Phased-In Tax Cuts and Economic Activity

By Christopher L. House and Matthew D. Shapiro*

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, 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 Robert J. Barro (1979) argues, this logic implies that changes in tax rates should be unpredictable, that is, tax rates should follow random walks.[1]

In practice, however, government policy frequently ignores these principles and often specifies that tax rates follow various phase-ins and sunsets. The 2001 and 2003 tax laws both featured changes in the tax code at prescribed times. The 2001 Economic Growth and Tax Relief Reconciliation Act (EGTRRA) called for a scheduled sequence of rate reductions in the top four tax brackets. The law cut tax rates for all brackets above the 28-percent tax bracket by ½ percentage point immediately and provided for further reductions effective in 2002, 2004, and 2006. By 2006, the top marginal tax rate was scheduled to fall by more than 4 percentage points. Under the 2001 tax bill, the tax changes sunset in 2011 and so, absent further legislation, tax rates will revert to their pre-EGTRRA levels at that time. Two years later, the 2003 Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) legislated further changes in the tax system. Reductions in income tax rates that were scheduled to occur in 2004 and 2006 under EGTRRA instead went into effect immediately. The 2003 law also provided temporary reductions in taxes on dividends and capital gains.

This paper considers the macroeconomic implications of the timing of these tax cuts. We construct a dynamic general equilibrium model that allows the government to specify a path of tax rates on labor and capital income. The model allows us to assess the effects of tax changes under various timing assumptions. We use the model to analyze and quantify the effects of the phased-in tax cuts passed in 2001 and the effects of the subsequent acceleration of tax cuts in 2003. Our analysis suggests that the timing of the tax cuts had substantial effects on output, labor, and investment. In particular, our calculations attribute the slow recovery from the 2001 recession, in part, to declines in labor supply stemming from the phased-in nature of the tax cuts. Additionally, the rebound in economic activity in mid-2003 coincides with the removal of the phase-ins enacted in the 2003 tax bill. A comparison of the simulated and actual time series over this time period shows that about half of the rebound in GDP in mid-2003 can be attributed to the elimination of the phase-in of the tax cuts.

The remainder of the paper is organized as follows. Section I presents the model. Section II describes the basic features of the 2001 and 2003 tax laws and uses the model to estimate the aggregate effects of the timing of the tax cuts. Section II also considers the robustness of these findings to alternative parameter values and compares the model's predictions to the actual record of economic performance during the period. Section III presents our conclusions.

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[1] As intuitive as Barro's principle is, it is not universal. Kenneth L. Judd (1985) and Christophe Chamley (1986) 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.

I. The Model

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

The representative agent derives utility from consumption (C_t) and experiences disutility associated with labor (N_t). At each date t, the agent seeks to maximize

$$(1)\quad E_t \sum_{j=0}^{\infty} \beta^{t+j}\left[\frac{C_{t+j}^{1-(1/\sigma)}}{1-(1/\sigma)} - \zeta \frac{N_{t+j}^{1+(1/\eta)}}{1+(1/\eta)}\right]$$

subject to the constraints

$$(2)\quad (1-\tau_t^N)W_tN_t + (1-\tau_t^K)R_tK_t + \tau_t^K\delta K_t + T_t = C_t + I_t + K_t\frac{\phi}{2}\left(\frac{I_t}{K_t}-\delta\right)^2(1-\tau_t^K)$$

And

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

Here, W_t is the real wage, N_t is labor, R_t is the real rental price of capital, K_t is the level of the capital stock, and T_t represents any lump-sum transfers. The tax rates τ^N and τ^K are distortionary taxes on labor income and capital income, respectively. The parameter σ is the intertemporal elasticity of substitution, η is the Frisch labor supply elasticity, α is capital's share in production, and ζ is a scaling parameter. In addition to the resource cost of investment, the household also incurs investment adjustment costs if $\phi > 0$. Note that we allow the representative agent to deduct both depreciation and adjustment costs from the tax bill.

Firms hire labor and rent capital to maximize profits. They produce output with the constant returns to scale production function

$$(4)\quad Y_t = K_t^{\alpha}N_t^{1-\alpha}.$$

The firm's profit maximization conditions imply that

$$(5)\quad W_t = (1-\alpha)K_t^{\alpha}N_t^{-\alpha} \quad \text{and}$$
$$R_t = \alpha K_t^{\alpha-1}N_t^{1-\alpha}.$$

Finally, the goods market clearing condition is

$$(6)\quad Y_t = C_t + I_t + G_t + K_t\frac{\phi}{2}\left(\frac{I_t}{K_t}-\delta\right)^2.$$

We abstract from international flows of goods and capital.

We assume that the government balances its budget each period. Thus,

$$(7)\quad G_t = \tau_t^N N_t W_t + \tau_t^K K_t \times \left[R_t - \delta - \frac{\phi}{2}\left(\frac{I_t}{K_t}-\delta\right)^2\right] - T_t.$$

This assumption may seem extreme. In fact, it is innocuous. Although the timing of the distortionary taxes (τ^N and τ^K) does influence the equilibrium, the timing of the lump-sum transfers is irrelevant.

The focus of this paper is the short-run aggregate effects of the phase-in of the tax changes. Whether the budget is eventually balanced by future spending cuts or future tax increases will have wealth effects. These changes in wealth, however, do not change the pattern of economic activity that we highlight.

Denote the marginal utility of consumption and the marginal disutility of labor as $u'(C_t) = C_t^{-(1/\sigma)}$ and $v'(N_t) = \zeta N_t^{1/\eta}$. Utility maximization implies that, in equilibrium,

$$(8)\quad v'(N_t) = u'(C_t)W_t(1-\tau_t^N),$$

[2] Alan J. Auerbach and Laurence J. Kotlikoff (1987) present a detailed and comprehensive treatment of fiscal policy in a dynamic model. Auerbach (1989) and Auerbach and James R. Hines (1987) analyze the effects of timing of taxes. Barro (1989), N. Gregory Mankiw (1987), and Marianne Baxter and Robert G. King (1993) consider the effects of government purchases and the financing of such purchases in general equilibrium models.

TABLE 1—BASELINE PARAMETERS

Parameter	Baseline value
Discount factor, annual rate (β)	0.98
Capital share (α)	0.35
Depreciation rate, annual (δ)	0.10
Labor supply elasticity (η)	1.0
Elasticity of intertemporal substitution (σ)	0.2
Curvature of adjustment cost function (ϕ)	0

$$q_t = \beta E_t\Bigg[u'(C_{t+1})\Bigg\{(1-\tau^K_{t+1})R_{t+1} + \tau^K_{t+1}\delta + \frac{\phi(1-\tau^K_{t+1})}{2} \times \left(\left[\frac{I_{t+1}}{K_{t+1}}\right]^2 - \delta^2\right)\Bigg\} + (1-\delta)q_{t+1}\Bigg] \tag{9}$$

and

$$q_t = u'(C_t)\left[1 + \phi\left(\frac{I_t}{K_t} - \delta\right)(1-\tau^K_t)\right], \tag{10}$$

where q_t is the shadow value of an additional unit of capital.[3]

Given any initial position of the system, a rational expectations equilibrium requires that equations (3) through (10) hold in every period. These equations govern the evolution of the variables K_t, I_t, C_t, q_t, N_t, Y_t, W_t, and R_t taking the exogenous forcing variables $\{\tau^N_t, \tau^K_t, G_t\}^\infty_{t=0}$ as given. The government's budget constraint holds implicitly.

Our quantitative results depend on the parameters of these functions. The parameter values we use in our baseline simulations 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 annual 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 economic depreciation rate of 0.10. We set the remaining three parameters—the Frisch labor supply elasticity, the elasticity of intertemporal substitution, and the curvature of the investment adjustment cost function—at baseline values $\eta = 1.00$, $\sigma = 0.20$, and $\phi = 0$. Because they can have important effects on our results, we consider a range of alternative values for these parameters.[4]

In line with historical averages, we set the steady-state share of real government purchases in GDP to 0.2. The initial income tax rates are assumed to be $\tau^N = 0.362$ and $\tau^K = 0.183$. These correspond to the effective marginal tax rates on wage and capital income estimated by the Congressional Budget Office (U.S. Congress, CBO, 2001, p. 34–35) prior to the 2001 tax bill. The tax rate on wage income includes the payroll tax for Medicare and Social Security as well as state income taxes. The CBO's estimate of the tax rate on capital is low relative to statutory marginal rates; the estimate includes housing capital, which according to the CBO gets a tax subsidy.

We assume that the economy begins in an initial steady state. At time $t = 0$, the government announces a new path for tax rates and government purchases. Agents take the sequences $\{\tau^N_t, \tau^K_t, G_t, T_t\}^\infty_{t=0}$ as given. We solve the model by taking a log-linear approximation in the neighborhood of the initial steady state. As a robustness check, we also solved the model with a nonlinear shooting algorithm. The results were, for all practical purposes, identical.

[3] Note q is not Brainard-Tobin's Q, which is the ratio of q to the marginal utility of consumption at date t.

[4] Although a Frisch elasticity of one is high compared with evidence from much of the labor economics literature, it is smaller than elasticities used in the real business cycle literature. RBC models place greater emphasis on the extensive margin and usually follow Edward C. Prescott (1986), Gary D. Hansen (1985), and Richard Rogerson (1988) in adopting Frisch elasticity of at least two. Our baseline value is also in line with recent estimates in studies that focus on unconstrained choices about labor supply (see Henry S. Farber, 2005, and Miles S. Kimball and Shapiro, 2003). Most empirical evidence indicates that the elasticity of intertemporal substitution is substantially less than one (see Robert E. Hall, 1988). Our calibration is roughly the average estimate in Hall (1988), John Y. Campbell and Mankiw (1989), and Robert B. Barsky et al. (1997).

TABLE 2—STATUTORY TAX RATES AND AGGREGATE EFFECTIVE MARGINAL TAX RATES UNDER THE 2001 TAX LAW

	Tax brackets (joint returns)				Effective marginal tax rates	
Date	\$45,200–109,250	\$109,250–166,340	\$166,340–297,300	\$297,300 and above	Labor tax rate (τ^N)	Capital tax rate (τ^K)
pre-EGTRRA	28	31	36	39.6	36.20	18.30
2001:3–2001:4	27.5	30.5	35.5	39.1	35.92	18.22
2002:1–2003:4	27	30	35	38.6	35.64	18.14
2004:1–2005:4	26	29	34	37.6	35.08	17.99
2006:1 and beyond	25	28	33	35	34.40	17.80

Notes: The table shows tax rates for tax brackets above the 15-percent rate. The 2001 tax changes were retroactive to January, even though they were enacted in the middle of the year. The tax brackets are for 2001, married filing jointly. Under current law, the brackets adjust annually for inflation. Source for effective marginal tax rates: U.S. Congress, CBO (2001, pp. 34–35) 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.

II. The 2001 and 2003 Tax Laws

The tax policy changes enacted in 2001 and 2003 included cuts in the tax rate on both labor and capital income. The tax rate cuts under the 2001 law were phased in over a period of five years in a series of steps. The 2003 tax law accelerated the rate cuts called for in the original 2001 law and also implemented an additional temporary reduction in the tax rate on capital income. In this section, we describe the 2001 and 2003 tax legislation and present estimates of the effect of these tax changes on economic activity. We also consider the robustness of our results to alternative parameterizations of the model. We begin by describing the provisions in each law.

A. *Provisions*

The 2001 Tax Law.—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. Relative to their pre-EGTRRA values, tax rates above the 15-percent rate were cut by 0.5 percentage point in 2001. The legislation called for subsequent rate cuts in 2002, 2004, and 2006. By January 2006, the tax rates above the 15-percent bracket were scheduled to fall by 3 percentage points, except the top rate, which was scheduled to fall by 4.6 percentage points. Under the 2001 tax law, these tax rates remain in effect until 2011. In 2011, the tax reductions sunset, that is, the tax rates revert to their pre-EGTRRA levels. (See U.S. Congress, Joint Committee on Taxation, 2001, for a summary of the provisions.) Table 2 summarizes the time path of marginal tax rates under the 2001 law.

In addition to the changes in marginal tax rates, the law 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. The law also featured a phased-in reduction and subsequent elimination of the estate tax. Finally, the law created a new 10-percent bracket for the first \$12,000 of taxable income (\$6,000 for singles) effective in 2001. The U.S. 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. (See Shapiro and Joel Slemrod, 2003a, b, and David S. Johnson et al., 2006, for discussion of this aspect of the tax bill and estimates of its effect on consumer expenditures.) These rebate checks, though highly visible in 2001, did little to reduce marginal tax rates. Only households with taxable income below \$12,000 (\$6,000 for single filers) experienced a reduction in their marginal tax rate as a consequence of the new 10-percent bracket. Hence, even though the 10-percent bracket has a large impact on average tax liabilities and aggregate revenues, it has a minor effect on marginal rates.

The Congressional Budget Office (U.S. Congress, CBO, 2001) produced estimates of the impact of the tax law on effective 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 law was passed to 34.4 percent in 2006. The CBO estimated that the effective marginal tax rate on capital income would fall 0.5 percentage point from 18.3 percent 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. 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. 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. Table 2 presents the precise tax path we use in our simulations of the 2001 tax law.

The 2003 Tax Law.—President Bush signed the Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) on May 28, 2003. We focus on the major provisions of the 2003 law. It made immediate the phased-in tax rate reductions enacted in 2001, so that the rate cuts scheduled for 2004 and 2006 went into effect retroactively to the beginning of 2003. The sunset provisions of the 2001 tax law remained in place. The 2003 tax law also reduced tax rates on capital income for seven years. The dividend tax rate and the tax rate on capital gains were reduced to 15 percent for 2003 to 2008. (For low-income individuals, the tax rate on capital gains and dividend income was cut to 5 percent for 2003 to 2007 and to zero in 2008.) The dividend tax rates revert to the ordinary income tax rates in 2009; the capital gains tax rates revert to 20 percent (10 percent for lower-income individuals) in 2009. (See U.S. Congress, Joint Tax Committee, 2003a, b.)

There were several other prominent changes to the tax code that are worth mentioning. The expansions of the 15-percent bracket for married couples, and the 10-percent bracket for all taxpayers, which were to be phased in under the 2001 law were made immediate in the 2003 law. In 2005 these brackets were to revert to the paths specified in the 2001 law. Also, 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 were to be subject to the AMT under current law.

We do not attempt a quantitative analysis of all of these complex provisions. Instead, we focus attention on the acceleration of the income tax cuts and the seven-year tax cut on capital income. We estimate the effects of the temporary tax cuts on capital gains and dividend income by reducing the capital tax rate in the model for the years 2003 through 2008 by 1.37 percentage points.[5]

B. *Aggregate Effects*

We are now in a position to analyze the effects of the 2001 and 2003 tax laws. We begin with our baseline specification and then present sensitivity analysis.

Baseline Simulations.—Figures 1 and 2 show the reaction of the model to the 2001 and 2003 tax laws under two different assumptions about what the household believes will happen in 2011 when tax rates are legislated to revert to

[5] To calibrate the effective capital tax cut, we focused on the dividend tax cut. First, we calculated the fraction of dividend income in total capital income. For the years 1990–2002, this fraction was 0.0914. Second, because dividend income is highly skewed toward upper-income households, we treated all dividend income as though it were taxed at a rate of 30 percent prior to JGTRRA and 15 percent afterward. This gives us an additional reduction in the effective tax rate on capital income of 1.37 percentage points. This calculation neglects endogenous changes in the dividend payout rate to the tax law. Using time series evidence, James Poterba (2004) projects that the tax change should eventually increase dividend payouts by almost 20 percent. Jennifer L. Blouin et al. (2004) estimate the change in the payout rate to be roughly 10 percent, while Raj Chetty and Emmanuel Saez (2005) estimate it to be 20 percent. Such changes would have only modest effects on our calculations.

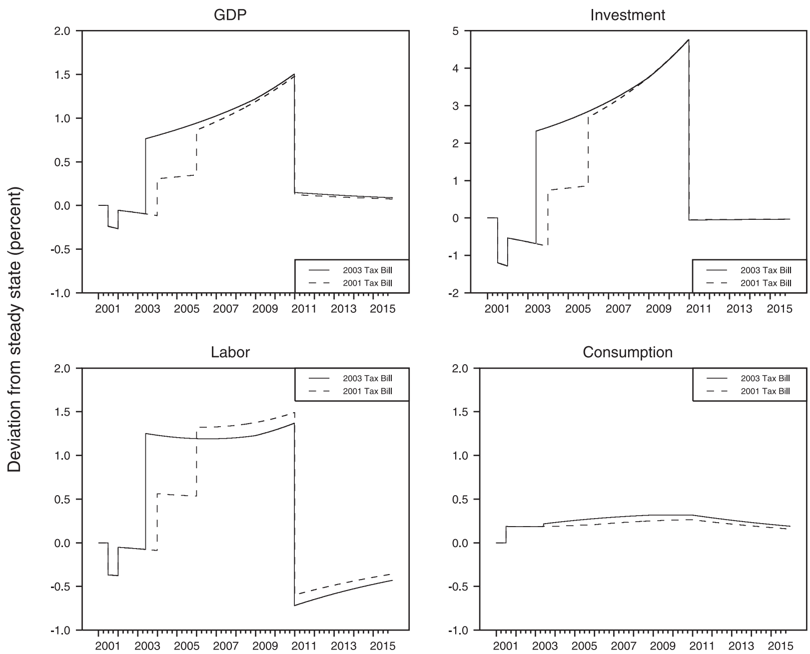

FIGURE 1. SIMULATED RESPONSE TO THE 2001 AND 2003 TAX BILLS, SUNSET

their pre-2001 levels. In Figure 1, we assume that, as the 2001 tax law requires, the tax rates revert to their original, pre-EGTRRA levels in 2011. In Figure 2, we assume that the 2006 tax rates remain in place indefinitely. In each figure, the dashed line corresponds to what would have happened if the 2003 law had not been passed, while the solid line shows the combined reaction to the two policies. The comparison of Figures 1 and 2 is useful for considering the implications of alternative long-run financing options. Because long-run financing plans affect tax rates or government spending only in the distant future, they have only wealth effects in the short run, which is the period we study. In the figures, different paths of long-run financing cause parallel shifts in the short-run paths of production, consumption, and investment. Thus, while variations in the eventual financing of the tax policy influence the equilibrium, they do not change the relative timing of economic activity implied by the path of tax rates in the short run.

Both figures have several common features. First, consumption rises immediately regardless of whether the plan sunsets because there is a positive wealth effect even though the setup is Ricardian. A reduction in distortionary taxes is financed with a reduction in lump-sum transfers T. Lower distortionary tax rates reduce distortions on labor supply and investment while the tax cut is in effect and the reduction in these deadweight losses implies an increase in income. Thus, even though government spending remains unchanged, the tax cut in the model does have a positive effect on the household's permanent income. Under the assumption that the tax cut sunsets, in the first quarter after the policy change, consumption is 0.187 percent above its initial steady state level. (This is the time-averaged response of real consumption over the first quarter the policy is in effect. The plots are calculated based on periods of 0.01 year; quarters are marked for convenience.) Naturally, the change in consumption is larger when the tax cut is expected to be permanent. In this case, consumption rises above its initial steady state by 0.296 percent. If the tax cuts

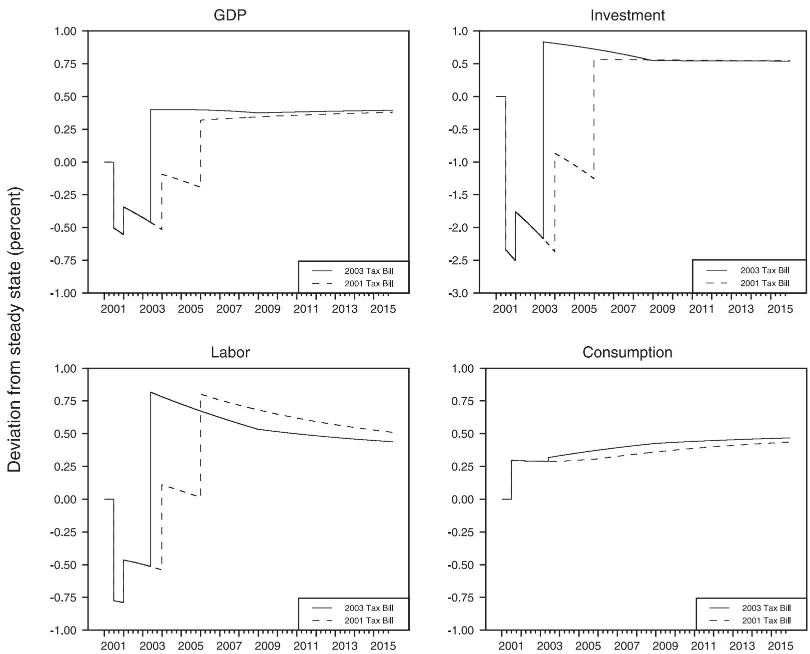

FIGURE 2. SIMULATED RESPONSE TO THE 2001 AND 2003 TAX BILLS, NO SUNSET

were financed by reductions in current or future government purchases, the income effect would be even greater. On the other hand, if future budget balance were achieved by increasing distortionary taxes, the wealth effects would be closer to zero. In any case, the differences between Figure 1 with the sunset and Figure 2 without it are very small relative to the substitution effects from the phase-in. Hence, there is little to be gained in understanding the short-run impacts of the policy by considering alternative scenarios for the very long run.

Second, during the period of the phase-in, employment, production, and investment are all below their initial levels. This, again, is due to the forward-looking nature of the household. To see this, consider the labor supply decision of the representative agent (equation (8)),

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

While forward-looking consumers experience the income effects of the policy as soon as the tax plan is announced, the substitution effects are deferred until the tax reductions are phased in. Consumption rises when the policy change is announced. This, in turn, reduces the marginal utility of consumption $u'(C_t)$ and shifts the labor supply curve back. Because tax rates and the capital stock remain at their original levels, employment must fall to satisfy (8). (Note that the pre-tax wage is a decreasing function of N_t.) Under the assumption that the policy is expected to sunset, employment drops by 0.368 percent. To put this in context, relative to total employment in June 2001 (132 million), this corresponds to roughly 488,000 jobs if the employment adjustment occurred entirely at the extensive margin. Because the wealth effect is greater for a permanent change in policy, the short-run contraction in employment and production is more pronounced when consumers expect the tax cuts to be permanent. In this case, employment falls by 0.776 percent, or roughly 1 million workers. Low employment and production, together with high consumption, necessitates low levels of investment during the period of the phase-in. Note that investment remains well below its initial level until the middle of 2003 whether or not the policy is expected to sunset.

Production and employment both recover sharply in the middle of 2003 when JGTRRA is passed. The reduction in tax rates in the 2003 law provided immediate incentives to work. Though employment rises in either case, employment is greatest if the tax cut is expected to sunset (because the wealth effect is smaller). If the bill is expected to sunset, employment rises above trend by 1.245 percent. If the tax cuts are expected to remain in effect, employment increases to 0.807 percent above trend.

A natural question arises as to why the tax cut on capital income called for in the 2001 law did not stimulate investment in the short run. In theory this is indeed a possibility. Note, equation (9) implies that the shadow value of capital satisfies

$$q_t = \beta E_t\left[\sum_{j=0}^{\infty}[\beta(1-\delta)]^j u'(C_{t+j+1}) \times ((1-\tau^K_{t+j+1})R_{t+j+1} + \tau^K_{t+j+1}\delta)\right],$$

where we have omitted the adjustment cost terms for simplicity. The future reduction in capital tax rates should cause the shadow value to rise as soon as the policy is announced. This would provide an incentive to work and invest, even during the phase-in period. Thus, unlike phased-in tax cuts on labor income, phased-in tax cuts on capital income provide immediate incentives to produce. Indeed, if depreciation deductions are highly accelerated, then a phased-in permanent tax cut on capital income is even more stimulative than an immediate permanent tax cut.[6]

Several factors limit the quantitative impact of this effect. First, the effective reduction in capital taxes under the 2001 law was much smaller than the change in labor taxes. The phased-in tax cuts on labor income provided an incentive to postpone production. In equilibrium, this reduces employment and consequently reduces the marginal product of capital. Thus, the phased-in labor tax cuts reduce the shadow value of additional capital tempering any incentives from the lower capital income taxes. Second, because firms write off depreciation, the incentive effects of the tax cut are further tempered because they apply to only a fraction of the real rental income net of depreciation. Although our model assumes that the depreciation rate for tax purposes equals the economic rate of depreciation, accelerated depreciation schedules would further reduce the stimulative effects of the tax cut. Finally, if the household expects the tax cut to sunset, the tax benefits are in effect only until 2011. This time period is only a small fraction of the life of long-lived capital investments. All of these factors combined imply that the incentive effects from the reductions in the capital tax rates are overwhelmed by the contractionary effects of the phased-in labor tax cuts.

Sensitivity Analysis.—We now consider how the simulated effects of the tax policy depend on certain parameters of the model. Specifically, we consider variations in the Frisch elasticity of labor supply (η), the elasticity of intertemporal substitution (σ), and the curvature of the investment adjustment cost function (ϕ). We confine our attention to the immediate reaction of employment to the passage of the 2001 tax law. Table 3 summarizes the simulated percentage change in aggregate employment in the quarter following the passage of the bill.

The table gives results for six elasticities of labor supply: 0.1, 0.5, 1.0, 5.0, 10.0, and infinite. The last corresponds to the Hansen (1985) and Rogerson (1988) model of indivisible labor. Not surprisingly, as the elasticity of labor supply increases, there is a greater reduction in employment during the period of the phase-in.

Empirical evidence strongly suggests that the intertemporal elasticity of substitution is less than 1.00. Our baseline specification is 0.2. Here we consider four values for the intertemporal elasticity of substitution: 0.1, 0.2, 1.0, and 2.0. In the table, increases in this parameter temper the short-run change in employment.

[6] Auerbach (1989) provides a thorough analysis of the incentive effects of the timing of such tax policies. See House and Shapiro (2005) for further discussion of the changes in capital income taxes as they relate to recent tax legislation.

TABLE 3—SENSITIVITY ANALYSIS CHANGE IN EMPLOYMENT FOLLOWING THE 2001 TAX BILL
(*Percent deviation from initial steady state*)

		$\eta = 0.1$	$\eta = 0.5$	$\eta = 1.0$	$\eta = 5.0$	$\eta = 10.0$	$\eta = \infty$
Panel A. With sunset provision							
$\phi = 0.0$	$\sigma = 0.1$	0.004	−0.190	−0.462	−1.491	−1.865	−2.423
	$\sigma = 0.2$	0.017	−0.128	−0.368	−1.338	−1.701	−2.247
	$\sigma = 1.0$	0.039	0.078	0.025	−0.470	−0.713	−1.116
	$\sigma = 2.0$	0.043	0.149	0.201	0.132	0.037	−0.158
$\phi = 2.0$	$\sigma = 0.1$	0.006	−0.141	−0.311	−0.779	−0.908	−1.073
	$\sigma = 0.2$	0.019	−0.081	−0.225	−0.657	−0.780	−0.940
	$\sigma = 1.0$	0.040	0.107	0.115	0.010	−0.042	−0.123
	$\sigma = 2.0$	0.043	0.164	0.251	0.426	0.463	0.504
$\phi = 6.0$	$\sigma = 0.1$	0.009	−0.081	−0.165	−0.332	−0.368	−0.410
	$\sigma = 0.2$	0.021	−0.029	−0.095	−0.245	−0.280	−0.321
	$\sigma = 1.0$	0.040	0.125	0.167	0.212	0.215	0.216
	$\sigma = 2.0$	0.042	0.166	0.261	0.481	0.538	0.609
Panel B. Without sunset provision							
		$\eta = 0.1$	$\eta = 0.5$	$\eta = 1.0$	$\eta = 5.0$	$\eta = 10.0$	$\eta = \infty$
$\phi = 0.0$	$\sigma = 0.1$	−0.059	−0.519	−0.947	−2.164	−2.546	−3.088
	$\sigma = 0.2$	−0.018	−0.383	−0.776	−1.959	−2.339	−2.881
	$\sigma = 1.0$	0.036	0.021	−0.106	−0.805	−1.095	−1.545
	$\sigma = 2.0$	0.043	0.135	0.161	−0.027	−0.162	−0.414
$\phi = 2.0$	$\sigma = 0.1$	−0.054	−0.437	−0.739	−1.393	−1.551	−1.746
	$\sigma = 0.2$	−0.014	−0.307	−0.581	−1.215	−1.374	−1.572
	$\sigma = 1.0$	0.038	0.065	0.019	−0.248	−0.346	−0.483
	$\sigma = 2.0$	0.044	0.160	0.236	0.357	0.374	0.384
$\phi = 6.0$	$\sigma = 0.1$	−0.046	−0.329	−0.509	−0.808	−0.867	−0.933
	$\sigma = 0.2$	−0.007	−0.212	−0.374	−0.669	−0.730	−0.800
	$\sigma = 1.0$	0.040	0.102	0.112	0.065	0.044	0.013
	$\sigma = 2.0$	0.044	0.172	0.270	0.500	0.559	0.634

Notes: The table gives the immediate reaction of aggregate employment in the first quarter after the 2001 tax bill is passed as a percentage of the initial steady-state level of employment. In the table, ϕ is the (annual) investment adjustment cost elasticity, σ is the intertemporal elasticity of substitution for nondurable consumption, and η is the Frisch elasticity of labor supply. Source: authors' calculations.

Low values of σ imply that the agent is not willing to tolerate large variations in consumption over time. As a result, the income effect raises consumption immediately following the announcement of the policy. When σ is higher, the agent is more willing to defer consumption. According to equation (8), the more consumption is deferred in equilibrium, the less labor supply shifts back.

Finally, increases in the investment adjustment cost parameter also temper the initial reaction of employment to the shock. Shapiro (1986) and Hall (2004) present evidence consistent with moderate to negligible adjustment costs. Their adjustment cost parameters correspond to a value of $\phi = 2$ (annually). In the table we consider three cases: our baseline case ($\phi = 0$), moderate investment adjustment costs ($\phi = 2$), and high investment adjustment costs ($\phi = 6$). While high adjustment costs are consistent with estimates from q-theoretic investment regressions, they are generally regarded as implausibly high. When $\phi = 2$ (moderate adjustment costs), employment drops by 0.225 percent or 0.581 percent, depending on whether the policy is expected to sunset. For comparison, when $\phi = 0$ (our baseline calibration) the initial reduction in

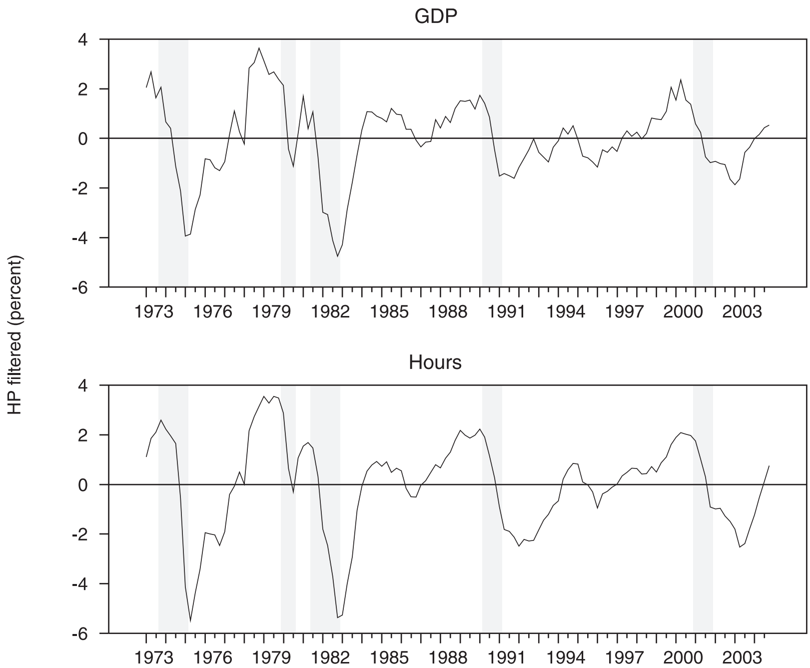

FIGURE 3. GDP AND HOURS OVER THE BUSINESS CYCLE

Note: Shaded areas are recessions (source: NBER).

employment was either 0.368 percent (with the sunset provision) or 0.776 percent (without the sunset provision).

Overall, these results suggest that, unless the labor supply elasticity is quite low, the phased-in tax cuts called for in the 2001 tax bill worked to depress employment as firms and workers waited for the lower tax rates to materialize.

C. *Phased-In Tax Cuts and the Economic Recovery of 2002–2003*

Our analysis suggests that the phased-in nature of the tax cuts in the 2001 tax bill may have constrained economic activity in the first years of the policy by providing incentives to delay production and investment. These incentives were removed when the tax cuts were accelerated in the 2003 tax bill. Economic activity appears to have accelerated in response to the removal of the phase-ins. This section compares our simulation of the policy response of key aggregates to the actual data.[7]

Figure 3 shows the time series of actual real GDP and total hours from 1973 through 2004. The data are Hodrick-Prescott filtered with the standard smoothing parameter of 1,600 for quarterly data.[8] Recessions are dated according

[7] Several other papers examine the 2001 tax cuts. 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 similar to those shown in our simulations under the assumption that the tax cuts sunset as scheduled. William G. Gale and Samara R. Potter (2002) provide a valuable summary and evaluation of the provisions of the legislation. They also provide an estimate of the long-run effects of the tax changes on labor supply, savings, and GDP growth.

[8] The specific series analyzed in this section are chain-weighted real GDP, consumption, gross private domestic investment, and total hours (total private employment times

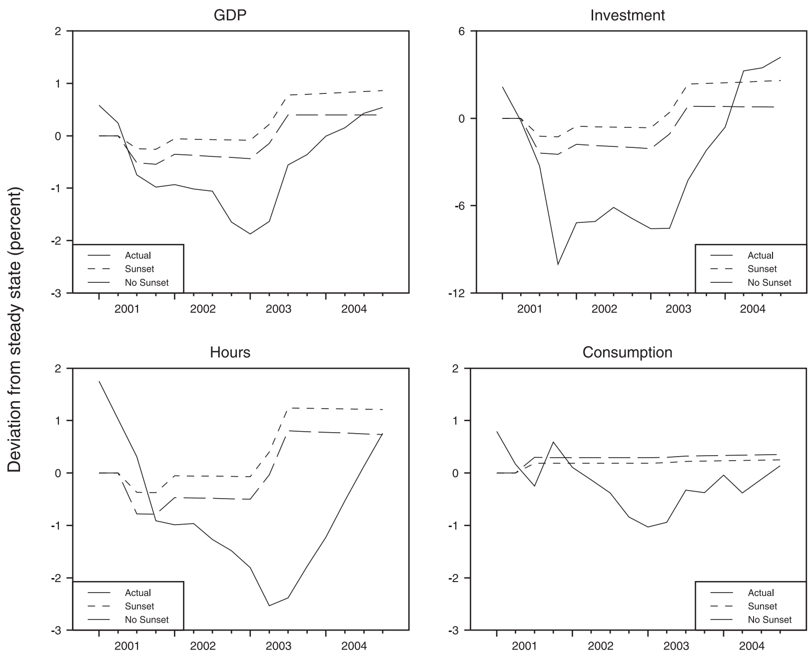

FIGURE 4. ACTUAL VERSUS SIMULATED DATA

to the National Bureau of Economic Research (NBER) business-cycle chronology. The NBER dates the recent recession as starting in the first quarter of 2001 (March) and ending in the last quarter of 2001 (November). A glance at Figure 3 reveals that the recovery from the recession of 2001 is quite different from other recent recessions. In previous recessions, the trough of GDP coincides with the end of the recession as dated by the NBER. In 2002, filtered GDP continued to decline sharply until it reached its trough at the beginning of 2003. The trough of hours post-dates the NBER trough by slightly more than does GDP.[9] Many factors, notably the September 11 terrorist attacks and their aftermath, may help explain the unusual behavior of economic aggregates in 2002 and 2003. Additionally, the NBER business cycle chronology is subject to considerable uncertainty. In any case, we now ask whether the phased-in nature of the tax cuts might account for the timing of the recovery from the 2001 recession.

Figure 4 shows actual data and our simulated deviations from steady state based on our analysis of the 2001 and 2003 tax bills. The solid line is the HP-filtered actual time series for GDP, investment, total hours, and total consumption for 2001 through 2004. As in Figure 3, the data are HP filtered with a smoothing parameter of 1,600. The two dashed lines show the simulated effects of the changes in tax rates. The upper dashed lines show the simulation under the assumption that the tax rate reductions sunset in 2011 as provided by the tax bills. The lower dashed lines show the simulations without the sunset. The simulations are based on the law in effect as of the quarter graphed, so the rates of the 2001 bill apply until the second quarter of 2003, when the 2003 bill eliminated

average weekly hours of production workers). Detrending near the end of the sample is inherently difficult. We examined alternative, less flexible estimators of the trend (HP filters with higher smoothing parameters or linear-quadratic trends). While the qualitative implications for the timing of the effects of the policy are not sensitive to alternative detrending procedures, the levels of the detrended actual series, especially for hours, are somewhat sensitive to the choice of detrending method.

[9] Following the 1990 recession, both hours and GDP had delayed recoveries.

the phase-in. For purposes of comparison with the actual data, we convert the simulated data to a quarterly time-series. Whether the tax rate changes are expected to sunset in 2011 affects the level of the variables (through the wealth effect), but has little effect on the profiles of the time paths. Consequently, assumptions about whether the policy will sunset, or how the tax cuts will be financed in the distant future, have little bearing on the timing effects highlighted in this paper.

Figure 4 suggests that the simulated response to the tax cuts contributes to explaining the actual time series. Our analysis suggests that the phased-in nature of the cuts pushed GDP and labor below trend in 2001 and 2002. Actual GDP, hours, and investment were weak over this period. The simulated data can help explain the weakness, i.e., that the substantial tax cuts did not create a recovery in 2001. They fall short, however, of explaining the continuing decline of activity in 2002. Clearly, other factors explain the drop in output and labor in 2002. The simulations show, however, that the phased-in nature of the tax cuts meant that the significant tax cuts enacted in mid-2001 provided no boost to the economy to offset these factors.

Consumption moves little in the simulations because the impact of the tax rate changes on wealth is negligible relative to quarter-to-quarter shocks in consumption. Hence, one would not expect simulated consumption to account for much of the observed change in consumption.

In mid-2003, when the 2001 tax rate cuts were made immediate, there were substantial increases in simulated output, labor, and investment. The effect on simulated consumption of eliminating the phase-ins was so small that it cannot be seen in the graphs because the timing of the tax cuts had essentially no effect on wealth. In the data, GDP, hours, and investment also start rising coincident with the passage of the 2003 tax bill. The actual data increase by more than the simulated data, but the simulated changes account for a substantial fraction of the observed changes. The actual HP filtered data for GDP increased by 1.5 percent from the first quarter of 2003 (just prior to the removal of the phase-ins) to the last quarter of 2003. Over the same period, simulated GDP increased by roughly 0.9 percent under the specification with the sunset and 0.8 percent in the simulation without it. Hence, the simulated movement in GDP accounts for somewhat more than half the cyclical change in GDP over this period. The amount of investment accounted for by the simulations over this period is even greater. Note that the increases in the actual data are spread over more quarters than are the simulated increases. (The simulated increases are spread over two quarters, in contrast to the continuous-time simulations of Figure 1 and 2, because of the averaging inherent in quarterly data.) While GDP and investment mirror the simulated data in the second half of 2003, the increase in hours is noticeably delayed relative to the model's predictions.

In summary, our simulations suggest that the 2001 tax bill initially reduced economic activity. In the actual data, activity continued to fall relative to trend through 2002 despite the end of the recession according to the NBER. Our simulations suggest it is not surprising that fiscal policy did not offset whatever other factors were depressing output during this period. In mid-2003, economic activity rebounded, especially as measured by GDP and investment. Hours recovered, but with a greater delay. Though the evidence of case studies is inherently circumstantial, our findings suggest that the elimination of the phased-in tax cuts in mid-2003 is an important part of accounting for the timing and magnitude of the rebound of economic activity.

Other shocks—from technology, monetary policy, other aspects of fiscal policy, the September 11 attacks, and the wars in Afghanistan and Iraq—were surely important in accounting for movements in aggregate economic activity. Hence, it would be a mistake to expect the simulations of the tax rate changes to account fully for the fluctuations in the actual data.

III. 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. Phased-in tax cuts on capital income provide immediate incentives to work and produce and especially to accumulate capital to take advantage of the lower future tax rates.

Phased-in tax cuts are not new to U.S. tax policy. 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. Because they have such strong incentive effects, it is natural to ask why tax changes are so often phased in over time. One possible explanation is that budget rules in the U.S. Congress make phase-ins more politically palatable. Budget rules play many roles in shaping U.S. tax policy. With respect to the 2001 tax bill, two particular rules stand out. First, federal budget rules mandate reporting the revenue consequences of tax laws over ten-year windows. For a phased-in permanent tax cut, the revenue losses in the first ten years are much smaller than the long-run impact. According to the Bush Administration's 2002 budget, the president's tax cut proposal would reduce revenues by 1.5 trillion dollars in the ten-year period after passage of the law. At the same time, according to the Administration's estimates, the revenue losses for the years 2007 to 2011 were more than twice the revenue losses for the first five years (2002 to 2006). Because the debate over tax laws focuses on the first ten years rather than their long-run impact, phased-in tax reductions make permanent tax cuts appear to be less costly than they truly are.

Second, a provision of the Budget Act, called the Byrd rule, effectively requires a supermajority of 60 votes in the Senate to pass tax reductions that extend beyond 10 years. A majority of the Senate favored the permanent phased-in tax cuts proposed in the 2001 budget, but not the 60-percent supermajority required by the rule. Accordingly, Congress enacted a ten-year tax cut with a sunset provision in 2011.[10]

The phase-in under the 2001 tax bill gave firms and workers an incentive to delay production during the period of the phase-in. By accelerating the tax cuts scheduled for 2006, the 2003 tax bill gave firms and workers an immediate incentive to produce. Our model suggests that these incentives were large enough to account for a substantial amount of the behavior of actual GDP from 2001 to 2004. The slow recovery from the 2001 recession and the sudden increase in economic activity in mid-2003 are exactly what the model predicts in response to the time path of the tax rates. The model does an excellent job of explaining the behavior of total production and investment. It predicts roughly half of the actual change in GDP following the acceleration of the tax cuts in mid-2003 and even a greater fraction of the change in investment. It does not do as well at predicting the timing of the observed change in hours and employment. The model predicts that hours and employment should both react immediately in the middle of 2003. While employment does increase in mid-2003, the increase is drawn out over a substantial period of time. When the 2001 and 2003 tax cuts were passed, it was widely believed that the sunsets would be eliminated by future legislation. If, instead, the tax rate cuts do sunset, as they might given the looming fiscal deficits, our analysis shows that economic activity will increase as the sunset approaches and then fall when the sunsets take effect.

The ability of the model to use the timing of the tax cuts to explain economic activity depends importantly on the elasticity of labor supply. If this elasticity is low, then the phase-in will have only modest effects in the short run. Of course, low labor supply elasticities also imply that the beneficial long-run effects of lower taxes will also be modest. It is thus difficult to argue that phased-in tax cuts have favorable long-run supply-side effects, but only modest effects on economic activity in the short run.

[10] See House and Shapiro (2004) for more detailed documentation of the role of budget rules in shaping the 2001 and 2003 tax bills. Auerbach (2006) also identifies budget rules as having potentially significant effects on the design of tax policy. Gale and Peter R. Orszag (2003) discuss sunsets.

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