2010) argue that fiscal policy was very unusual during the Korean War period. In order to exclude this period, I shorten the sample size. First a consider a sample that excludes the WWII from 1945 to 2008 and a sample that excludes the WWII and Korean War from 1957Q1 to 2008Q1.

Figure 4.10 shows the results using the two proposed scenarios. Panel a shows impulse response function excluding the WWII while panel b shows the response function excluding both the WWII and Korean War. All of the point estimates are positive but only quarter 1, 2, 5, 7 and 9 are significant at 90% confidence. Contrarily, the results associated with the post Korean War sample are negative the 6 first quarters and after the 12 quarters. However, the point estimates are not significant. These results can be explain by the fact that the biggest conflicts during the war news shocks sample are the WWII and the Korean War. Likewise, it may be possible that the last conflicts were expected and policy makers used deficits to smooth taxes, keeping the tax rates constant.

4.4.6 Different Spending Shock Variables

The Ramey (2009) news spending shocks used in the baseline results are based on a narrative approach. However, diverse studies (Shapiro and Ramey, 1998; Blanchard and Perotti, 2002; Fisher and Peters, 2010) have proposed different approaches such as excess returns on stock to estimate spending shocks. In order to check whether the baseline results are consistent with different spending shocks, I estimate the baseline equation 4.8 replacing the Ramey (2009) shocks by alternative spending shocks.

Dummy War Shocks

Shapiro and Ramey (1998) suggests a different approach to identify spending shocks. Specifically, these authors[35] (1998) use a very simple approach proposing a dummy war variable based on episodes were Business Week suddenly began to forecast large increases in defense spending induce by major political events that were unrelated to the state of the US economy. In this context, Ramey (2011) extends Shapiro and Ramey (1998) data from 1939 through up 2008 to include the WWII and September 11 episodes.

Similar to the news spending shocks, the war variable includes the five main foreign political events. However, this war variable takes the form of a dummy variable. Specifically, the spending dummy shock variable takes a value of unity in 1940:2, 1950:3, 1965:1, 1980:1 and 2001:3[36]. Ramey and Shapiro (1998) show that this dummy variable has a reasonable amount of predictive power for the growth of real defense spending[37]. Figure 4.11 panel a shows the path of defense spending as a fraction of GDP. The dotted lines represent the dates associated with Ramey and Shapiro (1998) and Ramey (2011) dummy spending shocks. This figure illustrates that the major movements in defense spending all come

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[35]They use this dummy variable to study the impact of spending shocks on output, consumption, real product wages, and interest rates.

[36]These dates correspond to the beginning of the WWII, Korean War, Vietnam War, Cater-Reagan Buildup and 9/11 respectively.

[37]Ramey and Shapiro (1998) estimate a regression of the growth of real defense spending on current and eight lags of the military date variable after the WWII. This regression model has an R-squared of 0.26. Likewise, I perform the same exercise to expand the sample to include the WWII and the 09/11 conflicts. I find an R-square of 0.23 which is very similar to the Ramey and Shapiro (1998) estimate.

following one of the five military dates.

In order to check if the baseline result are consistent, I use this dummy variable as an alternative measure of war spending shock. Specifically, I replaced the news spending shocks by the dummy variable. Panel a of Figure 4.12 shows the cumulative impact of the dummy spending shocks on the average tax rate. Contrarily to the baseline results, there is no evidence of the tax smoothing hypothesis associated with the dummy spending war. These results can be explained as follow. First, the dummy variable approach introduces government spending shocks in a very rudimentary way and does not exploit the potential quantitative information that is available. Second, the regression fit seems to be very poor. The R-square of the regression analysis associated with Panel a of Figure 4.12 is only 0.05. Third, the baseline regression results using the news spending variable depend, in part, on the inclusion of big government defense spending increases as the ones during the WWII and Korean War.

Survey of Professional Forecaster Shocks

The results from excluding the WWII and the Korean war show no support of the tax smoothing hypothesis. The defense news spending variable does not explain the changes in the tax rates for the post Korean war period. In fact, the R-square is very low. In order to study this later time period, I use a spending based on the survey of professional forecasters. Specifically, I define the spending shocks as the difference between actual spending growth as percent of GDP between t-1 and t and the forecasted growth of defense spending as percent of GDP for the same period, where the forecast was made in quarter t-1[38]. Figure 4.11 panel b shows the forecasted growth of defense spending as percent of GDP.

Using these forecasted shocks, I estimate the baseline equation 4.8 with the forecast shock substituted for the defense news shock. Figure 4.12 panel b shows the effect of this shock on the the average tax rate. An increase of forecasted spending shocks, increases the average tax rate all of the quarters after the shocks. However, only the first quarters are

[38]This approach is consistent with Ramey (2011). Similar to Ramey (2011), I use the forecast growth rather than the forecast themselves so that I can combine the two samples of spending forecast. From 1968Q1 to1981Q2, the Survey of Professional Forecasters predicted nominal defense spending while from 1981Q3 to the present the forecasters predicted government spending growth.

statistically significant. The point estimates suggests that a spending increase raises the average tax rate 1% after quarter 5. Contrary to the results excluding the WWII and the Korean War, these results provide evidence of the tax smoothing argument after the post Korean period.

Cumulative Excess Returns on Stocks of Defense Contractors Shocks

Fisher and Peters (2010) propose an alternative exogenous measure of increases in government defense spending based on stock returns. They use the cumulative excess returns on stocks of defense contractors relative to the rest of the stock market as an indicator of expected increases in defense spending. Fisher and Peters (2010) explain that there are changes to military spending that do not respond to the state of the economy. Fisher and Peters (2010) also argue that increases in military spending raise future profits of defense contractors companies, raising the returns associated with these companies relative to the returns associated with the rest of the companies. In order to see is the baseline results are consistent with this spending shock, I use Fisher and Peters (2010) spending shocks. Specifically, I use the same specification as the baseline, but with the Fisher Peters (2010) variable replacing the news spending variable. The cumulative returns on stock series is available for 1958 to 2008. Figure 4.11 panel c shows the cumulative excess returns on stocks defense contractors relative to the rest of the stock market.

Figure 4.12 panel c shows the impact on the average tax rate to this spending shock. The cumulative impact of the average tax rate is positive and negative at some horizon quarters. However, only the positive cumulative response function estimates are significant at 90% of confidence. Although, the results do not provide a strong support of the tax smoothing hypothesis, it provides some evidence that this hypothesis may hold. These results are consistent with the results using Professional forecaster predictions. Similar to the previous results using different government spending shocks, these results may be explained by the fact that during the last two foreign conflicts, tax decisions were not based on current and future higher spending.

4.4.7 Political Variables

A time series model is said to be underspecified if some key variables that are part of the Data-generating process (DGP) are omitted. Underspecification leads to biased OLS estimates and an estimate covariance matrix that may be misleading. Moreover, this bias does not go away as the sample size increases.[39]. If political variables play a key role in the average tax rates and spending news relation and if such variable is omitted, the baseline regression could suffer from this type of problem. For this reason, I include political variables into the baseline regression equation 4.8.

$$\Delta \frac{T_t}{Y_t} = \alpha + \sum_{p=0}^{P} \beta_p \omega_{t-p} + \sum_{p=0}^{P} \eta_p D_{t-p} + e_t \tag{4.14}$$

where D is a dummy political variable.

This political variable captures whether the party of the president in turn plays a big role on the tax decision process. Usually, Republican politicians are usually seen as advocates of smaller government and lower tax rates while Democrat politicians are seen as advocates of bigger government and higher tax rates. Figure 4.13 panel a shows the cumulative impact of a spending shock on the average tax rate including a dummy variable for democrat administrations. Panel b of this figure shows the results including a dummy variable for either a new Democrat president or and new Republican president. Finally, panel c shows the results including a dummy variable for a unified government (that is, the same party controlling both houses of Congress and the presidency). These panels show that an increase in government spending increases the average tax rate throughout all the horizon forecast. In line with the previous findings, these results find evidence of the tax smoothing hypothesis.

4.4.8 Annual Data

The baseline specification and all of the robustness results of the previous sub-sections use quarterly data. However, policymakers usually determine how much to tax and not to tax firms and households annually. In order to check whether policy makers decisions affect the

[39]One of the conditions that must hold for underspecification bias to exist in a linear regression analysis is that the omitted variable must be correlated with one or more of the included independent variables.

tax and spending relationship, I aggregate the quarterly spending news variable to elaborate an annual spending news variable. I also incorporate annual tax data using two different sources: BEA and the Budget of the United States Government.

First, I estimate the baseline model using the annual spending shocks along with the annual average tax rates from the BEA. In order to be consistent with the baseline, I assume 4 lags of the spending shocks. Figure 4.14 panel b shows the cumulative response of the average tax rate to an increase in government spending. For comparison purposes, panel a of this figure also shows the baseline results using quarterly data. Once again, there is strong evidence of the tax smoothing hypothesis using yearly data. The response of the annual average tax rate to spending shocks is quite similar to that using quarterly tax data. An increase in the government spending shock increases the average tax rate through out the 4 years of the forecast horizon. These results are similar with the ones from the baseline results presented on panel a of Figure 4.14.

Since the BEA annual data are based on quarterly data, I also estimate the impact of spending shocks on taxes using annual data from the Budget of the United States Government since the Budget data capture policymakers tax decision better than the BEA data. Figure 4.14 panel c presents the results using budget revenues. The response of the budget average tax rate to government spending increases is quite similar to the response using quarterly tax rate data. An increase in government spending increases the average tax rate through out all the four years. The point estimates suggest that a military spending increase of 1% increases the average tax rate around 0.5%. This point estimates are statistically significant at 90% of confidence.

4.5 Conclusions

The tax smoothing hypothesis argues that government decides taxes based on current and future government spending. Under this approach, if the government knows future spending with certainty, the current tax rate will be set to reflect those expenditures and the tax rate will be constant over time. Under uncertainty, however, the government forecasts future expenditures and set a current tax rate congruent with those forecasts. That is, anticipated government spending shocks lead to changes in tax rates. This paper tests the tax smoothing hypothesis using exogenous news spending war shocks that takes into the account expectations. Specifically, these spending shocks are an approximation to the changes in expectations at the time. This is in contrast to the previous studies that use spending shocks associated with current government spending, leaving aside the importance of expectations in the tax decision process.

My results provide strong evidence of the tax smoothing hypothesis when I include conflicts with large government defense spending, such as WWII and Korean War. I find that government news spending shocks increases the average tax rate. In fact, I find that a spending increase of 1% of GDP increases the average tax rate all of the 16 horizon quarters. This result contracts with the ones from previous studies that find no evidence of the tax smoothing hypothesis using shocks associated with actual government spending and defense spending from VAR models. In fact, delating the spending news shocks a few quarters provides the same results as previous studies of no tax smoothing effects. This outcome emphasizes the importance of the timing of spending shocks in the tax decision process. The results hold even under different robustness tests such as additional lags, additional variables, different spending shocks and definitions of the tax variable, and annual data.

The set of results provided in this paper have also some policy implications. First, it provide empirical evidence towards the importance of expectations in the tax decision process. My results show that policymakers make tax decisions whenever they have news about future spending and do not wait until these spending actually change. Second, the results also show that policymakers do set tax rates looking at current and future spending, especially when these spendings are expected to be large such as the military spending associated with the WWII, and Korean War. The tax smoothing hypothesis seems to hold better, at least empirically, when the WWII and the Korean War are included in the data sample. Third, my results show that war conflicts are one important source of budget deficits and that we should expect fiscal deficit during foreign conflicts. I find that a spending increase of 1% of GDP increases the average tax rate 0.4% after the 12th quarter. The fact that the rise in taxes does not fully match the increase of spending suggest that the government has to run deficits to finance the rest of the cost associated to the foreign conflicts. Likewise, the fact that government surpluses were present during the Clinton's

Administration provides evidence of the tax smoothing since there were no foreign conflicts during this period.

Table 4.1: Ramey's (2011) Korean War Spending Shock, Billions

Forecast Date	Year									
	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Pre-Spending 1950	15	15	15	15	15	15	15	15	15	15
Mid 7/50	27.5	27.5	27.5							
8/5/1950	33	33	33	27	27	27	27	27	27	27
Second half of 8/1950	33	45			27	27	27	27	27	27
September 1950	25.5	48	50	50	50	50	50	50	50	50
Average IIIQ/1950	28.7	38	38.8	34.7	34.7	34.7	34.7	34.7	34.7	34.7

Source: "Ramey, V. (2009), "Defense News Shocks, 1939-2008: Estimates Based on News Sources"

Table 4.2: Unit Root Tests for the Average Tax Rates

Tests	Drift	No Drift
Levels		
ADF	0.23	0.51
PP	0.27	0.51
First Difference		
ADF	0.00	0.00
PP	0.00	0.00

*The values reported in this table are p-values

Table 4.3: Average Tax Rate Forecastability Test

Independent Variable	P-Value
Government Spending	0.11
Defense Spending	0.18
Ramey Spending Shocks	0.004***
Dummy Spending Shocks	0.11
Legislated Tax Shocks	0.81
Inflation	0.15
Debt	0.21
RGDP	0.19
Interest Rates	0.44

Note: Asterisks indicate evidence of Granger causality at 1% (***), 5%(**) and 10%(*) confidence, respectively.

Table 4.4: Estimated Impact of a Ramey (2011) Defense Spending increase on the Average Tax Rates.

Regressor	Coefficients	Standard Errors
Constant	−0.00	(0.00)
ω_t	0.10	(0.06)
ω_{t-1}	0.04	(0.07)
ω_{t-2}	0.15	(0.07)
ω_{t-3}	−0.07	(0.07)
ω_{t-4}	−0.05	(0.06)
ω_{t-5}	0.11	(0.04)
ω_{t-6}	−0.06	(0.04)
ω_{t-7}	0.14	(0.04)
ω_{t-8}	−0.02	(0.04)
ω_{t-9}	−0.01	(0.04)
ω_{t-10}	−0.00	(0.04)
ω_{t-11}	0.03	(0.04)
ω_{t-12}	0.04	(0.04)
ω_{t-13}	−0.03	(0.04)
ω_{t-14}	−0.17	(0.04)
ω_{t-15}	0.12	(0.03)
ω_{t-16}	−0.04	(0.03)
R^2	0.25	
DW	2.15	

The sample period is 1943Q1-2008Q4.

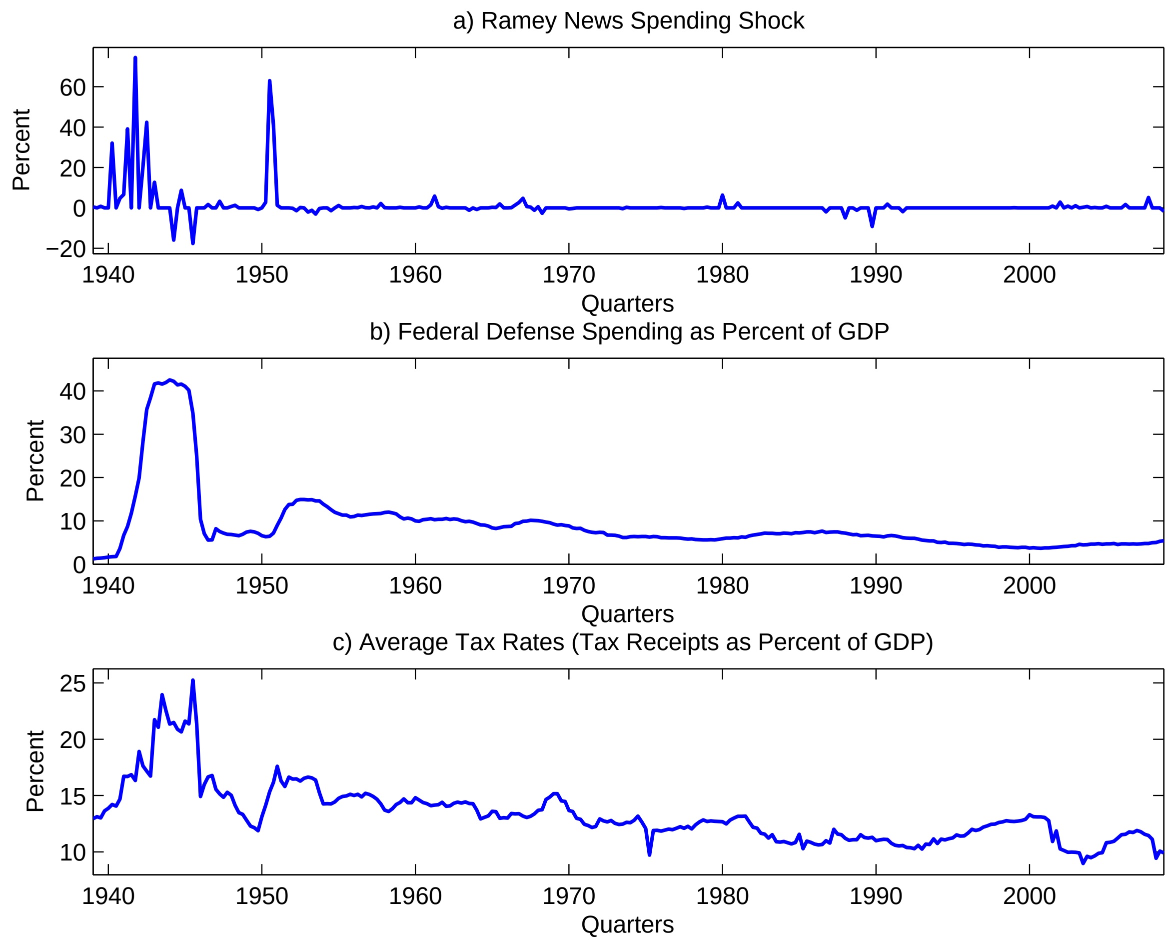

Figure 4.1: Average Tax Rates and Government War Spending Shock as Percent of GDP. The Average Tax Rates are Calculated using Nominal Current Tax Receipts excluding Non-Tax Items and Social Security Contributions Scaled by GDP. Sources: Ramey (2011) “Identifying Government Spending Shocks: It’s all in the timing” and Bureau of Economic Analysis (BEA).

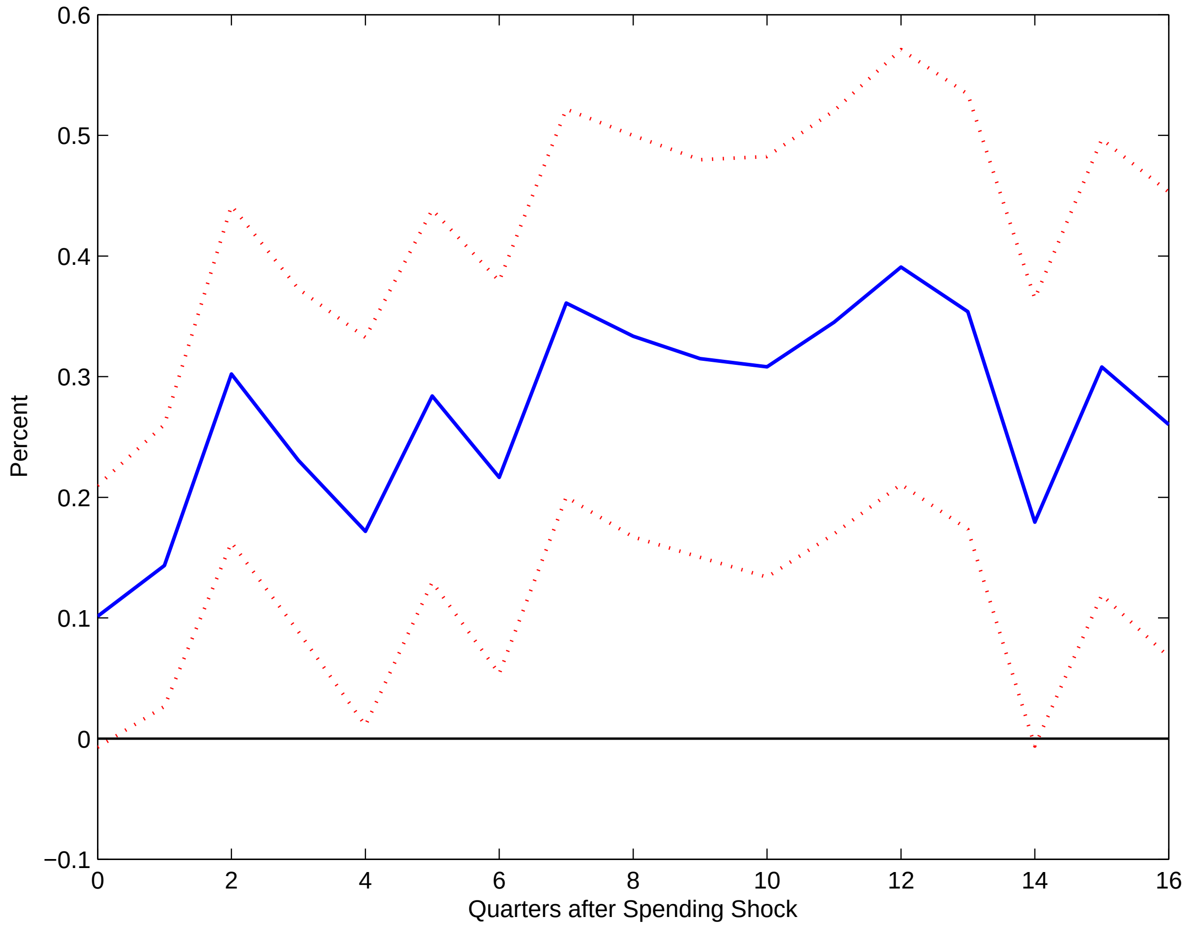

Figure 4.2: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Baseline Result: 16 Lags.

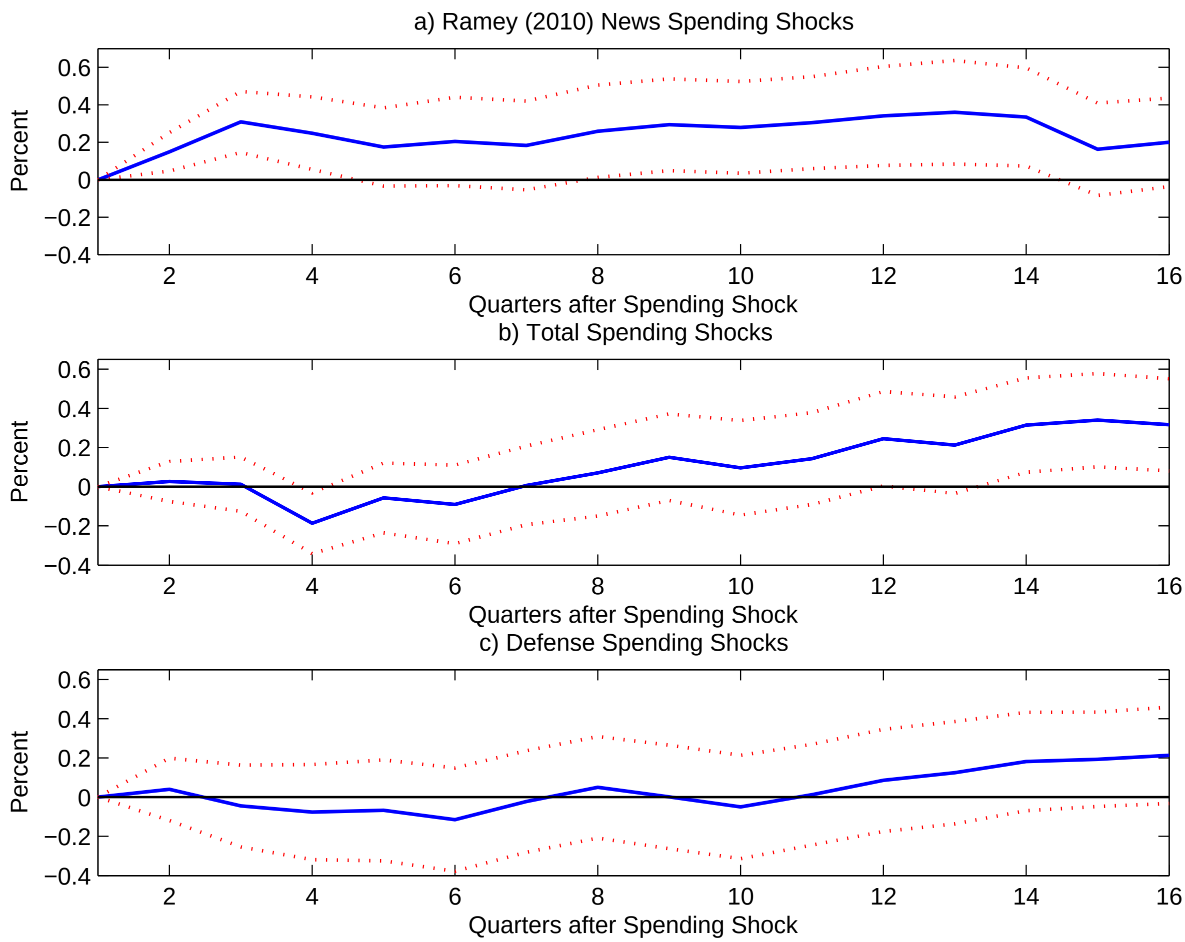

Figure 4.3: Comparison of Different Impulse Response Functions. Estimated Cumulative Impact of Different Spending Shocks on the Average Tax Rate.

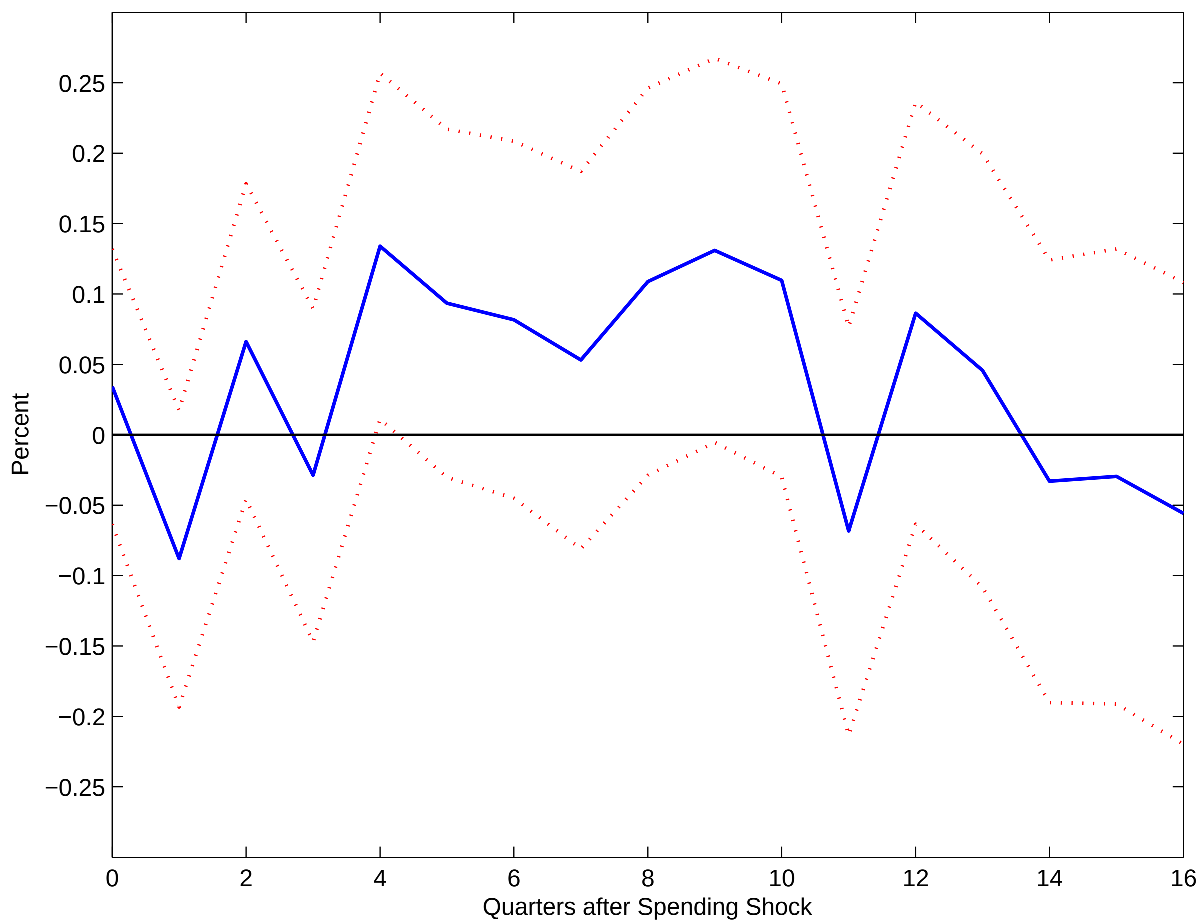

Figure 4.4: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate Delaying the News Spending Shocks.

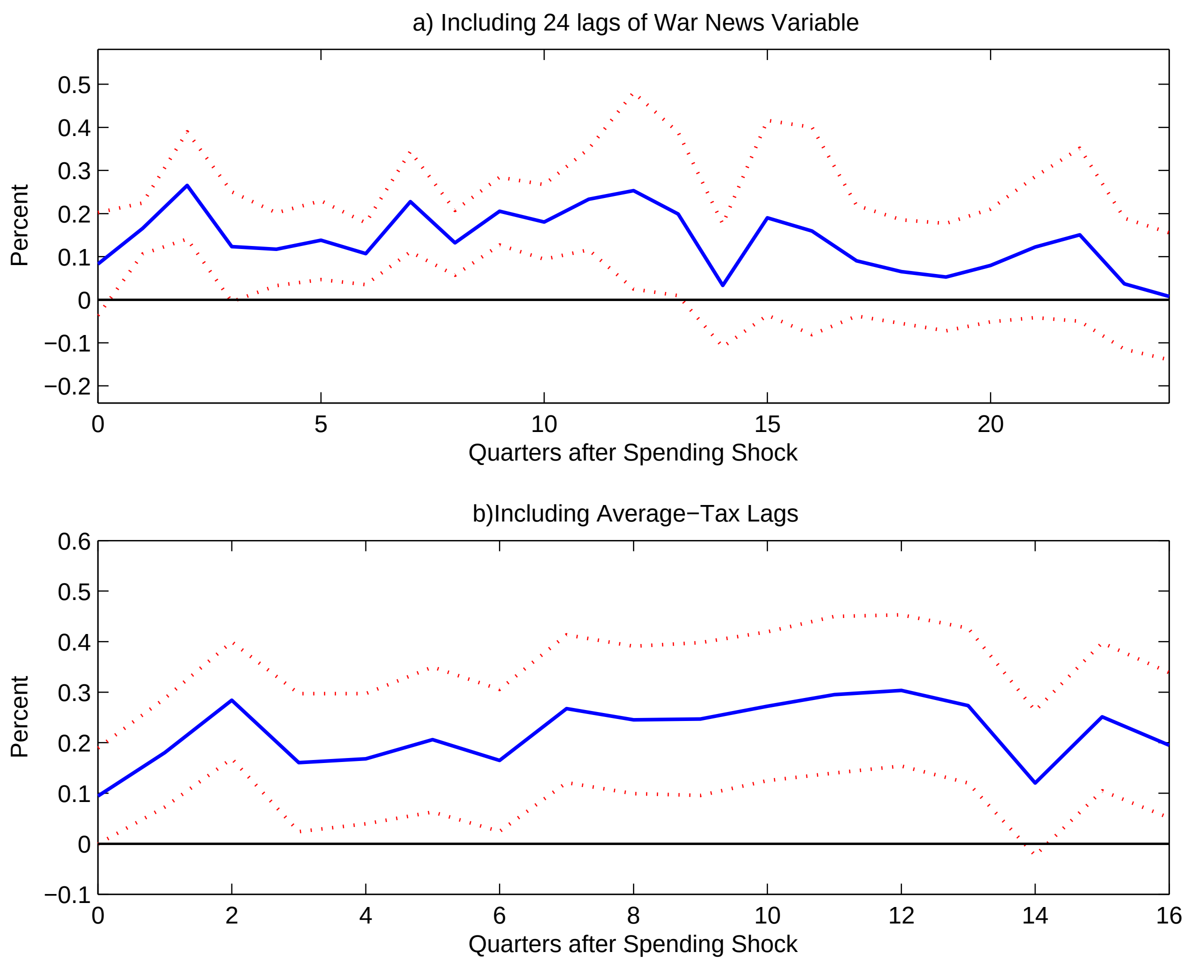

Figure 4.5: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Richer Dynamics: Additional Lags and Average Tax Lags.

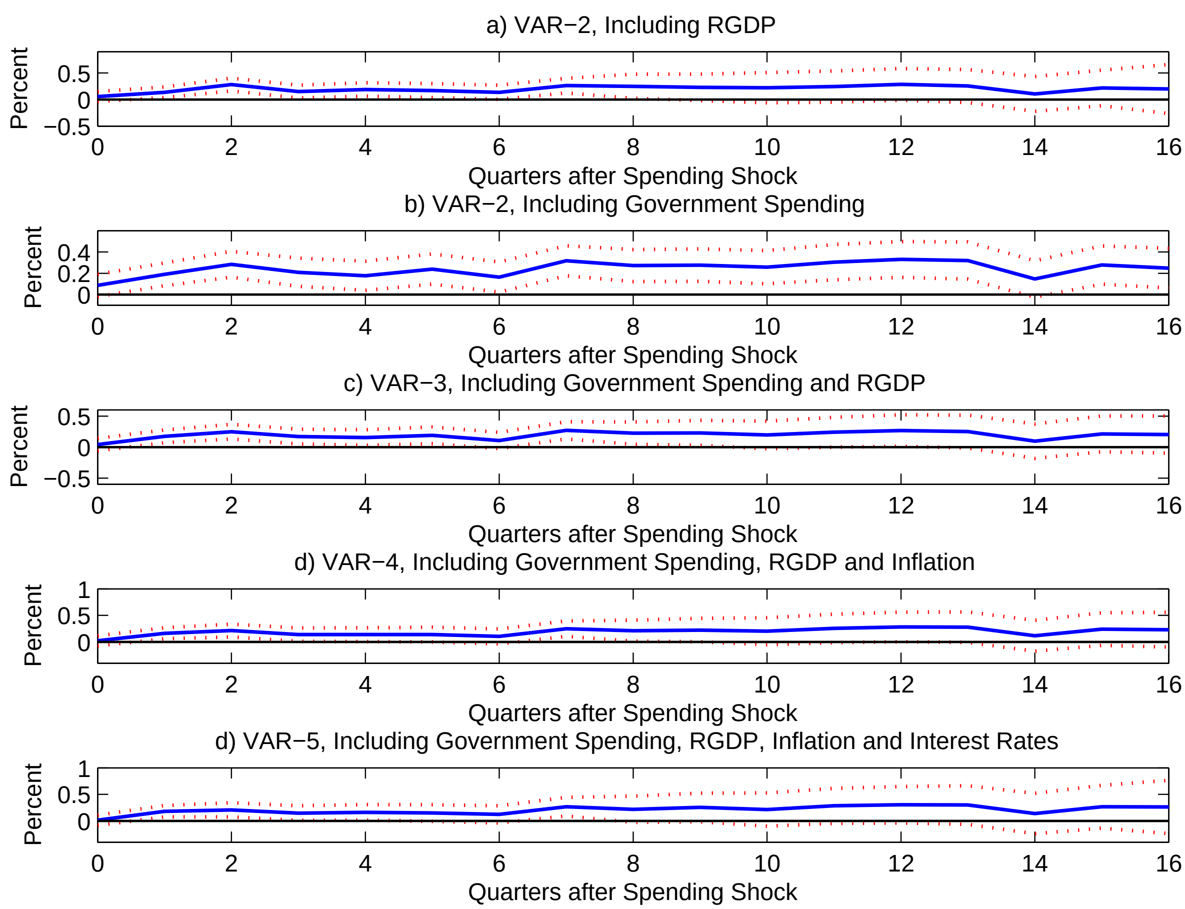

Figure 4.6: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. VAR Model.

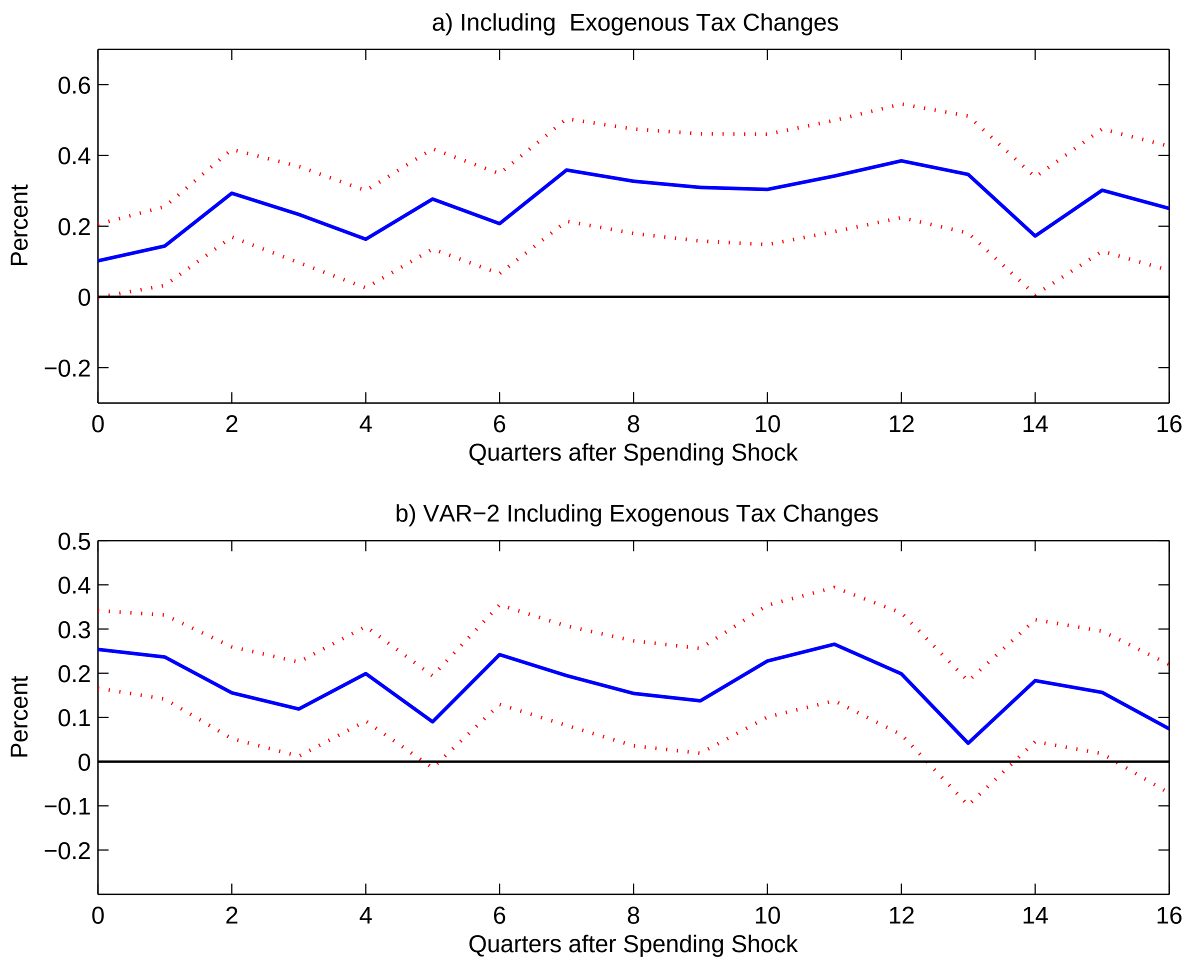

Figure 4.7: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Controlling for Exogenous Tax Shocks.

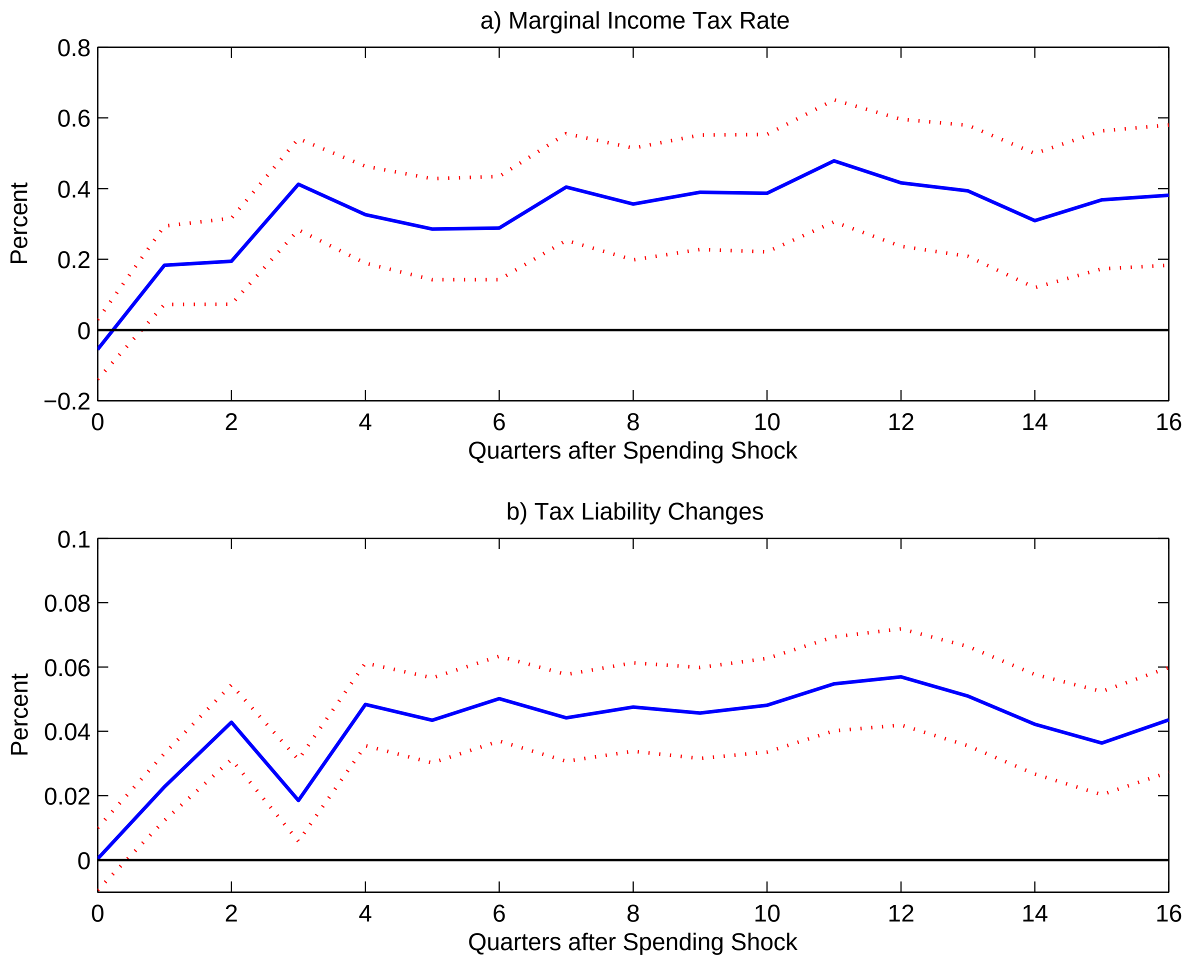

Figure 4.8: Estimated Cumulative Impact of a Spending War Shock on the Average Marginal Income Tax Rate.

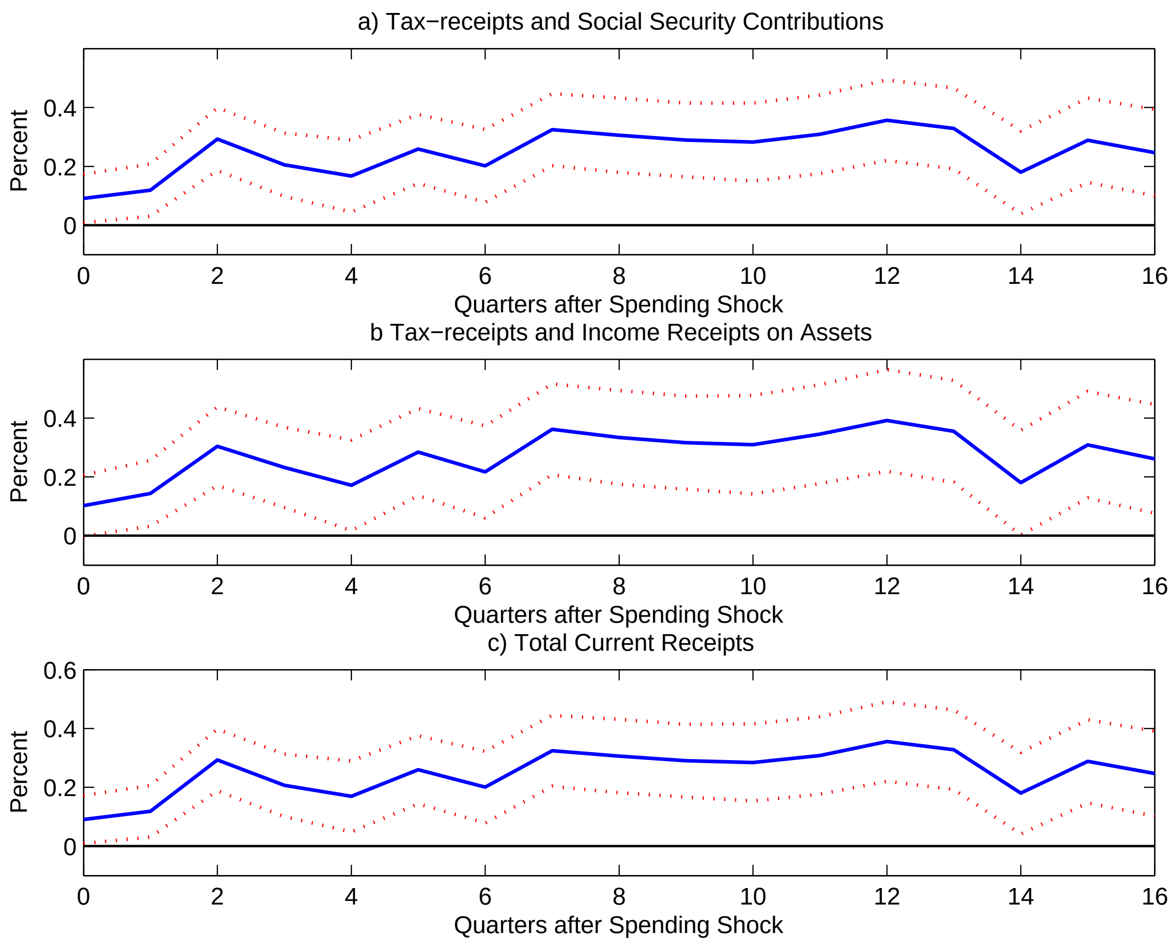

Figure 4.9: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Different Receipts Definitions.

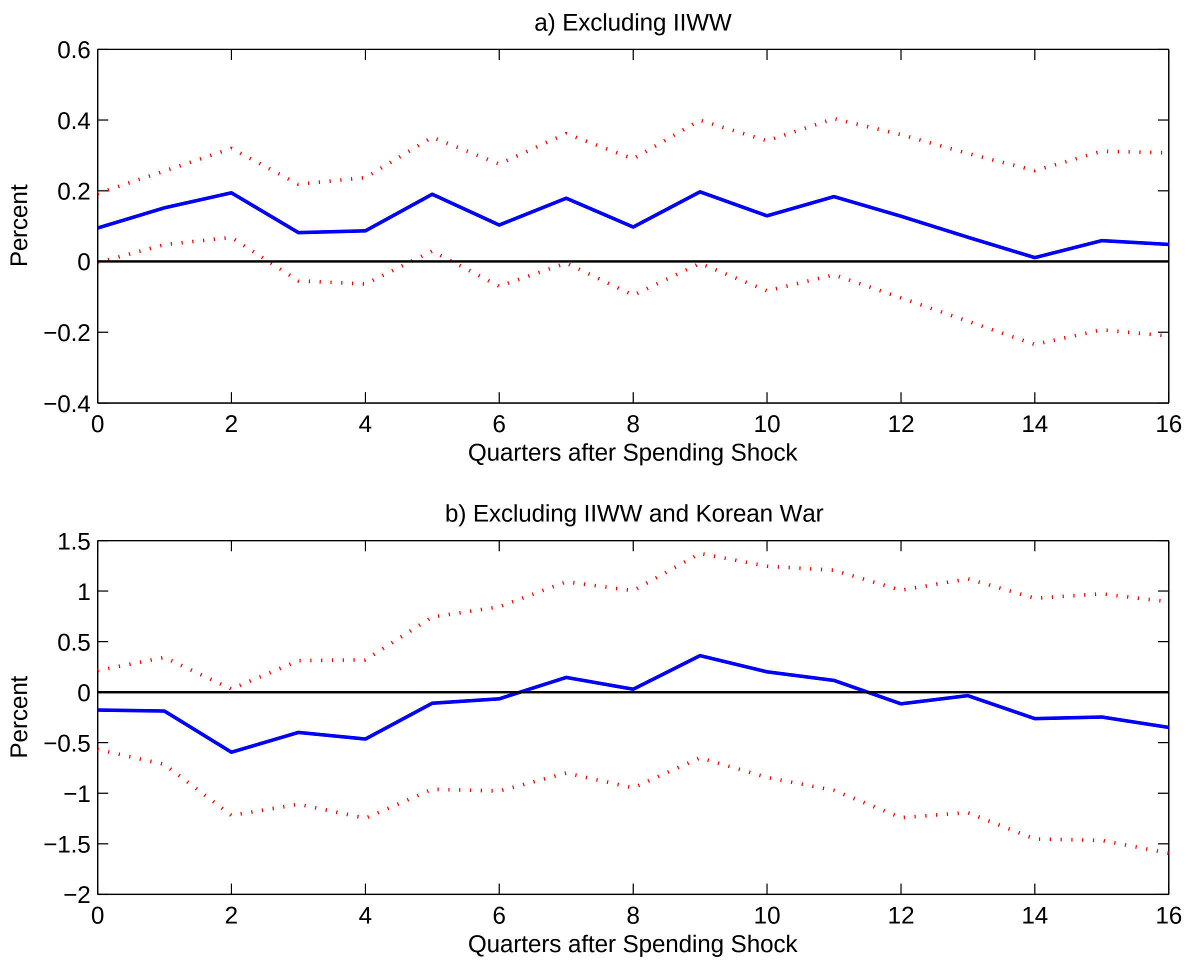

Figure 4.10: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Sub-Sample.

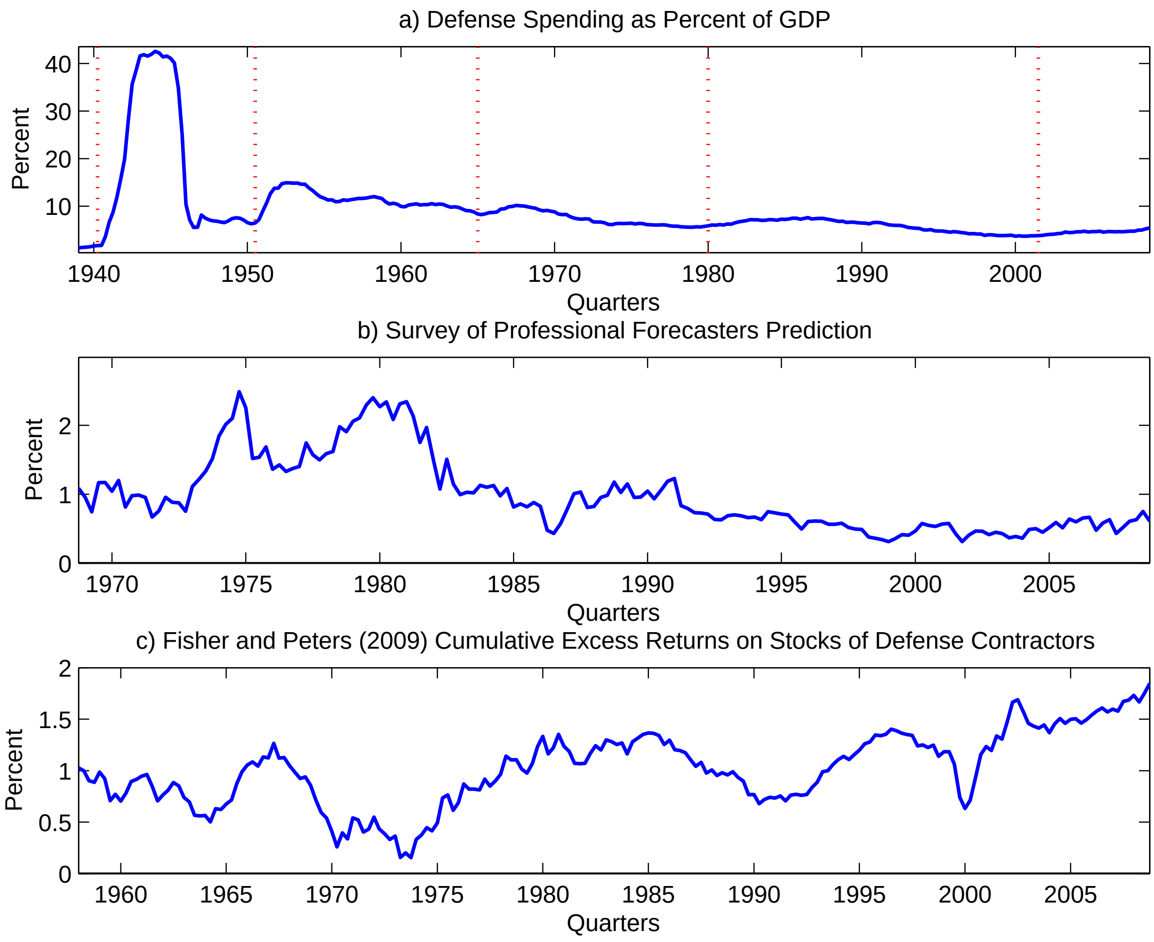

Figure 4.11: Alternative Defense Shocks. Dotted lines in Figure a represent the dates associated with the Dummy War Shocks.

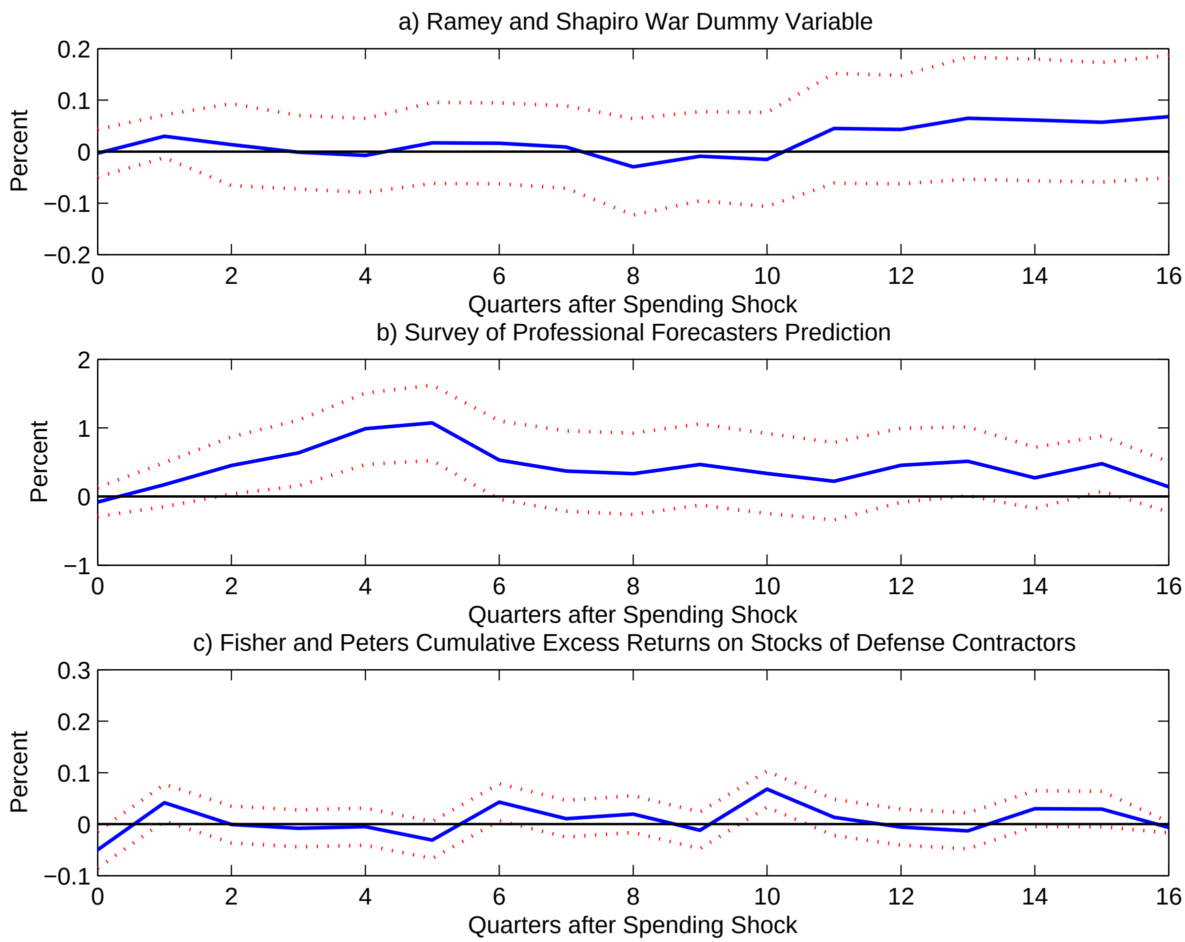

Figure 4.12: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Ramey and Shapiro War Dummy Variable and Professional Forecast Shocks.

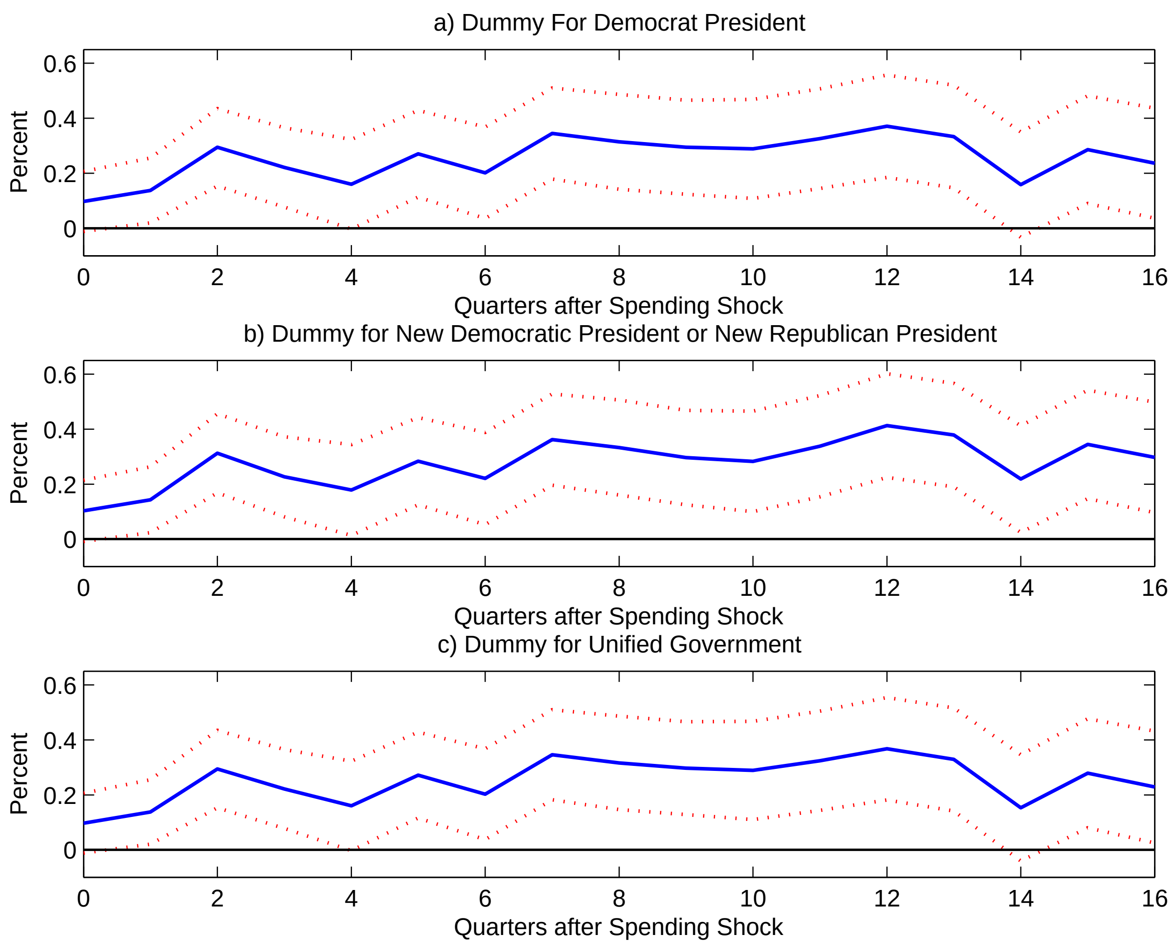

Figure 4.13: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Political Variables

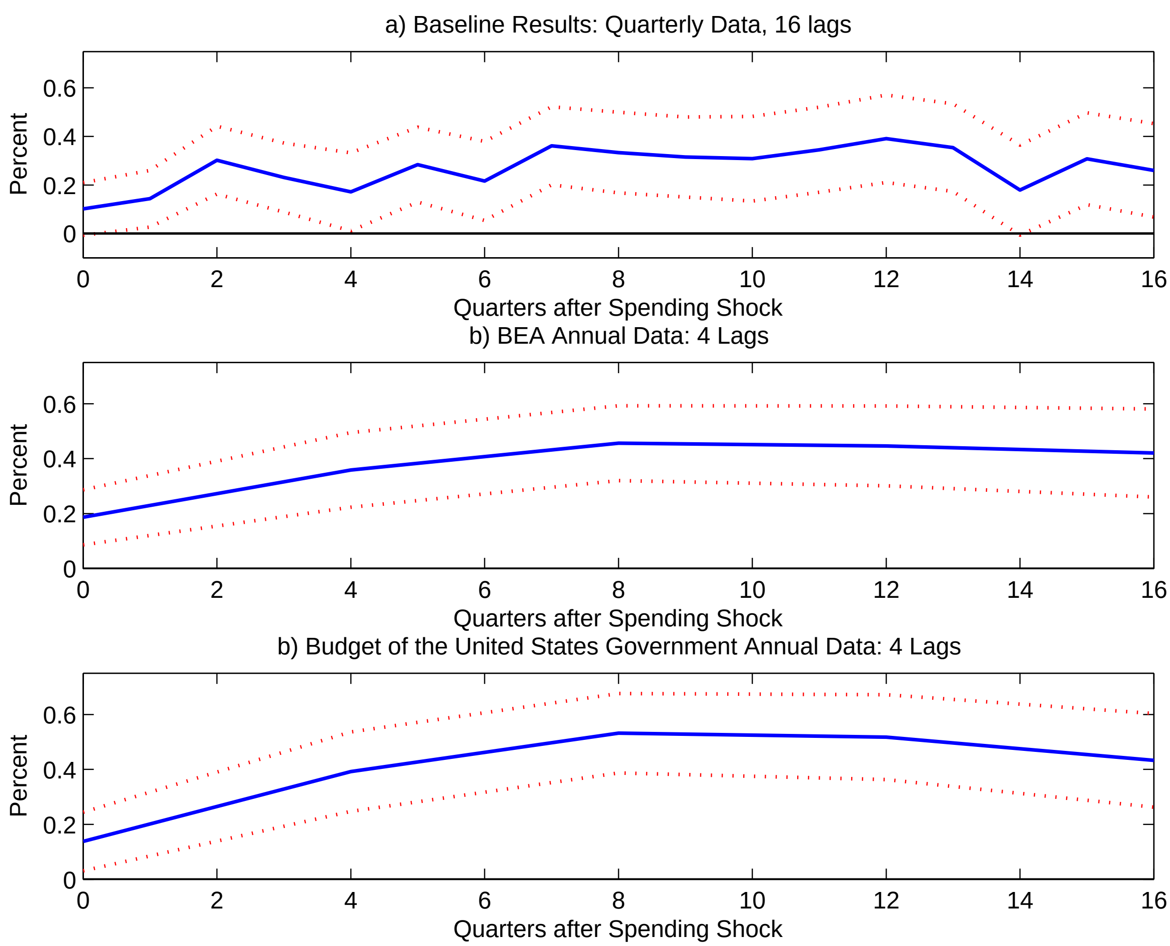

Figure 4.14: Estimated Cumulative Impact of a Spending War Shock on the Average Tax Rate. Annual Data and Baseline Results.

BIBLIOGRAPHY

[1] Aiyagari, R., A. Marcet, T. Sargent, and J. Seppala, (2002). "Optimal Taxation without State Contingent Debt", *Journal of Political Economy*, 110, December, 1220-1254.

[2] Anderson, W., M.S. Wallace and J. T. Warner (1986), "Government Spending and Taxation: What Causes What?", *Southern Economic Journal* 52(3), 630-639.

[3] Andrews, D. W. K. (1993), "Test for Parameter Instability and Structural Change with Unknown Change Point", Econometrica, 61(4) pp. 821-856.

[4] Auerbach, A. J. (1989), "Tax Reform and Adjustment Costs: The Impact on Investment and Market Value", *International Economic Review* 30(4), 939-962.

[5] Auerbach, A. J. (2003), "Fiscal Policy, Past and Present", *Brookings Papers on Economic Activity* 1, 75-138

[6] Baghestani, H. and R. McNown. (1994), "Do Revenues or Expenditure Respond to Budgetary Disequilibria", *Southern Economic Journal* 61(2), 311-322.

[7] Bai, J. and P. Perron (2003), "Computation and Analysis of Multiple Structural Change Models, *Journal of Applied Econometrics* 18, 122.

[8] Baron, J, and E. J. McCaffery (2004), "Starving the Beast: The psychology of Budget Deficits", *Mimeo.*

[9] Barro, R. J. (1979), "On the Determination of Public Debt", *Journal of Political Economy* 87 (October), 940-971

[10] Barro, R.J. (1990). "On the Predictability of Tax-Rate Changes", *Macroeconomic Policy*, Cambridge MA, Harvard University Press, 268-297.

[11] Barro, R. J. (2003), "There is a Lot to Like about Bush's Tax Plan", *Business Week* February 24, 28.

[12] Barro, R. J. and C. J. Redlick. (2010). "Macroeconomic Effects from Government Purchases and Taxes" *Working Paper*, Harvard University, February.

[13] Blanchard O. and R. Perotti. (2002), "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output", *The Quarterly Journal of Economics* 117(4), 1329-1368.

[14] Buchanan, J., and R. Wagner. (1978), "Dialogues concerning Fiscal Religion", *Journal of Monetary Economics* 4, 627-636.

[15] Chen, Y, K. Rogoff and B. Rossi (2010), "Can Exchange Rates Forecast Commodity Prices?", *Quarterly Journal of Economics* 125(3): 1145-1194.

[16] Daggett, S. (2010), "Costs of Major U.S. Wars", *Congressional Research Service*, Report for Congress. June 29.

[17] Dickey, D. and W. A. Fuller (1981), "Likelihood ratio Statistics for Autoregresive Time Series with a Unit Root", *Econometrica* 49, 1057-1072.

[18] Engle, R. and C. Granger (1987), "Co-Integration and Error Correction: Representation, Estimation and Testing", *Econometrica* 55(2), 251-276.

[19] Ewing, B. T., J. E. Payne, M.A. Thompson and O. M. Al-Zoubi (2006), "Government Expenditures and Revenues: Evidence from Asymmetric Modeling", *Southern Economic Journal* 73(1), 190-200.

[20] Fisher, J. D.M. and R. Peters (2010), "Using Stocks Returns to Identify Government Spending Shocks". *The Economic Journal*, 120, 414-436.

[21] Friedman, M. (1967), "Fiscal Responsability". *Newsweek*, August 7, 68.

[22] Furstenberg, G.M., R. J. Green and J. Jeong (1986), "Tax and Spend or Spend and Tax?", *The Review of Economics and Statistics* 68(2), 179-188.

[23] Gravelle. J. G., T. L. Hungerford and M. Labonte (2009), "Economic Stimulus: Issues and Policies", *Congressional Research Service* November.

[24] Hamilton, J. D. (1994), "Time Series Analysis", *Princeton University Press, Princeton, N. J.*

[25] House, C.L. and M. D. Shapiro (2006), "Phased-in Tax Cuts and Economic Activity", *American Economic Review* 96(4) 1835-1849.

[26] Hayashi, F. (2002) "Econometrics", Princeton University Press, Princeton and Oxford.

[27] Hoover, K. D. and S. M. Sheffrin. (1992), "Causation, Spending and Taxes: Sand in the Sandbox or Tax Collector for Welfare State?", *The American Economic Review* 82(1), 225-248.

[28] Hall, R. R. (1971) "The Dynamic Effects of Fiscal Policy in an Economy with Foresight", *Review of Economics Studies* 38, 229-244.

[29] Islam, M. Q. (2001), “Structural Break, Unit Root and Causality between Government Expenditures and Revenues”, *Applied Economics Letters* 8(8), 565-567.

[30] Johansen, S. (1988), “Statistical Analysis of Cointegrating Vectors”, *Journal of Economic Dynamics and Control* 12, 231-54.

[31] Kochin, L., D. Bejamin and M. Meador (1983), “The Observational Equivalence of Rational and Irrational Consumers if Taxation is Efficient”, *Federal Reserve Bank of San Francisco*, 7, 103-125.

[32] Krugman, P. (2008), “Fiscal Poisson Pill”, *New York Times* june 16, 2008.

[33] Labonte, M. and M. Levit (2008), “Financing Issues and Economic Effects of American Wars”, *Congressional Research Service*, Report for Congress.

[34] Lo, Andrew W. and A. C. MacKinlay (1988), “Stock Market Prices Do Not Follow Random Walks: Evidence From a Simple Specification Test, *The Review of Financial Studies*, 1, 4166.

[35] Lo, Andrew W. and A. C. MacKinlay (1989), “The Size and Power of the Variance Ratio Test in Finite Samples *Journal of Econometrics*, 40, 203-238.

[36] Luna, E. M. (2014a), “Causation, Spending and Revenues: Some Evidence Robust to Parameter Instability”, *Working Paper*, University of Washington.

[37] Luna, E. M. (2014b), “Do Anticipated and Unanticipated Tax Policy Changes Starve the Beast?”, *Working Paper*, University of Washington.

[38] Luna, E. M. (2014c), “Does the Tax Smoothing Hypothesis Hold? Evidence using Exogenous Government Spending Shocks”, *Working Paper*, University of Washington.

[39] Mertens, K. and M. Ravn (2009), “Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated U. S. Tax Policy Shocks”, *NBER Working Paper 16289.*

[40] Musgrave, R. (1966), “Principles of Budget Determination”, *In Public Finance: Selected Readings* edited by H. Cameron and W, Henderson. New York: Random House, 15-27.

[41] Payne, J. P. (2003), “A Survey of the International Empirical Evidence on the Tax-Spend Debate”, *Public Finance Review* 31(3), 302-324.

[42] Peacock, A. and J. Wiseman (1979), “Approaches to the Analysis of Government Expenditures Growth”, *Public Finance Quarterly* 7, 3-23

[43] Phillips, P. and P. Perron. (1988), ”Testing for a Unit Root in Time Series Regression”, *Biometrica* 75, 335-346.

[44] Ramey, V. (2012), “Government Spending and Private Activity”, *Working Paper* University of California, San Diego and NBER.

[45] Ramey, V. (2011), “Identifying Government Spending Shocks: It’s all in the timing”, *Quarterly Journal of Economics.*

[46] Ramey, V. (2009), “Defense News Shocks, 1939-2008: Estimates Based on News Sources”, *University of California, San Diego and National Bureau of Economic Research.* October.

[47] Ramey, V. and M. Shapiro (1998), “Costly Capital Reallocation and the Effects of Government Spending”, *Carnegie-Rochester Conference Series on Public Policy*, *American Economic Review.*

[48] Romer, C. D. and D. H. Romer (2009a), “An Narrative Analysis of Postwar Tax Changes”, *University of California, Berkley.*

[49] Romer, C. D. and D. H. Romer (2009b), “Do Tax Cuts Starve The Beast? The Effect of Tax Changes on Government Spending”, *Brooking’s Papers on Economic Activity.*

[50] Romer, C. D. and D. H. Romer (2010), “The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks”, *American Economic Review.*

[51] Romer, D. (2011), “Advanced Macroeconomics”, *McGraw-Hill/Irwin.* Fourth Edition.

[52] Rossi, B. (2006), “Are Exchange Rates Really Random Walk? Some Evidence Robust to Parameter Instability”, *Macroeconomic Dynamics* 10(1), 20-38.

[53] Rossi, B. (2005), “Optimal Tests for Nested Model Selection with Underlying Parameter Instability”, *Econometric Theory* 21(5), 962-990.

[54] Stock J. and W. Watson (1996), “Evidence on Structural Instability in Macroeconomics Time Series Relations””, *Journal of Business and Economic Statistics* 14(1), 11-30.

[55] Tassava, C. (2008) “The American Economy during World War II”, *EH.Net Encyclopedia*, February 10.

[56] Tempalski, J. (2011) “Revenue Effects of Major Tax Bills Updated Tables for all 2010 Bills”, *Department of the Treasury*, Office of Tax Analysis. June.

[57] Yang, S. S. (2005), “Quantifying Tax Effects Under Policy Foresight”, *Journal of Monetary Economics* 52(8), 1557-1168.

[58] Young, A. T. (2008) “Tax-Spend or Fiscal Illusion? Allowing for Asymmetric Revenues Effects in Expenditure Error-Correction Models”, Mimeo.

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