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Seigniorage as a Tax: A Quantitative Evaluation

In this paper we construct a computable general equilibrium model, calibrate it to selected data for the American economy, and use it to explore the efficacy of the seigniorage tax associated with various monetary arrangements. We find that the key feature of any monetary-tax arrangement is its equilibrium after-tax real return schedule on liquid assets held by the households. We also find that considerable seigniorage, which we define to be the difference between government expenditures other than interest paid on government debt and taxes collected, can be large. We find that the seigniorage tax is a poor one relative to a tax on labor income. In particular, we find that if the after-tax real return on saving deposits is −5 percent, as it was on average in the 1974–1978 period, welfare is one-half percent of consumption lower than it would be if the after-tax real return were zero, as it approximately was in both the 1964–1968 and 1984–1988 periods.

The work builds on that of A. İmrohoroğlu (1990), 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

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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 (1990) 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 the households, are significantly different in economies where liquid assets are used for self-insurance purposes rather than for transaction purposes.[2]

This work also builds on the Diaz-Gimenez and Prescott (1989) 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), labor is assumed to be indivisible, so agents either work some institutionally determined work week 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 are permitted to vary, the equilibrium behaves as if there were an institutionally determined work week. Additional theoretical support for this assumption is provided by Diaz-Gimenez (1990), 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 was made by Lucas (1981) in his comments on Fischer's (1981) estimate of the cost of inflation. What is evaluated 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

[1]In precluding other insurance technologies, we are following, among others, Bewley (1980), Lucas (1980), and Scheinkman and Weiss (1986). Green (1987) and Townsend (1980) 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 (1989).

[2]Cooley and Hansen (1990), for a calibrated economy with homogeneous agents and a cash-in-advance constraint, find that an inflation tax is not more burdensome than a labor income tax.

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 section 1 we specify our class of model economies. In section 2 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 American economy. In section 3 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 efficacy of the inflation tax in this world relative to an income tax on labor and interest income. The second set of experiments also forbids the payment of interest on deposits. The difference is that there is random variation in the rate of inflation. The third set of experiments entails an arrangement that permits interest to be paid on deposits.

1. STRUCTURE OF THE ECONOMIES

The economy consists of a continuum of ex ante identical agents who maximize:

$$E\,\{\Sigma_t \beta^t U(c_t, \tau - n_t)\} \tag{1}$$

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:

$$U(c_t, \tau - n_t) = (1 - \sigma)^{-1}\,\{[c_t^{\gamma}(\tau - n_t)^{1-\gamma}]^{1-\sigma} - 1\}\,, \tag{2}$$

where $0 < \gamma < 1$, $\sigma > 0$, and $\sigma \neq 1$. An agent faces a productivity shock that is time varying and independent across households. The process for this idiosyncratic shock is assumed to follow a finite-state Markov chain with the transition probabilities $\pi(s,s') = Pr\{s_{t+1} = s' | s_t = s\}$ 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

$$w(s_t)n_t \tag{3}$$

where $w(s_t)$ is the agent's productivity parameter and 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 $w(s_t)$. On the other hand, 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, $\chi(z,z') = Pr\{z_{t+1} = z' | z_t = z\}$ 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 $R_{TB}(z)$. Government sets the return on the T-bill and the deposit reserve requirement ratio, RR. Households 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,

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

on deposits $D \geq 0$. Letting P_t be the price of a unit of the consumption good in terms of currency, a household must pay a fee of $P_t\alpha_0$ if it maintains an interest-bearing account at date t.

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

$$A_{t+1} = X_t + \max \{0, X_t R_D(z_t) - P_t\alpha_0\} \tag{5}$$

where

$$X_t = A_t + (1 - \theta)w(s_t)n_t P_t - C_t \tag{6}$$

and θ is the labor income tax rate.

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

$$I(D_t) = P_t\alpha_0 + \alpha_1 D_t . \tag{7}$$

Those 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 cost is the sum of the $I(D)$ over all agents with $X > P\alpha_0/R_D(z)$.

Household's Problems

The household's problem in real terms is a stationary discounted dynamic program. We let lower-case 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, a household's optimality equation is

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

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

(i) $n \in \{0,1\}$
(ii) $a',c,x \geq 0$
(iii) $x = a/e(z) + (1 - \theta)w(s)n - c$
(iv) $a' = x + \max\{0,xR_D(z) - \alpha_0\}$,

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 $0 < \theta < 1$, that $w(s) > 0$ for all s, and that $e(z) \geq 1$ is sufficient to insure that this is a well-behaved discounted dynamic program. Households 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 households of type (a,s) at a point in time. Society's resource constraint at that date t is

$$g + \sum_{a,s} i(a,s,z)y_{as} + \sum_{a,s} c(a,s,z)y_{as} \leq \sum_{a,s} n(a,s,z)\ w(s)y_{as} . \tag{9}$$

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 costs per type (a,s) agent if the current aggregate shock is z.[3] From (7),

$$\begin{aligned} i(a,s,z) &= \alpha_0 + x(a,s,z)\alpha_1 && \text{if } x(a,s,z) > \alpha_0/R_D(z) \\ &= 0 && \text{otherwise} . \end{aligned} \tag{10}$$

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

$$a' = f(a,s,z) . \tag{11}$$

2. COMPUTATION OF THE EQUILIBRIUM AND CALIBRATION OF THE ECONOMY

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.

[3] Our definition of consumption is not the same as the one used in the National Income and Products accounts. Our definition excludes intermediation service.

We choose the model period to be six weeks. The choice for the time period is dictated by computational considerations. Shortening of the period length increases computation costs significantly but does not affect conclusions. The subjective time discount factor, β, is assumed to be .995, which implies an annual subjective time discount rate of 4 percent. Parameter γ is chosen to be .33, which implies a share 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 when they work.

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 two and a half times as productive in their high productivity state, $s = 1$, as they are in their low productivity state, $s = 2$. Thus, real wages are: $w(1) = 1.0$; $w(2) = .40$.

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

$$\boldsymbol{\pi} = \begin{bmatrix} .9565 & .0435 \\ .5000 & .5000 \end{bmatrix} . \tag{12}$$

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 section 3.

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 z and the measures 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 measure of type (a,s) households at time t. We emphasize, 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 aggregate shock z_t.

The following equations specify the measure of agents of types (a',s') in the next period given measure y and shock z, and therefore defines the law of motion h:

$$y'_{a's'} = \Sigma\, y_{as}\, \pi(s,s') \tag{13}$$

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

Given y_t and z_t, these formulae 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 $z_t = z$. Law of motion h and 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 constant over time, the aggregate behavior of the economy is deterministic:

$$y_{t+1} = h(y_t,\bar{z}) \ . \tag{14}$$

As 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 a household's law of motion depends only on their own (a,s) and the exogenous aggregate state variable z. That this law of motion does not depend upon 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 the linear equations:

$$\Psi(a',s',z') = \Sigma\ \Psi(a,s,z)\chi(z,z')\pi(s,s') \ , \tag{15}$$

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 (13) defines a function that maps probability distributions into probability distributions. Let T denote this function. The invariant distribution Ψ that we seek is the fixed point of T:

$$\Psi = T(\Psi) \ . \tag{16}$$

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

$$\Psi_{n+1} = T(\Psi_n) \tag{17}$$

converges to this fixed point of T. We found eight hundred model periods, that is, one hundred 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.

3. RESULTS OF COMPUTATIONAL EXPERIMENTS

In this section we present results obtained from various experiments that analyze economies with different monetary arrangements. The section is organized as follows: Subsection 3.1 examines the statistical properties of economies with 100 percent reserve requirements. Welfare of an individual is computed for economies with different inflation rates. Subsection 3.2 introduces inflation volatility to the above economy and examines how the welfare of an individual is affected by volatility. Subsection 3.3 introduces an intermediation technology that permits interest to be paid on deposits.

3.1. Economies with 100 Percent Reserve Requirements

The experiments in the first set 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, 2.5, 5, 7.5, and 10 percent. There are no fluctuations in the inflation rate.

We are examining the efficacy of an inflation tax. For this reason, as the inflation tax rate varies, 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 the inflation tax with a labor income tax. Table 1 summarizes the statistical properties of these economies.

In the above 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 0 percent inflation, velocity is 2.6175, which is equal to 5.8949 divided by 2.2406. Velocity is 3.3750 when inflation is 5 percent. This implies an interest elasticity of 0.126.

TABLE 1

STATISTICAL PROPERTIES OF ECONOMIES WITH 100 PERCENT RESERVE REQUIREMENTS

	Inflation Rate				
	0%	2.5%	5%	7.5%	10%
Average					
Real return on deposits	0%	−2.5%	−5%	−7.5%	−10%
Utility	−0.2843	−0.2851	−0.2857	−0.2864	−0.2869
Consumption[a]	5.8648	5.8682	5.8711	5.8742	5.8771
(st. deviation)	(0.9238)	(0.9671)	(0.9989)	(1.0241)	(1.0436)
Asset holdings	2.2406	1.9248	1.7396	1.6083	1.5124
Employment rate	0.9216	0.9226	0.9235	0.9245	0.9254
Revenues/Output					
Income tax recepits/output	0.2037	0.1971	0.1920	0.1875	0.1836
Seigniorage receipts/output	0.0000	0.0065	0.0115	0.0159	0.0197

[a] These are eightly data at annual rates.

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

The loss associated with higher inflation rates can be calculated by finding the percentage increase in the productivities that is necessary for agents to be as well off as they would be in the zero percent economy. Those costs are reported in Table 2.

Overall, the results indicate that inflation is a poor tax relative to an income tax for these economies. For example, with 5 percent inflation, the productivities $w(s)$ must be scaled up by one-half percent of consumption for agents to be as well off as those in the zero percent inflation economy. As welfare losses go, this is not a small number.

One interesting finding is that the cost of inflation does not increase with the square of the inflation rate in this economy. If one applies the Bailey (1956) method, estimated costs, which are the area under the demand for money, increase 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 costs associated with the consumption smoothing role of liquid assets.

3.2. *Inflation Volatility*

In this section we introduce inflation volatility. The inflation policy rule for these experiments is $e(1) = 1.000$ and $e(2) = 1.05$, while the process on z is such that,

$$Pr\{z_{t+1} = z | z_t = z\} = \phi \text{ for } z \in \{1,2\} . \tag{18}$$

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, which are one-eighth of a year. For $\phi = ½$, the inflation rates are i.i.d. over time.

Table 3 summarizes the results of experiments with different persistence parameters. The question that is asked 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.

TABLE 2

WELFARE COMPARISONS

Inflation rates:	0%	2.5%	5%	7.5%	10%
Costs as a percent of consumption relative to 0% inflation:	—	.27%	.5%	.7%	.9%

TABLE 3

COST OF INFLATION RATE VARIABILITY

Persistence of inflation	$\phi = 0.50$	$\phi = 0.90$	$\phi = 0.99$
Cost of volatility relative to no volatility	0.0	0.0	0.0

The finding is that inflation rate volatility does not add to the cost of inflation associated with the consumption smoothing role of liquid assets. In these economies, real rates of return are identical on the average, thus average utilities are identical. This is true whether or not changes in the inflation rate are or are not persistent. These findings are in sharp contrast to the findings if the costs of inflation are estimated as the area under the demand for money.

3.3. Economies with Intermediation

In the economies analyzed in this section, we set the deposit reserve requirement ratio below 100 percent and, as a result, in equilibrium the intermediation technology explained in section 1 is used by the agents.

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

Columns 1–3 of Table 4 describe economies with an after-tax real return on deposits of approximately 0 percent. The monetary arrangements employed in those economies are quite different. For example, the economy analyzed in column 1 has 0 percent inflation rate, 0 percent nominal return on T-bills, and no reserve requirements.

In the economy described in column 2, the inflation rate and the nominal return

TABLE 4

STATISTICAL PROPERTIES OF ECONOMIES WITH INTERMEDIATION

	Monetary Arrangements[a]		
	Inflation = 0% RR = 0% R_{TB} = 0%	Inflation = 3% RR = 0% R_{TB} = 3%	Inflation = 3% RR = 49% R_{TB} = 6%
Average			
Real return on deposits	0.0%	0.0%	0.0%
Utility	−0.2847	−0.2847	−0.2847
Consumption[a]	5.8568	5.8570	5.8570
(st. deviation)	(0.9224)	(0.9230)	(0.9230)
Asset holdings	2.2384	2.2421	2.2421
Employment rate	0.9216	0.9216	0.9216
Revenues/Output			
Income tax recepits/output	0.2047	0.2007	0.2007
Seigniorage receipts/output	0.0000	0.0030	0.0030

[a] In all the above economies annual α_0 = 0.008, and α_1 = 0%.

[b] The consumption flow variables are eightly data at annual rates.

on T-bills is 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 5.84, the ratio of α_0 to average consumption is 0.00137. If we take annual per capita consumption to be twenty thousand dollars, this would correspond to a fixed cost of approximately $27 annually. The reserve requirement and the intermediation costs 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 is 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 use currency sometimes and deposits at other times to smooth their consumption.

In column 3, an economy with 3 percent inflation rate and 6 percent nominal interest rate is described where the reserve requirement rate is set at 0.49. Minimum deposits implied in this case are again 0.27.

Clearly these 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 near zero percent. Also, for the economies reported in Table 4, 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 columns 1–3 of Table 5. In those economies after tax real return on deposits is −5 percent. There is a slight difference between the economy in column 1 and the economies in columns 2 and 3. Annually, resources used up in intermediation are zero in the first economy and 0.12 percent in the last two. In the economies with the same real return on deposits and the same total intermediation costs, average consumption, employment, and welfare are the same. In all the economies examined in this section, government expendi-

TABLE 5

STATISTICAL PROPERTIES OF ECONOMIES WITH INTERMEDIATION

	Monetary Arrangements[a]		
	Inflation = 6% RR = 30% R_{TB} = 1%	Inflation = 6% RR = 43% R_{TB} = 3%	Inflation = 6% RR = 71% R_{TB} = 6%
Average			
Real return on deposits	−5.0%	−5.0%	−5.0%
Utility	−0.2858	−0.2863	−0.2863
Consumption[a]	5.8716	5.8616	5.8616
(st. deviation)	(1.0003)	(0.9981)	(0.9981)
Asset holdings	1.7233	1.7225	1.7225
Employment rate	0.9237	0.9236	0.9236
Revenues/Output			
Income tax recepits/output	0.1907	0.1921	0.1921
Seigniorage receipts/output	0.0127	0.0114	0.0114

[a] In all the above economies annual $\alpha_0 = 0$. Intermediation parameter α_1 is 0 in the first economy and 1 percent in the last two economies.

[b] The consumption flow variables are eightly data at annual rates.

tures are constant and equal to about 20 percent of output. *The above 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.*

Using this environment we can examine the efficacy of seigniorage as a tax. In these environments 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 revenues collected through the labor income tax. In Tables 4 and 5, revenues collected through seigniorage are reported for every experiment. As we have seen above, economies with different monetary arrangements yield the same welfare if the after-tax real return on deposits is the same. For those economies, it is worth noting that the seigniorage collected are also identical.

In order to examine the welfare implications of seigniorage, we compare economies with 0 and −5 percent after-tax real returns. In Table 6 we have documented that the average after-tax real return on saving deposits was −4.6 in the 1974–1978 period, slightly negative in the 1964–1968 period, and slightly positive in the 1984–1988 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 0 percent after-tax real rate is about −0.2847. In those economies, total resources used up in intermediation were 0.12 percent of output. In economies with −5 percent real return and the same amount of intermediation costs, average utility goes down to −0.2863. The welfare loss is about 0.55 percent of consumption. If we compare the average utility in the −5 percent real return economy to the one with 0 percent real return, both with zero intermediation costs, again we find the welfare loss to be about 0.5 percent of consumption. That is, with −5 percent real interest rate, the productivities must be scaled up by 0.5 percent for agents to be as well off as those in an economy with 0 percent after-tax real return.

Notice that the welfare loss of −5 percent after-tax real interest rate found in this environment with intermediation, where agents can use currency and deposits to smooth out consumption, is the same as the welfare loss found in the environment of subsection 3.1 where agents use currency only to smooth out consumption because of 100 percent reserve requirements. In fact, seigniorage is given the best

TABLE 6

AVERAGE REAL RETURNS

	Period		
	1964–1968	1974–1978	1984–1988
3-month T-bills before tax	1.4%	−1.7%	4.0%
3-month T-bills after tax	0.0	−3.9	0.8
Savings accounts before tax[a]	0.5	−2.7	3.0
Savings accounts after tax[b]	−0.7	−4.6	0.9

[a] Used super now account rate for 1984–1988.

[b] A 33 percent income tax is assumed and the GNP deflator was used to convert the nominal returns to real returns.

chance in an economy with 100 percent reserve requirements. This is due to the fact that some real resources are used up in intermediation and there is no intermediation with 100 percent reserve requirements. In the economy with 100 percent reserve requirements and −5 percent real return, the average utility is −0.2857, whereas in the economy with positive intermediation costs and −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 costs.

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

4. CONCLUDING REMARKS

In this paper we analyze the efficacy of the seigniorage tax associated with 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 that must specify the nature of the tax system and the legal constraints that are employed.

For the economies examined, we find that 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 1974–1978 period, welfare is approximately 0.5 percent of consumption lower than it would be if the after-tax real return were zero as it approximately was in the 1964–1968 and 1984–1988 periods.

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