Parental altruism and common property regulation

MATTHEW A. TURNER University of Toronto

Abstract. Since any regulation of a common property resource must be selected and enforced by a government of finitely lived agents, a natural way to study common property regulation is to study the behaviour of these governments. In this paper such behaviour is analysed in an overlapping generations economy where agents are altruistic towards their children.

Altruisme parental et régulation d'une ressource en propriété commune. Puisque toute régulation d'une ressource en propriété commune doit être choisie et exécutée par un gouvernement composé d'agents dont la vie est limitée, une manière naturelle d'étudier la régulation d'une ressource en propriété commune est d'étudier le comportement de ces gouvernements. Ce mémoire analyse le comportement de ces gouvernements dans une économie où les générations se chevauchent et où les agents ont un comportement altruiste envers leurs enfants.

1. INTRODUCTION

There exists a class of resources whose allocation, both intertemporally and intratemporally, depends substantially on regulatory decisions made by various government agencies. Resources in this class include federal fisheries, forests, and mineral rights. While not firmly in this class of regulated resources, air-quality, ozone, and bio-diversity are moving in this direction. These resources are 'common property' in the sense that their allocation results not from the atomistic actions of a market economy, but from the regulations that result from the common will of the body politic, as filtered through the various institutions that make up the government.

This paper is based on chapter 1 of my dissertation, submitted to Brown University (1995). I would like to thank Vernon Henderson, Toby Page, Harl Ryder, Steven Kohlhagen, and referees of this *Journal* for their help. Remaining errors are entirely my own responsibility. The author gratefully acknowledges the support of the Woods Hole Oceanographic Institution.

Canadian Journal of Economics Revue canadienne d'Economique, XXX, No. 4a
November novembre 1997. Printed in Canada Imprimé au Canada

0008-4085 / 97 / 809–821 $1.50

Since any regulation of these common property resources must be selected and enforced by a government of finitely lived agents, a natural way to study common property regulation is to study the behaviour of these governments. This analysis takes the following two stylized facts as a point of departure. First, current governments represent only the current body politic. Future agents' preferences affect current decisions only in so far as the current generation is altruistic towards its descendants. Second, a government cannot commit a successor to any action, except by changing the quantity of the common property resource that is left for this successor. With this one exception, future governments can undo any action, any precedent, or any constitution laid down by their predecessors.

If we consider the most optimistic scenario, where (1) governments are efficient and allow contemporaneous agents costlessly to choose regulation on their contract curve and (2) parents love their children, is it reasonable to expect governments to choose regulation that is consistent with Pareto optimality? To answer this question, I analyse the regulatory behaviour of governments of finitely lived agents in an overlapping generations economy where parents are altruistic towards their children. Contrary to findings in Marglin (1963) and Mirman and Levhari (1980), I show in this paper that costless cooperation among living agents is not a sufficient condition for the Pareto optimal exploitation of a common property resource. This deviation from the Pareto optimum occurs because current agents are unable to protect their savings, the resource stock, from their as yet unborn descendants. This allows the children to 'free ride' on their parents' savings and can provide parents with an incentive to overconsume in order to avoid sharing with their unborn descendants. This deviation from the Pareto optimum may not always occur if parents are sufficiently altruistic towards their children.

Since current governments cannot commit their successors to corrective policies, the problem of free-riding children is also a commitment, or 'dynamic consistency,' problem. Kydland and Prescott (1977) and Kotlikoff, Persson, and Svensson (1988) examine similar commitment problems in the context of fiscal and monetary policy. In neither of these papers is common property regulation or the role of parental altruism considered. Both are considered in this paper, and it is shown that dynamic consistency is a problem in common property regulation and that this problem is sometimes solved by parental altruism.

The paper is organized as follows. In the next section the analytical framework used in the rest of the paper is developed. The benchmark class of Pareto optimal resource allocations is characterized in section III. In sections IV and V the paper's main result is presented and extended to a private property economy. The results are discussed in section VI, and the paper is concluded in section VII.

II. THE MODEL

Consider a two-period economy with a population composed of three agents. Agent Zero is born old and dies in the first period. Agent One is born in the first period and dies in the second. Agent Two is born and dies in the second period. Agent

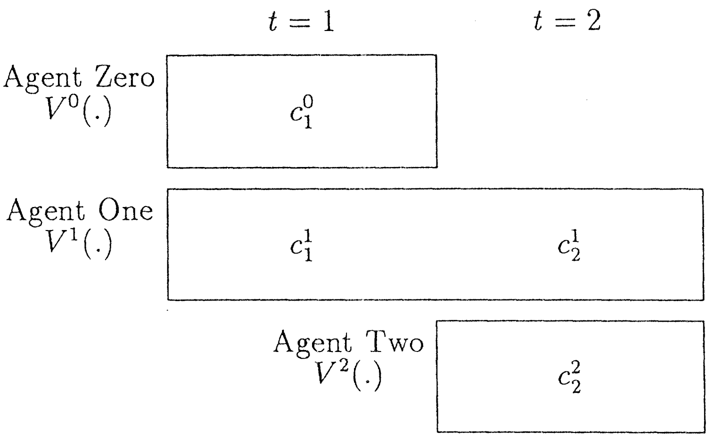

FIGURE 1

Zero is the parent of Agent One, and Agent One is the parent of Agent Two. All agents derive utility from a single perishable composite consumption good in each period that they are alive and possibly from the utility of their descendant(s). If each agent represents an N agent cohort, then the model also describes an economy with a large number of agents.

Let c_t^i denote consumption by Agent i in time period t. Let $c = (c_1^0, c_1^1, c_2^1, c_2^2) \in R_+^4$ denote an allocation. Preferences are represented by the following utility functions,

$$V^0(c_1^0, c_1^1, c_2^1, c_2^2) = u(c_1^0) + \rho V^1(c_1^1, c_2^1, c_2^2)$$

$$V^1(c_1^1, c_2^1, c_2^2) = u(c_1^1) + \delta u(c_2^1) + \rho V^2(c_2^2)$$

$$V^2(c_2^2) = u(c_2^2),$$

$u' > 0$, $u'' \leqq 0$, and $u'(x) \longrightarrow \infty$ as $x \longrightarrow 0$. Agent One's rate of time preference is $\delta > 0$, and $\rho \geqq 0$ describes the magnitude of parental altruism. These assumptions on u guarantee that V^i is concave. Population structure is illustrated in figure 1.

This economy is one of the simplest that (1) allows for contemporaneous agents who are born at different times and (2) has heterogenous agents in both periods. The fact that second period agents are born at different times drives the paper's main result. The fact that agents are heterogenous in each period assures that the role of government in each period is not trivial.

Let $\mathcal{Y}_t$ denote the stock of a common property resource in period t. The consumption good is produced in period t by harvesting this resource. Harvesting is costless and takes place without the addition of capital and labour. Let $S_1 = \mathcal{Y}_1 - c_1^0 - c_1^1$ denote the amount of stock saved in period one. Any stock saved in the first period grows at rate k, so that the second period stock level is given by $\mathcal{Y}_2 = kS_1$. This growth equation describes an exhaustible resource when $k \leqq 1$ and a renewable resource for $k > 1$.

This model describes the following two economies. First, it describes a population that lives on an island and supports itself by costlessly harvesting fish from a common pond. These people have no access to capital markets, so that the only way to provide for future consumption is to leave fish in the pond. Fish left in the pond grow at rate k. Second, if we let $u(c) = c$ and let δ denote a market discount rate, then the model describes a population of profit maximizing fishermen who costlessly harvest from a common pool, sell the product in the market (at price $= 1$), and invest the proceeds at an exogenous market rate.

These two stories aside, exploiting a commons will generally require inputs of capital and labour, in addition to access to the commons. In the current analysis I omit labour and capital in order to concentrate exclusively on the allocation of the common property resource. If other inputs were included, then the subject for analysis would be the allocation of rents due to the common property resource, after other factors receive their marginal products. If we regard $\mathcal{Y}_t$ as a measure of the rents due to the resource, instead of a measure of the size of the resource stock, then the current analysis describes the allocation of these rents. Given this interpretation, the omission of capital and labour is a simplifying assumption that eases the development of intuition applicable to more complicated economies. The model also precludes technical progress. This, too, is a simplifying assumption that may be relaxed without affecting the results.

III. PARETO OPTIMALITY

To characterize the set of Pareto optimal allocations, first consider a one-period economy with three insatiable agents and an endowment of a single consumption good. Absent altruism, every allocation is Pareto optimal. Second, consider the same three-person economy when one of the agents is altruisic towards the others. In this case, every allocation is Pareto optimal, provided that the altruistic agent cannot be made better off by giving some consumption away. The OLG economy described above is a three-person economy with two altruistic agents and one agent who would like to divide consumption between two periods. In this economy every allocation will be Pareto efficient if parents cannot be made better off by transferring consumption to their children, and Agent One cannot be made better off by a different division of consumption between periods. This intuition is formalized in the following proposition.

PROPOSITION 1. *Suppose c is feasible allocation. The allocation c is a Pareto optimal if and only if*

$$(a1) \quad \frac{\partial V^0}{\partial c_1^0} \geqq \rho \frac{\partial V^1}{\partial c_1^1}$$

$$(a2) \quad \frac{\partial V^1}{\partial c_1^1} = k \frac{\partial V^1}{\partial c_2^1} \ (\textit{if } (c_1^1, c_2^1) \neq (0, 0)$$

$$(a3)\quad \frac{\partial V^1}{\partial c_2^1} \geqq \rho \frac{\partial V^2}{\partial c_2^2}, \text{ and}$$

$$(a4)\quad c_1^0 + c_1^1 + \frac{c_2^1 + c_2^2}{k} = \mathcal{Y}_1.$$

The four conditions in the proposition may be derived by maximizing the utility of Agent Zero subject to a feasibility constraint (a4), and threshold utility levels for Agents One and Two. Condition (a2) assures that Agent One cannot improve his utility by transferring consumption between periods. According to conditions (a1) and (a3), no agent can improve his utility by transferring consumption to his descendant. Since the V^i are concave by hypothesis, conditions (a1)–(a4) are necessary and sufficient for Pareto optimality (Takayama 1985, 92).

IV. REGULATION

By definition, a 'common property resource' is one that is regulated by a government that allows the relevant group of agents to exercise collective control over the way the resource is allocated. In reality, governments often regulate a commons by the imposition of quotas, standards, or some other mechanism that operates indirectly on the allocation of the resource. To concentrate on the way that governments choose policy objectives, rather than the way that they implement them, suppose that governments in each period regulate a commons by choosing a division of the resource between consumption for each constituent and savings. That is, suppose that first-period governments choose a regulatory policy, (c_1^0, c_1^1, S_1), and that second-period governments choose a regulatory policy (c_2^1, c_2^2, S_2).

The precise choice of regulatory policy will depend on the level of resource stock, and on the particular structure of the institutions that make up each period's government. For the current purpose, any two governments are identical if they result in the same choice of regulatory policy given the same level of the resource stock. This means that a government (for either period), may be defined as a three-tuple of functions mapping from a stock level into a regulatory policy. This characterization of governments allows the analysis to consider very large 'equivalence classes' of government institutions without describing the actual voting, bargaining, or bureaucratic structures that choose a regulatory policy. Accordingly, denote a second-period government by the mapping $(c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2), S_2(\mathcal{Y}_2))$. A first-period government is similarly defined as a mapping $(c_1^0(\mathcal{Y}_1), c_1^1(\mathcal{Y}_1), S_1(\mathcal{Y}_1))$.

Provided that bargaining is not too costly, if the government in either period does not choose regulation on its constituents' contract curve, then we should expect agents to put pressure on the government to renegotiate the regulation until gains from trade are exhausted. If this occurs, we say that a government is 'efficient.' More formally, we say that a government is efficient if it always chooses regulation such that neither of its constituents can be made better off without harming the other. Since neither government represents all three of the agents in the economy, this is not equivalent to assuming that the economy chooses a Pareto optimal allocation of the common property resource.

Assuming that the second-period government is efficient has two consequences. First, since neither second-period agent is alive tomorrow, both second-period agents can be made better off by decreasing any positive level of second-period savings, so that $c_2^1(\mathcal{Y}_2) + c_2^2(\mathcal{Y}_2) = \mathcal{Y}_2$. Second, if the second-period government is efficient, then old Agent One cannot be made better off by giving consumption to Agent Two, though Agent One may want to take some consumption from Agent Two. More formally, if the second-period government is efficient, Agent One's marginal utility from his own second-period consumption must be larger than his marginal utility from his child's consumption, or $\partial V^1/\partial c_2^1 \geqq \rho(\partial V^2/\partial c_2^2)$. This condition will always hold if gifts from parent to child are possible in the second period.[1] If we suppose that the first-period government is efficient, then young Agent One cannot be made better off by savings that are more or less than $S_1(\mathcal{Y}_1)$. Assuming an efficient first-period government also requires that Agent Zero cannot be made better off by giving consumption to his child, $\partial V^0/\partial c_1^0 \geqq \rho(\partial V^1/\partial c_1^1)$. This condition will always hold if gifts from parent to child are possible in the first period.

If the institutions of government are sufficiently stable that the young agents in period one can reasonably anticipate the behaviour of the second-period government, then agents today will anticipate the relationship between savings in period one, and the allocation of these savings in period two. This supposition may be formalized with the assumption that first-period agents perfectly foresee the regulatory policy selected by the second-period government. That is, first-period agents know $(c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2), S_2(\mathcal{Y}_2))$.

Given this description of first- and second-period governments and the assumptions of efficiency and perfect foresight, we can state and prove the paper's main result.

PROPOSITION 2. *Suppose that*
(b1) the governments in periods one and two are efficient
(b2) the second-period government satisfies $\partial c_2^1(\mathcal{Y}_2)/\partial \mathcal{Y}_2$, $\partial c_2^2(\mathcal{Y}_2)/\partial \mathcal{Y}_2 > 0$, *and*
(b3) first-period agents perfectly foresee the behaviour of the second-period government. Then, the economy allocates the resource stock Pareto optimally if
(b4) $\partial V^1/\partial c_2^1 = \rho(\partial V^2/\partial c_2^2)$
and fails to allocate the resource Pareto optimally if
(b5) $\partial V^1/\partial c_2^1 > \rho(\partial V^2/\partial c_2^2)$

Proof. By (b1) and (b3) the first-period government is efficient and first-period agents are able to foresee the actions of the second-period government. This means that the first-period government must solve

1 It is irrelevant to the analysis whether these gifts from parent to child are made collectively through the government or atomistically between parent child pairs.

$$\max V^0(c_1^0, c_1^1, c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2))$$

$$\text{s.t. } V^1(c_1^1, c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2)) \geqq V^{1^*}$$

$$c_1^0 + c_1^1 + S_i \leqq \mathcal{Y}_1$$

$$\mathcal{Y}_2 = kS_1$$

$$c_1^0, c_1^1, S_1 \geqq 0.$$

Form the Lagrangian and use the relationships $\partial V^0/\partial c_1^1 = \rho(\partial V^1/\partial c_1^1)$ and $\partial V^0/\partial c_2^1 = \rho(\partial V^1/\partial c_2^1)$, to simplify the resulting Kuhn-Tucker conditions. If we recall that the conditions on u guarantee an interior solution, this gives the following necessary condition for a regulatory policy selected by an efficient first-period government,

$$k\left(\frac{\partial V^1}{\partial c_2^1}\frac{\partial c_2^1(\mathcal{Y}_2)}{\partial \mathcal{Y}_2} + \frac{\partial V^1}{\partial c_2^2}\frac{\partial c_2^2(\mathcal{Y}_2)}{\partial \mathcal{Y}_2}\right) = \frac{\partial V^1}{\partial c_1^1}. \tag{2}$$

By (b1) the second-period government is efficient, so that

$$\frac{\partial c_2^1(\mathcal{Y}_2)}{\partial \mathcal{Y}_2} + \frac{\partial c_2^2(\mathcal{Y}_2)}{\partial \mathcal{Y}_2} = 1. \tag{3}$$

Recalling (b2) and substituting (3) and (b5) into (2) gives

$$\frac{\partial V^1}{\partial c_1^1} < k\frac{\partial V^1}{\partial c_2^1}.$$

It follows from condition (a2) of Proposition 1 that the allocation of the common property resource is not Pareto optimal if (b1), (b2), (b3), and (b5) hold.

Conversely, substituting (3) and (b4) into (2) gives

$$\frac{\partial V^1}{\partial c_1^1} = k\frac{\partial V^1}{\partial c_2^1}.$$

Conditions (a1) and (a3) of proposition 1 follow directly from (b1), while (a4) follows from (b1) and the first-order conditions of (1). Therefore, by proposition 1, the economy chooses a Pareto optimal allocation if (b1), (b2), (b3), and (b4) are satisfied. □

Condition (b2) requires that the second-period government increase the consumption of its constituents as stock levels increase. This condition rules out governments that are 'too sensitive' to changes in the stock level. In particular, it prohibits 'strange' second-period allocation processes like the one that switches from a dictatorship by the young $[c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2)] = (0, \mathcal{Y}_2)$ to a dictatorship by the old $[c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2)] = (\mathcal{Y}_2, 0)$ when $\mathcal{Y}_2$ crosses a certain threshold. Condition (b2) also prohibits any second-period government that gives the whole marginal product to either agent over any interval. Thus (b2) prohibits the second-period government that gives a fixed amount of the stock to Agent Two and the entire residual to Agent One.

If the second-period resource stock were private property belonging to old Agent One, then Agent One would give away his private resource stock until $\partial V^1/\partial c_2^1 = \rho(\partial V^2/\partial c_2^2)$. Since this is just condition (b4), it is clear that condition (b4) requires that the second-period government choose the allocation that is most preferred by old Agent One. When this occurs, we have from proposition 2 that an efficient first-period government chooses a regulatory policy such that Agent One's marginal rate of substitution equals the growth rate of the resource stock, and a Pareto optimal allocation is obtained.

Conversely, if (b5) holds, then young Agent Two consumes more of the resource than his parent would like him to have. By preventing his parent from allocating savings so that (b4) holds, Agent Two imposes a cost on his parent. Since there is no market in which Agent Two compensates his parent for this harm, it is an externality. In effect, children 'free ride' on their parents by consuming a resource they did not save. Viewed this way, according to proposition 2, if (b5) holds, then free-riding children impose an externality on their parents. The externality caused by free-riding children causes parents to undersave relative to the Pareto optimum.

In the literature many ways have been proposed to solve externality problems, for example, taxes, bribes, and privatization. The effect of each solution is to equilibrate private and social costs. In this case, Agent One must capture the whole marginal return to his savings. Given that (b5) holds, there must therefore be an increase in $c_2^1(\mathcal{Y}_2)$ relative to c_1^1. Since the first-period government is efficient, no deviation from the selected first-period regulatory policy is rational for both first-period agents. If the first-period agents are to choose regulation that results in an efficient allocation, some manipulation of the second-period allocation process is required.

Is it ever rational for Agent Two to allow the government to transfer consumption to his parent? Suppose, for example, that Agent Two offers to compensate Agent One for any increase in savings. If the compensation schedule is properly constructed, then the efficient first-period government will increase savings so that $\partial V^1/\partial c_1^1 = (\partial V^1/\partial c_2^1)k$, and the resulting allocation could Pareto dominate the original allocation. Agent Two's dominant strategy, however, is to repudiate any agreement that alters the second-period allocation in favour of Agent One. This shows that the problem of free-riding children is a commitment problem as well as an externality problem. The economy would choose Pareto optimal allocations if it could commit to the appropriate taxes or bribes, but these policies are not dynamically consistent and cannot occur in a finite economy.

Current governments undersave in order to avoid an external cost that will be imposed on them by their as yet unborn descendants. Although this intuition is developed in the context of a two-period economy, it should extend to any economy where not all agents are born at the same time, and all living agents participate in the government. In particular, the intuition should extend to more conventional infinite-horizon OLG economies.

It is also natural to ask whether the problem of free-riding children persists in an economy where capital and labour are required for production, along with access to the commons. In this case, a regulatory policy will restrict (or tax) inputs of labour and capital, or else restrict consumption of the resource stock. These restrictions, selected by each period's government, will allocate resource rents between young and old. If the eventual allocation of these rents is such that parents would like to reduce their children's consumption, then we should expect parents to undersave the resource stock, and possibly oversave capital. This suggests that increasing the complexity of the production process should be expected to increase the complexity responses to the problem of free-riding children but should not be expected to eliminate the problem.

To see that the intuition behind proposition 2 is also preserved in an economy where young agents supplant their parents more 'smoothly' than in the stylized economy examined here, consider an economy like the three-agent economy examined previously, but with fifty agents, each of whom lives fifty years. Imagine that one agent is born and one agent dies in each year. Agents are identical in every way except for their age. This means that the forty-nine agents who survive from the first period to the second will share the return to their savings with only one new agent. On the other hand, the one agent who survives forty-nine periods into the future will share the return to his first-period savings with forty-nine new agents. On average, over the next fifty years, half the return to first-period savings is captured by agents who were not alive in period one. This is the same proportion of second-period stock that Agent Two would expect in the corresponding two-period model. This means that parents have approximately the same disincentive for savings in the two-period and the fifty-period economies.

V. PRIVATE PROPERTY

The following reinterpretation of the model presented in section II is closely related to the one used by Kotlikoff, Persson, and Svensson (1988) to examine problems with dynamic inconsistency in fiscal policy. In their analysis, individuals are unable to commit credibly to a low tax rate and therefore have an incentive to undersave relative to the Pareto optimum. The framework developed here gives rise to similar behaviour, with an important difference. In Kotlikoff, Persson, and Svensson (1988), the incentive to undersave results from the dynamic inconsistency in a single cohorts' preferences. In the present analysis, the incentive to undersave is largely independent of preferences and results from changes in government policy as children supplant their parents in the body politic.

Let $\mathcal{Y}_t$ denote the stock of a natural resource, and suppose that this resource stock is the private property of the old agent in each period. Private capital may be consumed, saved, or used to pay taxes. Capital saved in period one grows at rate k, so that second-period capital is given by $\mathcal{Y}_2 = kS_1$. In each period there is a government that generates revenue by levying a tax on capital, and transfers this revenue to the young agent who either consumes or saves it. This government chooses a tax rate $\tau_t \in [0, 1]$ on capital, as the outcome of bargaining between young and old. In the second period, the government chooses tax rate τ_2 and the young agent consumes his whole transfer. Thus, the second-period allocation is given by $[c_2^1(\mathcal{Y}_2), c_2^2(\mathcal{Y}_2)] = ((1-\tau_2)\mathcal{Y}_2, \tau_2\mathcal{Y}_2)$. As before, gifts from young to old are allowed so that $\partial V^1/\partial c_2^1 < \rho(\partial V^2/\partial c_2^2)$ does not occur. If first-period agents can perfectly foresee the second-period tax rate, then they undersave in order to avoid sharing with their as yet unborn children whenever $\partial V^1/\partial c_2^1 > \rho(\partial V^2/\partial c_2^2)$.

The object of this discussion is not to point out that a proportional tax on savings leads to non-Pareto optimal savings. Rather, it points out that if we take as our primitive concept the bargaining strength of different participants in the government, then property rights do not appear to be very important. Property rights may protect individuals from other individuals but need not protect individuals from the government. More to the point, as pointed out in this section, privatizing the resource need not solve the problem of free-riding children. In the common property economy and the private property economy, governments choose allocations on the basis of political strength, not property rights.

VI. DISCUSSION

Both Marglin (1963) and Mirman and Levhari (1980) discuss an externality problem similar to the problem of free-riding children. Marglin (1963) considers an economy of identical two-period agents who in period 1 contribute to the provision of a public good in period 2. Absent cooperation in the first period, the economy chooses less than the optimal provision of the public good as agents free-ride on each others' contributions. If cooperation is possible in the first period then the public good is provided at the Pareto optimal level.

Mirman and Levhari (1980) consider the exploitation of a common property fishery by identical infinitely lived agents. As in Marglin (1963), agents free-ride on each others' savings and the economy saves less than the Pareto optimal amount of the resource. Since Mirman and Levhari (1980) consider an infinite horizon economy, they are also able to determine conditions under which cooperation can be sustained by 'trigger' strategies. These strategies are shown to support a cooperative equilibrium in which Pareto optimal saving occurs.

In contrast to these earlier papers, proposition 2 demonstrates that cooperation between living agents in each period is not sufficient for Pareto optimality if agents are born at different times. Current agents may find it in their interest to overconsume relative to the Pareto optimum in order to avoid sharing with their unborn children. This result can hold even if parents are altruistic towards their children.

The problem of free-riding children is also a 'dynamic inconsistency' problem. Turner (1995) examines an infinite horizon generalization of the two-period economy treated here. In this economy, as in Kotlikoff, Persson, and Svensson (1988), it is possible to sustain cooperative equilibria that overcome the dynamic inconsistency and achieve a Pareto optimum. These cooperative equilibria are achieved by allowing the different generations to play complicated strategies against each other. Since these strategies unravel if there is ever an agent who cannot be punished by his successor (e.g., a last agent), these cooperative equilibria cannot occur in the two-period model examined here. Since the analysis in Turner (1995) and Kotlikoff, Persson, and Svensson (1988) assumes that parents are not altruistic towards their children, the possibility that parental altruism can substitute for intergenerational cooperation remains to be examined.

From proposition 2, a government of finitely lived agents satisfying (b1), (b2), and (b3) will choose Pareto optimal regulation if and only if the second-period government and preferences are such that condition (b4), $\partial V^1/\partial c_2^1 = \rho(\partial V^2/\partial c_2^2)$, holds. Therefore, parental altruism is a determinant of whether the economy chooses a Pareto optimal allocation to the extent that it affects whether or not this condition holds. In particular, there is no allocation satisfying (b4) if $\rho = 0$, and for any allocation with $c_2^1,\ c_2^2 > 0$, there exists ρ large enough that (b4) holds.

If the second-period government is efficient, then it chooses a regulatory policy such that $c_2^1 + c_2^2 = \mathcal{Y}_1$. Thus, the second-period government can also be described as a mechanism for solving a bargaining problem. It divides a pie of size $\mathcal{Y}_2$ between old Agent One and Agent Two. This bargaining may result in an allocation that 'splits the difference' between Agent One's most preferred second-period allocation, the one that satisfies (b5), and Agent Two's most preferred allocation, $(c_2^1,\ c_2^2) = (0, \mathcal{Y}_2)$. Both Nash and sequential offers bargaining have this property (Osborne and Rubinstein 1990). If this is true, then (b5) will not be satisfied for any finite level of parental altruism, and hence, the first-period government will never choose Pareto optimal regulation.

Conversely, suppose that the second-period government gives the agents a share of the resource stock that does not depend on the degree of parental altruism, for example, equal shares. In this case, for any given sharing rule there exists a value of ρ^* such that (b5) holds,[2] and parental altruism removes the incentive for first-period agents to overconsume relative to the Pareto optimal level. More generally, this result extends to any second-period allocation processes in which Agent One's share does not depend on how altruistic he is towards Agent Two. If Agent One's share of second-period consumption does not depend on ρ, and if ρ is sufficiently large, then the problem of free-riding children does not occur. Conversely, if parents are not sufficiently altruistic, the problem of free-riding children occurs and causes the economy to choose an allocation that is not Pareto optimal.

Kydland and Prescott (1977) consider the implications of dynamic inconsistency for fiscal and monetary policy. They conclude that the best policy response to dynamic inconsistency is to commit to rules for choosing policy, rather than choosing the policy that looks best in each period. This is similar to the result outlined in

2 For $\rho > \rho^*$, condition (b5) is still obtained if parents are allowed to make gifts to their children.

the preceding paragraph. If the second-period government is characterized by a sharing rule that does not vary with preferences or stock level, then Pareto optimal allocations are possible when parents are sufficiently altruistic. Conversely, if the second-period government is characterized by a bargaining process, such as Nash or sequential offers bargaining, which chooses shares based on preferences and stock levels, then no amount of parental altruism leads to Pareto optimal allocation.

Kydland and Prescott's intuition that rules can solve dynamic inconsistency problems is interesting and relevant to regulating a commons. However, it seems not to offer any particular policy prescription. To see this, suppose that the first-period agents recognize that the problem of free-riding children will lead them away from the Pareto optimum. They therefore write a constitution requiring the second-period government to follow a sharing rule rather than a bargaining process. Then either the second-period agents repudiate this constitution, since it shifts second-period consumption towards their parents, or the first-period agents could have used the constitution to impose Pigovian taxes or Coasian bribes that would also have moved the economy to a Pareto optimum. That is, if the economy can commit to follow rules in the future, then it has no commitment problem and could commit to other types of regulation to solve the problem of free-riding children.

The literature contains many other investigations of altruism. Two that have been particularly important are Barro (1974) and Becker (1974). Barro considers an overlapping generations economy in which parents are altruistic towards their children. Given that there is an 'operative bequest motive,' this analysis shows that finitely lived agents behave as if they were infinitely lived. Barro's 'Operative bequest motive' requires that parents make a non-negative bequest to their children. The corresponding, slightly more general condition considered here is that children not take more than their parents want to give (this is condition (b4) of proposition 3). While Barro considers the implications of an operative bequest motive, in this paper the plausibility of this assumption and the implications of its failure in a regulated economy are considered. Becker (1974) also considers the role of parental altruism and finds that the presence of a single altruistic agent can cause an entire group of egotistical agents to behave as if they were altruistic. Like those of Barro (1974), Becker's results are contingent on non-negative gifts from parents to children. Additionally, Becker's analysis is static and hence immune to the commitment problem presented here.

VII. CONCLUSION

In this paper the way that common property is regulated in an overlapping generations economy where parents are altruistic towards their children is examined. In contrast to earlier analyses of public goods and common property by Marglin (1963), and Mirman and Levhari (1980), it is found that cooperation in each period is not sufficient for Pareto optimality. This occurs because 'free-riding children' give current agents an incentive to overconsume in order to avoid sharing with their unborn descendants.

The problem of free-riding children is also a dynamic consistency problem. Such problems have been treated, in different contexts, by Kotlikoff, Persson, and Sversson (1988), Turner (1995), and Kydland and Prescott (1977). None of these authors considers the role of parental altruism. The role of parental altruism is considered here. It is found that if future governments choose regulation as the outcome of a bargaining game, then the economy fails to choose a Pareto optimal allocation of the resource for all levels of parental altruism. Conversely, if the second-period government chooses regulation on the basis of a fixed proportions sharing rule, then any such second-period government can lead to a Pareto optimal allocation if parents are altruistic enough.

Kydland and Prescott also find that fixed rules are desirable in the presence of dynamic inconsistency. However, this fact does not lead to policy recommendations in this instance. If governments can commit to particular sharing rules, then they can also commit to other types of corrective policy.

REFERENCES

→ Barro, R. (1974) 'Are government bonds net wealth?' *Journal of Political Economy* 82, 1095–117

→ Becker, G. (1974) 'A theory of social interaction.' *Journal of Political Economy* 82, 1063–1096.

Coase, R.H. (1988) *The Firm, the Market and the Law* (Chicago: University of Chicago Press)

→ Kotlikoff, L., T. Persson, and L. Svensson (1988) 'Social contracts as assets: a possible solution to the time-consistency problem.' *American Economic Renew* 78, 662–77

→ Kydland, F.E., and E.C. Prescott (1977) 'Rules rather than discretion.' *Journal of Political Economy* 85, 473–91

→ Marglin, S. (1963) 'The social rate of discount and the optimal rate of investment.' *Quarterly Journal of Economics* 77, 95–111

→ Mirman, L., and D. Levhari (1980) 'The great fish wars.' *Bell Journal of Economics* 11, 322–34

Osborne, M., and A. Rubinstein (1990) *Bargaining and Markets* (New York: Academic Press)

Takayama, A. (1985) *Mathematical Economics*, 2nd ed. (Cambridge: Cambridge University Press)

Turner, M. (1995) 'Tradition and common property regulation.' University of Toronto Working Paper