Has Fiscal Policy Helped Stabilize the Postwar U.S. Economy?

John Bailey Jones
Department of Economics
University at Albany
State University of New York
jbjones@csc.albany.edu

Initial Draft: October 9, 1997
Current Draft: June 6, 2001

Abstract

In this paper, I consider whether postwar fiscal policy has helped stabilize the U.S. economy. I do this by adding to the stochastic growth model fiscal policy feedback rules estimated from postwar data. These rules allow fiscal policies to respond to current and lagged output and labor hours. I use the estimated policy rules to see if postwar fiscal policy reduces output volatility and/or lengthens expansions and shortens recessions. I find that fiscal policy in general provides little stability on either count. I also find that the endogenous feedback links, by themselves, can provide some stabilization.

JEL Classification: E32, E62.

This paper extends and substantially revises the third chapter of my dissertation. I am grateful to Stanislav Anatolyev, Peter Arcidiacono, Kim-Sau Chung, Betty Daniel, Eric French, Eric Leeper, Jonathan Parker, Kenneth West, Christopher Wheeler and participants at several seminars for comments and suggestions. Paul Söderlind graciously provided GAUSS translations of several LAPACK routines. Comments from editor Martin Eichenbaum and an anonymous referee greatly improved the paper. Finally, I am deeply indebted to my advisor, Rodolfo Manuelli. Any remaining errors are my own.

1. Introduction

In this paper, I consider whether fiscal policy has helped stabilize the postwar U.S. economy. To do this, I estimate fiscal policy reaction functions for the postwar economy and study their effect on the stochastic growth model. In particular, I use these estimated policy rules to see if postwar fiscal policy: (1) reduces output volatility; and/or (2) lengthens expansions and shortens recessions. I find that fiscal policy generally provides little stability in either respect.

My motivation is the following. The government is a major component of the postwar economy; it was a much smaller component of the pre-Depression economy. For example, in 1929, the average tax rate on labor income was 2 percent, the average tax rate on capital income was 19 percent, and government purchases of goods and services constituted 13 percent of GDP.[1] In 1975, the average tax rate on labor income was 23 percent, the average tax rate on capital income was 41 percent, and government purchases of goods and services constituted 23 percent of GDP. Given the scale of government, it is natural to wonder how the postwar economy would have behaved in its absence. In this paper, I consider the question in some detail. And while I lack the detailed data to support an explicit comparison of prewar and postwar fiscal policy, if one believes that prewar—especially pre-Depression—fiscal policy was essentially no policy at all, then a study of postwar fiscal policy can contribute to the ongoing debate about postwar economic stabilization.

At the core of this debate is the claim that the U.S. economy has become more stable, in the sense of the two criteria listed above, since World War II. For example, several studies have found that economic activity has become less volatile since World War II.[2] Similarly, Diebold and Rudebusch (1992) argue that expansions have been longer and contractions

---

[1] The tax rates are described below. The government spending ratio is based on the standard measures of GDP and government purchases found in the national accounts, rather than the ones used in the exercises below.

[2] See Diebold and Rudebusch (1992), and the references therein.

shorter in the postwar era. Many researchers have claimed, however, that this seeming stabilization is due mainly to the way in which the prewar data are constructed.[3] And if one accepts the claim of stabilization, one must then find its cause. By studying the effect of postwar fiscal policy, this paper explores the plausibility of fiscal policy as a stabilization mechanism, as well as the plausibility of the stabilization hypothesis itself.[4]

In recent years, many authors have studied the interaction between fiscal policy and business cycles in dynamic equilibrium models. In the literature most relevant to this study, there seem to be two basic approaches. One is to allow fiscal policy to be endogenous, that is, contingent on the actions of the private sector, but to keep the feedback rule simple, and to restrict the number of policy-related shocks.[5] In many cases, these studies work with optimal policies, rather than the feedback rules actually observed in the data.[6] Another active topic has been whether fiscal policy creates and/or eliminates indeterminacy.[7]

The second approach is to estimate stochastic policy processes from the data, but to make fiscal policy exogenous to the decisions of private agents.[8] McGrattan (1994) and McGrattan, Rogerson and Wright (1997) form a middle ground, by estimating fiscal policy as part of a vector autoregression of exogenous state variables, so that fiscal policy can re-

---

[3] Much of this work began with Romer's work (1986a, 1986b) on the unemployment and output series. Watson (1994) provides a similar critique of the NBER dating procedure.

[4] It is worth stressing that the issue I am studying is stabilization, not welfare. Indeed, in the variant of the stochastic growth model that I use here, adding fiscal policy will always reduce welfare.

[5] This is the approach taken by King, Plosser and Rebelo (1988) and Greenwood and Huffman (1991). Leeper (1991) and Sims (1994) discuss the extent to which fiscal and monetary policies are tied down by fundamental restrictions such as debt limits. Baxter and King (1993) do not consider any feedback rules, but instead carefully study the effect of isolated policy disturbances.

[6] A good example is Chari, Christiano and Kehoe (1994), who derive optimal government spending in a stochastic environment. Ambler and Paquet (1996), Guo and Lansing (1994), and Lansing (1997) conduct similar exercises.

[7] Cazzavillan (1996), Christiano and Harrison (1999), Guo and Lansing (1996, 1998), and Schmitt-Grohe and Uribe (1997) consider this question.

[8] Christiano and Eichenbaum (1992), Braun (1994), Chang (1995), Kollman (1995), Ramey and Shapiro (1998) and Finn (1998) use this approach. Ambler and Paquet (1996) and Jonsson and Klein (1996) follow this approach in part as well.

spond to other exogenous shocks.[9] For the questions considered here, this is a considerable improvement, but it turns out that having policies respond directly to endogenous variables, as opposed to the underlying exogenous shocks, can have major effects on the uniqueness and stability of an economy's equilibria.[10]

My approach is to assume that three key fiscal policy variables—the tax rate on capital income, the tax rate on labor income, and government purchases as a fraction of output—can be written as functions of their own lags, current and lagged output, and current and lagged hours of work. I estimate the parameters of the economy, including these fiscal policy feedback rules, from postwar U.S. data, using the generalized method of moments. My work is complementary to that of Leeper and Sims (1994) and McGrattan (1991) who estimate both "private sector" parameters and policy rules. It also resembles Jonsson and Klein (1996), who allow income taxes to be (isoelastically) progressive. My approach differs from its predecessors in that I allow a richer set of endogenous feedback rules (in terms of allowing contemporaneous and lagged responses), and in that I more carefully examine the effects of making fiscal policy endogenous. In the latter respect, my approach resembles the work of Edelberg, Eichenbaum and Fisher (1999), and Burnside, Eichenbaum and Fisher (1999). But unlike these authors, who seek to identify and analyze exogenous policy shocks,[11] I also study the effect of the endogenous responses. My work also differs from theirs in that I focus on policy experiments, while Edelberg et al. and Burnside et al. focus on evaluating the stochastic growth model's performance.

What I find is that fiscal policy has provided little stabilization. In particular, the vari-

---

[9] Chari, Christiano and Kehoe (1994) also estimate and analyze a simple feedback rule where tax rates depend on exogenous government spending and technology. Braun (1994) allows innovations to fiscal policy to respond to innovations to technology.

[10] Christiano, Eichenbaum and Evans (1998) show, using composite functions, that any policy that depends on endogenous variables can be expressed solely as a function of exogenous variables. In this paper it is more straightforward, however, to estimate fiscal policy as a function of endogenous variables.

[11] Blanchard and Perotti (1999) perform a similar exercise in a vector autoregression framework.

ance of Hodrick-Prescott-filtered (HP-filtered) output increases when the postwar fiscal regime—endogenous responses, exogenous shocks and all—is introduced. The results are sometimes weaker under other measures of volatility, but I always find postwar fiscal policy to be at best negligibly stabilizing. I do find that the endogenous feedback links, by themselves, are generally stabilizing, although this result is somewhat less robust. If the feedback links are removed, fiscal policies are unambiguously destabilizing, but their effect on the relative volatilities and cross-correlations of different macroeconomic variables is small. This result arises in large part because I allow the economy to face technology, preference and depreciation shocks, building upon the approach of Parkin (1988).[12] It turns out that technology, preference and depreciation shocks together dominate the fiscal policy shocks. I also find that shocks to fiscal policies and technology are usually accompanied by offsetting shocks to preferences.[13] As I discuss below, the implications of that result extend beyond the immediate question of fiscal stabilization.

The rest of the paper is organized as follows. In section 2, I describe the underlying economic model. In section 3, I describe the data I use to estimate my model, and how I estimate it. I discuss my results in section 4, and conclude in section 5.

2. The Model

The model consists of a single representative firm, a representative household, and a government. The firm and the household behave in the standard fashion; the firm maximizes profits, and the household maximizes its discounted lifetime utility. The government, on the other hand, does not necessarily have a formal objective function, but instead follows a

---

[12] Baxter and King (1991) provide a literature review of this approach to preference shocks. Preference shocks also appear in Bencivenga (1992), Holland and Scott (1998) and Lansing (1997), who calibrates a model of optimal fiscal policy. Ambler and Paquet (1994) analyze depreciation shocks in a model with stochastic technology. Ingram, Kocherlakota and Savin (1994) provide a general discussion of multiple-shock models.

[13] Most authors assume that these shocks are independent. Parkin (1988) finds a similar correlation between technology and preference shocks.

set of feedback rules. These rules, which I ultimately estimate from the data, give taxes and government purchases as a function of their own lagged values, output and labor hours.

2.1 Firms

The numeraire is final output, Y_t, which is produced by a representative price-taking firm. The firm faces a Cobb-Douglas production function:

$$\begin{aligned} & Y_t = Z_t \overline{K}_t^{a} \overline{L}_t^{1-a}, \\ & 0 < a < 1, \end{aligned} \tag{1}$$

where $\overline{K}_t$ and $\overline{L}_t$ denote capital and labor, respectively. Z_t is the exogenous and stochastic technology parameter.

Each period, the firm solves

$$\begin{aligned} & \max_{\left\{\overline{K}_t, \overline{L}_t\right\}} \; Z_t \overline{K}_t^{a} \overline{L}_t^{1-a} - r_t \overline{K}_t - w_t \overline{L}_t, \\ & s.t. \quad \overline{K}_t, \overline{L}_t \geq 0, \end{aligned} \tag{2}$$

where r_t is the cost of renting capital, and w_t is the real wage.

2.2 Households

The economy is populated by a single representative household, whose size, N_t, is exogenous and deterministic. Normalizing each member's labor endowment to 1, the household's flow utility from consumption, C_t, and leisure, $N_t - L_t$, is

$$\begin{aligned} & U\left(C_t, L_t\right) = N_t \left[\ln\left(\frac{C_t}{N_t}\right) + \frac{\chi_t}{1-\gamma}\left(1 - \frac{L_t}{N_t}\right)^{1-\gamma} \right], \\ & \gamma \geq 0, \\ & \frac{1}{1-\gamma}\left(x\right)^{1-\gamma} \equiv \ln\left(x\right), \gamma = 1. \end{aligned} \tag{3}$$

χ_t is an exogenous and stochastic preference shock. Note that fiscal policies do not affect the marginal returns to private consumption or leisure.[14]

The household sells labor and rents capital, the law of motion for which is

---

[14] McGrattan (1994) and McGrattan, Rogerson and Wright (1997), who estimate a richer model, find that one cannot reject the first part of this assumption.

$$K_{t+1} = (1-\delta_t) K_t + I_t, \tag{4}$$

where I_t denotes investment and $\delta_t \in (0,1)$ denotes the rate of depreciation. Each period, the household faces the following budget constraint:

$$(1-\tau_{Kt}) r_t K_t + (1-\tau_{Lt}) w_t L_t + \delta_t \tau_{Kt} K_t + h_t Y_t = C_t + I_t. \tag{5}$$

τ_{Kt} and τ_{Lt} are the tax rates on capital and labor income, respectively. (Note that depreciation expenses are tax-deductible.) h_t denotes government transfers as a fraction of output. τ_{Kt}, τ_{Lt} and h_t can (and do) depend on other variables, both exogenous and endogenous, but for the moment I suppress this in the notation.

The household takes as given all prices and all government quantities. The family also takes as given aggregate output Y_t, and thus total transfers; I do not account for the taxes implicit in the U.S. transfer system.

The household's objective is to maximize the discounted stream of per capita utility. It thus solves

$$\max_{\{C_t, L_t, K_{t+1}, I_t\}_{t=0}^{\infty}} E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\ln\left(\frac{C_t}{N_t}\right) + \frac{\chi_t}{1-\gamma}\left(1-\frac{L_t}{N_t}\right)^{1-\gamma} \right] \right\} \tag{6}$$

$$\begin{aligned} &s.t. \quad (4);\ (5); \\ &K_0\ given; \\ &C_t, I_t \geq 0; \\ &L_t \in [0, N_t]. \end{aligned}$$

$E_t\{\cdot\}$ denotes expectations conditional on information at time t, and $\beta \in (0,1)$ is the household's discount factor. The solution must also satisfy the transversality condition

$$\lim_{j\to\infty} E_t \beta^{t+j} \left\{ \frac{K_{t+j+1}}{C_{t+j}} \right\} = 0. \tag{7}$$

2.3 The Government

There is a government, which collects taxes from the household. Some of these taxes are used to make purchases of the final good. As discussed above, these purchases have no effect on the marginal returns to private consumption and leisure or on the firm's production function. Any taxes not used to make purchases are transferred back to the household in a lump-sum payment; the government balances its budget every period. The government has no debt.[15] The government's budget constraint is thus

$$h_t Y_t = \tau_{Kt} r_t K_t + \tau_{Lt} w_t L_t - \delta_t \tau_{Kt} K_t - g_t Y_t. \tag{8}$$

Here g_t denotes the fraction of output that the government consumes.[16]

The tax and spending rates are functions of their own lags, current and lagged output, and current and lagged labor hours. This reflects the notion that policymakers care about output and employment. In their most general form, the fiscal policy rules can be written as

$$\begin{pmatrix} \tau_{Kt} \\ \tau_{Lt} \\ g_t \end{pmatrix} = \mathbf{G}_t \left(\mathbf{u}_t, \mathbf{u}_{t-1}, ..., \mathbf{u}_{t-q}, \boldsymbol{\xi}_t \right), \tag{9}$$

where $\mathbf{G}_t$ is a vector-valued function, $\mathbf{u}_t \equiv (Y_t, L_t, \tau_{Kt}, \tau_{Lt}, g_t)'$, $\boldsymbol{\xi}_t$ is a (3×1) vector of policy shocks and $q \geq 1$. One can interpret these rules as structural, or as the reduced-form solution to some unspecified maximization problem. Either interpretation is consistent with the exercises I conduct here, as I do not change any "private sector" parameters. Similarly, the rules can reflect both "automatic stabilizers" and conscious actions by policymakers. In the sections that follow I specialize these feedback rules, making them time-invariant functions of detrended variables.

2.4 Equilibrium

The resource constraint for this economy is

---

[15] Since the model is Ricardian with respect to the pattern of transfers, the balanced budget assumption is unrealistic to the extent that distortionary taxes and government purchases depend on the level of government debt.

[16] I assume that all government spending is alike. Finn (1998) argues that government employment should be modeled separately from government purchases of goods. Shapiro and Ramey (1998) argue that an important feature of government spending is the way it in which it reallocates resources across sectors.

$$Y_t = C_t + I_t + g_t Y_t. \tag{10}$$

Definition: Given the initial values $K_0 = \overline{K}_0$ and $\{\mathbf{u}_{-1}, ..., \mathbf{u}_{-q}\}$, and the exogenous stochastic processes $\{Z_t, \delta_t, \chi_t, N_t, \boldsymbol{\xi}_t\}_{t=0}^{\infty}$, an equilibrium is a collection of stochastic processes for quantities, $\left\{C_t, I_t, Y_t, K_{t+1}, L_t, \overline{K}_{t+1}, \overline{L}_t\right\}_{t=0}^{\infty}$, with $K_{t+1} = \overline{K}_{t+1}$ and $L_t = \overline{L}_t$, $\forall t$; prices, $\{w_t, r_t\}_{t=0}^{\infty}$; and fiscal policies, $\{\tau_{Kt}, \tau_{Lt}, g_t, h_t\}_{t=0}^{\infty}$ such that: (i) given the prices and fiscal policies, the quantities solve the household's problem given by equations (6) and (7) and the producer's problem given by equation (2); (ii) the fiscal policies satisfy equations (8) and (9); and (iii) the resource constraint given by equation (10) is satisfied.

Upon manipulation of the first-order conditions, part (i) of the definition becomes:

$$\chi_t \left(1 - \frac{L_t}{N_t}\right)^{-\gamma} = \frac{N_t}{C_t} \left(1 - \tau_{Lt}\right) \left(1 - a\right) \frac{Y_t}{L_t}, \tag{11}$$

$$\frac{1}{C_t} = \beta E_t \left\{ \frac{1}{C_{t+1}} \left[\left(1 - \tau_{Kt+1}\right) \left(a \frac{Y_{t+1}}{K_{t+1}} - \delta_{t+1} \right) + 1 \right] \right\}, \tag{12}$$

along with equation (7). Both equations are familiar; equation (11) gives the labor market equilibrium, and equation (12) is the Euler equation. Upon inserting the resource constraint and the production function, the capital accumulation equation becomes

$$K_{t+1} = \left(1 - \delta_t\right) K_t + \left(1 - g_t\right) Z_t K_t^a L_t^{1-a} - C_t. \tag{13}$$

It follows that any set of processes for quantities and fiscal policies that satisfies equations (7) through (9) and (11) through (13) is an equilibrium.

2.5 Specialization and Linearization

Since the model has no closed form solution, I analyze it numerically. To do this, I log-linearize the equilibrium of section 2.4 around a balanced growth path, following the approach of King, Plosser and Rebelo (1988), Campbell (1994), Farmer and Guo (1994) and many others.

Such a log-linearization requires several specializations. The first is that technology follows

$$Z_t = G_Z^t \cdot \exp\left(z_0 + z_t\right), \tag{14}$$

where $G_Z > 0$ is the deterministic growth rate of technology. Similarly the leisure preference parameter χ_t follows

$$\chi_t = \exp\left(\chi + x_t\right), \tag{15}$$

and depreciation obeys

$$\delta_t = \delta + d_t,$$

with the stochastic component of technology, depreciation, and preferences following a first-order vector autoregression:

$$\begin{pmatrix} z_{t+1} \\ d_{t+1} \\ x_{t+1} \end{pmatrix} = \mathbf{\Phi} \begin{pmatrix} z_t \\ d_t \\ x_t \end{pmatrix} + \boldsymbol{\nu}_{t+1}, \tag{16}$$

where $\boldsymbol{\nu}_{t+1}$ is a stationary martingale difference sequence and the eigenvalues of $\mathbf{\Phi}$ all lie inside the unit circle.

One can show that along a balanced growth path, with depreciation, preferences (χ_t) and fiscal policies suitably fixed, L_t/N_t is constant, while C_t/N_t, K_t/N_t and Y_t/N_t grow at the constant rate

$$G = G_Z^{1/(1-a)}. \tag{17}$$

I also assume that along a balanced growth path, the population grows at the rate G_N. Dividing through by the appropriate growth rates renders stationary the processes that comprise an equilibrium. While z_t, d_t, x_t, τ_{Kt}, τ_{Lt}, and g_t should be stationary along a balanced growth path, I transform the other quantities, with $p_t \equiv \ln\left(P_t/\left[N_t G_P^t\right]\right)$.

Letting carats "$\widehat{\ }$" denote deviations from this balanced growth path, the final specialization is to rewrite the fiscal policy response function as

$$\begin{pmatrix} \widehat{\tau}_{Kt+1} \\ \widehat{\tau}_{Lt+1} \\ \widehat{g}_{t+1} \end{pmatrix} = \mathbf{F}_0 \begin{pmatrix} \widehat{y}_{t+1} \\ \widehat{\ell}_{t+1} \end{pmatrix} + \mathbf{F}\left(L\right)\mathbf{v}_t + \boldsymbol{\xi}_{t+1}, \tag{18}$$

$$\mathbf{v}_t \equiv \left(\widehat{y}_t, \widehat{\ell}_t, \widehat{\tau}_{Kt}, \widehat{\tau}_{Lt}, \widehat{g}_t\right)',$$

where $\mathbf{F}(L)$ is a polynomial of (3×5) matrices in the lag operator L and $\boldsymbol{\xi}_{t+1}$ is a stationary martingale difference sequence.

2.6 The Linearized Model

Log-linearizing the "private sector block" and combining it with the policy feedback rule given by equation (18) yields the following linear expectational difference equation

$$\mathbf{A}_0 E_t(\mathbf{w}_{t+1}) = \mathbf{A}_1 \mathbf{w}_t, \tag{19}$$

$$\mathbf{w}_t \equiv \left(\widehat{c}_t, \widehat{\tau}_{Kt}, \widehat{\tau}_{Lt}, \widehat{g}_t, \widehat{k}_t, \mathbf{v}'_{t-1}, \mathbf{v}'_{t-2}, \mathbf{v}'_{t-3}, z_t, d_t, x_t\right)'.$$

$\mathbf{A}_0$ and $\mathbf{A}_1$ are (23×23) matrices. The first two rows of this system give the Euler equation and capital accumulation equation. The next 15 rows contain the laws of motion for lags of $\mathbf{v}_t$, and incorporate a log-linearization that expresses output and hours as functions of $\mathbf{w}_t$. The next three rows contain the fiscal policy rules, and the last three give the law of motion for the technology, depreciation and preference parameters.

A solution to the model is a matrix $\mathbf{A}$ (which can usually equal $\mathbf{A}_0^{-1}\mathbf{A}_1$) and a process

$$\mathbf{e}_{t+1} \equiv \mathbf{w}_{t+1} - E_t(\mathbf{w}_{t+1}), \tag{20}$$

such that the stochastic process generated by

$$\mathbf{w}_{t+1} = \mathbf{A}\mathbf{w}_t + \mathbf{e}_{t+1}, \tag{21}$$

satisfies (19). To ensure that the transversality condition is met, I require further that $\mathbf{w}_t$ be covariance stationary. But even then $\mathbf{e}_{t+1}$ is usually not unique unless one uses economic theory and/or the data to impose additional restrictions.

It turns out that one can write the forecast error as

$$\mathbf{e}_{t+1} = \mathbf{H}\boldsymbol{\varepsilon}_{t+1}, \tag{22}$$

where $\mathbf{H}$ is a $(23 \times m)$ matrix and $\boldsymbol{\varepsilon}_{t+1}$ is a $(m \times 1)$ random vector, with $m \leq 23$. By construction $\boldsymbol{\varepsilon}_{t+1}$ has a non-singular covariance matrix, so that m gives the stochastic dimension of $\mathbf{w}_t$. My approach for finding m and $\mathbf{H}$ is largely standard, and most closely follows Klein (2000) and Sims (1997), who work with the generalized Schur (QZ) decomposition.[17] I discuss my approach for finding $\boldsymbol{\varepsilon}_{t+1}$ when I describe my numerical exercises. In brief, what I do is estimate from the data the process given by the last 22 rows of

$$\mathbf{A}_0 \left[\mathbf{w}_{t+1} - E_t\left(\mathbf{w}_{t+1}\right)\right] = \mathbf{A}_0 \mathbf{H} \boldsymbol{\varepsilon}_{t+1}, \tag{23}$$

which I then use to find the covariance structure of $\boldsymbol{\varepsilon}_{t+1}$.

A system of linear difference equations like equation (19) is said to be "saddle-path stable" when its stationary solution is such that the endogenous (control) variables can be written as unique linear functions of the exogenous (state) variables. In the baseline stochastic growth model, this implies that control variables such as output or consumption can be written as unique functions of capital and technology. Returning to the model at hand, the structure for $\mathbf{A}_0$ and $\mathbf{A}_1$ that I estimate from the data is such that if the three fiscal policy variables are treated as state variables—as they would be if there were no feedback links—the model is saddle-path stable—as it would be if there were no feedback links. This contrasts with Schmitt-Grohe and Uribe (1997) and Guo and Lansing (1998), who study fiscal feedback rules that do affect their models' stability properties.

As Klein (2000) and Sims (1997) point out, saddle-path stability can also be defined in terms of forecast errors; saddle-path stability occurs when the dimension of the innovation vector $\boldsymbol{\varepsilon}_{t+1}$ equals the number of state variables, so that the forecast errors of the control variables are unique linear functions of the forecast errors of the state variables. This is the framework that leads to equation (23), and what I find is that the feedback rules do not affect the dimension of $\boldsymbol{\varepsilon}_{t+1}$.

---

[17] My solution approach also draws upon Blanchard and Kahn (1980), Broze, Gourieroux and Szafarz (1985, 1995), Farmer (1993), and King, Plosser and Rebelo (1987). Paul Söderlind provided a GAUSS translation of the LAPACK routines that do the real QZ decomposition. A technical appendix describing my solution method is available upon request.

3. Data and Econometric Approach

3.1 Data

The data used to estimate the model are quarterly observations from the first quarter of 1958 (when quarterly tax data become available) through the last quarter of 1997; once lags and leads are accounted for, the data cover the third quarter of 1959 through the third quarter of 1997. One consequence of using this sample period is that the data exclude the Korean War, the largest postwar fiscal event. To the extent that the Korean War is an idiosyncratic event, as Edelberg et al. (1999) and Burnside et al. (1999) take it to be, it arguably should be omitted, or at least handled separately, in the analysis.[18]

The data include: real per capita output, consumption, investment, labor hours, and capital; the ratio of government purchases to GDP; and tax rates on capital and labor income. With the exception of the hours and population series, all of the data are derived from the national accounts. All of the data are seasonally adjusted.

The way in which the data are constructed is largely standard; I relegate most of the description to Appendix A. Three series warrant discussion in the text. The aggregate depreciation rate is found as

$$\delta_t = 1 + \frac{I_t}{K_t} - \frac{K_{t+1}}{K_t}. \tag{24}$$

The capital and labor tax series are constructed from the national accounts with the methodology of Mendoza, Razin and Tesar (1994). I use average tax rates, rather than marginal ones, primarily because the former are easily constructed on a quarterly basis. I describe my approach, and the resulting tax series, in some detail in Appendix B. As Mendoza, Razin and Tesar (1994) point out, on an annual basis the average tax rate series compare favorably with estimates of marginal rates. Note that even though tax schedules might be fixed over

---

[18] The Korean War is one of three "Ramey-Shapiro" (1998) events that Edelberg et al. and Burnside et al. set aside for special analysis. While the other two events—the Vietnam War and the Carter-Reagan buildup—are in the sample, they are, as the referee pointed out, relatively small.

the course of a year, tax rates can still vary on a quarterly basis, as households move across tax brackets.[19]

3.2 Econometric Approach

I estimate the structural parameters of the model using the generalized method of moments framework developed by Hansen (1982), following Christiano and Eichenbaum (1992), Braun (1994) and Hamilton (1994). I also build upon the approach of Parkin (1988), in that I treat the unobserved part of the labor supply equation as a preference shock, and in that I treat the unobserved part of the capital accumulation equation as a depreciation shock.

For many of the estimates, it is necessary to assume that the random vector

$$\left(\tau_{Kt}, \tau_{Lt}, g_t, \delta_t, \frac{C_{t+1}}{C_t}, \frac{Y_t}{K_t}, \frac{Y_t}{C_t}, \frac{L_t}{N_t}\right)',$$

along with its cross-products, is stationary and ergodic. Since the quantities in this vector are ratios, such an assumption holds for many technology, depreciation and preference processes.

The theoretical model implies that any trends in the data are functions of the productivity growth rate G. It is well known, however, that the data show additional "idiosyncratic" trends. For example, the depreciation,[20] labor tax, and government spending series display pronounced trends over the sample, which I remove. In many cases, at least one of these trends changes the model's stability properties. In addition, output, consumption, investment and capital all grow at different rates, in part reflecting the trends in government

---

[19] The squared first differences of the capital tax series average $(10.1, 6.0, 5.4, 3.7) \times 10^{-5}$ for the first through the fourth quarters, respectively. (If 1975, a year of particularly volatile taxes, is excluded, the numbers are $(8.8, 6.0, 5.4, 3.8) \times 10^{-5}$.) The squared first differences of the labor tax series average $(3.2, 1.6, 1.5, 0.2) \times 10^{-5}$ for the first through the fourth quarters, respectively. This suggests that while many of the changes in taxes occur in the first quarter, when the tax code shifts—and also indicate that the quarterly tax series used here are responding to changes in the tax code in a timely fashion—there are still other sources of variation. To keep the model tractable, I abstract away from this heteroskedasticity.

[20] The trend in depreciation is due in part to quirks of the chain-weighting procedure used to deflate the data and, as described by Kopcke (1993), to an investment shift toward information processing equipment, which depreciates more quickly than other equipment or structures.

spending and depreciation. Since these four idiosyncratic trends have no counterpart in the model, I remove them when estimating the model. In particular, I estimate the model's parameters with linearly detrended data, which, when necessary, is centered around the steady state values implied by the model. Such an approach is consistent with the notion that the model's equations hold across all frequencies. Issues of stabilization, however, are most salient at the business cycle frequencies, and so I consider second moments for both linearly detrended and HP-filtered data.

I calibrate, rather than estimate, three parameters. I set G_N, the population growth rate, to its sample mean of 1.0037.[21] I set β so that the steady state return on a risk-free asset, $G_N G/\beta$, equals 0.99^{-1}. I set γ, the inverse of the intertemporal elasticity of substitution for leisure, equal to 3, which in the baseline case sets the output variance for linearly detrended data implied by the model more or less equal to that observed in the data. Given that many analyses assume indivisible labor (so that $\gamma = 0$), or logarithmic preferences, this value appears high, but it is still below the results of many micro-level studies.[22]

I describe the detailed moment conditions and the mechanics of how I estimate the parameters in Appendix C. It bears noting here, however, that the orthogonality conditions for estimating the feedback rules are

$$E\left\{\left[\begin{pmatrix}\widehat{\tau}_{Kt+1}\\ \widehat{\tau}_{Lt+1}\\ \widehat{g}_{t+1}\end{pmatrix} - \mathbf{F}_0\begin{pmatrix}\widehat{y}_{t+1}\\ \widehat{\ell}_{t+1}\end{pmatrix} - \mathbf{F}\left(L\right)\mathbf{v}_t\right]\otimes\begin{pmatrix}\mathbf{v}_t\\ \mathbf{v}_{t-1}\\ \mathbf{v}_{t-2}\\ \mathbf{v}_{t-3}\\ \widehat{k}_{t+1}\\ \widehat{k}_t\end{pmatrix}\right\} = \mathbf{0}, \tag{25}$$

$$\mathbf{v}_t \equiv \left(\widehat{y}_t, \widehat{\ell}_t, \widehat{\tau}_{Kt}, \widehat{\tau}_{Lt}, \widehat{g}_t\right)'.$$

It seems likely that contemporaneous hours and output will be correlated with the policy

---

[21] G_N is not formally estimated because N_t is assumed to be deterministic.

[22] For example, see the discussion in Reilly (1994, pp. 463 and 473). Note that the intertemporal elasticity of substitution for labor is given by $\frac{1}{\gamma}\frac{1-L/N}{L/N}$, which for the exercise at hand implies an elasticity of about 1.3.

forecast errors, $\boldsymbol{\xi}_{t+1}$. I account for this by instrumenting for hours and output, using as instruments current and lagged values of the capital stock, and four lags of output, hours and fiscal policies. Initial analyses suggested that the capital and labor tax feedback rules could be modeled with two lags, and the law of motion for government spending with four lags.[23]

In the interest of parsimony and generating a rich set of instruments, I assume that the matrices of $\mathbf{F}(L)$ are sparse; each fiscal policy variable depends mainly on its own lags, current and lagged hours, and current and lagged output growth. Baxter and King (1993) point out that the way in which government spending is financed—taxes or transfers—is important. To capture this sort of effect, I include two direct cross-policy links: labor taxes respond to lagged government spending; and government spending responds to lagged labor taxes. I briefly discuss a specification that excludes the cross-policy links.

3.3 Moments

The second moments implied by the model follow readily from equation (23). In particular, suppose that the forecast error $\boldsymbol{\varepsilon}_{t+1}$ can be written as

$$\boldsymbol{\varepsilon}_{t+1} = \mathbf{M}\boldsymbol{\zeta}_{t+1}, \tag{26}$$

with $E_t\left\{\boldsymbol{\zeta}_{t+1}\boldsymbol{\zeta}'_{t+1}\right\} = \mathbf{I}$. It follows that

$$var\left(\mathbf{w}_t\right) = \mathbf{A}\cdot var\left(\mathbf{w}_t\right)\cdot\mathbf{A}' + \mathbf{HMM'H'}. \tag{27}$$

Using the linearization $\mathbf{q}_{t+1} = \mathbf{R}\mathbf{w}_t$, one can readily find second moments for output and other variables of interest. Recognizing that $\Delta\mathbf{w}_{t+1} = \left[\mathbf{A}-\mathbf{I}\right]\mathbf{w}_t + \mathbf{H}\boldsymbol{\varepsilon}_{t+1}$, one can similarly find the variance of first differences.

I calculate the model's implications for HP-filtered data by applying the time-invariant HP filter described in Burnside (1999). Using this filter allows one to find HP-filtered

---

[23] While I have chosen to adopt a more parsimonious specification, the preliminary analyses did suggest that labor taxes could be modeled well with five lags.

autocovariances analytically, as weighted sums of the autocovariance matrices for non-HP-filtered series.

The innovation matrix $\mathbf{M}$ is set so that the forecast errors generated by the model match those found in the (non-HP-filtered) data. Recall that $\mathbf{A}_0$ and $\mathbf{A}_1$ are constructed so that the last six rows of equation (19) give the fiscal policy reaction functions and the law of motion for the exogenous shocks. $\mathbf{M}$ is then found by solving

$$\widetilde{\mathbf{A}_0\mathbf{H}}\mathbf{M} = \begin{bmatrix} \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{N} \end{bmatrix}, \tag{28}$$

where $\widetilde{\mathbf{A}_0\mathbf{H}}$ is the last 22 rows of $\mathbf{A}_0\mathbf{H}$—the row excluded is the linearized Euler equation—and $\mathbf{N}$ is the Choleski decomposition for innovations to technology, preferences and fiscal policies shown below in Table 3. Recall that fiscal policies respond to contemporaneous hours and output. $\mathbf{N}$ thus decomposes the fiscal policy forecast error that remains after accounting for forecast errors in hours and output. $\mathbf{HM}$, on the other hand, decomposes the error from the time-t forecast of fiscal policies at time $t+1$. Multiplying through by $\mathbf{A}_0$ reconciles the two types of forecast error. Since lagged variables are known in advance, and the capital stock is assumed to be known in advance as well, they have no forecast error. The right-hand side of equation (28) thus includes 16 rows of zeros. The dimensions of $\mathbf{H}$ and $\mathbf{M}$ are complicated functions of the matrix $\mathbf{A}$. It turns out, however, that $\mathbf{M}$ is (22×22), so that equation (28) has an exact solution.

Corresponding to the second moments implied by the model are the second moments of the underlying data. These moments are estimated in the standard fashion. The linearly detrended data is centered around the steady state values implied by the model and the idiosyncratic linear trends discussed earlier,[24] while the HP-filtered data is detrended using

---

[24] The joint weighting matrix for the structural parameters and data moments is thus block diagonal, with the optimal weighting matrix for the structural parameters in the upper left corner, and an identity matrix in the lower right corner.

a smoothness parameter of 1600.[25]

The final moments are the average lengths of expansions and recessions. To identify expansions and recessions, I use a simple dating rule developed by Boldin (1994) that identifies economic episodes using output growth. To find the episode lengths implied by the model, I turn to simulations. In particular, I simulate 1600 time series of 150 quarters, apply Boldin's rule to each simulated output series, and average the episode lengths across the 1600 simulations.[26]

4. Results

4.1 Parameter Values

Table 1 presents the estimates for the technology and preference parameters. The standard errors are based on the Newey-West (1987) covariance estimator, with six autocovariances. All of the estimates appear reasonable. The depreciation rate of 1.2 percent per quarter is lower than some estimates, but this is in part because I have defined δ in absolute, rather than per capita, terms. The capital share, a, of 33 percent is consistent with other estimates. I discuss the tax series in more detail in Appendix B.

Table 2 presents the coefficients for the fiscal policy feedback rules. The coefficients show that capital taxes respond more strongly to output, while labor taxes respond more strongly to hours, and government spending responds about equally to each variable. Labor taxes also respond strongly to government spending, while government spending responds weakly to labor taxes. Another notable feature of the policies is their persistence in their own lags.

---

[25] I use an HP filtering procedure for GAUSS written by Matheny, van Norden and Vigfusson.

[26] Under Boldin's rule, recessions begin in the first period where total (not per capita) output growth is negative in the current period and one of the next two periods. Subsequent expansions begin in the first period that (annualized) output growth exceeds 2.5 percent in the current period and one of the next two periods. Only complete episodes are used, and simulations where the economy does not experience at least one complete expansion and recession are discarded. An alternative and more involved approach is the Bry-Boschan algorithm used by Watson (1994).

The interpretation of these coefficients can be sharpened by viewing the underlying data series. Figure 1 plots each of the model's driving processes against output and hours, showing linearly detrended series. There are several striking results. The series for output and technology both illustrate the post-1973 growth slowdown. Capital and labor taxes both fall in response to the Kennedy and (especially) Reagan tax cuts. The government spending ratio rises to cover the Vietnam War and Reagan buildup/Gulf War episodes. Finally, the preference process mirrors hours; recall that an increase in the preference parameter χ_t makes consumers *less* willing to work.

Table 3 describes the preference, depreciation and technology processes, in combination with the forecast error for the fiscal policy feedback rules. The lower right corner of the first matrix contains $\mathbf{\Phi}$, the matrix of autoregressive coefficients for the three exogenous processes. The second matrix gives the elements of the matrix $\mathbf{N}$, the Choleski decomposition of the covariance matrix for innovations to fiscal policies, technology, depreciation and preferences. $\mathbf{N}$ is lower triangular, with the policy variables first in the ordering. This reflects the assumption that the feedback rules fully capture the contemporaneous response of the policy variables to the rest of the economy.

Note that there are strong links between innovations in the "policy" and "non-policy" blocks, especially with respect to preference shocks. Looking at the first column of $\mathbf{N}$ reveals that an orthogonal innovation to capital taxes generates offsetting movements in labor taxes and preferences; labor taxes go up while consumers become more willing to work. The second column shows that an orthogonal innovation to labor taxes has a similar effect. There are also links between preferences and technology; the fourth column of $\mathbf{N}$ shows that improvements in technology are generally associated with a decreased willingness to work. A similar positive correlation between technology and preferences appears in Parkin (1988, Table 3). Farmer and Guo (1995), who estimate a model with increasing returns, find a negative correlation.

To better understand the preference innovations, recall from equations (11) and (15) that the preference process x_t is given by

$$x_t = \ln\left(\frac{Y_t}{C_t}\right) - \ln\left(\frac{L_t}{N_t}\right) + \ln(1-\tau_{Lt}) + \ln(1-a) + \gamma\ln\left(1-\frac{L_t}{N_t}\right) - \chi.$$

Holding everything else constant, and inserting the production function, one can linearize this equation to approximate x_t as $\phi_0\widehat{\ell}_t + \phi_1\widehat{\tau}_{Lt} + \phi_2 z_t$, with ϕ_0 and ϕ_1 negative, and ϕ_2 positive. Then to get the relations found in $\mathbf{N}$, it must be the case that forecast errors in $\widehat{\ell}_t$ are (roughly) orthogonal to forecast errors in $\widehat{\tau}_{Lt}$ and z_t. Parkin (1988) suggests one possible explanation, namely measurement error. Another possibility is that labor market frictions delay the response of hours to innovations in taxes or technology. The offsetting preference shocks allow the model to capture these sophisticated dynamics. Farmer and Guo (1995) offer a similar interpretation. To the extent this is the case, I assume that the labor market approximation used here is accurate enough to support the fiscal policy experiments.

4.2 Impulse Response Functions

Figure 2 presents impulse response functions for each of the orthogonal shocks shown in Table 3. Table 3 revealed that the processes driving the model have a large number of contemporaneous and lagged interactions. These interactions, along with the feedback rules, make it difficult to study the model's dynamics. Figure 2 instead shows the responses that arise when the interactions (the off-diagonal elements of $\mathbf{\Phi}$ and $\mathbf{N}$) and the feedback rules are set to zero. In other words, Figure 2 shows the responses that arise when the model's driving processes—with the exception of lagged interactions between labor taxes and government spending—are completely independent and completely exogenous. Since similar response functions appear in (collectively) King, Plosser and Rebelo (1988), Christiano and Eichenbaum (1992), Baxter and King (1993) and Braun (1994), I will keep the descriptions brief.

The first three panels of Figure 2 show the responses to the three fiscal shocks. The capital tax shock lowers the consumer's expected after-tax return to saving, inducing an increase in consumption and leisure. Hours and output drop accordingly. Over time, the capital stock shrinks as well, keeping output depressed even as hours return to their steady state value. By decreasing after-tax wages, the labor tax shock generates a similar, but considerably stronger, pattern of responses. Because of the balanced budget assumption, the tax hikes in isolation have relatively weak wealth effects. The labor tax hike generates the analogue of the standard wealth effect, however, through its effect on government spending. In particular, an increase in government spending lowers the consumer's wealth, increasing labor supply, hours and output. These wealth effects also appear in the response functions for a shock to the government spending ratio, where hours and output rise. But as Baxter and King (1993) argue, the impact of a government spending shock depends even more critically on how taxes respond; the responses of output and hours mirror the response of labor taxes.[27]

The impulse response functions for the technology shock are the familiar ones, and the responses to a preference shocks are equally straightforward. The responses to depreciation shock are a bit more interesting, in that they are virtually undetectable. The muted responses are largely due to scaling—a "one-unit" depreciation shock is one-hundredth the size of a one-unit tax shock. They also reflect offsetting wealth and substitution effects: a depreciation shock both lowers the expected return to saving and depresses the consumer's

---

[27] The way in which a government spending shock generates a tax decrease differs from Burnside, et al.'s (1999) finding that "Ramey-Shapiro" military spending episodes are associated with tax increases. Among other things, this difference could reflect the omission of the tax-funded Korean War build-up in the data used here (see Ohanian, 1997) and differences between the three episodes and other government spending shocks. In addition, with the feedback rules shut down, the responses shown here are not directly comparable to Burnside, et al.'s responses, which are inclusive of feedback rules.

income stream.[28] As a result, hours change relatively little and the depreciation increase affects output mainly by reducing the capital stock.

To give a sense of how the fiscal policy feedback rules operate, Figure 3 displays the effects of a technology shock. The first panel of Figure 3 displays the impulse response functions that arise in the full model. One notable result is that hours initially fall in response to the technology shock. This reflects interactions between the technology and preference shocks. an increase in technology initially generates an increased desire for leisure, keeping hours down. Over time leisure becomes increasingly less desirable, and hours increase accordingly. The interactions between the two shocks also generate a slight hump in the impulse response function for output. Turning to the fiscal policies, the first panel of Figure 3 shows that the technology shock yields an immediate and sustained increase in capital taxes. Over the first year, labor taxes barely move, but they then enjoy a modest rise. The government spending ratio rises on impact and stays slightly higher throughout. The overall level of government spending of course depends not only on the spending ratio but on the level of output. Given the increase in output, however, it is clear that government spending increases as well.

The responses in the first panel of Figure 3 suggest that the endogenous tax responses dampen movements in output and hours, while the responses of government spending amplify them. The second panel of Figure 3 measures the overall effect, by showing the response functions that arise with and without the fiscal policy feedback rules. For the time period shown, the feedback rules compress both the output and hours responses. These effects are fairly modest, however, and the feedback rules do not change the responses' overall shape. Figure 3 suggests that the fiscal policy feedback rules provide relatively little stabilization.

---

[28] In Ambler and Pacquet's (1994) model, depreciation shocks are uncorrelated, and thus affect expected returns only through their effect on the capital stock.

4.3 Moments in the Data

The first column of Table 4 presents moments for the postwar U.S., with standard errors. Table 4 shows two measures of "output volatility." The first of these is the standard deviation of output around its trend. The standard deviations of the other variables are expressed as fractions of this measure. The second is the standard deviation of output growth. For the most part, the second moments are familiar. One notable feature is that hours have a weak correlation with output. As King, Plosser and Rebelo (1988) point out, hours and output appear to be positively correlated at high frequencies and negatively correlated at low frequencies.

The correlations of fiscal variables with output and hours are for the most part very roughly measured. The strongest are the positive correlation between the government spending ratio and hours and the negative correlation between labor taxes and hours. Both of these correlations suggest that the dominant relationship between fiscal policy and the economy is that of exogenous fiscal shocks generating responses in the labor market—labor tax increases depressing hours and government spending increases boosting hours.

The first column also shows that under Boldin's (1994) rule, expansions have lasted an average of 23 quarters and recessions have lasted 5 quarters. This is roughly in line with the NBER chronology since 1958, where expansions have lasted an average of 18 quarters, and recessions have lasted an average of 4 quarters. One reason the fit might not be better is that the output series used here excludes inventory investment and net exports.

The first column of Table 5 presents moments for postwar data passed through the HP filter. Referring back to Table 4 reveals that filtering significantly tightens the correlation between hours and output. Even more striking are the changes in the correlations of the fiscal policy variables. Upon filtering, the negative correlation between hours and taxes vanishes, and the government spending ratio becomes negatively correlated with both output and hours. These negative correlations suggest that the overall level of government spending is fairly unresponsive to output and hours at the business cycle frequencies, which comports with the findings of Cooley and Prescott (1995).

4.4 Moments Generated by the Model

The key results of the paper reside in columns (2) to (5) of Tables 4 and 5, which show the moments that the model generates with and without different components of the postwar fiscal policy processes. All of the cases are based on the parameters shown in Tables 1 through 3, with parameters set to zero as required. Since these moments are functions of the parameters in Tables 1 through 3, their standard errors are derived in the standard way from the covariance matrix for the underlying estimates.

Column (2) of Table 4 gives the moments generated by the full model for linearly detrended data. Beneath most of the estimated moments in column (2) are square brackets that contain t-statistics for the differences between the moments generated by the model and the moments found in the data. Given the number of moments involved, it is not surprising that the model is statistically rejected along some dimensions; the more relevant issue is whether the model provides an adequate framework for the policy experiments. In this respect, the overall fit is comparable to the one found by McGrattan et al. (1997). Qualitatively, the model matches most features of the data, the largest exceptions being the cross-correlations of capital and labor taxes with hours, and the correlation between labor taxes and output. Comparing columns (2) through (5) suggests that the feedback rules often move the correlations in the “right direction” but “overshoot” the target. Among other things, this could reflect small permutations in the feedback rules compounding through persistent fiscal policy processes.

These types of low-frequency effects have been removed in Table 5, which presents moments for HP-filtered series. Looking at column (2) of Table 5 reveals that model generally does no better at fitting the data at the business cycle frequencies than it does at fitting the data across all frequencies. Given that the stochastic growth model has difficulty replicating macroeconomic spectra (see, for example, the discussion in Otrok, 2001) and that the model was estimated to satisfy unfiltered moment conditions, this is not surprising.[29] On the other hand, the model does fairly good job of matching the fiscal policy correlations at business cycle frequencies.

While the fit is far from exact, in general the model does as well or better than most variants of the stochastic growth models in providing a plausible starting point.[30] One success of the model is that it generates a negative correlation between hours and average labor productivity (for example, -0.31 in column (2) of Table 5). As discussed in Baxter and King (1991), this reflects the presence of two fundamental shocks: a preference shock that causes hours and productivity to move in opposite directions, and a technology shock that causes hours and productivity to move together. The negative correlation also reflects the interaction between the technology and preference shocks that was shown in Table 3; an orthogonal innovation to technology causes firms to be more efficient and workers to seek more leisure. The net result is a large increase in average productivity accompanied by a decrease or small increase in hours.

Column (3) of Tables 4 and 5 presents results for the basic stochastic growth model, where fiscal policies are identically zero. Among other things, this involves shutting down the orthogonal policy shocks; recalling Table 3, the first 3 columns of the Choleski matrix $\mathbf{N}$ (the lower triangular matrix in Table 3) are set to zero. Comparing columns (2) and

---

[29] An alternative approach employed by McGrattan et al. (1997) is to re-estimate the model with HP-filtered data. (They found that the two sets of parameters differed mainly in the estimated shock processes.) I have not taken such an approach, in part because of issues of estimating different parameters at different frequencies, and in part because doing so makes the results much harder to interpret.

[30] The work of Edelberg et al. (1999) and Burnside et al. (1999) suggests, however, that the stochastic growth model will have to be extensively modified before it can fully replicate the economy's response to fiscal shocks.

(3) yields the central exercise of this paper, which is to consider how the postwar economy would have behaved in the absence of government. Adding postwar fiscal policy: decreases the standard deviation of logged output by 0.12 percentage points; increases the standard deviation of HP-filtered output by 14 percentage points; increases the standard deviation of output growth by 0.11 percentage points; and shortens both expansions and recessions. In terms of business cycle stabilization, the most meaningful of these measures is probably the variance of the HP-filtered data, which implies that postwar fiscal policy has been destabilizing. But even if all measures are considered, the conclusion is that fiscal policy has provided little stabilization.

The next exercise is disentangle the effects of exogenous fiscal shocks from the effects of the feedback rules. In column (4) of Tables 4 and 5, the orthogonal policy shocks remain shut down, but fiscal policies now follow the full set of feedback rules presented in Table 3. Comparing columns (3) and (4) suggests that the feedback rules are stabilizing: relative to the no-government case, output volatility markedly decreases for both HP-filtered and linearly detrended data. The volatility of output growth decreases a little as well, while expansions get longer and recessions get shorter. Taken as a whole, the feedback rules are stabilizing, if only weakly. Comparing columns (5) and (2) yields similar conclusions.

In column (5), fiscal policies vary—so that $\mathbf{N}$ is full rank—but they do not directly respond to output or hours. Put differently, the fiscal policy response functions have zero coefficients on $\widehat{y}$ and $\widehat{\ell}$, but non-zero coefficients on all other variables.[31] Comparing columns

---

[31] While this sort of exercise is similar in spirit to the way in which Edelberg et al. (1999) and Burnside et al. (1999) analyze an exogenous fiscal policy shock, there are some important differences. A fiscal policy shock not only has a direct effect on fiscal policies, but by affecting output and hours it also affects fiscal policies indirectly through feedback links. Using the approach detailed in Christiano, Eichenbaum and Evans (1998), Edelberg et al. and Burnside, et al. construct “exogenous” fiscal policy processes that incorporate both of these effects. Constructing such a process allows them to consider whether the stochastic growth model can replicate the economy’s response to a military spending shock. In contrast, the exogenous fiscal policies considered in column (5) are completely devoid of feedback links. This allows me to address a different issue, namely the relative importance of exogenous fiscal shocks and endogenous fiscal responses in a complete model of the economy.

(3) and (5) reveals that the exogenous fiscal policies are destabilizing. But in general, the exogenous policy processes have relatively little effect on how the model behaves, especially on the non-policy correlations. (A notable exception is that adding exogenous fiscal policies markedly increases the relative volatility of investment.) For the most part, introducing the feedback rules—moving from column (3) to column (4)—has as much of an effect on the correlations as introducing the exogenous policy shocks—moving from column (3) to column (5).

Another way of assessing the impact of the exogenous fiscal shocks is to decompose the variance of the variables shown in Table 4 among the orthogonal shocks shown in Table 3. Table 6 shows the decomposition. A striking result is the relatively small role played by fiscal policy. For example, fiscal policy innovations generate about 32 percent of the variance of HP-filtered output. In contrast, McGrattan (1994) finds that fiscal policy innovations generate just under 60 percent of output variance. Among other things, this difference reflects different treatment of trends (especially for labor taxes), different sample periods and the absence of a preference shock in McGrattan's model. Table 6 also reveals that feedback responses have a big effect on the volatility of the fiscal policies themselves. While this is especially true for the linearly detrended policies, where non-fiscal innovations are the dominant source of volatility, non-fiscal innovations are important for the HP-filtered policies as well.

In interpreting these decompositions, it is important to recognize how the shocks interact. For example, Table 3 shows that a labor tax innovation generates virtually offsetting effects on tax rates and preferences. Table 3 also shows that a government spending shock generates a large decline in technology. While this interaction will appear in the decomposition as government-generated variance, it probably reflects innovations to the government spending ratio that arise because technology shocks affect the spending ratio's denominator—output—but not its numerator.[32] But even under the most generous interpretation, fiscal shocks generate a minority of the variance.

The role of preference shocks is also worth noting. Hall (1997) concludes that preference shocks explain virtually all of the variance of hours, and are thus the dominant force behind business cycles. The results presented here, while striking, are much less stark. Preference shocks explain less than 40 percent of output variance. And even at business cycle frequencies, a significant portion of the variance in hours cannot be attributed to preferences.

4.5 Alternative Specifications

I turn now to briefly considering some alternatives to the baseline case. All of the results are summarized in Table 7. The first column of Table 7 presents the standard deviations of linearly detrended and HP-filtered output found in Tables 4 and 5. (In the interest of brevity, I have not shown the standard deviations of output growth or episode lengths.) The first column of Table 7 also shows the changes in the standard deviations that occur when postwar fiscal policy is added to the basic growth model, along with the standard errors for those changes.

Each alternative reflects one change to the baseline case. The first of these changes is a sparser specification for the feedback rules, shown in column (2). Under this specification, labor taxes and government spending no longer respond to each other's lagged values. Note that policies can still interact contemporaneously (through $\mathbf{N}$), and through coordinated responses to output or hours. Table 8 shows the feedback rules that result under this sparse specification. Comparing Table 8 with Table 2 reveals that the responses to output and hours are fairly similar across the two specifications. Returning to Table 7, comparing columns

---

[32] The negative relationship in the innovations is also offsetting the positive coefficient on contemporaneous output in the government spending feedback rules, which in turn is probably capturing the positive low-frequency correlation between output and the government spending ratio shown in Table 4.

(1) and (2) shows that the feedback rules are somewhat less stabilizing when the cross-policy links are excluded; moving from "Exogenous Shocks Only" to "Full System," one sees that output volatility decreases less when the sparser specification is used. Another difference is that exogenous fiscal shocks play a smaller role under the sparser specification. This can be seen by comparing the "Feedback Rules Only" and "Full System" cases. In the baseline model, removing the fiscal shocks lowers the variance of HP-filtered output by 32 percent—the variance drops from 1.39 to 0.94 percent. (Note that this is equivalent to the summing the fiscal policy components of the variance decomposition in Table 6.) Performing the same calculations with the sparser specification reveals a drop of 19 percent. But overall, the two specifications of fiscal policy generate similar results.

The second alternative, shown in column (3), is to assume that utility is logarithmic in leisure. This involves decreasing γ from 3 to 1. Since fiscal policies affect the economy in large part through the labor market, it is hardly surprising that they can have a bigger effect when labor supply is more elastic. In particular, column (3) shows the same patterns as column (1), but the magnitudes of the shifts are larger. Moving to logarithmic preferences also increases volatility in general. Such a result is not immediate, because it follows from equation (11) that as one decreases γ, one decreases the estimated variance of the preference shock χ_t.

An unresolved issue is the effect of government spending, especially in investment, on production. In the baseline case, I follow Christiano and Eichenbaum (1992) by adding government capital to the capital stock. This reflects the assumption that all government capital is an inframarginal substitute for private capital. In column (4), I consider the impact of this assumption by treating all government spending as unproductive. This requires me to subtract government investment from the investment series, government consumption of fixed capital from the government spending series, and government capital from the capital stock series. Comparing column (4) to column (2) shows that the fiscal policy innovations generate less volatility. On the other hand, the fiscal policy feedback links no longer dampen the fluctuations of HP-filtered output. The total effect of fiscal policy, however, is quite similar under two measures of government spending.

The final alternative, shown in column (5), is to use a different measure of total hours. While the baseline measure uses estimates of average hours from the Bureau of Labor Statistics' establishment survey, the alternative measure relies on the Bureau's household survey (Citibase variable LHOURS, available through 1993). Unlike the baseline measure, the alternative measure of per capita hours drifts upward over the sample, and so I remove a linear trend from this series before analyzing it. With the trend removed, the two measures of hours generate similar results.

Looking across the various cases, one can draw several broad conclusions. The first is that fiscal policy increases the variance of HP-filtered output, but decreases, albeit insignificantly, the variance of output around its trend. The second is that the endogenous component of fiscal policy, taken by itself, in most cases reduces the variance of HP-filtered output, and always reduces the variance of linearly detrended output. A third conclusion, found by comparing the "No Government" and the "Exogenous Shocks Only" experiments, is that even with the offsetting preference shocks discussed in Table 3, the exogenous component of fiscal policy is destabilizing.

5. Conclusion

The goal of this paper was to see whether fiscal policy has helped stabilize the postwar U.S. economy. To answer this question, I first estimated a model of the economy where fiscal policies can respond to hours and output. I then simulated the model, and analyzed how the economy changed as different elements of the postwar fiscal policy were eliminated. While there was variation across different specifications, my analyses yielded several broad results. First, adding the postwar fiscal regime increases the variance of HP-filtered output. The results are sometimes weaker under other measures of volatility, but I never find postwar fiscal policy to be more than weakly stabilizing. I also found that allowing taxes and spending to respond to output and hours was stabilizing under most specifications. A third result was that the exogenous component of fiscal policies was destabilizing, but not essential to explaining the relative variances and correlations of different economic variables. Finally, I found that innovations to fiscal policies (and technology as well) tended to generate offsetting innovations to preferences.

The way in which preference innovations behave could well reflect frictions that dampen or delay the response of labor to fiscal policies. A fruitful line of future research, then, would be exercises in the vein of Burnside, Eichenbaum and Rebelo (1993), where fiscal policies are studied in an economy with labor hoarding or related frictions.

6. Appendix A: Data Construction

The capital stock includes series for fixed private capital, durable goods, and government capital. These series are constructed from the national accounts by the U.S. Department of Commerce, as described in Herman and Katz (1997). I convert the annual series into quarterly observations with the quarterly investment series and imputed depreciation rates for each major category of capital. The aggregate depreciation rate is constructed from the investment and capital series as described in equation (24). In adding government capital, I follow Christiano and Eichenbaum (1992) by making the assumption that government capital is an inframarginal substitute for private capital.

Consumption consists of purchases of services and non-durable goods, and an imputed service flow from durable goods.[33] The baseline measure of investment consists of private and government fixed investment and purchases of durable goods. Government spending consists of government purchases of goods and services less government investment. Output equals the sum of consumption, investment and government spending. The government spending ratio is found using these real quantities. While real quantities can run into “adding-up” problems, there are non-trivial differences between the deflators for government spending and output as a whole.

Labor hours equal average employee hours in non-agricultural establishments, multiplied by the total employment. Both series are compiled by U.S. Bureau of Labor Statistics, with average hours coming from the Bureau’s establishment survey. To get per capita quantities, I divide the preceding series by the civilian non-institutional population, 16 years and older. I normalize the time endowment by assuming each person has 1369 hours available in a quarter. Using this value, I find that individuals spend about 20 percent of their time allotment on the job. There also exists an hours series that uses a measure of average hours

---

[33] The service flow is calculated as a carrying charge on the stock of durable goods, which is found by multiplying the stock by the sum of the depreciation rate and an annuity charge of one percent per quarter.

taken from the Bureau's household survey. Since each series has its strengths, I briefly consider this second measure when discussing alternative specifications.[34]

7. Appendix B: Calculation of Average Tax Rates

My approach to calculating average tax rates on capital and labor income closely follows that of Mendoza, Razin and Tesar (1994). I work with the national income and product accounts data collected by the Bureau of Economic Analysis and provided through the Bureau's STAT-USA on-line service. All of these items are indexed by table and line numbers from the Survey of Current Business.

I begin by finding τ_p, the average personal income tax rate:

$$\tau_p = \frac{FIT + SIT}{W + PRI/2 + CI}, \tag{B.1}$$

$$CI \equiv PRI/2 + RI + CP + NI, \tag{B.2}$$

where:

FIT = Federal income taxes (3.2: line 3);[35]
SIT = State and local income taxes (3.3: line 3);
W = Wages and salaries (1.14: line 3);
CI = Capital income;
PRI = Proprieter's income (1.14: line 9);
RI = Rental income (1.14: line 17);
CP = Corporate profits (1.14: line 20);
NI = Net interest (1.14: line 29).

As discussed by Joines (1981), the division of proprietor's income into capital and labor income is somewhat arbitrary. Joines analyzes both extreme cases (all capital or all labor income). I take the middle ground, and split proprietor's income evenly between capital and labor income.

---

[34] A comparison of the two series can be found in recent editions of Employment and Earnings (1999). While the establishment data are arguably more accurate, the household series has conceptual advantages.

[35] Federal income taxes in the second quarter of 1975 are adjusted upward to remove the rebate component of the Tax Reduction Act of 1975, as the rebate was based on 1974 tax liabilities. (I assume that the rebate was unanticipated in 1974.) See the April, 1975 Survey of Current Business, and the 1976 Economic Report of the President.

The labor tax rate, τ_L, is then calculated as

$$\tau_L = \frac{\tau_p \left[W + PRI/2\right] + CSI}{EC + PRI/2}, \tag{B.3}$$

where

CSI = Total contributions to social insurance (3.1: line 5);
EC = Total employee compensation (1.14: line 2).

In addition to wages and salaries, employee compensation includes contributions to social insurance and untaxed benefits.

The capital tax rate, τ_K, is calculated as

$$\tau_K = \frac{\tau_p CI + CT + PT}{CI + PT}, \tag{B.4}$$

where

CT = Corporate taxes (3.1: line 3);
PT = Property taxes (3.3: line 9).

I add property taxes to the denominator as they are deducted from profits. On the other hand, I exclude returns (net of depreciation) to durable goods; as Braun (1994) notes, including such returns would lower the average capital tax rate.

My approach is also similar to that used by Joines (1981), McGrattan (1994) and McGrattan et al. (1997), with the main difference being that Joines, McGrattan, and McGrattan et al. estimate the personal income tax rate as a marginal rate from tax records, rather than as an average rate from the national accounts. By way of comparison, when my tax rates are calculated with annual data, the correlation between my average tax rates and the marginal tax rates in McGrattan, et al., after detrending over the period 1958 - 1992, is roughly 0.90 for labor taxes and 0.80 for capital taxes.[36] Directly comparing magnitudes is a little more difficult, because different studies classify income differently. This complication aside, the values of τ_L that I find are of a magnitude similar to those found by Mendoza,

---

[36] When trends are included the correlations rise to 0.93 and 0.85, respectively.

Razin and Tesar, as well as the marginal tax rates found by McGrattan and McGrattan et al., all of which average around 20-25 percent. My estimates of the average tax rates for capital average around 40 percent, which are lower than McGrattan's marginal rates (roughly 50 percent), but similar to those found by Mendoza, Razin and Tesar. Readers interested in other tax series are referred to Joines, and Mendoza, Razin and Tesar, who provide many comparisons and references.

8. Appendix C: Moment Conditions and Estimation Mechanics

The moment conditions used in this paper fall into three distinct "blocks." The first of these blocks is a set of unconditional moments for estimating the parameters $(\tau_K, \tau_L, g, \delta, a, G, \chi, z_0)$, and the idiosyncratic trends $(G_{\tau L}, G_g, G_\delta)$:[37]

$$E\left\{\tau_{Kt} - \tau_K\right\} = 0, \tag{C.1}$$

$$E\left\{[\tau_{Lt} - \tau_L - G_{\tau L}t] \cdot \begin{pmatrix} 1 \\ t/T \end{pmatrix}\right\} = \mathbf{0}, \tag{C.2}$$

$$E\left\{[g_t - g - G_g t] \cdot \begin{pmatrix} 1 \\ t/T \end{pmatrix}\right\} = \mathbf{0}, \tag{C.3}$$

$$E\left\{[\delta_t - \delta - G_\delta t] \cdot \begin{pmatrix} 1 \\ t/T \end{pmatrix}\right\} = \mathbf{0}, \tag{C.4}$$

$$E\left\{\frac{\beta}{G_N G} G \frac{[C_{t-1}/N_{t-1}]}{[C_t/N_t]}\left[(1-\tau_{Kt+1})\left(a\frac{Y_t}{K_t} - \delta_t\right) + 1\right] - 1\right\} = 0, \tag{C.5}$$

$$E\left\{[\ln(Z_t) - z_0 - (1-a)\ln(G) \cdot t] \cdot \begin{pmatrix} 1 \\ t/T \end{pmatrix}\right\} = \mathbf{0}, \tag{C.6}$$

$$E\left\{\ln(\chi_t) - \chi\right\} = 0, \tag{C.7}$$

where t is defined to have a mean of zero, T is the sample size,[38] and the residuals $\ln(\chi_t)$ and $\ln(Z_t)$ are given by

---

[37] This block of equations also includes four equations analogous to equation (C.6) for finding the idiosyncratic trends in output, consumption, investment and capital, as well as an equation for finding the average growth rate of output (which differs from its trend growth rate). (The equations for the trends utilize steady state values implied by the model's parameters.) These estimators are incorporated in the standard errors for all of the estimates shown below.

[38] My approach for handling trends follows Burnside and Eichenbaum (1996).

$$\ln(\chi_t) = \ln\left(\frac{Y_t}{C_t}\right) - \ln\left(\frac{L_t}{N_t}\right) + \ln(1-\tau_{Lt}) + \ln(1-a) + \gamma\ln\left(1 - \frac{L_t}{N_t}\right), \quad \text{(C.8)}$$

$$\ln(Z_t) = \ln(Y_t) - a\ln(K_t) - (1-a)\ln(L_t). \quad \text{(C.9)}$$

The second block of equations contains the orthogonality conditions for estimating the feedback rules:

$$E\left\{\left[\begin{pmatrix} \widehat{\tau}_{Kt+1} \\ \widehat{\tau}_{Lt+1} \\ \widehat{g}_{t+1} \end{pmatrix} - \mathbf{F}_0 \begin{pmatrix} \widehat{y}_{t+1} \\ \widehat{\ell}_{t+1} \end{pmatrix} - \mathbf{F}(L)\,\mathbf{v}_t\right] \otimes \begin{pmatrix} \mathbf{v}_t \\ \mathbf{v}_{t-1} \\ \mathbf{v}_{t-2} \\ \mathbf{v}_{t-3} \\ \widehat{k}_{t+1} \\ \widehat{k}_t \end{pmatrix}\right\} = \mathbf{0}, \quad \text{(C.10)}$$

$$\mathbf{v}_t \equiv \left(\widehat{y}_t, \widehat{\ell}_t, \widehat{\tau}_{Kt}, \widehat{\tau}_{Lt}, \widehat{g}_t\right)'.$$

The final block of equations yields estimates for the forcing processes and their innovations:

$$E\left\{\left[\begin{pmatrix} z_{t+1} \\ d_{t+1} \\ x_{t+1} \end{pmatrix} - \mathbf{\Phi} \begin{pmatrix} z_t \\ d_t \\ x_t \end{pmatrix}\right] \otimes \begin{pmatrix} z_t \\ d_t \\ x_t \end{pmatrix}\right\} = \mathbf{0}, \quad \text{(C.11)}$$

$$E\left\{vech\left(\begin{pmatrix} \boldsymbol{\xi}_{t+1} \\ \boldsymbol{\nu}_{t+1} \end{pmatrix} \begin{pmatrix} \boldsymbol{\xi}_{t+1} \\ \boldsymbol{\nu}_{t+1} \end{pmatrix}' - \mathbf{N}\mathbf{N}'\right)\right\} = \mathbf{0}, \quad \text{(C.12)}$$

where the matrix $\mathbf{N}$ has 21 non-zero elements.

Since the system of equations formed by (C.1) through (C.12) is overidentified, efficient estimation requires two steps. First, consistent but inefficient estimates are found by: (1) finding the sample means given by (C.1) through (C.9);[39] (2) estimating (C.10) with two-stage least squares (after subtracting steady state values and trends estimated in the first step); and (3) using the residuals from parts (1) and (2) to estimate (C.11) and (C.12). These initial estimates are then used to find Hansen's (1982) optimal weighting matrix,

---

[39] Rather than solve equations (C.5) and (C.6) jointly, I first estimate G as the average growth rate of output, and then solve (C.5) and (C.6) in order.

which is in turn used to estimate all the parameters jointly.[40]

---

[40] Since the objective function is irregular, the joint estimation requires a combination of the BFGS and Simplex search algorithms. The latter utilizes code written by Honore and Kyriazidou and downloaded from the electronic GAUSS library at American University. The starting values are the parameters found in the first step of estimation. In general, the parameters change little between the two steps of estimation. Hansen's (1982) overidentification test statistic, here distributed $\chi^2\left(30\right)$, has a value of roughly 23.

Figure 1

The Model’s Driving Processes: 1959.III-1997.III

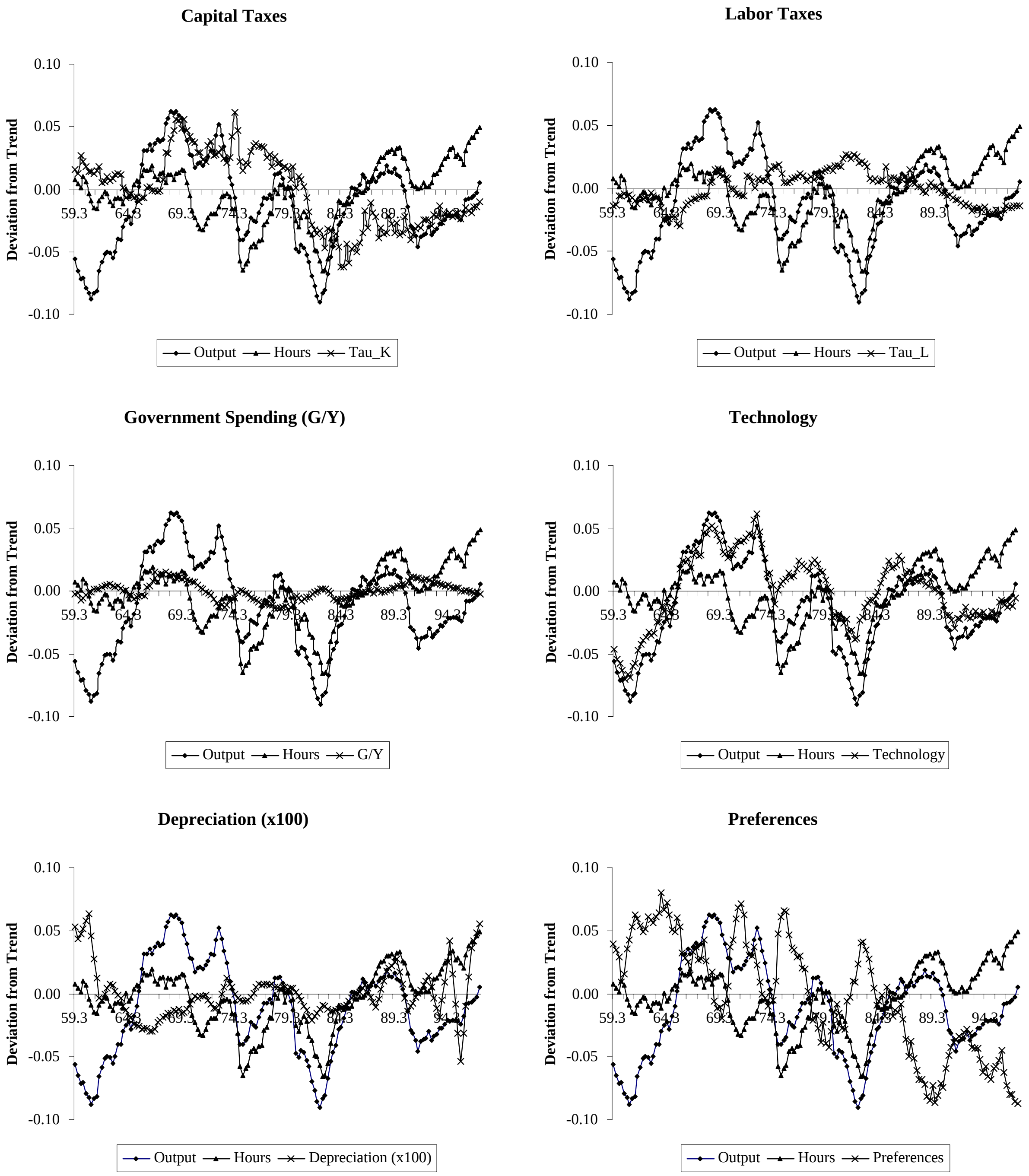


Figure 2

Responses to Independent Exogenous Shocks

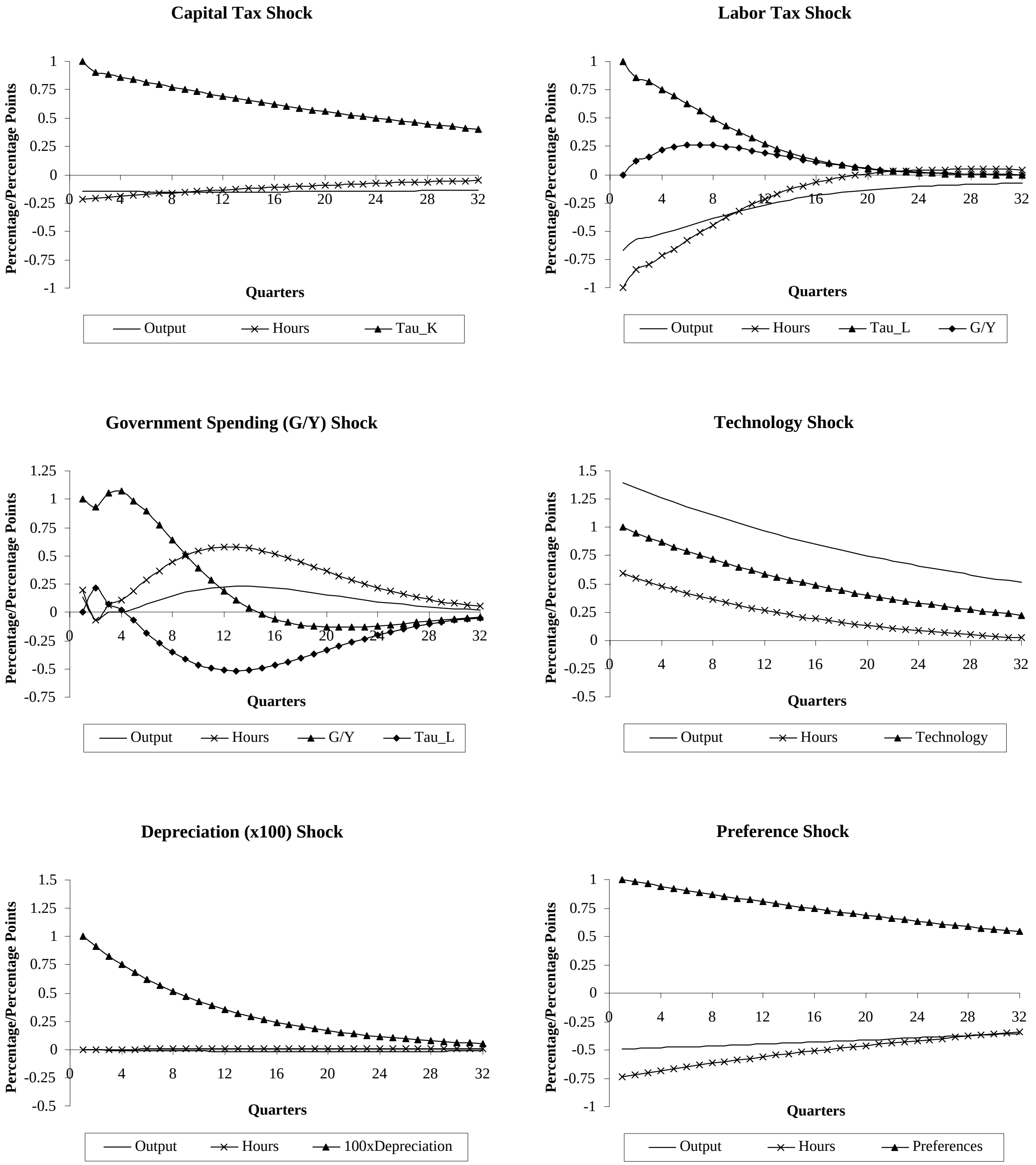
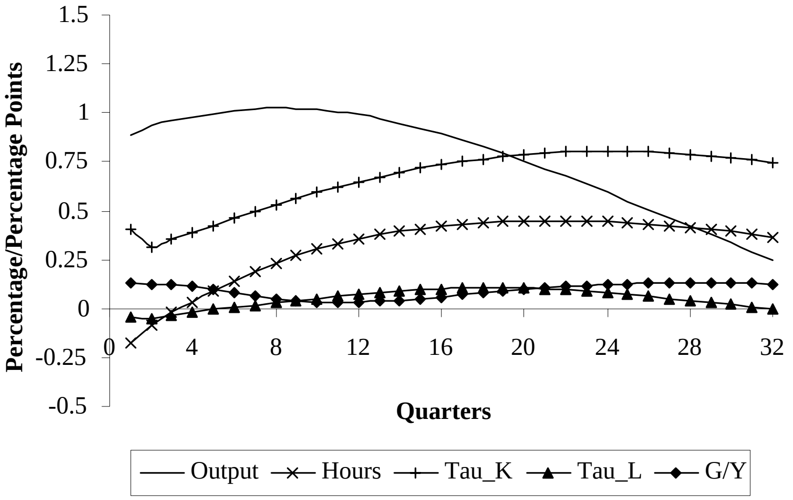


Figure 3

Responses to a Technology Shock

Responses with Feedback Rules



Responses with and without Feedback Rules

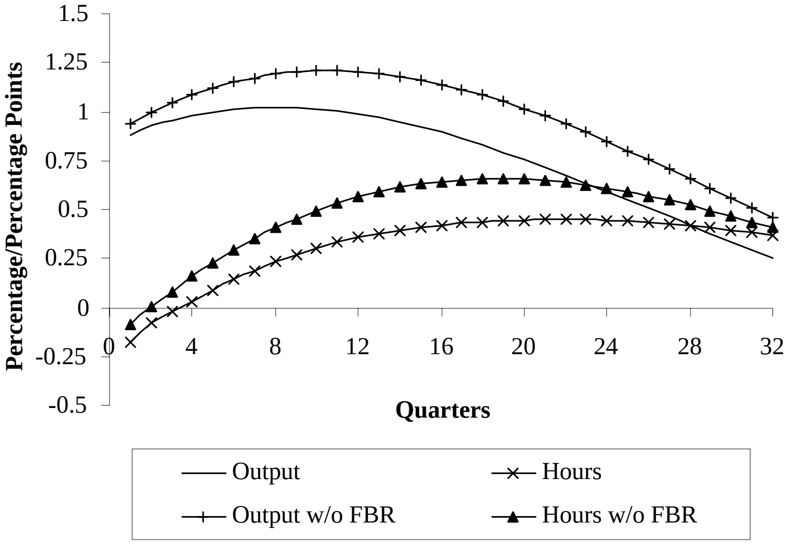


Table 1

Parameter Estimates for Preferences and Technologies[a]

Parameter	
$\beta / [GG_N]$ (Effective Discount Factor)	0.99
γ (1/[Leisure Elasticity of Substitution])	3.0
G_N (Population Growth Rate)	1.0037
a (Capital's Share)	0.328 (0.0024)
δ (Depreciation, in percent)	1.231 (0.0013)
G (Technology Growth Rate)	1.0037 (0.0001)
τ_K (Capital Income Tax Rate)	0.390 (0.0023)
τ_L (Labor Income Tax Rate)	0.231 (0.0012)
g (Government Spending/Output)	0.176 (0.0007)
χ (Leisure Preference Parameter)	0.759 (0.003)
z_0 (Technology Parameter)	1.613 (0.014)

[a] Parameters estimated using equations (D.1) through (D.9). Standard errors (in parentheses) calculated using a Newey-West covariance estimator with six autocovariances. Parameters lacking standard errors were not estimated.

Table 2

Parameter Estimates for Fiscal Policy Feedback Rules[a]

	Dependent Variable		
Explanatory Variable	Capital Taxes ($\widehat{\tau}_{Kt+1}$)	Labor Taxes ($\widehat{\tau}_{Lt+1}$)	Government Spending ($\widehat{g}_{t+1}$)
$\widehat{\ell}_{t+1}$	0.215 (0.125)	0.069 (0.086)	−0.099 (0.063)
$\widehat{\ell}_{t}$	−0.325 (0.147)	0.004 (0.092)	0.134 (0.067)
$\widehat{\ell}_{t-1}$	0.139 (0.058)	−0.090 (0.030)	0.007 (0.023)
$\widehat{\ell}_{t-2}$	NA	NA	−0.044 (0.021)
$\widehat{\ell}_{t-3}$	NA	NA	0.046 (0.018)
$\widehat{y}_{t+1}$	0.500 (0.113)	−0.035 (0.066)	0.131 (0.056)
$\widehat{y}_{t}$	−0.631 (0.162)	−0.003 (0.074)	−0.120 (0.068)
$\widehat{y}_{t-1}$	0.173 (0.072)	0.057 (0.030)	−0.009 (0.028)
$\widehat{y}_{t-2}$	NA	NA	−0.016 (0.026)
$\widehat{y}_{t-3}$	NA	NA	0.010 (0.014)
$\widehat{\tau}_{Kt}$	0.906 (0.038)	NA	NA
$\widehat{\tau}_{Kt-1}$	0.065 (0.042)	NA	NA
$\widehat{\tau}_{Lt}$	NA	0.861 (0.046)	0.117 (0.025)
$\widehat{\tau}_{Lt-1}$	NA	0.057 (0.037)	−0.058 (0.026)
$\widehat{\tau}_{Lt-2}$	NA	NA	0.014 (0.025)
$\widehat{\tau}_{Lt-3}$	NA	NA	−0.033 (0.026)
$\widehat{g}_{t}$	NA	0.212 (0.097)	0.927 (0.067)
$\widehat{g}_{t-1}$	NA	−0.305 (0.083)	0.168 (0.095)
$\widehat{g}_{t-2}$	NA	NA	−0.053 (0.067)
$\widehat{g}_{t-3}$	NA	NA	−0.139 (0.068)

[a] Parameters estimated using equation (25). ℓ denotes logged labor hours, y logged output. Carats "$\widehat{\ }$" denote deviations from values along a balanced growth path. Standard errors (in parentheses) calculated using a Newey-West covariance estimator with six autocovariances.

Table 3

Parameter Estimates for Exogenous Variables[a]

$$\begin{pmatrix}\boldsymbol{\xi}_{t+1}\\ z_{t+1}\\ d_{t+1}\\ x_{t+1}\end{pmatrix} = \begin{bmatrix} \underset{(3\times3)}{\mathbf{0}} & \underset{(3\times1)}{\mathbf{0}} & \underset{(3\times1)}{\mathbf{0}} & \underset{(3\times1)}{\mathbf{0}} \\ \underset{(1\times3)}{\mathbf{0}} & \underset{(0.010)}{0.953} & \underset{(0.018)}{-0.051} & \underset{(0.006)}{0.031} \\ \underset{(1\times3)}{\mathbf{0}} & \underset{(0.013)}{0.028} & \underset{(0.028)}{0.910} & \underset{(0.015)}{-0.026} \\ \underset{(1\times3)}{\mathbf{0}} & \underset{(0.016)}{-0.102} & \underset{(0.027)}{-0.052} & \underset{(0.012)}{0.980} \end{bmatrix} \begin{pmatrix}\underset{(3\times1)}{\mathbf{0}}\\ z_t\\ d_t\\ x_t\end{pmatrix}$$

$$+ \begin{bmatrix} \underset{(0.027)}{0.721} & 0 & 0 & 0 & 0 & 0 \\ \underset{(0.014)}{0.172} & \underset{(0.017)}{0.320} & 0 & 0 & 0 & 0 \\ \underset{(0.014)}{0.025} & \underset{(0.009)}{0.005} & \underset{(0.018)}{0.186} & 0 & 0 & 0 \\ \underset{(0.041)}{-0.106} & \underset{(0.053)}{0.034} & \underset{(0.046)}{-0.314} & \underset{(0.045)}{0.459} & 0 & 0 \\ \underset{(0.025)}{0.011} & \underset{(0.024)}{0.001} & \underset{(0.031)}{-0.008} & \underset{(0.031)}{-0.008} & \underset{(0.110)}{0.723} & 0 \\ \underset{(0.077)}{-0.160} & \underset{(0.100)}{-0.269} & \underset{(0.125)}{0.008} & \underset{(0.089)}{0.362} & \underset{(0.043)}{-0.117} & \underset{(0.041)}{0.928} \end{bmatrix} \boldsymbol{\zeta}_{t+1}$$

---

[a] Parameters estimated using equations (D.11) and (D.12). z_{t+1} gives the deviation of the logged technology shock from its trend value. d_{t+1} gives the deviation of the depreciation rate from its trend value, multiplied by 100. x_{t+1} gives the deviation of the logged leisure preference parameter from its steady state value. $\boldsymbol{\xi}_{t+1}$ is the vector of forecast errors for the fiscal policy feedback rules given by equation (18). $\boldsymbol{\zeta}_{t+1}$ is a martingale difference sequence with $E_t\left\{\boldsymbol{\zeta}_{t+1}\boldsymbol{\zeta}'_{t+1}\right\} = \mathbf{I}$. Responses to the orthogonal innovations are expressed in percentages. Standard errors (in parentheses) are calculated using a Newey-West covariance estimator with six autocovariances.

Table 4

Moments and Correlations for Linearly Detrended Series[a]

	U.S. Data: 1959III-97III	Full System[b]	No Government[c]	Feedback Rules Only[d]	Exogenous Shocks Only[e]
	(1)	(2)	(3)	(4)	(5)
Std. Dev. of Output (%)	3.90 (0.451)	3.90 [0.00]	4.02 (0.88)	3.29 (0.75)	4.89 (0.92)
Std. Dev. of ΔOutput (%)	0.75 (0.067)	0.87 [1.61]	0.76 (0.06)	0.73 (0.08)	0.94 (0.05)
Standard Deviation/Standard Deviation (Output)					
Consumption	0.79 (0.056)	0.55 [−2.83]	0.50 (0.04)	0.55 (0.09)	0.48 (0.05)
Investment	1.96 (0.188)	2.65 [2.49]	2.58 (0.09)	2.46 (0.21)	3.00 (0.12)
Hours	0.64 (0.100)	0.80 [1.44]	0.74 (0.07)	0.88 (0.13)	0.74 (0.04)
Productivity[f]	0.93 (0.096)	0.88 [−0.38]	0.69 (0.08)	0.96 (0.13)	0.63 (0.07)
τ_K	0.74 (0.108)	0.96 [1.07]	NA	0.89 (0.21)	0.60 (0.19)
τ_L	0.33 (0.047)	0.39 [0.72]	NA	0.35 (0.08)	0.18 (0.04)
g	0.18 (0.030)	0.25 [1.33]	NA	0.25 (0.05)	0.13 (0.03)
Contemporaneous Correlation with Output					
Consumption	0.91 (0.032)	0.84 [−1.45]	0.80 (0.03)	0.86 (0.03)	0.78 (0.03)
Investment	0.86 (0.042)	0.85 [−0.17]	0.96 (0.01)	0.85 (0.05)	0.94 (0.02)
Hours	0.42 (0.142)	0.54 [0.73]	0.73 (0.07)	0.48 (0.11)	0.78 (0.06)
Productivity[f]	0.79 (0.069)	0.64 [−1.67]	0.67 (0.08)	0.60 (0.09)	0.68 (0.05)
τ_K	0.31 (0.156)	0.33 [0.07]	NA	0.54 (0.22)	−0.32 (0.10)
τ_L	−0.01 (0.199)	0.47 [1.83]	NA	0.65 (0.16)	0.02 (0.06)
g	0.13 (0.167)	0.15 [0.07]	NA	0.29 (0.17)	−0.30 (0.06)
Contemporaneous Correlation with Hours					
Productivity[f]	−0.23 (0.150)	−0.30 [−0.35]	−0.02 (0.17)	−0.41 (0.15)	0.07 (0.12)
τ_K	−0.20 (0.200)	0.55 [3.25]	NA	0.75 (0.07)	−0.22 (0.07)
τ_L	−0.56 (0.102)	0.00 [2.35]	NA	−0.03 (0.24)	0.02 (0.07)
g	0.30 (0.082)	0.68 [2.87]	NA	0.83 (0.08)	−0.17 (0.07)

Table 4

Moments and Correlations for Linearly Detrended Series (cont)[a]

	U.S. Data: 1959III-97III	Full System[b]	No Government[c]	Feedback Rules Only[d]	Exogenous Shocks Only[e]
	(1)	(2)	(3)	(4)	(5)
Episode Lengths					
Length of Expansions[g]	23.3 (NA)	18.2 [NA]	24.3 (NA)	26.9 (NA)	16.3 (NA)
Length of Recessions[g]	4.8 (NA)	4.1 [NA]	4.5 (NA)	4.0 (NA)	4.3 (NA)

[a] Output, consumption, investment, and productivity are expressed as log deviations from linear trends. Hours are expressed as log deviations from a steady state value based on the model's parameters. Fiscal policies are expressed as deviations from steady state values. (Labor taxes and the government spending ratio have been linearly detrended.) Columns (2) - (5) are found as a function of the model's parameters. Column (1) is estimated from the data. Parentheses give standard errors, which are calculated using a Newey-West covariance estimator with six autocovariances. Square brackets give t-statistics for the differences between the moments generated by the estimated model parameters and the moments found in the data.

[b] Stochastic growth model with fiscal policies fluctuating around their steady state values as functions of their own lagged values and current and lagged hours.

[c] Baseline stochastic growth model with fiscal policies identically zero.

[d] Stochastic growth model with fiscal policies following feedback rules in the absence of exogenous policy shocks.

[e] Stochastic growth model with fiscal policies exogenously fluctuating around their steady state values.

[f] Productivity is defined as output divided by hours.

[g] Recessions and expansions are defined with the rule developed by Boldin (1994). Only complete episodes are used. Episode lengths in columns (2) - (5) are calculated with the mean lengths for 1600 simulations of 150 quarters.

Table 5

Moments and Correlations for HP-filtered Series[a]

	U.S. Data: 1959III-97III	Full System	No Government	Feedback Rules Only	Exogenous Shocks Only
	(1)	(2)	(3)	(4)	(5)
Std. Dev. of Output (%)	1.51 (0.159)	1.18 [−1.97]	1.04 (0.09)	0.97 (0.11)	1.29 (0.08)
Standard Deviation/Standard Deviation (Output)					
Consumption	0.64 (0.023)	0.36 [−4.78]	0.19 (0.02)	0.33 (0.06)	0.25 (0.03)
Investment	2.86 (0.087)	3.79 [6.31]	3.20 (0.06)	3.39 (0.24)	4.09 (0.18)
Hours	0.79 (0.037)	0.95 [2.59]	1.10 (0.07)	1.09 (0.08)	1.01 (0.04)
Productivity	0.56 (0.059)	0.73 [2.06]	0.72 (0.06)	0.78 (0.07)	0.66 (0.04)
τ_K	0.61 (0.087)	0.80 [1.90]	NA	0.50 (0.10)	0.70 (0.05)
τ_L	0.34 (0.051)	0.45 [1.70]	NA	0.19 (0.06)	0.39 (0.03)
g	0.23 (0.028)	0.30 [1.37]	NA	0.21 (0.04)	0.28 (0.05)
Contemporaneous Correlation with Output					
Consumption	0.94 (0.016)	0.60 [−2.93]	0.58 (0.11)	0.55 (0.21)	0.43 (0.12)
Investment	0.94 (0.019)	0.92 [−0.72]	0.99 (0.002)	0.91 (0.03)	0.96 (0.01)
Hours	0.83 (0.041)	0.72 [−1.91]	0.77 (0.04)	0.73 (0.04)	0.79 (0.03)
Productivity	0.61 (0.051)	0.43 [−2.27]	0.21 (0.10)	0.27 (0.10)	0.32 (0.06)
τ_K	0.19 (0.109)	0.26 [0.60]	NA	0.82 (0.06)	−0.27 (0.10)
τ_L	−0.09 (0.131)	0.04 [0.91]	NA	0.50 (0.16)	−0.13 (0.06)
g	−0.55 (0.138)	−0.31 [1.60]	NA	0.09 (0.18)	−0.45 (0.05)
Contemporaneous Correlation with Hours					
Productivity	0.06 (0.093)	−0.31 [−3.06]	−0.46 (0.07)	−0.47 (0.08)	−0.34 (0.06)
τ_K	0.26 (0.108)	0.26 [0.00]	NA	0.79 (0.08)	−0.24 (0.10)
τ_L	0.05 (0.126)	0.11 [0.40]	NA	0.75 (0.15)	−0.17 (0.08)
g	−0.54 (0.102)	−0.16 [2.59]	NA	−0.01 (0.27)	−0.23 (0.09)

[a] See notes to Table 4. The moments presented here are for series passed through the HP filter, using a smoothness parameter of 1600.

Table 6

Variance Decomposition[a]

	Percentage of Variance Attributable to:[b]					
	τ_K	τ_L	g	z	d	x
Linearly Detrended Variables						
Output	9.4 (4.6)	1.6 (1.4)	17.7 (4.8)	32.8 (8.3)	17.0 (9.1)	21.5 (9.0)
Consumption	6.7 (2.9)	5.2 (4.5)	16.7 (8.1)	33.4 (9.1)	27.0 (12.9)	11.0 (11.0)
Investment	11.7 (5.8)	1.7 (1.3)	25.2 (6.1)	20.0 (5.9)	12.3 (6.3)	29.1 (8.3)
Hours	5.1 (3.6)	1.7 (1.5)	8.5 (5.9)	12.4 (8.3)	7.7 (4.8)	64.6 (14.9)
Productivity	2.7 (1.7)	4.3 (2.5)	8.3 (3.6)	23.1 (6.4)	18.7 (10.2)	42.9 (11.7)
τ_K	22.8 (9.2)	0.6 (1.0)	15.4 (5.4)	32.4 (9.8)	13.6 (9.0)	15.3 (9.0)
τ_L	6.4 (2.5)	25.8 (7.8)	7.5 (2.7)	5.5 (4.4)	7.1 (4.6)	47.7 (10.3)
g	2.4 (2.2)	9.7 (3.6)	19.6 (4.8)	11.2 (6.6)	5.8 (4.8)	51.3 (10.4)
Output Growth	7.5 (5.1)	0.2 (0.2)	22.9 (5.5)	23.1 (6.5)	4.7 (2.4)	41.6 (4.3)
HP-filtered Variables						
Output	6.8 (4.8)	0.1 (0.3)	25.3 (6.1)	24.3 (6.3)	5.2 (2.9)	38.2 (4.4)
Consumption	4.0 (2.8)	3.8 (4.5)	34.7 (9.9)	44.3 (9.9)	11.8 (7.8)	1.4 (3.2)
Investment	11.3 (7.8)	0.4 (0.5)	34.4 (9.3)	7.0 (4.1)	8.7 (4.7)	38.2 (7.6)
Hours	4.6 (4.0)	0.8 (0.7)	4.4 (5.0)	2.5 (2.2)	6.8 (3.1)	80.9 (5.1)
Productivity	1.2 (1.2)	1.6 (1.5)	19.1 (9.7)	57.8 (9.4)	6.4 (3.3)	13.9 (2.3)
τ_K	66.6 (8.9)	0.1 (0.1)	6.8 (2.4)	4.8 (2.5)	1.8 (1.1)	19.9 (8.1)
τ_L	17.0 (3.1)	64.5 (5.5)	6.6 (2.2)	1.6 (1.7)	1.4 (0.8)	8.9 (4.8)
g	3.0 (2.3)	8.1 (3.9)	55.0 (7.9)	7.1 (5.1)	1.6 (1.5)	25.2 (6.6)

[a] See notes to Tables 3, 4 and 5.

[b] Percentage of variance due to each of the orthogonal shocks in the Choleski decomposition shown in Table 3. τ_K indicates the capital tax shock (first row of the innovation matrix), while τ_L, g, z, d and x give the labor tax, government spending, technology, depreciation and preference shocks, respectively.

Table 7

Effects of Fiscal Policy on Output Volatility[a]

	Baseline[b]	Sparser Feedback Rules[c]	$\gamma = 1$[d]	New Measure of g[e]	New Measure of Hours[f]
	(1)	(2)	(3)	(4)	(5)
Standard Deviation of Linearly Detrended Output (%)					
No Government[g]	4.02	4.01	4.66	4.83	3.68
Feedback Rules Only[g]	3.29	3.48	3.36	4.03	3.28
Exogenous Shocks Only[g]	4.89	4.81	5.78	5.49	4.12
Full System[g]	3.90	3.94	4.08	4.42	3.54
Full System less No Government	−0.12 (0.19)	−0.08 (0.14)	−0.57 (0.31)	−0.41 (0.29)	−0.15 (0.12)
Standard Deviation of HP-filtered Output (%)					
No Government[g]	1.04	1.10	1.23	1.16	1.17
Feedback Rules Only[g]	0.97	1.08	1.01	1.17	1.14
Exogenous Shocks Only[g]	1.29	1.27	1.51	1.30	1.37
Full System[g]	1.18	1.20	1.24	1.27	1.31
Full System less No Government	0.14 (0.06)	0.10 (0.05)	0.01 (0.08)	0.11 (0.06)	0.14 (0.05)

[a] See notes to Tables 4 and 5.
[b] Model presented in Tables 4 and 5.
[c] Model presented in Tables 4 and 5 using the sparser fiscal policy feedback rules shown in Table 8.
[d] Model presented in Table 4 and 5 under the assumption of logarithmic preferences for leisure.
[e] Model presented in Table 4 and 5 with revised measure of government spending.
[f] Model presented in Table 4 and 5 with revised measure of labor hours.
[g] These four rows correspond to columns (2) through (5) of Tables 4 and 5.

Table 8

Parameter Estimates for Fiscal Policy Feedback Rules[a]

	Dependent Variable		
Explanatory Variable	Capital Taxes ($\widehat{\tau}_{Kt+1}$)	Labor Taxes ($\widehat{\tau}_{Lt+1}$)	Government Spending ($\widehat{g}_{t+1}$)
$\widehat{\ell}_{t+1}$	0.233 (0.109)	0.005 (0.055)	-0.055 (0.043)
$\widehat{\ell}_{t}$	-0.351 (0.131)	0.088 (0.061)	0.077 (0.053)
$\widehat{\ell}_{t-1}$	0.147 (0.053)	-0.115 (0.026)	0.030 (0.020)
$\widehat{\ell}_{t-2}$	NA	NA	-0.068 (0.019)
$\widehat{\ell}_{t-3}$	NA	NA	0.040 (0.013)
$\widehat{y}_{t+1}$	0.488 (0.080)	-0.043 (0.047)	0.023 (0.043)
$\widehat{y}_{t}$	-0.633 (0.126)	-0.005 (0.054)	-0.004 (0.055)
$\widehat{y}_{t-1}$	0.187 (0.068)	0.066 (0.024)	-0.019 (0.023)
$\widehat{y}_{t-2}$	NA	NA	-0.009 (0.020)
$\widehat{y}_{t-3}$	NA	NA	0.009 (0.011)
$\widehat{\tau}_{Kt}$	0.898 (0.035)	NA	NA
$\widehat{\tau}_{Kt-1}$	0.078 (0.036)	NA	NA
$\widehat{\tau}_{Lt}$	NA	0.874 (0.031)	NA
$\widehat{\tau}_{Lt-1}$	NA	0.054 (0.031)	NA
$\widehat{g}_{t}$	NA	NA	0.981 (0.054)
$\widehat{g}_{t-1}$	NA	NA	0.127 (0.077)
$\widehat{g}_{t-2}$	NA	NA	-0.017 (0.057)
$\widehat{g}_{t-3}$	NA	NA	-0.189 (0.063)

[a] Parameters estimated using equation (25). ℓ denotes logged labor hours, y logged output. Carats "$\widehat{\ }$" denote deviations from values along a balanced growth path. Standard errors (in parentheses) calculated using a Newey-West covariance estimator with six autocovariances.

References

Ambler, S. and A. Paquet, 1994. Stochastic Depreciation and the Business Cycle. International Economic Review 35, 101-116.

Ambler, S. and A. Paquet, 1996. Fiscal Spending Shocks, Endogenous Government Spending, and Real Business Cycles. Journal of Economic Dynamics and Control 20, 237-256.

Baxter, M. and R.G. King, 1991. Productive Externalities and Business Cycles. Federal Reserve Bank of Minneapolis, Institute for Empirical Macroeconomics, Discussion Paper 53.

Baxter, M. and R.G. King, 1993. Fiscal Policy in General Equilibrium. American Economic Review 83, 315-334.

Bencivenga, V.R., 1992. An Econometric Study of Hours and Output Variation with Preference Shocks. International Economic Review 33, 449-471.

Blanchard, O.J., and C.M. Kahn, 1980. The Solution of Linear Difference Models Under Rational Expectations. Econometrica 48, 1305-1311.

Blanchard, O.J., and R. Perotti, 1999. An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. Mimeo, MIT and Columbia University.

Boldin, M., 1994. Dating Turning Points in the Business Cycle. Journal of Business 67, 97-131.

Braun, R.A., 1994. Tax Disturbances and Real Economic Activity in the Postwar United States. Journal of Monetary Economics 33, 441-462.

Broze, L., C. Gourieroux and A. Szafarz, 1985. Solutions of Linear Rational Expectations Models. Econometric Theory 1, 341-368.

Broze, L., C. Gourieroux and A. Szafarz, 1995. Solutions of Multivariate Rational Expectations Models. Econometric Theory 11, 229-257.

Burnside, A.C., 1999. Real Business Cycle Models: Linear Approximation and GMM Estimation. Mimeo, The World Bank.

Burnside, A.C., and M. Eichenbaum, 1996. Factor Hoarding and the Propagation of Business-Cycle Shocks. American Economic Review 86, 1154-1174.

Burnside, A.C., M. Eichenbaum, and J. Fisher 1999. Assessing the Effects of Fiscal Shocks. Federal Reserve Bank of Chicago Working paper WP-99-18.

Burnside, A.C., M. Eichenbaum and S. Rebelo, 1993. Labor Hoarding and the Business Cycle. Journal of Political Economy 101, 245-273.

Campbell, J.Y., 1994. Inspecting the Mechanism. Journal of Monetary Economics 33, 463-506.

Cazzavillan, G., 1996. Public Spending, Endogenous Growth and Endogenous Fluctuations. Journal of Economic Theory 71, 394-415.

Chang, L.J., 1995. Business Cycles with Distorting Taxes and Disaggregated Capital Markets. Journal of Economic Dynamics and Control 19, 985-1009.

Chari, V.V., L.J. Christiano and P.J. Kehoe, 1994. Optimal Fiscal Policy in a Business Cycle Model. Journal of Political Economy 102, 617-652.

Christiano, L.J., and M. Eichenbaum, 1992. Current Real-Business-Cycle Theories and Aggregate Labor-Market Fluctuations. American Economic Review 82, 430-450.

Christiano, L.J., M. Eichenbaum, and C. Evans, 1998. Modelling Money. NBER working paper No. 6731.

Christiano, L.J., and S.G. Harrison, 1999. Chaos, Sunspots, and Automatic Stabilizers. Journal of Monetary Economics 44, 3-31.

Cooley, T.F., and E.C. Prescott, 1995. Economic Growth and Business Cycles. In: T.F. Cooley, (Ed.), Frontiers of Business Cycle Research. Princeton, New Jersey, Princeton University Press.

Council of Economic Advisors, 1976. Economic Report of the President, 1976. U.S. Government Printing Office, Washington, D.C.

Diebold, F.X., and G.D. Rudebusch, 1992. Have Postwar Economic Fluctuations Been Stabilized? American Economic Review 82, 993-1005.

Edelberg, W., M. Eichenbaum, and J. Fisher, 1999. Understanding the Effects of a Shock to Government Purchases. Review of Economic Dynamics 2, 1999, 166-206.

Farmer, R.E.A., 1993. The Macroeconomics of Self-Fulfilling Prophecies. The MIT Press, Cambridge, MA

Farmer, R.E.A., and J.T. Guo, 1994. Real Business Cycles and the Animal Spirits Hypothesis. Journal of Economic Theory 63, 42-72.

Farmer, R.E.A., and J.T. Guo, 1995. The Econometrics of Indeterminacy: An Applied Study. Carnegie-Rochester Conference Series on Public Policy 43, 225-272.

Finn, M.G., 1998. Cyclical Effects of Government's Employment and Goods Purchases. International Economic Review 39, 635-657.

Greenwood, J., and G.W. Huffman, 1991. Tax Analysis in a Real Business Cycle Model: On Measuring Harberger Triangles and Okun Gaps. Journal of Monetary Economics 94, 167-190

Guo, J.T., and K.J. Lansing, 1994. Tax Structure, Optimal Fiscal Policy, and the Business Cycle. Federal Reserve Bank of Cleveland Economic Review 30, 2-14.

Guo, J.T., and K.J. Lansing, 1996. Fiscal Policy, Increasing Returns, and Endogenous Fluctuations. Mimeo, University of California, Riverside, and Federal Reserve Bank of Cleveland.

Guo, J.T., and K.J. Lansing, 1998. Indeterminacy and Stabilization Policy. Journal of Economic Theory 82, 481-490.

Hall, R.E., 1997. Macroeconomic Fluctuations and the Allocation of Time. NBER Working Paper 5933.

Hamilton, J.D., 1994. Time Series Analysis. Princeton University Press, Princeton, NJ.

Hansen, L.P., 1982. Large Sample Properties of Generalized Method of Moments Estimators. Econometrica 50, 1029-1054.

Herman, S.W., and A.J. Katz, 1997. Improved Estimates of Fixed Reproducible Wealth, 1929-95. Survey of Current Business 77, 69-92.

Holland, A., and A. Scott, 1998. The Determinants of UK Business Cycles. The Economic Journal 108, 1067-1092.

Ingram, B.F., N.R. Kocherlakota, and N.E. Savin, 1994. Explaining Business Cycles: A Multiple-shock Approach. Journal of Monetary Economics, 34 415-428.

Joines, D.H., 1981. Estimates of Effective Marginal Tax Rates on Factor Incomes. Journal of Business 54, 191-226.

Jonsson, G., and P. Klein, 1996. Stochastic Fiscal Policy and the Swedish Business Cycle. Journal of Monetary Economics 38, 245-268.

King, R.G., C.I. Plosser and S.T. Rebelo, 1987. Production, Growth and Business Cycles: Technical Appendix. Mimeo, University of Rochester.

King, R.G., C.I. Plosser and S.T. Rebelo, 1988. Production, Growth and Business Cycles I. The Basic Neoclassical Model. Journal of Monetary Economics, 21 195-232.

Klein, P., 2000. Using the Generalized Schur Form to Solve a System of Linear Expectational Difference Equations. Journal of Economic Dynamics and Control 24, 1405-1423.

Kollman, R., 1995. Fiscal Policy, Productivity Shocks, and the U.S. Trade Balance Deficit. Federal Reserve Bank of Minneapolis, Institute for Empirical Macroeconomics, Discussion Paper 98.

Kopcke, R.W., 1993. The Determinants of Business Investment: Has Capital Spending Been Surprisingly Low? New England Economic Review, January/February 1993, 3-31.

Lansing, K.J., 1997. Optimal Fiscal Policy in a Business Cycle Model with Public Capital. Canadian Journal of Economics 31, 337-364.

Leeper, E.M., 1991. Equilibria under ‘Active’ and ‘Passive’ Monetary and Fiscal Policies. Journal of Monetary Economics 27, 129-147.

Leeper, E.M., and C.A. Sims, 1994. Toward a Modern Macroeconomic Model Usable for Policy Analysis. In: S. Fischer and J. Rotemberg (Eds.), NBER Macroeconomics Annual 1994, 81-118.

McGrattan, E.R., 1991. The Macroeconomic Effects of Distortionary Taxation. Federal Reserve Bank of Minneapolis, Institute for Empirical Macroeconomics, Discussion Paper 37.

McGrattan, E.R., 1994. The Macroeconomic Effects of Distortionary Taxation. Journal of Monetary Economics 33, 573-601.

McGrattan, E.R., R. Rogerson and R. Wright, 1997. An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy. International Economic Review 38, 267-290.

Mendoza, E.G., A. Razin, and L.L. Tesar, 1994. Effective Tax Rates in Macroeconomics: Cross-country Estimates of Tax Rates on Factor Incomes and Consumption. Journal of Monetary Economics 34, 297-323.

Newey, W.K., and K.D. West, 1987. A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. Econometrica 55, 703-708.

Ohanian, L.E., 1997. The Macroeconmic Effects of War Finance in the United States: World War II and the Korean War. American Economic Review 87, 23-40.

Otrok, C., 2001, On Measuring the Welfare Cost of Business Cycles, Journal of Monetary Economics 47, 61-92.

Parkin, M., 1988. A Method for Determining Whether Parameters in Aggregative Models are Structural. Carnegie-Rochester Conference Series on Public Policy 29, 215-252.

Ramey, V., and M.D. Shapiro, 1998. Costly Capital Reallocation and the Effects of Government Spending. Carnegie-Rochester Conference Series on Public Policy 48, 145-194.

Reilly, K.T., 1994. Annual Hours and Weeks in a Life-cycle Labor Supply Model: Canadian Evidence on Male Behavior. Journal of Labor Economics 12, 460-477.

Romer, C.D., 1986a. Spurious Volatility in Historical Unemployment Data. Journal of Political Economy 94, 1-37.

Romer, C.D., 1986b. Is the Stabilization of the Postwar Economy a Figment of the Data? American Economic Review 76, 314-334.

Schmitt-Grohe, S., and M. Uribe, 1997. Balanced-Budget Rules, Distortionary Taxes, and Aggregate Instability. Journal of Political Economy 105, 976-1000.

Sims, C.A., 1994. A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy. Economic Theory 4, 381-399.

Sims, C.A., 1997. Solving Linear Rational Expectations Models. Mimeo, Yale University.

Watson, M.W., 1994. Business Cycle Durations and Postwar Stabilization of the U.S. Economy. American Economic Review 84, 24-46.

U.S. Department of Commerce, Bureau of Economic Analysis, 1975. Survey of Current Business, 55 (April).

U.S. Department of Labor, Bureau of Labor Statistics, 1999. Employment and Earnings (March).