Abstract - We explore the short-run effects of fiscal policy using simulations of an empirical, rational-expectations, open-economy macromodel developed at the Federal Reserve Board. Based on this model, we find that tax cuts and spending increases generally stimulate economic activity in the short run, contrary to the extreme view that forward-looking financial markets more than offset the direct expansionary impulse of those actions. However, the magnitude of the stimulus is greatly attenuated by the financial-market feedback. For example, a sustained cut in personal income taxes raises output by less than the amount of the tax cut itself, and it likely reduces output (relative to baseline) in the first several years if phased in gradually over time. Our results also show that the estimated stimulus imparted by fiscal policy is sensitive to reasonable variation in the model’s parameters.

INTRODUCTION

Traditional analyses of fiscal policy imply that raising government spending or reducing taxes stimulates economic activity in the short run. However, an alternative view developed by Blanchard (1984) and Branson (1985) emphasizes that such policies also induce responses in capital markets that tend to diminish economic activity. The idea is straightforward: An expectation of larger future budget deficits boosts future short-term interest rates, and these higher future short-term rates boost current long-term interest rates. Higher long-term rates damp business investment and other interest-sensitive spending, offsetting at least part of the direct expansionary effect of the tax cut or spending increase.

This alternative view raises the possibility that purportedly expansionary fiscal policies could actually reduce economic activity in the short run, depending on the time path of the fiscal actions and the degree to which financial markets respond to changes in expected long-run conditions. In the extreme, it might be possible that the traditional recommendation for countercyclical fiscal policy has the opposite of its intended effect, with economic stimulus coming from smaller budget deficits rather than larger ones. Theory alone cannot predict whether the indirect damping effects caused by forward-looking financial markets will more than offset the direct stimulative effects of higher government spending or lower taxes. However, theory suggests that this outcome
is more likely if the fiscal action is phased in over time, because the direct stimulus takes hold only gradually, while the depressing effect of the financial–market reaction occurs immediately.

Economists in several presidential administrations have invoked this logic to argue that seemingly contractionary fiscal policies might spur economic activity in the short run. Nearly twenty years ago, the 1984 Economic Report of the President (pages 40–41) stated that a credible phased-in deficit reduction plan would not hamper near-term economic growth. Almost ten years ago, the 1994 Economic Report of the President (pages 34–38) stated that the deficit reduction package enacted in the preceding year had brought down long-term interest rates and that the “declines in long–term interest rates that have occurred since the 1992 election . . . are more than enough to offset the contractionary effects of this decrease in the structural deficit.”

A number of recent papers have added new empirical evidence on the net stimulative effect of various fiscal actions. For example, Ramey and Shapiro (1998), Edelberg, Eichenbaum, and Fisher (1998), Fatas and Mihov (1999), Blanchard and Perotti (2001), and Mountford and Uhlig (2002) use vector autoregressions in different ways to study the macroeconomic effects of increases in government spending or decreases in taxes. However, the techniques used in these papers cannot distinguish effectively among tax cuts or spending increases with different time patterns or different compositions, in part because they do not control explicitly for expectational effects related to future fiscal policy actions and other factors. Another line of research—including Alesina and Perotti (1997), Giavazzi, Jappelli, and Pagano (2000), and others—has examined case studies of fiscal retrenchments and expansions. Hemming, Kell, and Mahfouz (2000) review the literature on the effectiveness of fiscal policy in stimulating economic activity and conclude that: “The empirical evidence from advanced economies suggests that fiscal multipliers are typically positive but small . . . While there is some evidence of negative fiscal multipliers, . . ., the preconditions for such an outcome cannot be precisely pinned down” (page 3).

In this paper we explore the effects of fiscal policy over a five-year period using simulations of an empirical, rational–expectations, open–economy, structural macromodel developed at the Federal Reserve Board. We examine a variety of fiscal actions: a sustained income–tax cut, a one-time income tax rebate, an investment tax credit, and a sustained increase in government purchases. Our findings are unavoidably sensitive to the specification of the model, so we present results under different assumptions about the sensitivity of consumption to short–run fluctuations in income, the sensitivity of international capital flows to shifts in U.S. interest rates, and other factors. Our results are also conditional on the monetary policy that accompanies the fiscal actions. We assume that the federal funds rate is set according to a simple policy rule under which a fiscal action that successfully stimulates the economy will induce only a modest rise in short–term interest rates. Experimentation with monetary policy rules that are even less responsive in the short run yields essentially the same qualitative conclusions.

1 Elmendorf, Liebman, and Wilcox (2002, pgs. 72–77) review the role played by this alternative view of fiscal policy during early discussions of deficit reduction and economic stimulus in the Clinton administration. Summers (2000) provides the administration’s retrospective view of the effects of fiscal policy in the 1990s.

2 We use the term “sustained” to describe tax cuts or spending increases that last more than ten years. We do not examine fiscal changes that are truly permanent, because these actions—if not accompanied by offsetting budget adjustments—yield long–run movements in the debt–GDP ratio that are extremely large.
Our conclusions can be summarized briefly. First, in our model a sustained cut in personal income taxes provides only a small economic stimulus in the short run, and it reduces output in the longer run relative to baseline. The estimated short-run tax-cut multiplier is well below one (in absolute value) in most of our simulations, suggesting that variations in taxes large enough to generate substantial short-run macroeconomic effects would have large budget consequences, and thus could significantly impede other objectives of tax policy such as efficiency and equity. Second, forward-looking financial markets offset much of the incipient short-run stimulus of a sustained personal income tax cut—roughly half in our example. Indeed, such a tax cut is mildly contractionary if phased in over an extended period, because the indirect damping effect through financial markets slightly precedes the direct stimulus from higher income. This result implies that some back-loaded fiscal expansions may be contractionary, and some back-loaded contractions may be expansionary. Third, a one-time income tax rebate creates a significant initial stimulus if a majority of consumption tracks current income, but very little stimulus if it does not. Fourth, a sustained tax incentive for business investment has little effect on economic activity for about a year but generates substantial stimulus thereafter. Fifth, a sustained increase in government purchases boosts output immediately when the additional outlays occur; the practical import of this finding is tempered by the substantial lags in deciding on changes in spending and then disbursing the funds. Again, these results are sensitive to the specification of the model used in the analysis; alternative specifications might yield different conclusions.

The next section of the paper briefly describes the relevant characteristics of the model we use, and the following section discusses the relationship between budget deficits and interest rates in the model. Two ensuing sections present our simulation results, and a final section concludes.

A FRAMEWORK FOR ANALYSIS

FRB/US is a large-scale, quarterly, econometric model of the U.S. economy, developed at the Federal Reserve Board. The model was designed to accord with economic theory and to fit the data well—both equation-by-equation and for the entire system of equations. As discussed by Brayton, Levin, Tryon, and Williams (1997), the autocorrelations and moments generated by the model line up reasonably well with historical observations, and the dynamics of the model as a whole conform closely with the dynamics of reduced-form vector autoregressions. This combination of empirical fit and theoretical structure makes the FRB/US model an especially useful tool for evaluating the effects of alternative fiscal (and monetary) policies.

For our analysis, a critical feature of the model is that households and firms are forward-looking, and base their decisions on expectations of future income, sales, financial conditions, and so on. The simulations in this paper assume that expectations are formed rationally—that is, in a manner consistent with the structure of the model. However, the presence of adjustment costs implies that households and firms respond only gradually to changes in expectations and other economic factors. As a result, the economy is New Keynesian in the short run (with labor and product markets not always in steady state, and inflation inherently persistent) and neoclassical in the long run (with markets returning to steady-state equilibrium over time). FRB/US is not strictly a dynamic, stochastic, general-equilibrium model, but it is within hailing distance of one.

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3 See Taylor (2000) for other concerns about discretionary countercyclical fiscal policy.
In this paper we simulate the FRB/US model under alternative fiscal policies and compare the outcomes to a baseline in which the economy is in long–run equilibrium. Because the model is essentially linear, the effect of fiscal policy on economic conditions is mostly independent of the economy’s starting point, so the results we report also reflect the impact of fiscal policy during recessions and booms. In the remainder of this section we summarize briefly the aspects of FRB/US that are most relevant to the subject of this paper. General descriptions of the model can be found in Brayton and Tinsley (1996), Brayton, Levin, Tryon, and Williams (1997), Brayton, Mauskopf, Reifschneider, Tinsley, and Williams (1997), and Reifschneider, Tetlow, and Williams (1999); additional information is available upon request.

### Household Spending

Consumer spending on nondurable goods and services in FRB/US follows an error–correction framework in which actual consumption adjusts slowly toward target consumption. Because households are forward–looking, their target consumption depends on perceived permanent income and property wealth. Permanent income includes separate terms for labor income, transfer income, and property income. The formulas for permanent income discount future income 25 percent per year, a value chosen through a grid search to maximize the fit of the consumption equation. This discount rate is much higher than one would find in a standard perfect–foresight lifecycle model, but it is appropriate if households are highly risk averse and face uninsurable income uncertainty. Indeed, Carroll and Summers (1991) and Carroll (2001) note that Friedman’s (1957, 1963) original statement of the permanent income hypothesis used a high discount rate, effectively setting permanent income equal to average expected income over the following half–dozen years.

Owing to various frictions (perhaps habit persistence in part, although this is not modeled explicitly), actual consumer spending adjusts only half of the way toward its target level after one year. Spending also responds to the expected cyclical position of the economy: Higher expected unemployment over the next few years holds down spending today, perhaps because it signals a heightened uncertainty about each household’s future income and thus raises the discount rate applied to it. Lastly, about ten percent of spending is done by households whose consumption equals their income. The overall short–term sensitivity of consumer spending to current income in FRB/US is somewhat larger than ten cents on the dollar, because of the cyclical effect just described and because current income affects permanent income. Still, the estimated response is much smaller than Campbell and Mankiw’s (1989) finding that about half

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4 To be clear, the cyclical position of the economy affects households’ and firms’ behavior, but it does not much affect their reaction to changes in fiscal policy.

5 It is worth stressing that the results reported in this paper are based on the version of FRB/US in place in May 2002. Previous versions of FRB/US would have given somewhat different quantitative answers to the questions posed in this paper; no doubt future versions will as well. These changes in model properties over time are a natural consequence of continued economic research and model development. For example, the original version of FRB/US introduced in 1995 had a simpler supply–side structure than that in place today. This change, coupled with modifications to the international sector and to other equations of the model, has moderated the effect of fiscal policy on long–run real interest rates.

6 Because property wealth enters separately, the inclusion of permanent property income might seem redundant. However, its estimated coefficient is economically and statistically significant. Moreover, because property income equals the after–tax rate of return multiplied by property wealth, its inclusion can be viewed as an indirect way to make consumption depend on the return to saving.
of consumption is done by households who follow the “rule of thumb” of setting consumption equal to income. Some of our simulations raise the effective rule–of–thumb share to 50 percent, making the model’s consumption dynamics similar to those of the Campbell–Mankiw model.

Household outlays for consumer durable goods and housing are derived by assuming that the desired stocks of durables and housing are proportional to overall target consumption, with a proportionality factor that depends on the user cost of those items. User cost incorporates interest rates, relative prices, and (for housing) the tax deductibility of mortgage interest payments. Outlays display accelerator–type behavior, in which spending overshoots its long–run target in order to achieve a more rapid adjustment of the stocks of durables and housing.

Consumer spending on nondurable goods and services does not respond directly to interest rates or the personal tax rate on capital income. However, shifts in interest rates matter for spending indirectly through their effect on wealth and expected property income (factors that help determine the long–run target level of spending). Similarly, changes in capital income taxes matter for spending indirectly through their effect on expected after–tax property income. Through these channels, increases in the after–tax rate of return on saving raise the aggregate private saving rate, all else equal.

**Business Investment**

Businesses in FRB/US determine their investment by maximizing expected profits subject to costly adjustment of the capital stock. The target ratio of capital to output depends on the parameters of the Cobb–Douglas production function and on user cost. The user cost incorporates the cost of financing, the price of capital, the depreciation rate, and the corporate tax system; it does not include personal income taxes, so changes in those taxes in the model do not affect investment directly. Firms’ financing cost is measured as a weighted average of the costs in debt and equity markets; a grid search implies that roughly equal weights optimize the fit of the investment equation. The real cost of debt finance is the tax–adjusted nominal yield on BAA corporate securities less expected inflation; the real cost of equity finance is the nominal yield on Treasury bonds plus an estimated equity premium, less expected inflation.

Because of planning lags, engineering requirements, and other costs of adjustment, business investment depends on both past and expected future values of the target capital–output ratio. The estimated equation implies that about one–sixth of the adjustment of equipment capital to a shock to output or user cost is completed within one year; adjustment of nonresidential structures is considerably slower.

**Government Sector**

The major categories of government spending and taxes vary cyclically in FRB/US around their long–run trends. Transfer payments and tax collections act as automatic stabilizers, while spending on goods and services is estimated to be slightly procyclical.

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7 The estimated business investment equations are derived from a production function that has a Cobb–Douglas structure for labor, energy, and aggregate capital services. The capital services aggregate is a function of four types of capital using a translog approximation that allows for substitution based on relative prices. Because this substitution is driven primarily by secular declines in the relative price of computers, it plays little role in the analysis of fiscal policy, and we simplified the capital equations to Cobb–Douglas for the current paper.

Aggregate Supply, Wages, and Prices

Potential output in FRB/US depends on actual capital services, potential labor input, potential energy input, and trend multifactor productivity. According to FRB/US, trend multifactor productivity is not affected by the fiscal policies we examine, and we also do not consider any changes in potential energy input. However, our results do incorporate the effects of fiscal policy on capital services—through changes in housing and business investment—and on potential labor input—through tax-induced changes in hours worked.

For the version of FRB/US used in this paper, we set the long-run uncompensated elasticity of trend hours worked with respect to (one minus) the marginal tax rate at 0.17, as in Gale and Potter (2002).9 These authors briefly review the very large literature on wages and labor supply, including research on the effect of changes in tax rates. In a nutshell, this literature generally finds a small elasticity of hours worked for men, a somewhat larger elasticity for women working full-time, and an even larger elasticity for women not working full-time who can move along the participation margin as well as the hours margin. Gale and Potter’s aggregate estimate of 0.17 is the weighted average of their chosen elasticities of 0.05 for men, 0.3 for women who work full-time, and 0.8 for other women.10 We assume that households adjust potential labor supply in the same sluggish manner as consumption, so that only half of the distance from the target is closed within one year.

In FRB/US, actual labor input in production depends on firms’ decisions about how much labor to employ. Labor input responds only gradually to movements in potential labor supply and—in keeping with the empirical evidence on labor hoarding during business cycles—to movements in output. In other words, the estimated labor demand and supply equations in the model are consistent with Okun’s law.

In equilibrium, workers are paid the value of their marginal product, and prices are set according to a markup over trend unit labor costs. However, labor contracts and other rigidities slow the speed at which wages and prices adjust to shifts in supply and demand. As a result, cyclical dynamics in FRB/US are consistent with the New Keynesian approach to business cycles.

Monetary Policy and Financial Markets

Our simulations assume that the Federal Reserve sets the federal funds rate in accordance with a simple policy rule of the sort analyzed by Taylor (1993) and others. In particular, we assume that the funds rate is raised above its equilibrium value (defined as the policymaker’s estimate of the equilibrium real rate plus the current rate of inflation) by half of the difference between the actual and target inflation rates, and by half of the percentage difference between actual and potential output.11 This coefficient on the out-

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9 By contrast, in the standard version of FRB/US the wage elasticity of hours supplied is assumed to be zero. This restriction ensures that, in the long run, labor force participation does not rise unchecked in the face of ongoing technological progress that causes the real wage to grow continually over time.

10 Auerbach and Feenberg’s (2000) analysis of federal taxes as automatic stabilizers assumes that the elasticity of labor supply with respect to temporary changes in tax rates is between 0.3 and 1.0, because the income effect is small from a lifetime perspective and because people can substitute their labor supply intertemporally. Our analysis focuses on sustained changes in tax rates to which these arguments do not apply.

11 The policymaker’s estimated equilibrium real interest rate used in our version of the Taylor rule is not fixed, but adjusts gradually over time toward the true equilibrium real interest rate—that is, the value of the real funds rate consistent with stable inflation and the unemployment rate equal to the NAIRU. This gradual learning rule ensures that macroeconomic stability is achieved in the long run, but it prevents the funds rate from jumping upon enactment of fiscal policy that alters the economy’s true equilibrium real rate.
put gap is the one proposed originally by Taylor, but it appears to understate the responsiveness of monetary policy to the output gap during the past decade, which is more consistent with a coefficient of unity. We view the relative restraint of this assumed reaction function as a virtue for this paper, because it allows the short–run effects of alternative fiscal policies to show through more clearly in our results. At the same time, assuming that monetary policy is completely unresponsive to economic conditions would not be reasonable, because the economy would become unstable in the long run. One of our simulations illustrates the effect of a more delayed monetary response.

The markets for bonds, equities, and foreign exchange are forward–looking in FRB/US. As a result, anticipated future values of the federal funds rate influence the current prices and yields on financial assets through standard arbitrage relationships. Long–term interest rates adhere to the expectations theory of the term structure. Yields on Treasury securities equal a weighted average of the expected future funds rate, adjusted for time–varying term premiums that move inversely with the expected cyclical state of the economy. Yields on corporate securities are constructed in a parallel fashion, and rates on home mortgages key off the 10–year Treasury yield.

Equity prices equal the present discounted value of future dividend payments, where the discount rate equals the corporate bond rate plus an equity premium. In the simulations, the equity premium is assumed to be fixed at approximately 2 1/2 percent. Firms have a target dividend–payout ratio and smooth actual dividends through transitory fluctuations in earnings.

The short–run path of the real exchange rate is determined by the condition for uncovered interest parity. This condition implies that, apart from risk, if the expected yield on a dollar–denominated bond is higher than the yield on a bond denominated in a foreign currency, investors will hold the foreign bond only if the dollar is expected to depreciate enough to equate the two yields when measured in a common currency. The long–run value of the dollar is determined by purchasing power parity. Therefore, when domestic interest rates rise relative to foreign rates, the dollar immediately appreciates to ensure the requisite amount of future depreciation and the same long–run exchange rate. FRB/US assumes that the duration of the average bond is six years, so a 1 percentage point increase in the spread between domestic and foreign long–term interest rates causes a 6 percent appreciation of the dollar, all else equal. The value of the dollar is also influenced by the ratio of net foreign assets to GDP, acting as a proxy for country risk. In the long run, this relationship implies that domestic real interest rates equal foreign real interest rates plus a premium, where the magnitude of the premium depends on U.S. for-

12 The FRB/US formulas for the cost of capital and the valuation of equities are based on the traditional view of dividend taxation, in which such taxation represents a marginal burden on business investment. Under this view, a reduction in the personal income tax rate has no effect on equity valuation but pushes down the cost of capital (see Poterba and Summers, 1985). An alternative, so–called “new,” view of dividend taxation asserts that dividend taxes are capitalized into the value of equities and do not affect the marginal incentive to invest. Under this view, a reduction in the personal income tax rate raises equity values but affects the incentive to invest only in the short run (see Auerbach, 1979, Bradford, 1981, and King, 1977). Analysts remain divided on which of these perspectives—or some other perspective—is correct. Adopting the “new” view of dividend taxation in FRB/US would likely have little effect on our qualitative conclusions. For example, the first simulation reported below induces a 10 percent drop in equity prices; the formula and parameters in Auerbach (1996) imply that this drop would be about 8 1/2 percent under the new view.

13 This statement and the FRB/US equation for uncovered interest parity ignore the effects of taxes. Those effects are very complex and, under some reasonable assumptions, of second–order importance.
Eign indebtedness. The model also includes a foreign sector that accounts for movements in the output gap, interest rates, and inflation rates of our major trading partners.

**International Trade and Capital Flows**

Exports of goods and services in FRB/US depend primarily on foreign GDP, the exchange rate, and relative price levels; imports are a function of domestic GDP, the exchange rate, and relative price levels. The elasticities of both exports and imports with respect to the exchange rate and relative prices are estimated to be 0.7. These elasticities apply to trade in goods and services together; because services are less price sensitive, the corresponding implicit elasticities for trade in goods (merchandise trade) are close to unity. This figure roughly matches the average elasticity for merchandise imports and exports estimated by Hooper, Johnson, and Marquez (1998), as well as the elasticities those authors report from two earlier “representative studies” (Cline, 1989; and Marquez, 1990).

The sum of net exports and net investment income from abroad (the balance in the current account) is, as a matter of accounting, exactly equal to net foreign investment. Note that net foreign investment equals investment by domestic residents in other countries less domestic investment undertaken by foreign residents, so it is the negative of the net capital inflow from abroad in the balance of payments. Thus, any change in the net capital inflow is mirrored by equal-sized changes in net exports and net investment income. If an increase in budget deficits gives rise to larger capital inflows that help finance government borrowing, net exports must decline by the same amount.

An important uncertainty for the present analysis is the responsiveness of international capital flows to changes in fiscal policy. Because an increase in the capital inflow goes hand-in-hand with a decrease in net exports, we can restate this uncertainty about capital flows as uncertainty about two factors: the response of the real exchange rate, and the elasticity of exports and imports with respect to the real exchange rate. If we maintain our assumption that the value of the dollar is determined by uncovered interest parity in the short run and purchasing power parity in the long run, then a greater net capital inflow can occur only with greater price elasticities for exports and imports. Therefore, one of our simulations assumes that the price elasticities of exports and imports are twice as large as in the standard FRB/US specification—values that are above the upper end of the range of estimates found by previous researchers. Alternatively, we could drop our assumption about uncovered interest parity and purchasing power parity, allowing fiscal policy to permanently alter the value of the dollar. In this case, a greater net capital inflow would be consistent with the model’s baseline price elasticities for imports and exports, as long as the dollar appreciated substantially in the short run and did not revert to its original level even after several decades. However, the ongoing capital flows that would occur under this scenario would leave foreign portfolios with a rising share of dollar-denominated assets; such a combination of dollar appreciation and a sustained increase in foreign indebtedness seems unlikely on both logical and empirical grounds, as we explain in the next section, so we do not pursue it further.

**FISCAL POLICY AND FINANCIAL MARKETS**

In the simulations we present below, an increase in the government budget deficit owing to lower taxes or higher government spending leads to higher interest rates, all else equal. This connection will not surprise most readers, but neither is
it universally accepted, so we think that the subject merits discussion.

We begin with some national income accounting identities. Let $Y$ denote national income, $C$ private consumption, $S$ private saving, and $T$ taxes less government transfer payments. The private sector’s budget constraint implies that: $Y = C + S + T$. National income also equals national output, which can be divided into four types of spending: $Y = C + I + G + NX$, where $I$ is domestic investment, $G$ is government purchases of goods and services, and $NX$ is net exports of goods and services. Balance in the international accounts requires: $NX = NFI$, where $NFI$ is net foreign investment. Combining these identities yields an expression for equilibrium in the market for loanable funds: $S + (T - G) = I + NFI$, where the left side shows national saving as the sum of private and public saving, and the right side shows the uses of these saved funds for investment at home and abroad.

Now consider the effect of a reduction in taxes. Unless the resulting drop in public saving is entirely offset by higher private saving and lower net foreign investment (that is, larger capital inflows), domestic investment must decline. Achieving the decline in domestic investment requires a higher interest rate. In other words, a budget deficit that is not entirely offset by higher private saving and larger net inflows of foreign capital will raise the interest rate that equilibrates saving and investment. The key issue, then, is the size of these offsets. The FRB/US specification is consistent with our reading of the voluminous empirical evidence in these areas: Both offsets are substantial, but they are far from complete.

Private saving is likely to increase in response to a larger budget deficit because forward-looking consumers realize that additional government debt will force higher future taxes. In an extreme case, households will save the entire tax cut to meet their upcoming tax liability, and national saving will be unchanged (Barro, 1974). Elmendorf and Mankiw (1999) review the theoretical and empirical debate over the Ricardian equivalence proposition and conclude that “a substantial fraction of households probably do not behave as the proposition assumes” (page 1654). In particular, they argue that consumption is not smoothed over time nearly as much as would be required for Ricardian equivalence (or even the basic lifecycle model) to hold. For evidence on this point, see Campbell and Mankiw (1989), Carroll and Summers (1991), Parker (1999), Souleles (1999), Wilcox (1989), and the survey by Browning and Lusardi (1996).

Net capital inflows are also likely to increase in response to a larger budget deficit, but by less than one might expect in a world where many countries allow capital to move freely across their borders. Although gross capital flows are large, the empirical evidence shows that capital mobility on a net basis is limited, perhaps because of asymmetric information or risk diversification. One form of evidence is the high correlation between domestic saving and domestic investment, documented by Feldstein and Horioka (1980), Obstfeld and Rogoff (2000), and others. Confirming evidence comes from significant differences in real interest rates across countries (Mishkin, 1984, and Cumby and Mishkin, 1986) and from the heavy concentration of individual portfolios in domestic securities (French and Poterba, 1991).

Elmendorf and Liebman (2000) conclude from this set of research that a one-dollar increase in the budget deficit might generate a 25-cent increase in private saving, and that the resulting 75-cent de-

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14 Mussa and Goldstein (1993), Gordon and Bovenberg (1996), and Obstfeld and Rogoff (2000) review the evidence regarding international capital mobility and discuss a number of explanations for the observed immobility.
crease in national saving might generate a 25–cent increase in the net inflow of capital; altogether, this leaves a 50–cent decrease in domestic investment. Recent analyses by the Congressional Budget Office (CBO, 1997 and 1999) assume that the increase in private saving would be 40 cents and that the drop in domestic investment would be only about 35 cents. In FRB/US, a one–dollar increase in the budget deficit increases private saving by roughly 50 cents after several years, and raises net capital inflows by about 35 cents, leaving only a 15–cent drop in domestic investment. Thus, the amount by which budget deficits crowd out domestic investment in FRB/US is considerably smaller than the amount assumed in some other analyses.

It bears emphasis that larger responses of private saving and international capital flows to higher budget deficits will trim the effect of deficits on interest rates, but may also diminish the stimulative effect of deficits on the economy as a whole. Large responses do imply that less domestic investment is crowded out than otherwise—but they also imply that consumption rises by less and net exports fall by more. We explore these issues in the simulations below.

Notwithstanding the indirect evidence discussed earlier in this section, direct evidence for the proposition that larger budget deficits lead to higher interest rates is admittedly weak. Indeed, Elmendorf and Mankiw summarize the research on reduced–form relationships between these variables by stating that “it has typically supported the Ricardian view that budget deficits have no effect on interest rates” (page 1658). How does one reconcile this (lack of) reduced–form evidence with the indirect evidence on household behavior and capital mobility that implies a strong connection between deficits and interest rates? Elmendorf and Mankiw argue that the reduced–form literature: “. . . is ultimately not very informative. Examined carefully, the results are simply too hard to swallow, for three reasons. First, the estimated effects of policy variables are often not robust to changes in sample period or specification. Second, the measures of expectations included in the regressions generally explain only a small part of the total variation in interest rates . . . Third, [these papers often] cannot reject the hypothesis that government spending, budget deficits, and monetary policy have no effect on interest rates . . . These findings suggest that this framework has little power to measure the true effects of policy” (page 1658).

Uncovering the effect of fiscal policy on interest rates is difficult because so many economic variables affect those rates. Elmendorf and Mankiw emphasize:

“Interest rates depend on expectations of fiscal policy and other variables, and those expectations are hard to measure. A number of studies use forecasts from vector autoregressions as a proxy for expectations, [which] assumes that variables follow a stable time–series process and do not incorporate non–quantitative information . . . Measurement error in the proxies for expectations biases the estimated coefficients toward zero and, thus, toward the null hypothesis of Ricardian equivalence” (page 1657).

In sum, we think that the positive response of interest rates to increases in future budget deficits displayed in FRB/US (all else equal) is an unsurprising and positive aspect of the model.

EFFECTS OF A SUSTAINED CUT IN PERSONAL INCOME TAXES

In this section we consider the effects of a sustained (but not completely permanent) cut in personal income taxes under a variety of different assumptions; these alternatives highlight the channels
through which fiscal policy operates and illustrate the effect of variations in the model. The baseline for all of the simulations is the economy in steady-state equilibrium, and all variables are described and shown in terms of changes relative to that baseline; for concreteness, we label the initial period for the policies as the first quarter of 2002. Except when noted, we assume that the policy we describe is perfectly credible to households, businesses, and financial–market participants. This assumption is an important one, and allowing policies to win credibility only gradually would be an interesting topic for future research.

**Standard FRB/US Specification**

We assume that tax rates are cut by enough to reduce federal personal income taxes by 1 percent of GDP, or roughly $100 billion in 2002, under static assumptions about the tax base. This reduction amounts to slightly more than a 10 percent cut in the average federal income tax rate. We further assume that the tax cut stems from a proportional reduction in marginal tax rates across the income distribution, so that all workers experience roughly a 10 percent drop in their marginal tax rates. Of course, this assumption strengthens the labor–supply effect relative to more realistic alternatives in which part or all of the tax cut arises from inframarginal changes. We leave the tax cut in place for ten years, at the end of which the debt–GDP ratio (incorporating the extra debt owing to higher interest costs) is higher by about 13 percentage points.

The tax rate then rises gradually—first to hold the increase in the budget deficit relative to baseline at 2 percent of GDP for several years, and then to return the budget to balance. This policy causes the debt–GDP ratio to peak at 25 percentage points above the baseline after 20 years, an increment that roughly matches the increase in this ratio between 1980 and 1993.

The macroeconomic effects of this policy are summarized in Figure 1 and the top part of Table 1. (Additional results for this simulation and the subsequent ones are provided in appendix tables available from the authors upon request.) The top left panel of the figure shows the federal budget surplus as a percent of GDP between 2001 and 2006. The top right panel shows that the federal funds rate inches up over time. The same panel shows that the 10–year Treasury yield jumps up when the tax cut is announced, anticipating future increases in the funds rate—which occur largely after 2006 and therefore do not appear in this figure. The middle left panel shows that equity prices drop nearly 10 percent when the tax cut is announced, owing to both a higher discount rate on future dividends (because of higher interest rates) and lower expected dividends (because of the decline in business investment). The middle right panel shows that real consumption increases, as the effect of the tax cut on permanent income more than offsets the effect of lower wealth, and that real investment is crowded out by higher real interest rates.

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15 CBO (2001) reports that the average marginal tax rate on wages and salaries is 24 percent. Combined with a social insurance tax rate of roughly 15 percent (combined employer and employee share) and a state and local income tax rate of 5 percent, the increase in the after–tax wage stemming from the assumed cut in the federal marginal rate equals: $((1 – .05 – .15 – .213)/(1 – .05 – .15 – .24)) – 1 = 4.8 percent. With our assumed elasticity of labor supply equal to 0.17, this tax cut would induce an increase in potential labor supply of roughly 0.8 percent and an increase in potential GDP of about 0.5 percent.

16 Allowing the tax cut to persist for several additional decades would not appreciably alter the short–run response of the economy to the policy change.

17 Those future funds–rate increases owe to two factors: a rise in the equilibrium real rate over the following fifteen years that is implied by the relative effect of fiscal policy on aggregate demand and aggregate supply; and a somewhat higher average rate of inflation going forward.
The bottom left panel of the figure shows that the level of potential real GDP increases about one-half percent over two years, with the additional labor supply partly offset by diminished capital services due to weaker investment. Actual real GDP rises not quite one-half percent after a year, and is aligned quite closely with potential GDP after a couple of years.

The bottom right panel shows that the unemployment rate dips about one-tenth percentage point within a few quarters, because the increased labor demand from higher current and expected future output more than offsets the increased labor
supply from lower marginal tax rates. The inflation rate drifts up slightly owing to expectations of lower unemployment in the future.

The top part of Table 1 presents the changes in saving and investment under this scenario. Looking at the values for 2006, one can see that private saving increases by about 50 percent of the drop in public saving (.71/–1.38), and that international capital flows offset about 70 percent of the drop in national saving (–.49/[.71–1.38]). Altogether, domestic investment falls by about 15 percent of the increase in the budget deficit.

Figure 2 summarizes the long-run effect of this tax cut. Over time, the reduction in capital services increases in magnitude, and the labor supply effect turns negative because higher taxes are needed to service the additional debt while balancing the budget. As a result, potential GDP falls below baseline after about 15 years, and actual GDP falls with it.

In sum, simulating the FRB/US model suggests that a sustained tax cut reduces output in the long run and raises output by less than 50 cents per dollar of tax reduction in the short run. The fact that the multiplier is relatively small is arguably not an important concern: As long as the

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In this and other simulations that include a labor supply response to fiscal policy, the unemployment rate is pushed up initially by the lags in firms’ decisions to hire newly available workers. To the extent that greater labor supply makes the unemployment rate higher than it would otherwise be, that increment should not be interpreted as a harmful effect of the policy. On the contrary, reducing the disincentive to work presumably increases economic efficiency and (all else equal) well-being, even if the additional labor supply becomes employed only gradually.
multiplier has the customary sign, any desired amount of economic stimulus could still be generated by a sufficiently large tax cut. However, tax policy aims to achieve multiple objectives in addition to macroeconomic stabilization—such as efficiency and equity, both within and across cohorts. These goals may be adversely affected by substantial changes in taxes, especially if such changes are prompted by cyclical developments that are difficult to predict in advance. Therefore, if macroeconomic stabilization requires large, unpredictable swings in taxes, fiscal policy is relatively less attractive as a stabilizing tool.

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* deviation from baseline, expressed as a percent of GDP
** percent deviation from baseline
*** deviation from baseline, expressed in percentage points
**Gradual Financial-Market Response**

A principal motivation for this paper is the argument that forward-looking financial markets undo much of the putative stimulative effect of lower taxes or higher spending. To illustrate the effect of forward-looking financial markets, our second simulation assumes that long-term interest rates do not jump up when the tax cut is introduced, but converge gradually (at a rate of 10 percent per quarter) toward the values consistent with future short-term interest rates. Equity prices and the value of the dollar converge to their fully rational values at a similarly slow speed. All other expectational variables are the same as in our first simulation, so this scenario embodies the improbable combination of myopic investors and fully rational households and firms; however, we emphasize that this simulation is not intended as a realistic possibility, but as an artificial experiment to quantify the importance of forward-looking financial markets to our previous result.

Figure 3 presents the results of this simulation. GDP rises by nearly 1 percent after a year, compared with less than one-half percent when financial markets are forward-looking. By this metric, the forward-looking nature of financial markets offsets roughly 50 percent of the incipient stimulative effect of this tax cut. Because the boom in output is substantially larger than the slight gain in potential output, the unemployment rate falls nearly half a percentage point, and inflation picks up a bit. The federal funds rate rises about 1 percentage point in response to the increase in inflation and the increase in actual output in excess of potential GDP.

An alternative type of “gradual response” is one by which monetary policy reacts to economic developments with a substantial lag. However, when we repeat our first simulation holding the federal funds rate fixed for two years, and set according to the Taylor rule thereafter, we find essentially no difference in the effect of the tax cut on real GDP. The key point is that financial-market participants are assumed to understand that the funds rate will eventually be raised, so long-term interest rates increase immediately and by roughly as much as in the first simulation. Thus, the speed of the monetary policy reaction is less important than the speed of realization by financial markets that a reaction will ultimately ensue.

Circumstances may arise under which this anticipatory bond-market response would not operate in the usual manner. In particular, if short-term interest rates are expected to remain at zero for a prolonged period—perhaps the current situation in Japan—then stimulative fiscal actions may not produce the standard increase in bond yields. Thus, extreme conditions exist under which monetary policy becomes relatively ineffective as a stabilization tool, and fiscal policy proves more useful. For further discussion of this issue, see Reifschneider and Williams (2000) and Clouse, Henderson, Orphanides, Small, and Tinsley (2000).

**Holding Potential Output Fixed**

Analyses of countercyclical fiscal policy generally focus on the effects of policy on aggregate demand and do not consider their effects on aggregate supply. A notable exception is Auerbach and Feenberg (2000), who argue that the stabilizing effect of the progressive income tax operating through a wage-responsive supply of labor may be as important quantitatively as its traditional stabilizing effect through aggregate demand. In particular, Auerbach and Feenberg estimate that a cyclical decline in income reduces marginal tax rates sufficiently to induce a marked temporary increase in labor supply. To illustrate the impact on our results of changes in aggregate supply, our fourth simulation holds potential output fixed.
Figure 4 shows that real GDP rises about one-tenth of a percent in the first quarter and then returns to baseline within several years, compared with a more sustained pickup closer to one-half percent in our first simulation. Thus, the response of aggregate supply—labor supply, in particular—accounts for more than half of the total stimulative effect of the tax cut. Recall, however, that our assumed tax cut stems entirely from a reduction in marginal tax rates; if we had assumed some reduction in the inframarginal tax burden instead, the total stimulative effect of the tax cut would be smaller, and the share stemming from changes in labor supply would be smaller as well.
More Rule–of–Thumb Consumption

The next simulation substantially increases the sensitivity of consumer spending to current income. Under the baseline FRB/US specification, a one–dollar permanent shock to income raises spending by about 20 cents initially; under this alternative specification, the same shock boosts spending by about 50 cents, in line with Campbell and Mankiw’s (1989) estimate of the share of consumption done by rule–of–thumb consumers.

Figure 5 shows that the tax cut provides a larger boost to economic activity under these conditions. Compared with the first simulation, consumption naturally rises more abruptly, and investment boosts spending by about 50 cents, in line with Campbell and Mankiw’s (1989) estimate of the share of consumption done by rule–of–thumb consumers.
falls by about the same amount. Thus, real GDP now increases over three-quarters of a percent after several quarters, compared with less than one-half percent in the first simulation, and the unemployment rate falls about three-tenths of a percentage point, compared with one-tenth in the first simulation. The second part of Table 1 shows that private saving rises much less during the first year than under the standard model, but increases roughly in line with the standard model in subsequent years. All told, the short-run impact of the tax cut is still fairly small, with a multiplier less than one.
**Greater Reaction of International Capital Flows**

The next simulation increases the net inflow of foreign capital in response to the tax cut. As described earlier, we model this greater reaction by doubling the price elasticity of exports and imports. The third part of Table 1 shows that international capital inflows offset nearly 100 percent of the drop in national saving (\(-\frac{.72}{.50 - 1.30}\)) in this scenario.

Figure 6 shows that the ten–year Treasury yield initially rises less than 10 basis points in this simulation, compared with about 25 basis points in the first simulation; most of this small increase reflects an uptick in expected average inflation over the next ten years. Because real interest rates are barely changed, so is investment. However, the larger capital inflow requires a larger decline in net exports; relative to the first simulation, more of the increase in consumption demand is satisfied by foreign production, and less by a shift in domestic production from investment goods to consumption goods. Net exports respond gradually to movements in the exchange rate, and therefore decline less than consumption rises; on balance, real GDP rises a little more than half a percent after a year, a slightly larger effect than in the first simulation. Yet, the short–run effect of the tax cut is again small, with a multiplier of roughly one–half.

**EFFECTS OF ALTERNATIVE FISCAL POLICIES**

In this section, we consider the effects of several alternative fiscal policies: a phased–in personal income tax cut, a one–time personal tax rebate, a tax incentive for business investment, and an increase in government spending.

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19 We assume that households do not substitute their desired labor supply intertemporally. Therefore, their labor supply in the early years of the tax cut is boosted by the reduction in marginal tax rates that has already occurred, but it is not affected by the further declines in marginal rates ahead.

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**A Phased–In Personal Income Tax Cut**

We turn first to the sustained cut in personal income taxes examined in the previous simulations, but assume now that it occurs in ten equal annual increments starting in 2002 rather than occurring all at once. We also assume that the full policy is perfectly credible from the beginning to households, businesses, and financial–market participants; all of the other assumptions are identical to the first simulation.

Figure 7 shows that this phased–in tax cut slightly reduces real GDP for several years. The direct stimulus of lower taxes is delayed: Households discount expected future income at a high rate, so tax reductions more than a few years away have only a modest effect on current consumption, all else equal. Financial markets do not discount the future as heavily, so the damping influences of higher interest rates and lower equity prices affect the economy immediately. The opposing influences of higher after–tax income and lower wealth leave consumption little changed for the first three or four years, while investment falls noticeably from the start. Not until 2006, when half of the full tax cut is in place, does aggregate demand rise above its baseline value.

**One–Time Personal Tax Rebate**

We now turn to the effects of a one–time $100 billion rebate on personal income taxes—an amount roughly equal to the first year of the sustained tax reduction, but paid out in one quarter. This rebate is assumed to involve no change in marginal tax rates and thus induce no change in labor supply.

Figure 8 shows that this policy boosts consumption by about one–half percent in the quarter when the rebate is issued, compared with a rebate equal to 4 percent
of GDP on an annualized basis in that quarter. The rebate has virtually no effect on consumption in subsequent quarters. For the vast majority of households in FRB/US whose consumption responds gradually to changes in permanent income, spending barely reacts to the rebate at all; for the small minority of households who set consumption equal to current income, spending jumps in the quarter of the rebate and recedes in the next quarter. Long–term interest rates and investment hardly budge. As a result, GDP is about 0.3 percent higher in the quarter when the rebate is issued and virtually unchanged in subsequent quarters.

Figure 6. Effect of a Sustained Cut in Personal Income Taxes with Greater Reaction of International Capital Flows
Figure 9 presents the effects of the same policy under the alternative specification that about half of consumption is done by rule-of-thumb consumers, who are assumed to consume their entire rebate within two quarters. As one would expect, the tax rebate has a much larger effect on consumption and output under these circumstances. Investment rises a bit through an accelerator effect and then drops slightly below baseline. GDP is more than 1 percent higher for the first half year, then below baseline for about two years, and back at baseline thereafter. The unemployment rate follows the opposite pattern: it is down nearly half a percentage point initially, above baseline for a while, and then back at baseline. This
oscillation of output and unemployment stems from the lagged effects of the increase in the federal funds rate induced by the initial surge in output.

In sum, a tax rebate appears to impart a substantial short-run stimulus to the economy if a significant share of households spend the money. How households actually respond to temporary tax cuts is unclear. Shapiro and Slemrod (2001) report that only a fifth of households in the Michigan Survey Research Center’s Survey of Consumers said that they expected to spend last year’s tax rebate. However, one wonders whether the drumbeat of national exhortation to increase saving
had persuaded households that saving the rebate was the “right” thing to do, leading them to respond to the question more in line with their aspirations than their behavior. In any event, a number of studies find that consumption is substantially more sensitive to current income than the basic lifecycle model predicts, as noted above. Some studies suggest in particular that households have a fairly high propensity to consume out of transitory tax changes: Shapiro and Slemrod (1995) find that about 40 percent of households planned to spend the extra cash flow from the 1992 change in tax withholding (but not tax liability), and Souleles (1999) esti-
mates that between one-third and two-thirds of every dollar of tax refund is spent within one quarter. On the other hand, analyses of aggregate consumption following the 1975 tax rebate (Blinder, 1981; Modigliani and Steindel, 1977; and Poterba, 1988) find somewhat smaller initial effects of the rebate on consumption.

**Figure 10.** Effect of a 10 Percent Investment Tax Credit on Equipment and Software

* Federal Budget Surplus *

* Interest Rates ***

* Equity Prices **

* Real Consumption and Investment **

* Actual and Potential Real GDP **

* Unemployment and Inflation ***

* deviation from baseline, expressed as a percent of GDP

** percent deviation from baseline

*** deviation from baseline, expressed in percentage points

**Tax Incentive for Business Investment**

An alternative tax change often considered as a short-run economic stimulus is a tax incentive for business investment. Our next simulation shows the macroeconomic effects of granting a 10 percent investment tax credit (ITC) on equipment and software. We assume that the ITC re-
mains in place for a sustained period and that all economic agents believe that to be true. Clearly, these are limiting assumptions. The magnitude of our simulated ITC is consistent with U.S. tax policy between the mid–1970s and mid–1980s; it reduces the user cost of equipment capital by roughly 14 percent.

Figure 10 shows that a credible, sustained investment tax credit provides a

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20 Our original intention in this study was to include an analysis of a temporary ITC as well, but incorporating the effects of temporary tax policies on the user cost of capital and business investment turned out to be more difficult than we had anticipated. The root of the problem is that the effect of temporary tax incentives has not
substantial stimulus to economic activity—but with a lag of several quarters. The explanation for this lag is simply that adjustment costs make investment respond only slowly to the jump in the desired long-run capital stock caused by the ITC. Meanwhile, financial markets foresee the coming increase in real GDP and acceleration of inflation, and they anticipate a significant increase in the federal funds rate; as a result, long-term interest rates rise immediately by more than one percentage point. Equity prices drop 15 percent, because the effect of higher future dividends (stemming from lower corporate taxes and higher investment) is more than offset by the effect of the higher interest rates used to discount those dividends. The fourth part of Table 1 shows that the increase in investment is financed by a much larger inflow of foreign capital than in our other simulations.

**Increase in Government Spending**

Our final simulation examines the effects of a sustained increase in federal purchases equal to 1 percent of GDP. Figure 11 shows that this policy raises GDP by nearly one percentage point during the first several quarters, compared with a boost to GDP of less than one-half percentage point from the same-sized reduction in personal income taxes shown in Figure 1. Changes in government spending have a larger stimulative effect than changes in taxes because a sizable share of each dollar of lower taxes goes to private saving, whereas each dollar of additional government spending boosts aggregate spending by the full dollar. Consumption falls below baseline in this scenario, and investment drops more sharply than in the first simulation.

These results would appear to suggest that an increase in government outlays is an effective way to stimulate the economy in the short run. However, our calculations ignore a key practical question, which is the speed at which outlays can be increased. Passing appropriations bills takes time, and disbursing additional appropriated funds can take even longer, depending on the type of spending being considered. Thus, a comparison of Figures 1 and 10 may overstate the advantage of higher spending relative to lower taxes as a short-run stimulus.

**CONCLUSION**

Using an empirical, open-economy, rational-expectations macromodel, we examined the short-run effects of a variety of fiscal policies. We found that tax cuts and spending increases generally stimulate economic activity in the short run, contrary to the extreme view that forward-looking financial markets more than offset the direct expansionary impulse of those actions. However, the magnitude of the stimulus is greatly attenuated by the financial-market feedback, and many policies have little net effect on output in the short run. For example, a sustained cut in personal income taxes raises real GDP by less than the amount of the tax cut itself, and it likely reduces GDP if phased in gradually over time. A tax rebate boosts the economy to a noticeable extent only if a significant share of consumption tracks current income, and a sustained tax incentive for business investment boosts the economy to a significant degree only after several quarters. A sustained increase in government purchases raise output quickly, with a multiplier close to one, but may be difficult to implement within a few quarters.

been fully resolved, although work on this problem is ongoing (Cohen, Hansen, and Hassett, 2002). We would also have liked to analyze the effects of imperfect credibility, because the history of U.S. tax policy shows that permanent investment incentives do not exist. However, this analysis too would have required a persuasive, empirically-based model of the effect of temporary investment incentives, which FRB/US does not presently include.

21 See Congressional Budget Office (2002) for a discussion of the relative stimulus provided by various other tax policies.
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