MACRO POLICY AND INFLATION: AN OVERVIEW

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Abstract. Inflation depends generically on current and expected monetary and fiscal policies. There are three ways to carry $1 today into the future: money, bonds, and real assets. That dollar’s purchasing power varies inversely with the price level. The real return on money depends on the flow of transactions services it supports and the expected inflation rate; the analogous return on bonds is the nominal interest rate, adjusted for risk and expected inflation; the returns on real assets are their marginal products, adjusted for risk. Arbitrages among money balances, bonds, and investment goods determine their relative values and demands. Expected money growth, tax rates, and government spending directly impinge on these expected rates of return and determine the price level and inflation rate. Given an initial tax reduction that is financed by new government debt, the paper considers alternative responses of current and future policies that are feasible, and derives the implications for inflation in several standard environments.

1. Introduction

Conventional Keynesian thinking about macro policy focuses on the impacts of current government spending, tax, and interest rate policies on employment, personal income, and aggregate demand. Impacts on inflation depend on where the economy is operating relative to potential output. If the economy is at or near potential, a stimulus to demand raises inflation through the usual Phillips curve mechanisms.

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resource utilization is slack, however, the inflationary consequences are benign. This thinking underlies nearly all reporting in the financial press about macro policies.

Over the past 30 years, this static perspective on policy has been extended to include an intertemporal dimension, often with surprising results. Barro (1974) showed that if individuals rationally discount future tax liabilities associated with current bond-financed tax cuts, then tax-debt policies are neutral. Sargent and Wallace (1981) argued that if fiscal policy is constant in a certain sense, then current tighter monetary policy must raise inflation in the future and may raise inflation now. Both unconventional outcomes hinge on particular assumptions about how future policies respond to expansions in current government debt.

There are many possible interactions between monetary and fiscal policies. At any point in time, monetary and fiscal authorities can raise revenues through direct income taxes or indirect inflation taxes, and it can reduce spending by purchasing fewer goods or by reducing transfer payments. A government can also sell debt to cover any shortfall between revenues and expenditures. As an obligation of the government, debt creates dynamic interactions between current and future policies. Any current policies that increase real government indebtedness must generate changes in future policies to service or retire the new debt. Similarly, any future policies that imply reduced debt service must induce changes in current policies to ensure lower debt is carried into the future. In economies like the United States, where there is no institutional mechanism linking actions of monetary and fiscal policy authorities, it is extraordinarily difficult to predict which among the set of policy interactions that theory says must occur actually will occur.

Dynamic analysis of macro policies leads to a more fundamental understanding of the inflationary impacts of fiscal policy than is reflected in the Keynesian perspective. The equilibrium price level and inflation rate emerge from the valuation of all assets jointly. By this perspective, current and expected future policies take center stage: it is not meaningful to ask about the effects of bigger budget deficits without coupling them with some consistent set of expected policies.

There is plenty of precedent for this topic that predates more recent, formal discussion. Important work includes Friedman (1948, 1960), Brunner and Meltzer (1972, 1993), and Tobin (1961, 1969, 1980). Aiyagari and Gertler (1985) is a relatively recent important contribution. Sargent and Wallace (1981) lay the foundation for what is now referred to as “the fiscal theory of the price level,” as developed in Leeper (1991, 1993), Sims (1994), and Woodford (1994, 1995). The fiscal theory is now part of standard graduate macro curricula [Elmendorf and Mankiw (1999), Ljungqvist and Sargent (2000), Walsh (2003), and Woodford (2003)].
Two key questions arise in dynamic analyses of policy:

1. What are the liabilities of the government in the future?
2. How do reasonable expectations about future policy influence current decisions and the impacts of policy?

These questions are addressed in an environment with an array of assets that at a minimum includes money, government debt, and capital. One dollar today has purchasing power $1/P_t$, where $P_t$ is the current price level. The real return on non-interest-bearing money between today and tomorrow depends on the flow of transactions services it supports and the expected inflation rate, $\pi_{t+1} = P_{t+1}/P_t$; the analogous return on bonds is the nominal interest rate, $R_t$, adjusted for risk and for expected inflation; the return on real assets is $r_t$, adjusted for risk. Arbitrages among money balances, bonds, and investment goods determine their relative values and demands. Expected money growth, tax rates, and government spending directly impinge on these expected rates of return and determine the price level and inflation rate. Only in special and rare circumstances can the arbitrages be separated so that inflation becomes an entirely monetary or entirely fiscal phenomenon. Inflation, therefore, depends generically on expected future monetary and fiscal policies.

This framework is ubiquitous and applies to all policy analyses. Formal models detail policy transmission mechanisms and specify how expectations are formed. But the general message should not be lost in the details: expected monetary and fiscal policies determine relative rates of return, portfolio choices, current policy options, and the equilibrium.

Although equilibrium restricts the dynamic interactions among macro policies, there remains a rich class of feasible policies. Sections 2-4 use standard macro models to explore that class of policies and derive the equilibria produced by alternative policy specifications. The models increase in their complexity and their realism. The sections consider the consequences of an expansion in nominal government liabilities engineered by a bond-financed tax reduction in those models. Several themes run through the theory:

- Any statement about the impacts of monetary (fiscal) policy necessarily carries assumptions about fiscal (monetary) policy behavior.
- Any given monetary (fiscal) policy action can generate a range of responses of current and future inflation, depending on what economic decision makers expect future policies will be.
- Predicting the inflation consequences of a policy action requires specifying all current and expected future monetary and fiscal policies.
Section 5 applies the theory to address two practical issues tied to U.S. data: the possibility that countercyclical monetary and fiscal policies are counterproductive in the sense that they exacerbate and prolong the business cycle; the potential inflation impacts of U.S. demographic changes that imply substantial increases in social security and medicare expenditures in this century. The paper concludes with a discussion of future directions for research.

2. A Simple Model

We begin with the simplest perfect foresight model for describing the relationship between monetary and fiscal policies and inflation. Substitution between real and nominal assets is eliminated by assuming an endowment economy with lump-sum taxes. This simplification occurs with important loss of generality, as section 4 shows.

2.1. Setup. An infinitely lived representative household is endowed with a constant quantity $y$ of goods each period and chooses $\{c_t, M_t, B_t\}$ to solve

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) + v(M_t/P_t)], \quad 0 < \beta < 1,$$

subject to

$$c_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} + \tau_t \leq y + \frac{M_{t-1}}{P_{t-1}} + \frac{R_{t-1}B_{t-1}}{P_{t-1}},$$

with $M_t \geq 0$, where $M_t$ is nominal money balances, $B_t$ is a nominal bond that costs $1 at $t$ and pays $R_t$ dollars at $t+1$, and $\tau_t$ is lump-sum taxes (if positive) and transfers (if negative). Initial assets $M_{-1} + R_{-1}B_{-1} > 0$ are given. For now, we consider perfect foresight equilibria, so the $E_t$ operator denotes equilibrium expectations of private agents over future policy; it distinguishes between current and past policies (dated $t$ and earlier) and future policies (dates $s > t$).

The government chooses $\{M_t, B_t, \tau_t\}$ to finance a constant level of purchases of goods, $g$, to satisfy the government budget constraint

$$g = \frac{M_t - M_{t-1}}{P_t} + \frac{B_t - R_{t-1}B_{t-1}}{P_t} + \tau_t.$$ 

2.2. Equilibrium. Arbitrage between the two nominal assets—money and bonds—equates the marginal rate of substitution between consumption and real money balances to the opportunity cost of holding money:

$$\frac{v'(M_t/P_t)}{u'(c_t)} = \frac{R_t - 1}{R_t}. $$
Market clearing implies that \( c_t = c = y - g \) for all \( t \), and money and bond markets clear by equating the private sector’s demand for the assets to the policy authority’s supply. Imposing equilibrium yields a simple Fisher relation

\[
R_t = \beta^{-1} E_t \pi_{t+1},
\]

where \( 1/\beta \) is the constant real interest rate, and from (4), an equilibrium real balances (“money demand”) relation

\[
v'(M_t/P_t) = u'(c) \frac{R_t - 1}{R_t}.
\]

We focus on circumstances in which the economy is in a stationary equilibrium at dates \( s > t \), but starts from a different equilibrium at \( t \). This breaks time into two periods: now and the future. Assume policies are fixed in the future stationary equilibrium:

\[
\tau_s = \tau, \quad \rho_s = \rho, \quad s > t,
\]

where \( \rho_s = M_t/M_{t-1} \) is the growth rate of the money supply. At \( t \), however, policies may be different:

\[
\tau_t \neq \tau, \quad \rho_t \neq \rho.
\]

In the stationary equilibrium with constant real money balances, inflation, \( \pi \), depends only on money growth:

\[
\pi = \rho.
\]

Combining this with the Fisher relation implies that in the stationary equilibrium the nominal rate depends on money growth,

\[
R_s = \beta^{-1} \rho_{s+1}, \quad s \geq t,
\]

so stationary real balances is

\[
\frac{M_s}{P_s} = f(\rho_{s+1}), \quad s \geq t.
\]
2.3. **Equilibrium Expectations.** We now derive two versions of the government budget constraint that describe the trade-offs among current and future monetary and fiscal policies that can arise in equilibrium. Imposing equilibrium prices on (3) at $t$,

$$f(\rho) \left[ 1 + \frac{B_t}{M_t} - \frac{1}{\rho_t} \left(1 + \frac{R_{t-1}B_{t-1}}{M_{t-1}}\right) \right] = g - \tau_t. \quad (12)$$

For given policies in the (future) stationary equilibrium, (12) reports the feasible trade-offs among current (date $t$) policies, when initial government liabilities are $(M_{t-1}, R_{t-1}B_{t-1})$. Imposing equilibrium on the government budget constraint for dates $s > t$, and assuming future policy is anticipated (so $R = \beta^{-1}\rho$),

$$f(\rho) \left[ 1 - 1/\rho + \left(1 - \frac{1}{\beta}\right) \frac{B}{M} \right] = g - \tau, \quad (13)$$

where we assume that $B_t/M_t = B/M$, so the bond-money ratio is constant in the stationary equilibrium at $B/M$. For a given state of government indebtedness, $B/M$, (13) describes the trade-offs among future policies that are consistent with equilibrium. The bond-money ratio, which links current policies to future policies, can equivalently be thought of in terms of the real value of government debt outstanding or the debt-output ratio.

2.4. **Bond-Financed Tax Cut.** In the policy experiments we consider, the level of government spending is held fixed at $g$. The experiments take the form of an initial cut in taxes at $t$, $d\tau_t < 0$, which is financed by new sales of nominal bonds, and then they consider alternative responses of current and future policies that satisfy (12) and (13). The analysis traces the impacts of each complete specification of policy behavior on the price level and inflation.

2.4.1. **Policy 1.** Hold current and future money growth, $(\rho_t, \rho)$, fixed. By (10) and (11), this policy pegs the nominal interest rate at $R = \rho/\beta$ and fixes equilibrium real balances at $f(\rho)$. Neither the initial price level, $P_t$, nor the stationary inflation rate, $\pi$, change. A reduction in real taxes today is consistent with equilibrium today if nominal debt expands to satisfy (12) with fixed money growth. This raises $B_t/M_t$, which by (13) requires that future taxes rise sufficiently to service the new, higher level of government indebtedness. This mix of policies implies Ricardian Equivalence: the timing of taxes and debt is irrelevant for equilibrium allocations and prices. The policies also imply monetary policy is independent of fiscal considerations, as the quantity theory of money maintains. Of course, as this exercise illustrates, the quantity theory requires a particular kind of fiscal behavior.
2.4.2. **Policy 2.** The central bank credibly pegs the nominal interest rate by fixing future money growth, $\rho$, and the fiscal authority credibly fixes future taxes, $\tau$. Can this be an equilibrium? With future policies fixed, (13) implies current policies cannot alter government indebtedness in the future, summarized by $B/M$, so the expansion in nominal debt cannot be transformed into higher real debt. $P_t$ must rise in proportion to $B_t$. But a pegged nominal interest rate fixes real money balances, according to (11), so the current money stock must expand in proportion to the increase in prices, ensuring no change in $B_t/M_t$ in (12). The central bank loses control of the current money stock and the price level, as adjustments in these variables are governed by fiscal needs that are beyond the bank’s direct control. A pegged nominal rate subordinates current monetary policy to fiscal needs, but this is not “monetization of deficits” in the usual sense of printing money to purchase newly issued government debt. Instead, the expansion in money is a passive adjustment of the money supply to clear the money market at the prevailing interest rate and price level. The monetary expansion is given by $dM_t = dB_t/(B_t/M_t)$, making clear that the monetary accommodation varies inversely with the level of indebtedness.\(^1\)

2.4.3. **Policy 3.** The central bank fixes current money growth, $\rho_t$, while the fiscal authority continues to hold future taxes constant. Because some future policy is free to adjust, it’s feasible for current policy to imply more debt in the future. To service that higher debt, future money growth and inflation must rise, increasing the nominal interest rate and reducing real money balances at $t$. Since $M_t$ is fixed, $P_t$ must rise to clear the money market. It is higher inflation and seigniorage revenues—revenues derived from the “inflation tax” on nominal assets—that service future debt. Again, with future net-of-interest fiscal deficits held fixed at $g - \tau$, monetary policy is constrained by fiscal needs and, in this case, the central bank loses control of future inflation.\(^2\)

### 3. A Simple Model with Random Policies

The model in the previous section helps set the logic of how current and future macro policies interact to determine the equilibrium. Stationary analysis, however,

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\(^1\)This exercise corresponds to “the fiscal theory of the price level” as described by Leeper (1991), Sims (1994), and Woodford (1995). As Cochrane (2001) observes, the precise result discussed relies on government debt being sold at par. If it sold at a discount instead, the price of bonds may absorb some of the adjustment to equilibrium, offsetting some of the price level impacts.

\(^2\)Sargent and Wallace (1981) employ these assumptions about policy in their classic “Unpleasant Monetarist Arithmetic” example.
can make it difficult to link the results to observed time series. It can also be informative to characterize policy behavior in terms of simple rules, rather than sequences of policy variables. For example, it is now popular to describe the Federal Reserve’s policy of “leaning against the wind” as raising the federal funds rate whenever the inflation rate exceeds the Fed’s target level [Taylor (1993)].

3.1. Setup. To the model in section 2 we append the following rules for monetary policy:

\[ R_t = e^{\alpha_0} \pi_t^\alpha \theta_t \]  

and for tax policy:

\[ \tau_t = e^{\alpha_0} b_{t-1}^\gamma \psi_t, \]  

where \( b_{t-1} = B_{t-1}/P_{t-1} \) is real debt at the end of period \( t-1 \), which is carried into period \( t \), and \( \theta \) and \( \psi \) are random variables with unit mean, possibly serially correlated, describing exogenous changes in monetary and tax policy. With this modification, the expectations operator \( E_t \) is now taken with respect to \( \Omega_t = \{ \theta_{t-j}, \psi_{t-j}, j \geq 0 \} \). Random policies shift the focus of fiscal finance away from average and toward marginal sources of revenues.

3.2. Equilibrium. Randomness coupled with policy rules makes the model analytically intractable, so analysis focuses on local dynamics in the neighborhood of the steady state when the policy shocks are identically zero. Define the percentage deviation from steady state as \( \hat{x}_t \equiv \ln x_t - \ln \bar{x} \), where \( \bar{x} \) denotes steady state value. The model reduces to a system of two linear stochastic difference equations in inflation and real debt:\(^3\)

\[ E_t \hat{\pi}_{t+1} = \alpha \hat{\pi}_t + \hat{\theta}_t \]  

and

\[ \hat{b}_t + \lambda_1 \hat{\pi}_t - [\beta^{-1} - \gamma(\beta^{-1} - 1)] \hat{b}_{t-1} + \lambda_2 \hat{\pi}_{t-1} + [\beta^{-1} - 1] \hat{\psi}_t + \lambda_3 \hat{\theta}_t + \lambda_4 \hat{\theta}_{t-1} = 0, \]  

where

\[ \lambda_1 = \frac{m}{\theta} (\alpha \varphi + 1) + \beta^{-1} \]  
\[ \lambda_2 = -\alpha \left[ \frac{m}{\theta} \varphi + \beta^{-1} \right] \]  
\[ \lambda_3 = \frac{m}{\theta} \varphi \]  
\[ \lambda_4 = - \left[ \frac{m}{\theta} \varphi + \beta^{-1} \right]. \]  

\(^3\)Leeper (1991) contains a more complete derivation.
\( \varphi \) is the negative interest elasticity of money demand and \( m/b \) is the steady state money-debt ratio expressed in terms of real balances and real debt.\(^4\) Expression (17) is simplified by focusing on a steady state with no government spending (\( \bar{g} = 0 \)) and a constant price level (\( \bar{\pi} = 1 \)). The eigenvalues of (16) and (17) are \( \alpha \) and \( \beta^{-1} - \gamma(\beta^{-1} - 1) \), and a unique saddle-path equilibrium requires (the modulus of) the two roots to lie on either side of 1 [Blanchard and Kahn (1980)]. We focus on two economically meaningful regions of the policy parameter space for which unique equilibria exist:

\[
\text{Region I: } \alpha > 1 \text{ and } \gamma > 1 \\
\text{Region II: } \alpha < 1 \text{ and } \gamma < 1.
\] (19)

Policy impacts on inflation are qualitatively different across the two regions.

Policy behavior in the two regions is "active" or "passive," referring to the constraints a policy authority faces. An active authority pays no attention to the state of government debt and is free to set its control variable as it sees fit. Monetary policy is active in Region I and fiscal policy is active in Region II. A passive authority responds to government debt in a manner constrained by the equilibrium, which depends on private behavior and the active authority’s actions. Fiscal policy is passive in Region I and monetary policy is passive in Region II.

3.3. **Bond-Financed Tax Cut.** An exogenous reduction in taxes is parameterized as a negative realization of the shock to the tax rule, \( \psi_t \). Policies 1-3 considered above are reproduced under alternative settings of the two crucial policy parameters, \((\alpha, \gamma)\).

3.3.1. **Policy 1.** In Region I, monetary policy is active and responds to an increase in inflation by raising the nominal interest rate by enough to increase the real interest rate. Fiscal policy reacts passively to increases in government debt by raising future taxes sufficiently to service the new debt. Under these policies, tax disturbances do not influence equilibrium prices, interest rates, or real balances.

Equilibrium inflation is given by

\[
\hat{\pi}_t = -\frac{1}{\alpha} E_t \sum_{i=0}^{\infty} \left( \frac{1}{\alpha} \right)^i \hat{\theta}_{t+i}
\] (20)

\(^4\)To obtain (17), use the log-linear approximations of money demand \( \hat{m}_t = -(1/\chi)(\beta/(1 - \beta)) \hat{R}_t \), where \( 1/\chi \) is the intertemporal elasticity of substitution of real balances, and of the policy rules to obtain expressions for \( \hat{R}_t \) and \( \hat{\pi}_t \). Use those expressions in the linearized government budget constraint.
and the sequence for equilibrium real debt, \( \{ \hat{b}_t \} \), evolves according to the stable difference equation (16). Evidently, inflation—and money growth—is entirely a monetary phenomenon in the sense that it is independent of shocks to tax policy. Debt and taxes, on the other hand, respond to both monetary and tax disturbances. This result corresponds to Policy 1 in section 2.4.1.

3.3.2. Policy 2. Fiscal policy is active in the second region and does not set taxes with an eye toward satisfying the government’s budget constraint. The central bank behaves passively, adjusting money growth and thereby the nominal interest rate, to prevent government debt from following an unsustainable path. Constrained by fiscal financing needs, the central bank can no longer achieve any price level it desires and tax disturbances can be inflationary.

To reproduce Policy 2 in section 2.4.2, consider the special case of a pegged nominal interest rate \((\alpha = 0)\) and exogenous taxes \((\gamma = 0)\). Also assume the policy shocks are serially uncorrelated. Equilibrium inflation is

\[
\hat{\pi}_t = -\left( \frac{1 - \beta}{\beta \frac{m}{b} + 1} \right) \hat{\psi}_t - \frac{m}{b} \left[ \beta (1 - \varphi) + \varphi \right] \hat{\theta}_t + \hat{\theta}_{t-1}.
\]

(21)

Note that the steady state level of government debt influences the responses of inflation to both monetary and fiscal policy changes. A tax cut (negative realization of \(\psi\)) raises inflation, with the elasticity of inflation with respect to taxes rising in the level of government debt. If monetary policy raises the nominal rate (positive realization of \(\theta\)), current inflation may rise or fall, depending on the interest elasticity of money demand. For elasticities ranging from inelastic to modest, inflation falls, matching conventional notions that a higher nominal rate is “tighter” policy. But the Fisher relation kicks in, so the same increase in \(R_t\) raises the expected inflation rate one-for-one.

As in section 2.4.2, fiscal disturbances are not permitted to change the real value of government debt. In equilibrium, real debt is

\[
\hat{b}_t = \beta \frac{m}{b} (1 - \varphi) \hat{\theta}_t,
\]

(22)

so \(i.i.d\). tax changes leave debt unchanged, while open-market sales raise the level of debt.

In the equilibrium just presented, on average seigniorage revenues are zero because the steady state is one with a constant price level. On the margin, though, seigniorage is very important: without the appropriate (passive) adjustment in the money stock, there can be no equilibrium—government debt would follow an unsustainable explosive path and become worthless. Standard methods to evaluate if seigniorage is
an “important” source of revenues, such as computing the time-average of seigniorage revenues as a share of GDP, may have nothing to say about its importance on the margin. There is reason to believe this point is may be important in practice. Setting $\alpha = 0$ implies the central bank does not adjust its interest rate instrument in the face of fiscal disturbances. Because exogenous changes in taxes, which correspond to realizations if $\psi$, are notoriously difficult to identify in data, it is also difficult to trace whether this kind of accommodation of fiscal policy occurs.

3.3.3. **Policy 3.** Suppose the central bank, instead of literally pegging the nominal rate, adjusts it less than one-for-one with inflation ($0 < \alpha < 1$), while the fiscal authority continues to set taxes exogenously ($\gamma = 0$). Now tax cuts raise inflation and the nominal rate jointly. Higher $R$ raises expected inflation, which is rationalized by the passive increase in future money growth. Instead of the passive response of money growth occurring contemporaneously with the tax shock, as in the previous section, monetary policy’s passive adjustment occurs gradually, raising both current and expected money creation. Although again this is not the usual monetization of deficits, the equilibrium exhibits the common view that deficits are monetized if and only if deficits predict money growth [King and Plosser (1985)].

4. **A Portfolio Choice Model**

This section extends the previous models by introducing the margin between real and nominal assets. The additional margin brings the analysis closer to actual economies by eliminating the artificial neutrality of expected taxes that limits the applicability of the previous sections.

4.1. **Setup.** The model consists of a representative household, two firms—one producing goods and one producing transactions services—and a government. Gross physical assets of the economy at $t$, $f(k_{t-1})$, are allocated to consumption, $c_t$, capital, $k_t$, and government purchases of goods, $g_t$. The aggregate resource constraint is

$$c_t + k_t + g_t = f(k_{t-1}).$$  \hspace{1cm} (23)

We assume capital depreciates completely each period.

Two types of representative firms rent factors of production from households and sell their outputs back to households. The goods producing firm rents $k$ at rental rate $r$ and pays taxes levied against sales of goods to solve

$$\max_{k_{t-1}} D_{Gt} = (1 - \tau_t)f(k_{t-1}) - r_t k_{t-1}. $$ \hspace{1cm} (24)

The transactions services producing firm hires labor $l$ at wage rate $w$ to solve
with \( P_T \) the price of transactions services relative to consumption goods. Production functions are strictly concave and differentiable. Both firms behave competitively, taking all prices as given.

The representative household owns the firms and pays taxes on capital income. It has disposable income

\[
I_t = r_t k_{t-1} + D_{Gt} + w_t l_t + D_{Tt} + z_t, \tag{26}
\]

where \( z_t \geq 0 \) is lump-sum transfer payments from the government. The household’s expenditures on consumption and new capital goods at date \( t \) must be financed with real money balances carried over from the previous period, \( M_{t-1}/P_t \), or with transactions services, \( T_t \), to satisfy the constraint

\[
\frac{M_{t-1}}{P_t} + T_t(c_t + k_t) \geq c_t + k_t, \tag{27}
\]

Transactions services can be thought of as a clearinghouse, money market mutual funds, or credit cards and the labor supplied to that sector reflects resources used in producing the services. Those resources should not be construed as “labor supply” in the usual sense.

Household preferences are defined over consumption and leisure. Households are endowed with a unit of time each period and solve

\[
\max_{\{c_t, l_t, T_t, M_t, B_t, k_t\}} E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, 1 - l_t), \quad 0 < \beta < 1, \tag{28}
\]

where \( 1 - l_t \) is leisure, subject to the finance constraint, (27), the budget constraint

\[
c_t + k_t + \frac{M_t + B_t}{P_t} + P_t T_t \leq I_t + \frac{M_{t-1} + R_{t-1} B_{t-1}}{P_t}, \tag{29}
\]

and \( 0 \leq l_t \leq 1 \). Future government policy is the sole source of uncertainty; the operator \( E \) in (28) denotes equilibrium expectations of private agents over future policy. The household starts with initial assets \( k_{-1} > 0 \) and \( M_{-1} + R_{-1} B_{-1} > 0 \).

The government finances expenditures on goods, \( g_t \), and transfer payments, \( z_t \), by levying taxes, issuing new debt, and creating new money to satisfy the restraint:

\[
\tau_t f(k_{t-1}) + \frac{M_t - M_{t-1}}{P_t} + \frac{B_t + R_{t-1} B_{t-1}}{P_t} = g_t + z_t, \tag{30}
\]
4.2. **Equilibrium.** Assume the following functional forms:

\[
f(k_{t-1}) = k_{t-1}^{\sigma}, \quad 0 < \sigma < 1, \quad (31)
\]

\[
T(l_t) = 1 - (1 - l_t)^{\alpha}, \quad \alpha > 1, \quad (32)
\]

\[
U(c_t, 1 - l_t) = \log(c_t) + \gamma \log(1 - l_t), \quad \gamma > 0. \quad (33)
\]

Equating supply and demand for capital yields the solution:

\[
k_t = \left(1 - \frac{1}{\eta_t}\right) (1 - s_t^g) f(k_{t-1}), \quad (34)
\]

where \(s_t^g \equiv g_t / f(k_{t-1})\) and \(\eta_t \equiv E_t \sum_{i=0}^{\infty} \beta^i d_t^\mu \left[1 - \beta \frac{\gamma}{\alpha} \left(\frac{1 - \tau_{t+i+1}}{1 - s_t^g}\right)\right]\), \(d_t^\mu \equiv \prod_{j=0}^{i-1} \frac{1 - \tau_{t+j+1}}{1 - s_t^g}\), \(d_0^\mu \equiv 1. \quad (35)
\]

Equating supply and demand for money yields

\[
(1 - T_t) \left[\frac{c_t + x_t}{c_t} - \frac{\gamma}{\alpha}\right] = \frac{\mu_t}{\rho_t}, \quad (36)
\]

where \(\rho_t \equiv M_t/M_{t-1}\) and

\[
\mu_t \equiv \beta \frac{\gamma}{\alpha} E_t \sum_{i=0}^{\infty} \beta^i d_t^\mu, \quad d_t^\mu \equiv \prod_{j=0}^{i-1} \frac{1}{\rho_t+j+1}, \quad d_0^\mu \equiv 1. \quad (37)
\]

This implies equilibrium real money balances

\[
\frac{M_t}{P_t} = \Delta_t (1 - s_t^g) f(k_{t-1}), \quad (38)
\]

where \(\Delta_t \equiv \frac{\mu_t}{\eta_t - \frac{\gamma}{\alpha}}. \quad (39)\)

In (38) and (39), \(\mu\) substitutes for the opportunity cost of money, \((R - 1)/R\), as arbitrage between money and bonds implies

\[
\mu_t = \beta \frac{\gamma}{\alpha} \left(\frac{R_t}{R_t - 1}\right). \quad (40)
\]

The nominal interest rate depends only on expected future money growth.
This setup is extreme in the sense that only expected monetary and tax policies are non-neutral; changes in current money growth or the current tax rate are neutral. But the setup is general in its linkages between relative asset returns and expected policies.

We characterize the equilibrium in terms of policy expectations functions \((\mu_t, \eta_t)\), current government claims, \(s^g_t\), and initial assets, \((k_{t-1}, M_{t-1}, R_{t-1}B_{t-1})\). \((\mu_t, \eta_t)\), which summarize the information agents need to form rational expectations about the equilibrium of the economy, capture the portfolio balance effects of expected policies. \(\mu\) is the marginal value of real money balances and is ubiquitous in dynamic monetary models. \(\eta\) is a measure of the extent to which government expenditures are financed by taxing output, which affects the return on investment and generates substitution between real and nominal assets. Hence, \(\eta\) determines the division of wealth between real and nominal assets—or the choice between consumption and investment—while \(\mu\) determines the return on nominal assets.

\(\eta\) captures a Tobin (1965) effect through two interdependent impacts of expected policies. One impact is a direct tax distortion, which alters the private return on real assets. To isolate this effect, consider the impact of higher expected future taxes, holding future money growth and government-spending shares fixed. Further suppose that debt is identically zero and, in order to focus on substitution effects, that the revenues collected through higher distorting taxes are rebated as a lump sum. Higher future tax rates reduce the expected return on investment and induce agents to substitute from investment to consumption. A lower expected return on capital also induces substitutions into nominal assets, including money, and produces the Tobin effect. With the current money stock fixed, higher money demand drives down the current price level.

A second impact comes from \(\eta\)'s summary of the composition of expected fiscal financing in terms of the relative sizes of the real and inflation tax bases. Higher \(\eta\) reflects an increase in expected nominal liability creation, a rise in the inflation tax base, and a reduction in the role of real taxation in financing government expenditures. This trade-off can be seen heuristically from manipulating the government budget constraint to obtain an alternative expression for the terms \((1 - \tau)/(1 - s^g)\) that appear in the definition of \(\eta\) in (35):

\[
\frac{1 - \tau_t}{1 - s^g_t} = 1 + \frac{(M_t - M_{t-1} + B_t - R_{t-1}B_{t-1})/P_t}{(1 - s^g_t)f(k_{t-1})}, \quad t \geq 0. \tag{41}
\]

Terms in \((1 - \tau)/(1 - s^g)\) reflect the fraction of private resources absorbed by the acquisition of new nominal liabilities issued by the government. Higher \(\eta\) indicates an expected shift in future financing that expands the inflation tax base and contracts...
the real tax base. By reflecting the relative sizes of the two tax bases, changes in $\eta$ generate an expected inflation effect that is not embedded in the nominal interest rate. Whenever policies change $\eta$, conventional money demand expressions that depend only on the nominal interest rate, such as (4), will mispredict the inflationary impacts of future policies.

4.3. **Equilibrium Expectations.** Equilibrium requires that current and future policies satisfy the government’s budget constraint and that agents’ expectations of policy are consistent with equilibrium. This creates interactions among current and future policies. For analytical simplicity, we reduce the analysis to two periods—now and the future—and focus on circumstances in which the economy is in a stationary equilibrium in the future (dates $s > t$), but starts from some other position now, at date $t$. Fix current and future government spending shares, $\{s^g_t, s^z_t\}$, all $t$, where $s^z_t = z_t/f(k_{t-1})$, and assume future money growth and tax rates are constant:

$$\rho_{t+j} = \rho, \quad \tau_{t+j} = \tau, \quad j > 0. \tag{42}$$

The government budget constraint can be expressed entirely in terms of current and expected policies. In period $t$ the constraint is

$$\left[ \frac{\rho_t - 1}{\rho_t} + \frac{B_t}{M_t} \cdot \frac{R_{t-1}}{M_{t-1}} \right] \Delta_t = \frac{s^g_t + s^z_t - \tau_t}{1 - s^g_t}. \tag{43}$$

Given expectations of policy embedded in $\Delta_t$ and initial government indebtedness as summarized by $R_{t-1}B_{t-1}/M_{t-1}$, (43) reports equilibrium trade-offs among current policies.

We now derive equilibrium trade-offs among future policies given the state of government indebtedness. Shift the timing of (43) forward one period and assume future interest liabilities are correctly anticipated at $t$ by substituting the expression for equilibrium $R_t$. Assume the bond-money ratio is constant at $B/M = B_t/M_t$ in the stationary equilibrium, so there can be no net additions to debt in the future. Reducing the analysis to two periods forces government indebtedness in the future to equal the level inherited from current policies. Dropping the time subscript for variables dated $t+1$ and imposing equilibrium yields

$$\Delta_t = \left[ \frac{s^g_t + s^z_t - \tau_t}{1 - s^g_t} \right] \cdot \frac{1}{\left(1 - \frac{1}{\beta}\right) \frac{B}{M} + \left(\frac{\rho - 1}{\rho}\right)}. \tag{44}$$

Given government indebtedness carried into the future, as summarized by $B/M$, (44) describes the trade-offs among future policies that are consistent with fixed $\Delta_t$ being an equilibrium.
Trade-offs between (43) and (44) determine the interactions between current policies and expectations of future policies. Any change in policy at $t$ that requires a change in $\Delta_t$ must be accompanied by a change in policy in the future that is consistent with the new values of $\Delta_t$, given the level of government debt $B/M$.

4.4. **Bond-Finance Tax Cut.** We hold sequences of government spending shares, $\{s^g_t, s^z_t\}$, fixed across the policy experiment. The experiments take the form of an initial cut in taxes at $t$, $d\tau_t < 0$, which is financed by new sales of nominal bonds. We then examine the equilibria produced by alternative responses of current and future policies that satisfy (43) and (44).

4.4.1. **Policy 1.** Hold current and future money growth fixed at $(\rho_t, \rho)$. This policy pegs the nominal interest rate by fixing $\mu_t$—see (37) and (40)—but it does not fix real money balances unless $\eta_t$ is also constant. New debt issued to finance the tax reduction raises $B_t/M_t$, so a higher level of debt is carried into the future. To clear the government budget constraint in the future, (44) implies future taxes must rise. But higher taxes reduce the return on capital (lower $\eta$) and induce substitution from real to nominal assets, including money. The current price level must fall. This non-Keynesian result that current fiscal expansion reduces inflation stems from links between current and expected policies created by the expansion of government debt.

4.4.2. **Policy 2.** Fix both future money growth and future taxes at $(\rho, \tau)$. By assumption, all future policies are constant in the face of the current tax cut. For the same reasons as in section 2.4.2, current policies must adjust to ensure the real value of debt in the future is unchanged. This occurs when the current money stock rises by the amount that (44) dictates to maintain the pre-tax cut level of $B_t/M_t$. The monetary expansion required to maintain equilibrium is exactly enough so that the increase in future seigniorage (because the level of money supplied is now higher) at the fixed rate of money growth just suffices to pay for the increased debt service. With equilibrium real money balances fixed by constant future policies, by (38) the price level rises in proportion to the increase in $M_t$. Gordon and Leeper (2005) label this “the canonical fiscal theory exercise.”

The fiscal theory contrasts with the tax cut policy examined in section 4.4.1. That bond-financed tax cut was pure fiscal policy in the sense that it was independent of the path of the money stock. It also reduced nominal spending and the price level. An essential aspect of the fiscal theory is that the current money stock adjusts to clear the money market, raising nominal demand and the price level. If policy authorities

\footnote{In fact, when future $s^g$ and $\tau$ are fixed, the real balance relationship reduces to the conventional one $M_t/P_t = h(R_t)$.}
were pegging the nominal interest rate and fixing future taxes without reference to anything happening in the economy, the fiscal theory and higher prices are inevitable consequences of a tax cut.

4.4.3. Policy 3. The fiscal authority holds future taxes constant and the central bank fixes current money growth. An expansion in current debt can be carried into the future if future money growth rise sufficiently to generate the seigniorage revenues to service the new debt. This raises expected inflation, lowers the expected return on money (lower $\mu$), decreases money demand, and raises the price level. Future inflation rises. The change in future money growth, of course, depends on the future bond-money, which determines the change in debt service.

5. U.S. Fiscal Policy: Present and Future

Even readers intrigued by the economic logic of the previous arguments, may wonder about their quantitative significance and applicability to practical policy issues. This section aims to alleviate those concerns by applying the richer model in section 4 to the potential for countercyclical policies to be counterproductive and to the inflationary implications of the projected paths of U.S. social security and medicare expenditures.

5.1. Countercyclical Policies. In variants of the setup in section 4, Gordon and Leeper (2000, 2002) quantify the intertemporal policy impacts emphasized in that setup. Parameters of the model are chosen to match aspects of U.S. data. Time series on U.S. policy variables, $\{\rho_t, \tau_t, s_g^t, s_z^t\}$, are used to compute perfect foresight versions of the policy expectations functions $\{\mu_t, \eta_t\}$. Those expectations functions and current realizations of $s_g^t$ are fed into the analytical expressions for investment as a share of output and for the velocity of money. Current and expected policies are the sole source of variation in the exercise: in the absence of changes in policy variables or without significant private responses to policy, investment and velocity would be approximately constant.

Although countercyclical policies arise from both automatic stabilizers and discretionary policy changes, for present purposes nothing rests on the precise mechanism that produces the policies. In terms of current fiscal policies, countercyclical policy corresponds to lower than normal output, and brings forth a lower than normal tax rate and higher than normal government spending shares. Monetary policy responds over the cycle to two factors. First, to accommodate the decline in money demand associated with an economic contraction, the Federal Reserve reduces money growth. Second, to counteract the downturn, the Fed reduces the nominal interest
rate by increasing the growth of high-powered money. The net effect is procyclical money growth, which appears in statistical characterizations of the data [Cooley and Hansen (1995)].

Basic public finance reasoning suggests that countercyclical policies can be counterproductive. Taken together, countercyclical monetary and fiscal policies reduce revenues and increase expenditures during downturns. The resulting increase in future government liabilities implies that some future policy must change. Suppose individuals expect future taxes to rise. This reduces the return on investment (lowers \( \eta \)) and reduces investment, which exacerbates and prolongs the downturn. Substitution from real to nominal assets reduces inflation more than it might otherwise fall during the contraction.

We compute perfect foresight policy paths as a benchmark for specifying expectations. While this represents a limiting case in terms of how much information agents possess about policy realizations, it is agnostic about policy behavior by not assuming policy obeys time-invariant functions. Moreover, the \( \{\mu_t, \eta_t\} \) sequences derived from realizations of U.S. policy variables reflect any dynamic interactions of the kind discussed in section 4.3 that are embedded in actual policy behavior.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Level (log)</th>
<th>Cyclical Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Std. Dev. (%)</td>
<td>Serial Correlation</td>
</tr>
<tr>
<td>Investment/Output (Data)</td>
<td>11.09</td>
<td>.980</td>
</tr>
<tr>
<td>Investment/Output (Model)</td>
<td>7.09</td>
<td>.995</td>
</tr>
<tr>
<td>Output Velocity (Data)</td>
<td>29.46</td>
<td>.998</td>
</tr>
<tr>
<td>Output Velocity (Model)</td>
<td>8.01</td>
<td>.995</td>
</tr>
</tbody>
</table>

Table 1. Portfolio Choice Statistics

Table 1 compares summary statistics for investment shares and velocity from U.S. data and the model. The model explains 64% of variation in the level of the investment shares and 30% at cyclical frequencies. It also accounts for 27% of the standard deviation of the level of velocity and 50% at cyclical frequencies. Simulated data are highly persistent and their cyclical components are even more persistent than U.S. data.

These results are startling. All variation in the model stems from realizations of current and expected future macro policies. If policy variables were constant,

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*6Perfect foresight is a limiting case of the idea that agents have good information about tax rates and government spending some quarters into the future.*
simulated data would be constant. The cyclical pattern exhibited by simulated data arises from \textit{countercyclical} policies. With substantial fractions of the variation in portfolio choices attributable to current and expected macro policies, those policies evidently have important quantitative impacts.

5.2. \textbf{Social Security and Medicare.} Combining the gradually aging U.S. workforce with existing provisions for social security and medicare carries profound implications for future government liabilities. The Congressional Budget Office’s (2002) projections for growth in government’s claims on the economy are summarized in Table 2.\textsuperscript{7} Future government liabilities are likely to grow substantially, a situation that cannot persist without substantial shifts in other policies. Which policies are expected to change determines the impacts on current and future inflation.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Social Security, Medicare, Medicaid</th>
<th>Other Spending</th>
<th>Interest Expense</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>7.6</td>
<td>8.5</td>
<td>2.3</td>
<td>18.4</td>
</tr>
<tr>
<td>2010</td>
<td>8.8</td>
<td>7.6</td>
<td>0.8</td>
<td>17.2</td>
</tr>
<tr>
<td>2020</td>
<td>11.3</td>
<td>7.1</td>
<td>-0.5</td>
<td>17.9</td>
</tr>
<tr>
<td>2030</td>
<td>13.9</td>
<td>7.1</td>
<td>-0.2</td>
<td>20.8</td>
</tr>
<tr>
<td>2040</td>
<td>15.5</td>
<td>7.1</td>
<td>1.1</td>
<td>23.8</td>
</tr>
<tr>
<td>2050</td>
<td>16.7</td>
<td>7.1</td>
<td>3.1</td>
<td>26.9</td>
</tr>
<tr>
<td>2060</td>
<td>18.1</td>
<td>7.1</td>
<td>5.8</td>
<td>31.0</td>
</tr>
<tr>
<td>2070</td>
<td>20.0</td>
<td>7.1</td>
<td>9.4</td>
<td>36.5</td>
</tr>
<tr>
<td>2075</td>
<td>21.1</td>
<td>7.1</td>
<td>11.5</td>
<td>39.7</td>
</tr>
</tbody>
</table>

\textit{Source: Congressional Budget Office (2002).}

\textbf{Table 2. Federal Outlays as Percentage of GDP}

Rising social security, medicare, and medicaid expenditures appear as an increase in expected transfer payments, $s^2$ in the model. We assume—perhaps unrealistically—that $s^2$ cannot be changed, so there will be no reductions in benefits from the social programs. There are two possible responses of policy: hold current policies fixed so future debt is given by $B/M = B_t/M_t$ or adjust current policies so that a lower level of debt is carried into the future. Each of these requires specifying further adjustments in policies to determine their impacts.\textsuperscript{8}

\textsuperscript{7}See De Nardi, Imrohoroglu, and Sargent (1999) for a quantitative analysis of future social security and medicare liabilities.
If current policies are fixed, then (44) reports the set of future policies consistent with higher $s^*$, given debt inherited from the past. Suppose that future spending and tax rates are unchanged. Then higher money growth must be expected to raise the revenues needed in the future. Higher $\rho$ reduces the value of money balances now (lower $\mu$), which induces individuals to substitute out of money. Both current and future inflation rates rise substantially given the magnitudes in Table 2. In contrast, if future money growth is fixed, then some combination of lower government spending, $s^g$, and higher tax rates, $\tau$, must be expected to be realized. This policy shifts expected future financing away from inflation taxes and toward income taxes (lower $\eta$), reducing the expected return on capital. Individuals substitute out of real assets into nominal ones today. The current price level falls to clear the money market. Because the capital stock declines, output is lower in the future, which drives up the price level in the future, for a given path of the money stock.

It may be possible for current policies to adjust sufficiently so that a lower level of debt is carried into the future and future policies do not need to change to accommodate the higher transfer payments. Essentially, this makes some of the outlays on interest expenses in Table 2 available for social security, medicare, and medicaid. To reduce $B_t/M_t$, (43) requires some combination at time $t$ of higher money growth, lower government purchases, lower transfers, or higher taxes. Higher $\rho_t$ acts as a lump-sum tax on nominal assets and the price level rises proportionately. Lower $s^*_t$ or higher $\tau_t$ are also lump-sum and have no impact on the equilibrium. A cut in $s^g_t$, however, frees up resources available to the private sector, which increases money demand and reduces the current price level.

The wide range of possible consequences from projected government transfer payments actually understates the uncertainty surrounding the issue. Policy reforms that seem politically impossible now become increasingly likely as the budgetary consequences are realized. As the political situation evolves in the future, it’s likely that some of the future policy adjustment will occur in benefits, so $s^*$ ultimately will rise less than the CBO now projects.

6. Realism: A Caveat

All the results in this paper come from economic environments in which prices adjust instantaneously to clear markets. While this assumption makes sense for asset

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8Auerbach (2002) evaluates the impacts of the tax cut enacted in June 2001 on national savings. His analysis, though quantitative, is similar in spirit to ours in that he considers the implications of alternative expected future policies consistent with equilibrium. He does not derive the implications for the price level and inflation, however.
prices, few economists believe it holds for all goods prices and the overall price level. Modifying the environments so that at least some prices adjust gradually converts the one-time changes in the price level into a sequence of changes in inflation rates that eventually produce the same price level when prices are flexible [Leeper (1993), Woodford (1998)]. Of course, if prices do not adjust fully instantly, then quantities adjust instead. So many of the purely nominal adjustments in the present environments translate into real, short-run adjustments when prices are sluggish.

7. Directions for Research

Explorations of the implications of explicitly modeling dynamic interactions among current and expected future macro policies has just begun. So far the explorations have used stylized economic environments and a limited range of assumptions about how expectations are formed.

How expectations are estimated matters a great deal in this analysis. Perfect foresight represents one extreme [Gordon and Leeper (2000)], while econometric methods that rely entirely on historic correlations to project future policies represent another extreme [Gordon, Leeper, and Zha (1998)]. Reality doubtless lies in between. Research suggests Americans have some foresight of fiscal policy [Steigerwald and Stuart (1997)] and analytical work suggests that sorting out the degree of foresight may be important for obtaining good quantitative estimates of monetary and fiscal impacts [Leeper (1989) and Yang (2004)].

Another aspect of getting accurate assessments of expectations of policy arises: if policy can shift randomly but infrequently between rules (or “regimes”), then the regime switching should be modeled so expectations of policy incorporate any possible future regime changes. This point was made in the context of the Lucas (1976) critique by Cooley, LeRoy, and Raymon (1984). In the context of fiscal policy, Davig (2002) shows that elasticities with respect to tax changes can take a variety of magnitudes and signs, depending on private agents’ beliefs about fiscal regime. Amending the simple model in section 3 to allow the policy parameters to switch randomly between Regime I and Regime II values, qualitatively changes the nature of the equilibrium. If regime can switch, then even if current monetary policy is “active” and tax policy is “passive,” tax disturbances will be inflationary. This suggests that the dependence of inflation on fiscal policy is generic.

How people learn about policy is also likely to be important in accurately determining policy impacts. Sargent (1999) uses a model in which the central bank learns about the nature of the Phillips curve and private agents learn about policy to tell a story about how the United States brought inflation down from its double-digit
levels in the late 1970s and early 1980s. He reaches the pessimistic conclusion that a return to the days of high inflation cannot be ruled out. Embedding learning in an environment with nontrivial monetary and fiscal policy interactions could offer a very different, and far richer, interpretation of history.

Empirical work on monetary and fiscal interactions is very much in its infancy. To date the work focuses on trying to isolate particular historical episodes in which macro policies operated in Region I or Region II of section 3, without modeling the probabilities of switching between policy regimes [Cochrane (1999), Woodford (1999), Canzoneri, Cumby, and Diba (2001), Afonso (2002)].

Much research remains to be done along all these lines.
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References


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