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Fiscal Policy in the Aftermath of 9/11

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Abstract

This paper investigates the nature of U.S. fiscal policy in the aftermath of 9/11. We argue that the recent dramatic fall in the government surplus and the large fall in tax rates cannot be accounted for by either the state of the U.S. economy as of 9/11 or as the typical response of fiscal policy to a large exogenous rise in military expenditures. Our evidence suggests that, had tax rates responded in the way they 'normally' do to large exogenous changes in government spending, aggregate output would have been lower and the surplus would not have changed by much. The unusually large fall in tax rates had an expansionary impact on output and was the primary force underlying the large decline in the surplus. Our results do not bear directly on the question of whether the decline in tax rates and the decline in the surplus after 9/11 were desirable or not.

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1. Introduction

This paper investigates the nature of U.S. fiscal policy in the aftermath of 9/11. We focus on the question: Is fiscal policy in the aftermath of 9/11 well explained as the normal response of the U.S. economy to a large exogenous increase in military expenditures? In our view, the answer is no. The recent dramatic fall in the government surplus (i.e. the rise in the deficit) and the large fall in labor and capital tax rates cannot be accounted for by either the state of the U.S. economy as of 9/11 or as the typical response of fiscal policy to a large exogenous rise in military expenditures. The explanation must be sought elsewhere. The most obvious candidates are recent changes in the U.S. tax code and the slowdown in economic activity around the onset of the Iraq war. Our results indicate that changes in the tax code played the primary role. Specifically, we argue that had tax rates responded in the way they 'normally' do to large exogenous changes in government spending, the government surplus would not have changed by much and might have actually risen.

To establish the 'normal' response of fiscal policy to large shocks, we build on the approach used by Ramey and Shapiro (1998). These authors identify three political events, arguably unrelated to developments in the domestic U.S. economy, that led to large, exogenous increases in military expenditures. These events, which we refer to as Ramey - Shapiro episodes, coincide roughly with the onset of the Korean War, the Vietnam War, and the Carter - Reagan defense buildup. We identify the normal response of fiscal policy to a large military shock with our estimate of the dynamic response paths of government purchases, the government surplus and capital and labor tax rates to a Ramey - Shapiro episode.

To assess whether fiscal policy was unusual after 9/11, we use our estimated statistical model to generate forecasts of tax rates, output, government consump-

tion, the real interest rate and the surplus conditional on (i) the occurrence of a fiscal shock in 2001:3, (ii) the state of the economy as of 2001:2 and (iii) the assumption that fiscal policy responds to 9/11 in the same way that it did in the three Ramey - Shapiro episodes. We find that the general rise in government consumption is well explained by the 9/11 shock. So too is the rise in output, although there is clear evidence of another shock which drove output down in 2002. However, the responses of the surplus to GDP ratio and tax rates are substantially less well explained by the 9/11 shock. For example, the declines in average capital and labor tax rates are *much* larger than our conditional forecast. Perhaps even more striking is the difference between the actual and predicted values of the surplus to GDP ratio. Our statistical model predicts that, had the government responded to 9/11 as it typically did in the Ramey-Shapiro episodes, then absent other shocks, the surplus would initially have risen and then slowly declined to the point where the consolidated budget was balanced. In reality, the surplus suffered a sharp, ongoing decline. Taken together, these results suggest that fiscal policy in the aftermath of 9/11 is not well explained as the normal response of policy to a large exogenous increase in military spending.

This leaves open the question: How would aggregate output and the surplus to GDP ratio have responded to the post-9/11 rise in government consumption had the government pursued alternative tax policies? We cannot use our statistical model to address the impact of systematic changes in policy. A structural model is required. The particular model that we use is the one developed in Burnside, Eichenbaum and Fisher (2004). We use this model because it does well at accounting quantitatively for the consequences of the Ramey - Shapiro episodes.

We consider three possible tax responses to 9/11. In the first, we assume that tax rates responded the way they normally do after a Ramey - Shapiro episode. In the second, we assume that tax rates do not change from their pre-

9/11 levels. In the third, we assume that average labor and capital taxes fall by four percentage points in a very persistent way. This fall roughly corresponds to the actual decline in average taxes between 2001:2 and 2003:3. In all cases, we assume that government consumption rises in a way commensurate with what actually occurred after 9/11.

Our findings can be summarized as follows. With the first and second specifications, 9/11 would have been associated with a small initial rise, followed by a persistent but small decline, in the surplus to GDP ratio. In contrast and consistent with the actual post-9/11 data, the third specification implies that the surplus to GDP ratio would have declined immediately and then stayed well below its pre-shock level for an extended period of time. To the extent that the Bush tax cuts are viewed as highly persistent, this result provides a formal interpretation of the view that the large drop in the surplus to GDP ratio following 9/11 is due to an atypical reduction in tax rates after a large increase in military spending.

Our structural model also implies that a cut in tax rates leads to a subtantial rise in output, with the precise magnitude depending on the elasticity of labor supply. Evaluating the welfare tradeoff between the rise in output and the fall in the surplus to GDP ratio associated with the cut in tax rates is beyond the scope of this paper.

The remainder of this paper is organized as follows. Section 2 discusses our strategy for estimating the effects of a Ramey - Shapiro episode and presents our results. In that section we also use our statistical model to assess how unusual fiscal policy was in the aftermath of 9/11. In section three we discuss our economic model and use it to assess how the surplus and aggregate output would have behaved under alternative tax responses to 9/11. Finally, section 4 contains concluding remarks.

2. Evidence on the Effects of a Shock to Fiscal Policy

In this section we describe our strategy for estimating the effects of an exogenous shock to fiscal policy and present our results. This strategy is very close to the one used in Burnside, Eichenbaum and Fisher (2004).

2.1. Identifying the Effects of a Fiscal Policy Shock

Ramey and Shapiro (1998) pursue a 'narrative approach' to isolate three arguably exogenous events that led to large military buildups and increases in government purchases: the Korean War, the Vietnam War and the Carter-Reagan defense buildup following the invasion of Afghanistan by the Soviet Union. Based on their reading of history, they date these events at 1950:3, 1965:1 and 1980:1. The weakness of this approach is that we only have three episodes of exogenous fiscal policy shocks to work with. In our view, this weakness is more than offset by the compelling nature of Ramey and Shapiro's assumption that the war episodes are exogenous. Certainly their assumption seems plausible relative to the assumptions typically imposed to isolate the exogenous component of statistical innovations in government purchases and tax rates. See Blanchard and Perotti (1998), Ramey and Shapiro (1998) and Edelberg, Eichenbaum and Fisher (2004) for discussions of alternative approaches.

To estimate the impact of exogenous movements in government purchases, G_t, capital and labor income tax rates, τ_{kt} and τ_{nt}, on the economy, we use the following procedure. Suppose that G_t, τ_{kt} and τ_{nt} are elements of the vector stochastic process Z_t. Define the three dummy variables D_{it}, $i = 1, 2, 3$, where

$$D_{it} = \begin{cases} 1, & \text{if } t = d_i \\ 0, & \text{otherwise} \end{cases}$$

and d_i denotes the i^{th} element of

$$d = \begin{pmatrix} 1950{:}3 & 1965{:}1 & 1980{:}1 \end{pmatrix}'.$$

We assume that Z_t evolves according to:

$$Z_t = A_0 + A_1 t + A_2(t \geq 1973:2) + A_3(L)Z_{t-1} + \sum_{i=1}^{3} A_4(L)\psi_i D_{it} + u_t, \quad (2.1)$$

where $Eu_t = 0$,

$$Eu_t u'_{t-s} = \begin{cases} 0, \text{ for all } s \neq 0 \\ \Sigma, \text{ for } s = 0, \end{cases}$$

Σ is a positive definite matrix of dimension equal to the number of elements in Z_t, t denotes time, and $A_j(L)$, $j = 3, 4$ are finite ordered vector polynomials in nonnegative powers of the lag operator L. As in Ramey and Shapiro (1998) we allow for a trend break in 1973:2.[1] A consistent estimate of the response of Z_{it+k}, the i^{th} element of Z at time $t + k$, to the onset of the i^{th} Ramey-Shapiro episode is given by an estimate of the coefficient on L^k in the expansion of $\psi_i \left[I - A_3(L)L\right]^{-1} A_4(L)$.

The ψ_i in (2.1) are scalars with ψ_1 normalized to unity. The parameters ψ_2 and ψ_3 measure the intensity of the second and third Ramey-Shapiro episodes relative to the first. Based on the observed changes in government purchases, we set ψ_2 and ψ_3 to 0.30 and 0.10, respectively. These weights were obtained by comparing the percentage peak rise after the onset of the Vietnam and the Carter-Reagan defense buildup episodes to the analog rise after the Korea episode. Relation (2.1) implies that while the fiscal episodes may differ in intensity, their dynamic effects are the same, up to a scale factor, ψ_i. While arguable, this assumption is consistent with the maintained assumptions in Ramey and Shapiro (1998), Burnside, Eichenbaum and Fisher (2004) and Edelberg, Eichenbaum and Fisher (1999). It is also consistent with the assumptions in Rotemberg and Woodford (1992) who identify an exogenous shock to government purchases with the innovation

[1] In practice we found that our results were robust to not allowing for a break in trend, i.e. to setting $A_2 = 0$.

to defense purchases estimated from a linear time invariant vector autoregressive representation of the data.

Our specification of Z_t includes the log of time t per-capita real GDP, the log of per-capita real government consumption, average capital and labor income tax rates, the real interest rate and the nominal government surplus to GDP ratio. Our measure of the government surplus is the consolidated federal, state and local budget surplus' of revenues over expenditure, inclusive of interest payments. Below, we also consider the primary surplus to GDP ratio.[2] The real interest is the interest rate associated with Moody's Baa corporate bonds that have average maturity of roughly 20 years minus the consumer price index inflation rate over the previous year. We assume that Z_t depends on six lagged values of itself, i.e. $A_3(L)$ is a sixth order polynomial in L. This lag length was chosen using the modified likelihood ratio test described in Sims (1980). All estimates are based on quarterly data from 1947:1 to 2001:2. Note that we purposefully do not include the data containing 9/11 and its aftermath in this stage of our empirical work. The Appendix describes the data used in our analysis.

2.2. Empirical Results

In this subsection we present the results of implementing the procedure discussed above.

2.2.1. The Data

Figure 1 displays the data used in our analysis. Column 1 displays the log of real military spending, real government consumption and our measure of the real interest rate. In all cases we include vertical lines at the dates of Ramey-Shapiro episodes and 2001:3 which encompasses 9/11. Notice that the time series on real

[2]The response of both surplus to GDP ratio measures to a Ramey - Shapiro epsiode is very similar.

defense expenditures is dominated by three events: the large increases in real defense expenditures associated with the Korean war, the Vietnam war, and the Carter-Reagan defense buildup. The Ramey-Shapiro dates essentially mark the beginning of these episodes. There also appears to be a significant buildup in real defense expenditures around the period of 9/11. In our economic model, it is total government consumption, rather than military purchases that is relevant. As Figure 1 reveals, the Ramey-Shapiro and 9/11 episodes also coincide with rises in real government consumption. For completeness, Figure 2 displays the data on the ratio of government consumption to GDP. Notice that ratio rises significantly in the four episodes of concern.

Turning to the real interest rate, two interesting features are worth noting. First the real interest rate is consistently higher in the post-1980 period than in the pre-1980 period. Second, there is not a consistent pattern of a rise in the real interest rate in the immediate aftermath of the four episodes of exogenous increases in military spending.

Column 2 displays our measures of labor and capital tax rates as well as the ratio of nominal primary (dashed line) and total (solid line) government fiscal surpluses to nominal GDP. Tax rates were constructed using quarterly data from the national income and products accounts and the method employed by Jones (2002).[3] Note that labor tax rates rise substantially after all three Ramey-Shapiro dates while capital tax rates rise after the first two episodes. In contrast to the Ramey - Shapiro episodes, tax rates fall sharply around the 9/11 episode.

Turning to the surplus to GDP ratio, two features are worth noting. Unlike the Ramey-Shapiro episodes, there is a sharp decline in this ratio in the immediate aftermath of 9/11. In addition, the real interest rate and the surplus-GDP ratio

[3]See Burnside, Eichenbaum and Fisher (2004) for a discussion of how these tax rates were computed and how they relate to other measures used in the literature.

are negatively correlated, with a correlation coefficient of -0.53. While certainly of interest, this last correlation does not bear directly on the Ricardian Equivalence hypothesis which, among other things, pertains to the response of real interest interest to a rise in the surplus, holding government consumption constant.

2.2.2. The Dynamic Response of the Economy to A Fiscal Shock

Recall that we normalize the first episode (Korea) to be of unit intensity and we set the intensities of the second and third episodes to 0.30 and 0.10, respectively. Below we report the dynamic response function of various aggregates to an episode of unit intensity. This simply scales the size of the impulse response functions. In interpreting these results it is important to recall that we do *not* include the 9/11 episode in estimating the response of the economy to a fiscal shock.

Elsewhere we have documented the response of private sector aggregates to the onset of a Ramey - Shapiro episode.[4] Here we focus on aggregate output as a simple summary measure of overall economic activity. In addition we examine the behavior of the real interest rate since this plays a potentially important role in determining the size of the overall government surplus.

The first row of Figure 3 reports the dynamic responses of real government consumption and output to a fiscal shock.[5] The solid lines display point estimates while the dashed lines correspond to 95% confidence interval bands.[6] As can be

[4] See Ramey and Shapiro (1998), Edelberg Eichenbaum and Fisher (1999) and Burnside, Eichenbaum and Fisher (2003).

[5] The impulse response functions for output and government consumption are reported as percentage deviations from a variable's unshocked path. The response functions of labor and capital tax rates, the real interest rate and the Surplus-GDP ratio are reported as deviations from their unshocked levels, measured in percentage points.

[6] These were computed using the bootstrap Monte Carlo procedure described in Edelberg, Eichenbaum and Fisher (1999). The Monte Carlo methods that we used to quantify the importance of sampling uncertainty do not convey any information about 'date' uncertainty. This is because they take as given the Ramey and Shapiro dates. One simple way to assess the importance of date uncertainty is to redo the analysis perturbing the Ramey and Shapiro dates.

seen, the onset of a Ramey-Shapiro episode leads to large, persistent, hump-shaped rises in government consumption and output. Table 1 summarizes the 'multiplier' effect on output of a fiscal shock. Specifically, we calculate the cumulative change in output divided by the cumulative change in government consumption at various horizons. This multiplier is highest at the end of year one and declines thereafter. In sharp contrast to simple textbook Keynesian models, the multiplier is much less than one.

Table 1. The Fiscal Multiplier

First Year	Second Year	Third Year	Fourth Year
0.61	0.28	0.21	0.19

Rows 2 and 3 in the first column of Figure 3 display the dynamic response of capital and labor tax rates to a fiscal policy shock. Four results are worth noting. First, the labor tax rate rises in a hump-shaped pattern, mirroring the dynamic response of government purchases, with the peak occurring about two years after the onset of a Ramey-Shapiro episode. Second, the maximal rise in the labor tax rate is 2.71 percentage points after nine quarters. This represents a 25 percent increase in the tax rate relative to its value in 1949. Third, the capital tax rate also rises in a hump-shaped manner, but the maximal rise occurs before the peak rises in government purchases and labor tax rates. Fourth, the rise in the capital tax rates is large, with the maximal rise of 6.83 percentage points occurring after three quarters.

The second and third rows of the second column of Figure 3 report the responses of the real interest rate and the surplus to GDP ratio. Notice that the real interest rate falls while the surplus to GDP rises in the immediate aftermath

Edelberg, Eichenbaum and Fisher (1999) document the robustness of inferences under the assumption that the different episodes are of equal intensity.

of Ramey Shapiro episode. After 3 quarters, the real interest rate begins to rise and the surplus to GDP ratio begins to fall. The behavior of the surplus to GDP ratio reflects that (i) capital tax rates peak prior to the peak in government consumption and then begin to decline, and (ii) labor tax rates rise along with government consumption. This pattern of tax rates leads to the result that the surplus first rises and then, only with a lag, begins to decline.

We now present an alternative way to assess the historical impact of the Ramey Shapiro fiscal episodes on the economy. Specifically, we used the estimated version of (2.1) to generate forecasts of Z_t conditional on the occurrence of a fiscal shock, given the state of the economy at the time that the shock occurs. The forecasts for the impact of the Korean, Vietnam and Carter-Reagan episodes correspond to the long dashed lines in Figures 4, 5 and 6. These correspond to what the estimated model says Z_t would have been given the fiscal shocks in question, absent any additional shocks. The short dashed lines in these figures are the forecasts values of Z_t assuming that no shock, fiscal or otherwise, occurred, given the state of the economy at the time of relevant Ramey- Shapiro episode or afterwards. The solid lines correspond to the actual values of Z_t.

According to Figure 4, given the state of the economy, the fiscal shock associated with the Korean episode accounts for much of the actual movement in tax rates, the real interest rate and the surplus to GDP ratio for the first few years after 1950:3. From the perspective of our statistical model, this is equivalent to saying that other shocks played only a minor role during this time period. This is less so for the period after the Vietnam War (Figure 5) and much less so for the period after the invasion of Afghanistan (Figure 6). For example, the fiscal shock does little to explain the sharp rise and subsequent fall in the labor tax during the period 1980 to 1983. It also does not explain the initial rise and subsequent steep declines in capital tax rates during the Carter - Reagan episode.

This is *not* a statement that the model is incorrectly specified. It simply says that other important shocks occurred in the aftermath of the last two Ramey - Shapiro episodes.

2.2.3. How Unusual is Post-9/11 Fiscal Policy?

In this subsection we address the question: Is fiscal policy in the aftermath of 9/11 well explained as the normal response of the economy to large exogenous shocks to government military expenditures? To be clear, by 'normal' we mean our estimates of the response of fiscal policy to the onset of a Ramey - Shapiro episode. To address this question we proceed as follows. First, we assume that, in terms of the rise in government consumption, the 9/11 episode is 10% as intense (in the sense defined above), as the Korean episode. Second, we use the estimated version of (2.1) to generate forecasts of Z_t conditional on the occurrence of a fiscal shock in 2001:3, given the state of the economy as of 2001:2. This forecast assumes that fiscal policy responds to 9/11 in the same way that it did in the other three Ramey - Shapiro episodes. Figure 7 reports the forecasts generated under this assumption (the long dashed line). As before the solid line displays the realized values of Z_t. The short dashed line denotes the forecasts of Z_t given the state of the economy as of 2001:2, but assuming there was not a fiscal shock in 2001:3.

As can be seen, the general rise in government consumption is well explained by the 9/11 shock. So is the rise in output although there is clear evidence of another shock which drove output down in 2002. Other things equal, the decline in output would reduce tax revenues and the government surplus. The behavior of the other variables in Z_t is substantially less well explained by the 9/11 shock. For example, the declines in average capital and labor tax rates are *much* larger than our conditional forecast. Perhaps even more striking is the difference between the actual and predicted values of the surplus to GDP ratio. The statistical

model predicts that, had the government responded to 9/11 as it did to the other Ramey Shapiro shocks, then absent other shocks, the surplus would initially have risen and then slowly declined to the point where the consolidated budget was essentially balanced. In fact, the surplus suffered a sharp, ongoing decline. This reflects that (i) tax rates fell much more sharply than anticipated and (ii) output grew less quickly

3. The Impact of Alternative Tax Policies

In this section we consider the question: How would have aggregate output and the surplus responded to the post-9/11 rise in government consumption had the government pursued alternative tax policies? We cannot answer this question using purely statistical models of the sort discussed above because the experiments we wish to contemplate amount to a change in policy. Standard Lucas critique reasoning says we can only conduct this type of experiment in an economic model. Burnside, Eichenbaum and Fisher (2004) argue that a particular neoclassical business cycle model does a good job of accounting for the quantitative impact of a Ramey-Shapiro episode on aggregate hours worked, after tax real wages, consumption and investment. So that model provides a useful 'laboratory' within which to examine the impact of alternative fiscal policies. In this section we describe this model and use it to address our question.

3.1. A Simple Neoclassical Model

In this subsection we discussion the neoclassical model in Burnside, Eichenbaum and Fisher (2004) that allows for habit formation and adjustment costs in investment. The latter two perturbations do not affect the qualitative properties of the model but they improve the model's ability to account for the quantitative affects of a fiscal shock.

A representative household ranks alternative streams of consumption and hours worked according to

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\log(C_t^*) + \eta V(1 - n_t) \right], \tag{3.1}$$

where

$$C_t^* = C_t - bC_{t-1}, \quad b \geq 0 \tag{3.2}$$

$$V(1 - n_t) = \begin{cases} \frac{1}{1-\mu}(1 - n_t)^{1-\mu}, & \mu \geq 0 \\ \ln(1 - n_t), & \mu = 1 \end{cases} . \tag{3.3}$$

Here E_0 is the time 0 conditional expectations operator, β is a subjective discount factor between 0 and 1, while C_t and n_t denote time t consumption and the fraction of the household's time endowment devoted to work, respectively. When $b > 0$, (3.1) allows for habit formation in consumption. Given (3.3), the representative household's Frisch elasticity of labor supply, evaluated at the steady state level of hours, n, is equal to $(1 - n)/(n\mu)$.

The household owns the stock of capital, whose value at the beginning of time t we denote by K_t. As in Christiano, Eichenbaum and Evans (2001) and Christiano and Fisher (2003) capital evolves according to according to

$$K_{t+1} = (1 - \delta)K_t + F(I_t, I_{t-1}) \tag{3.4}$$

where

$$F(I_t, I_{t-1}) = (1 - S\left(\frac{I_t}{I_{t-1}}\right))I_t. \tag{3.5}$$

The functional form for F in (3.5) penalizes changes in I_t. Many authors in the literature adopt specifications which penalize the level of investment. Christiano, Eichenbaum and Evans (2001) argue that it is difficult to generate hump shaped responses of investment to shocks with the latter specification. In contrast, hump

shaped responses of investment emerge naturally with specification (3.5). Christiano and Fisher (2003) argue that these adjustment costs are useful for understanding the dynamics of stock market and investment good prices.

We restrict the function, S, to satisfy the following properties: $S(1) = S'(1) = 0$, and $s \equiv S''(1) > 0$. Under our assumptions, in a nonstochastic steady state $F_1 = 1$, $F_2 = 0$. The steady state values of the variables are not a function of the adjustment cost parameter, s. Of course, the dynamics of the model are influenced by s. When $s = 0$ the model is equivalent to one without adjustment costs. Given our solution procedure no other features of the S function need to be specified.

The household rents out capital and supplies labor in perfectly competitive spot factor markets. We denote the real wage rate per unit of labor by w_t and the real rental rate on capital by r_t. The government taxes rental income net of depreciation, and wage income at the rates τ_{kt} and τ_{nt}, respectively. Consequently, after-tax real wage and rental rate on capital are given by $(1 - \tau_{nt}) W_t$ and $(1 - \tau_{kt})r_t + \delta\tau_{kt}$, respectively. Therefore, the household's time t budget constraint is given by

$$C_t + I_t \leq (1 - \tau_{nt}) W_t n_t + (1 - \tau_{kt}) r_t K_t + \delta\tau_{kt} K_t - \Phi_t \tag{3.6}$$

where Φ_t denotes lump sum taxes paid by the household.

A perfectly competitive firm produces output, Y_t, according to

$$Y_t \leq K_t^{\alpha} {n_t}^{1-\alpha}, \quad 0 < \alpha < 1. \tag{3.7}$$

The firm sells its output in a perfectly competitive goods market and rents labor and capital in perfectly competitive spot markets.

The government purchases G_t units of output at time t. For simplicity we assume the government balances its budget every period. Government purchases are financed by capital taxes, labor taxes and lump sum taxes, Φ_t. Consequently

the government's budget constraint is given by

$$G_t = \tau_{nt} W_t n_t + \tau_{kt}(r_t - \delta)K_t + \Phi_t.$$

Given our assumptions, Ricardian equivalence holds with respect to the timing of lump sum taxes.[7] So we could allow the government to borrow part or all of the difference between its expenditures and revenues raised from distortionary taxes, subject to its intertemporal budget constraint, and it would not affect our results.

The vector $f_t = [\log(G_t), \tau_{kt}, \tau_{nt}]'$ evolves according to

$$f_t = f + h_f(L)\varepsilon_t. \tag{3.8}$$

Here ε_t is a zero mean, iid scalar random variable that is orthogonal to all model variables dated time $t-1$ and earlier. In addition $h_f(L) = [h_1(L), h_2(L), h_3(L)]'$ where $h_i(L)$, $i = 1, 2, 3$ is a q^{th} ordered polynomial in nonnegative powers of the lag operator L, and f denotes the steady state value of f_t. Note that ε_t is common to both government spending and taxes. This formalizes the notion that government spending and taxes respond simultaneously to a common fiscal shock.

The problem of the representative household is to maximize (3.1) subject to (3.6), (3.3), (3.4), (3.5), (3.2), (3.8) and a given stochastic process for wage and rental rates. The maximization is by choice of contingency plans for $\{C_t, K_{t+1}, n_t\}$ over the elements of the household's time t information set that includes all model variables dated time t and earlier.

The firm's problem is to maximize time t profits. Its first order conditions imply

$$W_t = (1-\alpha)\left(K_t/n_t\right)^{\alpha} \quad \text{and} \quad r_t = \alpha\left(n_t/K_t\right)^{1-\alpha} .$$

We use the log-linearization procedure described by Christiano (1998) to solve for the competitive equilibrium of this economy. To conserve on notation we ab-

[7] This assumes the absence of distortionary taxes on government debt.

stracted from growth when presenting our model. However we do allow for growth when calibrating the model. Specifically we assume that total factor productivity grows at the constant growth rate γ, so that production is given by $Y_t = \gamma^t K_t^\alpha n_t^{1-\alpha}$.

This model of growth is inconsistent with the way we treated growth in section 2 where we assume a trend break in 1973:2. To understand the nature of the approximation involved, note that Christiano's solution procedure involves taking a log linear approximation about the model's steady state. Suppose that the break in trend is unanticipated and the model has converged to its stochastic steady state by the time of the third Ramey Shapiro episode. One way to implement Christiano's procedure is to compute two log linear equilibrium laws of motion for the model corresponding to the pre- and post-1973:2 periods. The difference between the two is that the log linear approximation is computed about two different steady states of the model corresponding to the pre- and post-1973:2 growth rate of technology. We approximate this procedure by computing one law of motion around the steady state of the model assuming a growth rate of output, $\gamma = 1.005$. This is equal to the average growth rate of output over the whole sample period.

3.2. Calibration

In this subsection we briefly describe how we calibrated the model's parameter values. We assume that a time period in the model corresponds to one quarter and set $\beta = 1.03^{-1/4}$. The parameter η was set to imply that in nonstochastic steady state the representative consumer spends 24% of his time endowment working (see, for example, Christiano and Eichenbaum (1992). To evaluate the dependence of the model's implications on the Frisch labor supply elasticity we consider three values for μ. The first, $\mu = 0$, corresponds to the Hansen-Rogerson infinite elasticity case. The second, $\mu = 1$, implies the utility function for leisure is

logarithmic. Combined with our assumption that the representative agent spends 24 percent of his time endowment working, this value corresponds to a Frisch labor supply elasticity of 3.16. Finally, we consider $\mu = 10$, which corresponds to a Frisch labor supply elasticity of 0.33, which is similar to the low elasticities often obtained using microeconomic data. The rate of depreciation on capital δ was set to 0.021 while α was set to 0.34 (see Christiano and Eichenbaum 1992). We also set $b = 0.8$ and $s = 2.0$. This value of b is close to values used in the literature (see for example Boldrin, Christiano and Fisher (2001). The value of s is close to the value estimated by Christiano, Eichenbaum and Evans (2001). They show that $1/s$ is the elasticity of investment with respect to a one percent temporary increase in the price of installed capital. So a value of s equal to two implies this this elasticity is equal to 0.5. We chose this value because it leads to a better performance of the model (see Burnside, Eichenbaum and Fisher 2004).

3.3. Accounting for a Ramey-Shapiro Episode

As mentioned above, Burnside, Eichenbaum and Fisher (2004) analyze the ability of the model to account for the response of hours worked, the after tax real wage rate, consumption and investment to a Ramey-Shapiro episode. They argue that the model does well from both a qualitative and a quantitative perspective in accounting for the dynamics of these variables. Here we briefly discuss the model's performance with respect to output, the real interest rate and the primary surplus to GDP ratio to the onset of a Ramey-Shapiro episode. For this exercise we specify $h_i(L), i = 1, 2, 3$ to correspond to the estimated response of total government consumption, the capital income tax rate and the labor income tax rate at $t + j$ to the onset of a Ramey-Shapiro episode at time t.[8]

Figure 8 displays the dynamic response of output, the real interest rate and the

[8] In practice we use 50 coefficients in $h_1(L)$ and 16 coefficients in $h_2(L)$ and $h_3(L)$.

surplus to GDP ratio, to a fiscal shock of unit intensity, i.e. a shock correpsonding to the intensity of the Korean epsiode. Columns 1, 2 and 3 three report results for $\mu = \{0, 1, 10\}$, i.e. high, medium and low Frisch labor supply elasticities. In all cases, the long dashed lines correspond to the model based impulse response functions. The solid lines are our empirical estimates of the impulse response functions of output, the real interest rate and the primary surplus. The lines with the small dashes are 95% confidence intervals around the empirical point estimates.

Notice that for all values of μ, the model generates a prolonged rise in output in response to a positive fiscal policy shock that is within the 95% confidence intervals of our point estimates. The rise in output reflects the fact that an increase in G_t raises the present value of the household's taxes and lowers its permanent income. Since leisure is a normal good, equilibrium hours worked rises. Notice that the rise in output is largest when labor supply is the most elastic. The basic intuition for this result is as follows. The larger is μ the more the household wishes to smooth hours worked. Since hours worked do not change in steady state, as μ becomes larger, the household finds it optimal to respond to a rise in the present value of its taxes by reducing private consumption by relatively more and varying hours worked less.

Not surprisingly, the model does much less well with respect to the real interest rate. In the model agents' have a strong desire to smooth consumption service flows. This in turn implies that the real rate moves very little. So this model, like most neoclassical models, does poorly at matching movements in asset prices.

Now we consider the response of the surplus to GDP ratio. Our model based measure is the difference between government revenues from distortionary taxes minus government purchases. It is important to emphasize that our model allows for lump sum taxation, something clearly at variance with institutional reality. So

we have much more confidence in the model's qualitative predictions rather than its quantitative predictions for the surplus. That being said, Figure 7 indicates that all versions of the model succeed in reproducing the qualitative response of the surplus to GDP ratio, generating an initial rise followed by a fall. Since the initial rise in output is most pronounced when $\mu = 0$, this version of the model does the best job of accounting for the initial rise in the surplus. All versions of the model do a reasonable job of accounting for the quantitative fall in the surplus to GDP ratio.

3.4. Alternative Tax Policies

Here we consider the model's implications for three alternative tax responses to 9/11 which correspond to three specifications for the j^{th} coefficient in the expansion of $h_i(L), i = 1, 2, 3$. In the first, which we refer to as the *normal specification*, these coefficients are given by 0.10 times the estimated response of real government purchases, the capital income tax rate and the labor income tax rate at $t + j$ to the onset of a Ramey-Shapiro episode at time t. This corresponds to our assumption that the 9/11 shock is 0.10 as 'intense' (from an economic point of view) as the Korean episode.[9] In the second case, which we refer to as the *no tax change specification*, we retain the specification of $h_1(L)$ from the normal specification, but set the coefficients in $h_2(L)$ and $h_3(L)$ equal to zero. This means that tax rates do not respond to the fiscal shock and remain fixed at their pre-9/11 level. Finally, in the third case, which we refer to as the *lower tax specification*, we retain the specification of $h_1(L)$ from the normal specification, but reduce average labor and capital taxes taxes by four percentage points in a very persistent way.[10] This roughly corresponds to the actual decline in average taxes between 2001:2

[9] In practice we use 50 coefficients in $h_1(L)$, $h_2(L)$ and $h_3(L)$.

[10] Specifically, we assume that tax rates rise after the initial shock by 0.001 percent each year.

and 2003:3 shown in Figures 1 and 6.

Columns 1, 2 and 3 of Figure 9 report our results for the three specifications.[11] Throughout the solid line, the dashed line and the dotted line correspond to the response of the model in the high, medium and low elasticity labor supply case, respectively. Not surprisingly, the response of output to the increase in government consumption is inversely related to the response of taxes. For example, the peak rise in output in the normal specification when $\mu = 1$, is roughly 0.29, whereas it is 0.42 in the no tax change specification. Indeed a close to permanent drop in taxes generates an enormous rise in output. Even in the low labor supply specification, $\mu = 10$, the fiscal shock generates a highly persistent rise in output that approaches of 1.6% after 4 years.

The normal specification implies that a fiscal shock is associated with a small rise in the surplus to GDP ratio followed by a persistent but small decline. The surplus to GDP ratio responds in a similar way under the no tax change specification. Finally, consistent with the actual post-9/11 data, the lower tax change specification implies that the surplus to GDP ratio declines immediately and stays well below its pre-shock level for an extended period of time. To the extent that the tax cuts are viewed as highly persistent, this result provides a formal interpretation of the view that the large drop in the surplus to GDP ratio following 9/11 is due to an atypical reduction in tax rates after a large increase in military spending.

Of course, it is difficult to know whether the tax cuts will turn out to be permanent or whether agents perceived them as such. To assess the robustness of our results, we considered the model's implications for a temporary tax cut. This specification is identical to the lower tax specification except we assume that tax

[11] Because the intensity of the shock is 0.10, the impulse response functions correspoding to the normal specification in Figure 9 are one-tenth the size of the corresponding impulse response functions in Figure 8

rates return to their pre-shock levels after three years. Interestingly, in results not displayed, we find that the responses of output and the surplus to GDP ratio in the two tax cut cases are very similar over the first three years. Thereafter, the responses differ substantially. In the temporary tax cut case, after year three, output starts declining to its pre-shock level. In contrast, in the permanent tax cut case, output remains persistently high (see Figure 9). In the temporary tax cut case, after year three, the surplus to GDP very quickly reverts to its pre-shock value. But, in the permanent tax cut case, that ratio remains very low for an extended period of time (again, see Figure 9). We infer that, at least in our model, the basic effects of a cut in tax rates do not depend sensitively on how permanent the cuts are. A cut in tax rates lead to a rise in output and a fall in the surplus to GDP ratio, for as long as the tax cuts are in effect.

We conclude by considering the relative contributions of the rise in government purchases and the cut in tax rates to the fall in the surplus to GDP ratio that occurs in the lower tax specification. Taking as given the rise in government purchases and output that occurs in that specification, we calculated the dynamic response of the surplus to GDP ratio assuming that tax rates stayed at their pre-shock steady state levels. Figure 10 displays our results in the high, medium and low elasticity labor supply cases, corresponding to the solid, dashed and dotted lines, respectively. Note that in the first two cases, the surplus to GDP ratio actually rises after the increase in government purchases. This reflects the large rise in output, and tax revenues, when labor supply is relatively elastic. In the low labor supply elasticity case, the rise in government consumption leads, after a brief delay, to a decline in the surplus to GDP ratio. But this decline is very small (roughly 0.5 percentage points) compared to the decline of 3.5% percentage points that occurs under the lower tax specification. This adds further support to our claim that the primary factor driving the post-9/11 decline in the surplus

to GDP ratio was the cut in tax rates.

4. Conclusion

In this paper we argued that fiscal policy in the aftermath of 9/11 is not well explained as the normal response of the U.S. economy to a large exogenous increase in government consumption. It is difficult to explain the dramatic fall in the government surplus and the large fall in labor and capital tax rates as reflecting either the state of the U.S. economy as of 9/11 or as the typical response of fiscal policy to a large exogenous rise in military expenditures.

We also addressed the question of how aggregate output and the surplus to GDP ratio would have responded to the post-9/11 rise in government consumption had the government pursued alternative tax policies. Using the model developed in Burnside, Eichenbaum and Fisher (2004), we argued that, had government tax policy responded to 9/11 in the same the way that it responded to other large exogenous increases in military spending, 9/11 would have been associated with a small change in aggregate output and the surplus to GDP ratio. Our model also implies that, given the same path of government spending, a cut in tax rates similar to those actually observed in the aftermath of 9/11, would have resulted in a sharp, persistent decline in the government surplus to GDP ratio and a relatively large rise in aggregate output. This provides additional evidence in favor of the view that the recent sharp drop in the surplus to GDP ratio reflects ongoing tax policy developments that are atypical relative to post-WWII U.S. experience after a large increase in military spending.

We conclude by emphasizing that our results do not bear on the question of whether the decline in tax rates and the decline in the surplus after 9/11 were desirable or not.

Data Appendix

All data series are seasonally adjusted except for the population and the real interest rate. Output is GDP (Haver mnemonic GDPH). Defense spending includes both consumption and investment spending (GFDH). Government consumption is defense spending plus Federal, State and Local consumption expenditures (chain weighted sum of GFDH, GFNEH and GSEH). All real series are in units of 1996 chain-weighted dollars. The surplus is the ratio of the consolidated Federal, State and Local surplus as measured in the National Income and Product Accounts (GBAL). The real interest rate is the difference between the Moody's BAA composite bond rate (FBAA) and consumer price index inflation over the prior four quarters (CPIU). Our measure of the poplulation is the civilian working age population (LN16N).

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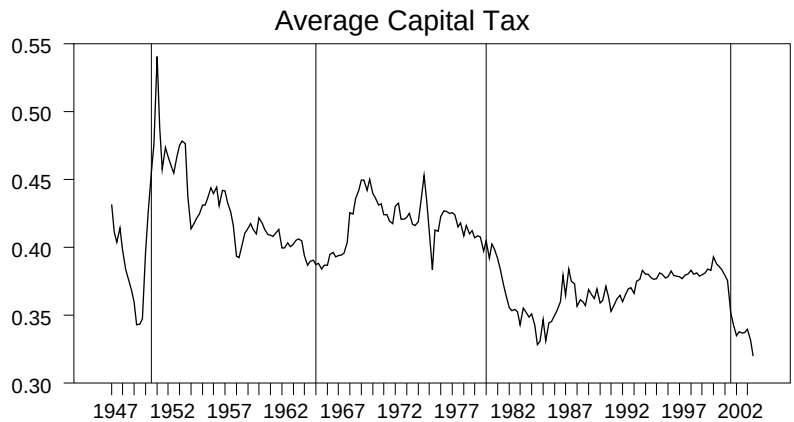
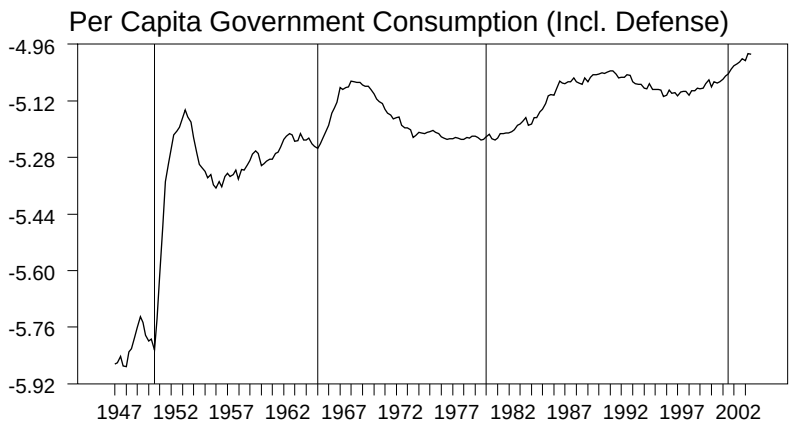
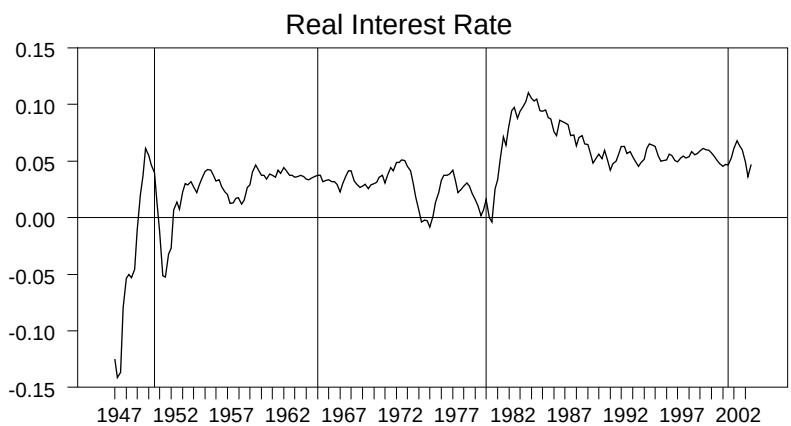
Figure 1: Data Used in the Analysis

Vertical Lines - Ramey-Shapiro Dates and 9/11







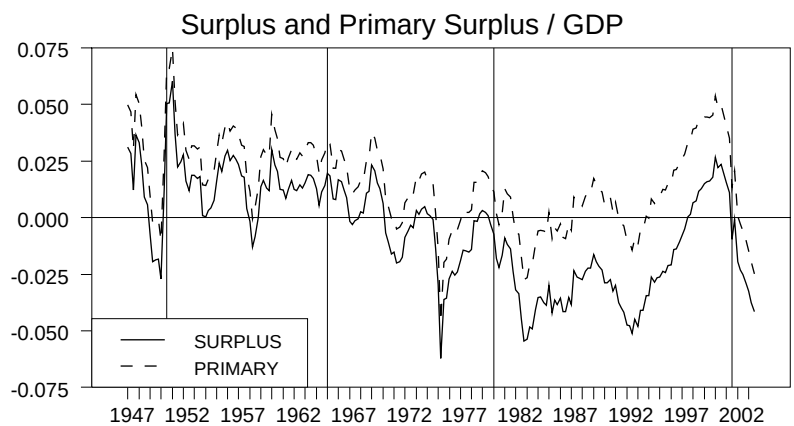


Figure 2: Government Consumption as a Fraction of GDP

Vertical Lines - Ramey-Shapiro Dates and 9/11

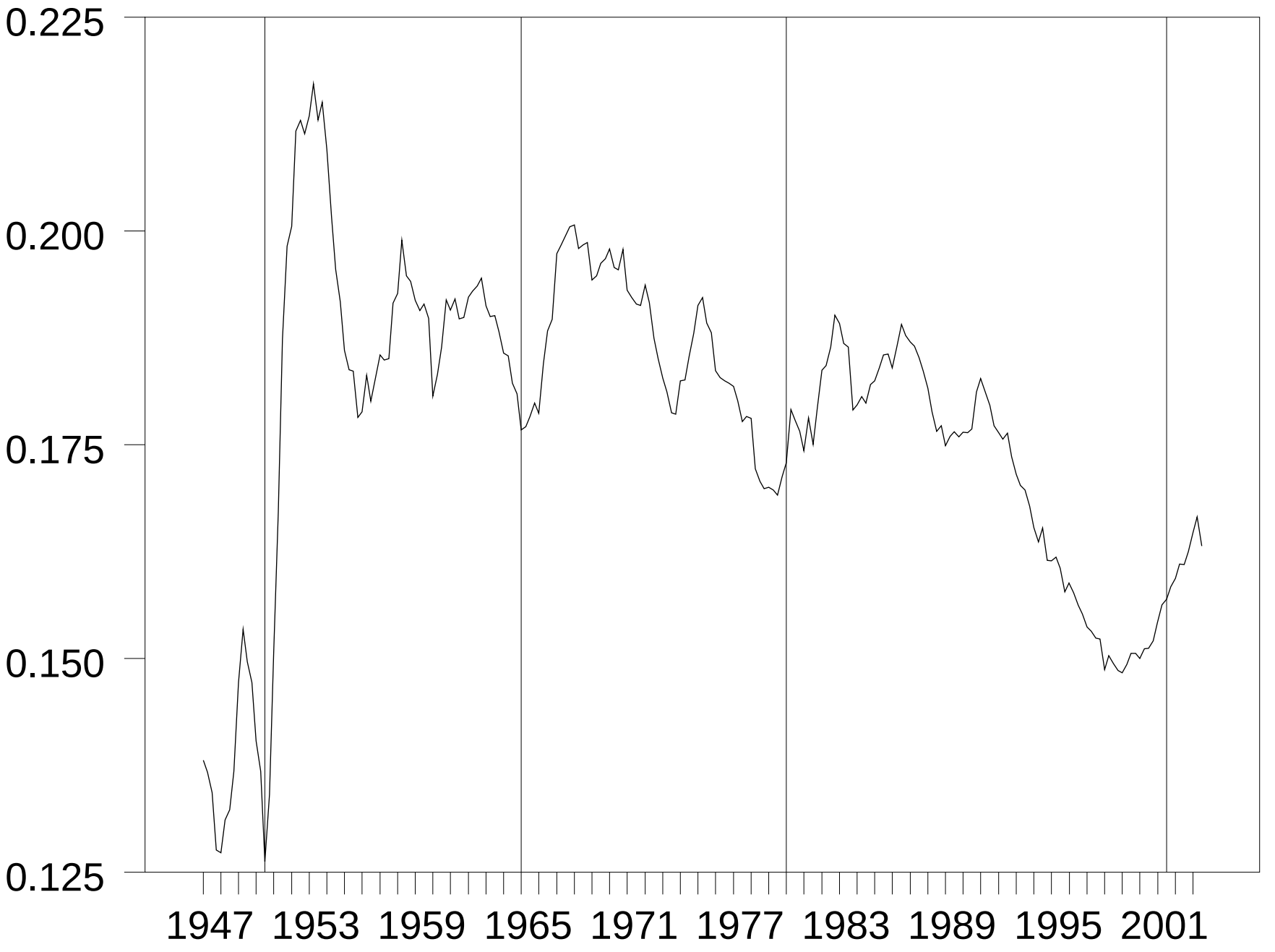
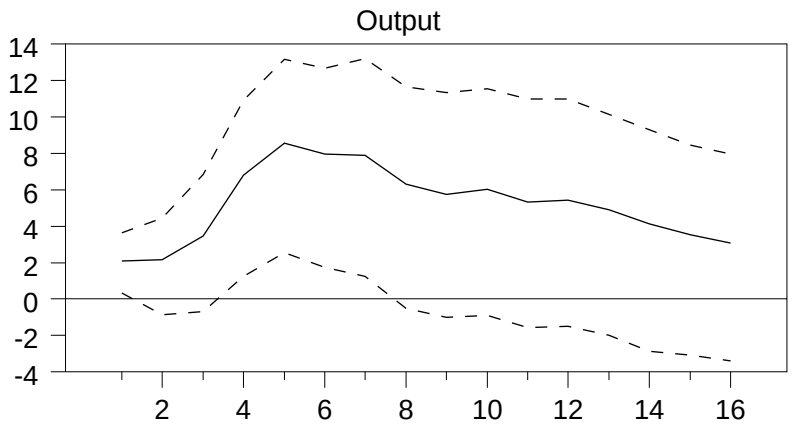
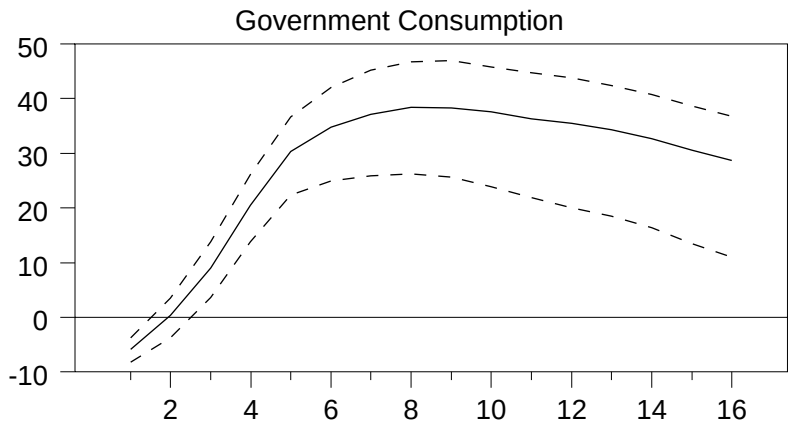
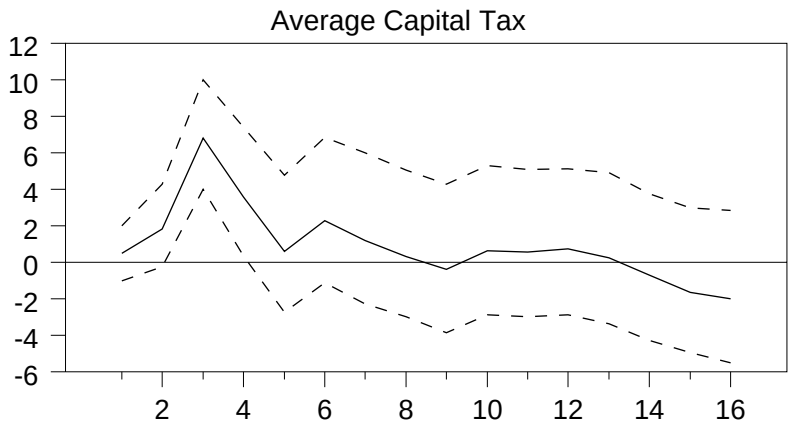


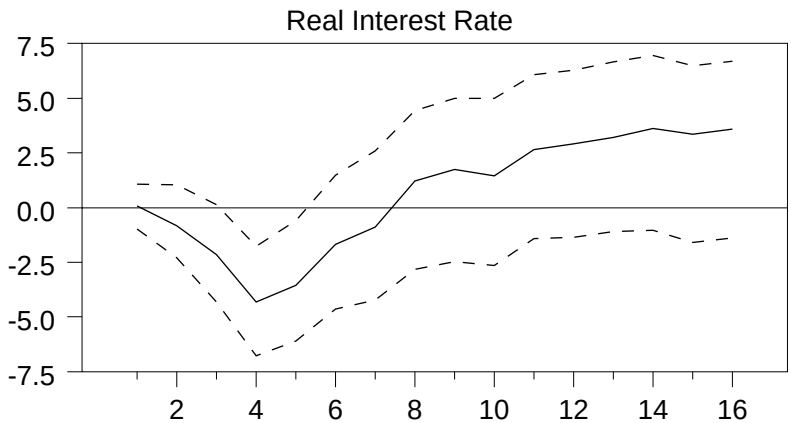
Figure 3: Estimated Responses to Pre-9/11 Episode

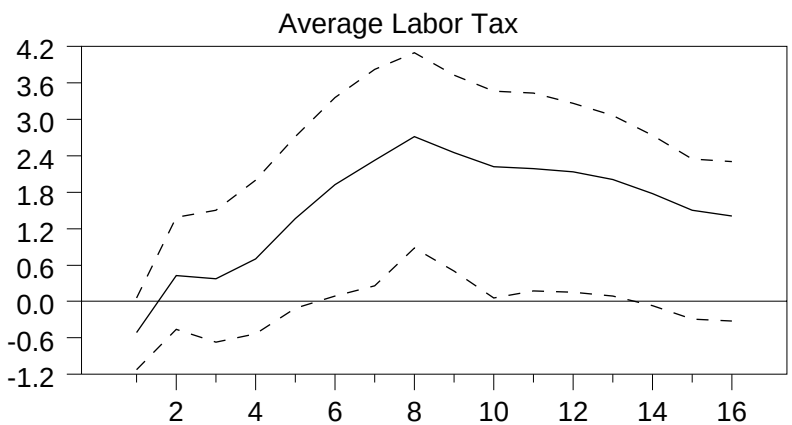
Solid Line - Point Estimates, Dashed Lines - 95% Confidence Interval











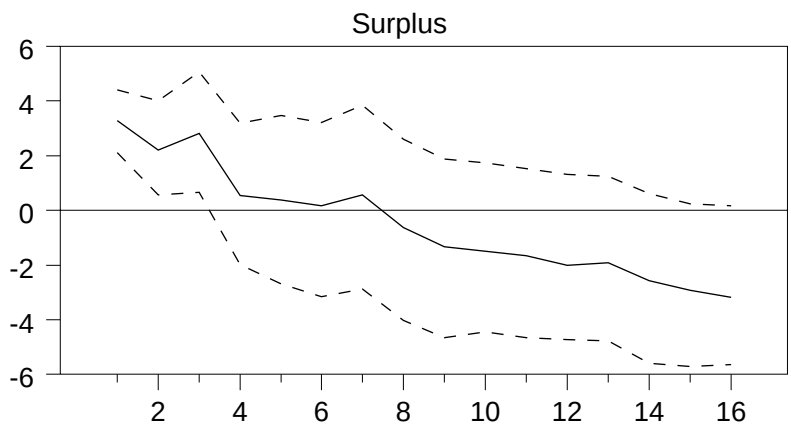


Figure 4: Historical Decomposition of the Korean War Episode

Solid Line - Actual Data, Long Dashed Line - Forecast With Ramey-Shapiro Episode,
Short Dashed Line - Forecast Without Ramey-Shapiro Episode

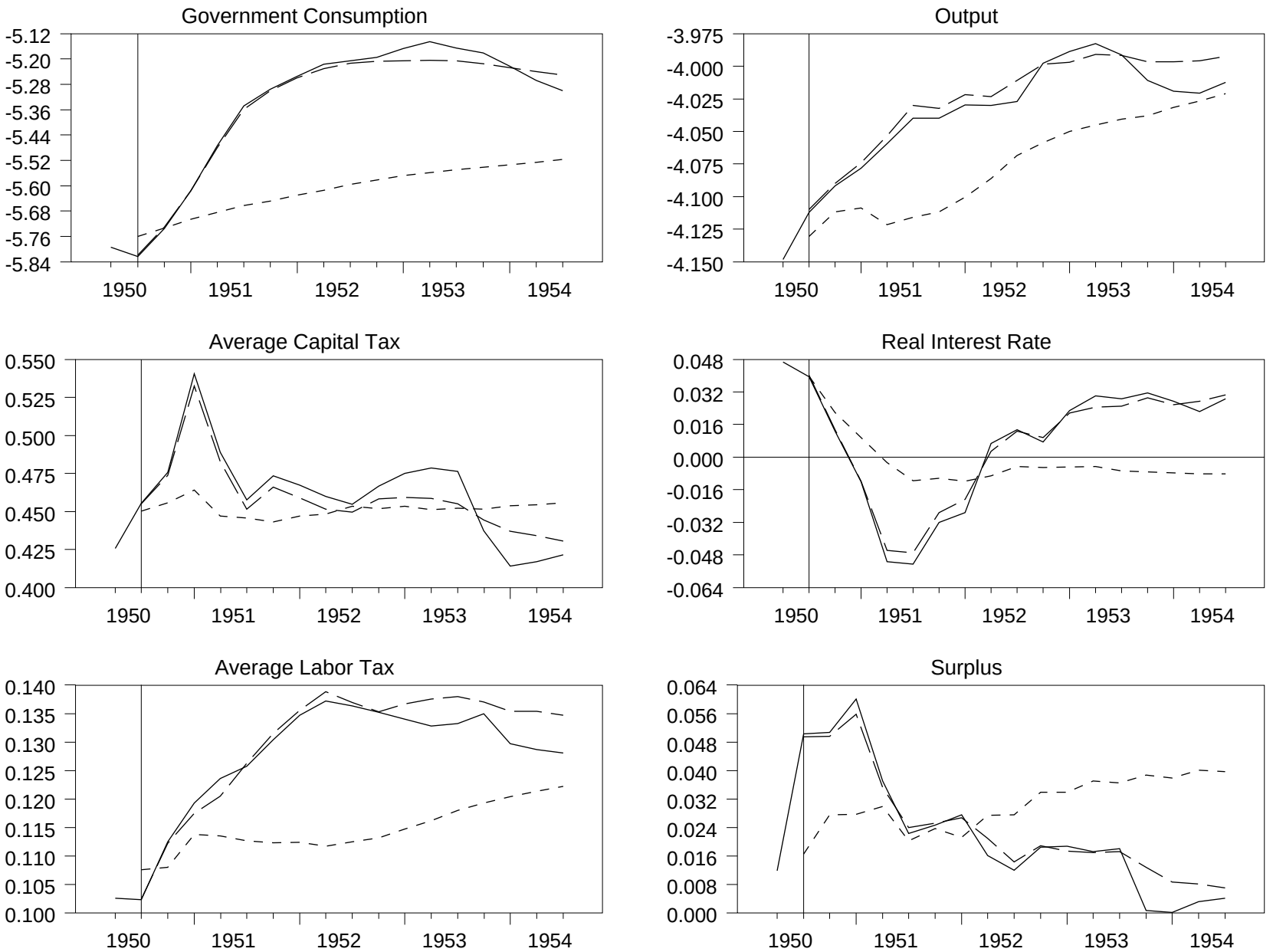


Figure 5: Historical Decomposition of Vietnam War Episode

Solid Line - Actual Data, Long Dashed Line - Forecast With Ramey-Shapiro Episode,
Short Dashed Line - Forecast Without Ramey-Shapiro Episode

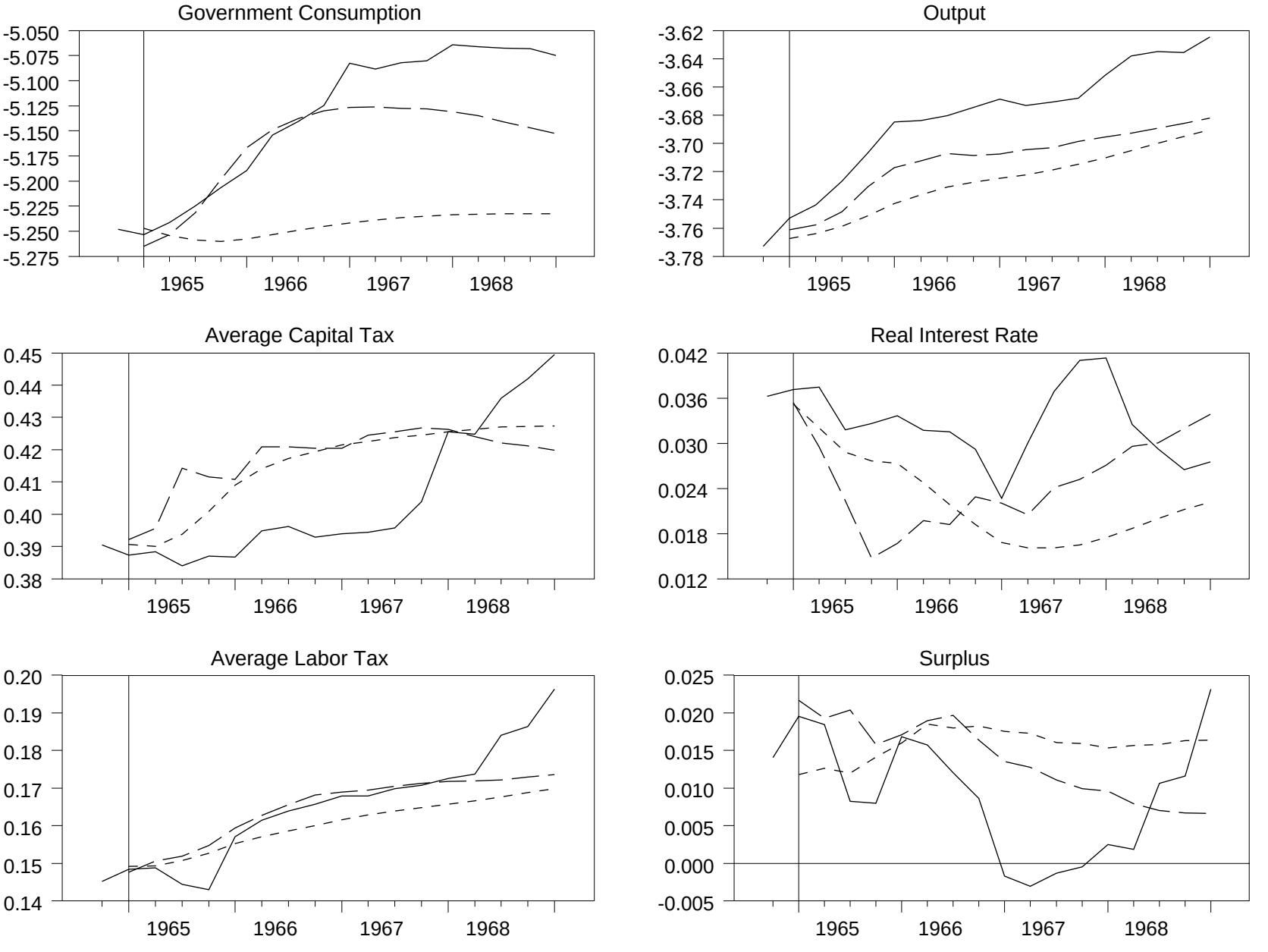


Figure 6: Historical Decomposition of Carter-Reagan Buildup Episode

Solid Line - Actual Data, Long Dashed Line - Forecast With Ramey-Shapiro Episode,
Short Dashed Line - Forecast Without Ramey-Shapiro Episode

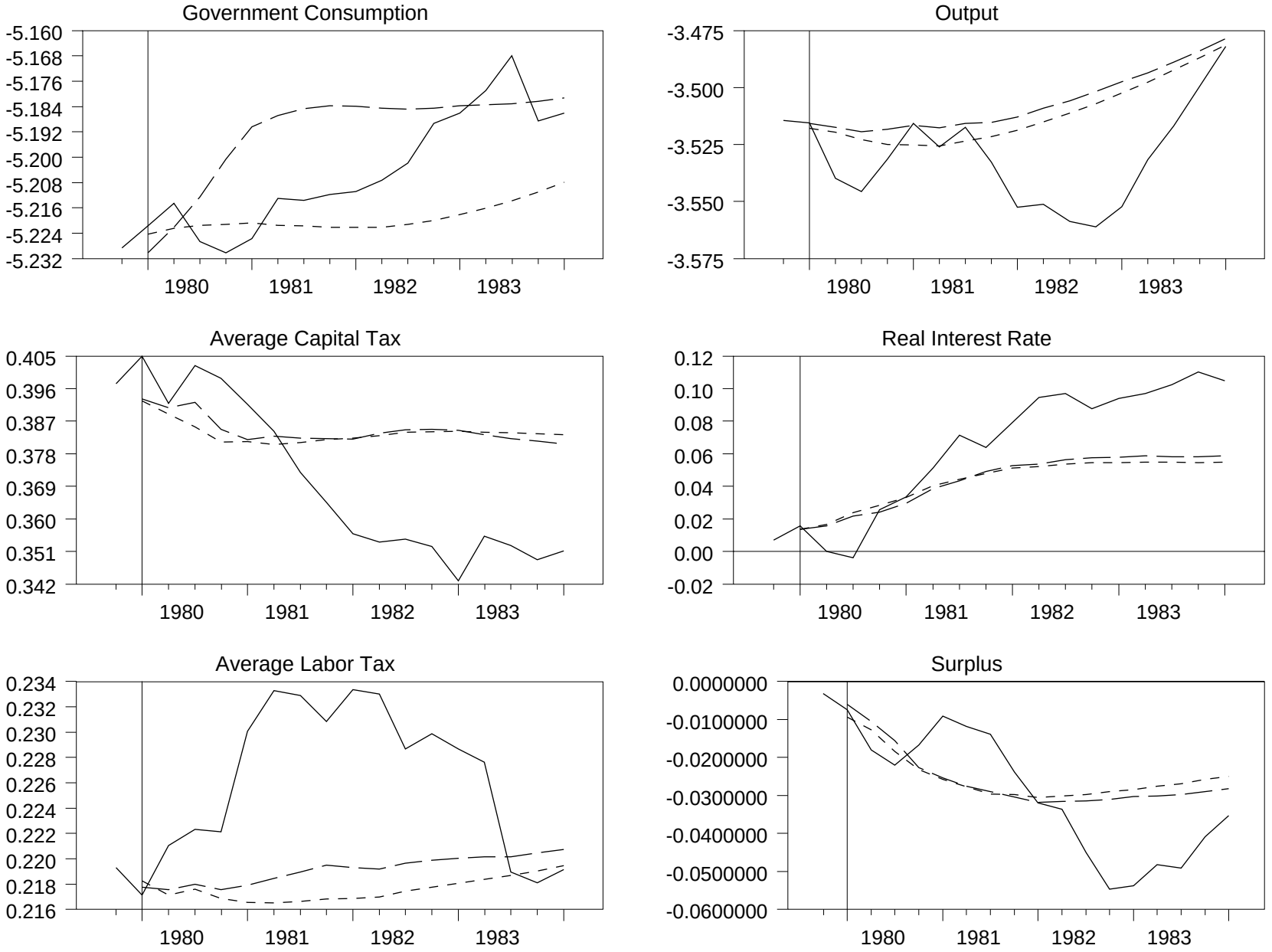


Figure 7: Predicted and Actual Dynamics in the Aftermath of 9/11

Solid Line - Actual Data, Long Dashed Line - Forecast Assuming Ramey-Shapiro Episode,
Short Dashed Line - Forecast Without Ramey-Shapiro Episode

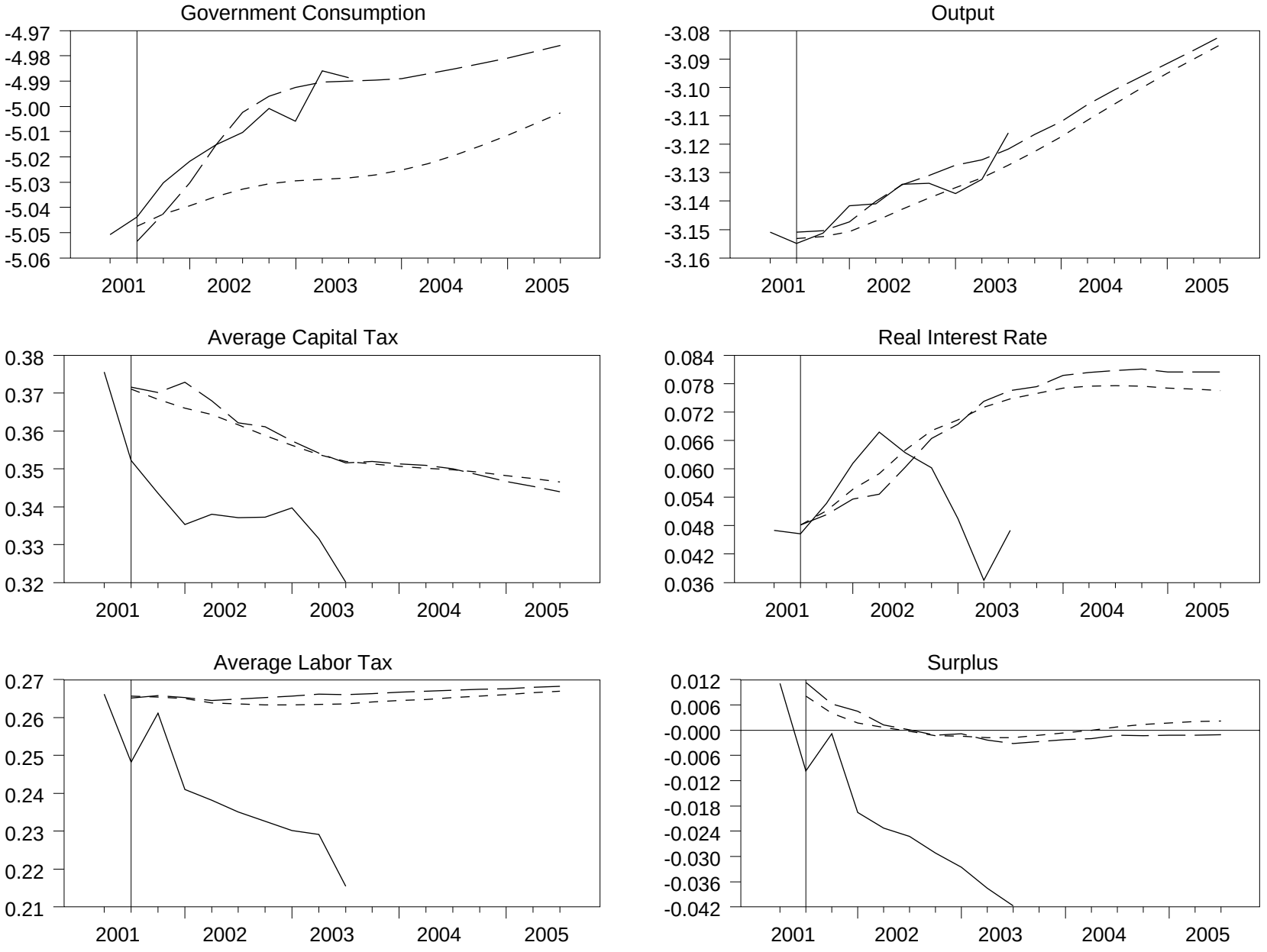


Figure 8: Theoretical Response to Pre-9/11 Ramey-Shapiro Episode

Solid Line - Empirical Response, Short Dashed Line - 95% Confidence Interval,
Long Dashed Line - Theoretical Response

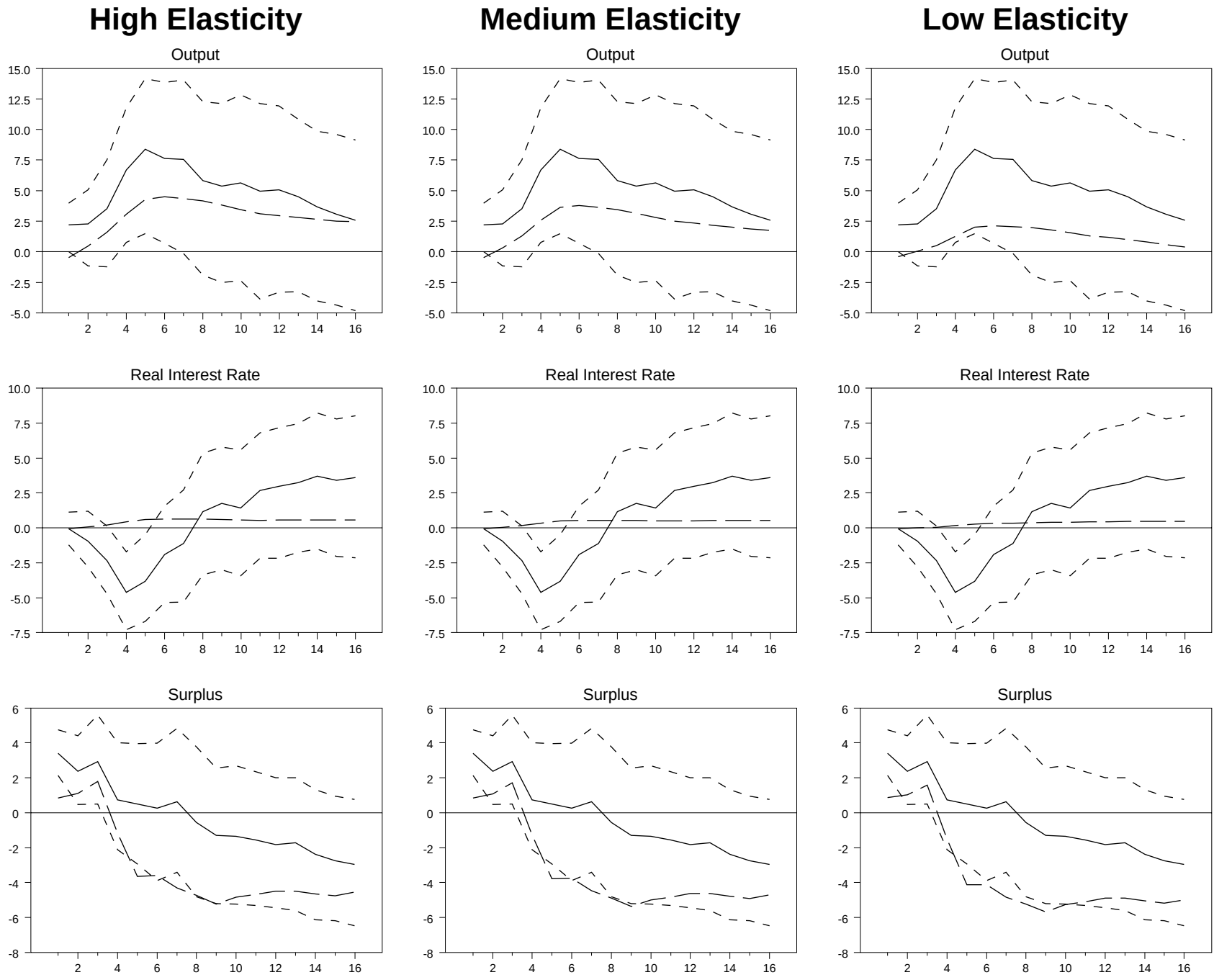


Figure 9: Fiscal Policy Experiments in the Neoclassical Model
Solid Line - High Elasticity, Dashed Line - Medium Elasticity, Dotted Line - Low Elasticity

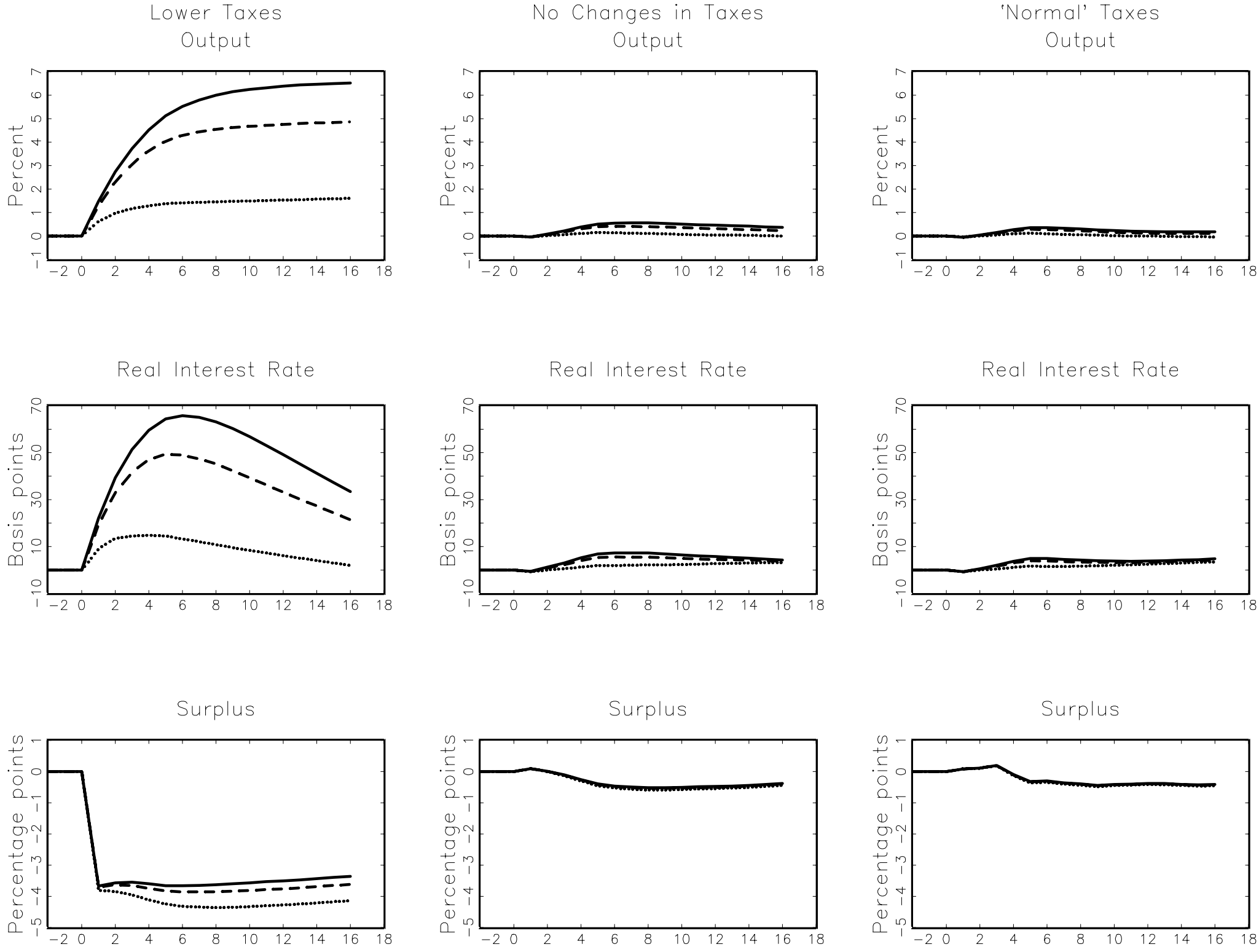
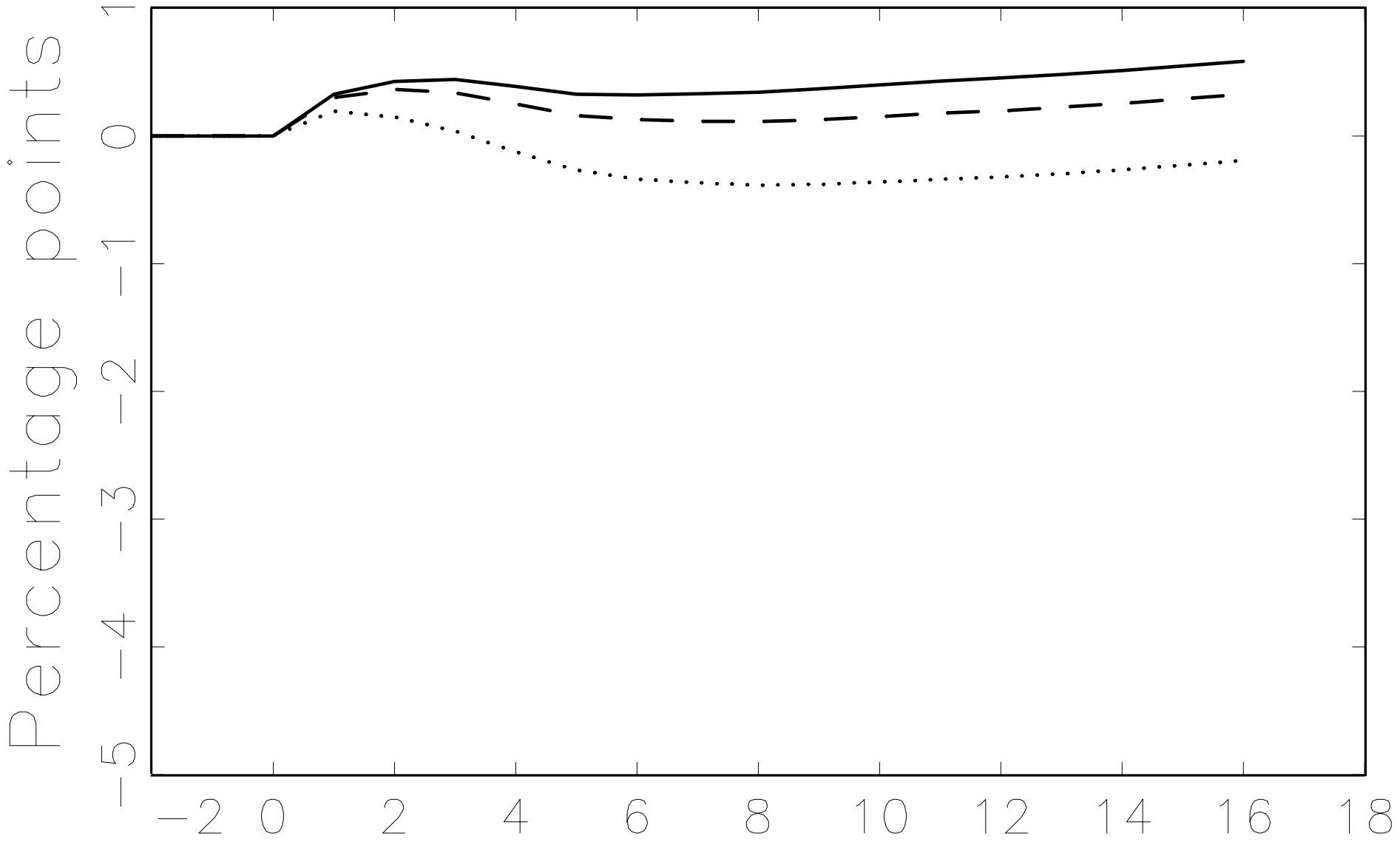


Figure 10: Response of the Surplus to GDP ratio in the Lower Tax Specification
Assuming Taxes Remain at their Steady State Levels

Solid Line - High Elasticity, Dashed Line - Medium Elasticity, Dotted Line - Low Elasticity



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