Effects of Alternative Monetary Stabilization Policies: An Unexpected Finding

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In this paper we quantitatively explore the effects of a shift from a regime with a higher real return on interest-bearing government debt to a regime with a lower real return on this asset. The applied general equilibrium methodology is employed. Our model world has people being born every period. During their working years they make labor-leisure decisions in the face of risk as to the market values of their time endowments. They buy houses and finance this investment in part by borrowing from banks. They also save for their retirement by accumulating nominal assets as well as by building up equity in their houses.

The model economy is calibrated to selected features of U.S. data, in particular to asset-GNP ratios and to valued added in the financial intermediary sector. Households lend large amounts to banks and other financial intermediaries. Financial intermediaries lend large amounts to households, to governments, and to nonfinancial businesses. In terms of value most of these loans to households are home mortgages. The difference in the implicit rate at which financial intermediaries borrow from households and the implicit rate at which intermediaries lend is large being approximately five percent. Nearly all this spread is payments to the factors of production employed in the financial intermediary sector. The part of value added which is bad debt is small in comparison to the payments to the factors of production.

The model economy that we use in this study is the one developed in Díaz-Giménez, et. al (1992). This model economy is used to determine the consequences of a regime change that results in the real return on government debt being two percent lower on average then it was before the change. This is not a large change. Two percent changes are within the range of actual changes in real returns that have occurred in the United States in the post-war period.

In determining the consequences of a regime change for output and employment, the expected duration of the new regime is crucial. The principal and unexpected finding is that if the expected duration of the regime switch is long there is a period in which output and employment are significantly below average. If the expected duration of the regime switch is not long, the consequences for output and employment are small.

These experimental results do not establish that persistent shifts to regimes with lower real returns on interest-bearing government debt will depress the economy. These experiments do establish that such a policy change may depress the economy. Many more applied general equilibrium analyses of economies with monetary assets are needed before we can with any confidence say what the effects are of alternative monetary and government debt policies. This study along with earlier ones of İmrohoroğlu (1992) and Díaz-Giménez (1992) should be viewed as being the first steps in this research program.

The paper is organized as follows. In Section 1 the model economy is specified and an equilibrium is defined. In Section 2 the model is calibrated to selected features of 1986 United States data. These dimensions are asset-GNP ratios, value added in the financial intermediary sector, and the implicit financial household borrowing and lending rates. By definition, matching on the first two dimensions implies matching on the third. In Section 3 the experiments are specified and the results are reported. The final sector discusses future applied general equilibrium studies in economies with nominal assets.

1. Model Economy

Population Dynamics and Information

The economy is inhabited at each point in time by a large number, actually a measure of households. Each period some households die and an equal measure are born so that total population size is constant. The economy is subject to an economy-wide disturbance, z_t. This disturbance follows a finite state first-order Markov process with transition probabilities given by

(1) $\pi_z(z'|z) = \Pr\{z_{t+1}=z'|z_t=z\}$

where $z, z' \in Z = \{1,2,\ldots,n_z\}$. We assume that the Markov chain generating z is such that is has a single ergodic set, no transient states, and no cyclically moving subsets. Each household also faces an idiosyncratic random disturbance, s_t, that affects its individual production opportunities, its utility flow function, and its probability of dying. Conditional on the realization of the economy-wide shock one period ahead, these idiosyncratic disturbances are assumed to be independent and identically distributed across households. The process for these household-specific production shocks is also assumed to follow a finite-state Markov chain with conditional transition probabilities given by

(2) $\pi_s(s'|s,z') = \Pr\{s_{t+1}=s'|s_t=s,\ z_{t+1}=z'\}$

where $s, s' \in S = \{1,2,\ldots, n_s\}$ and $z' \in Z$.

The state n_s is an absorbing state and corresponds to death. We use $\sigma(s)$ to indicate whether or not a person is alive at a point in time. A person is alive at t if $\sigma(s_t) = 1$ and is dead if $\sigma(s_t) = 0$. Therefore, the function $\sigma(s_t) = 1$ for $s = n_s$ and $\sigma(s_t) = 0$ for $s < n_s$.

The joint processes on each household's idiosyncratic shock, s, and on the economy-wide shock, z, are therefore Markov chains with $n = n_s n_z$ states. The joint transition probabilities are

(3) $\pi[(s',z')|(s,z)] = \pi_z(z'|z)\pi_s(s'|s,z')$.

The measure of people born at each date with initial idiosyncratic shock is ψ_s.

The Government Sector

The government in this economy taxes labor and net interest income at a rate θ. This is a proportional tax and is restricted to being a function of the current value of the economy-wide shock, z_t, only. The tax rate at date t is $\theta(z_t)$. The government also issues two assets. The first asset bears no interest, and it determines the unit of account. We denote it by R, and we call it reserves. The second asset is a risk-free promise to deliver one unit of reserves at the beginning of the period immediately after its date of issue. We denote it by B, and we call it T-bills. This asset sells at a discount. (Note that throughout this paper we follow the convention that capital letters denote nominal quantities, that is, in terms of units of R. Except where otherwise indicated, lowercase letters denote the real values of the corresponding variables, that is, in terms of the current-period consumption good.)

Variable p_t is the price of one unit of the date t consumption good in terms of date t reserves. Government policy determines the pricing process on reserves, $e_t = \epsilon(z_t) = p_{t+1}/p_t$, and the nominal interest rate on government debt, $i_t = \iota(z_t)$, where the interest is paid in advance. To implement these policies the government stands ready to exchange p_t units of reserves per unit of consumption good and to exchange promises to deliver one unit of reserves next period per $1 - \epsilon(z_t)$ units of reserves this period. We only consider economies with a positive nominal interest-rate policy, that is, policies with $\iota(z) \geq 0$ for all $z \in Z$. The government requires banks to keep at least a fraction $\rho_t = \rho(z_t)$ of their customers' deposits in reserves. Additional legal constraints preclude households from holding T-bills directly. Only the financial intermediaries have access to the T-bill market. Note that the pricing policies and the reserve requirement policy are also restricted to being a function of the current value of the economy-wide shock, z_t, only.

At date t the government makes transfers to households. The transfer is contingent on the economy-wide shock z_t and upon the household's real financial assets, a_t, its tangible assets, k_t, and its idiosyncratic shock, s_t. The transfer policy is $\omega(a,k,s,z)$. Finally, the government taxes households' estates. When a household dies, its estate is liquidated and the proceeds are used to pay off its debts. The remaining assets of the estate, if any, are subject to a 100 percent estate tax.

A government policy rule is, therefore, a specification of $[\epsilon(z),\iota(z),\theta(z),\rho(z),\omega(a,k,s,z,)]$ and the associated processes on government consumption, g, on the government supply of T-bills, B_g, and on the government supply of reserves, R_g.

The Banking Sector

Banks play two roles in our model economies. Their first role is to intermediate between households by making loans to households who want to borrow and by accepting deposits from households who want to lend. Their second role is to intermediate between the household and government sectors by pooling household savings and buying T-bills and reserves.

We assume that both the deposit and the lending technologies are freely accessible and that they display constant returns-to-scale. A bank uses η_D units of the composite good per unit of real deposits, D/p. The associated nominal costs of servicing deposits are $\eta_D D$. Similarly a bank uses η_L units of the composite good per unit of real loans, L/p, and the associated nominal costs of servicing loans are $\eta_L L$. Interest is paid in advance. Given these assumptions, a bank faces a sequence of static profit maximization problems. These problems are

$$(4) \qquad \max_{B_b, R_b, L_b, D_b} B_b + R_b + L_b - D_b$$

subject to

$$(5) \qquad B_b(1-i) + L_b(1-i_L) + R_b + \eta_D D_b + \eta_L L_b \leq D_b(1-i_d)$$

$$(6) \qquad R_b \leq \rho D_b$$

$$(7) \qquad L_b, R_b, D_b \geq 0.$$

Here B_b denotes bank purchases of T-bills, L_b denotes bank loans to the household sector, R_b denotes bank purchases of reserves, D_b denotes household deposits accepted, and i_L and i_D denote, respectively, the nominal interest rates on loans and deposits. Constraint (5) is the cash-flow constraint while (6) is the reserve requirement. The objective function (4) is the end-of-period net worth of the bank.

Given that we only consider policies with a positive nominal interest rate, T-bills always dominate reserves in rate of return and, at an optimum, inequality (6) holds with equality. For optima to exist with strictly positive D_b and L_b, the interest rates must satisfy the following conditions:

(8) $i_l = i_L(z) = i(z) + \eta_L$

(9) $i_D = i_d(z) = [1-\rho(z)]i(z) + \eta_D$.

Perfect competition and constant returns-to-scale imply that equilibrium bank profits are zero. Note also that, from equations (8) and (9), we can obtain the difference between the household borrowing and lending rates:

(10) $(1-\rho)i_L - i_D(z) = (1-\rho)\eta_L - \eta_D$.

In our model economy banks require collateral for their loans. Households can borrow up to the resale value of their end-of-period collateral.

The Household Sector

Preferences

Households are only concerned with their future consumption and leisure if they are alive. Consequently, they order their random streams of these goods according to

(11) $$E \sum_{t=0}^{\infty} \beta^t \sigma(s_t)\left[U_1(c_t,k_t',\tau-n_t,s_t) + U_2(g_t)\right]$$

where U_1 and U_2 are continuous and strictly concave utility functions; β is the time-discount factor; c_t is household consumption which is restricted to being nonnegative; $k_t' \in K = \{0,k_1,k_2,...,k_n\}$ represents the services of the capital goods and consumer durables held by the household during period t; τ is the household's endowment of productive time; n_t is time allocated to market activities, which we call labor services; and g_t is public per-capita consumption. Hence, $\tau - n_t$ is time allocated by the household to nonmarket activities, which we call leisure. Finally, $\sigma(s) = 1$ for $s < n_s$, that is if a person is alive, and $\sigma(n_s) = 0$ if a person has died.

Productive Opportunities

The household's date t production of the composite good is

$$w(s_t,z_t)n_t \tag{12}$$

where w(s,z) is that household's technology parameter. This composite good can be transformed into consumption, investment, banking services, or capital maintenance services on a one-to-one basis. When they choose to work, agents are paid their marginal product. Therefore w(s,z) equals the household's real wage. Following Rogerson (1988) and Hansen (1985), we assume a labor indivisibility. Labor services, n_t, are constrained to belonging to the set $\{0,1\}$, where zero corresponds to not being employed and one to being employed.

Initial Endowments and Liquidation of Assets

Households are born with zero assets. When their time comes to die, they do so overnight, after the current-period labor, consumption, investment, and savings have taken place. Early in the following morning, their estates are liquidated. Their capital goods are transformed into units of the current-period composite good which are then sold in the market. The proceeds of this sale are used to pay off the household's loans, if any. Whatever is left over, together with the remainder of the estate, is taxed away by the government.

Capital Maintenance and Disinvestment

We assume that household capital has to be maintained. Each period μ units of the composite good are required to maintain each unit of capital. We also assume that there is an irreversibility in the capital accumulation process. When a household decides to sell part of its capital stock, $k > 0$ units of capital are transformed into ϕk units of the composite good, where $0 < \phi < 1$.

The Household's Decision Problem

Households are indexed by the triple (a,k,s) where a denotes the beginning of period real asset holdings. The dynamic problem solved by an (a,k,s)-type household is the following:

(13) $$v(a,k,s,z) = \max_{c,n,d,\ell,x^d,x^s,a',k'} \{\sigma(s)U_1(c,k',\tau-n,s) + \beta \sum_{s',z'} v(a',k',s',z')\pi[(s',z')|(s,z)]\}$$

subject to

(14) $$c + x^d + d + \mu k' \leq a + [1-\theta(z)][w(s,z)n + di_D(z) - \ell i_L(z)] + x^s + \ell + \omega(a,k,s,z)$$

(15) $$\ell \leq \phi k' e(z)$$

(16) $$a' \leq (d-\ell)/e(z)$$

(17) $$k' = k + x^d - x^s/\phi$$

a' belongs to the finite set A, $k' \in K$, $n \in \{0,1\}$, nonnegativity constraints, and a, k given. Here x^d and x^s denote current-period purchases and sales of investment goods, d denotes the real value of end-of-period deposits and ℓ is the real value of the end-of-period loans; i_D is the interest rate on deposits and i_L is the interest rate on loans which we assume are paid up front; and $e(z_t) = p_{t+1}/p_t$ is the process on prices. Since the household's problem is a finite-state, discounted dynamic program, an optimal stationary Markov plan always exists.

Definition of Equilibrium

In the goods and securities markets, the government is not a small agent, so treating it as just another price-taking agent is not reasonable. Instead, part of the specification of the economy must be the policy arrangement employed and the resulting government excess-demand correspondence for assets and commodities. Features of our explicit arrangement include which markets operate and what rules govern banks. Another feature of our policy arrangement is that at each date the government exchanges goods for reserves at price p_t. Furthermore, the prices satisfy $p_{t+1} = p_t\epsilon(z_t)$. Also, there is a reserve requirement $\rho(z)$ and an income tax rate $\theta(z)$. Finally, the government issues as many T-bills to banks at price $1 - \iota(z)$ as is demanded. For such arrangements there is a well-defined government excess-demand correspondence.

The *state of a household* is the four-tuple (a,k,s,z). The measure of agents of type (a,k,s) is y(a,k,s). We let y denote the corresponding measure. The economy-wide state is the pair (y,z).

An equilibrium for a policy arrangement $\{\epsilon(z),\iota(z),\theta(z),\rho(z),\omega(a,k,s,z)\}$, given y_0, consists of six basic parts: a government policy $\{g(y,z),b_g(y,z),r_g(y,z)\}$, a household policy $\{c(a,k,s,z), d(a,k,s,z),\ell(a,k,s,z),n(a,k,s,z),x^d(a,k,s,z),x^s(a,k,s,z),a'(a,k,s,z),k'(a,k,s,z)\}$, a banking policy $\{b_b(y,z),\ell_b(y,z),r_b(y,z),d_b(y,z)\}$, z-contingent interest rates $\{i_D(z),i_L(z),i(z)\}$, an inflation rate process e(z), and a law of motion for the measure of agent types $y'_{a',k',s'} = f_{a',k',s'}(y,z,z')$ such that

i. Given the process on $i_d(z)$, $i_\ell(z)$, e(z), and $\theta(z)$, the household policy solves the household's optimization program described in equations (13)-(17) above.

ii. Given the process on i(z), $i_L(z)$, $i_D(z)$, and $\rho(z)$, the banking policy solves the banking maximization program described in equations (4)-(7) above.

iii. The goods market clears:

$$\sum_{a,k,s} y(a,k,s)[c(a,k,s,z) + x^d(a,k,s,z) + d(a,k,s,z)\eta_D + \ell(a,k,s,z)\eta_L + \mu k'(a,k,s,z)] + g(y,z) = \sum_{a,k,s} y(a,k,s)[n(a,k,s,z)w(s,z) + x^s(a,k,s,z)] \tag{18}$$

for all (y,z) in the support of the distribution of (y_t,z_t) for some t.

iv. The asset markets clear:

$$b_b(y,z) = b_g(y,z) \tag{19}$$

$$(20) \qquad \ell_b(y,z) = \sum_{a,k,s} y(a,k,s)\ell(a,k,s,z)$$

$$(21) \qquad r_b(y,z) = r_g(y,z)$$

$$(22) \qquad d_b(y,z) = \sum_{a,k,s} y(a,k,s,)d(a,k,s,z).$$

v. Household and aggregate behavior are consistent:

$$(23) \qquad f_{a',k',s'}(y,z,z') = \sum_{a,k,s,\in A(a',k',z')} y(a,k,s)\pi[(s',z')|(s,z)] + \psi_{a'k's'}(a,k,s)$$

where

$$(24) \qquad A(a',k',z) = \{(a,k,s) : a' = [d(a,k,s,z) - \ell(a,k,s,z)]/e(z),\ k' = k(a,k,s,z) + x^d(a,k,s,z) - x^s(a,k,s,z)/\phi\}$$

and where ψ specifies the measure of types for the newborn. In our world, all the mass of ψ is on (a',k') pairs for which $a' = k' = 0$, and the total measure of those who are born is equal to the measure of those who die.

vi. The behavior of endogenous variables is consistent with the policy arrangement. For our class of policy arrangements, this requires $e(z) = \epsilon(z)$, $i(z) = \iota(z)$, and $g(y,z) \geq 0$ for all (y,z) is the support of the distribution of (y_t,z_t) for some t.

For the government excess-demand correspondence that we consider, there is at most one equilibrium. The computational procedure we use to find the equilibrium is to first solve the household's problem, which is a finite-state discounted dynamic program, and then use (18) to determine $g(y,z)$. If $g_t = g(y_t,z_t)$ is a positive stochastic process, we have found the unique equilibrium given the policy arrangement. Otherwise, we have established that no equilibrium exists for that policy arrangement.

2. Calibration

If there are no aggregate shocks, the equilibrium path of the economy-wide state converges to a unique steady state with a fixed distribution of households as indexed by their individual state (a,k,s). In steady state the interest rates, inflation rates, aggregate shocks, and aggregate flows are all constant. The model economy is calibrated so that the steady state of the model economy approximately matches average rates for the United States economy in recent years.

By *households* we mean the decision units that correspond to either individuals or families. These decision units can enter into contracts and own assets, and they make consumption, labor, and saving choices that are constrained by a household-specific budget constraint. Note that this financially based definition of households is significantly different than the one used in the NIPA of most countries. In the NIPA, a household is a unit which consumes goods and services and supplies factors of production to the business sector. The households in our framework, in addition to these activities, produce goods and services. Our household sector, therefore, includes small businesses such as farms, sole proprietorships, and partnerships which the NIPAs include in the unincorporated business sector. In our framework, as in the NIPAs, corporations and government enterprises are not included in the household sector.

Table 1 reports the consolidated 1986 household balance sheet for the United States for our definition of a household. Household nominal assets are large being 1.54 times as big as annual GNP. Household nominal liabilities are also large being 0.70 times as big as GNP. The next most important component of household wealth is the value of owner-occupied housing. Some other points worth noting are the following. First, almost two-thirds of nongovernment tangible assets are owned by the household sector, and only one-third are owned by the corporate sector. Second, owner-used real estate and consumer durables are a large part of household capital. Indeed, they constitute more than two-thirds of the households' tangible assets and over one-half of the total economy's tangible assets. Owner-occupied housing and consumer durables are the components of capital that correspond to capital in the model economy.

The average interest rates at which financial intermediaries borrow from households and lend to households and government differ greatly. The difference in financial intermediaries' implicit lending and borrowing rate is nearly 5 percent. In 1986, value added in the financial intermediary sector was 5.5 percent of GNP and final product of this sector was 5.4 percent. Most of this value added was payment to factors of production. Only 0.3 percent of GNP was bad debt.

Additional data concerning household borrowing and lending is presented in Table 2. In 1986 interest rates on household borrowing varied from 18.3 percent on unpaid credit card balances to 10.2 percent on new mortgages. The interest rates at which households lent to financial intermediaries were much lower being in the 5 to 6 percent range. This is further evidence of the large differences in the implicit interest rates at which households borrow and lend.

Figure 1 plots the real return on U.S. T-bills from 1970–92. Historically the real average return on government debt has been low and has been subject to considerable variation. The return on tangible capital in the business sector has been much smoother. This suggests that the return on government debt is not tied down by the return on capital in the business sector but is affected by the monetary and debt policy that is in effect.

Government Policy

The model economy was calibrated to interest rate on government debt of 5 percent (annually) and an inflation rate of 4 percent. This implies a real interest rate on government debt of 1 percent which is in approximately the average value for the post-war U.S. economy. The income tax on labor and net interest income in the model economy is 20 percent.

Banking Technology

We calibrate to a nominal interest rate on deposits of 4 percent and a nominal loan rate of 9.5 percent. These interest rates, along with the policy parameters, imply the η_D and η_L parameter values.

Population Dynamics

To calibrate to the stocks of borrowing and lending by households, we introduce a retirement state s = 3, as well as two working-age states s = 1 and s = 2. State s = 1 corresponds to the productivity of that household's labor time being high; state s = 2, to productivity of that household's labor time being low. Productivity in state 2 is 32 percent of the productivity in state 1. We think of state s = 2 as corresponding to a minimum-wage job opportunity.

The working life of an individual is geometrically distributed, with an expected duration of 33 years. The retirement life of our individuals is also geometrically distributed. The expected duration of retirement is 10 years. State s = 4 corresponds to death. Each period the measure of those who are born is equal to the measure of those who die. As a result total population is constant.

Following İmrohoroğlu (1992), we select the transition probabilities between states 1 and 2 so that the expected time a worker spends in state s = 2 is three model periods, and the expected time a worker spends in state s = 1 is 27 model periods. This implies that in each period of time 90 percent of the workers have the high productivity parameter and 10 percent have the low productivity parameter. These parameter values produce annual income fluctuations of household labor income of the magnitude reported in U.S. household surveys. For newborns the probability of being type s = 1 is 0.9, and that of being type s = 2 is 0.1.

Household Preferences for Private Consumptions

The set of possible housing stocks is $K = \{0,3\}$. A household with $k = 3$ corresponds to a family owning a house with a value three times its annual income. This ratio is twice as large as the typical ratio for U.S. households. The reason we select this larger number is that we want the model's household capital stock to match the U.S. household capital stock, which includes consumer durables and small business capital.

For workers ($s=1$ or $s=2$) with $k = 3$, the utility function of private consumption is

$$U_1(c,3,n,s) = [c^{\alpha-\alpha_k} k^{\alpha_k} (\tau-n)^{1-\alpha}]^{1-\psi}/(1-\psi).$$

We select $\tau = 2.22$ so that $n = 1$ corresponds to people working, including commuting, 45 hours of the 100 weekly hours of productive time. The α_k is selected so that $k = 3$ would be optimal if the household rented housing services at a rate equal to the sum of the real after-tax interest rate on borrowing and the maintenance cost. This maintenance cost μ is set to 0.05.

Workers ($s=1$ or $s=2$) who have no capital ($k=0$) can transform the composite good at rate $1/\gamma$ into housing services. Their indirect utility is

$$U_1(c,0,n,s) = \max\, [c_1^{\alpha-\alpha_k} c_2^{\alpha_k} (\tau-n)^{1-\alpha}]^{1-\psi}/(1-\psi)$$

subject to

$$c_1 + \gamma c_2 \leq c.$$

We select γ equal to twice the sum of the real borrowing rate and the maintenance cost μ. This is sufficiently large that owning a house dominates renting housing services. Households purchase a house as soon as they have enough savings for the required down payment.

Retirees have productivities $w(3,z) = 0$. As a result, their wage rate is zero, and they select $n = 0$. Their utility function is simply

$$U_1(c,k,n,s) = \delta_r [c^{\alpha}]^{1-\psi}/(1 - \psi).$$

The larger is the parameter δ_r, the more important is consumption during retirement relative to consumption during the working period of a person's life. Hence, the larger is δ_r, the higher is the equilibrium saving for retirement. The parameter δ_r is selected so that aggregate deposits at banks match U.S. data.

3. Experiments and Results

A regime change is, following Cooley, LeRoy, and Raymon (1984), a highly persistent change in the process on the policy variables. Within our structure, there are regimes if the set of z states can be partitioned so that the expected time that z_t remains in a partition is long while the expected time that z_t remains in all proper subsets of a partition is not long. As we are interested in regimes with no aggregate uncertainty, a two state Markov chain with highly persistent states is used in these experiments. The first state corresponds to the high T-bill interest rate regime and the second state to the low interest rate regime.

The policy process is as follows. Both states have $\epsilon(z) = 1.005$, which corresponds to a 4 percent annual inflation rate, tax rate $\theta(z) = 0.20$, and reserve requirement $\rho(z) = 0.01$. The only element of the policy arrangement which varies across regimes is the interest rate on T-bills. The T-bill interest rates for the two regimes are $\iota(1) = 0.00625$ and $\iota(2) = 0.00375$ which corresponds to annual nominal interest rates of 5 and 3 percent, respectively, and to annual real interest rates of 1 percent and -1 percent, respectively. The degree of persistence of the two regimes will be varied over the experiments.

Experiment 1. Highly Persistent Regime Change.

The expected durations of states $z = 1$ and $z = 2$ are 50 years. The initial disturbance of y is the value to which the sequence $y_{n+1} = f(y_n, 1, 1)$ converges. This is the approximate distribution if z has been 1 for a long time prior to the regime change.

Figure 2 plots the paths of output and consumption subsequent to a switch from the 1 percent real interest rate regime to the -1 percent real interest rate regime. The unexpected finding is that a switch to a lower interest rate *depresses* the economy temporarily.

Experiment 2. Less Persistent Regime Change.

We next considered the case for which the expected durations of the z states are 5 years rather than 50 years. Figure 3 plots the paths of consumption and output subsequent to a switch to the lower interest rate regime after a long period in the high interest rate regime. The finding is that regime changes which are not of high persistence have minimal impact upon the model economy.

4. Concluding Comments

We emphasize that the development of computable general-equilibrium models with nominal assets and financial intermediation is still in its infancy. But the preliminary findings using these models are that financial intermediation is important for evaluating alternative monetary and government finance policy. The welfare effects of alternative monetary-finance policies have been found to be large (e.g., İmrohoroğlu 1992, Díaz-Giménez et. al. 1992, İmrohoroğlu and Prescott 1991). These effects are every bit as large and in some cases larger than the welfare numbers obtained in more traditional public finance studies that abstract from financial intermediation.

The set of monetary economies with financial intermediation that we currently can study is limited by our tools for computing equilibria. But these tools are advancing rapidly and, given recent advances of Díaz-Giménez and Rios-Rull (1993) and others, the set of economies that can be studied is quickly expanding. The tools for computing equilibrium of these heterogenous-agent economies already have advanced significantly beyond those used in this study. It is now or soon will be possible to introduce features into these heterogenous-agent model economies with financial assets that will result in these models being much better laboratories for conducting monetary and public finance policy experiments.

In particular there are three features that could be introduced while preserving computability of equilibrium. First, following Rios-Rull (1992) the model economy could be calibrated to actual mortality experiences rather than having geometric life as in this study. Second, capital in the household sector could become a continuous variable rather than being restricted to two discrete levels. Third, the entrepreneur could be introduced. These entrepreneurs would borrow from banks and would make capital investments. There are other features whose introduction would result in a better match between theory and measurement, but future advances in computational methods are needed before we can compute the equilibrium of models with these features. One such feature would be to expand the set of government excess-demand correspondences permitted. We could then conduct policy experiments in which public consumption is held fixed and only the monetary-financing policy varies. Currently this is practical only for steady state analyses as in İmrohoroğlu (1992) and İmrohoroğlu and Prescott (1991).

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Table 1

U.S. household sector balance sheets for selected years

	Stock/GNP		
	1959	1975	1986
Total assets	3.86	3.64	4.15
Tangible assets	1.95	2.06	2.09
Residential structures	0.81	0.84	0.86
Land	0.52	0.54	0.63
Plant, equipment, and inventories	0.24	0.31	0.24
Consumer durables	0.38	0.37	0.36
Debt assets	1.10	1.17	1.54
Financial corporate debt	0.64	0.72	0.81
Pension fund reserves	0.17	0.27	0.48
Nonfinancial corporate debt	0.09	0.08	0.07
Government debt	0.20	0.10	0.18
Equity assets[a]	0.81	0.41	0.52
Total liabilities	0.45	0.60	0.70
Owed to			
Financial corporations	0.39	0.55	0.65
Nonfinancial corporations	0.05	0.04	0.04
Government	0.01	0.01	0.01
Net worth	3.41	3.04	3.45

SOURCE: Alvarez and Fitzgerald (1992).

[a]Included is the market value of mutual fund shares (other than money market funds) held by households.

Table 2

Selected U.S. household sector borrowing
and lending stocks and interest rates, 1986

	Stock/GNP
Borrowing	**Stock/GNP**
Year-end outstanding stocks	
Mortgages	0.60
Consumer credit	0.16
Bank loans	0.04
Average net interest rates	
New mortgages[a]	10.2%
New car, 48 months	14.0
Personal credit, 24 months	16.5
Credit card	18.3
Prime rate	8.3
Lending	**Stock/GNP**
Year-end outstanding stocks	
Checkable deposits & currency	0.13
Time deposits[b]	0.56
U.S. government securities[c]	0.14
Average net interest rates	
NOW accounts	5.0%
Certificates of deposit, 6 months	6.7
U.S. T-bill, 6 months	6.3

SOURCES: Board of Governors of the Federal Reserve System: (i.) Balance Sheets for the U.S. Economy 1949-1990, Flow of Funds, September 1991; (ii.) Annual Statistical Digest 1986; (iii.) Money Stocks, Liquid Assets and Debt Measures, 1986.

[a]This is an effective rate on conventional mortgage. It includes fees and charges, assuming repayment at the end of ten years.

[b]This includes small and large time deposits and money market fund shares.

[c]This includes savings bonds, agency issues, and other Treasury issues.

Table 3a

Calibrated household parameters[a]

Parameter		**Values**
Preferences		
Private consumptions share	α	0.3330
Capital service share	α_k	0.1080
Risk aversion	ψ	4.0000
Time-discount factor	β	0.9994
Public consumption constant	δ_g	0.0104
Productive time	τ	2.2200
Retirees' constant	δ_r	0.2100
Technology		
Maintenance cost	μ	0.0500
Rental service coefficient	γ	0.0270
Disinvestment cost	$1-\phi$	0.1000
Real wage: State 1	$w(1,z)$	0.1250
State 2	$w(2,z)$	0.0400
Probability of newborn being: Type 1	ψ_1	0.9000
Type 2	ψ_2	0.1000

[a]Model period is one-eighth of a year.

Table 3b

Calibrated bank and government parameters[a]

Parameter		Value
Per unit banking costs		
Deposits	η_D	0.0011875
Loans	η_L	0.0056250
Government policy		
Reserve requirement	$\rho(z)$	0.01000
Tax rate on labor & interest income	$\theta(z)$	0.20000
Nominal interest rate on T-bills	$\iota(z)$	0.00625
Inflation rate process	$\epsilon(z)$	1.00500
Welfare transfers to:		
Indigent retirees	$\omega(0,0,3,z)$	0.02000
Others	$\omega(a,k,s,z)$	0.00000

[a]Model period is one-eighth of a year.

Table 3c

Calibrated household idiosyncratic shock transition probabilities.

From this period, state s		To next period, state s′			
		1	2	3	4
Working age					
High productivity	1	0.9593	0.0369	0.0038	0.0000
Low productivity	2	0.3317	0.6645	0.0038	0.0000
Retired	3	0.0000	0.0000	0.9869	0.0131
Dead	4	0.0000	0.0000	0.0000	1.0000

Table 4a

Calibrated economy's steady-state balance sheet data

	Stock/GNP
Household sector	
Tangible capital	2.71
Deposits	1.01
Loans	0.46
Net worth	3.26
Government sector	
Reserves	0.01
Debt	0.54

Table 4b

Calibrated economy's steady-states NIPA data

	% of GNP
Value added by sectors	
Housing	15.74
Banking	3.01
Goods producing	81.25
Products	
Consumption	82.61
Goods	50.29
Housing	29.30
Maintenance	13.56
Banking services	3.10
Government purchases	16.55
Investment	0.84

Figure 1 - Realized Real Return on 3-Month Treasury Bills

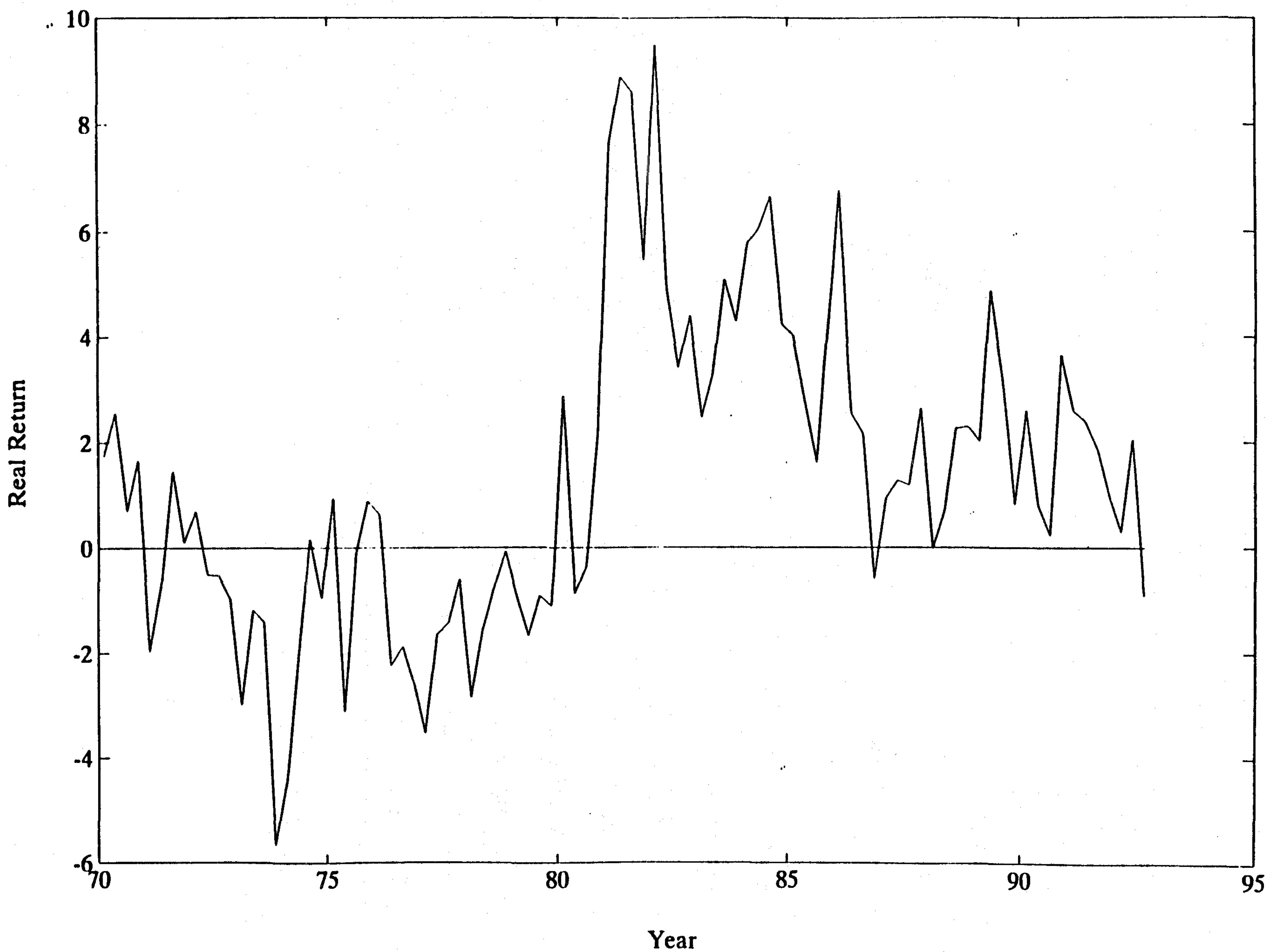


Figure 2

Response to High Persistence Regime Change: 5% to 3% T-bill Rate

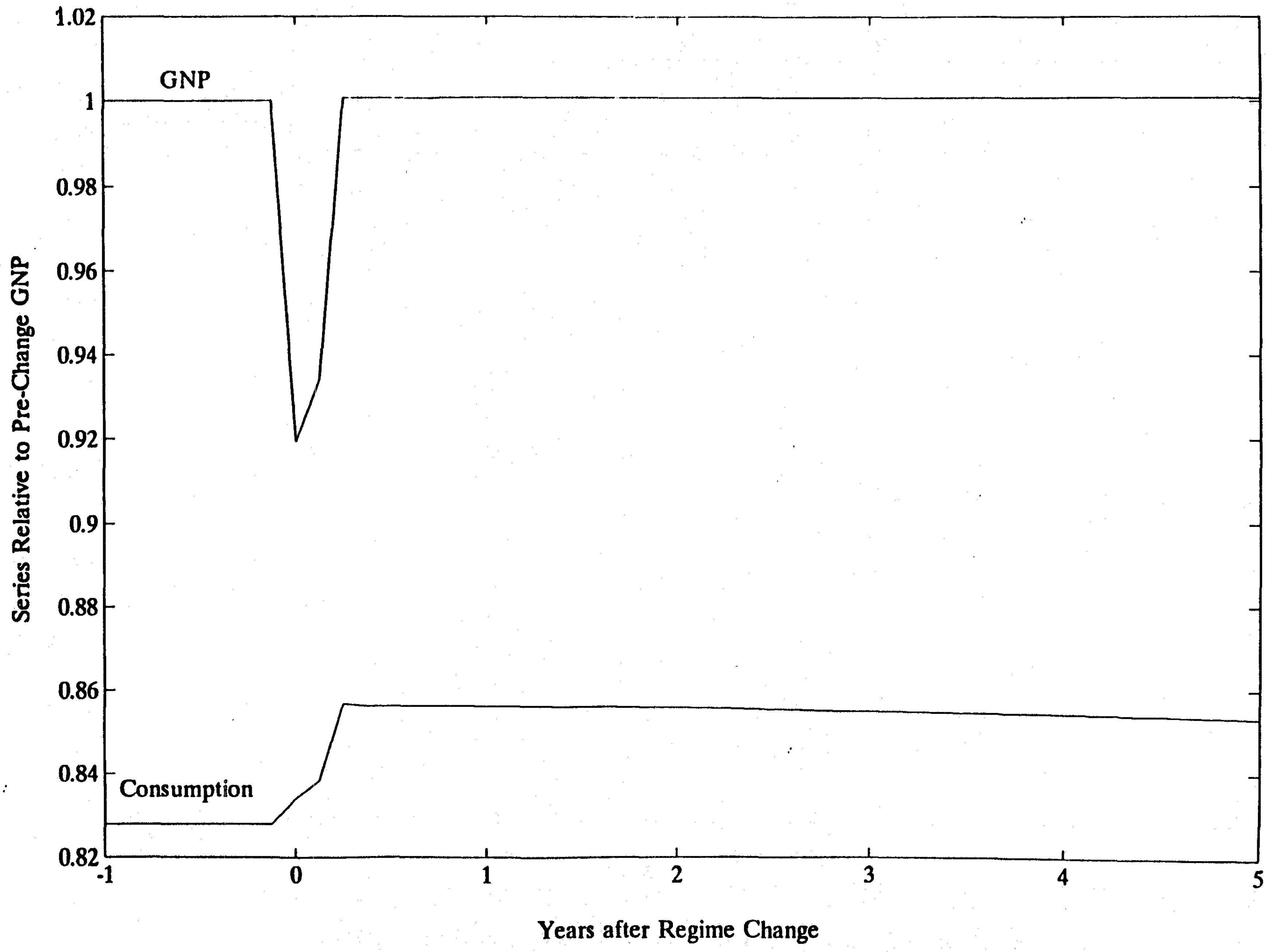
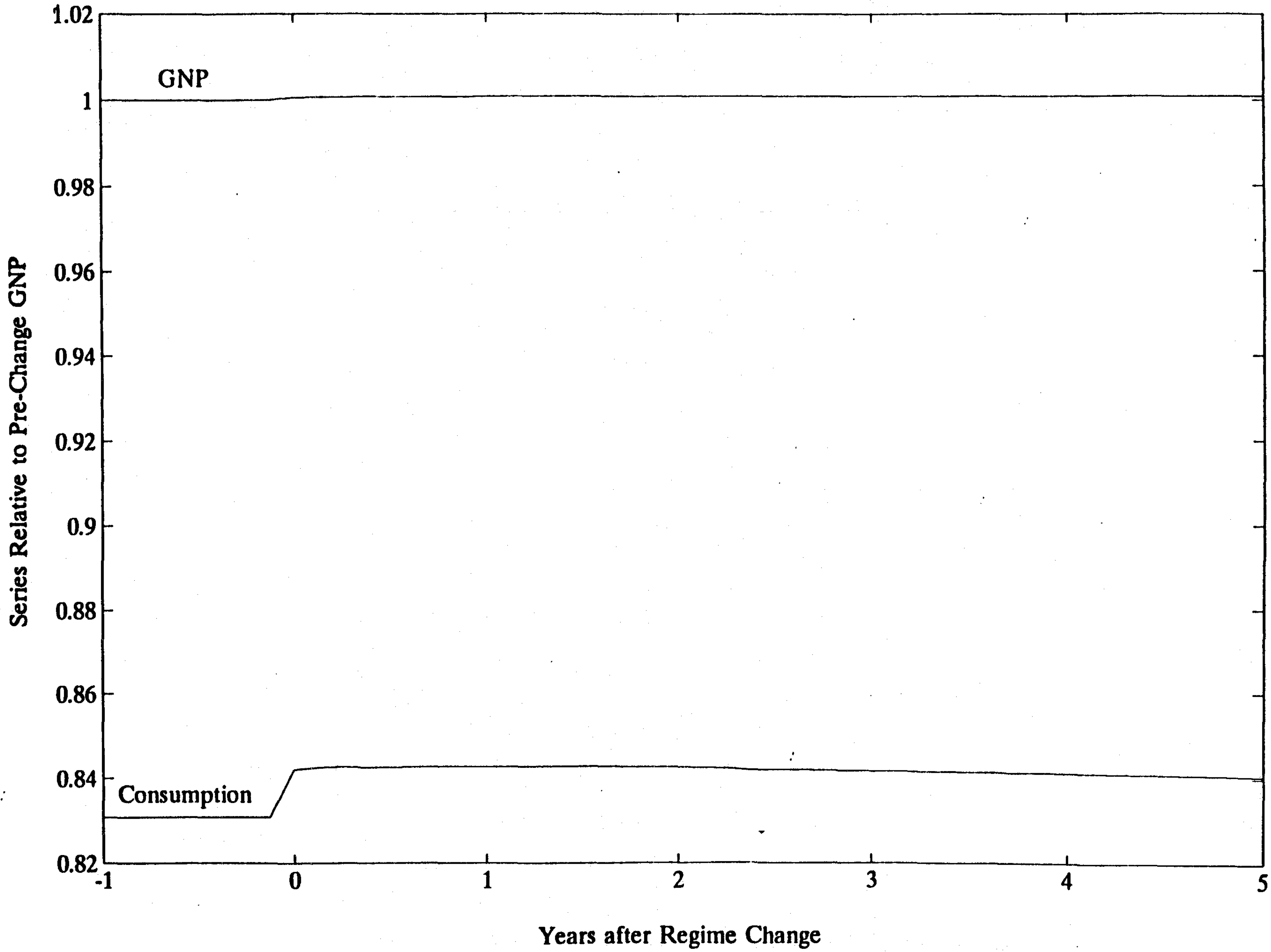


Figure 3

Response to Low Persistence Regime Change: 5% to 3% T-bill Rate



FINAL

*****Please note the changed time for the reception and dinner**

Center for Economic Policy Research - Stanford University
and Federal Reserve Bank of San Francisco

MACROECONOMIC STABILIZATION POLICY:
LESSONS FOR THE FUTURE

March 5 and 6, 1993

Conference Agenda

Friday, March 5 - Littlefield Center, Wattis Room

8:00 A.M. Continental Breakfast

8:30 A.M. EDWARD C. PRESCOTT, University of Minnesota
"Effects of Alternative Monetary Stabilization Policies"

Discussant: ROBERT HALL, Stanford University

9:45 A.M. Break

10:00 A.M. JOSEPH STIGLITZ, Stanford University and BRUCE GREENWALD, Bell Communications Research
"Monetary Policy and the Theory of the Risk-Averse Bank"

Discussant: WILLIAM BRAINARD, Yale University

11:15 A.M. Break

11:30 A.M. CHARLES JACKLIN, Stanford University
"Bank Capital Requirements and Incentives for Lending"

Discussant: BEN BERNANKE, Princeton University

12:45 P.M. Lunch - **Stauffer Auditorium, Hoover Institution**
Speaker: ROBERT PARRY, President, Federal Reserve Bank of San Francisco
"Banks and Bank Regulation in the Current Economic Environment"

Littlefield Center, Wattis Room

2:00 P.M. LAWRENCE CHRISTIANO and MARTIN EICHENBAUM, Northwestern University
"Optimal Choice of Monetary Policy Instruments in a Dynamic Stochastic Macro Model"

Discussants: DONALD L. KOHN, Federal Reserve Board
JOHN B. TAYLOR, Stanford University

3:30 P.M.	Break	
3:45 P.M.	JEFF FUHRER, Federal Reserve Bank of Boston and GEORGE MOORE, Federal Reserve Board *"Monetary Policy and the Behavior of Long-Term Interest Rates"*	
	Discussants:	TIM COGLEY, Federal Reserve Bank of San Francisco BENNETT MCCALLUM, Carnegie-Mellon University
5:15 P.M.	Adjourn	
5:45 P.M.	Reception and Dinner - **Stanford University Faculty Club** Speaker: DAVID MULLINS, Vice Chairman, Federal Reserve Board	

Saturday, March 6 - Stauffer Auditorium, Hoover Institution

8:30 A.M.	Continental Breakfast	
9:00 A.M.	CARL WALSH, University of California at Santa Cruz and Federal Reserve Bank of San Francisco *"Optimal Contracts for Independent Central Bankers: Private Information, Performance Measures and Reappointment"*	
	Discussants:	VALERIE RAMEY, University of California, San Diego ALLAN H. MELTZER, Carnegie-Mellon University
10:30 A.M.	Break	
10:45 A.M.	LARS P. HANSEN, University of Chicago and THOMAS J. SARGENT, Hoover Institution and University of Chicago *"Flat Rate Taxes with Adjustment Costs and Several Capital Stocks and Household Types"*	
	Discussants:	ROBERT KING, University of Rochester JOHN SHOVEN, Stanford University
12:15 P.M.	Adjourn	