# Social Contracts as Assets: A Possible Solution to the Time-Consistency Problem

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*We present a new solution to the time-consistency problem that appears capable of enforcing ex ante policy in settings where other enforcement mechanisms do not work. The solution involves a social contract that specifies the optimal ex ante policy and is effectively sold by successive old generations to successive young generations, who pay for the social contract through intergenerational transfers. Both old and young generations have an economic incentive to fulfill the social contract.*

The requirement that policies be *ex post* optimal, or time consistent, in general leads to outcomes that are suboptimal relative to those that binding commitments would sustain. A classical example, considered by Stanley Fischer (1980), is capital taxation in a two-period model. A second-period capital levy is first best from the perspective of period two, but third best from the perspective of period one. If there is nothing to enforce a government commitment against second-period capital taxation, the *ex post* desire to engage in first-best taxation drives the economy from a second-best to a third-best outcome.

Researchers have suggested a variety of ways to enforce commitment to *ex ante* optimal policies. Finn Kydland and Edward Prescott (1977) argue for rules rather than discretion. A number of writers—see Kenneth Rogoff (1987) for a survey—introduce government reputation as a mechanism to enforce commitment. Robert Lucas and Nancy Stokey (1983), and Mats Persson, Torsten Persson, and Lars Svensson (1987) show that, assuming partial commitment to honoring its bonds, governments can deter deviations from *ex ante* policies by devising financial instruments whose market values fall if *ex post* policy deviates from *ex ante* policy.[1]

This paper presents a solution to the time-consistency problem that appears capable of enforcing *ex ante* policy in a variety of settings in which other enforcement mechanisms do not work. The solution involves formulating a "social contract" (or institution or agreement) that specifies the *ex ante* optimal policy and that can be "sold" by successive old generations to successive young generations. Each young generation pays for the social contract by paying a larger share of taxes than it would otherwise do. Both old and young generations have an economic incentive to fulfill the social contract. For the old generation that owns the social contract, breaking the social contract makes it valueless, and the generation suffers a capital loss. For the young generation the

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[1] Persson (1988) gives a broad survey of recent research on time-consistency (credibility) problems.

economic advantage of purchasing the social contract exceeds its price as well as the economic gain from setting up a new social contract.

Fischer's model extended to include overlapping generations provides a convenient device for illustrating the potential asset nature of social contracts. Assume, to keep matters simple, that only the elderly consume the public good. Since the old and young have no common interests they live side by side, but have separate governments called councils. These councils are democratically elected each period, and since the members of any generation are identical, each council simply carries out the current unanimous wishes of its constituents. Each generation's council has the right to tax its constituents and is obliged to supply the public good when its constituents are old. In fact our model makes each generation completely economically independent. This feature of the model obviously abstracts from important aspects of actual policymaking problems. But we wish to focus here on the role of social contract in enforcing desirable policies from an efficiency point of view. This is best done by abstracting from redistribution directly by taxation of other generations, and indirectly by policy-induced changes in factor prices.

Assume now that the *ex ante* second-best, but time-inconsistent tax structure involves relatively low capital taxation. In contrast, the third-best, time-consistent tax structure clearly involves higher capital taxation, because each individual when old will wish his council to levy an *ex post* nondistortionary tax on capital. Since the capital tax will be anticipated when young, saving will be distorted, implying a third-best rather than second-best level of welfare.

In this model each generation is self-governing and cannot be bound by any "rules." Reputation in the context of incomplete information about the policymaker—as in David Backus and John Driffill (1985)—requires, as far as we can see, the policymaker to be an agent separate from its constituency. In our model we consider the government simply as a representative of its constituency, with the same preferences as the identical consumers it represents. Reputation, in the incomplete-information interpretation therefore does not work. Reputation in the context of complete information about the policymakers—as in Robert Barro and David Gordon (1983)—requires the policymakers, planning horizon to be effectively infinite. Thus, it does not work here since policymakers solely represent their generation who has a finite horizon. Nevertheless, our solution resembles the (complete information) reputational mechanism in some ways. Finally, the partial commitment approach, while also resembling our solution in some respects, requires invoking a certain degree of precommitment. Since such precommitment is in no way suggested by the model, it is not a very satisfying solution.

Enforcement through the sale of a social contract can arise in the following way. Suppose one particularly enterprising leader of the young, after tedious discussions with her electorate, drafts a social contract which states that the generation holding the social contract is exempt from capital taxation (above a certain level). The enterprising leader of the young ensures her electorate that in the next period, when their generation (called the first generation) is old, she will approach the council of the young (called the second generation) and offer to sell the social contract in exchange for tax revenue from the young to help pay for the public good of the old. She argues convincingly that after agreeing on an acceptable amount of tax revenue, the council of the second-generation young will purchase the social contract. The reason is that (1) the social contract will protect the second generation from excessive (and third best) capital taxation because selling the social contract to the subsequent young (the third generation) will be more beneficial in terms of additional tax receipts than the second-period efficiency gains from capital taxation, and (2) the cost of purchasing the social contract less its resale value is less than the transactions' costs to the second generation of negotiating about the creation of their own social contract.

As demonstrated below, there is, in fact, an equilibrium in which the social contract is

passed on from one generation to the next, no generation wishes to abrogate the social contract, and, if the social contract is destroyed by chance, it will immediately be reconstituted. The result is that an outcome with low capital taxes and high saving, almost as good as the second-best outcome, can be enforced.

In contrast to the analyses of Lucas and Stokey (1983), and Persson, Persson, and Svensson (1987) in which potential capital losses on government financial assets deter deviations from *ex ante* policy, the assets in this paper are agreements which may or may not be written down explicitly. Thus, in our example, no physical contract or certificate is required, simply an understanding that the quid pro quo for the old to maintain the tradition (institution) of no capital taxation is for the young to contribute the appropriate share to pay for the public good of the old. Probably the paper's closest antecedent is Jonathan Eaton's (1985) analysis of banks' repayment enforcement. In Eaton's paper failure of banks to pursue defaulters leads to a reduction in their stock values.[2]

The paper examines the sale of social contracts in a simple linear model that yields analytical expressions for second- and third-best tax structures. The linear model is attractive because excess burdens are additive; indirect utility in distorted regimes differs from the first-best level of utility by the sum of excess burdens. Section I presents the model, while Section II presents the unobtainable first-best optimum, the unenforceable second-best optimum, and the time-consistent third-best optimum. Section III demonstrates how a "salable" social contract comes into existence and how a social contract can enforce an outcome close to the second best. These points are illustrated with a numerical example. Section IV deals with enforcement without transaction costs. Section V discusses extensions and broader implications of our results.

## I. The Model

The model is a life-cycle overlapping generations model with production and investment. There is one good and labor. Production is linear, and output of goods in period $t$, $Y_t$, depends on the input of capital in period $t-1$, $K_{t-1}$, and labor in period $t$, $L_t$, according to

$$(1) \quad Y_t = RK_{t-1} + wL_t, \quad R > 1 \text{ and } w > 0.$$

The gross rate of return to capital, $R$, is constant, as is the average and marginal product of labor, $w$. Capital depreciates completely in one period, so the net rate of return to capital, the real interest rate, is constant, equal to $R-1$ and positive.[3] The competitive (before-tax) wage rate equals $w$.

A new generation of identical consumers is born in each period. Each consumer lives for two periods, labeled 1 and 2. A young consumer has preferences described by the linear utility function

$$(2) \quad u(c, l, d, m) = D(c - \lambda l) + d - \mu m,$$
$$\lambda > 0, \quad \mu > 0 \quad \text{and} \quad D > 0,$$

where $c$ and $d$ are consumption when young and old, $l$ and $m$ are labor supply when young and old, $\lambda$ and $\mu$ are the constant marginal rates of substitution between leisure and consumption when young and old, and $D$ is the gross rate of time preference (equal to one plus the rate of time preference). Utility is normalized so that the marginal utility of consumption in period 2 is unity.

[2]Since writing this paper, we have become aware of ideas that resemble our own in the work by David Kreps (1984) on "corporate cultures," and by Jacques Crémer (1986) on cooperation in ongoing organizations.

There is also a certain parallel between our suggested mechanism and the mechanism known as "posting a bond" in the labor economies literature. In both cases a cheater forfeits some resources by cheating. In our case the mechanism does not need any outside enforcement (by the courts) but is instead self-enforcing.

[3]An alternative interpretation of the model, which leads to equivalent results (since we disregard any nonnegativity conditions on the capital stock), is that the country is a small open economy facing a perfect world capital market with a constant (real) interest rate equal to $R-1$.

The feasible set of consumption and labor supply is given by

$$(3) \qquad 0 \le \underline{c} \le c, \quad 0 < \underline{l} \le l \le \bar{l},$$

$$0 \le \underline{d} \le d, \quad \text{and} \quad 0 < \underline{m} \le m \le \bar{m}.$$

That is, there are nonnegative lower limits $\underline{c}$ and $\underline{d}$ on consumption when young and old, and positive upper and lower limits on labor supply when young and old.

There are taxes on labor in periods 1 and 2 and on savings. A young consumer faces budget constraints

$$(4) \qquad c + s = (w - \tau)l, \; s \ge 0, \quad \text{and}$$

$$(5) \qquad d = (R - \theta)s + (w - \sigma)m,$$

where $s$ is savings, and $\tau$, $\sigma$, and $\theta$ are absolute taxes on labor when young, labor when old, and savings. By assumption borrowing is not allowed.[4] Therefore savings is restricted to be nonnegative.

Given the linear utility function, it is easy to derive saving and labor decisions. Maximizing the utility function subject to the feasibility set and the budget constraints gives

$$(6) \qquad s = \begin{cases} (w - \tau)l - \underline{c} & \text{for } R - \theta \ge D \text{ and} \\ 0 & \text{for } R - \theta < D, \end{cases}$$

$$(7) \qquad l = \begin{cases} \bar{l} & \text{for } (w-\tau)\max((R-\theta)/D, 1) \\ & \quad \ge \lambda \text{ and} \\ \underline{l} & \text{for } (w-\tau)\max((R-\theta)/D, 1) \\ & \quad < \lambda, \end{cases}$$

$$(8) \qquad m = \begin{cases} \bar{m} & \text{for } w - \sigma \ge \mu \text{ and} \\ \underline{m} & \text{for } w - \sigma < \mu. \end{cases}$$

What matters for the saving decision is only the relation between the after-tax rate of return, $R - \theta - 1$, and the rate of time preference, $D - 1$. When the after-tax rate of return is above the rate of time preference, the consumer consumes the minimum amount $\underline{c}$ when young and saves the maximum amount. The maximum saving is the difference between his after-tax wage $(w - \tau)l$, which depends on the labor supply when young according to (7), and the minimum consumption. When the after-tax rate of return is below the rate of time preference, saving is equal to its minimum, which is zero since we assume no borrowing. When the after-tax return equals the rate of time preference, saving is indeterminate. In this case we assume that the consumer saves the maximum amount.

Similarly, what matters for the labor supplies is only the relation between the after-tax wage rate and the rate of substitution between consumption and leisure. With regard to labor supply in the first period, (7), one has to take into account that there are two potentially relevant marginal rates of substitution. When $R - \theta > D$, consumption in the first period is constant and at its minimum. Then the relevant marginal rate of substitution is between leisure in the first period and consumption in the second period, $D\lambda$, and the relevant after-tax wage rate is $(R - \theta)(w - \tau)$, measured in second-period goods. If instead $R - \theta < D$, saving is zero and consumption in the first period equals after-tax income in the first period. Then the relevant marginal rate of substitution is $\lambda$, and the relevant after-tax wage rate is $w - \tau$. This combined gives (7). If the after-tax wage rate is above the marginal rate of substitution, the best thing is to work the maximum hours. If the after-tax wage rate is below the rate of substitution, the best thing is to work the minimum hours. If the after-tax wage rate is equal to the rate of substitution, the consumer is indifferent between working as much as possible, and as little as possible, or anything in between. We assume in this case that he works the maximum hours. With regard to second-period labor supply in (8), $w - \sigma$ and $\mu$ is the relevant after-tax wage rate and marginal rate of substitution, both when $R - \theta > D$ and when $R - \theta < D$, since in the latter case saving is zero and second-period consumption is not necessarily at its minimum.

[4] Borrowing could be allowed, without affecting the qualitative results.

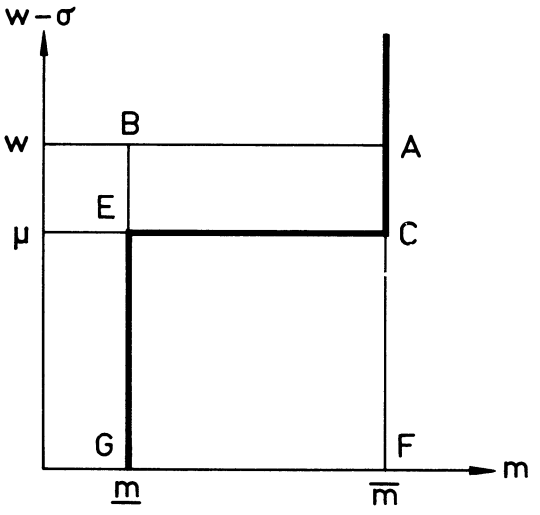


FIGURE 1

We also assume that the below-tax wage rate is above the rates of substitution between leisure and consumption and that the before-tax return to capital is above the rate of time preference

$$(9) \quad w > \lambda, \quad w > \mu, \quad \text{and} \quad R > D.$$

In the absence of taxes the consumer would work the maximum hours when young and old, and he would save the maximum amount when young.

Figure 1 further illustrates consumer behavior. The bold line shows the compensated (and uncompensated, since they are identical here) supply of labor when old, $m$, as a function of the net wage rate, $w - \sigma$. The before-tax wage rate $w$ is above $\mu$ by assumption, and, in the absence of a tax on labor, the consumer when old would be in equilibrium at point $A$ in the diagram. For sufficiently high taxes on labor, the net wage would fall below $\mu$, and the consumer would work the minimum hours and be in equilibrium at some point on the vertical line $EG$. An equilibrium at the minimum hours is inefficient. The cost to the consumer of working $\bar{m}$ rather than $\underline{m}$ is the area $CEGF$, equal to $\mu(\bar{m} - \underline{m})$. But the value to society is the area $ABGF$, equal to $w(\bar{m} - \underline{m})$. The deadweight loss is the area $ABEC$, equal to $(w - \mu)(\bar{m} - \underline{m})$.

## II. The First Best, the Second Best, and the Third Best

Below we consider equilibria when generations interact. In this section, however, we examine equilibria when each generation is economically independent. As mentioned, the representative body of a generation is called the council. In each period, there are two councils, one representing the young and one representing the old. The council of a given generation supplies a fixed amount of public goods, $g$, to its generation when the generation is old and can finance this second-period expenditure by taxing its generation in both periods. Before discussing equilibria with distortionary taxation, we describe the first-best optimum that would result if the council had access to lump-sum taxes. Let the council impose a second-period lump-sum tax equal to $g$ on the old and set all other taxes equal to zero. Then in the first-best optimum with lump-sum taxation (denoted with an asterisk (*) superscript) labor supply when young, labor supply when old, and saving are at their maxima. Thus

$$(10) \quad l^* = \bar{l}, \quad m^* = \bar{m} \quad \text{and} \quad s^* = w\bar{l} - \underline{c}.$$

Consumption when young is at the minimum. Consumption when old is equal to savings plus wages when old minus the lump-sum tax. Hence, the utility level for the generation is

$$(11) \quad u^* = D(\underline{c} - \lambda\bar{l}) + Rs^* + w\bar{m} - g - \mu\bar{m}.$$

We use this equilibrium as a reference case in discussing equilibria with distortionary taxes.

Let us now assume that the council does not have access to lump-sum taxes. Instead it has the right to tax labor and savings of its generation as well as to borrow or lend. The

council faces budget constraints

$$b = \tau l \quad \text{and} \tag{12}$$

$$g = \theta s + \sigma m + Rb, \tag{13}$$

where $b$ is the council's saving in period 1. The two constraints can be collapsed into one intertemporal budget constraint

$$g = R\tau l + \theta s + \sigma m. \tag{14}$$

Consider first the case in which the council can make a binding commitment in period 1 to given taxes in period 2. As suggested by the discussion of Figure 1, for sufficiently low taxes there is no distortion of the labor supply and saving decisions. We assume that the maximum nondistortionary taxes on labor and savings fall short of the required public expenditure

$$g > R(w-\lambda)\bar{l} + (w-\mu)\bar{m} + (R-D)\bar{s}. \tag{15}$$

The maximum nondistortionary taxes are $\tau = w - \lambda$ and $\sigma = w - \mu$ on labor in period 1 and 2, and $\theta = R - D$ on savings. The maximum amount of savings, $s$, when the consumer faces the maximum nondistortionary tax on labor in period 1, $\bar{s}$, is $\bar{s} \equiv \lambda\bar{l} - \underline{c}$.

Without (15) the optimal taxation problem would be trivial. With (15), the council is forced to increase one or several taxes above their maximum nondistortionary levels. If the tax on labor supply in period 2 is increased, labor supply drops to its minimum, causing a deadweight loss equal to $(w-\mu)(\bar{m}-\underline{m})$. If the tax on savings is increased, saving drops to zero, causing a deadweight loss equal to $(R-D)\bar{s}$. If the tax on labor in period 1 is increased, first-period labor supply drops to its minimum, causing a direct deadweight loss of $D(w-\lambda)(\bar{l}-\underline{l})$ plus an indirect deadweight loss—due to lower savings—of $(R-D)(\bar{s}-\underline{s})$, where $\underline{s}$ is given by $\underline{s} \equiv (w-\tau)\underline{l} - \underline{c} \leq \lambda\underline{l} - \underline{c}$.[5] We now assume that the deadweight loss from distorting period-2 labor is smaller than the other distortions:

$$(w-\mu)(\bar{m}-\underline{m}) < \min\left[D(w-\lambda)(\bar{l}-\underline{l}) + (R-D)(\bar{s}-\underline{s}), (R-D)\bar{s}\right]. \tag{16}$$

This means that the council prefers to increase taxes on labor in period 2, rather than to increase taxes on savings or period-1 labor. We next assume that increasing taxes on period-2 labor above the distortionary level provides enough revenue to finance public expenditure. We later make the stronger assumption that distortionary taxation of labor in period 2 raises enough revenue to pay for $g$ in the case when no saving is forthcoming; hence

$$g < R(w-\lambda)\bar{l} + w\underline{m}. \tag{17}$$

Given the assumptions (15)–(17), labor supplies and saving in the second-best optimum under commitment are

$$l = \bar{l}, \quad m = \underline{m}, \quad \text{and} \quad s = \bar{s}. \tag{18}$$

The tax rates (denoted by an overbar) are

$$\bar{\tau} = w - \lambda, \quad \bar{\theta} = R - D, \quad \text{and} \quad \bar{\sigma} = \left(g - R\bar{\tau}\bar{l} - \bar{\theta}\bar{s}\right)/\underline{m}. \tag{19}$$

The only distortion is that labor in period 2 has dropped to its minimum. Consequently, the utility level for the generation is

$$\bar{u} = u^* - (w-\mu)(\bar{m}-\underline{m}). \tag{20}$$

It falls short of the first-best utility level by the deadweight loss from distorting labor supply in period 2.

[5]Notice that $D$ multiplies $(w-\lambda)(l-\underline{l})$. This is because utility is normalized to that the marginal utility of second-period consumption is unity.

The second-best optimum under commitment is unenforceable. There is nothing in the model that enforces the commitments to particular taxes in period 2. Indeed, since capital is predetermined in period 2, the council in period 2 has an incentive to deviate from the preannounced policy and levy a nondistortionary tax on capital if it can thereby avoid a distortionary tax on second-period labor. Such will be the case if, as we assume, the savings tax base, $R\bar{s}$, is sufficiently large to make it possible to lower labor taxes in period 2 to the nondistortionary level; that is,

$$(21) \quad g < R(w-\lambda)\bar{l} + (w-\mu)\bar{m} + R\bar{s}.$$

If (21) holds and capital equals $\bar{s}$, the council in period 2 would optimally set the tax on savings equal to

$$(22) \quad \hat{\theta} = \left[g - R(w-\lambda)\bar{l} - (w-\mu)\bar{m}\right]/\bar{s}.$$

By (15) it follows that $\hat{\theta}$ is large enough to reduce the net rate of return below the rate of time preference

$$(23) \quad R - \hat{\theta} < D.$$

Equation (23) implies that a young consumer anticipating the council's behavior would not save (see (6)). The reduction of saving from $\bar{s}$ to zero produces a deadweight loss equal to $(R-D)\bar{s}$, and erodes the tax base in period 2. The council is left with no choice but to levy a tax on labor in period 2 above the distortionary level.

It follows that the third-best optimum without precommitment will have the following taxes (denoted by a caret( $\hat{}$ ))

$$(24) \quad \hat{\tau} = w - \lambda = \bar{\tau} \quad \text{and}$$

$$\hat{\sigma} = \left(g - R\bar{\tau}\bar{l}\right)/\underline{m} > \bar{\sigma},$$

in addition to the tax $\hat{\theta}$ on savings.[6] Note that our assumption (17) ensures that there exists a tax on labor in period 2 which fulfills (24). The labor and saving decisions yield

$$(25) \quad l = \bar{l}, \quad m = \underline{m} \quad \text{and} \quad s = 0.$$

The utility level is

$$(26) \quad \hat{u} = \bar{u} - (R-D)\bar{s}$$

$$= u^* - (w-\mu)(\bar{m} - \underline{m})$$

$$-(R-D)\bar{s}.$$

Compared to the unenforceable second-best optimum, the third-best optimum has an additional deadweight loss, namely the saving distortion.

### III. Enforcing the Second-Best Optimum Through a Social Contract

We now propose a mechanism, namely a social contract, that enforces an outcome very close to the second-best optimum. The social contract has the following two clauses:

(C1) Capital taxation (either explicit or implicit) above the prespecified level $\theta = R - D$ is prohibited.

(C2) The council of the young contribute a specified transfer $Q$ to the council of the old.

We assume that each young generation can set up a social contract like (C1–2) at a transactions cost $T$. Notice that if the (councils of) succeeding generations stick to the social contract, each young generation effectively purchases the social contract from the coexisting old generation.

We now show that there exists an equilibrium with the properties that, starting from

[6] This outcome would not result if levying distortionary taxes on first-period labor alone would yield revenue to finance $g$ *and* less deadweight loss than taxing second-period labor and savings. To rule out this possibility, we need to assume either that $g > Rw\underline{l} + (w-\mu)(\bar{m} - \underline{m}) + (R-D)\underline{s}$ or that $D(w-\lambda)(\bar{l} - \underline{l}) + (R-D)(\bar{s} - \underline{s}) > (w-\mu)(\bar{m} - \underline{m}) + (R-D)\bar{s}$.

a society without a social contract, a social contract is set up by an initial generation and that, once set up, it is fulfilled by all subsequent generations. Furthermore, every council acts individually, rationally, and expectations are never falsified. In the language of game theory, the equilibrium is subgame perfect.

The intergenerational game has sequential moves in each period. The young decide whether or not to fulfill the existing social contract after the old have decided on the tax structure. We could think of the councils of the young and the old forming a joint government and bargaining about the price of the social contract, that is, about the transfer $Q$. We do not study the details of this bargaining process, but since we are dealing with a stationary environment it seems reasonable to treat $Q$ as a constant. Our results below will give the possible range for the transfer, however.

To understand how the social contract comes into being, suppose the economy is initially contractless and consider the economic incentives to establish the social contract. It is useful to specify the extensive form of the game. Figure 2 shows part of the game tree. Node $N_1$ corresponds to an initial situation without a social contract in an arbitrary start-up period, called period 1. The council of the young in period 1, called the first generation, faces a choice between either setting up a social contract (move "$S$") or continuing without a social contract and remain in the *third*-best equilibrium (move "3"). Node $N_2$ corresponds to the beginning of the next period, called period 2, when the first generation in period 1 chose to set up a social contract and now has become old. At node $N_2$ the first generation faces a choice between either fulfilling clause (C1) of the social contract (move "$F$") or breaking the clause and overtaxing capital beyond the prespecified level (move "$O$"). Depending upon the choice of the first generation, node $N_4$ or $N_5$ is reached. If the first generation in period 1 chose to continue in the third-best equilibrium, node $N_3$ is reached in the beginning of period 2, and there is no choice for the first generation but to continue in the third-best equilibrium (3),

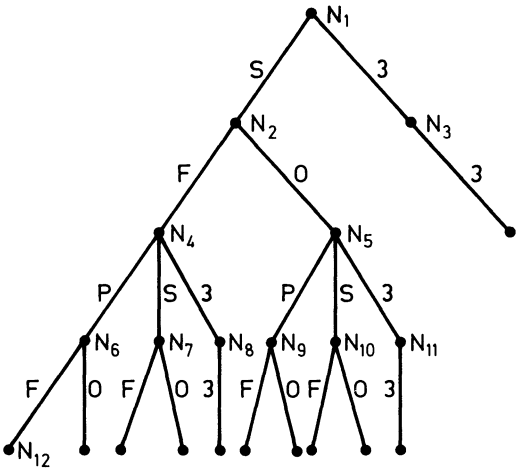


FIGURE 2

and the society remains without a social contract.

At nodes $N_4$ and $N_5$ the young in period 2, called the second generation, face three alternatives. They can choose to obey clause (C2) of the social contract and pay the transfer $Q$ to the first-generation old (move "$P$"), they can set up a new social contract ($S$), or they can choose the third-best equilibrium (3). These choices lead to one of the nodes $N_6 - N_{11}$ in the beginning of period 3 when the second generation has become old. Now they face the choice between fulfilling ($F$) or breaking ($O$) clause (C1) of the social contract in nodes $N_6$, $N_7$, $N_9$, and $N_{10}$, whereas there is no choice but to continue in the third-best equilibrium in nodes $N_8$ and $N_{11}$ (3).

Assume now that all generations (councils) follow an identical strategy, namely,

(S1) When young: (a) if a social contract exists and the existing contract has never been broken, fulfill clause (C2), that is, pay the transfer $Q$ (move $P$), (b) otherwise, do not pay the transfer but set up a new social contract of the form (C1–2) (move S).

(S2) When old: (a) if an unbroken social contract exists of the form (C1–2),

fulfill clause (C1), that is, do not overtax capital (move $F$), (b) otherwise, if a social contract exists, overtax capital (move $O$), or if a social contract does not exist, continue in the third-best equilibrium (move 3).

In the subsequent discussion we derive conditions which guarantee that no generation has an incentive to deviate unilaterally from the strategy (S1–2). This is exactly what is required in a subgame-perfect equilibrium.

We hence want to show that the path $N_1N_2N_4N_6N_{12}$ is a subgame-perfect equilibrium. Let us start with node $N_1$. The first generation of young to devise the social contract (move $S$) has the special advantage of not having to purchase the social contract, that is, to pay the transfer $Q$. On the other hand, it has to bear the transactions cost of establishing the social contract. The budget constraints confronting the council of the first generation are

$$b = \tau l \quad \text{and} \tag{27a}$$

$$g - Q = \theta s + \sigma m + Rb, \tag{27b}$$

where including $Q$ in (27b) assumes that the second generation follows (S2). The budget constraints of each member of the first generation are given in (4) and (5). The transactions cost is $T$ utils, incurred when young, but measured in second-period utility. We assume that the transactions cost for establishing a new social contract is the same for all generations irrespective of whether a social contract has existed or not.[7]

The first generation levies nondistortionary taxes $\theta^1$ on savings and $\tau^1$ on first-period labor supply, where

$$\theta^1 = R - D = \bar{\theta} \quad \text{and} \tag{28}$$

$$\tau^1 = w - \lambda = \bar{\tau}.$$

The corresponding tax on the first-generation's labor in period 2, $\sigma^1$, is distortionary and is given by

$$\sigma^1 = \left(g - Q - R\bar{\tau}\bar{l} - \bar{\theta}\bar{s}\right)/\underline{m} < \bar{\sigma}.^8 \tag{29}$$

The labor and saving decisions resulting from this choice of taxes are

$$l = \bar{l}, \quad m = \underline{m}, \quad \text{and} \quad s = \bar{s}. \tag{30}$$

and the utility level of the first generation is thus

$$u^1 = \bar{u} + Q - T. \tag{31}$$

Note that this utility level is just the second-best level of utility less the transactions cost plus the value $Q$ obtained from selling the social contract to the second generation.

The first generation of young will institute the social contract—that is, follow (S1b) and choose S at node $N_1$—if instituting the social contract increases their utility above the third-best optimum, that is, if

$$u^1 \geq \hat{u}. \tag{32a}$$

According to (26), (32a) requires

$$Q + (R - D)\bar{s} \geq T. \tag{32b}$$

Condition (32b) states that the gain from the sale of the social contract plus the reduction in the saving distortion from achieving a second-best tax structure must exceed the transactions cost of establishing the social contract.

We must also show that the first generation has an incentive to fulfill the social contract when old—that is, to follow (S2) and choose $F$ at node $N_2$. If this generation fulfills the social contract when it is old, its utility when old is

$$v^1 = \bar{v} + Q, \tag{33}$$

[7] We could also let the transactions' cost be lower if a social contract already exists, without changing the qualitative results.

[8] This applies if $\sigma^1 > w - \mu$, in which case the second-period labor distortion remains. If $\sigma^1 < w - \mu$, the distortion is eliminated and the first generation is even better off.

where $\bar{v}$ is the period-2 utility in the unenforceable second-best optimum. Thus the gain in old age utility from sticking to the social contract relative to the unenforceable second best is $Q$, the receipt from the sale of the social contract. If the first generation breaks the social contract in their second period ($O$) it will impose the following taxes

$$\tilde{\sigma}^1 = w - \mu \quad \text{and} \tag{34}$$

$$\tilde{\theta}^1 = \left[ g - R(w-\lambda)\bar{l} - (w-\mu)\overline{m} \right] / \bar{s} = \hat{\theta}.$$

Second-period utility in this case, $\tilde{v}^1$, is $\bar{v}$ plus the elimination of the second-period labor distortion, $(w-\mu)(\overline{m}-\underline{m})$,

$$\tilde{v}^1 = \bar{v} + (w-\mu)(\overline{m}-\underline{m}). \tag{35}$$

The necessary condition for the first generation to fulfill the social contract in period 2 is

$$v^1 \geq \tilde{v}^1, \tag{36a}$$

which implies

$$Q \geq (w-\mu)(\overline{m}-\underline{m}). \tag{36b}$$

This yields a lower bound on the price of the social contract.

When faced at node $N_4$ with the social contract set up by the first generation, the second generation, according to (S1), buys the social contract from the first generation. For this to hold the second generation must prefer purchasing the existing social contract (move $P$) to (1) not purchasing the existing social contract and establishing its own social contract (move $S$), and to (2) pursuing the third-best optimum (move 3). If the second generation's council purchases the existing social contract and is able to resell the social contract, its council faces the following budget constraints

$$Q + b = \tau l \quad \text{and} \tag{37a}$$

$$g - Q = \theta s + \sigma m + Rb, \tag{37b}$$

which together imply

$$g + (R-1)Q = R\tau l + \theta s + \sigma m. \tag{38}$$

Equation (38) points out that the second generation's council effectively rents the social contract for the amount $(R-1)Q$ since it purchases the social contract when young and resells it when old. Given (38) the optimal tax rates are the nondistortionary taxes on first-period labor supply and saving, $\bar{\tau}$ and $\bar{\theta}$, and the distortionary tax $\sigma^2$ on second-period labor supply.[9] The latter is determined by

$$\sigma^2 = \left[ g + (R-1)Q - R\bar{\tau}\bar{l} - \bar{\theta}\bar{s} \right] / \overline{m} \tag{39}$$

$$> \bar{\sigma}.$$

Since the second generation achieves the unenforceable second-best optimum except that it has to rent the social contract, its utility $u^2$ is

$$u^2 = \bar{u} - (R-1)Q. \tag{40}$$

For the second generation to be willing to purchase the social contract rather than create its own, $u^2$ must exceed $u^1$; hence,

$$u^2 \geq u^1. \tag{41a}$$

If (41a) holds (32) ensures that $u^2$ exceeds the third-best optimum $\hat{u}$. Conditions (31), (40), and (41a) imply

$$T \geq RQ. \tag{41b}$$

In words, (41b) requires that the cost of creating a new social contract exceed the gain from not having to purchase the old social contract. This condition yields an upper bound on the admissible price of the social contract.

The second generation must also prefer to fulfill the social contract when they are old; that is, prefer to follow (S2) and choose $F$ at

[9] We assume that taxing second-period labor is enough to finance *total* spending of the council: $g + (R-1)Q$. Thus there is no additional distortion caused by raising the revenue for the rent of the law $(R-1)Q$. In a nonlinear model, we would have to add an additional welfare triangle to the cost of acquiring the social contract, however.

node $N_6$. Consequently, $v^2$, the second generation's utility when old if it purchases the social contract must exceed $\tilde{v}^2$, the utility when old if it reneges and overtaxes capital (move $O$). Compared to the unenforceable second best, the consumption of the second generation in period 2 if it obeys the social contract is smaller by the amount of rent on the social contract. Hence,

$$v^2 = \bar{v} - (R-1)Q. \tag{42}$$

If the second generation breaks the social contract it foregoes the contribution $Q$ from the third generation and imposes taxes according to

$$\tilde{\sigma}^2 = w - \mu \quad \text{and} \tag{43}$$

$$\tilde{\theta}^2 = \left[ g + RQ - R(w-\lambda)\bar{l} + (w-\mu)\overline{m} \right] / \bar{s} > \hat{\theta}.$$

Each member of the second generation will respond to these second-period taxes by working full time, and their second-period utility will be

$$\tilde{v}^2 = \bar{v} - RQ + (w-\mu)(\overline{m} - \underline{m}). \tag{44}$$

The condition for preferring $F$ to $O$ is

$$v^2 \geq \tilde{v}^2, \quad \text{or} \tag{45a}$$

$$Q \geq (w-\mu)(\overline{m} - \underline{m}), \tag{45b}$$

which is identical to (36b).

Finally, we have to verify that the second generation would not deviate from (S1) if the first generation in fact did not set up a social contract when young or broke the social contract when old. Faced with no existing social contract, the second generation would have the same problem as the first. Consequently, if condition (32) holds, (S1b) is optimal. Faced with a broken social contract at node $N_5$, the second generation could contemplate deviating from (S1b) and (S) either by pursuing the third-best optimum (3), or by purchasing the social contract even though it had been broken ($P$). If (32) holds, setting up a new social contract is better than the third best. In contrast, purchasing the broken social contract would be worse than the third best because the social contract could not be resold to the third generation, given that the third generation follows (S1b), leaving the second generation with third-best utility $\hat{u}$ less $RQ$. The above argument shows that the threat of punishment facing the first generation is not empty. If the first generation breaks the social contract when old, it is indeed optimal for the second generation to carry out the punishment inherent in (S1b).

An alternative justification for (S1b) that does not require invoking punishment behavior, albeit selfish punishment behavior, by future generations is simply to view transactions costs in the following way. Since the old and young generations have formed a government, a decision of the old to break the social contract would impose transactions costs on the young who will have to participate in negotiations about the capital levy. Once the young see that they will have to bear the transactions cost of redrafting the existing social contract, they will decide they are better off setting up their own social contract. Thus transactions costs may be such that once a social contract/institution is broken, it is in effect destroyed and cannot be subsequently sold. In this case strategy (S1b) follows automatically since it is impossible to purchase a social contract/institution that no longer exists.

In summary, we have found that deviations from (S1–2) by the first and second generations are indeed ruled out by conditions (32), (36), and (41). Because the third and subsequent generations are in the same situation as the second generation, the conditions (32), (36), and (41) apply to them as well. We have therefore shown that, provided these conditions hold, there is a perfect equilibrium in which the social contract (C1–2) is instituted once and then sold from generation to generation. The conditions to be satisfied in such an equilibrium can be

reexpressed as the inequalities

(46)

$$(w-\mu)(\bar{m}-\underline{m}) < T/R < (R-D)\bar{s}/(R-1) \quad \text{and}$$

(47)

$$\max[T-(R-D)\bar{s},(w-\mu)(\bar{m}-\underline{m})] < Q < T/R.$$

The transactions cost $T$ must satisfy inequality (46). For given $T$, any $Q$ in the interval (47) will do.

To obtain a sense of the potential range of $Q$ satisfying these constraints consider the following parameter values

$$R=2, \quad D=1.8, \quad \bar{s}=1, \quad w=1, \quad \mu=.85,$$

$$\bar{l}=\bar{m}=1, \quad \underline{m}=.9, \quad \text{and} \quad T=.04.$$

Since one period is roughly 30 years of real time, setting $R$ equal to 2 is equivalent to assuming an annual real interest rate slightly greater than 2 percent. According to these parameters pretax national income in both the unenforceable and the enforceable second-best steady states is 2.9, since the young earn 1, the old earn .9, and capital income is 1. Income in the third-best steady state is only 1.9 reflecting the loss of capital income. The labor supply distortion in the second period is .015, or slightly more than one-half percent of total second-best income. According to (46) $T$ must exceed .03, which is slightly more than 1 percent of second-best income. This value of $T$ may seem large, especially if one considers that income in this model corresponds roughly to income over a 30-year period. However, the costs of setting up complex institutions have, at times, been very substantial, including, in the extreme, costly wars to settle disputes. If $T$ is assumed to equal .04, then $Q$ must lie between .02 and .015.

## IV. Enforcement Without Transactions Costs

A second-best equilibrium may be supported by social contracts also if there are no transactions costs. Suppose that there are no transactions cost and that each generation adopts the strategy consisting of (S2) and

(S1′) When young: (a) if a social contract exists and the existing contract has never been broken, obey clause (C2), that is, pay the transfer $Q$ (move $P$), (b) if a social contract has ever been broken, do not pay the transfer and do not set up a new social contract (move 3), (c) otherwise, do not pay the transfer but set up a new social contract of the form (C1–2) (move S).

The new element is (b), which results in the third-best equilibrium forever if a social contract is ever broken.

It is straightforward to verify that this strategy supports a subgame-perfect equilibrium, provided that $Q$ lies in the interval given by

(48)

$$(w-\mu)(\bar{m}-\underline{m}) < Q < (R-D)\bar{s}/(R-1).$$

The strategy (S1′–2) is in the nature of a James Friedman (1971) "trigger strategy," in that a deviating generation is punished by the succeeding generations reverting to the "stage-game equilibrium," which here is the third best.[10] By (S1b) there is something of a trigger strategy element also in our equilibrium with transaction costs. In the equilibrium with transactions costs, however, a deviating generation is not punished by the succeeding generation reverting to the "stage-game equilibrium." Instead it is pun-

[10] Trigger strategies abound in the macro literature on how reputation can enforce *ex ante* optimal policies. Despite the formal similarities, there are conceptual differences between the arguments. In the usual reputation argument the disincentive to deviate for an *infinite*-horizon policymaker is the threat of future policy failures. Here, the disincentive to deviate for a *finite*-horizon policymaker is instead the threat of an immediate capital loss on the policymaker's asset.

ished by the succeeding generation's setting up a social contract of its own, which is a second-best and Pareto-optimal equilibrium given that lump-sum taxes are infeasible.[11] We believe that this feature makes our transactions-cost equilibrium much more plausible than the standard trigger strategy equilibrium.

It is interesting that also in situations where there are no transactions costs there exist strategies with equilibria where the economy after a deviation quickly returns to the second-best situation. Consider the strategies consisting of (S2) and

(S1″) When young: (a) if a social contract exists, the existing contract has never been broken, and the existing contract was not set up by a generation who broke the previous contract, obey clause (C2), that is, pay the transfer $Q$ (move $P$), (b) otherwise, do not pay the transfer but set up a new social contract of the form (C1–2) (move S).

The new element relative to (S1) is that the young generation sets up a new contract and does not pay to the old generation, if the old generation broke a previous social contract and set up their own social contract in order to avoid paying the transfer.[12] This provides punishment of young who choose $S$ rather than $P$ in node $N_4$, and yet restores the second-best equilibrium. It is straightforward to show that there exists a subgame-perfect equilibrium with strategy (S1″–2) for $Q$ obeying the condition (48).

## V. Extensions, Broader Implications, and Conclusion

One obvious question to raise at this stage is whether the sale of social contracts can enforce seemingly time-inconsistent taxation in other optimizing models. Among neoclassical intertemporal models Barro's (1974) altruistic, infinite horizon model is the principal alternative to the life-cycle model, so it may be useful to consider the sale of social contracts in that model. As is well known, the main distinction between the two models is that in contrast to the life-cycle model, intergenerational redistribution per se in Barro's model is of no economic consequence. Hence, current old generations will not care about the price at which they sell social contracts to the next generation since they know that changes in that price simply redistribute between themselves and their children. It appears that the sale of social contracts would be useless in the Barro model.

A second question about extensions of our model is whether it covers other types of taxes and other types of fiscal policy. The answer appears to be yes. There is no reason to preclude the writing of social contracts or the making of agreements that cover the entire array of feasible direct and indirect taxes on goods and assets. Social contracts or agreements could also extend to investment incentives, changes in which can lead to capital losses and thus constitute covert government asset taxation (see, for example, Alan Auerbach and Laurence Kotlikoff, 1987, ch. 9).

The sale of social contracts could also enforce Pareto-improving intergenerational transfers, such as unfunded Social Security, when the economy is beyond the Golden Rule level of capital accumulation. The enforcement problem here, of course, is that each young generation might choose to renege on the existing system and instead set

[11] Like most subgame-perfect equilibria, our transactions-cost equilibrium is not renegotiation proof, however. (See, for example, Joe Farell and Erik Maskin (1987) for a discussion of this equilibrium concept, which is a recent refinement of subgame perfection.) It fails on one point: When punishing a preceding deviating generation by setting up a new social contract in node $N_5$, the subsequent young generation incurs the transaction cost $T$, which is inefficient.

[12] This strategy is an example of Peter Hammond's (1975) trigger strategy: If the old were "noncooperative," the young should not transfer anything to the old and be labeled "cooperative," or be labeled noncooperative. If the old were cooperative, the young should give the transfer to the old and be labeled cooperative, or be labeled noncooperative. (We were alerted to the relation to Hammond's work by Merwan Engineer, 1986.)

up its own intergenerational transfer program. The same type of enforcement problem arises in Paul Samuelson's (1958) consumption loan model; in that model each young generation, in the absence of an enforcement mechanism, would choose to issue its own money rather than transfer to the current old by accepting their money.[13]

While our model assumes that only the old consume the public good, it appears to generalize to include joint consumption of the public good by young and old. Payment from the young to the old may also occur under the guise of contributions to finance unfunded Social Security benefit payments or, more generally, by the young adopting debts of the old.[14]

A third question is whether the sale of social contracts can enforce time consistency of policies other than fiscal policies in life-cycle type models. In particular, what about monetary policy? Again the answer appears to be yes. In principle, it should be possible to solve the surprise-inflation problem studied by Leonardo Auernheimer (1974) and Guillermo Calvo (1978) with a social contract or agreement or institution determining the rate of money creation. If such a social contract is sold to the next generation, the temptation to run a surprise inflation may be outweighed by the potential loss of revenues from the sale of the anti-inflation social contract. Taking the model in this paper literally, one may of course argue that intergenerational aspects are of minor importance when it comes to the short-run conduct of monetary policy. However, it may be that similar mechanisms can work when individual policymakers with finite horizons are appointed to overlapping terms of office in a long-lived committee, such as in the Board of Governors of the Federal Reserve.[15]

Finally, the notion of selling agreements to enforce time consistency may have wider applications. Take as an example seniority-based wage scales in unionized firms. In establishing unions initial older union workers may institute a steep wage-tenure profile to maximize their own lifetime earnings. Steep wage-tenure profiles can reward those with substantial tenure and avoid sharing sizable amounts of rents with new union hires who are willing to take less than they can earn elsewhere when young in exchange for higher wages in middle and old age. Time-consistency problems may arise in such union contracts. Suppose first, there are young, middle age, and older union members; second, that the union is controlled by the oldest union members; and third, that the only other group capable of reestablishing a union are the middle-age workers. If a steep wage tenure profile is established, the oldest union members will, at any point in time, have an incentive to renege on their promised pay increases to middle-age members and simply hire (or have the firm hire) more lower-paid young workers. Breaking their social contract in this manner may, however, reduce or eliminate their ability to attract new workers. Since the older workers' payments in excess of their marginal product may be financed, in large part, by paying younger workers less than their marginal product, tearing up the union agreement by reneging on pay increases to middle-age workers may be too costly. The other group

[13]Engineer (1986) adopts our framework to show how transfer institutions such as money may be enforced in Samuelson's consumption loan model.

[14]The intergenerational transfer associated with the sale of laws will also have an independent effect on savings, reducing savings in the sale of laws equilibrium below that in the unenforceable second best. While third-best savings in our model is zero, it seems possible that, in a less stylized model, savings in the third best could exceed savings in the sale of laws equilibrium.

[15]Guido Tabellini (1987) and Douglas Waldo (1987) show that a low inflation rule may be time consistent when policymakers with finite horizons overlap in a committee like the Board of Governors, which decides on monetary policy by majority vote. What prevents deviation from the low inflation rule in these papers is not an "intergenerational" transfer scheme between the committee members, however, but rather that the "median voter" in the committee does not have a last period of office, unlike an individual finite-horizon policy-maker.

that could break the union agreement is current middle-age workers. If they could costlessly toss out current old members and garner the excess wage payments to the oldest members for themselves by setting up a new union they would. However, if the transactions cost of such action exceeds the gain a new union will not occur.[16]

To conclude, the sale of social contracts, agreements, and, more broadly, institutions appears to provide *ex post* enforcement of behavior preferred *ex ante* in a range of public and private contexts. These arrangements need not be explicit, and the payment for their purchase may be made in a variety of forms. As a consequence it may prove difficult to refute empirically this subtle resolution of the time-consistency problem.

[16]Alberto Alesina and Stephen Spear (1987) exploit the ideas in our paper and in Crémer (1986) in yet another context. They show how conflicts of interest between senior and junior members of a political party may be resolved by help of a transfer scheme within the party.

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