Evaluating the Welfare Effects of Alternative Monetary Arrangements*

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In this paper we construct a computable general equilibrium model, calibrate it to selected data for the U.S. economy, and use it to explore the welfare effects of various monetary arrangements. We find that the key feature of any monetary arrangement is its equilibrium after-tax real return schedule on liquid assets held by households. If this schedule is the same for two different arrangements, then so are the welfare effects. Further, the amounts of *seigniorage* collected—that is, the difference between tax receipts and government expenditures net of interest payments on the government debt—are the same as well. We find that relative to a tax on labor income, seigniorage is a poor source of revenue. In particular, we find that if the after-tax real return on saving deposits is –5 percent, as it was on average in the United States in the 1974–78 period, welfare is 0.5 percent of consumption lower than it would be if the after-tax real return were zero, as it approximately was in the United States in both the 1964–68 and 1984–88 periods.

The work builds on that of İmrohoroğlu (forthcoming), who finds that for worlds in which non–interest-bearing nominal assets are the only liquid assets, the cost of constant inflation is far greater than the area under the empirical demand for money relation. With such arrangements, the after-tax real return is the negative of the inflation rate. The key feature of her model is that agents hold money in order to smooth consumption in the face of idiosyncratic income variability for which there is no insurance.[1] Her structure is in the permanent income tradition, with people varying money holdings in order to smooth consumption. This feature is not the one upon which Bailey (1956) focuses when he estimates the cost of inflation as the area under the demand for money function. Neither is it the one upon which Cooley and Hansen (1989, 1991) focus in their applied general equilibrium analysis of the cost of inflation. They, with their cash-in-advance constraint, are focusing on the transactional role of money. In focusing on the consumption-smoothing role, and implicitly also on savings for special needs, we are not arguing that this transactional feature is unimportant. Our findings do indicate that the welfare implications of moderate inflation, provided it is associated with correspondingly lower real returns on liquid assets held by households, are significantly different in economies where liquid assets are used for self-insurance purposes than in economies where they are used for transaction purposes.[2]

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[1] In precluding other insurance technologies, we are following, among others, Bewley (1980), Lucas (1980), and Scheinkman and Weiss (1986). Townsend (1980) and Green (1987) study economies with features that severely limit or preclude insurance of idiosyncratic risks. For a review and extension of this literature, see Kehoe, Levine, and Woodford 1990.

[2] Cooley and Hansen (1989, 1991) find that, for a calibrated economy with homogeneous agents and a cash-in-advance constraint, an inflation tax is not more burdensome than a labor income tax.

This work also builds on the Díaz-Gimenéz and Prescott (1990) extension to İmrohoroğlu's work. Like her, they have a continuum of agents with identical preferences and idiosyncratic shocks to the productivity of their time in the market sector. Following Rogerson (1988) and Hansen (1985), we assume labor is indivisible, so agents either work some institutionally determined workweek or do not work at all. Theoretical justification for this assumption is provided by Hornstein and Prescott (1989), who find that for empirically reasonable elasticities, if the hours that capital can be operated is permitted to vary, the equilibrium behaves as if there were an institutionally determined workweek. Additional theoretical support for this assumption is provided by Díaz-Gimenéz (1991), who finds that self-insurance through variation in the holding of liquid assets is a good substitute for the Rogerson (1988) lottery scheme.

In this study a technology is introduced to intermediate large-denomination nominal bills that the government issues. This extension permits the consideration of open market operations and the introduction of various legal constraints such as interest rate ceilings and reserve requirements, which are features of arrangements that have been employed in the United States in the postwar period. We find that the cost of inflation depends upon the institutional arrangements employed. Two arrangements with identical inflation rates and government expenditures can have very different welfare costs. This point has been made by Lucas (1981) in his comments on Fischer's (1981) estimate of the cost of inflation. What we evaluate here is an arrangement that must specify which contracts are enforceable and the nature of the tax systems.

In this study we also introduce uncertainty in monetary policy, which is defined by the process on the nominal interest rate and the inflation rate. With this extension, the state of the economy at a point in time must specify the entire distribution of the continuum of individuals as indexed by their asset and idiosyncratic human capital shock, along with the current value of the Markov process indexing monetary policy.

In the first section of this paper, we specify our class of model economies. In the second section, we define the equilibrium and specify our computation procedure used to compute it. In addition, we calibrate the economy to some key features of the U.S. economy. In the third section, we report the results of three sets of experiments. The first set of experiments employs an extreme legal constraint that forbids the payment of interest on deposits at financial intermediaries. We evaluate the welfare effect of the seigniorage tax in this world relative to that of an income tax on labor and interest income. The second set of experiments also forbids the payment of interest on deposits, but it includes random variation in the rate of inflation. The third set of experiments entails an arrangement that permits interest to be paid on deposits, as do the arrangements actually employed in the United States in the postwar period. For all the arrangements in this set, the after-tax real return on deposits is the same, as are the welfare effects. Inflation rates, however, are different across these arrangements. This demonstrates that except for the very special case of arrangements in which interest paid on deposits is zero, it does not make sense to speak of an *inflation tax.*

Model Structure

The economy consists of a continuum of initially identical agents who maximize

$$(1) \qquad E\left\{\sum_t \beta^t u(c_t, \tau - n_t)\right\}$$

where $0 < \beta < 1$ is their subjective time discount factor and $c_t \geq 0$ is their consumption of the perishable consumption good in period t. Parameter τ is the total endowment of productive time, and $0 \leq n_t \leq \tau$ is the amount of time allocated to market activities. Consequently, $\tau - n_t$ is leisure. The utility function is assumed to have the following form:

$$(2) \qquad u(c_t, \tau - n_t) = (1-\sigma)^{-1}\left\{[c_t^{\gamma}(\tau - n_t)^{1-\gamma}]^{1-\sigma} - 1\right\}$$

where the parameter $0 < \gamma < 1$ and the degree of risk aversion $\sigma > 0$ and $\sigma \neq 1$. An agent faces a productivity shock, s_t, that is time-varying and independent across agents. The process for this idiosyncratic shock is assumed to follow a finite-state Markov chain with the transition probabilities $\pi(s,s') = \text{prob}\{s_{t+1} = s' | s_t = s\}$, where $s, s' \in \{1,2,\ldots,n_s\}$. All the $\pi(s,s')$ are strictly positive. These processes are independent across agents.

At time t an agent's output is given by

$$(3) \qquad w(s_t)n_t$$

where $w(s_t)$ is the productivity parameter and, again, n_t is labor services that the worker provides. Since labor is assumed to be indivisible, n_t takes only two values. If an agent is employed, $n_t = 1$, and the agent receives the real wage rate $w(s_t)$. If an agent is not employed, $n_t = 0$, and that agent receives no income from the labor market.

Agents in this economy also face an aggregate shock, z_t, that describes the exogenous changes in the monetary policy. The process for this aggregate shock is assumed to follow a finite-state Markov chain with transition probabilities $\chi(z,z') = \text{prob}\{z_{t+1} = z' | z_t = z\}$ for $z, z' \in \{1,2,\ldots,n_z\}$.

The Monetary Arrangement

There are two assets issued by the government. The first asset is currency, which does not bear interest. The second asset is a Treasury bill, which pays nominal interest $R_{TB}(z)$. The government sets the return on the T-bill and the deposit reserve requirement ratio, RR. Agents cannot hold interest-bearing nominal government debt. This debt must be intermediated by banks.

There is a constant return-to-scale technology (relative to the number of depositors) that can intermediate government debt, and there is free access to this technology. Associated with each interest-bearing account, there is a real fixed cost α_0 and a nominal cost α_1 per dollar intermediated. Competition in the banking sector determines the nominal return,

$$(4) \qquad R_D(z) = (1-RR)R_{TB}(z) - \alpha_1$$

on deposits $D \geq 0$. If P_t is the price of a unit of the consumption good in terms of currency, then an agent must pay a fee of $P_t\alpha_0$ if the agent maintains an interest-bearing account at time t.

In equilibrium, an agent does not maintain an account if X, the amount of nominal assets the agent has after consumption and paying taxes, is less than $P\alpha_0/R_D$. Thus, the law of motion of nominal assets A_t is

$$(5) \qquad A_{t+1} = X_t + \max\{0, X_tR_D(z_t) - P_t\alpha_0\} + (1-\theta)w(s_t)n_tP_t$$

where

$$(6) \qquad X_t = A_t - c_tP_t$$

and θ is the labor income tax rate.

The cost of intermediating a deposit of size $D_t \geq 0$ is

$$(7) \qquad I(D_t) = P_t\alpha_0 + \alpha_1D_t.$$

Those agents with $X_t > P_t\alpha_0/R_D(z_t)$ will have $D_t = X_t$. Those with smaller X_t will have $D_t = 0$ and currency holdings equal to X_t. Total intermediation is the sum of the $I(D)$ over all agents with $X > P\alpha_0/R_D(z)$.

The Agent's Problem

The agent's problem in real terms is a stationary discounted dynamic program. We let lowercase letters denote the real values of flow variables. In the case of nominal assets, we let $a_t = A_t/P_{t-1}$, where A_t is the beginning-of-period nominal assets. Finally, a' is the beginning-of-next-period value of stock a. With this notion, an agent's optimality equation is

$$(8) \qquad v(a,s,z) = \max\{u(c,\tau-n) + \beta E\{v(a',s',z')\,|\,s,z\}\}$$

where the maximization is over (a',c,n,x) and is subject to

$$(9) \qquad n \in \{0,1\}$$

$$(10) \qquad a', c, x \geq 0$$

$$(11) \qquad x = [a/e(z)] - c$$

$$(12) \qquad a' = x + \max\{0, xR_D(z) - \alpha_0\} + (1-\theta)w(s)n$$

where $e(z) = P_t/P_{t-1}$ and interest on deposits is $R_D(z) = (1-RR)R_{TB}(z) - \alpha_1$. We consider only policies for which $[1 + R_D(z)]\beta < 1$ for all z. This, along with the facts that $0 < \theta < 1$, $w(s) > 0$ for all s, and $e(z) \geq 1$, is sufficient to insure that this is a well-behaved discounted dynamic program. Agents in this economy are identical except for their current human capital shock s and their current asset position a. We let y_{as} be the fraction of agents of type (a,s) at a point in time. Society's resource constraint at that time t is

$$(13) \qquad g + \sum_{a,s} i(a,s,z)y_{as} + \sum_{a,s} c(a,s,z)y_{as} \leq \sum_{a,s} n(a,s,z)w(s)y_{as}.$$

Here $c(a,s,z)$ and $n(a,s,z)$ are optimal consumption and employment decisions from dynamic program (8), g is real government expenditures, and $i(a,s,z)$ is the real intermediation cost per type (a,s) agent if the current aggregate shock is z.[3] From (7),

$$(14) \qquad i(a,s,z) = \begin{cases} \alpha_0 + x(a,s,z)\alpha_1 & \text{if } x(a,s,z) > \alpha_0/R_D(z) \\ 0 & \text{otherwise} \end{cases}.$$

Finally, the equilibrium law of motion for an individual's real assets a is

$$(15) \qquad a' = f(a,s,z).$$

Calibration and Equilibrium

For the environment to be fully specified, it is necessary to choose specific values for the parameters of this model. We calibrate this economy so that certain key statistics for the model economy match those of the U.S. economy.

We choose the model's time period to be six weeks. The choice for the time period is dictated by computational considerations. Shortening of the period increases computation costs significantly but does not affect conclusions. The subjective time discount factor, β, is assumed to be 0.995, which implies an annual subjective time discount rate of 4 percent. The parameter γ is chosen to be 0.33, which implies a share

[3] Our definition of consumption is not the same as the one used in the national income and product accounts. Our definition excludes intermediation service.

of leisure of two-thirds. The degree of risk aversion, σ, is selected to be 4. The exponent on consumption, which is the product of $\gamma(1-\sigma)$, is therefore -1. Total endowment of productive time is taken to be 2.2222. Thus, on average, when people choose to work, they will allocate 45 percent of their productive time to market activities.

The real wage that a worker receives is a function of that worker's idiosyncratic productivity shock s. Real wages are chosen such that workers are 2.5 times as productive in their high-productivity state, $s = 1$, as they are in their low-productivity state, $s = 2$. Thus, real wages are $w(1) = 1.00$ and $w(2) = 0.40$.

The transition probabilities $\pi(s,s')$ are chosen so that workers experience the high-productivity shock 92 percent of the time. The average duration of the low-productivity shock is two model periods. These choices imply that the transition matrix for the idiosyncratic shocks is

$$(16) \qquad \pi = \begin{bmatrix} 0.9565 & 0.0435 \\ 0.5000 & 0.5000 \end{bmatrix}.$$

We select the values of the parameters, the values for the real income in different states, and the process on the productivity shock in such a way that the model economy generates reasonable ratios of stocks to income.

Finally, the transition functions for the aggregate shock and the monetary policy rules are chosen. We experiment with different monetary policy regimes that cause the persistence of inflation to vary, and they are described in the next section.

The optimal value function and the decision rules for this finite-state discounted dynamic programming problem are obtained by successive approximations. The state of the economy is represented by z and by the fractions y_{as} of agents with asset level a and idiosyncratic shock s. In order to compute the statistical properties of the equilibrium Markov process, it is necessary to characterize the law of motion for the state of the economy, (y,z). Let $y_{t+1} = h(y_t,z_t)$ describe the equilibrium law of motion for the state of the economy, where y_{ast} is the fraction of type (a,s) agents at time t. We emphasize that, to specify the state of the economy at a point in time, the entire distribution of agent types, that is, y_t, is needed along with the aggregate shock z_t.

The following equation specifies the fraction of agents of types (a',s') in the next period given fractions y and shock z and therefore defines the law of motion h:

$$(17) \qquad y'_{a's'} = \sum y_{as}\pi(s,s')$$

where the summation is over (a,s) for which $a' = f(a,s,z)$.

Given y_t and z_t, these formulas determine y_{t+1}. The value of z_{t+1} given z_t is random, with $\chi(z,z')$ being the probability that $z_{t+1} = z'$ given $z_t = z$. The law of motion h and the transition matrix χ can be used to generate realizations of the equilibrium process for the economy given initial conditions.

In the case that there is no aggregate uncertainty and z_t is some constant $\bar{z}$ over time, the aggregate behavior of the economy is deterministic:

$$(18) \qquad y_{t+1} = h(y_t,\bar{z}).$$

Since the process on (a,s) is a Markov chain with a single ergodic set and no cyclically moving subsets, $\{y_t\}$ converges to a limit which is independent of y_0. For welfare comparison, when there is no aggregate uncertainty, we use this limiting distribution.

In the case that there is aggregate uncertainty, the sequence of distributions $\{y_t\}$ does not converge, and an alternative procedure is needed. We note that an agent's law of motion depends only on the agent's own (a,s) and the exogenous aggregate state variable z. That this law of motion does not depend on y is crucial for our computation procedures. This property is exploited as follows. The triplet (a,s,z) is subject to an ergodic Markov chain with no cyclically moving subsets. The invariant distribution Ψ for the Markov chain generating (a,s,z) is the fraction of time an individual is in state (a,s,z) in the limit as the sample period goes to infinity. Distribution Ψ is the unique solution to this linear equation:

$$(19) \qquad \Psi(a',s',z') = \sum \Psi(a,s,z)\chi(z,z')\pi(s,s')$$

where the summation is over the (a,s,z) for which $a' = f(a,s,z)$.

The method we employ to compute Ψ is successive approximations. The right side of (17) defines a function which maps probability distributions into probability distributions. Let T denote this function. The invariant distribution Ψ that we seek is the fixed point of T:

$$(20) \qquad \Psi = T(\Psi).$$

Since the Markov chain process is ergodic and there are no cyclically moving subsets, the sequence generated by

$$(21) \qquad \Psi_{n+1} = T(\Psi_n)$$

converges to this fixed point of T. We found 800 model periods, that is, 100 years, to be more than sufficient for initial conditions to disappear. In making welfare comparisons when there is aggregate uncertainty, we use this distribution Ψ.

Results of Experiments

In this section we present results obtained from various experiments that analyze economies with different monetary arrangements. The section is organized as follows. First we examine the statistical properties of economies with a 100 percent reserve requirement. The welfare of an individual is computed for economies with different inflation rates. Then we introduce fluctuations in the inflation rate to this type of economy and examine how the magnitude and persistence of those fluctuations affect the average welfare of individuals. Finally, we introduce an intermediation technology that permits interest to be paid on deposits.

Economies With a 100% Reserve Requirement . . .

Again, our first experiments employ an extreme monetary arrangement, namely, a 100 percent reserve requirement with no interest paid on reserves. With this particular arrangement, there are no intermediation costs and the nominal interest rate on deposits is zero. Thus, in this world, the real return on deposits is equal to minus the inflation rate. In effect, there is a single asset, namely, currency. We consider inflation rates of 0 percent, 2.5 percent, 5 percent, 7.5 percent, and 10 percent. In each economy, the inflation rate does not fluctuate.

We are examining how the welfare of individuals is reduced by seigniorage. For this reason, as we vary the inflation rate across economies, we vary the income tax rate θ in such a way that the government purchases of goods and services do not change. Thus, in all the experiments reported, we are comparing seigniorage with a labor income tax. Table 1 summarizes the statistical properties of these economies.

In these experiments, government expenditures are constant at approximately 20 percent of output. Velocity for these economies can be computed by dividing annual consumption by average asset holdings. For example, in the case of zero inflation, velocity is 2.6175, which is equal to 5.8648 divided by 2.2406. Velocity is 3.3750 when inflation is 5 percent. This implies an interest semi-elasticity of 5, which is the number Lucas (1981) uses when he estimates the cost of inflation with Bailey's (1956) method.

We can study the behavior of individuals in economies with different inflation rates by examining Table 1. In economies with higher inflation, individuals work more; consequently, average consumption is higher. With higher inflation, however, individuals have lower real asset holdings on average, and as a result of this, volatility of consumption as measured by the standard deviation of their consumption is greater. Examining the average utility in these economies reveals that welfare is lower if the inflation rate is higher.

The loss, or cost, associated with higher inflation rates can be calculated by finding the percentage increase in consumption that is necessary for agents to be as well off as they would be in the zero inflation economy. This cost is reported in the last column of Table 1.

Overall for these economies, seigniorage is a poor tax relative to an income tax. For example, with 5 percent inflation, consumption must be scaled up by 0.5 percent for agents to be as well off as those in the zero inflation economy. As welfare losses go, this is not a small number. In 1990, U.S. aggregate consumption was \$3,658 billion, and 0.5 percent of this number is \$18.29 billion.

One interesting finding is that the cost of inflation does not increase with the square of the inflation rate in this economy. If we apply the Bailey (1956) method, the estimated cost,

Table 1

Statistical Properties of Economies With a 100% Reserve Requirement*

	Variables (Average Levels)					Revenue as a % of Output From		
Inflation Rate (%)	After-Tax Real Return on Deposits (%)	Utility	Consumption**	Asset Holdings	Employment Rate (%)	Income Tax	Seigniorage	Cost of Inflation as a % of Consumption†
.0	.0	–.2843	5.8648	2.2406	92.16	20.37	.00	—
2.5	–2.5	–.2851	5.8682	1.9248	92.26	19.71	.65	.3
5.0	–5.0	–.2857	5.8711	1.7396	92.35	19.20	1.15	.5
7.5	–7.5	–.2864	5.8742	1.6083	92.45	18.75	1.59	.7
10.0	–10.0	–.2869	5.8771	1.5124	92.54	18.36	1.97	.9

*In these economies, the cost of intermediation and the nominal interest rate on deposits are zero and government expenditures are constant at about 20% of output.

**These are annual rates.

†These numbers are the % increase in consumption needed for average utility to be as high as in the zero inflation economy.

which is the area under the demand for money function, increases with the square of the inflation rate. This demonstrates that the standard approach for measuring the cost of inflation provides a poor measure of the inflation cost associated with the consumption-smoothing role of liquid assets.

. . . And Inflation Volatility

Now we introduce inflation volatility. The inflation policy rule for these experiments is $e(1) = 1.00$ and $e(2) = 1.05$, while the process on z is such that, for $z \in \{1,2\}$,

$$\text{prob}\{z_{t+1} = z \mid z_t = z\} = \phi \tag{22}$$

where the parameter ϕ is the persistence of changes in the inflation rate. The expected duration at a given inflation rate is $1/(1-\phi)$ model periods, each of which is one-eighth of a year. For $\phi = 1/2$, the inflation rates are independently and identically distributed over time.

The question we ask here is, What is the cost of volatility in inflation relative to no volatility? Thus, we compare the average utility of an agent in an economy with a 2.5 percent constant inflation rate to the average utility of an agent in economies where the inflation rate fluctuates between 0 and 5 percent with different persistences.

Our answer is that inflation rate volatility adds virtually nothing to the cost of inflation associated with the consumption-smoothing role of liquid assets. In these economies, real rates of return are identical on average; thus, average utilities are identical. This is true whether or not changes in the inflation rate are persistent and regardless of how persistent they are. These findings are in sharp contrast to the findings if the cost of inflation is estimated as the area under the demand for money function.

Economies With Intermediation

Finally, we set the deposit reserve requirement ratio below 100 percent, and as a result, in equilibrium the agents use the intermediation technology explained in the first section of the paper.

In Table 2, we report statistical properties of economies with different monetary arrangements. These arrangements specify a reserve requirement ratio, RR; a nominal return on T-bills, R_{TB}; and an inflation rate. The parameters of the intermediation technology are given by a variable intermediation cost, α_1, and a fixed cost, α_0.

The top half of Table 2 describes three economies with an after-tax real return on deposits of 0 percent. The monetary arrangements in those economies are quite different. For example, the first economy has no inflation, no nominal return on T-bills, and no reserve requirement.

In the next economy, the inflation rate and the nominal return on T-bills are both set at 3 percent and the annual real cost of having an account, α_0, is chosen to be 0.008. With the average consumption of 5.857, the ratio of α_0 to average consumption is 0.00137. If we take annual per capita consumption to be \$20,000, this would correspond to a fixed cost of approximately \$27 annually. The reserve requirement and the intermediation cost in this economy are taken to be zero; thus, the nominal interest on deposits is the same as the nominal interest on T-bills. Minimum deposits implied by the monetary arrangement and the intermediation technology in this case are 0.27. For this economy, average asset holdings are 2.2421; individuals whose asset holdings are below 0.27 do not earn any nominal interest. Thus, agents in this economy sometimes use currency and sometimes use deposits to smooth their consumption.

The third economy in Table 2 has a 3 percent inflation rate, a 6 percent nominal interest rate, and a reserve requirement rate set at 49 percent. Minimum deposits implied in this case are again 0.27.

Clearly, these three economies have very different monetary arrangements; however, they are chosen such that the after-tax real return on deposits in each one of them is 0 percent. Also, for these economies, resources used in intermediation are about 0.12 percent of output. Examining the statistical properties of these economies reveals that they are almost identical in their equilibrium levels of average consumption, employment, and asset holdings. Thus, the welfare levels are the same.

The same observations can be made by examining the three economies in the bottom half of Table 2. In these economies, the after-tax real return on deposits is −5 percent. There is a slight difference between the first of these economies and the other two. Annually, resources used up in intermediation are zero in the first economy and 0.12 percent in the others. In the economies with the same real return on deposits and the same total intermediation cost, average consumption, employment, and welfare are the same. In all the economies examined in this section, government expenditures are constant and equal to about 20 percent of output. The above findings show that what is crucial in the consumption-smoothing world is the after-tax real return on deposits and what has to be evaluated is the entire monetary arrangement.

Using this environment, we can examine how individual welfare is reduced when a government uses seigniorage as a tax. In these economies with stationary equilibria and no aggregate uncertainty, we can define *seigniorage* as the difference between government expenditures other than interest paid on government debt and government revenues collected through the labor income tax. In Table 2, revenues collected through seigniorage are reported for each of the six monetary arrangements. As we have seen above, economies with different monetary arrangements yield the same welfare if the after-

Table 2
Statistical Properties of Economies With Intermediation

After-Tax Real Return on Deposits (%)	Monetary Arrangements (%)			Variables (Average Levels)				Revenue as a % of Output From	
	Inflation	*RR*	R_{TB}	Utility	Consumption†	Asset Holdings	Employment Rate (%)	Income Tax	Seigniorage
0*	0	0	0	–.2847	5.8568	2.2384	92.16	20.47	.00
	3	0	3	–.2847	5.8570	2.2421	92.16	20.07	.30
	3	49	6	–.2847	5.8570	2.2421	92.16	20.07	.30
–5**	6	30	1	–.2858	5.8716	1.7233	92.37	19.07	1.27
	6	43	3	–.2863	5.8616	1.7225	92.36	19.21	1.14
	6	71	6	–.2863	5.8616	1.7225	92.36	19.21	1.14

†These are annual rates.
*In these three economies, the annual intermediation costs are $\alpha_0 = 0.008$ and $\alpha_1 = 0$.
**In these three economies, $\alpha_0 = 0$. However, in the first, $\alpha_1 = 0$, while in the other two, $\alpha_1 = 1$.

tax real return on deposits is the same. For those economies, it is worth noting that the seigniorage collected is also identical.

In order to examine the welfare implications, we compare economies with 0 and –5 percent after-tax real returns. In Table 3 we have documented that in the United States the average after-tax real return on saving deposits was –4.6 in the 1974–78 period, slightly negative in the 1964–68 period, and slightly positive in the 1984–88 period. Thus, the variations that we are considering are in line with those which actually occurred in the United States in the postwar period.

Average utility in economies with a zero after-tax real rate is –0.2847. In those economies, the total amount of resources used up in intermediation is 0.12 percent of output. In economies with a –5 percent real return and the same amount of intermediation cost, average utility goes down to –0.2863. The welfare loss is about 0.5 percent of consumption. If we compare the average utility in the –5 percent real return economy to the one with a zero real return, both with zero intermediation cost, again we find the welfare loss to be about 0.5 percent of consumption. That is, with a –5 percent real interest rate, consumption must be scaled up by 0.5 percent for agents to be as well off as those in an economy with a 0 percent after-tax real return.

Notice that the welfare loss of a –5 percent after-tax real interest rate found in this environment with intermediation, where agents use currency and deposits to smooth out consumption, is the same as the welfare loss found in the environment of Table 1, where agents use currency only to smooth out consumption because of a 100 percent reserve requirement. In fact, seigniorage is given the best chance in an economy with a 100 percent reserve requirement. This is due to the facts that some real resources are used up in intermediation and there is no intermediation with a 100 percent reserve requirement. In the economy with such a reserve requirement and a –5 percent real return, the average utility is –0.2857, whereas in the economy with a positive intermediation cost and a –5 percent real return, the average utility is –0.2863. The welfare loss associated with this is 0.18 percent of consumption and is entirely a function of the intermediation cost.

Table 3
Average Real Returns in the United States

Period	Rate Before Taxes (%)*		Rate After Taxes (%)**	
	3-Month T-Bills	Saving Deposits†	3-Month T-Bills	Saving Deposits†
1964–68	1.4	.5	.0	–.7
1974–78	–1.7	–2.7	–3.9	–4.6
1984–88	4.0	3.0	.8	.9

*Nominal rates are converted to real rates using the implicit price deflator of the gross national product.
**A 33% income tax is assumed.
†For 1984–88, this is the Super-NOW account rate. For the earlier periods, this is the maximum rate allowed under Regulation Q.
Source: Federal Reserve Board of Governors

To summarize, the findings suggest that what matters in the consumption-smoothing world is the after-tax real return on deposits and that seigniorage is a poor tax relative to an income tax for this sort of economy. In evaluating the welfare effect of seigniorage as a tax, the results found in 100 percent reserve requirement economies carry over to economies with intermediation. In fact, keeping the real return constant, we find that welfare is reduced slightly more with intermediation since some real resources are used up in that activity.

Summary

In this paper we analyze the welfare effects of various monetary arrangements in a general equilibrium model where a technology to intermediate large-denomination nominal bills that the government issues is introduced. This extension allows us to examine economies where agents hold currency and deposits at financial institutions in order to smooth out consumption.

Our findings indicate that what is crucial in the consumption-smoothing world is the after-tax real return on deposits and what has to be evaluated is the entire monetary arrangement. Two arrangements with identical inflation rates and government expenditures can have very different costs. What must be evaluated is a complete arrangement which must specify the nature of the tax system and the legal constraints that are employed.

For the economies examined, we find that the seigniorage tax is not a good one relative to a tax on labor income. If the after-tax real return is −5 percent, as it was in the 1974–78 period in the United States, welfare is approximately half a percent of consumption lower than it would be if the after-tax real return were zero, as it approximately was in the United States in the 1964–68 and 1984–88 periods. Half a percent of 1990 U.S. consumption is over $18 billion.

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