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## Discretion, Rules, and Volatility

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Economic models with multiple equilibria, such as Diamond and Dybvig (1983), have become increasingly useful in analyzing volatility in financial markets and in business cycles. In many of these models, indeterminacy is a result of incomplete financial markets or technological nonconvexities. Here we identify economic policy discretion to be another distinct cause of indeterminate equilibrium and examine how discretion affects the number of equilibria, as well as their volatility.

By *discretion*, we mean institutions that assign to successive policymakers the freedom to change, without cost, the decisions of their predecessors. Policy making looks forward in environments of this type: Today's decisions depend on the expectations of how tomorrow's policymakers will react to situations they expect to prevail the day after tomorrow, and so on forever. Policy choice is indeterminate because there is no way to pin down the behavior of the policymaker at  $t+1$ . One possible class of equilibria under this institutional framework will display large swings in policy variables of the sort that Milton Friedman (1948 and 1968) and other monetarist writers identified as the source of many business cycles.

As a counterpoint to discretion, we also study an environment dominated by constitutional rules, that is, institutions that restrict the freedom to alter policies inherited from the past. In particular, a

constitution that gives current policymakers some veto power over changes in future policies endows public choices with an element of precommitment that makes current policy a genuine state variable. This setting makes future policies more predictable when one knows past policies. It also delivers two desirable properties claimed for rules by Friedman (1948 and 1968) and by Kydland and Prescott (1977): Fluctuations are completely eliminated from the set of equilibria, and all equilibrium allocations are social optima.

The specific policy question we study is the evolution of social security transfers among finite-lived households in an infinite economy, where individual preferences over fiscal transfers are single-peaked, and policy conforms to the wishes of a well-defined median voter household. Analyzing social security naturally sheds light on a number of issues related to intergenerational resource transfers, for example, public debt, currency, and the generational distribution of the tax burden. As we shall see later, the reasons why societies maintain a social security system stem in part from a social compact and, hence, apply with equal force to issues like defaulting on public debt and preserving the purchasing power of currency.

For the time being we focus on social security in the overlapping generations model of pure exchange without fiat money. Selfish individuals live two periods and are endowed with (and consume) a single good. This good is private, and claims on it (consumption loans) are the only assets in the economy. We assume away altruistic preferences and the provision of public goods—two key elements in the political economy of fiscal policy—to bring out more clearly the impact of political institutions on fiscal policy outcomes.<sup>1</sup>

Political institutions in this article define the authority of the government, that

<sup>1</sup> These issues are investigated in Tabellini and Alesina (1990), and Tabellini (1991).

is, of the median voter, to tax away endowment income. We study two institutional environments that allow more and less of this power. The more discretionary of the two political systems we study is pure majority voting that permits the larger of the two population groups (young and old) in our economy to reduce the consumption of the minority group to its minimum feasible level. The less discretionary system is a constitution requiring the majority to obtain the approval of the minority to any changes in social security taxes and benefits.

Constitutional limits to fiscal transfers serve as an endogenous mechanism of partial policy commitment, one that has certain similarities with the standard assumptions used in the literature to exclude from the median voter's strategy set all off-equilibrium plays that depend on what might have transpired two or more periods earlier.<sup>2</sup> The constitutional approach seems to us to be preferable to artificial restrictions on voting strategies, for it corresponds to political structures we observe around us and does not altogether rule out trigger strategies. We regard economic institutions like public debt service and social security to rest on social compacts that connect many successive governments and many generations of (possibly self-interested) voters. We therefore wish to consider trigger strategies that allow in principle today's fiscal policies to spill over several periods into the future, not just tomorrow.

The next section describes a pure-exchange economy whose equilibria we analyze in the subsequent sections under the majoritarian and constitutional systems. The concluding section discusses the literature relating to social security games and some extensions of our main results.

## A BASELINE MODEL

We start with a simple economic environment in which the government has a socially useful role. The economy is an overlapping generations model of pure exchange of the Samuelson type: It consists

of an infinite number of two-period cohorts. At any point only two generations are alive: young and old. Agents are identical within generations. The young are endowed with  $e_1 > 0$  units of the only consumption good; the old receive  $e_2 \geq 0$  units. The consumption good cannot be stored and the population growth rate is  $n > 0$ .

There is an initial old generation,  $t = 0$ , which consumes only in old age. Agents in cohort  $t = 1, 2, \dots$  evaluate consumption bundles  $(c_t^y, c_{t+1}^o)$  by the utility function

$$u_t = U(c_t^y) + \beta U(c_{t+1}^o), \beta > 0,$$

where  $c_t^y$  represents the consumption at time  $t$  of the generation born at time  $t$  (the young), and  $c_{t+1}^o$  is the consumption at time  $t + 1$  of the same generation (the old). The utility function is concave, twice differentiable and separable over time. In addition, we assume that the absolute value of the Marginal Rate of Substitution at the initial endowment point  $(e_1, e_2)$  is below the gross growth rate of the economy, that is,

$$(1) \quad (1 + n)\beta > U'(e_1)/U'(e_2).$$

To motivate the institution of social security in the simplest possible manner, we rule out outside assets like fiat money or public debt, which permit resources to be transferred between generations. We also rule out productive capital and similar stores of value.

Without government intervention, autarky is the only equilibrium in this incomplete market economy. It corresponds to point  $\Omega$  in Figure 1. The life cycle utility of a typical generation  $t = 1, 2, \dots$  at autarky is,

$$(2) \quad \tilde{u} = U(e_1) + \beta U(e_2).$$

As we know, a social planner may easily achieve a higher level of life cycle utility for all generations  $t = 0, 1, \dots$  in a Samuelson economy. One example is a stationary reallocation from autarky that levies a lump sum tax  $\tau_y$  on each young

<sup>2</sup> The section on literature and extensions gives an overview. Contributions most relevant to this article are Hammond (1975), Sjöblom (1985), Kotlikoff et al. (1988), Esteban and Sakovics (1993), Boldrin and Rustichini (1995), and Cooley and Soares (1995).

person and distributes the proceeds equally among the older generation. The resulting equilibrium is the golden rule, corresponding to point G in Figure 1. This reallocation has the following generational payoff:

$$(3) \quad v_g = \begin{cases} U(e_1 - \tau_g) + \beta U(e_2 + (1+n)\tau_g) & t \geq 1 \\ U(e_2 + (1+n)\tau_g) & t = 0, \end{cases}$$

where  $\tau_g$  maximizes the right side of the top line in equation 3.

## SOCIAL SECURITY WITH MAJORITY VOTING

Many policy decisions in democracies require approval by a simple majority, that is, by 50 percent plus one vote in a chamber of deputies representing the electoral body. In practice, the will of an electoral majority may be limited by nonproportional representation, veto power from other branches of government, or various political power groups. Nevertheless, majoritarian systems are both descriptive and analytically tractable. For simple cases in which voters' preferences over policies outcomes are single-peaked, the Median Voter Theorem enables us to aggregate individual tastes and obtain as an equilibrium of the voting process the outcome most preferred by a well-defined agent—the median voter.

We analyze majority voting over social security in the spirit of Hammond (1975). We postulate a pay-as-you-go transfer system with no commitment technology: A vote every period determines the social security tax,  $\tau_t$ , levied on each young household, as well as the benefit  $(1+n)\tau_t$  paid out to each old household. The current median voter in this arrangement cannot compel future voters to pay tax  $\tau_s$  for any  $s > t$ . To reflect electoral realities and provide some incentives toward intergenerational cooperation, we assume that the median voter belongs in the young generation. Table 1 provides some support for this assumption.

Figure 1

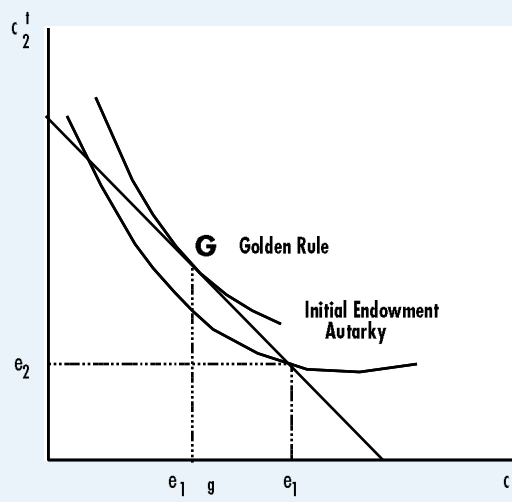


Table 1

### Median Voter's Age

| Year | Election for | Electorate | Reported Voters |
|------|--------------|------------|-----------------|
| 1992 | President    | 41         | 44              |
| 1990 | Congress     | 40         | 47              |
| 1988 | President    | 40         | 44              |
| 1986 | Congress     | 40         | 47              |
| 1984 | President    | 39         | 43              |
| 1982 | Congress     | 40         | 47              |
| 1980 | President    | 40         | 44              |
| 1978 | Congress     | 41         | 47              |
| 1976 | President    | 41         | 45              |
| 1974 | Congress     | 41         | 47              |
| 1972 | President    | 42         | 44              |
| 1970 | Congress     | 45         | 48              |
| 1968 | President    | —*         | 46              |
| 1966 | Congress     | 45         | 47              |
| 1964 | President    | 45         | 46              |

\* Data not available.

Source: U.S. Census, "Voting and Registration in the Election of 19\*\*"-Issues: 466, 453, 440, 414, 405, 383, 370, 344, 322, 293, 253, 228, 192, 174, and 143.

The set  $Y$  of feasible fiscal policies contains all tax/transfer schemes that ensure consumption by the young is nonnegative, and consumption by the old is bounded below by an exogenous subsis-

tence level that we assume to equal the old-age endowment. Hence,

$$(4) \quad \tau_t \in Y = [0, e_1].$$

The median voter in generation  $t$  maximizes

$$(5) \quad U(e_1 - \tau_t) + \beta U(e_2 + (1+n)\tau_{t+1}),$$

subject to equation 4 and given the strategy followed by the median voter of the succeeding cohort  $t+1$ . The electoral body consists of individuals aged between 21 and 76 years; a rough generational division will classify the age range 21- 48.5 as “young” and the age range 48.5- 76 as “old.”

## Open-Loop Equilibrium

A convenient benchmark is open-loop strategies that depend purely on calendar time and not at all on history. These strategies are independent of the actions of preceding players—both in and out of equilibrium—and hence provide no incentives for cooperation among generations. Hammond (1975) and Sjoblom (1985), in fact, recognized that the open-loop outcome is zero social security. Loewy (1988) also found that the open-loop equilibrium of a monetary economy shrinks to zero the purchasing power of currency. Because autarky is inefficient in a Samuelson-type economy, Pareto improvements are achieved by reallocations toward the golden rule. Open-loop equilibria are inefficient because they fail to transfer consumption in the correct direction.

## Subgame Perfect Equilibria

Selfish median voters who behave in the apparently cooperative fashion that sustains a social security system must do so because of enlightened self-interest, that is, because each cohort is individually better off with a social security system in place than without one. Incentives to coordinate fiscal policies over cohorts of median voters may be thought of as social compacts or norms enforced by a system of rewards and punishments.

Here is an example of how reinforcement works: Cohorts who transfer to the old the resources specified by the norm expect to receive in their own old age a normal payment; cohorts who defect from the norm in their youth for no apparent reason expect to receive a zero transfer in old age. Finally, cohorts who deviate from the norm with good reason, for example, to punish a prior unprovoked defection, expect to be treated normally later. Social norms in this example are enforced by a sequence of trigger strategies that connect the decisions of median voters with the behavior of their predecessors. Kandori (1992) and Salant (1991) have already demonstrated how these strategies make cooperation individually rational when it is infeasible to commit to a future policy course.

Simple majoritarian systems turn out to sustain any individually rational allocation as a subgame perfect equilibrium by the use of an appropriate trigger strategy profile. This folk-like result, conjectured in Hammond (1975), has the following formal statement:

*Proposition 1 (Majoritarian Folk Theorem):* For every feasible profile  $(v_s^*)_t$  of life cycle utilities bounded below by the autarkic equilibrium level  $\bar{v}$ , there exists a subgame perfect Nash equilibrium of the majoritarian social security game that starts at  $t$  and pays off  $v_s^* \geq \bar{v}$  for all  $s \geq t$ .

The proof, which we outline here, consists of defining an equilibrium strategy profile  $(\tau_s^*)_t$  for transfers consistent with payoffs  $(v_s^*)_t$ ; together with off-equilibrium play that punishes odd-numbered (first, third, etc.) successive defectors by driving their old-age consumption to its subsistence level  $e_2$ . To complete the proof, one shows that no median voter will be the first to defect from the equilibrium policy  $\tau_s^*$ , and that the best response to defection is immediate punishment by the next median voter. Only unprovoked defectors are punished out of equilibrium; nobody defects in equilibrium.

Fiscal policies sustaining subgame perfect equilibria under majority voting are ones that make each cohort prefer intergenerational cooperation over the open-loop outcome. In particular, all transfer policies satisfy the generational rationality constraint

$$(6) \quad U(e_1 - \tau_s^*) + \beta U(e_2 + (1+n)\tau_{s+1}^*) \geq \bar{v}.$$

As we surmise directly from Figure 2, inequality 6 defines a map,  $f$ , which connects today's social security tax with the *lowest* incentive compatible tax for tomorrow and has two fixed points. These are the subsistence transfer of zero, and a higher value,  $\tau_{\max}$ , above which individually rational transfers explode and youthful consumption becomes negative in finite time.

## Indeterminacy of Majoritarian Equilibria

Any feasible social security sequence  $(\tau_s^*)_t$  that satisfies inequality 6 is a subgame perfect equilibrium of the majority voting system. Figures 2 and 3 display all these sequences both directly and also in terms of the old-age consumption that corresponds to each one. Specifically, the set of equilibria contains:

- A continuum of constant sequences  $\tau_t = \tau \in [0, \tau_{\max}] \quad \forall t$ ;
- Dynamically inefficient sequences bounded above by the golden rule, for example, sequences that satisfy  $\tau_t \leq \tau_g - \varepsilon$  for some  $\varepsilon > 0$  and  $\forall t \geq T$ ;
- Volatile or cyclical sequences that may be generated by any non-monotone map,  $f$ , we care to draw within the shaded area of Figure 3.

Note also in Figures 2 and 3 that subgame perfect equilibria exist which pay off every cohort, except the initial old, more than the golden-rule utility level. This bonanza is made possible by the invention of

Figure 2

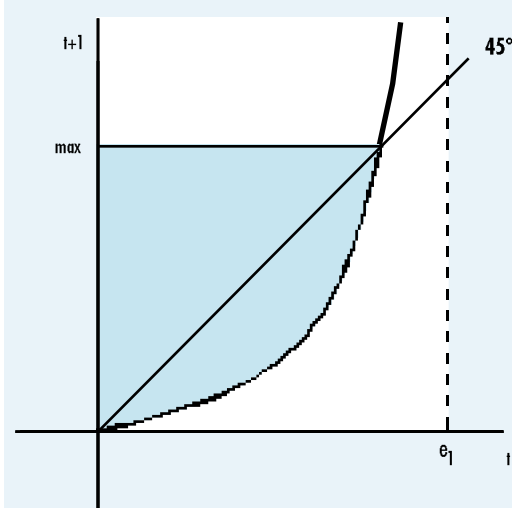
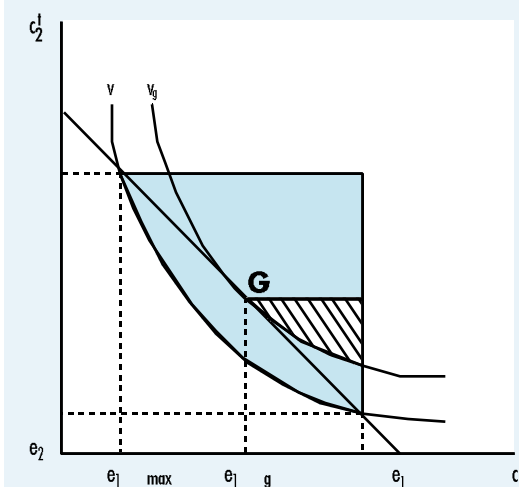


Figure 3



social security in some finite period, with an initial benefit below the golden-rule value  $\tau_g$ . The resulting surplus may then be spread among all subsequent cohorts by a rising sequence of benefits that converges to  $\tau_g$ .

The large amount of indeterminacy present in Figures 2 and 3 stems directly from voters' inability to commit their successors on a particular course of fiscal policy. The next section explores how refinements in political institutions bring about

Table 2

## Social Security Laws: Congressional Approval History\*

| Year | Law's Content                                | Approval Rate (%) |
|------|----------------------------------------------|-------------------|
| 1990 | No Future Increase in Benefits               |                   |
|      | No Future Reduction in Tax Rate              | H†: 413-15 (96)   |
| 1983 | Increase Retirement Age in 2000              |                   |
|      | No Reduction of Initial Benefits             |                   |
|      | Future Raise in Payroll Taxes                | H: 230-200 (53)   |
|      | Bill to Overhaul S.S. System                 | H: 243-102 (70)   |
|      |                                              | S‡: 58-14 (81)    |
| 1981 | No Benefits Reduction for Current Recipients | H: 450-13 (97)    |
|      | Restore Minimum Benefits                     | H: 412-10 (98)    |
|      |                                              | S: 96-0 (100)     |
| 1977 | Increase Taxable Income                      | H: 189-163 (54)   |
|      | Increase Payroll Tax Rate                    | S: 56-21 (73)     |
| 1973 | Increase Benefits by 11%                     | H: 301-13 (96)    |
|      | Increase Payroll Tax Rate                    | S: 66-0 (100)     |
| 1972 | Increase S.S./Medicare Benefits              | H: 305-1 (100)    |
|      | Increase Payroll Tax Rate                    | S: 61-0 (100)     |
| 1971 | Increase Benefits by 10%                     | H: 360-3 (96)     |
|      | Final Approval of 1970 Bill                  | S: 76-0 (100)     |
| 1970 | Increase Benefits by 10%                     |                   |
|      | Increase Taxable Base                        | H: 344-32 (91)    |
|      | Change to Medicare/Medicaid                  | S: 81-0 (100)     |
| 1967 | Increase Benefits by 13%                     | H: 390-3 (99)     |
|      |                                              | S: 62-14 (82)     |
| 1965 | Introduction of Medicare                     | H: 307-116        |
|      | Increase Benefits                            | S: 70-24          |
| 1964 | Increase Benefits by 5%                      | H: 388-8 (98)     |
|      | Increase Taxable Base/Tax Rate               | S: 60-28 (68)     |
| 1960 | Increase Benefits by 15%                     | H: 381-2 (99)     |
|      |                                              | S: 71-6 (92)      |

\* 1964-92.

† House.

‡ Senate.

Source: Congressional Quarterly Inc., "Congressional Quarterly Almanac," Volumes XX to L.

drastic changes in both the size and the volatility of fiscal policies.

## CONSTITUTIONAL RULES

Policy adjustments in a democratic society often require wider approval than

that of a simple legislative majority. This observation applies particularly when: (1) there is uncertainty as to the identity or preferences of future policymakers; and when (2) the policy change under consideration contains the seeds of its own reversal because it affects adversely the interests of (and will likely draw loud objection from) a politically significant group. Table 2 shows that congressional supermajorities were typically mustered whenever U.S. Social Security laws were changed.

In what follows, we ignore all future uncertainty and focus on case 2 above. Specifically, we consider a political arrangement that partly precommits fiscal policy by awarding the current median voter veto power over future policy changes. Veto power is exercised through a constitution, assumed to be fixed and immutable for the time being. The constitution empowers the younger cohort at time  $t$  to set up a binary fiscal policy agenda,  $Y_t$ , and entrusts the old to choose from the agenda the actual policy  $\tau_t$  to be implemented this period.

Formally, we have

$$(7a) \quad \tau_t \in Y_t = \{\tau_{t-1}, p_t\}$$

where  $\tau_{t-1}$  is last period's actual policy and  $p_t \in [0, e_1]$  is the new social security tax level proposed by the young. The status quo fiscal policy  $\tau_{t-1}$  plays the role of a state variable here and makes all the difference between the constitutional political structure and the majoritarian one.

Constitutionalism in this setting encourages commitment. The old can guarantee themselves the same social security as their immediate predecessors by vetoing any  $p_t \neq \tau_{t-1}$ . The young, too, can ensure a constant fiscal policy sequence by choosing  $p_t = \tau_{t-1}$ , that is, with an offer to maintain the status quo ante.

We assume the economy starts off in autarky, without a social security system, and the initial agenda in period one is

$$(7b) \quad Y_1 = \{0, p_1\} \quad p_1 \geq 0.$$

Old generations have a simple decision:

They pick the largest item on the agenda because their utility is monotone in the size of the transfer. The old would clearly choose to exercise their power to veto any reduction in social security; hence transfer sequences will be nondecreasing.

Agenda setting by the younger cohort guarantees them the golden-rule payoff  $v_g$ .<sup>3</sup> This is easiest to see when the social security system is invented: Starting from autarky at  $t = 1$ , any young cohort can get a unanimous vote to raise the social security transfer level from zero to the golden-rule value  $(1 + n)\tau_g$ , and veto any fiscal changes in the subsequent period  $t = 2$ .

Given the defection payoff, it is now straightforward to prove the following constitutional analogs of Proposition 1.

*Proposition 2* (Constitution Folk Theorem): For every feasible profile  $(v_s^*)_t$  of life cycle utilities whose lower bound is the golden-rule level  $v_g$ , there exists a subgame perfect Nash equilibrium of the constitutional social security game that starts at  $t$  with zero social security and pays off  $v_s^* \geq v_g$  for all  $s \geq t$ .

Subgame perfect constitutional transfers must be feasible, that is,

$$(8a) \quad \tau_s^* \in [0, \tau_g] \quad \forall t,$$

and individually rational for old and young alike, that is,

$$(8b) \quad \tau_{t+1}^* \geq \tau_t^*$$

$$(8c) \quad U(e_1 - \tau_t^*) + \beta U(e_2 + (1 + n)\tau_{t+1}^*) \geq v_g.$$

Inequality 8c again defines a map between today's actual tax and tomorrow's minimum incentive compatible tax. It has only one fixed point this time, just  $\tau_g$ .

Because no stationary allocation can pay more than the golden rule, one corollary of the individual rationality constraint (inequality 8c) is the following:

*Corollary:* The golden rule is the

unique stationary subgame perfect equilibrium.

Of course, it is possible for nonstationary equilibria to pay off more than the golden rule because an initial old generation received less. However, the distance of any nonstationary equilibrium from the golden rule must asymptotically shrink to zero because it would take an explosive sequence of transfers to keep welfare bounded away from the golden-rule payoff. In fact, one easily demonstrates the following result.

*Proposition 3:* All constitutional equilibria support allocations that converge to the golden rule.

The proof is straightforward: The tax sequence  $(\tau_s^*)_t$  is bounded and weakly increasing by definition. It converges to the golden-rule value  $\tau_g$  because it would be individually irrational for  $\tau_t^*$  to remain bounded above by a number less than  $\tau_g$  and infeasible to remain bounded below by a number bigger than  $\tau_g$ . The irrationality is simple to show: If  $\tau_t^* < \tau_g$  then inequality 8c tells us that a proposal to raise the social security tax to  $\tau_g$  immediately, and the veto subsequent changes would receive the unanimous approval of all currently existing generations. The infeasibility of maintaining  $\tau_t^*$  some distance above  $\tau_g$  forever is again easy to see from inequality 8c that requires transfer payments to increase faster than the rate of growth  $n$  if  $\tau_t^* > \tau_g$ .

To gain insight on this, look at Propositions 2 and 3 jointly. You will thus conclude that a constitutional grant of veto power to the minority is sufficient to eliminate all volatility and all dynamic inefficiency from majoritarian subgame perfect equilibria. Figure 3 shows how much the policy commitment emanating from this power shrinks the set of equilibrium allocations down to the lightly colored triangle that contains only one steady state.

## LITERATURE AND EXTENSIONS

Social security plays a role similar to public debt in reallocating consumption

<sup>3</sup> If the old generation was to set the agenda, the game would have no equilibria in pure strategies, as the young would refuse to transfer resources to the old, preferring instead to start a social security system when they become old.

among successive population cohorts. Like public debt and fiat money, social security is a social contrivance whose value as a transfer payment mechanism depends on mutual trust among cohorts and on some degree of intergenerational cooperation. In plain language, social security is like a bubble, and it would be useful to relate the social security equilibria we studied in the previous two sections with the dynamics of public debt and fiat money Wallace (1980), Tirole (1985), and others have studied.<sup>4</sup> The connection is easiest to establish in situations of zero primary budget deficits. Consider, for example, an actuarially fair tax sequence ( $\tau_t$ ) such that

$$(9a) \quad -\tau_t + (1+n)\tau_{t+1}/R_{t+1} = 0,$$

where

$$(9b) \quad R_{t+1} = u'(e_1 - \tau_t)/[\beta u'(e_2 + (1+n)\tau_{t+1})].$$

This sequence adds zero present value to each generation's life cycle income computed at interest rates that correspond to marginal rates of substitution at the consumption vector  $c^t = (e_1 - \tau_t, e_2 + (1+n)\tau_{t+1})$  implied by the sequence ( $\tau_t$ ). Each element of this sequence represents excess supply by a typical member of generation  $t$ , as well as  $1/(1+n)$  times the excess demand by each member of generation  $t-1$ . Equations 9a and 9b describe the reflected offer curve of a generation- $t$  household.

These two equations, in fact, describe dynamical equilibria in pure-exchange economies with a given stock of fiat money or public debt. All we need to reinterpret actuarially fair social security as public debt or currency is to think of  $\tau_t$  as the real per capita value of the government liability and of equation 9a as the government budget constraint in an economy with zero public consumption and zero primary budget deficit. Then it is easy to see that the golden-rule outcome is the only stationary actuarially fair equilibrium, likely to prevail under a credible constitutional arrangement that commits to maintaining the purchasing power of

social contrivances—or bubbles—like currency, public debt, or social security.

By the same token, the indeterminacy of equilibrium we encounter in economies with bubbles is directly related to the absence of a credible promise from the Treasury or the central bank to preserve the future value of the bubble. Another source of indeterminacy creeps in if, in addition, we permit governments or median voters to deviate from the fairness of the present-value relationship (equation 9a) by running a primary budget deficit of their choice. Then majoritarian equilibria may well suffer from the larger degree of indeterminacy exhibited by the subgame perfect allocations of Figures 2 or 3.

Shrinking the large set of subgame perfect equilibria has been a priority in the fiscal policy literature ever since Hammond (1975). It is typically achieved by ruling out trigger strategies. Kotlikoff et al. (1988) and Esteban and Sakovics (1993) restrict the strategy sets of the median voter to costly Markovian strategies of the form  $\tau_{t+1} = \phi(\tau_t)$ . They assign a fixed resource cost  $k > 0$  to any change in the social security tax. The resource cost works as a form of partial commitment.

Other researchers choose more eclectic equilibrium refinements that specify exactly how the various generations share the social surplus from social security. Boldrin and Rustichini (1995), for instance, assign the entire surplus to the generation that invents the system. Cooley and Soares (1995) study majoritarian stationary equilibria in a calibrated pure-exchange economy with four-period lived households. They focus on the tax rate preferred by the second-youngest generation. This generation closely corresponds to the age profile of the median U.S. voter.

We conclude by discussing the robustness of the conclusions reached earlier about the operating characteristics and the social desirability of constitutional rules for fiscal policy. It seems sensible to us to examine the flexibility of fiscal constitutions when structural para-

<sup>4</sup> See Azariadis (1993), chapters 19 and 24, for a modern treatment of bubble dynamics.

meters, for example, endowments and population growth, undergo temporary or permanent change. We do so to understand if the constitutional award of veto power to some minority voting block may result in socially excessive transfer payments of the type many analysts claim to observe in some European countries. A third important issue is whether the monotonicity property, or positive time-trend, of social security taxes stated in Proposition 2 generalizes when more than two economically active generations exist at any one time.

Inflexibility is a serious problem with constitutional fiscal structures. Imagine, in particular, that voters set the tax at a numerical level independent of any realizations of the income and other parameters of the economy.<sup>5</sup> An instructive example of this phenomenon is to endow the young with a binary stochastic income stream,

$$s_t = \alpha \text{ with probability } p \\ \beta > \alpha \text{ w.p. } 1 - p.$$

We keep old-age endowment constant at  $e_2$  as before and assume that voting takes place each period after endowment realizations. Hence the first young generation that experiences the high income realization,  $\beta$ , will obtain constitutional approval for raising the transfer level to the golden rule of the economy with deterministic income vector  $(\beta, e_2)$ . In later periods, old voters in this economy will resist any proposal to lower the transfer to the level implied by the golden rule of the economy with the smaller deterministic income vector  $(\alpha, e_2)$ , even if  $\alpha$  happens to be the income of the actual tax-paying generation. It is in this sense that constitutions or veto power may lead to excessive social security. Similar arguments can be made about random changes in population parameters.

What about the robustness of Proposition 2? Are constitutionally set social security transfers likely to be monotone if changes in the system require an elevated majority of voters rather than complete unanimity? This situation may be explored in a model with more than two coexisting

generations like Cooley and Soares (1995). In particular, would a coalition of, say, one quarter or more of all voters attempt to block a proposal to reduce permanently social security taxes or benefits by  $\varepsilon > 0$ ? The answer depends on the demographic and income structure of the economy, as well as on several other things, but it appears to us to be in the affirmative. This proposal will surely be opposed by retirees and persons sufficiently near retirement because it reduces the present value of their remaining lifetime incomes. The cut-off age depends on the prevailing rate of interest, but assuming this to be about 53 years of age, opposition against a reduction in social security will unite 20 or more cohorts in the 56- to 75-year-old age group, with 30 cohorts in the 21- to 50-year-old age group (including the median voting cohort) being in favor of reform, and the 51- to 55-year-olds standing on the margin.<sup>6</sup> If this opposition group has veto power, Proposition 2 will extend to economies with richer demographics than the one assumed here.

## REFERENCES

- Azariadis, Costas. *Intertemporal Macroeconomics*. Oxford: Blackwell, 1993.
- Boldrin, M., and A. Rustichini. "Equilibria with Social Security." Manuscript, Universidad Carlos III and CORE (1995).
- Cooley, T. F., and J. Soares. "A Positive Theory of Social Security Based on Reputation." Manuscript, University of Rochester (1995).
- Diamond, Douglas W., and Philip H. Dybvig. "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy* (June 1983), pp. 401–19.
- Esteban, Joan-Maria, and Jozef Sakovics. "Intertemporal Transfer Institutions," *Journal of Economic Theory* (December 1993), pp. 189–205.
- Friedman, Milton. "A Monetary and Fiscal Framework for Economic Stability," *The American Economic Review* (June 1948), pp. 245–64.
- \_\_\_\_\_. "The Role of Monetary Policy," *The American Economic Review* (March 1968), pp. 1–17.
- Hammond, Peter. "Charity: Altruism or Cooperative Egoism?" in *Altruism, Morality, and Economic Theory*, Edmund S. Phelps, ed. New York: Russell Sage Foundation, 1975, pp. 115–31.
- Kandori, Michihiro. "Repeated Games Played by Overlapping Generations of Players," *Review of Economic Studies* (January 1992), pp. 81–92.

<sup>5</sup> Current U.S. social security laws make no provisions allowing the rate of population growth or the taxpayer-to-beneficiary ratio to influence benefits per person. However, social security pensions are indexed against changes in the Consumer Price Index.

<sup>6</sup> Age 53 is the cutoff age at which a person aged  $T < 65$  years (who retires at 65 and lives on to age 77) is indifferent to all changes in social security taxes and contributions when the interest rate and growth rate are equal and small.

Kotlikoff, Laurence J., Torsten Persson, and Lars E.O. Svensson. "Social Contracts as Assets: A Possible Solution to the Time-Consistency Problem," *The American Economic Review* (September 1988), pp. 662–77.

Kydland, Finn E., and Edward C. Prescott. "Rules Rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy* (June 1977), pp. 473–91.

Loewy, Michael B. "Equilibrium Policy in an Overlapping Generations Economy," *Journal of Monetary Economics* (November 1988), pp. 485–99.

Salant, David J. "A Repeated Game With Finitely Lived Overlapping Generations of Players," *Games and Economic Behavior* (May 1991) pp. 244–59.

Sjölom, Kriss. "Voting for Social Security," *Public Choice* (1985), pp. 225–40.

Tabellini, Guido. "The Politics of Intergenerational Redistribution," *Journal of Political Economy* (April 1991), pp. 335–57.

\_\_\_\_\_ and Alberto Alesina. "Voting on the Budget Deficit," *The American Economic Review* (March 1990), pp. 37–49.

Tirole, Jean. "Asset Bubbles and Overlapping Generations," *Econometrica* (November 1985), pp. 1,499-528.

Wallace, Neil. "The Overlapping Generations Model of Fiat Money," in *Models of Monetary Economics*, John H. Kareken and Neil Wallace, eds. Federal Reserve Bank of Minneapolis, January 1980, pp. 49-82.