Phased-In Tax Cuts and Economic Activity

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ABSTRACT

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Phased-in tax changes are a common feature of tax legislation. This paper uses a dynamic general equilibrium model to quantify the effects of delaying tax cuts. According to the analysis of the model, the phased-in tax cuts of the 2001 tax bill substantially reduced employment, output, and investment during the phase-in period relative to alternative policies with immediate, but more modest tax cuts. The rules and accounting procedures used by Congress for formulating tax policy have a significant impact in shaping the details of tax policy and led to the phase-ins, sunsets, and temporary tax changes in both the 2001 and 2003 tax bills.

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Legislating predictable changes in tax rates violates one of the cardinal principles of public finance: Changes in tax rates should be permanent and immediate. Taxation typically distorts economic behavior and reduces economic efficiency. Because the deadweight burden of taxation is a convex function of the tax rate, there are efficiency gains to equalizing tax rates over time. As Barro (1979) argues, this logic implies that changes in tax rates should be unpredictable, that is, tax rates should follow random walks. Mankiw (1987) applies the same logic to seignorage. The Barro principle is not universal. Chamley (1986) and Judd (1985) show that, in economies with capital, the optimal tax rate on capital income must be zero in the steady state. Because it is often optimal to tax the initial capital stock heavily, the optimal tax rate on capital income should be phased-in.

In practice, however, government policy frequently ignores these principles and fails to take into account the effects of the timing of taxes on economic activity. The 2001 tax legislation called for reductions in the four top tax brackets that were to be put into effect in pre-announced scheduled intervals over the subsequent five years. The phased-in nature of this tax cut is by no means unique to the 2001 legislation. The tax cuts of 1964, the Reagan tax cuts of 1982, and the tax reform of 1986 all featured phased-in reductions in tax rates. Recent tax rate increases (the Bush 1990 and Clinton 1993 legislation for example) have not been phased in over a period of years. Wartime tax increases are also typically immediate, though they are often either explicitly or implicitly temporary.

This paper considers the macroeconomic implications of phasing-in tax cuts. We focus on three issues. First, we show how the timing of economic activity is affected by phased-in tax cuts compared to immediate cuts. In parallel to the optimal tax literature, we show that there are important differences between phased-in tax cuts on labor income and phased-in tax cuts on

capital income. Second, we discuss the implications of the phased-in nature of the 2001 law for the performance of the economy. We compare this with how the economy would have reacted if the legislation had cut taxes immediately. Finally, we ask why tax cuts are so often phased-in in practice.

To address the first two sets of issues, we construct a simple, dynamic general equilibrium model that allows the government to specify a predetermined path of tax rates on labor income and capital income. The model provides a quantitative assessment of the effects of phased-in tax cuts on employment, output, investment, and the fiscal deficit. The equilibrium model provides important checks on the analysis. In particular, it requires that the government's intertemporal budget constraint hold. We show that it makes a substantial difference how the government balances its budget in the long run.

We use the 2001 tax cut as a case study. *The Economic Growth and Tax Relief Reconciliation Act* (*EGTRRA*) was enacted in June 2001. The bill created a new 10 percent tax bracket. It cut tax rates for all brackets above the 28 percent tax bracket by 1/2 a percentage point immediately and provided for phased-in reductions effective in 2002, 2004, and 2006. By 2006, the top marginal tax rate was schedule to fall by more than 4 percentage points. In 2011, the tax plan would "sunset." That is, under the 2001 law, tax rates would revert to their original levels in 2011 absent further legislation.

Our analysis suggests that the timing of the tax cuts had substantial effects on labor supply, investment and economic performance. In particular, the slow growth of employment and output since the trough of the recession may be, in part, attributable to declines in labor

supply owing to the phased-in nature of the income tax reductions.[1] During the period of the phase-in, taxes on labor income are high relative to future tax rates. Workers have an incentive to work less currently while taxes are temporarily high.

The incentive to delay production and employment will be operative as long as the workers can intertemporally substitute consumption and work. If they can consume now but work later, then phased-in tax cuts give them good reasons to do so. In standard equilibrium models there are margins along which firms and workers can intertemporally substitute. In a closed economy model like the one we analyze in this paper, workers and firms can accumulate (or decumulate) capital. In an open economy model, the nation as a whole can borrow or lend with its trading partners. In either case, phased-in tax cuts will temporarily reduce investment and production as consumers try to reap the rewards of the future tax cut but delay working.

The strength of the motive to delay labor supply depends on consumers' preferences. If labor supply is highly elastic but, at the same time, consumers are not willing to substitute consumption intertemporally, then the incentive to defer production will be strong. If labor supply is less elastic and consumers are willing to defer consumption then the incentive to postpone production will be tempered.

Deferred tax cuts on capital income have very different effects from delayed labor tax cuts. The reason for the difference is simple: The decision to invest in new plant and equipment depends on the expected total discounted returns over the life of the capital. To the extent that capital is long-lived, a large part of these returns will be realized in the future. As a result,

[1] Of course, the labor market outcomes also depended on many other factors. Moreover, frictions in the labor market not reflected in our model may push workers off their labor supply curves temporarily. While admitting these possibilities, they are not reasons to completely dismiss the intertemporal substitution effects of the tax policy. The period of the phase-in is four

provided that the delay is short enough, a phased-in tax cut on capital income will provide almost the same incentive to invest now as an immediate tax cut would. In addition, compared to an immediate tax cut, a deferred tax cut also reduces the windfall to previously installed capital. As a consequence, phased-in capital tax cuts have better efficiency properties than phased-in labor tax cuts.

The rest of the paper is set out as follows: Section I presents the model and Section II analyzes separately the case of delayed labor tax cuts and delayed capital tax cuts. In Section III, we use the model to analyze the 2001 tax bill. We also consider the robustness of our findings to alternative parameter values. The robustness analysis clarifies the economic mechanisms driving the results. Section III also discussions the 2003 tax bill, which features temporary rather than phased-in tax rate cuts. Section IV, considers the role played by Federal budget rules in forming tax policy. We argue that these rules tend to encourage tax cuts that are phased-in and temporary and as a result may have substantial macroeconomic consequences. In Section V, we present our conclusions.

I. The Model

We consider a standard business cycle model extended to allow for a government sector.[2] The government finances its spending with both distortionary and lump-sum taxes. We allow for both anticipated and unanticipated changes in tax rates and government purchases.

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years, which should be long enough for workers and firms to overcome adjustment costs and for prices and wage rates to equilibrate.

[2] Auerbach and Kotlikoff (1987) present a detailed and comprehensive treatment of fiscal policy in a dynamic model. Barro (1989) and Baxter and King (1993) consider the effects of government purchases and the financing of such purchases in general equilibrium models.

The representative agent derives utility from consumption (C_t) and experiences disutility associated with labor (N_t). The agent seeks to maximize

$$\sum_{t=0}^{\infty} \beta^t E_t \left[u\left(C_t\right) - v\left(N_t\right) \right] \tag{1}$$

subject to the constraints:

$$(1-\tau_t^N) W_t N_t + (1-\tau_t^K) R_t K_t + \tau_t^K \delta K_t - T_t = C_t + I_t + K_t \varphi\left(\frac{I_t}{K_t}\right)(1-\tau_t^K) \tag{2}$$

and

$$K_{t+1} = K_t\left(1-\delta\right) + I_t. \tag{3}$$

Here, W_t is the real wage rate, N_t is the supply of labor, R_t is the real rental price of capital, K_t is the level of the capital stock and T_t is a lump sum tax. The tax rates τ^N and τ^K are distortionary taxes on labor income and capital income respectively. The model allows for investment adjustment costs. The function φ is assumed to be convex in the investment rate I_t/K_t, with $\varphi\left(\delta\right) = 0,\ \varphi'\left(\delta\right) = 0$, and $\varphi''\left(\delta\right) = \phi \geq 0$. Note that we allow the representative agent to deduct both depreciation and adjustment costs from their tax bill.

Firms produce output with the constant returns to scale production function $F(K,N)$. The firm's profit maximization conditions imply that

$$W_t = \frac{\partial F}{\partial N}(K, N) \tag{4}$$

and

$$R_t = \frac{\partial F}{\partial K}\left(K_t, N_t\right). \tag{5}$$

Finally, the goods market clearing condition is

$$Y_t = F(K_t, N_t) = C_t + I_t + G_t + K_t\varphi\left(\frac{I_t}{K_t}\right). \tag{6}$$

We abstract from international flows of goods and capital (reflected by the absence of net exports in the resource constraint (6)). While to some extent, allowing for international capital flows would alter our results, modeling other countries in a realistic way would significantly complicate the model. We assume that the government runs a balanced budget period-by-period. Thus,

$$G_t = \tau_t^N N_t W_t + \tau_t^K K_t\left[R_t - \delta - \varphi\left(\frac{I_t}{K_t}\right)\right] + T_t. \tag{7}$$

Although the timing of the distortionary taxes (τ^N and τ^K) influences the equilibrium, the timing of the lump sum taxes is irrelevant.

Utility maximization implies that, in equilibrium,

$$v'(N_t) = u'(C_t)W_t\left(1-\tau_t^N\right), \tag{8}$$

$$q_t = \beta E_t\left[u'(C_{t+1})\left\{\left(1-\tau_{t+1}^K\right)\left[R_{t+1} + \frac{I_{t+1}}{K_{t+1}}\varphi'\left(\frac{I_{t+1}}{K_{t+1}}\right) - \varphi\left(\frac{I_{t+1}}{K_{t+1}}\right)\right] + \delta\tau_{t+1}^K\right\} + q_{t+1}(1-\delta)\right], \tag{9}$$

and

$$u'(C_t)\left[1 + (1-\tau_t^K)\varphi'\left(\frac{I_t}{K_t}\right)\right] = q_t. \tag{10}$$

Here q_t is the shadow value of K_{t+1} (the Lagrange multiplier on constraint (3)). Alternatively, if we define $Q_t \equiv \frac{q_t}{u'(C_t)}$ then we get a standard Euler equation

$$u'(C_{t+1})Q_t = \beta E_t\left[u'(C_{t+1})\left\{\left(1-\tau_{t+1}^K\right)\left[R_{t+1} + \frac{I_{t+1}}{K_{t+1}}\varphi'\left(\frac{I_{t+1}}{K_{t+1}}\right) - \varphi\left(\frac{I_{t+1}}{K_{t+1}}\right)\right] + \delta\tau_{t+1}^K + Q_{t+1}(1-\delta)\right\}\right]. \tag{11}$$

Q_t is the analog of Brainard-Tobin's Q in this model. It is the ratio of the shadow value of additional capital to the marginal utility of consumption at date t. The investment rate depends on Q_t and the tax rate on capital income (because of the deductibility of investment adjustment costs), so

$$\frac{I_t}{K_t} = (\varphi')^{-1}\left(\frac{Q_t - 1}{1-\tau_t^K}\right) = h\left(Q_t, \tau_t^K\right), \tag{12}$$

where $(\varphi')^{-1}(.)$ is the inverse function of $\varphi'\left(\frac{I}{K}\right)$. When there are no adjustment costs then $Q_t = 1$ in every period.

Given any initial position of the system, a rational expectations equilibrium requires that equations (3), (4), (5), (6), (8), (9), and (10) hold in every period. These are seven equations in the seven variables K_t, I_t, C_t, Q_t, N_t, Y_t, W_t, and R_t with the exogenous forcing variables $\left\{\tau_t^N, \tau_t^K, G_t, T_t\right\}_{t=0}^{\infty}$.[3]

The Steady State

Because we have chosen to abstract from long run productivity growth, our model has a non-stochastic steady state equilibrium for constant paths of government purchases and tax rates (i.e. $G_t = \bar{G}$, $\tau_t^N = \bar{\tau}^N$, $\tau_t^K = \bar{\tau}^K$ for all t). In a steady state,

$$1 = \beta\left[\left(1-\tau^K\right)R + \tau^K\delta + (1-\delta)\right].$$

[3] Because of Walras' Law and Ricardian equivalence, we can ignore T_t (and the government's budget constraint).

This condition determines R and as a consequence determines the steady state capital to labor ratio (K/N) and the steady state real wage (W). Note that R, W, and K/N depend only on the tax rate on capital income τ^K. The goods market clearing condition implies that in a steady state

$$C = \left\{ F\left(\frac{K}{N}, 1 \right) - \delta \frac{K}{N} \right\} N - G = N\zeta\left(\frac{K}{N} \right) - G ,$$

where ζ is increasing in the neighborhood of the steady state. Combining this with the labor market clearing condition gives us

$$v'(N) = u'\left(N\zeta\left(\frac{K}{N} \right) - G \right) W\left(\frac{K}{N} \right)\left(1 - \tau^N\right), \tag{13}$$

where we write $W\left(\frac{K}{N} \right)$ to indicate the dependence of the real wage on the capital to labor ratio.

Given τ^K, there is a unique steady state level of employment (N) that solves this equation provided that v' is strictly increasing and u' is strictly decreasing.[4]

Long-run effects

Although our primary focus is on the dynamic effects of tax changes it is worth pointing out some of the long run effects of tax changes at this point. First, consider a reduction in labor tax rates (τ^N) holding capital tax rates (τ^K) constant. The reduction in labor income taxes has no effect on the long run capital to labor ratio and as a result has no long run effect on W. Consequently, the right hand side of (13) rises for any given N. Thus, the new steady state equilibrium has higher employment. In addition, K, I, and C rise while W and R are unchanged.

[4] Neither the adjustment costs nor the fact that adjustment costs are deductible has any influence on the long run position of the model.

Because government purchases have not changed, the lower marginal tax rate is accompanied by an increase in the lump sum taxes that exactly offsets the loss in tax revenue. Since the tax is lump sum and consumers have an operative intertemporal budget constraint, the timing of this tax payment is irrelevant. Hence, this specification is equivalent to financing the tax cut by debt where the debt is to be retired in the future in a non-distortionary manner. The purpose of this specification is to eliminate the income effect of the tax cut and therefore focus attention on the substitution effect. The specification where government purchases fall to balance the budget has a substantial income effect that approximately offsets the substitution effect in labor supply. Neither of these specifications is particularly realistic, but they do serve to bracket the possibilities for how the government balances its budget in the long run.

Now suppose that τ^K is reduced while τ^N is held constant. The lower tax rate on capital income increases K/N and W. R falls just enough so that $R(1-\tau^K)$ is unchanged. While consumption must rise in the long run,[5] lower tax rates on capital income have ambiguous long run effects on employment. If marginal utility is relatively flat, then N rises. If marginal utility falls rapidly, then the consumers do not value the increased consumption very much. In this case, they economize on working and, as a result, employment falls. In either case K and I must rise.

Changes in government purchases also have significant effects on the long run position of the economy. If government purchases falls, the consumers experience a positive income effect. This increase in income leads them to increase consumption and reduce employment. Because

[5] If consumption does not increase, the marginal utility of consumption would either remain constant or would rise. Because labor taxes are constant while real wages rise, equation (13) implies that N would also rise. But, this would imply higher output and consequently higher consumption.

the capital to labor ratio only depends on the rate at which capital is taxed, reductions in government purchases also reduce the capital stock and investment in the long run.[6]

Welfare

Though we do not analyze the welfare effects of alternative policies, it is important to acknowledge that the alternative ways in which the government balances its budget have important welfare implications. In our model, the utility flow from government purchases is not explicitly accounted for. The simulations that balance the budget by cutting government purchases look very favorable for the level of consumption. This increase in consumption would need to be weighed against the drop in government purchases. To the extent that consumers value the services of the government, focusing exclusively on consumption is very misleading.

One could add a utility flow from government purchases to the model. Note, however, that if government purchases are additively separable in the utility function (1), there would be no changes whatsoever in the incentives faced by the consumers or the firms and as a result, this modification, while changing the welfare implications of the policy, would leave all equilibrium allocations the same.[7]

Functional forms

To analyze the dynamic effects of changes in tax policy we need to solve the model numerically. To do so, we specify functional forms for the utility and production functions. We choose

[6] Note that if $\tau^N = \tau^K = \tau$, and $G = \tau Y$, changes in tax rates have both income and substitution effects as they effect not only the payoff to working and accumulating capital but also the amount of resources the government takes from the economy. In the special case in which $u(C)$ is logarithmic, these income and substitution effects exactly offset and N is invariant to τ.

[7] If government purchases were non-separable from consumption, the results would be affected.

parameters for these functions that are typical in the real business cycle literature. The functional forms we use are

$$u(C)=\left[1-\frac{1}{\sigma}\right]^{-1} C_t^{1-\frac{1}{\sigma}}, \tag{14}$$

$$v(N)=\left[1+\frac{1}{\eta}\right]^{-1} N_t^{1+\frac{1}{\eta}}, \tag{15}$$

$$Y_t = AK_t^{\alpha} N_t^{1-\alpha}, \tag{16}$$

and

$$\varphi\left(\frac{I_t}{K_t}\right)=\frac{\phi}{2}\left(\frac{I_t}{K_t}-\delta\right)^2. \tag{17}$$

The parameter σ is the intertemporal elasticity of substitution, η is the Frisch labor supply elasticity, α is capital's share in production and ϕ is the curvature of the investment adjustment cost function ($\varphi''(\delta)$).

Benchmark Parameters

The parameters we use for our benchmark calculations are given in Table 1. These values fall within standard ranges of values used in typical dynamic general equilibrium models and models of economic growth. The discount factor is set at 0.98 to generate a 2 percent annual real interest rate. Capital's share is set to 0.35. We choose an annual depreciation rate of 0.10. The remaining three parameters—the Frisch labor supply elasticity, the elasticity of intertemporal substitution, and the curvature of the investment adjustment cost function—can have important effects on our results. Because of this, in addition to these benchmark settings, we consider a range of alternative values for these parameters.

We use 0.5 as our benchmark value for the Frisch labor supply elasticity (η). Although an elasticity of 0.5 is relatively high compared with evidence from much of the labor economics literature, it is much smaller than elasticities typically used in the real business cycle literature, which follows Prescott (1986) in adopting a value of at least 2. Our benchmark value is in line with estimates found in more recent studies that focus on situations in which individuals have to make unconstrained choices about labor supply.[8]

Our benchmark setting for the elasticity of intertemporal substitution (σ) is 1.0. We made this choice for two reasons. First, the assumption of logarithmic utility for consumption is standard in business cycle literature. Second, $u(C) = \log(C)$ is the only utility function for which income and substitution effects of a change in real wages exactly offsets without allowing for non-separabilities between labor and consumption [see King, Plosser, and Rebelo (1988) and Kimball and Shapiro (2003)]. Because the evidence suggests that σ is substantially less than 1 (see Hall (1988) and Barsky, *et al*. (1997)), we consider alternative values in the presentation of our results.

We assume that the economy begins in an initial steady state. The initial tax rates are assumed to be $\tau^N = 0.362$ and $\tau^K = 0.183$.[9] These correspond to the effective marginal tax rates on wage and capital income estimated by the Congressional Budget Office prior to 2001 Tax Bill. We assume that the share of real government purchases in GDP (G/Y) is 0.2 which is roughly in line with historical averages.

[8] For a discussion of this literature, see Farber (2003) and Kimball and Shapiro (2003).
[9] CBO's estimate of the tax rate on capital is low relative to that of labor. The CBO includes housing capital in this estimate. Housing is a large share of capital and, according to CBO, gets a tax subsidy.

Solution

We assume that, at time $t = 0$, the government announces a new path for tax rates and government purchases. Decisions from date 0 on are made with perfect foresight and with the sequences $\left\{\tau_t^N, \tau_t^K, G_t, T_t\right\}_{t=0}^{\infty}$ taken as given. The model is solved by taking a log-linear approximation in the neighborhood of the initial steady state.[10]

II. Dynamic Effects of Delayed Tax Cuts

In this section, we examine the effects of delayed tax cuts on economic activity. We compare the delayed tax cuts with immediate, but more modestly sized reductions in tax rates. The aim of this analysis is to illustrate transparently the economic effects of delaying tax cuts. We present separate analyses of capital taxation and labor taxation.

Typically, tax cuts of any kind reduce tax revenue. As a result, at some point, the government will have to either reduce purchases or raise taxes to balance its budget. The effects of tax cuts are strongly influenced by how the government chooses to balance its budget in the long run. We consider two alternatives. In the first instance, we simply assume that the government makes up for the reduction in revenue by raising lump sum taxes. This assumption has the advantage of allowing us to examine the effects of the tax rate reduction in isolation; however, it substantially overstates the advantages of the tax cuts by substituting non-distortionary taxes for distortionary taxes. In the second instance, we assume that the level of lump sum taxes is constant and that the government instead reduces purchases. For simplicity we assume that the reductions in government purchases take place concurrently with the reductions in revenue. Obviously, the timing of government purchases has strong effects the

equilibrium, but given the infinity of ways to specify the path of government purchases, this approach seems sensible.[11]

Neither lump sum tax increases nor concurrent reductions in government purchases accurately describe the fiscal policy that accompanied the 2001 tax cuts. When we turn to that example we also consider a case in which budget balance is achieved through the phase-out, or "sunset," provisions in the law.

Though the simulations described in this section are hypothetical, they are meant to inform the analysis of the 2001 tax law. The debate over that law was couched in terms of a 10-year budget window. Thus, we present two scenarios that have the same revenue consequences over a 10-year horizon. For each simulation, we calculate the revenue that the government would collect in the ten years following the change in policy under the assumption that interest rates, employment, real wages, the capital stock, and the real rental price of capital remain constant. If this were the case, the change in revenue associated with any tax policy would be simply

$$\Delta\text{Revenue} = \sum_{t=0}^{T}\left(\frac{1}{1+r}\right)^{t}\left[WN\Delta\tau_t^N + RK\Delta\tau_t^K\right], \tag{18}$$

where T is the length of the budget window. We then choose an immediate tax cut that entails the same loss in revenue over the same time period. To further match the basic shape of the 2001 tax cuts, we take the delay in the tax cut to be four years, roughly the same delay in the bill. We

[10] For a robustness check, we also solved the model with a nonlinear shooting algorithm. The results were, for all practical purposes, identical.

[11] We have run simulations in which the spending cuts were deferred into the future. If the deferral is long enough, the model will behave like the lump-sum tax simulations. If the deferral is modest (say 10-15 years) then the effects on employment and production are closer to the model with concurrent reductions in purchases.

consider one-percentage point delayed tax rate cuts, and then calculate the immediate tax cut that delivers the same 10-year revenue loss.[12]

Analytically, there is nothing special about the comparison of the policy over a 10-year window. Since such comparisons feature prominently in debates over the revenue impact of tax policy, it is a useful comparison for practical purposes.

A. Delayed Tax Rate Cuts: Labor Taxes

Consider two paths for labor tax rates. In the first, marginal tax rates on wage income are cut by one percentage point, but the rate reduction is delayed by four years. The reduction is fully credible at the time of its announcement (four years in advance) and workers rationally anticipate it. In the second, tax rates on labor income are cut immediately by 0.53 percentage points. As described above, this yields the same 10-year loss in revenue given the parameter values of our model. We compare these tax policies under two scenarios for balancing the budget: cutting government purchases and increasing lump sum taxes.

Figure 1 shows the effects of the delayed tax cut (the dark lines) and immediate tax cut (the light lines) under the assumption that the government cuts purchases to balance the budget. The top panel of Figure 1 shows the path of the "tax rates" for each of the two policies.

Consider first the effect of the immediate tax cut. The "tax revenue" panel shows that tax revenues fall. The decrease in government purchases equals the reduction in tax revenues. As a result, there is no effect on government debt.

[12] We do not take into account the endogenous responses of the economy to the policy, which would give us an accurate depiction of the effective loss in revenue. Instead we merely set their sum to be equal under the assumption that there are no responses to the policy. Hence, we use the "static scoring" method used by the government in reporting the effects of tax changes.

Consumption increases immediately because of the increase in lifetime earnings due to the tax cut. The reduction in labor income taxes increases the after-tax real wage and motivates workers to supply more labor. At the same time, the higher wealth from the reduced tax burden decreases labor supply. In the model, the wealth effect and the substitution effect roughly cancel and employment increases only slightly.[13] In the short run, because the capital stock cannot jump, output increases by roughly two-thirds of the percentage increase in labor. Capital accumulation leads to a very gradual increase in the capital stock that brings the capital-labor ratio back to its steady-state value.

In summary, with an immediate tax cut our model generates routine results. Output and employment (and the long run capital stock) do not change much owing to the approximate cancellation of income and substitution effects. Consumption gets a bigger share of GDP and government purchases get a smaller share. There are only very modest effects on investment.

The delayed tax cut produces dramatically different results. It leads to a substantial reduction in economic activity during the period of the delay. In the year following the policy announcement, employment is below trend by 0.33 percent, output is below trend by 0.25 percent and investment by 2.05 percent. The substitution effect leads workers to reduce labor supply. During the period of the delay, the tax rate is temporarily high relative to the future, so labor supply is reduced. GDP falls proportionately. The future tax cut does, however, make the consumers wealthier and thus causes an immediate increase in consumption. The increase in consumption comes at the expense of investment, which falls sharply. Employment falls further

[13] Even though our benchmark parameterization ($ln(C)$) satisfies the King-Plosser-Rebelo condition for offsetting income and substitution effects, there is a long run increase in employment in the model. This is because the tax rate on capital income has not been reduced. In the long run, the percentage increase in consumption will be less than the percentage increase in

as the date of the deferred tax cut approaches. The closer is the future tax cut, the more powerful the incentive to defer work.

Another way to see this is to consider the labor supply decision of the representative consumer (equation 8)

$$v'(N_t) = u'(C_t) W_t \left(1 - \tau_t^N\right).$$

Because of the permanent income hypothesis, the future tax reduction causes *C* to rise immediately. Forward-looking consumers experience the income effects of the policy as soon as the tax plan is announced however, because the tax reductions are delayed, the substitution effects are not realized until later. As a result, during the period of the phase-in, employment is low and consumption is high.

When the tax rate cut occurs in year four, employment, output, and investment jump. Once the tax rate on labor income actually falls, workers have extra incentive to supply labor. The increased labor supply raises the marginal product of capital and stimulates investment. As capital accumulates, output slowly rises to its new higher steady-state. Real interest rates are temporarily high during this period of time. The long-run dynamics are the same as those with the immediate tax cut. The magnitudes are larger because the delayed tax cut is larger than the immediate tax cut (by construction).

Figure 2 shows the same policy assuming that the government raises (lump sum) taxes to balance the budget rather than reducing government purchases. The "Debt/GDP ratio" panel shows how much government debt would increase were these lump sum tax increases deferred.[14]

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the after-tax real wage. If labor and capital tax rates were cut proportionally, income and substitution effects would cancel exactly.

[14] The timing of the lump sum tax increases does not affect the equilibrium.

The pattern of consumption in Figure 2 is similar to that in Figure 1, except that it is shifted down. The time path of employment and output is also similar to in Figure 1, but shifted up. In this case, consumption is lower, and income is higher because the increases in lump sum taxes exactly offset the wealth effect of lower distortionary tax rates. Hence, the strong wealth effects that were present in Figure 1 are greatly diminished in this experiment. The substitution effect is dominant.[15]

Note that balancing the budget by cutting government purchases lowers production and employment significantly (Figure 1) while financing the tax cut with future lump sum taxes (Figure 2) results in much smaller employment reductions. This is completely consistent with neoclassical theory. Higher government purchases deprive the private sector of resources and thus encourage production. Again, we emphasize that we are not making welfare comparisons in our analysis. Since we do not know how government purchases are valued by the private sector, we make no attempt to quantify the extent to which the reductions in government purchases offset the increases in private consumption.

The message of these simulations is clear. Phased in tax cuts on labor income give workers and firms incentives to delay work and investment until the tax cuts are in effect. While the tax cuts may be stimulative in the long run, the fact that they are phased-in stifles employment and production in the short run. These effects are even more dramatic when government purchases are reduced to balance the budget.[16]

[15] Alternatively, the government could balance its budget by increasing future *distortionary* taxes. This financing option would magnify the timing effects of tax changes by increasing the incentive to work when taxes are lowest.

B. Delayed Tax Rate Cuts: Capital Taxes

We now consider cutting the tax on capital income. Figure 3 compares a one percentage point cut in the tax rate on capital that is deferred for four years to a 0.65 percent cut in taxes put into effect immediately. As with the reduction in labor taxes, the immediate tax cut yields the same loss in revenue over a ten-year budget window.

Capital tax cuts have noticeably different effects than labor tax cuts. Consider first the immediate tax cut. The reduction in capital taxes increases output, employment, and consumption in the long run whether the budget is balanced by reductions in government purchases (Figure 3) or by increases in lump-sum taxes (Figure 4). When the policy change is announced, consumption falls and the interest rate rises because the capital stock is below its new steady-state level. Investment is high along the transition to the new steady state.

Unlike a delayed labor tax cut, which gives workers and firms the incentive to delay employment, a delayed reduction in capital taxes stimulates investment immediately. Another noteworthy difference is that tax cuts on capital income have much smaller effects on employment than do labor tax cuts.

The intuition for these differences is simple. First, because capital is long lived, investments made prior to the tax cuts still get benefits from the future tax reductions. Only a small fraction of the total payoffs to an investment are realized in the first few years. As a result, the timing effects do not affect the payoffs to investment much.

More formally, let q_t be the shadow value of additional capital (K_{t+1}) . Then, abstracting from adjustment costs, q_t is

[16] Although we do not have international trade in our model, it is clear that allowing agents to borrow from abroad would further reduce production during the period of the phase-in. The private sector would increase consumption in the short run by exporting capital.

$$q_t = \beta u'(C_{t+1})\left[\left(1-\tau^K_{t+1}\right)R_{t+1} + \tau^K_{t+1}\delta\right] + \beta q_{t+1}(1-\delta)$$
$$= \beta u'(C_{t+1})\left[\left(1-\tau^K_{t+1}\right)R_{t+1} + \tau^K_{t+1}\delta\right] + \beta^2(1-\delta)u'(C_{t+2})\left[\left(1-\tau^K_{t+2}\right)R_{t+2} + \tau^K_{t+2}\delta\right] + \ldots$$

or

$$q_t = \sum_{j=1}^{\infty} \beta^j (1-\delta)^{j-1} u'(C_{t+j})\left[\left(1-\tau^K_{t+j}\right)R_{t+j} + \tau^K_{t+j}\delta\right].$$

Because it takes the future tax rates into account, q_t "jumps" as soon as the tax cut is announced. Investment increases immediately, though as Figures 3 and 4 show, it does not reach its peak response until the tax cut is actually implemented. As the date of implementation approaches, investment increases because the benefits of the lower tax rate are discounted less.

Employment and output also increase at the announcement of the tax cut. This also follows from the fact that the future reductions in capital taxes affect the payoff to investment immediately. We can rewrite the labor supply equation as

$$v'(N_t) = w_t\left(1-\tau^N_t\right)q_t.$$

Because, q_t jumps as soon as the policy is announced, this brings forth an increased demand for labor. In equilibrium, output and employment rise immediately, though consumption falls.

The revenue impact of the delayed capital tax is also the opposite of the delayed labor tax. In the case of the delayed labor tax rate cut, tax revenue falls during the period of the delay because the decline in employment reduces the tax base. In the case of the delayed capital tax rate cut, the economy expands as it starts to build capacity to take advantage of the future lower tax rate. Even though tax rates are unchanged, revenue increases owing to the increase in economic activity.

The cost of delaying capital tax reductions is relatively low because current investment is forward looking. In fact, there are some obvious benefits to delaying the rate cut. An immediate

tax cut on capital is, for the most part, simply a windfall to existing capital and has not beneficial incentive effects.

Note that investment increases prior to the tax cuts even if, as in our benchmark parameterization, there are no explicit adjustment costs. Previous analyses of the response of investment to future changes in tax rates have featured adjustment costs. See Summers (1981) and Auerbach and Hines (1987). In those analyses, investment anticipates the change in tax policy so that convex adjustment costs can be smoothed over time. These analyses typically assume a constant interest rate and a perfectly elastic supply of investment goods. Without costs of adjustment, in these models investment would be delayed until the change in the tax policy is realized at which time capital would jump to its new steady state level. In our model, even without adjustment costs, investment rises immediately.[17]Investment adjustment costs do interact with phased-in tax cuts however. Because the firms are allowed to deduct the costs of installing new plant and equipment, the phased-in tax cuts create a sense of urgency. When adjustment costs are deductible, a phased-in tax cut gives firms added incentive to invest immediately while they can deduct their costs of adjustment at the high rates.[18]

[17] In general equilibrium models, diminishing returns to production and diminishing marginal utility of consumption play the role of adjustment costs. Accumulating capital rapidly requires that either consumption is low or that employment and production are high. Because there are increasing costs associated with either of these, it is better to spread out investment spending over time. Current investment will anticipate the change in tax policy because of changes in the interest rate.

[18] Employment can share some of the characteristics of investment. Working currently can raise productivity and wages in the future because of the returns to on-the-job training and experience. This is particularly true for workers early in their careers. If this channel is important, future wage tax cuts would encourage current labor supply though the human capital accumulation channel. If we incorporated this channel into our analysis it would partially offset the intertemporal substitution channel that is highlighted in the previous section and that dominates our analysis of the 2001 tax rate cuts in the next section.

III. The 2001 and 2003 Tax Rate Reductions

In this section, we present simulations of the model based on the tax policy changes enacted in 2001. These policy changes included cuts in both the tax rate on labor and capital. Moreover, the tax rate cuts were phased in over a decade in a series of steps. Hence, the 2001 law had various effects on economic activity, with the capital and labor tax provisions potentially offsetting. The series of gradual reductions in tax rates does not complicate the analysis appreciably, but it is difficult to infer the result based only on the simple cases we have considered so far. Hence, we present simulations based on tax rate paths that closely approximate the tax proposal and that were presumably the basis for households' and firms' decisions in the period after the law was passed.

In this section, we first describe the 2001 tax policy. We then present estimates of the effect of the tax changes on economic activity. Finally, we consider the robustness of our results to alternative parameterizations of the model.

A. The 2001 Tax Plan

The Economic Growth and Tax Relief Reconciliation Act of 2001 (*EGTRRA*) was approved by the congressional conference committee on May 25, 2001 and signed into law by President George W. Bush on June 7, 2001. The most important provisions of this bill were phased-in tax rate cuts. Relative to their pre-*EGTRRA* values, marginal tax rates above the 15 percent rate were cut by 0.5 percentage points in 2001, by 1.0 percentage point in 2002 and 2003, by 2.0 percentage points in 2004 and 2005, and by 3.0 percentage points (4.6 percentage points for the top bracket) in 2006 and beyond. Table 2 summarizes the time path of marginal tax rates under

the 2001 plan. These rate cuts sunset in 2011, that is, the tax rates are scheduled to revert to their pre-*EGTRRA* levels.[19] (We discuss the sunset provisions in more detail below.)

In addition to the changes in marginal tax rates, the law also had several other noteworthy provisions. The law reduced the "marriage penalty" by extending the 15 percent tax bracket for married individuals filing joint tax returns.[20] The law also featured a phased-in reduction and subsequent elimination of the estate tax. Finally, the bill created a new 10 percent bracket for the first $12,000 of taxable income ($6,000 for singles) effective in 2001. The Treasury paid most households a rebate of $600 ($300 for singles) in July through September 2001 as an advanced payment of the benefit of this new bracket.[21] These rebate checks, though highly visible in 2001, did little to reduce marginal rates. Only households with taxable income below $12,000 ($6000 for singles) experienced a reduction in their marginal tax rate as a consequence of the new 10 percent bracket.

The Congressional Budget Office (2001) produced estimates of the impact of the tax bill on marginal tax rates. It estimated that the effective marginal tax rate on labor income would fall 1.8 percentage points from 36.2 percent before the bill to 34.4 percent in 2006. It estimated that the effective marginal tax rate on capital income would fall 0.5 percentage point from 18.3 to 17.8 percent. The estimated effective marginal tax rate on labor income includes federal income taxes, payroll taxes, and state and local income taxes; for capital income, it includes federal income taxes, corporate taxes, and state and local income taxes. The effective tax rate on capital

[19] See Joint Tax Committee (2001a) for a summary of the provisions. See also Gale and Potter (2002) for discussion and analysis of the provisions of the law.

[20] Though the marriage penalty refers to the tax disadvantage of two-income individuals being married when the income of one spouse pushes the other into a higher tax bracket than he or she would face as a single filer, these provisions of the tax bill also apply to married couples with a single income.

is low because the CBO includes housing in its concept of capital. The housing stock is large and has a negative tax rate according to the CBO. Since the housing stock is conceptually part of the capital stock in our model, it is appropriate to include its tax treatment in the analysis. Note also that significant investment incentives were passed in 2002. We do not incorporate the 2002 changes in our analysis.

The CBO did not provide a time series for the effective marginal tax rates, but it seems reasonable to interpolate them using the reductions in the statutory rates discussed in the previous paragraph. In Table 3, we present the precise tax path used in our simulations of the 2001 tax bill.[22]

B. Aggregate Effects of the 2001 Tax Bill

Figures 5, 6, and 7 report simulations of the response of macroeconomic aggregates to the phased-in tax changes legislated in 2001 and tabulated in Table 2. In analyzing an actual tax policy, we are confronted with presenting a realistic assumption about how long-run budget balance is achieved. (Our analytic framework does not admit the possibility of ignoring the government's intertemporal budget constraint.) We also need to project what economic agents assume will happen in 2011, when tax rates are legislated to revert to their pre-2001 levels. In Figures 5 and 6, we assume that the 2006 tax rates remain in place indefinitely. This outcome was the objective of the Bush Administration. (We will discuss below why the law had the sunset provisions.) That assumption leaves us with the conundrum of how the budget will be balanced. In Figure 5, we assume concurrent cuts in government purchases as in Figures 1 and

[21] See Shapiro and Slemrod (2003a, 2003b) for a discussion of this aspect of the tax bill and estimates of its effect on consumer expenditures.
[22] The CBO calculation of effective marginal tax rates includes the AMT.

3. In Figure 6, we assume lump sum increases in taxes as in Figures 2 and 4. Neither assumption seems very realistic, though they do put bounds on the range of possible outcomes.

Alternatively, in Figure 7, we assume that, as the 2001 tax bill requires, the tax rates revert to their original levels prior to the tax policy after 10 years. In this simulation, we assume that the reduced tax revenues are simply rolled over into debt. This simulation has the advantage of reflecting what is actually in the 2001 law concerning tax rates. It also has the advantage of better reflecting reality, that is, there were no substantial cuts in purchases or increases in other taxes to offset the loss in revenue for the tax rate reductions.[23]

The immediate tax cut is calculated the same way as in Section 2 to yield the same discounted revenue loss over a 10-year budget window. In the immediate tax cut scenario, the labor tax rate falls 1.31 percentage points and the capital tax rate falls 0.36 percentage points.

The results for the 2001 tax cuts in Figures 5, 6, and 7 look very similar to those for the labor tax cuts in Figures 1 and 2 except for the timing and pattern owing to the phase-ins, and in the case of Figure 7, the sunset. Employment, output, and investment fall in Figure 5 in response to the announcement of the phased-in path. The reduction in employment is due to the incentive to shift work from the present to the future combined with a substantial income effect due to the reduction in government purchases. At the point of implementation of each of the tax cuts, production jumps up, but then follows a downward path owing to the anticipation of the next rate cut.

Figure 6 shares the same basic pattern as Figure 5 but with levels shifted up. The difference between these two experiments is, of course, the wealth effects that accompany the

[23] Gale and Orszag (2003b) show that if the sunset provisions in EGTRRA were removed (if the tax cuts were made permanent) then the associated 75-year loss in revenue would exceed the sum of the shortfalls in Social Security and Medicare in present value.

reduction in government purchases in Figure 5 but are absent in Figure 6. Thus, if the government does not reduce purchases, the wealth effect is smaller and labor supply remains high.

Figure 7 considers the case in which the tax rates sunset after 10 years with no offsetting changes in government purchases. This figure looks very much like Figure 6 during the period of the cuts. Once they sunset, the dynamics are mirror images of the immediate tax cuts discussed in the previous section. That is, at the point of the sunset, the dynamics of a permanent tax increase take over. Like the simulations in Figures 2, 4, and 6, the simulation in Figure 7 is probably too favorable for tax rate reductions. The interest payments on the rolled-over debt are financed by increase in lump sum taxes. Since such taxes are not generally available to policy makers, these simulations have all the efficiency gains of cutting taxes without reflecting tough choices from cutting purchases or from potentially distortionary increases in other taxes or cuts in transfer programs.[24]

Why do the 2001 phased-in tax cuts, which are mixtures of capital and labor tax cuts, lead to aggregate implications that match the behavior of a labor tax cut rather than a capital tax cut? Said another way, why do the labor tax cuts dominate the reductions in capital tax rates? First, the reductions in labor taxes are larger than the capital tax rate reductions. A cut in the labor tax rate of 1.8 percentage points from a starting point of 36.2 percent is a 5.0 percent cut in the tax rate. A cut in the capital tax rate of 0.5 percentage point from a starting point of 18.3 percent is a 2.7 percent cut in the tax rate. Second, because labor income is roughly two-thirds of total income, the larger tax rate cut applies to a larger base. Hence, in the estimates of the

[24] There are lump sum tax increases or transfer reductions that could be enacted. These include capital levies or reductions in the value of Social Security benefits for retired workers.

effect of the 2001 phased-in tax cuts, the contractionary effects of the delay in the labor tax rate cuts swamp the expansionary effects of the delay in the capital tax rates cuts.

On balance, the 2001 phased-in tax cuts provided more incentive to delay work effort than to stimulate employment. Whether the tax policy led to an absolute drop in activity (Figure 5) or merely a drop in activity relative to what would have occurred with a more modest, but immediate tax cut (Figures 6 and 7) depends on agents perceptions of how the government intends to close the budget gap. In either case, the lower economic activity leads to less tax revenue during the period of the phase-in, so the short-run budgetary benefits of deferring the tax rate cuts is illusory.

C. Robustness

Alternative elasticities

We now consider how the simulated effects of the 2001 phased-in tax cuts depend on the elasticity of labor supply (η) and the elasticity of intertemporal substitution (σ). Figure 8 gives the results under the assumption that lump sum tax increases balance the budget (as in Figure 6). Figure 8 shows the simulated time paths for consumption, employment, and GDP. The rows give results for σ equal to 0.2, 0.5., 1, and 2. The different lines in each panel correspond to different values of η. The light line is for η equal to 0.2, the dark line is for η equal to 1, and the dotted line is for η equal to 2. Recall that our baseline case in the previous figures has been σ equal to 1 and η equal to 0.5.

Consider first the paths for consumption. Lower labor and capital taxes imply that consumption is higher in the long run. The new long run level of consumption increases with a higher labor supply elasticity and with a higher elasticity of intertemporal substitution. The more

elastic labor supply is, the greater the increase in future income. Not surprisingly, as the elasticity of intertemporal substitution increases, the consumers are more and more willing to tolerate changing consumption over time. For $\sigma = 0.2$, consumption is nearly constant. As this elasticity gets higher, households are more willing to defer consumption. This makes the path of consumption steeper and makes future income higher due to high capital accumulation.

Now consider the paths for employment. As the labor supply elasticity becomes higher, labor becomes more and more responsive to both immediate and anticipated tax changes. For low levels of η, the long run increase in labor is very modest; for high levels, there are much bigger increases in labor as each successive tax rate cut is put into effect. The *level* of the path of labor is depends on the value of σ. High values of σ shift this time path up. Notice that for values of σ less than one, the wealth effect dominates the substitution effect and employment falls in the short run. For values greater than one, the substitution effect dominates, so the combination of current and future tax cuts causes employment to rise in the short run. Anticipated future tax cuts will be more likely to cause current reductions in employment if consumers are willing to delay employment but not willing to delay consumption. The relative position and shape of the time paths for GDP largely follow those of labor. In the short run, capital has not changed much. For cases in which σ is low, investment is actually negative following the announcement. As a result, while employment does rise eventually, the capital stock has fallen which reduces production in the short run.

Adjustment costs

While a willingness to substitute labor intertemporally is necessary for deferred tax changes to affect current behavior, it is not sufficient. There must also be a mechanism to break the link

between current production and current consumption. In this model, that mechanism is capital accumulation. If consumers want to increase current consumption in response to future increases in income, investment can fall in equilibrium to allow higher consumption given production. The capital stock can be rebuilt later by working more. If there are adjustment costs that attenuate changes in the rate of investment, then this channel to smooth consumption is less attractive. That is, if the capital stock is hard to adjust then labor and consumption must move in the same direction.[25]

Here we consider the effects of higher or lower adjustment costs on the equilibrium in our model. The degree of adjustment costs in our model is $\varphi'' = \phi$ which is governed by the curvature of the function $\varphi\left(\frac{I}{K}\right)$. We set the curvature at various values, including zero, to show the role of adjustment costs.[26]

In Figure 9, we show the response of consumption, employment, and investment to the phased-in tax cuts for different values of the adjustment cost parameter $\varphi''(\delta)$. Recall that our benchmark setting for this parameter was zero (no adjustment costs). Here we consider three cases: our benchmark case ($\varphi'' = 0$), moderate investment adjustment costs ($\varphi'' = 2$), and high investment adjustment costs ($\varphi'' = 6$). Shapiro (1986) and Hall (2002) present evidence consistent with moderate adjustment costs. While high adjustment costs are consistent with estimates from *q*-theoretic investment regressions, they are generally regarded as implausibly high. We include a higher adjustment cost to illustrate the point that it is the ability to move

[25] In open economy settings, trade deficits allow for a high degree of intertemporal substitution even in the absence of an explicit investment or storage technologies.

[26] Technically this is not a parameter at all but is instead a point on the function. Because we are using a solution that is only first order accurate, the only feature of the function that is important for the behavior of the model is $\varphi''\left(\frac{I}{K}\right)$.

consumption over time easily that makes an announcement of future tax cuts affect current real economic activity.

In the figure, the dark solid line corresponds to our benchmark settings, the light solid line represents an economy with "moderate" adjustment costs and the dotted line corresponds to the "high" adjustment cost model. In the benchmark model, consumption jumps as soon as the policy is announced and then rises smoothly from then on. Investment drops initially to finance the increased consumption. Employment responds only slightly to the tax policy in the first year. In contrast, in the adjustment cost models, consumption rises by less initially and then jumps each time the labor income taxes fall. Investment falls by less and employment responds more to the initial tax cuts.

Another interesting consequence of the adjustment cost models is that Brainard-Tobin's *Q* (in the bottom center panel) drops immediately. Consumers desire the additional consumption immediately but are restricted (by the adjustment costs) in their ability to intertemporally substitute. If we take *Q* as an indicator of stock market valuation then the 2001 tax cut policies also provide a rationale for the poor stock market performance in the wake of the policy.

D. Phased-in Tax Rate Cuts and the 2001 Recession

The NBER business cycle committee dated a business cycle peak in March 2001. As of the summer of 2003, it is not evident whether the economy has reached a trough. As the business cycle committee has noted, the recovery of employment since the peak has lagged that of other recessions.[27] At the same time, the recovery of income has been more rapid than usual. This inconsistency between the two main business cycle indicators has caused the committee to defer

[27] See NBER Business Cycle Committee reports available on the NBER WWW page.

declaring a business cycle trough. Investment, though always cyclical, has been particularly weak during this cycle.

The phased-in tax cuts enacted in 2001 is a potential explanation of the failure of employment to recover rapidly. As the results of the previous section make clear, the phased-in nature of these tax cuts provides a powerful incentive for businesses and workers to defer production and employment while at the same time it gives consumers reason to maintain high levels of consumption spending. The combination of high consumption and relatively lower levels of production means that investment spending will be particularly weak. To the extent that workers and firms respond to these incentives, the 2001 tax plan may have inadvertently worked to prolong the recession and stifle investment.

Of course, there were (and still are) many other factors that influenced employment and production decisions. The tax plan was, at most, a contributing factor to the tepid economic performance of the period.

E. The 2003 Tax Bill

In May 2003, the Congress enacted and President Bush signed the *Jobs and Growth Tax Relief Reconciliation Act* of 2003 (*JGTRRA*).[28] Some of the more prominent provisions of this legislation are as follows:

1. The 2006 tax rates enacted in the 2001 bill were implemented effective 2003 instead of being phased in the two steps in 2004 and 2006. The sunset provisions of the 2001 tax bill remained in place.

[28] See Joint Tax Committee (2003a, 2003b) for the details of this law.

2. The expansion of the 15 percent bracket for married couples and the expansion of the 10 percent bracket for all taxpayers, that was to be phased-in in the 2001 bill was accelerated to 2003 and then reverts to the phasing in 2005 as specified in the 2001 bill. The sunset provisions of the 2001 tax bill remain in place.
3. The exemption of the individual Alternative Minimum Tax (AMT) was increased for 2003 and 2004 only. This provision prevented roughly 8 million taxpayers from losing the full benefits of the marginal rate cuts in these years. In 2005 and beyond, these taxpayers will be subject to the AMT and hence face different tax rates (lower marginal, higher average) than as in the standard tax system.
4. The dividend tax rate is cut to 15 percent from 2003 to 2008 and reverts to the ordinary income rate in 2009. For lower income individuals, the rate is 5 percent from 2008 to 2007, zero in 2008, and the ordinary income rate in 2009 and after.
5. The capital gains tax rate is also cut to the same rates as the dividend tax through 2008 and then reverts to the rates as of 2002.

Though we do not attempt a quantitative analysis of these complex provisions, several points are worth noting. The immediate phase-in of the marginal tax rate reductions eliminates the delayed employment effect of the 2001 bill. The temporary increase in the AMT exemption cuts the average tax rate of many high-income individuals in 2003 and 2004 relative to later years. Both of these changes will tend to increase employment and output relative to the provisions of the 2001 bill.

The temporary reduction in capital taxes, through reductions in the dividend tax rate and the capital gains tax rate, is particularly noteworthy. Cutting taxes on existing capital generally has no allocative effects because installed capital represents investment decisions made

previously. Thus, a temporary reduction in capital income taxes seems like very bad policy. It reduces revenue and does not provide incentives for increased production or lead to a gain in efficiency.

Yet, while the 2003 cuts in capital taxes are temporary, they are relatively long lived. Even though the reduction in capital income taxes for existing capital has no efficiency benefit, the duration of the tax cuts is long enough that current investment responds positively to the lower tax rates. Figure 10 shows the results of a stylized capital income tax cut with roughly the same timing as the 2003 bill. In particular, it reduces capital income taxes by 1 percentage point for years one through six; following year six, the tax rate reverts to its original level from then on. As in Figure 7, the revenue loss from the tax reduction is rolled into debt with the interest payments financed by lump sum taxes.[29]

Investment and employment respond immediately but by small amounts. Employment rises in the first year by only 0.038 percent, output by 0.029 percent and investment by 0.257 percent. The temporary nature of the tax cut means that the stimulus is about 1/2 what it would be if the tax cut were permanent. For an immediate permanent cut in the capital income tax rate (of 1 percent), employment, output and investment increase by 0.067 percent, 0.052 percent and 0.461 percent respectively in the first year.

F. Related literature

Several other papers examine the 2001 tax cuts. Gale and Potter (2002) provide a valuable summary and evaluation of the provisions of the legislation. They also provide an estimate of the effect of the tax changes on labor supply, savings, and GDP growth. Their analysis is

[29] We use this stylized path absent good estimates of the effect of the 2003 bill's specific provisions on effective tax rates. The shape is correct, though the magnitude is hard to assess. The magnitudes of the estimated effects scale up or down linearly with the change in the tax rates.

confined to the long run effects of the policy so it is difficult to make direct comparisons with our paper. They estimate that labor supply increases in steady state by 0.48 percent by multiplying an average uncompensated elasticity of 0.17 by a 2.8 percent increase in the after-tax real wage. The uncompensated elasticity is not relevant for phase-in effects, which depends on the compensated or Frisch elasticity, so we cannot infer what their analysis would predict about the dynamic response of labor. (Our model implies an uncompensated elasticity of zero in the baseline $\sigma = 1$ case.) Their results for saving and investment are also hard to compare with our results because they implicitly hold the interest rate constant on one hand, but consider offsetting changes in the current account on the other. In contrast, our approach does allow for endogenous changes in the interest rate but abstracts from international borrowing and lending.

Gale and Potter conclude that the tax bill would depress the level of GDP once it is phased in. In contrast, we find a modest increase in GDP. One important factor explaining why we find a positive effect on GDP ultimately is that the capital stock increases in our simulations. The increase in the capital stock comes not only from the incentive effects of the capital tax rate reduction, which are modest in our calculations, but from the equilibrium response of the capital stock to the increase in labor supply. An increase in labor supply puts downward pressure on the wage and therefore stimulates capital accumulation.

Auerbach (2002) uses the Auerbach and Kotlikoff (1987) model to study the 2001 tax rate changes. The focus of Auerbach's analysis is the effect of the tax policy on national savings and investment. Though it is not the central focus of his paper, his analysis does take into account the phased-in nature of the tax cuts. He reports a pattern of output effects relative to baseline similar to that shown in our simulations. Quantitatively, his estimate of the output effect is similar to what we present in Figure 7 that shares the assumption with Auerbach that the

rate cuts will sunset as scheduled. As with our simulations assuming no cuts in government purchases, the increase in labor supply underlying these results come because there is no wealth effect offsetting the substitution effect.

Calomiris and Hassett (2002) present a survey of the evidence that leads them to make an optimistic forecast about the output and revenue effects of the 2001 tax bill. They do not produce quantitative estimates, and in particular, do not address the issue of the phase-in.

Gale and Orszag (2003a) show that the number of taxpayers affected by the alternative minimum tax (AMT) will grow dramatically in the next decade. They attribute much of this increase to the tax cuts in EGTRRA and JGTRRA. In our simulations, we assumed that the phased-in tax rates were "frozen" once the phase-in was complete. That is, the final tax rates in our model persist into the indefinite future. This assumption may be misleading if the AMT endogenously causes rates to rise over time. Roughly speaking, the effects of such an increase will be similar to a "mix" of our sunset simulation and the permanent phase-in.

IV. Government Budget Rules

The previous section showed how the timing of tax changes in recent tax legislation had substantial, and perhaps undesirable, effects on the timing of output, employment, and investment. Given that phased-in tax changes have these effects, it is natural to ask why they are so often features of tax policy. In this section we argue that legislative rules pertaining to the framing and scope of tax policy play important roles in shaping actual tax policy.

Budget rules shaped both the 2001 and 2003 tax bills. First, Federal budget rules mandate reporting the revenue consequences of tax bills over 10 year windows. This rule frames the debate and the description of the legislation. Second, provisions of the Budget Act allow

Senators to raise a point of order concerning tax changes that have an effect beyond ten years. This rule, called the Byrd rule, effectively requires a supermajority of 60 votes, rather than a simple majority, to pass tax reductions that extend beyond 10 years.

Budget Rules and the 2001 Tax Bill

The 10-year budget window had a major effect in shaping the 2001 legislation. The centerpiece of the 2001 tax cut proposal was the phased-in marginal tax rate reductions discussed in Section III. The phase-in allowed the budget consequences of the first 10 years of the tax cut to be much smaller than long run impact. According to the Bush Administration's 2001 budget, the President's proposal would have reduced revenue in the second ten years by three times the revenue loss in the first ten years. Because the debate over tax bills focuses on the first ten years rather than their steady-state impact, phased-in tax reductions make long run reductions in tax rates appear to be smaller than they truly are. The effort to fit the magnitude of tax cuts into particular 10-year targets strongly suggests that this rule has real consequences for the details of tax changes.

As it happened, President Bush could not secure the permanent phased-in tax rate reduction that he proposed in the budget. A majority of the Senate favored these provisions, but not the 60-Senator supermajority required by the Byrd rule. Accordingly, the Congress enacted a ten-year tax cut whose provisions sunset in 2011.

The combination of the 10-year budget accounting and the Byrd rule produced a schedule of tax rate cuts that phased in slowly and then disappeared after 10 years. A natural question arises: What did the public (and the members of congress) expect about the sunset provisions? Advocates of the tax cut clearly hoped that they would ultimately be made permanent. Indeed, a

bill was introduced in the House in 2002 proposing to do so. Moreover, President Bush proposed making them permanent in his initial tax proposal after the 2002 election in proposals he presented to Congress in early 2003.

In our quantitative estimation of the effects of the policy, we were agnostic about the public's expectations about the sunset. To this end, we presented estimates with and without the sunset. The sunset was far enough in the future that it did not affect the basic incentive to shift economic activity during the years of the phase in, though it did have an impact on the magnitude of the shifts in activity.

Budget Rules and the 2003 Tax Bill

The 2003 tax bill was also shaped by a debate that focused on the 10-year budget window. President Bush originally proposed a bill that would have eliminated the personal taxation of dividends and accelerated the tax rate cut provisions of the 2001 bill and made them permanent. Though the outlines of the proposal were included in summary fashion in the Budget presented to Congress on February 3, 2003, it contained no details. By March, enough details had emerged to enable the Congressional Budget Office to produce an analysis. The Congressional Budget Office original scored the revenue loss from the President's proposals at $1,455 billion over ten years.[30]

There was resistance, however, to a tax cut of this size from moderate Republican Senators. In particular, Senator George Voinovich, a pivotal member of the Finance Committee, announced he would support a cut of no more than $350 billion over ten years. Senator

[30] See CBO, March 2003, Table 8.

Voinovich cosponsored a resolution limiting the cuts to that amount. Though that resolution failed in a vote in the Senate on March 21, the $350 billion figure continued to frame the debate.

In April, when the President's proposals became more concrete, they were reported to have a 10-year budget cost of $726 billion. The House passed a bill with a revenue cost on $550 billion early in the morning on April 11. The Senate, later that day, approved a bill with a $350 billion 10-year revenue cost. Approval was narrowly won in the Senate—Vice President Cheney had to vote to break a tie—only because Finance Committee Chairman Senator Grassley promised the moderate Republicans that the bill that emerged from the conference committee would respect the $350 billion 10-year cost in the Senate bill.

The details of the final bill as discussed in the previous section were driven by the $350 billion, ten-year constraint. Unlike in 2001, there was substantial sentiment to front-load the tax cuts for several reasons. First, there was an aim to address the weak economy though tax cuts.[31] Indeed, 83 percent of the total effect on the budget of the 2003 bill was in the first three fiscal years of the 10-year window. (See Joint Tax Committee, 2003b.) Second, there was hope among those who sought larger tax cuts that the phase outs (e.g., of the Alternative Minimum Tax relief and of the dividend and capital gains tax reductions) could be eliminated in the future. Critics of the bill also saw this as a likely outcome, and therefore complained that the budgetary impact of the bill was understated.

Given that extending provisions of the bill was already part of the debate even as it was passed, it is very hard to assess how the 2003 bill changed expectations about future taxes. Moreover, to the extent that it was credible that the phase-outs would not be allowed to take

[31] When the Bush Administration proposed the 2001 tax bill, little attention was paid to stimulus. Its key attempt to stimulate the economy, the 2001 tax rebates, were introduced by Democrats,

effect it is hard to understand what the moderates achieved in forcing the $350 billion limit onto the conference report. In any case, by framing the debate in terms of ten-year sum of budgetary impact, a bill emerged with a complicated pattern of temporary tax changes and with little certainty about long run tax rates.

Discussion

The history of the 2001 legislation suggests that budget windows and budget rules have a substantial effect on the timing of tax rate changes. We should emphasize that these influences are not incorporated in our model. Indeed, it is difficult to do so convincingly.

Auerbach (2003) also identifies budget rules as having potentially significant effects on the design of tax policy. He considers a political economy model that allows for transitions in legislative control from one party to another. Budget windows that are too short allow policy makers understate the true financial cost of policy changes by cutting taxes or raising spending after the short horizon of the budget window. Budget windows can also be too long. Long windows allow policy makers to take credit for tax levies or spending cuts that are very far in the future even though there is no way to commit to the policy.

Although his model is quite stylized, the route taken by Auerbach is clearly fruitful for making sense of the very complicated reality of the political process. It also highlights how innovations, such as moving from 5-year to 10-year budget windows, which were meant to improve budgeting by focusing on the longer term, can have perverse implications for policy. Finally, we would emphasize how rules inherited from history, e.g, the supermajority

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though as the economy slowed in 2001, they were embraced by the Bush administration as a stimulus measure.

requirements of the Byrd Rule, can have considerable, though unintended, consequences for policy.

V. Conclusions

Phased-in tax changes have significant incentive effects that should not be overlooked when evaluating economic policy. Phased-in tax cuts on labor income give workers and firms an incentive to delay production until the tax cut takes effect. In contrast, phased-in tax cuts on capital income provide immediate incentives to work and produce and especially to accumulate capital to take advantage of tax rates that will be low in the future. Moreover, because much of the burden of current capital taxes is borne by existing capital, phased-in tax cuts on capital minimize the distortionary burden of capital taxation.

The 2001 tax legislation featured both phased-in reductions in labor taxes and capital taxes. The model presented in the paper suggests that, while the long run performance of the economy is enhanced by lower taxes, the short run effects of the phase-in reduced output, employment, and investment relative to what would have occurred were there an immediate, moderate tax cut. Accordingly, the 2001 tax bill may account in part for the slow recovery from the business cycle trough of 2001. The analysis also indicates that both investment and equity markets will perform poorly during the period of the phase-in.

Why would policy makers implement tax changes that phase-in over time? It is possible that policy makers are intentionally trying to affect the timing of households' and firms' decisions. For example, temporary investment incentives are sometimes advocated for short run stimulus. Such proposals explicitly recognize the effect on investment of the intertemporal cost

of capital. Moreover, as we have already discussed, delayed reductions in capital taxation stimulate investment without giving a windfall to previously-installed capital.

The case for manipulating the timing of labor taxes is much weaker. Indeed, their impact on the timing of work hardly features in the professional or political debate. Perhaps no one thinks these intertemporal effects are important. But as our robustness analysis makes clear, for parameter values where the timing of the tax cut has little effect on the allocation of labor across time, the tax cuts also have little effect on the steady-state level of labor. Hence, it not possible to advocate in the context of this analysis that the tax cuts have favorable long-run supply side impacts while ignoring the intertemporal effects.

Perhaps features of behavior or institutions not captured by the model could rationalize large steady state effects of tax cuts, but minimize the intertemporal effects. Candidates include adjustment costs in labor supply or labor demand, or institutional rigidities, such as in work schedules. We believe such frictions are important for very short-run changes in tax rates. For example, we would not expect to see large intertemporal effects on labor supply of the one-month payroll tax holiday proposed by some Democratic leaders in early 2003.

Yet, for the multi-year horizons analyzed in this paper, we doubt that these frictions are substantial for several reasons. First, econometric estimates of adjustment costs for production workers and their hours over quarterly horizons are very small (see Shapiro, 1986). Second, periods of several years should be long enough to overcome institutional rigidities. Third, if there are substantial steady-state impacts of tax rates on labor supply, adjustment costs and institutional rigidities must at some point be overcome. It is simply an incoherent to argue that rigidities can prevent the timing of taxes to matter, but they can be overcome so that steady state adjustments are made. Instead, those who doubt the intertemporal effect of tax changes such as

we analyze are likely adhering to a low estimate of the elasticity of labor supply with the implication that the long run effects of tax changes are also low.

Phased-in tax cuts are difficult to rationalize with standard economic reasoning. This lends credence to the view presented in the previous section—that the phased-in and temporary tax increases witnessed since 2001 are a sub-optimal outcome driven by the legislative process. The absence of a strong majority in the Senate, interacting with adherence to procedural and accounting rules for legislating tax policy, resulted in compromises with phase-in and sunsets of tax rate changes.

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Table 1. Benchmark Parameters

Parameter	Benchmark Value
Discount factor, annual rate (β)	0.98
Capital's share (α)	0.35
Labor supply elasticity (η)	0.5
Elasticity of intertemporal substitution (σ)	1
Curvature of adjustment cost function ($\varphi''(\delta)$)	0

Table 2. Time Path of Top Marginal Income Tax Rates Under the 2001 Tax Bill

date	Tax Rates (Percent)			
pre-*EGTRRA*	28	31	36	39.6
2001:3-2001:4	27.5	35.5	35.5	39.1
2002:1-2003:4	27	30	35	38.6
2004:1-2005:4	26	29	34	37.6
2006:1 and beyond	25	28	33	35

Note: The table shows tax rates for tax brackets above the 15 percent rate. The 2001 tax changes were retroactive of January, though enacted in the middle of the year.

Table 3. Time Path of Effective Marginal Tax Rates Resulting from the 2001 Tax Bill

time (quarters)	date	Labor tax rate (τ^N)	Capital tax rate (τ^K)
initial steady state	pre-*EGTRRA*	36.2	18.3
0,1	2001:3-2001:4	35.92	18.22
2-9	2002:1-2003:4	35.64	18.14
10-17	2004:1-2005:4	35.08	17.99
18 and beyond	2006:1 and beyond	34.4	17.8

Source: Congressional Budget Office (2001) for initial and 2006 figures interpolated as described in the text. Under the *EGTRRA* of 2001, tax rates revert to their pre-*EGTRRA* levels in 2011.

Figure 1. Immediate versus Delayed Labor Tax Rate Reductions

Budget balance achieved though reductions in current government purchases

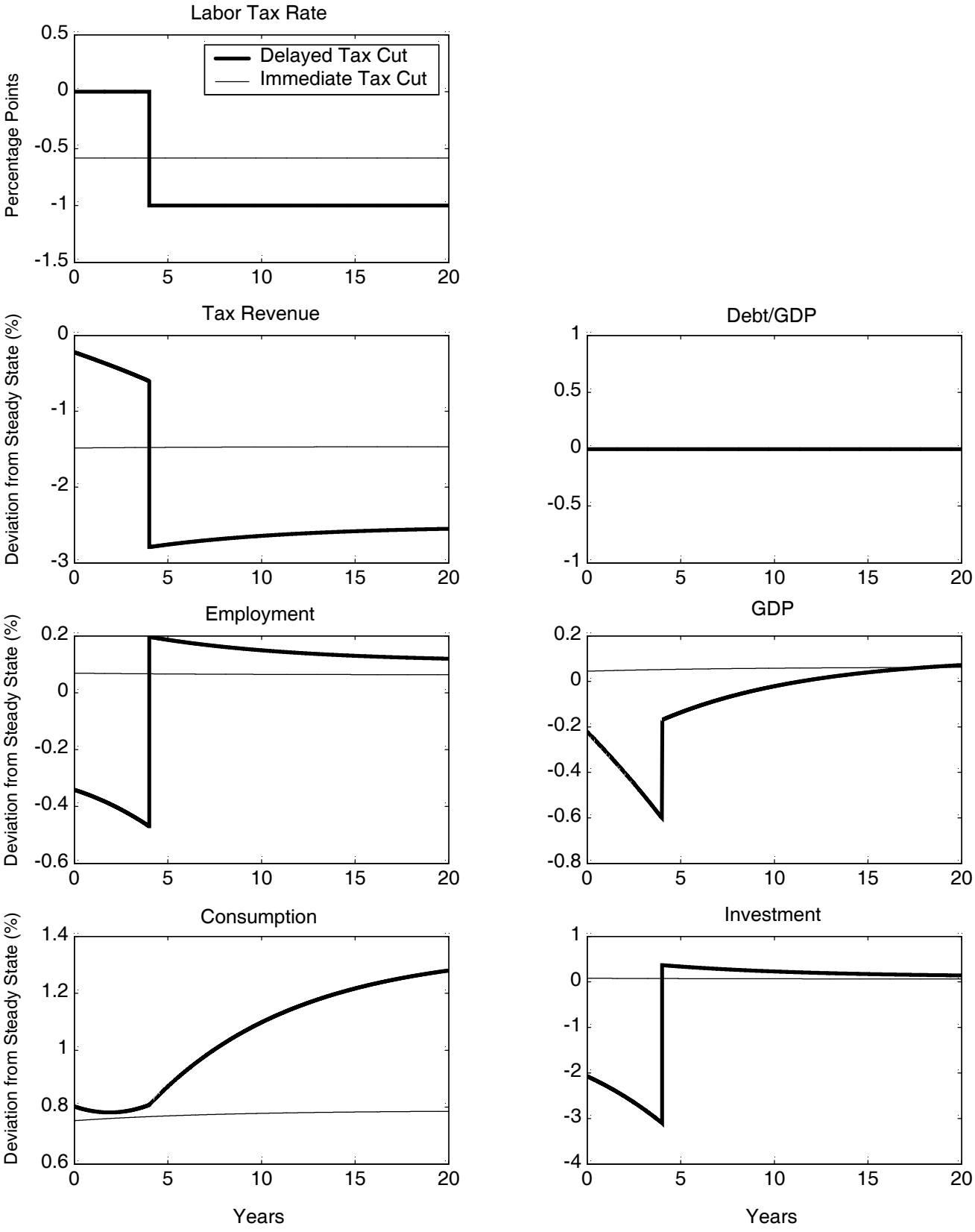

Figure 2. Immediate versus Delayed Labor Tax Rate Reductions

Budget balance achieved though future lump sum tax increases

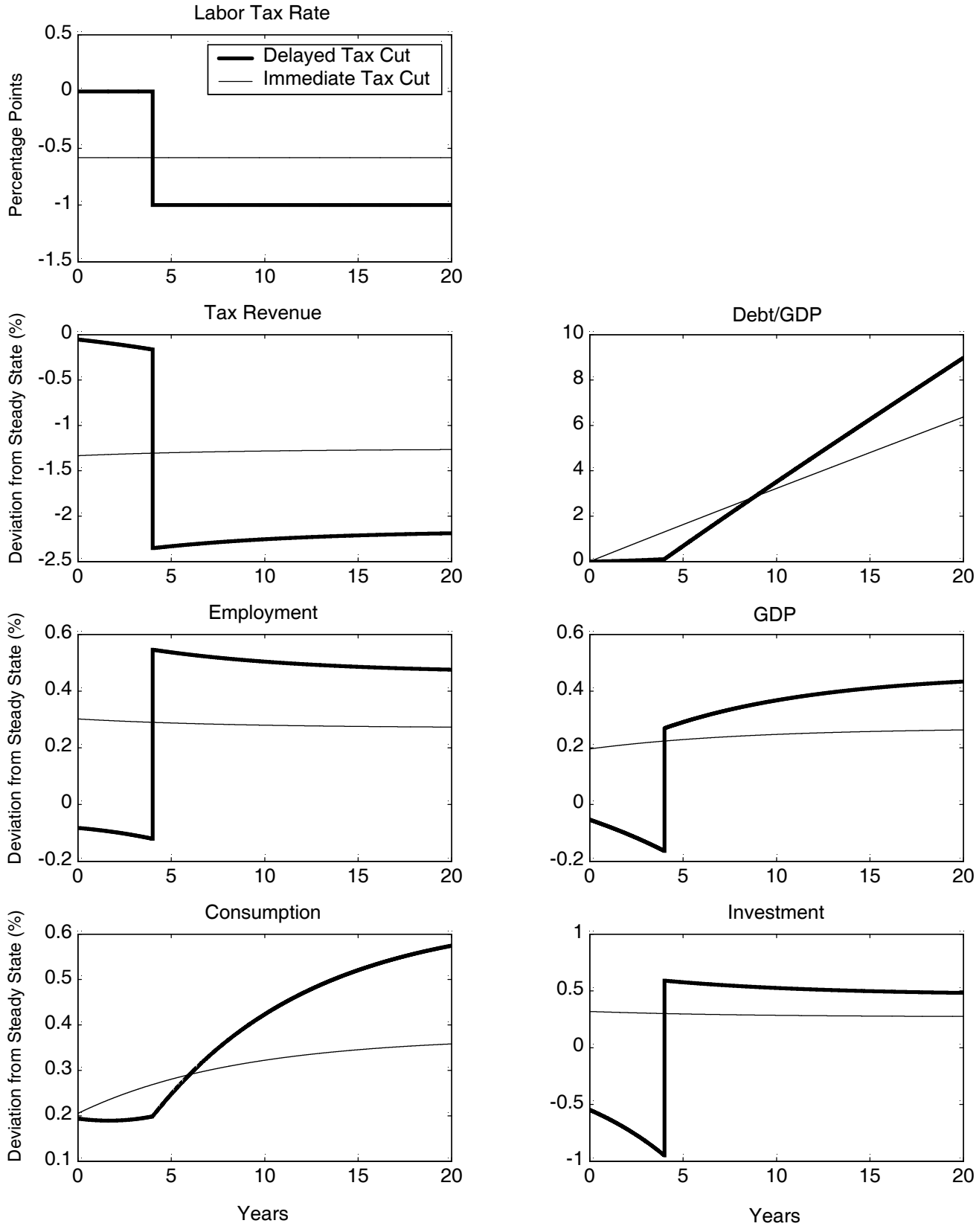

Figure 3. Immediate versus Delayed Capital Tax Rate Reductions

Budget balance achieved though reductions in current government purchases

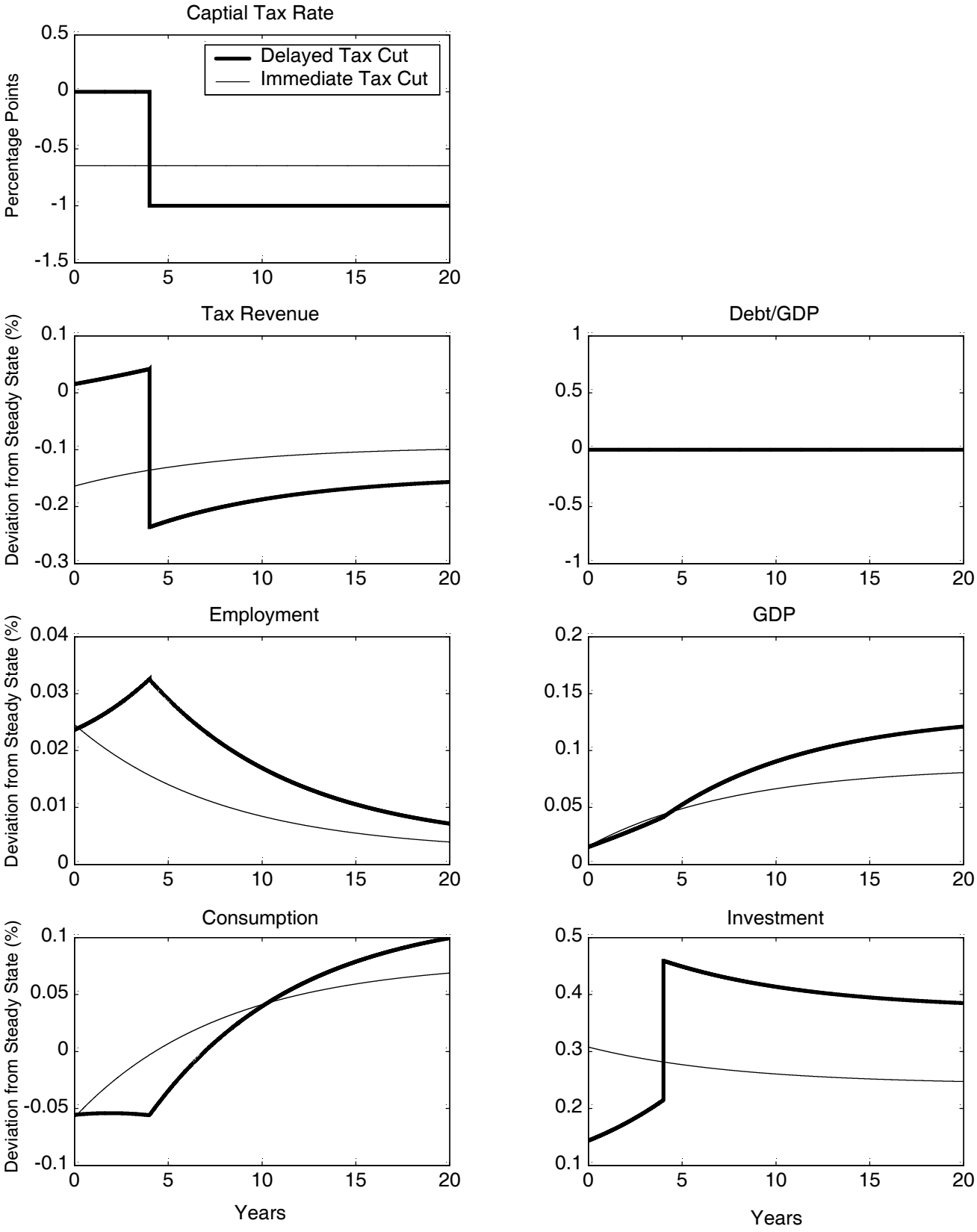

Figure 4. Immediate versus Delayed Capital Tax Rate Reductions

Budget balance achieved though future lump sum tax increases

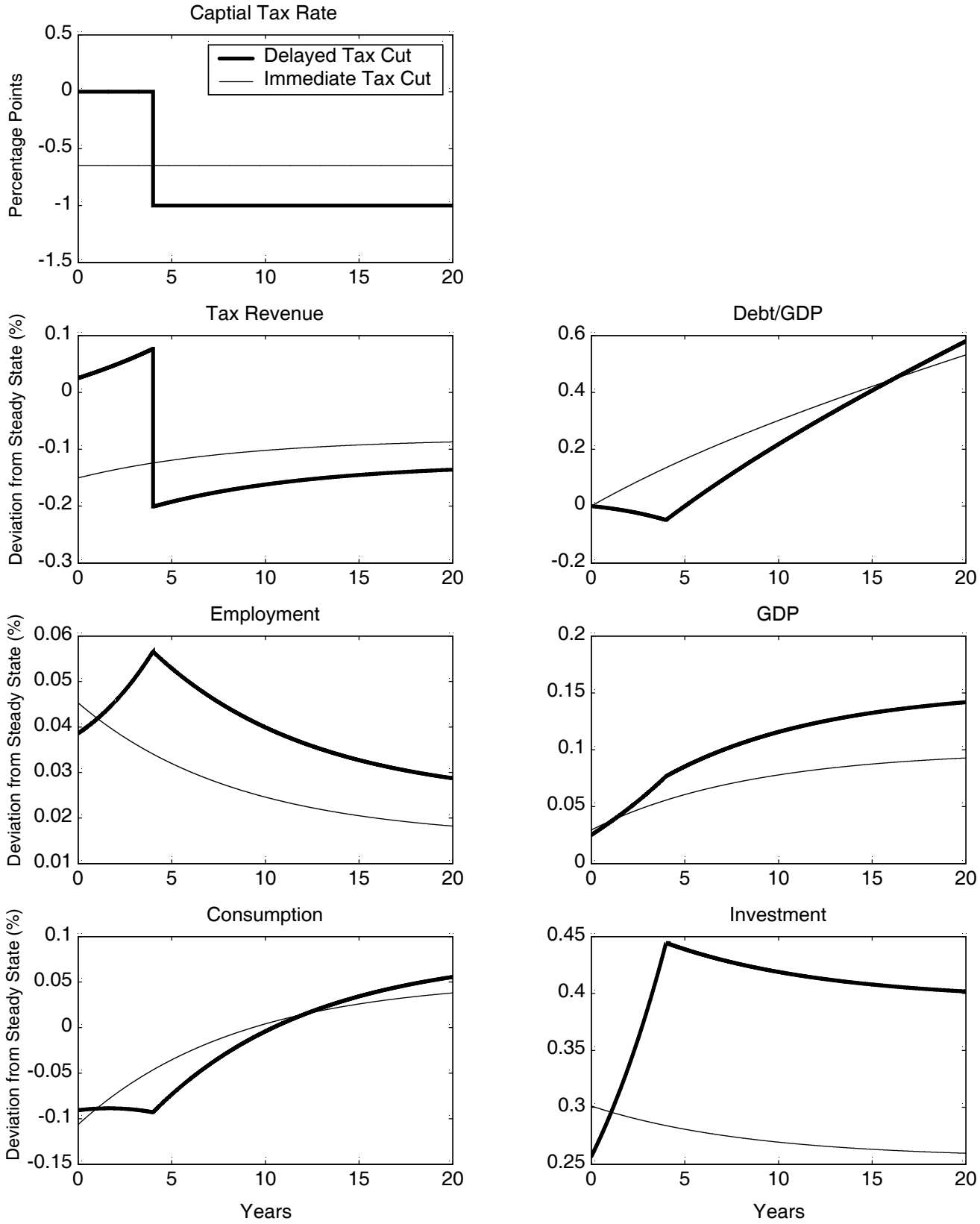

Figure 5. 2001 Phased-In Tax Reductions versus an Immediate Reduction

Budget balance achieved though reductions in current government purchases

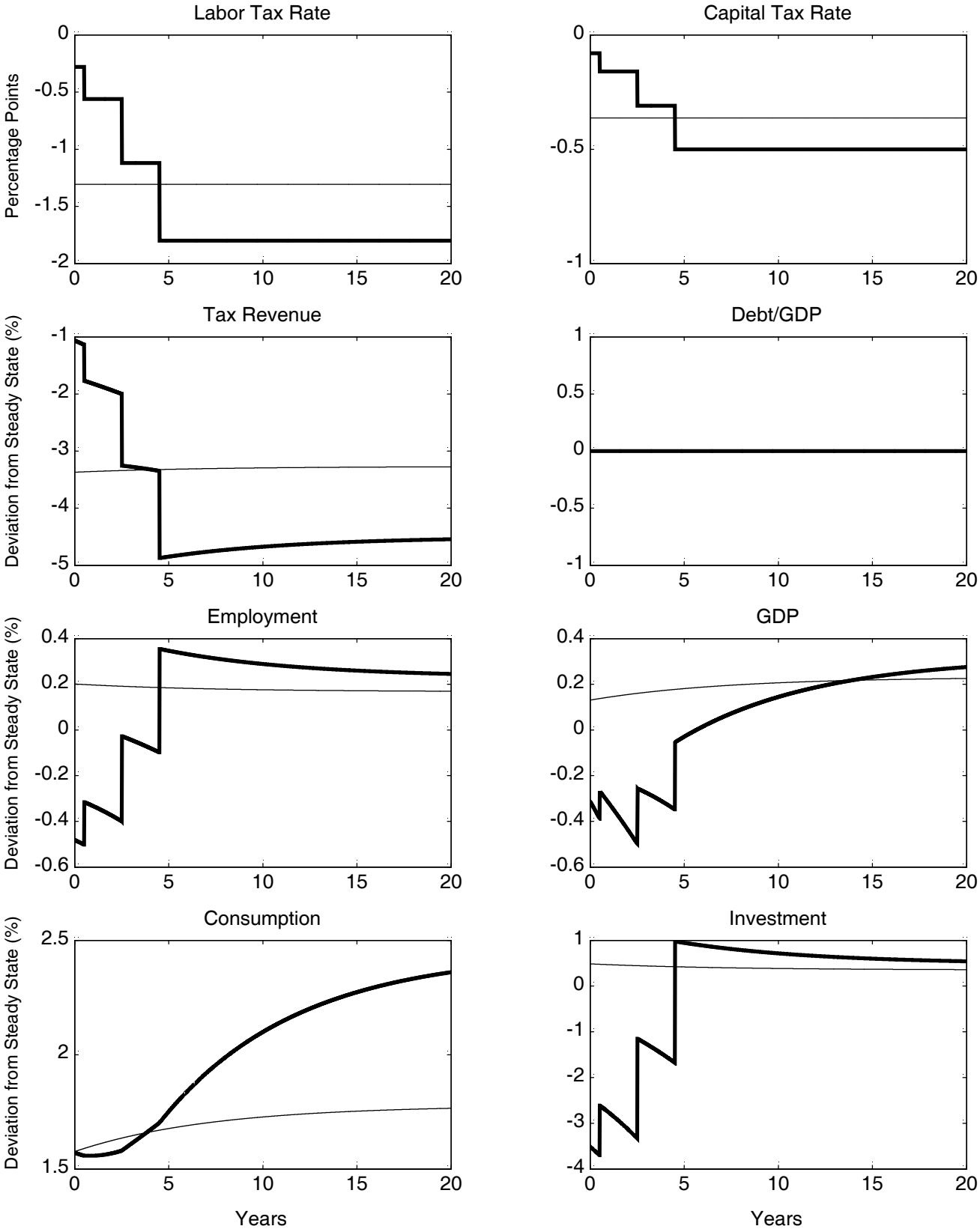

Figure 6. 2001 Phased-In Tax Reductions versus an Immediate Reduction

Budget balance achieved though future lump sum tax increases

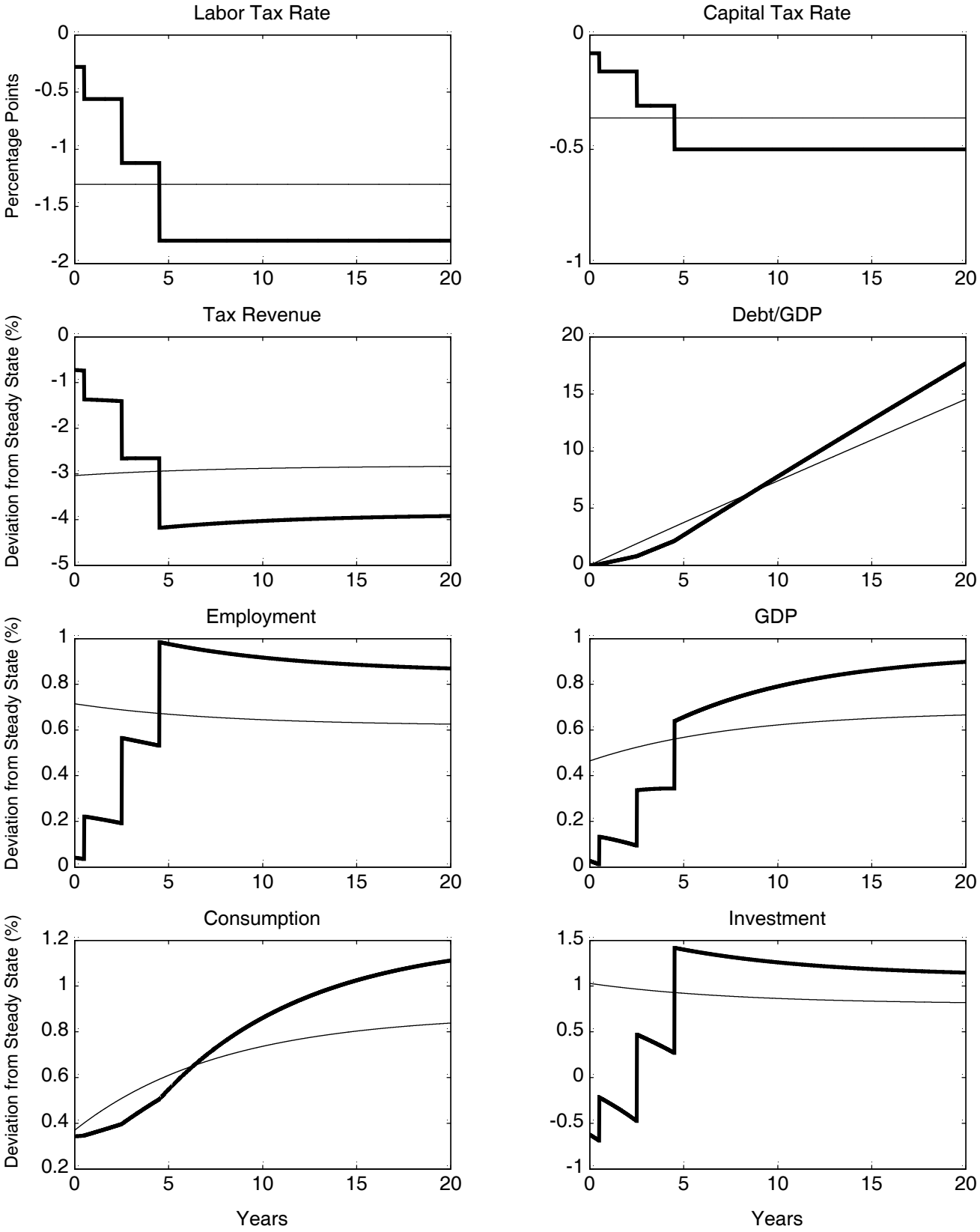

Figure 7. 2001 Phased-In Tax Reductions versus an Immediate Reduction

Tax rate reductions eliminated after 10 years (Sunset Provision)

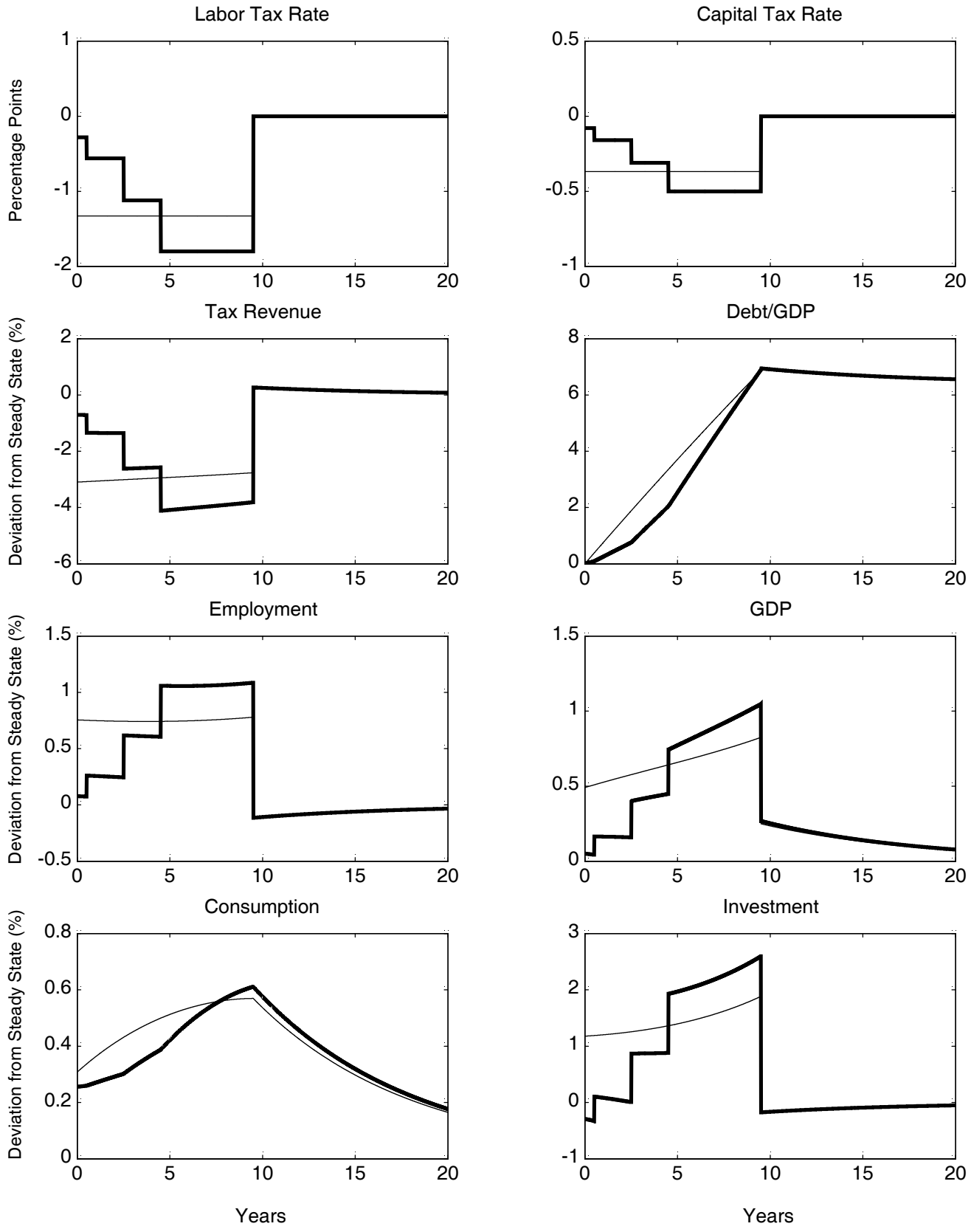

Figure 8: 2001 Phased-In Tax Reductions: Alternative Elasticities

Budget balance achieved though future lump sum tax increases

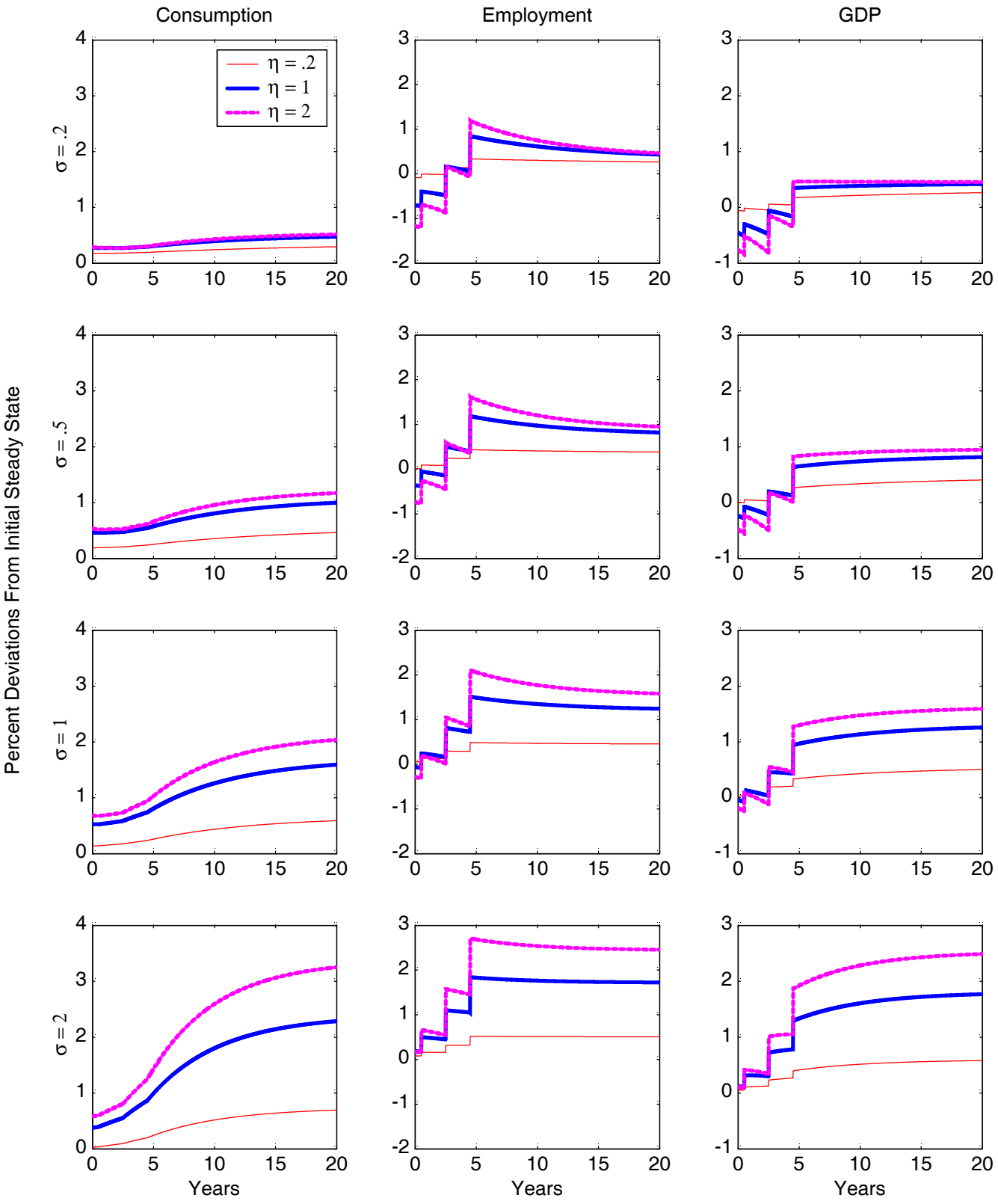

Figure 9: 2001 Phased-In Tax Rate Reductions: Alternative Adjustment Costs

Budget balance achieved though future lump sum tax increases

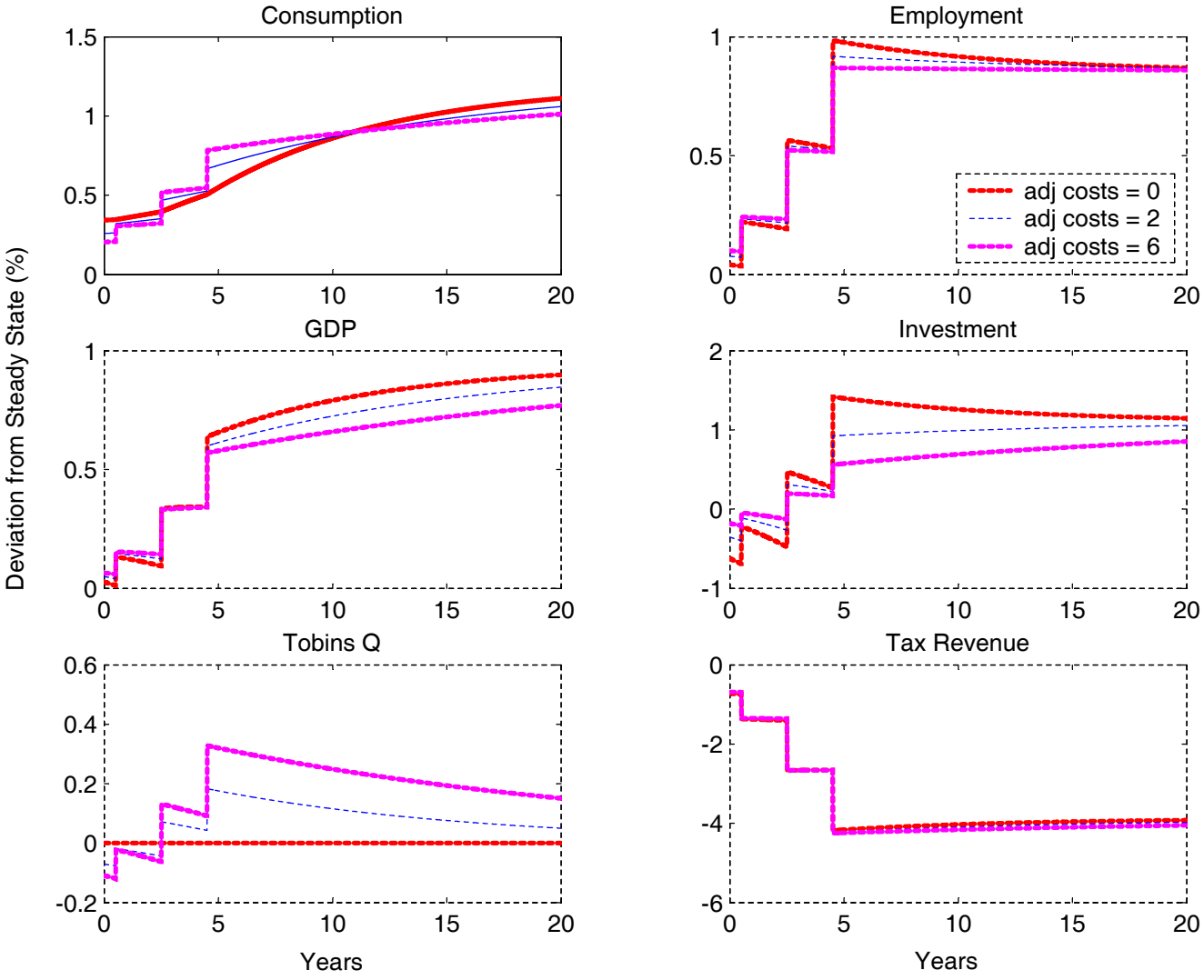

Figure 10: Temporary Reduction in Capital Income Taxation.

Budget balance achieved though future lump sum tax increases