



UNITED STATES
**DEPARTMENT OF
THE TREASURY**



**Office of Tax Analysis
U.S. Department of the Treasury**

A Dynamic Analysis of Permanent Extension of the President's Tax Relief

July 25, 2006

Executive Summary

This Report presents a detailed description of Treasury's dynamic analysis of the President's proposal to permanently extend the tax relief provisions enacted in 2001 and 2003 that are currently set to expire at the end of 2010. These enacted provisions include:

- Lower tax rates on ordinary income;
- Lower tax rates on dividends and capital gains;
- A ten-percent individual income tax rate bracket;
- Doubling of the child tax credit; and
- Reducing marriage tax penalties.

The purpose of the report is to provide a more in-depth, transparent understanding of dynamic analysis, while also illustrating the positive contributions the tax relief, together with spending reductions, can be expected to continue to make to the U.S. economy. In addition, the analysis shows the importance of making the tax provisions permanent for the U.S. economy's long-term economic growth.

Dynamic Analysis

Dynamic analysis goes beyond traditional analysis of tax policy by focusing on the broad economic effects in both the short and long term. Simply, dynamic analysis provides a more comprehensive and complete approach to analyzing tax policy by including its effects on the overall size of the economy and other major macroeconomic variables. The President's FY 2007 Budget proposes to create a division of dynamic analysis within the Department of Treasury's Office of Tax Analysis.

The Economic Benefits of Tax Relief

As evidenced by key economic indicators such as increased capital investment and Gross Domestic Product (GDP), and strong job growth, the President's tax relief played an important role in strengthening the U.S. economy as it was coming out of the recent recession, and in the longer-term by increasing the after-tax rewards to work and saving. Lower tax rates enable workers to keep more of their earnings, which increases work effort and labor force participation. The lower tax rates also enable innovative and risk-taking entrepreneurs to keep more of what they earn, which further encourages their entrepreneurial activity. The lower tax rates on dividends and capital gains lower the cost of equity capital and reduce the tax biases against dividend payment, equity finance, and investment in the corporate sector. All of these policies increase incentives to work, save, and invest by reducing the distorting effects of taxes. Capital investment and labor productivity will thus be higher, which means higher output and living standards in the long run.

Treasury has conducted its dynamic analysis using a model that accounts for the effects of this greater work effort, increase in savings and investment, and improved allocation of resources on the size of the economy. While this model captures many aspects of a modern economy and economic behavior, others are not reflected in the model. For example, the model assumes that resources are fully employed in the economy and that capital is only somewhat mobile internationally. These are areas for future development.

Different Components of Tax Relief Have Different Effects on the Economy

Treasury's dynamic analysis of the President's tax relief indicates that making the tax relief permanent can be expected to increase the level of annual output (i.e., national income) ultimately by about 0.7 percent. The analysis also shows separately the effects of the President's tax relief in three parts reflecting: 1) the lower tax rates on dividends and capital gains; 2) the lower tax rates on ordinary income (i.e., the top four rate brackets); and 3) the 10-percent tax rate bracket, higher child tax credit, and marriage penalty relief. This decomposition reveals that these tax relief components are likely to have very different effects on future economic activity. For example, extending just the lower tax rates on dividends and capital gains increases output in the long run by 0.4 percent, but when the lower tax rates for the four top income tax brackets are extended as well, output increases by a total of 1.1 percent in the long run.

Financing Tax Relief – Government Spending Reductions over Increased Tax Rates

The analysis reveals that the long-run effects of these policies depend crucially on whether they are financed by lower spending or higher taxes in the future and are sensitive to assumptions on underlying parameters. The issue of how, or even if, these policies need to be financed remains a source of discussion among economists. The analysis presented here suggests these policies will result in substantially more economic activity if they are financed by a future reduction in government spending than if they are financed by future tax increases. If the tax relief is financed by future tax increases – that is, if the aggregate amount of tax relief is temporary – then it may result in lower output in the long run. For that reason, the Administration has emphasized permanence for the tax relief *and* spending restraint in its Budgets.

A Dynamic Analysis of Permanent Extension of the President's Tax Relief

1. Introduction

This Report presents a detailed description of Treasury's dynamic analysis of the President's proposal to permanently extend the tax relief provisions enacted in 2001 and 2003 that are currently set to expire at the end of 2010. These provisions include the lower tax rates on ordinary income, the lower tax rates on dividends and capital gains, the 10-percent individual income tax rate bracket, a doubling of the child tax credit, and a reduction in marriage tax penalties.

Tax relief can be important when the economy is performing below its full potential, and can increase its potential in the longer term. In 2003, real GDP was below its potential level and the unemployment rate was elevated. The tax relief enacted in 2001 and 2003, together with reductions in short-term interest rates by the Federal Reserve, helped stimulate economic growth and move the economy out of the 2001 recession more quickly. Previous Treasury analysis using the Macroeconomic Advisers macro-econometric model estimated that without the tax relief passed in 2001, 2002, and 2003, as many as 3 million fewer jobs would have been created by the end of 2004 and real GDP would have been as much as 3.5 to 4.0 percent lower.

Beyond this short-term economic stimulus, the President's tax relief also helps encourage economic growth in the longer term by increasing the after-tax reward from work, saving, and investment. The lower tax rates enable workers to keep more of their earnings, which increases work effort and labor force participation. The lower tax rates also enable innovative and risk-taking entrepreneurs to keep more of what they earn, which further encourages their entrepreneurial activity. The lower tax rates on dividends and capital gains lower the cost of equity capital and reduce the tax biases against dividend payment, equity finance, and investment in the corporate sector. All of these policies improve incentives for work, saving, and investment by reducing the distorting effects of taxes. Capital investment and labor productivity will thus be higher, which means higher output and living standards in the long run.

The Treasury Department's dynamic analysis relies on a model that takes into account the effects of work effort, increase in savings and investment, and improved allocation of resources on the size of the economy. The overlapping generations (OLG) general equilibrium model used for this analysis (described in detail in the appendix to this report) is structured to account for the effects of changes in the effective tax rate on capital and labor income and the consequent effects on economic growth. Representative consumers and firms incorporate future prices into their current period decisions of how much to save, work, and produce. Output is generated by four production sectors, and individual level decisions of representative consumers determine the aggregate level of labor supply and savings in each year.

While this model captures many aspects of the economy and economic behavior, other aspects are not reflected in the model. For example, the model ignores cyclical disruptions in the employment of capital and labor, assuming instead that all resources in the economy are always fully employed. The model includes a relatively simple representation of international capital flows in which capital is only somewhat mobile internationally. There is no uncertainty in the

model and households and firms exhibit perfect foresight regarding future prices and tax rates. These are areas for future development.

This analysis shows the likely economic effects of making the tax relief permanent. The results indicate that the level of annual output (i.e., national income) may ultimately be higher by 0.7 percent because of the combined effects of the President's tax relief.

The analysis also shows separately the effects of the President's tax relief in three parts reflecting: 1) the lower tax rates on dividends and capital gains; 2) the lower tax rates on ordinary income (i.e., the top four rate brackets); and 3) the 10-percent tax rate bracket, higher child tax credit, and marriage penalty relief. This decomposition reveals that the tax relief components are likely to have very different effects on future economic activity. For example, extending just the lower tax rates on dividends and capital gains increases output in the long run by 0.4 percent, but when the lower tax rates for the four top income tax brackets are extended as well, output increases by a total of 1.1 percent in the long run. Extending the remainder of the tax relief – the 10 percent rate, the expansion of the child tax credit, and the reduction in marriage penalties – stimulated economic activity during and immediately after the recession and served other purposes, such as making the tax code more progressive. However, these elements of the tax relief do not have positive growth effects in the longer term in ways that this type of model can measure.

The analysis reveals that the long-run effects of these policies depend crucially on how they are eventually financed and are sensitive to assumptions on underlying parameters. The issue of how, or even if, these policies need to be financed remains a source of discussion among economists. The analysis presented here suggests these policies will result in substantially more economic activity if they are financed by a future reduction in government spending than if they are financed by future tax increases. If the tax relief is financed by future tax increases – that is, if the tax relief is temporary – it may well result in lower output in the long run. In effect, the temporary tax relief must be paid back with interest through future tax increases, which implies that future tax rates increase compared to current law. For that reason, the Administration has emphasized permanence for the tax relief *and* spending restraint in its Budgets. The sensitivity of the results to financing and parameter assumptions is described in detail below.

The remainder of this report is organized as follows. The next section describes previous work done by Treasury that estimated the short-run economic effects of the President's tax relief. Section 3 describes the model used in the permanence analysis in greater detail. Section 4 outlines the methodology employed in simulating the economic effects of extending the 2001 and 2003 tax relief and discusses some of the limitations of the model. Section 5 describes and explains the results and the last section concludes.

2. Effect of the President's Tax Relief in the Near Term

The focus of this Report is on the future economic effects of permanently extending the President's tax relief. As described in the introduction, the model used for this analysis assumes that the economy is always performing at its potential. This assumption simplifies the model and allows for a more detailed representation of household labor supply and savings behavior in both

the near term and the long run. Yet this simplification implies the model used for this report is not able to capture the short-run stimulus that tax relief may provide when the economy is operating below potential. Such a situation existed when the President's tax relief was passed in 2001 and 2003; real GDP was below its potential level and the unemployment rate was elevated.

The Treasury Department previously compared how the economy would have performed if there had been no tax relief using a different type of model that is designed to capture the interactions of economic sectors as the economy fluctuates around its potential growth path. These models attempt to account for changes in the level and growth of GDP, employment, inflation, and interest rates. Short-run changes in monetary and fiscal policies are important determinants of accelerations and deceleration of employment and output in these models. In this earlier analysis, the Treasury Department used the Macroeconomic Advisers macroeconometric model to estimate how the economy would have performed had there been no legislated fiscal stimulus from 2001 through 2004. This analysis found that the tax relief increased employment and output substantially above what would have occurred otherwise.

Specifically, Treasury found that, without enactment of the Economic Growth and Tax Relief Reconciliation Act of 2001, the Job Creation and Worker Assistance Act of 2002, and the Jobs and Growth Tax Relief Reconciliation Act of 2003: (1) by the second quarter of 2003, the economy would have created as many as 1.5 million fewer jobs and GDP would have been as much as 2 percent lower, and (2) by the end of 2004, the economy would have created as many as 3 million fewer jobs and real GDP would be as much as 3.5 to 4.0 percent lower.

Note that the analysis described in this section estimates the economic effects that the President's tax relief has already had on the economy, assuming that interest rates followed the same path as they did historically from 2001 forward. The remainder of the paper discusses the likely future economic effects of making the President's tax relief permanent.

3. Model description

For the remainder of the analysis in this Report, the Treasury Department used a conventional neoclassical growth model with overlapping generations of taxpayers developed by Tax Policy Advisers, LLC.¹ In this life-cycle model, tax policy affects the incentives to work, to save and invest, and to allocate capital among competing uses. Representative consumers and firms incorporate future prices into their current period decisions of how much to save, work, and produce. Output is generated by four production sectors, and individual level decisions of representative consumers determine the aggregate level of labor supply and savings in each year. An overview of the model follows, with important equations and further explanation provided in the appendix.

Firm Behavior

Firm behavior is modeled for each of the four production sectors – corporate, noncorporate, owner-occupied housing, and rental housing. In the owner-occupied housing sector, home owners are treated as "firms" who produce housing and rent it to themselves, taking into account

¹ See <http://www.taxpolicyadvisers.com>.

the tax advantages of home ownership. Each production function takes the standard Cobb-Douglas form.

Firm managers choose the optimal levels of labor demand and investment to maximize the value of the firm, or profits, in each period. Investment in each sector is determined according to the “ q ” theory of investment modified to include adjustment costs. This implies that firms will continue to invest as long as the increase in the value of the firm is greater than the after-tax cost of investment. Firm managers explicitly calculate the time path of investment in response to a change in the tax structure as a function of the tax-induced change in “ q ”, which denotes the ratio of the market value of capital assets to their replacement costs, taking into account convex costs of adjusting the level of investment from its steady state level. Differences in the level of depreciation allowances for tax purposes and economic depreciation are modeled explicitly, as is the value of the existing tax basis at any point in time. The debt-to-capital ratio is assumed to be fixed in each industry, and dividends in the corporate sector are assumed to be a fixed fraction of after-tax corporate earnings. The model assumes the traditional view of dividend taxes, which implies dividend taxes increase the cost of capital to firms.

Individual Behavior

The model has a conventional overlapping generations structure. All individuals in a given cohort are identical, with each living for 55 years, the last 10 of which are spent in retirement.² Each individual has perfect foresight and chooses consumption (and thus saving) to maximize lifetime utility – an aggregation of utility in each of the 55 periods of the lifecycle, discounted at a fixed rate of time preference that is common to all individuals – subject to a lifetime budget constraint that takes into account a hump-shaped age-wage profile, inheritances and a target bequest. Utility in each period is a CES function of leisure and an aggregate consumption good which is in turn an aggregation of four goods – a composite good produced by the corporate sector, a composite good produced by the non-corporate sector, owner-occupied housing, and rental housing. The intertemporal elasticity of substitution is assumed to be 0.35 and the intratemporal substitution elasticity between goods and leisure is assumed to be 0.8.³ Sensitivity to these and other parameters is considered in more detail below.

Government Behavior

The model includes a simple characterization of the Social Security program. Government services are separable in the individual utility function and government debt is a constant fraction of Gross National Product (GNP) in the initial steady state.

² This formulation, in effect, excludes an individual’s life prior to joining the labor force, but does include both individuals’ working years plus their retirement. An alternative approach to modeling the retirement decision would be to allow the retirement age to be endogenous so that individuals could come out of retirement and rejoin the work force in response to reform-induced changes in the after-tax wage. This potential labor supply response is precluded by assuming a fixed retirement age.

³ See Elmendorf (1996), Engen, Gravelle, and Smetters (1997) and Altig *et al.* (2001) for discussion on the plausible range of values for these parameters. These parameter values yield a Frisch elasticity of labor supply, which measures the labor supply elasticity holding the marginal utility constant, equal to 0.4. This value is consistent with the range of estimates reported in Browning, Hansen, and Heckman (1999).

The government finances government expenditures by collecting taxes, and issuing government debt. The tax instruments available to the government in the initial equilibrium include the following: (1) a corporate income tax; (2) an individual income tax with a progressive wage income tax structure and a tax base that is adjusted for various exclusions, exemptions, deductions and credits; and (3) constant rate capital income taxes applied at different average rates to non-corporate business income, interest income, dividends and capital gains.

An important feature of this type of model is that a permanent reduction in taxes, as compared to the baseline, would lead to an unsustainable accumulation of government debt relative to GNP and the model will not converge without an offsetting change to stabilize the debt-to-GNP ratio. In this type of model, the tax relief is typically financed by an offsetting change in taxes or spending, that can occur in the future or contemporaneously with the initial policy change and can take a multitude of forms. In this analysis it is assumed that the government's financing requirement is satisfied by either cutting future government spending or raising future taxes, in part to illustrate the sensitivity of the results to the financing assumption.

International Capital Flows

Although the focus of the model is on the U.S. domestic economy, it includes a simple representation of international capital flows, which are assumed to respond to differences in after-tax rates of return in the U.S. and the "rest of the world" through a constant elasticity expression.⁴ This approach represents a compromise between the standard closed economy approach and the alternative of a completely open economy in which capital is perfectly mobile and the international return to capital is fixed. A more sophisticated modeling of the international flows of goods and capital would be a marked improvement over the current version of the model.

4. Methodology

In the steady state, per-capita growth in the model is equal to a constant rate of technological change. In the initial steady state, the model's tax parameters are calibrated to match current law average marginal effective tax rates by income source over the budget window. Simplifying assumptions were made in order to meld the data into the stylized model. First, given the requirement of constant tax rates in the steady state, the initial tax rates were set equal to the average of current law rates over the period 2011-2016, when statutory rates are unchanging. Second, the initial steady state assumes that current law policies are fiscally sustainable. That is, tax revenues in each period are just large enough to pay for government spending and transfer payments, including interest on the government debt, so that the government debt-to-GNP ratio is constant.⁵ The initial share of tax revenues as a percentage of GNP is set to match current law averaged over the years 2011-2016.

⁴ This elasticity is set equal to 0.2 in the base case, which implies that international capital flows are not very sensitive to differences in the after-tax rate of return in the U.S. compared to the rest of the world.

⁵ Note that this approach ignores the structural fiscal imbalance of the Social Security and Medicare systems, but this assumption seems appropriate in generating the likely independent effect of a tax change and is commonly used in this type of analysis. For example, see Auerbach (2002).

The tax relief is decomposed into three parts to show the economic effects of each:

1. Extend the lower rates on dividends and capital gains. (Dividends and capital gains are taxed at a top rate of 15 percent, as compared to a top rate on dividends of 39.6 percent and for long-term gains of 20 percent in the absence of tax relief);
2. Extend the reduction in the top four ordinary individual rates. (These rates are maintained at 25, 28, 33 and 35 percent, as compared to the rates of 28, 31, 36 and 39.6 percent that would apply beginning in 2011 under current law. The repeal of the phase-out of personal exemptions and itemized deductions [PEP and Pease provisions] is also extended); and,
3. Extend the higher child tax credit (\$1,000 per child), reduction in marriage tax penalties (by increasing the standard deduction and increasing the size of the 15 percent bracket for joint filers), and the 10-percent tax rate bracket.⁶

The percentage decline in average marginal tax rates by income source compared to current law for the years 2011-2016 is shown in Table 1.⁷ Extending the lower tax rates on dividends leads to more than a 50 percent decline in the average marginal dividend tax rate compared to current law for the years 2011 through 2016. Extending the relief on capital gains leads to more than a 20 percent decline in the average marginal tax rate on capital gains for the same period. Lowering ordinary rates leads to a decline in the average marginal tax rate on labor income of 5.6 percent, while the average marginal rate on small business income (income from sole proprietorships, partnerships, and S-corporations) falls by 11.4 percent. Extending the remainder of the tax relief has only small effects on the change in marginal tax rates.⁸

Financing the Tax Relief

As discussed above, an important feature of this type of model is that tax relief must be financed by an offsetting change in government revenues or spending to stabilize the ratio of government debt to GNP. There are numerous possibilities for satisfying the government's intertemporal budget constraint and two are examined in this analysis: (1) the tax relief is permanent and future government spending is reduced, and (2) future taxes are increased. Specifically, in this analysis, the tax relief is assumed to remain in place through the end of the 10-year budget window (i.e., 2016), holding government spending equal to the baseline amount during this period, and issuing additional government debt relative to the baseline to account for the decline in tax revenues over the budget window. The tax relief is then financed by either: (1) adjusting government consumption spending in each year after the 10-year budget window to hold the ratio of government debt-to-GNP at the ratio that exists in the first year after the budget window (2017), or (2) adjusting all income tax rates proportionally in each period after the budget window to hold the government debt-to-GNP ratio equal to the value it takes in the first year

⁶ The economic effects of the repeal of the estate tax are not included in this analysis. There is considerable uncertainty regarding the likely behavioral responses to repealing the estate tax, and the target bequest motive used in this model is not very flexible in capturing the range of likely responses.

⁷ The average marginal rates are weighted by income from that source.

⁸ The decline in the marginal tax rate on wages actually becomes smaller (5.1 percent decrease) when the full tax relief is extended. This appears to be the result of more taxpayers being affected by the AMT and the longer phase-out of the child tax credit.

after the 10-year budget window (2017).⁹ The first financing option is consistent with the Administration’s policy of spending restraint. The second financing option, in effect, models the tax relief as temporary, which requires that future taxes increase enough to pay for the temporary decline in taxes with interest.

Sensitivity to Underlying Parameter Assumptions

The results also depend on how responsive households and firms are to changes in after-tax prices, such as the wage rate and the interest rate. The behavioral parameters used for the base case simulations are shown in Table 2. There are three primary parameters that affect the responsiveness of household labor supply and savings to tax changes: the intertemporal elasticity of substitution, the intratemporal elasticity of substitution between the composite consumption good and leisure, and the initial share of leisure in the time endowment. The base case simulations use values for these parameters that approximate “central tendency” estimates. However, there is uncertainty about the exact value of these parameters and results are also presented that consider “low” and “high” values for these parameters.¹⁰ In addition, the degree to which housing and non-housing goods are substitutable is adjusted. The approach taken for this Report is to adjust the parameters as a group, rather than individually, mostly to facilitate ease in presentation.¹¹ This approach provides only limited information on the importance that any given parameter would have on the results, but it provides an overall sense of the robustness of the results and highlights the uncertainty that remains in the economics literature on the likely responsiveness of taxpayers to changes in tax rates.

Limitations of the Model

The model used for this analysis captures many of the likely economic effects that would result from extending the President’s tax relief, including incentive effects on household labor supply and savings, the intersectoral reallocation of capital that would result from reducing the double taxation of corporate profits, and the crowding out of private investment that would occur by financing the tax relief through issuing government debt. Like all economic models, this model employs important simplifying assumptions, and other economic models, which employ different simplifying assumptions, could yield different economic results from extending the President’s tax relief. The model used in this analysis departs from economic reality in the following ways.

⁹ Auerbach (2002) and Auerbach and Kotlikoff (1987) employ a similar approach when examining the effects of a temporary tax decrease financed with future tax increases. The Congressional Budget Office (2004, 2006) also makes similar financing assumptions, but the reduction in government spending (or the increase in income taxes) is phased in over a 10-year period after the end of the 10-year budget window which allows the debt-to-GNP ratio to rise somewhat more in the long-run.

¹⁰ The Frisch labor supply elasticity equals 0.18 under the low response parameters and 0.75 under the high response parameters. This is consistent with the results surveyed by Browning, Hansen and Heckman (1999), and recent papers by Ziliak and Kniesner (1999, 2005) and Lee (2001), which estimate the Frisch labor supply elasticity for men ranges between 0.0 and 0.5. The econometric literature has generally found larger labor supply responses for women compared to men, but there are few studies that measure the Frisch labor supply elasticity for women. Aaronson and French (2002) suggest this value is believed to be around 1. This Report assumes the Frisch labor supply elasticity for women ranges between 0.55 and 1.25, and that women account for one-third of labor earnings.

¹¹ A similar approach is taken by Rogers (1997). For each simulation, this Report also adjusts the rate of time preference in order to maintain the initial capital-output ratio.

First, this model does not account for short-term deviations in output from potential GNP. This implies that the model does not capture some of the short-run benefits of tax relief when it occurs at a time when the economy is below its potential, which occurred with the 2001 and 2003 tax relief. Section 2 of this Report describes a separate Treasury analysis of the effect of the President's tax relief that includes these cyclical effects.

Second, the treatment of international capital flows is quite simple. A broader model would employ a more sophisticated representation of these flows and would also include international trade in goods. The limited role of international capital flows allowed in this model has only a minor impact on the economic results in this analysis. It is unclear whether a broader model of international trade and capital flows would lead to results that are smaller or larger in magnitude than the results presented in this paper.

Third, as mentioned above, the model assumes that the "traditional" view of dividend taxation holds, which implies that taxes on dividends increase the cost of investing in the corporate sector. An alternative approach that is termed the "new" view of dividend taxation suggests that dividend taxes are capitalized into the value of the firm, but do not affect marginal investment decisions.¹² The degree to which each view represents an accurate portrayal of the economy remains an unsettled issue. Recent research suggests a segmented market, with some firms behaving in a manner consistent with the traditional view and other firms behaving in a manner consistent with the new view.¹³

To the extent that the new view holds, the output gains resulting from extending the lower tax rates on dividends found in this analysis are likely to be overstated. However, this model also does not include a measure of other efficiency gains that would likely result from lowering the tax rate on dividends due to reducing the distortions between debt and equity financing. Moreover, the model assumes that the level of dividends and corporate payout decisions are held fixed.¹⁴ It is not clear whether a fuller model that accounts for both new view firms and these other financial distortions would show larger or smaller effects overall.

Fourth, this model assumes perfect certainty and perfect competition. Of course, as suggested by empirical research, some individuals save as a precaution against unforeseen events and at least a portion of savings is not very sensitive to changes in the interest rate. Thus, the implied elasticity of savings with respect to the after-tax interest rate in the certainty model is likely to be higher than in a model that incorporates risk. To partially offset the lack of risk in the model, households have a simple target bequest motive that tends to mitigate the savings response.¹⁵ On the other hand, some models with imperfect competition find that the distortionary effects of capital income taxation are larger than models that assume perfect competition.¹⁶

¹² For an excellent overview of these issues, see Zodrow (1991).

¹³ For example, see Auerbach and Hassett (2003).

¹⁴ The importance of these distortions is also diminished to the extent the new view holds.

¹⁵ It is worth noting, however, that Hurst, *et al.*, (2005) recently estimated that precautionary savings account for less than 10 percent of total wealth.

¹⁶ For example, see Judd (2002).

Fifth, this model likely overstates the economic cost of deficit finance of temporary tax relief as the rate of return to government bonds in the model is greater than the rate of growth in GNP.¹⁷ Historically, the average return on government debt is below the average growth rate of the economy, which implies it might not be necessary to increase taxes in the future in order to stabilize the government debt ratio. Some research suggests that the need to raise future tax rates to pay for temporary tax relief only occurs with a small probability.¹⁸

Finally, the financing assumptions used in this model are conventional for this type of analysis and are not meant to be predictions of what policies actually would be set by this Administration or by a future Administration or Congress. Numerous other policy prescriptions also could be employed. If the revenue cost of the tax relief is financed through reductions in government spending, then the sooner those reductions begin, the smaller would be the crowding out effect on private investment and the larger would be the increase in long-run output. If the revenue cost of the tax relief is financed through future tax increases, then the way future taxes are increased would greatly affect the long-run results; the more the future tax increases affect marginal rates, the more future economic output will suffer as a consequence.

5. Description of results

As described above, results are presented assuming that the tax relief is financed either through a future decrease in government spending or a future increase in taxes. The first year in the model is set to be 2007. Households and firms in the tax relief simulations anticipate the future continuation of lower tax rates after 2010 and the offsetting fiscal policy of reducing government consumption or increasing tax rates beyond the budget window. However, the macroeconomic effects for the first four years of the budget window (2007-2010) are generally small as tax rates do not change between the different simulations for those years. Results are presented in Tables 3 and 4, and discussed below for only the last six years of the budget window (2011-2016) and for the long run.

Tax Relief Financed with Future Decrease in Government Spending

For this set of results, the model assumes that government consumption purchases (i.e., government spending) adjust after 10 years to stabilize the government debt-to-GNP ratio. In the model, government consumption purchases do not enter household utility functions and only indirectly affect household decisions through market prices.¹⁹ Prior to 2017, the debt-to-GNP ratio is allowed to rise, but, beginning in 2017, government purchases decline in each year to hold the government debt ratio fixed.

Most of the economic effects of the tax relief can be explained by examining households' budgets and prices. The tax relief leads to offsetting substitution and income effects for both

¹⁷ The model assumes that the after-tax rates of return to government bonds, private bonds and corporate equity are equal.

¹⁸ See Ball, Elmendorf, and Mankiw (1998).

¹⁹ That is, government spending is not valued by households. An alternative assumption is that valued government spending decreases, such as government transfer payments to individuals. This would mostly eliminate the income effects of the tax relief and lead to larger output effects. A more detailed modeling of the government sector would also be an improvement in the model.

household leisure and consumption choices. The reduction in the marginal tax rates on labor and capital income increases the price of current leisure and consumption, and households respond by supplying more labor and savings through the substitution effect.²⁰ The reduction in tax liabilities increases household after-tax wealth, and households' desire to consume more leisure and consumption through an income effect. There is an additional income effect (termed the human wealth effect) which supports an initial increase in labor supply and savings. This effect arises from the increase in the after-tax interest rate that results from the lower tax on capital, but this effect becomes less important over time as the interest rate declines as capital accumulates.

However, other effects also are at work. The lower tax rate on dividends lowers the effective tax rate on investment in the corporate sector relative to the other sectors. The reduction in the double tax on corporate profits results in a more even taxation of investments across production sectors, a more efficient allocation of capital, and an increase in output.

In addition, when lower taxes on capital income are financed initially by issuing government debt, private investment is crowded out by an increase in government borrowing. Private saving may increase as a result of the tax relief (and may be augmented by capital inflows from abroad), but private investment will generally not increase by the same amount because a portion of the increase in private saving funds the increase in government debt. When the majority of the tax relief is on labor income, the crowding-out effect is even larger and private investment could even decline in the short run. When government purchases decline after the budget window to stabilize the government debt ratio, more private saving is released to fund private investment, although some crowding out of private investment does persist in the long run.

The short-run and long-run effects for all three steps of the permanence proposals under the base case parameters are shown in Table 3 for the two financing assumptions. The results from lowering the dividends and capital gains rates are shown in column (1). Substitution effects dominate when capital gains and dividends rates fall in 2011, and private savings and investment increase in both the short run and long run. The capital stock increases by an average of 0.2 percent from 2011-2016 compared to the baseline and GNP increases by 0.1 percent.²¹ The increase in output is helped by a more efficient allocation of capital that comes from reducing the double taxation of corporate investment. In the long run, the capital stock increases by 1.2 percent, and output increases by 0.4 percent, with a small decline in labor supply of 0.1 percent.

When reductions to the top four ordinary income tax rates are extended as well, crowding out during the budget window is more pronounced and the average increase in the capital stock is just 0.1 percent for the years 2011 through 2016. Domestically funded investment actually declines during this period, but capital inflows from abroad lead to an overall increase in the

²⁰ The reduction in the wage tax rate leads to a shifting from leisure towards labor within a period, while the reduction in the effective capital tax rate leads households to shift leisure and consumption into the future.

²¹ Real gross national product (GNP) is used as the measure of national output. Investment in the domestic economy financed by foreigners would lead to an increase in gross domestic product (GDP), but some of this increase must be returned to the foreign owners of the capital. GNP, which nets out the return to foreign-owned capital more accurately reflects the resources available to U.S. citizens.

capital stock.²² Column (2) of Table 3 also indicates that labor supply increases by 0.7 percent on average from 2011-16 leading to an increase in output of 0.7 percent during the same time period. Domestically funded private investment increases after the budget window as the government debt ratio is stabilized over time by reducing government spending, and in the long run the capital stock increases by 2.3 percent, labor supply increases by 0.2 percent, and output increases by 1.1 percent.²³

In contrast, column (3) shows that when adding the remaining tax relief that increases the deficit with only a small variation in marginal tax rates, then financing government debt more than offsets for the increase in private savings and capital inflows from abroad so that the capital stock declines on average by 0.3 percent from 2011-2016 compared to the initial steady-state, and GNP is only 0.5 percent larger (due to the increase in labor supply of 0.5 percent). Once government spending is reduced to stabilize the government debt ratio, private investment increases so that in the long-run, the capital stock increases by 2.3 percent and output increases by 0.7 percent.

Extending the increase in the child tax credit, the 10-percent marginal tax bracket, and the reduction in marriage tax penalties primarily increase individual after-tax income, but result in very little change in marginal tax rates. Households respond to this rise in income by increasing their consumption of goods and services. Households also consume more leisure, which leads to a long-run decline in labor supply of 0.3 percent through the income effect.²⁴ This decline in labor supply is the primary reason why the long-run increase in GNP is smaller than in the previous simulation. To a lesser extent, the greater crowding out of private investment that results from a higher government debt burden also contributes to this relative decline, as indicated by the decline in domestically financed investment from 2.6 to 2.3 percent. The overall capital stock shows no change between the two simulations due to an offsetting increase in foreign capital flows.

Tax Relief Financed with Future Increase in Taxes

Under this financing assumption, all average and marginal tax rates on labor and capital income are changed by the same proportion in each year after the 10-year budget window in order to maintain the baseline amount of government services and to maintain the government debt-to-GNP ratio at the value it takes at the end of the budget window. In effect, the tax relief is modeled as temporary, as it is more than reversed in the future by across-the-board, proportional tax increases.

²² The rows labeled “Investment” in Table 3 and Table 4 reflect domestically funded gross investment, while the rows labeled “Capital Stock” in Table 3 and Table 4 represent changes in the domestic capital stock regardless of whether the new investment is funded by domestic savings or foreigners.

²³ The long-run change in labor supply for the simulations in this section is small as the substitution effect resulting from higher after-tax wages is offset by an income effect from the household’s increase in lifetime wealth due to the decline in tax payments.

²⁴ As indicated in Table 1, the decline in the average marginal tax rate on labor income is also slightly smaller under the full extension of the tax cuts, compared to when just the top four ordinary rates are decreased. This also contributes to the relative decline in labor supply through the substitution effect.

Again, much of the results can be explained in terms of income and substitution effects. But in this case, as tax rates increase after the budget window, the substitution and income effects discussed above work in opposite directions. Households are forward looking and many of the transitional generations make choices that are influenced by both the tax decreases and the following tax increases. This implies that income effects are less important determinants of behavior during the budget window, and households respond by supplying more labor and savings during this period relative to the simulations discussed above in which future government consumption decreases.

The second set of results reported under column (1) in Table 3 shows the effects of financing the lower dividends and capital gains tax rates with future increases in all income taxes. On net, in the long run this combination of tax relief and tax increases reduces the burden of taxation on corporate investment in favor of greater taxation of labor income and, to a lesser extent, capital income in other sectors. This implies some increase in output resulting from a more efficient allocation of capital across production sectors. These gains are offset to a certain extent in the long run by the crowding out of investment due to a higher government debt ratio and the higher tax rates needed to pay for higher interest payments on the government debt. In the long run, the capital stock increases by 0.7 percent and GNP increases by 0.3 percent (compared to increases of 1.2 percent and 0.4 percent, respectively, when government consumption declines).

The results in column (2) show a similar pattern. Over the budget window, households work more and save more compared to the same tax relief with a government spending offset. Labor supply increases on average by 0.9 percent during 2011-16, rather than 0.7 percent; the capital stock increases by 0.6 percent, rather than 0.1 percent; and GNP increases by 0.9 percent, rather than 0.7 percent. In the long run, the increase in tax rates needed to stabilize the government debt ratio leads to no change in labor supply compared to an increase of 0.2 percent when government spending declines, and the capital stock increases by 0.3 percent compared to 2.3 percent when government spending declines. GNP increases in the long-run by only 0.3 percent, compared to the 1.1 percent increase described above.

Extending all of the tax relief and then financing with an increase in taxes after the budget window leads to short-run effects that are again slightly larger than if a reduction in government consumption is used to finance the revenue cost of the tax decrease. The capital stock increases by 0.6 percent during 2011-16 and GNP increases by 0.8 percent. However, in the long run, the combined effects of increasing marginal tax rates and crowding out lead to a decline in labor supply (0.8 percent), capital (1.8 percent) and GNP (0.9 percent).

Sensitivity Analysis

This section reports the macroeconomic results of the same tax changes and financing assumptions described above with different values for certain parameters that represent “low” and “high” levels of responsiveness.

Lowering the intertemporal elasticity of substitution reduces the degree to which households are willing to substitute consumption and leisure across time, which leads to a lower savings supply response to a decrease in capital taxes. If only dividends and capital gains tax rates are lowered

and financed by future reductions in government spending, the capital stock increases by 0.9 percent in the long-run using the lower parameter values, compared to a 1.2 percent increase using the base case parameters. In the long run, if lower tax rates on dividends and capital gains are extended and financed by reductions in future government spending, GNP increases by 0.3 percent using low parameter values, and by 0.5 percent using the high parameter values.

The choice of parameter values has little influence on the long-run increase in GNP when using future income tax increases to finance extensions of the lower rates on dividends and capital gains. For the low parameter values, GNP increases by 0.2 percent in the long run and for the high parameter values, GNP increases by 0.3 percent, as seen in column (1) of Table 4. The small difference is primarily the result of the parameters having offsetting effects. Lowering the intertemporal elasticity of substitution lowers the savings response, but lowering the intratemporal elasticity of substitution and the initial leisure share of the time endowment dampens the labor supply response and labor supply does not decline as much when future tax rates are increased.

The choice of parameter values has a greater influence when extensions of the lower ordinary tax rates for the top four individual brackets are added to the lower tax rates on dividends and capital gains. The long-run increase in GNP when the tax relief is financed by reducing future government spending ranges from 0.4 percent using the low responsiveness parameters to 1.6 percent using the high responsiveness parameters. When the tax relief is financed by increases in future tax rates, then GNP in the long-run falls by 0.1 percent under the low response parameters and increases by 0.6 percent under the high response parameters.

Similarly, when all of the tax relief is extended and financed by the reduction in future government spending, then long-run GNP increases by only 0.1 percent in the low response case and by 1.2 percent in the high response case. However, when using future income tax increases to pay for the tax relief, then, in both the low response and the high response case, GNP falls by 0.9 percent in the long run. Again, this is the result of lower behavioral response parameters working in offsetting ways when income taxes are raised. Lower intertemporal and intratemporal elasticity of substitutions imply a smaller labor supply response during the budget window and a higher debt-to-GNP ratio at the end of the window which results in larger crowding out effects. This leads to a large decrease in the capital stock (3.6 percent) in the long run. However, the lower labor supply response results in a reduction in labor supply of only 0.4 percent in the long run as future income taxes are increased. In contrast, under the higher response parameter values, the capital stock falls by only 1.3 percent, but labor supply falls by 1.1 percent as labor supply is more sensitive to the long-run increase in marginal tax rates on labor.

6. Conclusion

The analysis presented in the paper suggests that permanently extending the President's tax relief enacted in 2001 and 2003 likely would lead to a long-run increase in the capital stock and an increase in national output in both the short run and the long run. If the revenue cost of that tax relief is offset by reducing future government spending, the increase in output is likely be about 0.7 percent under plausible assumptions. If, instead, the tax relief is extended only through the

end of the budget window (i.e., it is temporary), the tax relief would increase national output in the short run, but long-run output would decline as future tax rates increase.

The analysis also suggests that if only the portions of the President's tax relief that primarily reduce marginal tax rates are extended (i.e., the lower rates on dividends, capital gains and the top four ordinary income brackets), it is likely that output would increase regardless of whether the revenue cost of the relief is financed through a future reduction in government spending or a future increase in tax rates, although the increase would be considerably larger if government consumption is reduced.

References

- Aaronson, Daniel and Eric French. 2002. "The Effects of Progressive Taxation on Labor Supply when Hours and Wages are Jointly Determined." *Federal Reserve Bank of Chicago WP* 2002-22.
- Altig, David, Alan Auerbach, Laurence Kotlikoff, Kent Smetters and Jan Walliser. 2001. "Simulating Fundamental Tax Reform in the United States." *American Economic Review* 91:574-595.
- Auerbach, Alan. 2002. "The Bush Tax Cut and National Saving." *National Tax Journal* 55:387-407.
- Auerbach, Alan. 1996. "Tax Reform, Capital Allocation, Efficiency, and Growth," in *Economic Effects of Fundamental Tax Reform* edited by Henry J. Aaron and William Gale (Brookings Institution Press: Washington, DC): 29-73.
- Auerbach, Alan and Kevin A. Hasset. 2003. "On the Marginal Source of Investment Funds." *Journal of Public Economics* 87:205-232.
- Auerbach, Alan J. and Laurence J. Kotlikoff. 1987. *Dynamic Fiscal Policy* (Cambridge University Press: Cambridge).
- Ball, Laurence, Douglas W. Elmendorf and N. Gregory Mankiw. 1998. "The Deficit Gamble." *Journal of Money, Credit and Banking* 30(4):699-720.
- Bernheim, B. Douglas. 2002. "Taxation and Saving." in *Handbook of Public Economics, Volume 3* edited by Alan Auerbach and Martin Feldstein (Elsevier Science Publishers: Amsterdam).
- Browning, Martin, Lars Peter Hansen, and James J. Heckman. 1999. "Micro Data and General Equilibrium Models." in *Handbook of Macroeconomics, Volume 1A* edited by John Taylor and Michael Woodford (Elsevier: New York).
- Congressional Budget Office. 2004. "Macroeconomic Analysis of a 10 Percent Cut in Income Tax Rates," *Congressional Budget Office Technical Paper Series* 2004-07.
- Congressional Budget Office. 2006. *An Analysis of the President's Budgetary Proposals for Fiscal Year 2007*.
- Cummins, Jason G., Kevin A. Hasset and R. Glenn Hubbard. 1994. "A Reconsideration of Investment Behavior Using Tax Reforms as Natural Experiments." *Brookings Papers on Economic Activity* 2:1-74.
- Diamond, John and George R. Zodrow, 2005. "Description of the Tax Policy Advisers General Equilibrium Model," manuscript, Rice University.

- Elmendorf, Douglas W. 1996. "The Effect of Interest-Rate Changes on Household Saving and Consumption: A Survey." Finance and Economics Discussion Series No. 1996-27 Board of Governors of the Federal Reserve System.
- Engen, Eric, Jane Gravelle and Kent Smetters. 1997. "Dynamic Tax Models: Why they do the things they do." *National Tax Journal* 50:657-682.
- Fullerton, Don and Diane Lim Rogers. 1993. *Who Bears the Lifetime Tax Burden?* (Washington, D.C.: The Brookings Institution).
- Goulder, Lawrence H. 1989. "Tax Policy, Housing Prices and Housing Investment." *Regional Science and Urban Economics* 19:281-304.
- Goulder, Lawrence H. and Lawrence H. Summers. 1989. "Tax Policy, Asset Prices and Growth: A General Equilibrium Approach." *Journal of Public Economics* 38:265-296.
- Goulder, Lawrence H., John Shoven and John Whalley. 1983. "Domestic Tax Policy and the Foreign Sector: The Importance of Alternative Foreign Sector Formulations to Results from a General Equilibrium Tax Analysis Model." in *Simulation Methods in Tax Policy Analysis*, edited by Martin Feldstein (Chicago: University of Chicago Press).
- Hayashi, Fumio. 1982. "Tobin's Marginal q and Average q : A neoclassical Interpretation." *Econometrica* 50:213-224.
- Hurst, Erik, Annamaria Lusardi, Arthur Kennickell, and Francisco Torralba. 2005. "Precautionary Savings and the Importance of Business Owners." *National Bureau of Economic Research Working Paper 11731*.
- Judd, Kenneth L. 2002. "Capital Income Taxation with Imperfect Competition." *American Economic Review* 92:417-421.
- Keuschnigg, Christian. 1990. "Corporate Taxation and Growth: A Dynamic General Equilibrium Simulation Study," in Johann K. Brunner and Hans-Georg Petersen, eds. *Simulation Models in Tax and Transfer Policy* (Campus Verlag) 245-78.
- Lee, Chul-In. 2001. "Finite Sample Bias in IV Estimation of Intertemporal Supply Models: Is the Intertemporal Substitution Elasticity Really Small?" *Review of Economics and Statistics* 83(4):638-646.
- Muthitacharoen, Athiphat and George R. Zodrow, forthcoming. "State and Local Taxation of Business Property: A Small Open Economy Perspective," *Proceedings of the Ninety-Eighth Annual Conference on Taxation*, National Tax Association.
- Rogers, Diane Lim. 1997. "Assessing the Effects of Fundamental Tax Reform With the Fullerton-Rogers General Equilibrium Model," in *Joint Committee on Taxation Tax Modeling Project and 1997 Tax Symposium Papers* (JCS-21-97), pp. 49-82.

Ziliak, James P. and Thomas J. Kniesner. 1999. "Estimating Life-Cycle Labor-Supply Tax Effects." *Journal of Political Economy* 107(2):326-359.

Ziliak, James P. and Thomas J. Kniesner. 2005. "The Effect of Income Taxation on Consumption and Labor Supply." *Journal of Labor Economics* 23(4):769-796.

Zodrow, George R. 1991. "On the 'Traditional' and 'New' Views of Dividend Taxation." *National Tax Journal* 44(4):497-509.

Table 1

Average Percentage Change in Average Marginal Tax Rates by Income Source Compared to Current Law for Years 2011-2016

	(1) Lower Dividends and Capital Gains Tax Rates	(2) (1) Plus Lower Top 4 Ordinary Rates	(3) (2) Plus Remaining Tax Cut Extensions
Wages	0.0%	-5.6%	-5.1%
Dividends	-52.8%	-52.9%	-54.1%
Capital Gains	-21.0%	-23.3%	-23.7%
Interest	0.0%	-7.1%	-8.2%
Business Income*	0.0%	-11.4%	-12.1%

Department of the Treasury
Office of Tax Analysis

* Includes income from IRS Form 1040 Schedules C, E and F

Table 2
Model Parameters

	Baseline	Low	High
Intertemporal substitution elasticity	0.35	0.20	0.50
Intratemporal substitution elasticity (between leisure and goods)	0.80	0.50	1.00
Leisure share of time endowment	0.40	0.30	0.50
Rate of time preference*	0.001	-0.055	0.024
Elasticity of substitution between housing and non-housing good	1.00	0.50	1.50
International capital flow elasticity	0.20	0.20	0.20
Population growth rate	0.01	0.01	0.01
Technological growth rate	0.01	0.01	0.01
Adjustment cost parameter	5.00	5.00	5.00
Capital income share	0.34	0.34	0.34
Capital/output ratio	2.29	2.29	2.29

Department of the Treasury
Office of Tax Analysis

*The rate of time preference was adjusted to maintain the initial capital-output ratio

Table 3

**Macroeconomic Effects of Extending The 2001 and 2003 Tax Cuts with Base Case Parameter Values:
Percentage Change from Initial Steady-State Values**

	(1)		(2)		(3)		
	Lower Dividends and Capital Gains Tax Rates		(1) Plus Lower Top 4 Ordinary Rates		(2) Plus Remaining Tax Cut Extensions		
	2011-2016	Long-run	2011-2016	Long-run	2011-2016	Long-run	
<u>Base Simulation*</u>							
Financed by Decreasing Future Government Consumption							
Real GNP	0.1%	0.4%	0.7%	1.1%	0.5%	0.7%	
Capital Stock	0.2%	1.2%	0.1%	2.3%	-0.3%	2.3%	
Labor Supply	0.0%	-0.1%	0.7%	0.2%	0.5%	-0.3%	
Consumption	0.1%	0.6%	1.1%	2.5%	1.3%	3.5%	
Investment	0.5%	1.6%	-0.5%	2.6%	-3.0%	2.3%	
Financed by Increasing Future Income Taxes							
Real GNP	0.2%	0.3%	0.9%	0.3%	0.8%	-0.9%	
Capital Stock	0.3%	0.7%	0.6%	0.3%	0.6%	-1.8%	
Labor Supply	0.1%	-0.1%	0.9%	0.0%	0.7%	-0.8%	
Consumption	0.0%	0.1%	0.7%	0.4%	0.5%	-0.7%	
Investment	1.1%	1.1%	2.1%	0.5%	1.8%	-2.0%	

Department of the Treasury
Office of Tax Analysis

* Assumes the U.S. is a large open economy with a simple representation of limited international capital flows

Table 4

Macroeconomic Effects of Extending The 2001 and 2003 Tax Cuts with Low and High Degree of Responsiveness: Percentage Change from Initial Steady-State Values*

	(1)		(2)		(3)	
	Lower Dividends and Capital Gains Tax Rates		(1) Plus Lower Top 4 Ordinary Rates		(2) Plus Remaining Tax Cut Extensions	
	2011-2016	Long-run	2011-2016	Long-run	2011-2016	Long-run
<u>Low Responsiveness</u>						
Financed by Decreasing Future Government Consumption						
Real GNP	0.1%	0.3%	0.3%	0.4%	0.1%	0.1%
Capital Stock	0.0%	0.9%	-0.4%	0.8%	-1.1%	0.6%
Labor Supply	0.0%	-0.1%	0.1%	-0.3%	-0.1%	-0.7%
Consumption	0.3%	0.7%	1.5%	2.9%	1.9%	4.0%
Investment	-0.3%	1.1%	-4.4%	0.2%	-7.8%	-0.5%
Financed by Increasing Future Income Taxes						
Real GNP	0.1%	0.2%	0.5%	-0.1%	0.4%	-0.9%
Capital Stock	0.2%	0.4%	0.3%	-1.6%	0.3%	-3.6%
Labor Supply	0.0%	-0.1%	0.4%	-0.1%	0.2%	-0.4%
Consumption	0.0%	0.2%	0.6%	0.5%	0.5%	0.0%
Investment	0.7%	0.6%	0.4%	-2.4%	0.0%	-5.3%
<u>High Responsiveness</u>						
Financed by Decreasing Future Government Consumption						
Real GNP	0.2%	0.5%	1.1%	1.6%	0.9%	1.2%
Capital Stock	0.2%	1.3%	0.5%	3.1%	0.2%	3.1%
Labor Supply	0.1%	0.0%	1.3%	0.7%	1.1%	0.1%
Consumption	0.0%	0.6%	1.2%	2.7%	1.3%	3.4%
Investment	1.0%	1.8%	1.4%	3.6%	-0.2%	3.4%
Financed by Increasing Future Income Taxes						
Real GNP	0.2%	0.3%	1.3%	0.6%	1.1%	-0.9%
Capital Stock	0.3%	0.8%	0.8%	0.9%	0.8%	-1.3%
Labor Supply	0.1%	-0.1%	1.4%	0.2%	1.1%	-1.1%
Consumption	0.0%	0.1%	0.9%	0.5%	0.7%	-1.1%
Investment	1.3%	1.3%	3.1%	1.4%	2.9%	-1.1%

Department of the Treasury
Office of Tax Analysis

* Assumes the U.S. is a large open economy with a simple representation of limited international capital flows

Appendix: Description of the Tax Policy Advisers OLG Model

The model has four production sectors – owner-occupied housing, rental housing, non-corporate non-housing goods and services, and a corporate non-housing goods and services sector. The time path of investment demands in all three sectors is modeled explicitly, taking into account capital stock adjustment costs. On the consumption side, the current tax advantage of owner-occupied housing relative to other assets is taken into account in modeling the demands for the four goods. This section outlines the basic structure of the model, which combines various features from similar and well-known models constructed by Auerbach and Kotlikoff (1987), Goulder and Summers (1989), Goulder (1989), Keuschnigg (1990) and Fullerton and Rogers (1993), with the time path of investment in each production sector calculated to maximize firm value in the presence of convex (quadratic) adjustment costs, following Hayashi (1982). The full details of the model are provided in Diamond and Zodrow (2005).

The Corporate and Non-Corporate Non-Housing Production Sector

In each period s , firms in the corporate and non-corporate production sectors produce output (X_s), which includes all non-housing goods and services, using capital K_s^X and labor L_s^X using a CES production function with an elasticity of substitution in production σ_X and a capital share parameter a_X . Firms are assumed to choose the time path of investment to maximize the present value of firm profits or, equivalently, maximize firm value V_X , net of all taxes. Total taxes in the corporate and non-corporate production sectors in period s , are

$$T_s^X = \tau_{bs}^X \left[p_s^X X_s - w_s L_s^X - f_{FT} I_s^X - \Phi_s^X I_s^X - f_{IT} i_s B_s^X - f_{IT} \delta_{\tau}^X K_{\tau s}^X \right] + (1 - \tau_{bs}^X) \tau_{ps}^X K_s^X,$$

where τ_{bs}^X is the tax rate on business income in sector X, p_s^X is the price of the good in sector X, w_s is the wage rate, I_s^X is gross investment, Φ_s^X are (deductible) adjustment costs per unit of investment, i_s is the before-tax interest rate, B_s^X is total indebtedness, $\delta_{\tau s}^X$ is depreciation for tax purposes, $K_{\tau s}^X$ is the remaining tax basis of the capital stock, τ_{ps}^X is the property tax rate in sector X, with property taxes assumed to be fully deductible against the business income tax, and f_{IT} (f_{FT}) is one under the income tax (consumption tax) and zero otherwise.²⁵ Following Goulder and Summers (1989) and Cummins, Hassett and Hubbard (1994), the adjustment cost function per unit of investment is assumed to be a quadratic function of gross investment per unit of capital

$$\Phi_s \left(\frac{I_s^X}{K_s^X} \right) = \frac{p_s^X (\beta^X / 2) (I_s^X / K_s^X - \mu^X)^2}{I_s^X / K_s^X}$$

²⁵ That is, depreciation and interest expense are deductible under an income tax, while expensing is allowed under a consumption tax with no interest deductions. The property tax on businesses is treated as a tax on capital rather than a benefit tax (Muthitacharoen and Zodrow, forthcoming).

where β^X is the parameter that determines the level of adjustment costs and μ^X is set so that adjustment costs are zero in the steady state.

Assuming firms do not make any financial investments, total net cash receipts, including net new bonds issued, BN_s^X , and net new shares issued (new equity investment in the non-corporate sector) VN_s^X , must either be used to finance new investments (including adjustment costs) or distributed to shareholders

$$[p_s^X X_s - w_s L_s^X - i_s B_s^X] - T_s^X + BN_s^X + VN_s^X = I_s^X (1 + \Phi_s^X) + DIV_s^X,$$

where DIV_s^X is the dividend payout in sector X. Each firm is assumed to maintain a fixed debt/asset ratio b^X and pay out a constant fraction of earnings after taxes and depreciation (the non-corporate firm distributes all net income) in each period. This implies that new investments in the corporate sector are financed with debt and new share issues if retained earnings do not supply enough equity to finance the desired level of investment. New investments in the non-corporate sector are financed with debt and new equity investments since there are no retained earnings in this sector.

The model assumes individual level arbitrage, which implies that the after-tax return to bonds must equal the after-tax return received by the owners of the firm, or

$$(1 - \tau_{bs}^X) i_s = \frac{(1 - \tau_{ds}) DIV_s^X + (1 - \tau_{gs}) (V_{s+1}^X - V_s^X - VN_s^X)}{V_s^X},$$

where τ_{is} is the average marginal personal income tax rate on interest income, τ_{ds} is the average marginal tax rate on dividends, τ_{gs} is the average effective annual accrual tax rate on capital gains $(V_{s+1}^X - V_s^X - VN_s^X)$. Solving this expression for V_s^X , subject to the transversality condition requiring a finite value of the firm, yields

$$V_s^X = \sum_{u=s}^{\infty} \frac{\left[\frac{(1 - \tau_{du})}{(1 - \tau_{gu})} \right] DIV_u^X - VN_u^X}{\prod_{v=s}^u \left[1 + (1 - \tau_{iv}) i_v / (1 - \tau_{gv}) \right]},$$

That is, the value of the firm in the composite good sector equals the present value of all future net distributions to the owners of the firm. The time path of investment that maximizes this expression in the presence of adjustment costs is

$$\frac{I_s^X}{K_s^X} = \frac{q_{s+1}^X - 1 + b^X + f_{FT} \Omega_s^X \tau_{bs} + f_{IT} Z_{s+1}^X}{p_s \beta^X (1 - \tau_{bs} \Omega_s^X)},$$

where q_{s+1}^X is shadow price of additional capital (commonly referred to as ‘marginal q’ which equals the ratio of the market value of a marginal unit of capital to its replacement cost), Ω_s^X is a weighted average of the dividend and capital gains tax rates divided by one minus the capital gains tax rate, and Z_{s+1}^X is the tax savings from accelerated depreciation allowances on future investments.

The relationship between ‘marginal q’ and ‘average q’ (denoted as Q_s^X) is

$$q_s^X = \frac{V_s^X - X_s^X}{K_s^X} = Q_s^X - \frac{X_s^X}{K_s^X}$$

where X_s^X is the value of future depreciation deductions on the existing stock of capital used in the production of the good in sector X.

The Owner-Occupied and Rental Housing Production Sectors

Housing is produced in the owner-occupied and rental housing production sectors where, following Goulder and Summers (1989) and Goulder (1989), rental housing is produced by non-corporate landlords and owner-occupied housing is produced by the owners. The technology used in the production of rental housing (R_s) and owner-occupied housing (O_s) is assumed to be identical – capital and labor combined in a CES production function with an elasticity of substitution in production of σ_H and a capital share parameter of a_H .²⁶ Landlords and owner-occupiers are also assumed to choose time paths of investment to maximize the equivalent of firm value, net of total taxes.

In the case of the rental housing sector, the firm is modeled as a non-corporate firm. This implies that landlords are taxed at the individual level, so total taxes paid are

$$T_s^R = \tau_{bs}^R \left[p_s^R R_s - w_s L_s^R - f_{IT} I_s^R - \Phi_s^R I_s^R - f_{IT} i_s B_s^R - m K_s^R - f_{IT} \delta_\tau^R K_{\tau s}^R \right] + (1 - \tau_{bs}^R) \tau_{ps}^R K_s^R,$$

where τ_{bs}^R is the average marginal tax rate applied to rental housing income,²⁷ m is annual maintenance expenditures per unit of rental housing capital, and the definitions of all other variables are analogous to those in the composite good production sector. Solving the cash flow equation in the rental housing sector for after-tax rents received by landlords S_s^R yields

²⁶ Thus, the producer prices of rental and owner-occupied housing services are identical. However, rental and owner-occupied housing services are not perfect substitutes, so that the mix of rental and owner-occupied housing services changes along the transition path to a new equilibrium.

²⁷ The tax rate on rental housing income is a weighted average of the non-corporate tax rate on landlord profits and the corporate tax rate. The weight is determined by the share of rental housing produced in the corporate sector, which is equal to 10 percent.

$$S_s^R = p_s^R F_s^R(\cdot) - w_s L_s^R - i_s B_s^R - mK_s^R - T_s^R + BN_s^R + E_s^R - I_s^R(1 + \Phi_s^R),$$

where E_s^R is net new equity invested by landlords in the rental housing sector. Individual arbitrage in this case implies

$$(1 - \tau_{is})i_s = \frac{S_s^R + (1 - \tau_{gs})(V_{s+1}^R - V_s^R - E_s^R)}{V_s^R}$$

which can be solved for the value of the rental housing firm

$$V_s^R = \sum_{u=s}^{\infty} \frac{\left[1/(1 - \tau_{gu})\right] S_s^R - E_s^R}{\prod_{v=s}^u \left[1 + (1 - \tau_{iv})i_s / (1 - \tau_{gu})\right]}$$

The time path of investment that maximizes this expression in the presence of adjustment costs is

$$\frac{I_s^R}{K_s^R} = \frac{q_{s+1}^R - \Omega_s^R + b^R \Omega_s^R + f_{FT} \Omega_s^R \tau_{bs}^R + f_{IT} Z_{s+1}^R}{p_s \Omega_s^R \beta^R (1 - \tau_{bs}^R)}.$$

The expression for relationship between ‘marginal q’ and ‘average q’ in the rental housing sector is analogous to that in the composite good sector.

By comparison, in the owner-occupied housing sector, since imputed rents are untaxed and maintenance expenditures are not deductible while mortgage interest and property taxes are deductible, total taxes are

$$T_s^O = -z_s \tau_{is} i_s B_s^O + (1 - z_s \tau_{is}) \tau_{ps}^O K_s^O,$$

where z_s is the fraction of individuals who are itemizers. The flow of (untaxed) imputed rents to owner-occupiers is

$$S_s^O = p_s^O F_s^O - w_s L_s^O - i_s B_s^O - T_s^O - mK_s^O + BN_s^O + E_s^O - I_s^O(1 + \Phi_s^O)$$

The expressions for individual level arbitrage and firm value are analogous to those in the rental housing sector, and investment in the owner-occupied sector is

$$\frac{I_s^O}{K_s^O} = \frac{q_{s+1}^O - \Omega_s^O + b^O \Omega_s^O}{p_s \Omega_s^O \beta^O}.$$

The expression for relationship between ‘marginal q’ and ‘average q’ in the owner-occupied housing sector is analogous to that in the composite good sector.

Individual Behavior

On the individual side, the model has a dynamic overlapping generations framework with fifty-five generations alive at each point in time. There is a representative individual for each generation, who has an economic life span (which begins upon entry into the work force) of fifty-five years, with the first forty-five of those years spent working, and the last ten spent in retirement. Individual tastes are identical so that differences in behavior across generations are due solely to differences in lifetime budget constraints. An individual accumulates assets from the time of “economic birth” that are used to finance both consumption over the life cycle, especially during the retirement period, and the making of bequests. The model follows Fullerton and Rogers (1993) in including a relatively primitive “target model” of bequests, with the real values of bequests assumed to be fixed and thus unaffected by changes in economic conditions, including changes in income.

At any point in time s , the consumer maximizes rest-of-life utility LU_s subject to a lifetime budget constraint that requires the present value of lifetime wealth including inheritances to equal the present value of lifetime consumption including bequests. In particular, an individual of age a at time $s = t$ chooses the time path of consumption of an aggregate consumption good and leisure in each period s to maximize rest-of-life utility

$$LU_s = \frac{\sigma}{\sigma - 1} \sum_{s=t}^{t+54-a} \frac{U_s(a)^{(1-\frac{1}{\sigma})}}{(1+\rho)^{s-t}},$$

where σ is the intertemporal elasticity of substitution, ρ is the pure rate of time preference, and $U_s(a)$ is assumed to be a CES function of consumption of the aggregate consumption good and leisure in period s with an intratemporal elasticity of ε and a leisure share parameter of a_E . The aggregate consumption good is modeled as a CES function of the composite good and aggregate housing services (including a minimum purchase requirement for both goods), with aggregate housing services in turn modeled as CES function of owner-occupied and rental housing services. In addition, as described in detail in Diamond and Zodrow (2005), the model includes a simple social security system, government purchases of the composite good, transfer payments, a hump-backed wage profile over the life cycle, a progressive tax on wage income, and constant average marginal tax rates applied to interest income, dividends, and capital gains. The progressive labor tax uses a quadratic approximation to average and marginal tax rates similar to the method used by Auerbach and Kotlikoff (1987).

International capital flows

Although the focus of the model is on the U.S. domestic economy, it includes a simple representation of international capital flows, which are assumed to respond to differences in after-tax rates of return in the US and the “rest of the world.” This approach represents a compromise between the standard closed economy approach and the alternative of a completely open economy in which international capital is perfectly mobile and the international return to

capital is fixed. Following Goulder, Shoven and Whalley (1983), capital imports (or exports) in period s are governed by the constant elasticity expression

$$\frac{K^W - K_s^F}{K^W} = \left(\frac{r_s^{US}}{r^W} \right)^{\varepsilon_K},$$

where K^W is the fixed rest-of-the-world capital stock,²⁸ r^W is the fixed rest-of-the-world return to capital, r_s^{US} is the return after taxes to capital in the US (given the fixed debt-asset ratio of b), K_s^F is foreign exports of capital to the US in period s , and ε_K is a constant (positive) elasticity that determines the extent of international capital flows in the model. Thus, foreign exports of capital to the US are

$$K_s^F = K^W \left[1 - \left(\frac{r^W}{r_s^{US}} \right)^{\varepsilon_K} \right].$$

For example, if $r_s^{US} > r^W$ as a result of the reform, then the US has positive capital imports in period s ($K_s^F > 0$).

Capital imports are treated as perfect substitutes for domestic capital. Given the level of capital imports in each period, the model is closed simply by assuming that the returns, after US taxes, to foreign capital are included in the aggregate demand for the corporate good and non-corporate goods, in fixed proportions equal to the rate of these two goods in the initial equilibrium. This approach effectively implies that the US is renting capital services from abroad in each period, with foreign capital owners spending an amount equal to their after-tax rents on the two US composite goods so that aggregate demand for the goods equal aggregate supplies for those goods. There is no additional international trade in goods or services in the current version of the model.

Market Equilibrium

All markets are assumed to be perfectly competitive. Market equilibrium in the model requires that total consumer demand, obtained by aggregating the demands of each of the 55 generations alive at any point in time, must equal aggregate supply in each of the four production sectors. In addition, factor demands must equal factor supplies in the labor and capital markets, the total amounts of debt and equity held as individual wealth must equal firm stocks of debt and equity, the government is allowed to finance government spending with tax revenues and government bonds as long as the debt to GNP ratio is constant in the long run, and both individual and firm expectations regarding the time paths of future prices must be satisfied in equilibrium.

²⁸ Note that K^W is fixed within a period, but must increase between each period at a rate equal to the growth rate of the US economy so that a long run equilibrium can be attained.