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The Real Tragedy of the Commons

In two celebrated and widely anthologized articles, as well as several books, the biologist Garrett Hardin claims (a) that the world population problem has a certain structure: it is a tragedy of the commons; and, (b) that, given this structure, the only tenable solutions involve either coercion or immense human suffering.¹ In this article, I shall argue for two claims. First, Hardin's arguments are deeply flawed.² The population

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1. "Tragedy of the Commons," *Science* 162 (1968): 1243-48; "Living in a Lifeboat," *Bio-science* 24 (1974): 561-68. See also *Living Within Limits* (Cambridge: Cambridge University Press, 1993); *The Ostrich Factor: Our Population Myopia* (Oxford: Oxford University Press, 1999). Some estimation of the influence of Hardin's work and the esteem with which it is held in the scientific community can be found in Joanna Burger and Michael Gochfield, "The Tragedy of the Commons 30 Years Later," *Environment* (December 1998): 4-27; the responses in "The Tragedy of the Commons Revisited," *Environment* (March 1999): 4-5, 45; and Hardin's "Extensions of 'The Tragedy of the Commons,'" *Science* 280 (1998): 682-83. Burger and Gochfield include a graph of the citation index from 1968 to 1997 showing persistent levels of over 100 citations per year among natural and social scientists.

2. Hardin's work has, of course, been criticized before, but I have not found the criticism I will make in the literature. First, most of the criticism is empirical, especially that offered by proponents of a benign demographic transition hypothesis, who maintain that

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problem as he conceives it does not have the structure of a commons; and even if it did, this would not necessitate the extreme responses he canvasses. Second, nevertheless, much of Hardin's pessimism is justified. Some environmental problems associated with population size do have tragic structures, although these are of a different form than Hardin envisions. For example, the problem of global climate change has an intergenerational aspect that makes it significantly worse than Hardin's commons, and for this reason (as opposed to Hardin's) extreme responses may be needed to avert environmental catastrophe.³

I. HARDIN'S ANALYSIS

In 1804, after a wait of approximately two million years, human population reached one billion. One hundred twenty-three years later in 1927, it topped two billion; thirty-three years later, in 1960, three billion. By 1974, fourteen years later, there were four billion people; thirteen years on, in 1987, five billion; and twelve years after that, in 1999, six billion.⁴ This is an amazing rate of progression. Bill McKibben reports that if the world's population had increased by the same number each year throughout its history as it did in 1994, then thinking backwards from its current total, the proverbial Adam and Eve would have to have started out in 1932.⁵

There are some positive signs. For example, the rate of increase in the number of humans appears to be slowing down.⁶ Nevertheless, since this rate is being applied to an expanding base of people, the absolute number of births will only come down to what it is today by the second quarter of this century. Furthermore, because people are living longer,

population will be curbed by development. Unfortunately, valuable though it is, this work does not directly address Hardin's main argument, which is not empirical but theoretical. Second, much of the theoretical criticism of Hardin revolves around his metaphors in "Lifeboat Ethics," not those in "Tragedy of the Commons." For a good discussion of the major views and their weaknesses, see Jesper Ryberg, "Population and Third World Assistance," *Journal of Applied Philosophy* 14 (1997): 207-19.

3. The climate change problem is a useful illustration for two reasons: because it seems to be the most serious environmental problem we face at present; and because something like the same incentive structure appears to some degree in other environmental problems.

4. United Nations, Department of Economic and Social Affairs, Population Division, *1998 Update* (<http://www.census.gov/ipc/www/worldpop.html>).

5. Bill McKibben, "Reaching the Limit," *New York Review of Books* (May 29, 1997).

6. The U.S. Bureau of Census estimates the peak to have been in 1962 and 1963 at 2.19 percent per year.

the total population will still be rising at the midcentury mark, and will then likely be around nine billion; that is, by around 2054, global population will be fifty percent larger than it is today. Hence, the problem of population growth is very much with us.

Population is a problem because the increased absolute number of people, and the rate of increase itself, are both likely to have a severe impact on the planet. Extra people place extra demands on food, water, and energy supply, and their activities cause environmental damage. So, it is important to understand what or who⁷ is causing the problem, and perhaps thereby determine what if anything can be done about it.

Hardin offers some dramatic answers to these questions. First, he claims that the population problem has a special structure—it is a commons problem—and that this structure “*remorselessly generates tragedy*.”⁸ The tragedy is that, left to their own devices, people have large families, causing misery to themselves and their communities and untold damage to the environment. Second, Hardin sees the problem as one primarily caused by, and affecting, those in the developing nations. Third, he argues that the only available solutions are severe. In one article, he argues that we should abandon the United Nation’s declaration that freedom to reproduce is a fundamental human right.⁹ Instead, Hardin thinks, we should use coercive instruments to prevent people from reproducing, or reproducing more than is wanted. In another article, Hardin argues that the affluent nations should refuse to assist their poorer neighbors in times of humanitarian crisis. Instead, he endorses Tertullian’s claim that we would be wise to think of “pestilence, famine, wars, and earthquakes” as “prun[ing] away [their] luxuriant growth.”¹⁰

Hardin’s idea is that the earth provides a corrective to the problem of population through natural catastrophe. But, he thinks, human interfer-

7. This is not to say that the issue is one of whom to blame, in the moral sense. Hardin thinks blaming misses the point. In “Lifeboat,” he says, “the concepts of blame and punishment are irrelevant. The question is, what are the operational consequences of establishing a world food bank?” (p. 563). In *Living Within Limits*, this is on his assumption that “each human being, like every other animal, is genetically programmed to seek its own good,” so that “[t]he tragedy is brought on not by individual sin (‘greed’), but by the system itself” (p. 218).

8. “Tragedy,” p. 1244; emphasis added.

9. *Ibid.*, p. 1246; *Ostrich*, p. 145.

10. “Lifeboat,” p. 564.

ence has disrupted the natural mechanism. Misguided altruism, in the form of the welfare state and food aid to overpopulated countries, has meant that the costs of overpopulation no longer fall on those who have the children. These institutions have created what Hardin calls 'a tragedy of the commons'.

The tragedy is illustrated with an example. Hardin asks us to imagine a group of farmers grazing cattle on common land. He says:

As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, "What is the utility to me of adding one more animal to my herd?" This utility has one negative and one positive component.

(1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.

(2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsman, the negative utility for any particular decision-making herdsman is only a fraction of -1.

Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another. . . . But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.¹¹

The commons, as Hardin understands it, seems to have two features. First, it is a multiperson prisoner's dilemma.¹² Second, it governs a single common resource. In this article, I shall focus on the first feature.¹³

11. "Tragedy," p. 1244. Repeated in *Living Within Limits*, pp. 217–18.

12. See Nick Griffin, "Lifeboat USA, Part 1," *International Journal of Moral and Social Studies* 3 (1988): 230–31.

13. The second feature also poses difficulties for Hardin. Environmental problems associated with population growth can impact resources at various levels (local, national, regional and global). Presumably, then, the best candidate for a single common resource is the biosphere as a whole. But Hardin does not take this approach. Instead, in "Lifeboat,"

II. THE PRISONER'S DILEMMA

A prisoner's dilemma is a situation with a certain structure. In the standard example, two prisoners are about to stand trial for a crime they are accused of committing together.¹⁴ Each faces the following proposition. He can either confess or not confess. If both confess, then each gets five years. If neither confesses, then each gets one year on a lesser charge. But if one confesses and the other does not, then the confessor goes free, and the nonconfessor gets ten years. Neither knows for sure what the other will do; but each knows that the other faces the same choice situation.

Given this scenario, each person has the following preference ranking:

- (1) I confess, the other prisoner doesn't. (Go free)
- (2) Neither of us confess. (1 year)
- (3) Both of us confess. (5 years)
- (4) I don't confess, but the other prisoner does. (10 years)

This situation is usually expressed with a diagram:

		Person B	
		don't confess	confess
Person A	don't confess	1, 1 (2nd, 2nd)	10, 0 (4th, 1st)
	confess	0, 10 (1st, 4th)	5, 5 (3rd, 3rd)

The reason why the situation is called a dilemma is as follows. Suppose I am one of the prisoners. I cannot guarantee what the other prisoner will do, and have no effective means to make it that I can do so. So I

he rejects a "spaceship earth" metaphor in favor of speaking of the rich countries as individual lifeboats that should defend themselves against the lifeboats of the poor countries. But it is not clear what the ecological grounds could be for taking individual countries as single common resources. For further criticisms, see William W. Murdoch and Allen Oaten, "Population and Food: Metaphors and the Reality," *Bioscience* 25 (1975); reprinted in Louis Pojman, *Environmental Ethics*, 2d ed. (Belmont, Calif.: Wadsworth, 1998), 357–61.

14. The title and illustration are attributed to Albert Tucker, who used them to popularize ideas developed by Merrill Flood and Melvin Dresher in investigating global nuclear strategy. For more information, see Stephen Kuhn, "The Prisoner's Dilemma," *Stanford Encyclopedia of Philosophy*, [http://setis.library.usyd.edu.au/stanford/entries/prisoner-dilemma/#Bib'](http://setis.library.usyd.edu.au/stanford/entries/prisoner-dilemma/#Bib)

need to consider each possibility. Suppose he confesses. Then it is better for me to confess also (since five years in jail is better than ten). Suppose he does not confess. Then it is better for me to confess (since going free is better than one year in jail). So, whatever he does, I should confess. But the situation is exactly the same for him. So, reasoning in the same way I do, he will confess also. Hence, the outcome will be that both of us confess (getting five years each). But this yields a suboptimal outcome. Each of us prefers the outcome that comes from us both not confessing (one year each) over the outcome that comes from us both confessing (five years each).¹⁵

For our purposes, the problem can be (roughly) characterized as follows:

PD1: It is *collectively rational* to cooperate: each agent prefers the outcome produced by everyone cooperating over the outcome produced by no one cooperating.

PD2: It is *individually rational* not to cooperate: when each individual has the power to decide whether or not she will cooperate, each person (rationally) prefers not to cooperate, whatever the others do.

PD1 and *PD2* generate the paradox as follows. In prisoner's dilemma situations, each individual has the power to decide whether or not she will cooperate. Hence, given *PD2*, if each person is individually rational, no one cooperates. But this means that each person ends up with an outcome that she prefers less than another outcome that is available. For, according to *PD1*, each prefers the cooperative over the noncooperative outcome.¹⁶

15. But neither of us can get there as things stand. Suppose one of us thinks, It's a prisoner's dilemma, so we should not confess. Then, the other person knows that we know this. But if he thinks we are not going to confess, the rational thing for him to do is to confess, since this gives him a better outcome. Remember that the previous reasoning showed that a prisoner should confess, no matter what the other prisoner does.

16. The prisoner's dilemma structure is interesting for both theoretical and practical reasons. The theoretical reason is that it involves a paradox of rationality. It shows that in some situations, individuals reasoning purely on the basis of self-interest can be led to make decisions that are suboptimal in terms of self-interest. (Strictly-speaking, the problem does not depend on self-interested motivation per se, but might arise for any value system with a similar structure, including some moral views. See Derek Parfit, *Reasons and Persons* [Oxford: Oxford University Press, 1984], pp. 55–56, 95–110.) The practical reason is that there are real world situations that have this structure.

Hardin's description of this kind of situation as a tragedy is apt. For what happens is more than simply a bad thing. The situation as it stands drives people by an inexorable process towards a situation that is worse by their own lights, and away from a situation that is better. Indeed, it is the very same values that make cooperation preferable that drive each agent away from it. In the classic example, prisoners want less jail time, that is why they collectively prefer cooperation; but their desire for less jail time also makes it individually rational for them not to cooperate.

III. COERCION AND POPULATION

Now, suppose the population problem were a prisoner's dilemma. What would follow? Hardin suggests two things. In "Tragedy of the Commons," he says that we should mutually agree on the use of coercive instruments to prevent people from reproducing, or reproducing more than is wanted. In "Lifeboat Ethics," he argues that the affluent nations should refuse to assist their poorer neighbors in times of humanitarian crisis.

These recommendations are difficult to accept.¹⁷ Indeed, there is a strong moral presumption against Hardin's solutions. For they imply that the rich countries should deliberately allow hundreds of millions of people to die, when the rich could help the poor at relatively small cost to themselves. This conflicts with even a very weak principle of beneficence.¹⁸ It may also be resisted on other moral grounds.¹⁹

17. Ryberg also argues that even if Hardin is right about the severity of the problem, it may not necessitate his solutions. Ryberg's argument relies on the idea that aid to the "overpopulated" countries coupled with regulation of population via famine and environmental disaster may still be best on Hardin's consequentialist grounds. See Ryberg, pp. 212–15. Hence, he disputes Hardin's empirical claims about the overall results of the prisoner's dilemma. By contrast, I take issue with Hardin's assumptions about what follows from the dilemma situation itself.

18. A principle of beneficence may be conceived of as either a principle of moral goodness (or virtue), or as a moral requirement. Here I directly intend the former, as beneficence is less controversial as a moral ideal (say, of charity), than as a moral requirement. But I also believe that the weak principle I have in mind is plausible as a requirement.

19. For example, some might argue that, in withholding aid, the rich countries seem to treat the people who starve as a result disrespectfully. For the starving seem to be treated in ways to which they could not in principle consent, and so can be conceived of as being coerced. (One might also say that they are thereby used by the rich as a means to solving a wider problem.) Hence, their actions conflict with major tenets of Kantian (and arguably commonsense) morality, which claim we should not treat others in ways to which we

Given the presumptions against Hardin's solutions, surely we should think on moral grounds that if almost anything else will work, then that is what we should do. This makes it relevant to consider alternative ways in which prisoner's dilemma situations might be resolved, ways that do not involve coercion. At least three are pertinent here. The first is to change people's motives, and so alter the preference structure that generates the problem. Hence, one might try to make people value some aspect of the situation in a new way. For example, fairly recently, many people have been made to disparage styrofoam cups to the extent that they have such a strong preference to drink from a reusable cup, that they are willing to carry one around with them. Or one might try to make people value cooperation itself.

The second solution is to appeal to broad considerations of self-interest. For example, it is well known that the dynamics of a prisoner's dilemma can be changed if the parties will meet again in other bargaining situations in the future. If we know that we must make a bargain again, we are much more likely to give up some gains from noncooperation now in exchange for the expectation of gains to be made from an overall strategy of cooperation.

The third solution is to appeal to a sense of fair play, and in particular to the notion of reciprocity. This is present in almost all societies, and supports a social attitude of rebuke to those who do not cooperate: they are socially shunned. This too can work to solve some problems without the need for coercive state interference.²⁰

Now the problem for Hardin is that, even if the population problem were a prisoner's dilemma, it seems plausible to think that any one of

could not in principle consent, and that we should never treat them merely as a means. These claims are, of course, controversial, even amongst Kantians. But an approach to aid problems which makes moves of this sort has been defended by Onora O'Neill, "Ending World Hunger" in Tom Regan, ed., *Matters of Life and Death*, 3d ed. (Belmont, Calif.: Wadsworth, 1993), and *Faces of Hunger: An Essay on Poverty, Justice, and Development* (London: Allen & Unwin, 1985).

20. In the original standard 'tit for tat' solutions to the prisoner's dilemma, the second and third strategies fit together. Robert Axelrod reported that "the two requisites for cooperation to thrive are that the cooperation be based on reciprocity, and that the shadow of the future is important enough to make this reciprocity stable." (Axelrod, *The Evolution of Cooperation* [New York: Basic Books, 1984]; selection reprinted in *Ethics*, Peter Singer, ed. [Oxford: Oxford University Press, 1994], pp. 88–92 at p. 90.) For egoists, these conditions hold when there is prolonged interaction over time and where this interaction holds the promise of great benefits to both sides.

these solutions (or some combination) might help to resolve it. The appeal to broad self-interest looks especially promising. The economic costs of having children are huge; and the noneconomic costs are also frequently high. Though, arguably, the noneconomic benefits of parenthood are similarly large, it seems more than possible to persuade people either to forgo these altogether (by having no children of their own, and making do with being biological or nonbiological aunts or uncles, for example), or to have fewer of these benefits (by having fewer children), in exchange for the savings incurred by not having children.²¹ Indeed, arguably, this is at least part of what has already happened in the developed countries, and has reduced the number of children there.

However, Hardin seems to treat the possibility of such solutions with outright disdain. In particular, he seems to think that an appeal to broad self-interest will not work because self-interest is far too deeply tied to the production of children for any change in reproductive behavior to occur.²² And he regards an appeal to fairness as not only ineffective, but also self-eliminating.

These attitudes of Hardin's suggest that he regards the population problem not just as a prisoner's dilemma, but a prisoner's dilemma that depends on circumstances of a particularly deep and intractable kind. So, in order to understand Hardin's attitudes, we must look at his arguments for the claim that population is a prisoner's dilemma.

IV. POPULATION AS A PRISONER'S DILEMMA

If population is a prisoner's dilemma, then it must have the following features:

Population-PD1: It is *collectively rational* to have smaller families: Each agent prefers the outcome produced by everyone having smaller families over the outcome produced by everyone having large families.

21. For an overview, see Andrew Hacker, "The Case Against Kids," *New York Review of Books*, vol. 47, no. 19 (November 30, 2000): 12–18.

22. Hardin says, "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons," ("Tragedy," p. 1244, emphasis added); about the population problem in particular he says, "the individual benefits as an individual from his ability to deny the truth [about the population tragedy] even though society as a whole, of which he is a part, suffers" ("Tragedy," p. 1244).

Population-PD2: It is *individually rational* to have a large family: when each individual has the power to decide whether or not she will have a large or small family, each person (rationally) prefers to have a large family, no matter what everyone else does.²³

The first problem for Hardin, which is widely noted, is that, on the assumption that most actual people are individually rational to this extent, *Population-PD2* seems to be empirically false. This is true both of its content and its form.

With regard to content, the raw data is remarkably consistent. First, as is often pointed out, there has been a significant transition in Western Europe over the past 100 years or so. All agree that Western Europe is *below* replacement level, and that this is almost true now in North America.²⁴ There was a spurt of population growth with industrialization, but now this is over. Furthermore, this happened without coercion. So, *Population-PD2* is not true of the behavior of people in these nations.²⁵ Second, the UN reports that *global* fertility rates have fallen significantly in the recent past (to 2.7 children per family in 1998, from 5 in the early 1950s); and, furthermore, this reflects a decline in fertility in *all* regions of the world (in the last twenty-five years, 6.6 to 5.1 in Africa, 5.1 to 2.6 in Asia, 5.0 to 2.7 in Latin America and the Caribbean).²⁶ So, *Population-PD2* seems unlikely to be true of the behavior of the world as a whole ei-

23. Hardin tends to speak in terms of "overbreeding," and seems to mean by this 'having as many healthy, surviving children as possible'. But his general argument requires only the more modest 'have a size of family above replacement level', and this is what I intend here. (I have avoided the use of 'breeding' as this term may seem offensive, and in any case encourages the animalistic connotations Hardin tries to give human behavior, connotations I resist below.)

24. The North American population figures are complicated by large immigration to both the United States and Canada. Without immigration, North America is likely to be slightly below replacement.

25. It is not true even in those nations officially in favor of more rather than fewer children. For example: Italy is officially Catholic; but nineteenth-century Italy had a fertility rate of five children per woman; but now it is down to significantly below that necessary for replacement. Indeed, the United Nations predicts very substantial immigration will be necessary to maintain its current population.

26. United Nations, *1998 Update*. This data is used by optimists about population in support of their view that there will be a benign demographic transition to lower total population. The pessimists may argue that these declines are coming too late (and they may be right). But this does not help Hardin's argument, for this is an empirical question, to be answered by the data. But Hardin doesn't provide any data. He provides a conceptual argument to show that the population problem is a prisoner's dilemma, and that coercion is required.

ther: all seem to be following the downward trend toward smaller family size.²⁷

As well as being in stark conflict with the raw data, *Population-PD2* also takes an overly simplistic form. It reduces the question of reproduction to the issue of family size. But even in the developing nations, matters are much more complex than this. For example, the recent Indian census has suggested that ultrasound technology is enabling Indians to follow the Chinese in aborting female fetuses at abnormally high rates. In India, then, it seems clear that sex plays a significant role in reproductive choice, and one that affects family size. And this fact is clearly relevant for population policy.²⁸

The second problem for Hardin is that *Population-PD2* seems independently implausible. Although *Population-PD1* seems plausible enough (it is undoubtably true that everyone is worse off if all have large families), what makes it in my interests to have a large family *whatever anyone else does*? Consider the following: For a prisoner's dilemma, we need this incentive structure:

	Couple B merely replaces	Couple B has a large family
Couple A merely replaces	2nd, 2nd Maintain current population	4th, 1st
Couple A has a large family	1st, 4th	3rd, 3rd Population explosion

27. For a good discussion of the data, see Elizabeth Willot, "Population Trends," in David Schmidtz and Elizabeth Willot, eds., *Environmental Ethics: What Really Matters, What Really Works* (Oxford: Oxford University Press, 2001).

28. A major cause of the problem seems to be (a) that these societies have no universal social security systems, and (b) that women are effectively relieved of all responsibilities for their own family when they marry. This tends to make the rationality of having a child depend on its sex, and perhaps the rationality of having an additional child depend on the sex of the preceding children. See Celia W. Dugger, "Modern Asia's Anomaly: The Girls Who Don't Get Born," *The New York Times, Week in Review*, Sec. 4 (May 6, 2001): 4. The issue is discussed in depth by Amartya Sen, "Missing Women," *British Medical Journal* 304 (March 7, 1992): 587; and *Development as Freedom*, (New York: Anchor, 1999), chap. 8.

But why would we think that couples have these preferences, so that the preferred outcome for all is to have a large family, and what is feared most of all is for others to have large families while we do not? Under moderately favorable conditions, it seems more plausible that some people will prefer replacement, or close to replacement, no matter what everyone else does; that very few people will prefer having lots of children just for the sake of it; and that some will prefer no children (or one). Indeed, the empirical evidence from the developed countries suggests that overall, taking everyone's preferences into account, uncoerced decisions produce a level of reproduction that is *below* the replacement level for a whole society.

To resist this argument, Hardin has to claim that it is always to the advantage of the individual to have a large family.²⁹ But why should we believe this? It is not clear. But Hardin seems tempted by the view that it is because it is *biologically advantageous* to have a large family. For example, he says:

*If each human family were dependent only on its own resources; if the children of improvident parents starved to death; if, thus, overbreeding brought its own "punishment" to the germ line—then there would be no public interest in controlling the breeding of families. But our society is deeply committed to the welfare state, and hence is confronted with another aspect of the tragedy of the commons. In a welfare state, how shall we deal with the family, the religion, the race, or the class (or indeed any distinguishable and cohesive group) that adopts overbreeding as a policy to secure its own aggrandizement? To couple the concept of freedom to breed with the belief that everyone born has an equal right to the commons is to lock the world into a tragic course of action.*³⁰

29. Hardin seems to realize this. He says that the independent herdsman "dare not refrain" from overloading the commons, because if he did so he would "suffer more" than a "selfish" one who does overgraze ("Lifeboat," p. 562); furthermore, if he did refrain from overgrazing, the herdsman would be (correctly) condemned as a "simpleton" ("Tragedy," p. 1246).

30. "Tragedy," p. 1246; emphasis in original. As is often noted, this seems to be an inaccurate description of the motivation of those in above-replacement countries. People in some societies have reason to have lots of children because there is no one else to look after them when they become old and there is high infant mortality. This makes it risky not to have lots of children, from the point of view of self-interest. This is actually worse than a prisoner's dilemma situation. For here the parents are likely not to prefer the constrained outcome, because they fear abandonment in old age more than general population problems.

Now, this argument faces two problems. First, it is concerned with groups and germ lines. It says nothing about the interests of the *individuals* involved. Therefore, it does nothing to justify the claim that it is always to the advantage of the individual to have a large family. Second, this claim would be plausible only if one posited a strong correlation between the biological interests of a germline and the self-interest of individuals carrying that germline. But, on any plausible theory of the interests or well-being of an individual, an individual's self-interest does not consist in, nor is it dominated by, even his or her own biological interests, let alone the biological interests of the group.³¹

But perhaps Hardin has a second argument that does not depend on people's interests. When arguing against the idea that an appeal to conscience might solve the population problem (my 'fair play suggestion'), he says:

People vary. Confronted with appeals to limited breeding, some people will undoubtedly respond to the plea more than others. Those who have more children will produce a larger fraction of the next generation than those with more susceptible consciences. The difference will be accentuated, generation by generation. . . . The argument assumes that conscience or the desire to have children (no matter which) is hereditary—but hereditary only in the most general formal sense. The result will be the same whether the attitude is transmitted through germ cells, or exosomatically. . . . The argument has been stated in the context of the population problem, but it applies equally well to any instance in which society appeals to an individual exploiting a commons to restrain himself for the general good—by means of his conscience. To make such an appeal is to set up a selective system that works toward the elimination of conscience from the race.³²

Hence, Hardin argues that reproductive restraint will be eliminated by natural selection: those who practice restraint will have fewer descendants than those who do not, and since the attitude of restraint is trans-

31. There is also a question about whether one can make sense of biological interests in evolutionary terms (and also, perhaps, whether one can make sense of the notion of biological interests). Such an approach is tried by Gary Varner, *In Nature's Interests?: Interests, Animal Rights, and Environmental Ethics* (Oxford: Oxford University Press, 1998). But note that even Varner believes that individuals have psychological interests in addition to their biological interests, and that the psychological interests trump the biological.

32. "Tragedy," p. 1246.

mitted between generations, this attitude will become progressively less common.

This argument faces serious practical, empirical, and theoretical problems. The practical problem is that natural selection works over very long time-scales. Hence, it is unlikely to happen fast enough to prevent the appeal to conscience working for a while. And perhaps a while is all we need worry about, if the benign demographic thesis is correct. The empirical problem is that if Hardin were right, we would expect people already to have the desire for as many children as possible, since we would expect the selection procedure to have been at work for generations.³³ But the empirical evidence suggests the opposite: global fertility rates are falling. The theoretical problem is the assumption that the attitude of restraint is transmitted between generations. There is simply no reason to believe that peoples' consciences will be the same as their parents', nor in particular that they will have the same attitude toward reproduction. Indeed, the empirical evidence stands squarely against it.

So, I conclude that Hardin's analysis of the population problem as a prisoner's dilemma is untenable. It relies on flawed assumptions about human motivation that rest on extremely dubious appeals to evolutionary biology.

V. TOTAL ENVIRONMENTAL IMPACT

The discussion so far has shown that Hardin's analysis of the population problem as a tragedy of the commons is fatally flawed, and even if it were not, Hardin's solutions would not be justified. But there is one respect in which Hardin's account is close to the truth. At least one aspect of the population problem does have a tragic structure; and extreme solutions may be required to overcome it.

33. That is, we would expect people already to have the desire for as many children as would maximize the chance of the genes being passed on. Against this, Hardin would presumably argue that the historical natural pruning had an effect on reproductive motivation, but one which is being undermined by the more recent welfare state and foreign aid programs. But here it is worth pointing out (a) that those countries without the welfare state have sustained high birth rates rather than held them back, and (b) that the decline in birth rates has occurred in rich countries even given the introduction of welfare. (Against [b], Hardin might argue that it is too early to tell what will happen in these countries, given that welfare is fairly recent; but still the empirical evidence does not look promising for him.)

To begin, it is worth observing that the important issue about population is not how many people there are. In itself, this tells us nothing and threatens little. The real issue is the environmental impact that people have, in particular on the so-called carrying capacity of the earth.³⁴ Thus, if there is an issue of population, it is the issue of how the number of people in the world interacts with the environmental impact per person, to produce the total environmental impact of humanity.

On this issue, however, there is reason to believe that the most important variable is the environmental impact per person, not the total human population.³⁵ If this is right, the benign demographic thesis turns out not to be so encouraging after all. For that thesis suggests that the price of a decrease in the absolute number of people is development. But development as we presently understand it requires additional energy consumption, and this in turn tends to involve an increase in the environmental impact per person.³⁶ (For the major sources of energy currently supporting the developed countries, especially oil and coal, come with significant environmental impacts.) Indeed, the development necessary for the less developed nations to reach a stable or even declining population would, on present technologies, involve a catastrophic increase in energy consumption, and so in the environmental impact per person.³⁷

34. Determining the carrying capacity is a difficult and extremely value-laden business, which raises philosophical issues of its own. For a helpful discussion, see Joel E. Cohen, *How Many People Can the Earth Support?* (New York: Norton, 1995), chap. 12, and app. 3 and 4.

35. See Griffin, "Lifeboat," pp. 223–4.

36. Global energy consumption rose from 21 to 318 exajoules between 1900 and 1988 (See William C. Clark, in *Managing Planet Earth* (New York: Freeman, 1990), p. 87. Bill McKibben reports that per capita consumption had risen from less than 1 megawatt-hour per person in 1800 to 19 megawatt hours per person in 1989 (McKibben, *The End of Nature* [New York: Anchor, 1989], p. 2).

37. For example, in 1997, India and China had commercial energy use per capita of 479 and 907 kg of oil equivalent respectively, compared to 3, 863 and 8,079 for the United Kingdom and United States respectively. (See World Bank, *World Development Indicators 2000*.)

Hardin recognizes that energy consumption per capita is a useful partial measure of quality of life. He also points out the sharp difference between figures for developed and less developed countries. But he refused to see this as a global problem. Instead, he argues for a localizing principle: that parochial distribution of resources should be matched by parochial consumption; and so sees the problem as a local one. (For example, he all but suggests that Bangladesh should reduce its population from 104 million to 2.7 million, rather than bemoan its lack of resources.) But there are two problems for Hardin here.

This news is bad enough, but there is worse to come. For the problem of an escalating environmental impact per person seems to have a structure similar to the one that so worries Hardin in his misdiagnosis of the problem of world population. Indeed, the structure of this problem is in some respects worse than the one Hardin envisions, and so more of a tragedy.

VI. THE INTERGENERATIONAL ISSUE

There are both inter- and intragenerational problems involving environmental impact. Consider first the intergenerational problem. Much of the damage inflicted by energy consumption is by current generations on future generations.³⁸ For example, global climate change is caused mainly by emissions of carbon dioxide, but the effects of these emissions on the global temperature suffer from an important time-lag. The lifetime of carbon dioxide in the upper atmosphere is over 100 years, so that the full (cumulative) effects of current emissions will not be felt un-

First, his defense of the principle ("there must be some sort of fragmentation of administrative tasks") is too weak either to justify the principle itself, or the conclusions he is prepared to draw from it. Second, Hardin admits that the principle does not apply to air and water, where a global approach is needed. But, as I shall stress below, the most serious environmental problems caused by current energy consumption involve atmospheric pollution, and so are global. (See Hardin "Cultural Carrying Capacity: a Biological Approach to Human Problems," *Bioscience* 36 (1986): 599–606, esp. 602–5.)

38. Future generations are often defined as those future people whom those presently alive will not live to meet (see, for example, Avner de-Shalit, *Why Posterity Matters: Environmental Policies and Future Generations* [London: Routledge, 1995], p. 138). For the sake both of simplicity, and of making clear the fundamental dynamics, I follow that usage here. However, 'future generations' is also often used to refer to those not presently alive, and it is important to emphasize that many of the points I will make apply in a more nuanced way to this less restricted notion. This is because the crucial issue is not when those who will live when we have gone appear, but the extent of our present concern for their well-being. (This is what gives a point even to the more restrictive use of the term "future generations.") Indeed, it is worth noting that much of what is said about future people in the restricted sense applies not only to future people in the less restricted sense, but also (in a graduated way) to people already presently alive. For even when there is overlap, and we care about the well-being of at least some of the people who remain after we are dead, that concern tends to be less than our concern for people around now (even when the same people are at issue) and to decline over temporal distance. (Such issues are important to a full account of the dynamics of the global warming problem, since there one would want to say more about the medium-range effects of climate change. But here I am offering only a basic outline, for illustrative purposes.)

til the beginning of the twenty-second century. By contrast, the benefit of burning fossil fuels, the energy thereby produced, is consumed by the present generation. Hence, whereas the present generation both causes the environmental damage and reaps the rewards, most of the costs fall on future generations.³⁹ This suggests that the current generation has a powerful self-interested reason to carry on polluting, and the future generations a powerful self-interested reason for wanting that pollution to stop.⁴⁰

Now, it is true that this problem has a tragic structure, and is a commons. But it is not a tragedy of the commons in Hardin's sense. It is worse. Present and future generations both have an interest in the earth's relative climatic stability, and therefore in its capacity to absorb the by-products of fossil fuel emissions. But, of course, the future generations have no control over what the present generation does with that capacity; whether it stays within, uses up, or exceeds it. Indeed, they could not *in principle* have any such control. They are not around to present a claim, nor to represent their interests. Worse, even if they were around, or even if someone could represent them, they would have no bargaining power. There is nothing that they can offer the present generation in exchange for cooperation (or nothing that the present genera-

39. Two qualifications are worth making here. First, not all of the rewards accrue to the present generation. Some are passed on in the form of technological advances and increases in the capital stock. This raises the prospect that future generations might be compensated for the damage they inherit through having better resources with which to deal with them. Such arguments are no doubt warranted in some cases: for example, some developing countries are probably right to think that they do best to improve their economic infrastructure rather than abate emissions at the moment, especially since the planet is already committed to some warming. However, in general, the point is limited by such factors as (a) that much of the benefit of emissions is not passed on but simply consumed; (b) that technology and capital are far from perfect substitutes for environmental quality; and (c) that the precise physical effects of global warming are likely to be unpredictable, severe, and possibly catastrophic (so that effective deployment of the inherited benefits to mitigate them may be extremely difficult).

Second, if the immediate effects of pollution are bad enough, the costs placed on the present generation may, of course, be high enough to give them a self-interested reason not to pollute. But this presently seems unlikely in the case of CO₂ emissions. (This is especially so because, even if the short-term future impact of climate change is significant, this will be caused by past emissions, and so is warming to which the present generation is already committed through the action of past generations.)

40. I leave aside the philosophical problem identified by Derek Parfit as the Non-Identity Problem. See Parfit, *Reasons and Persons*, chap. 16. But note that even Parfit thinks that we can carry on talking in terms of harms to future generations (*Ibid.*, p. 367).

tion could not take anyway). So, what happens is completely up to the present generation. And it has powerful self-interested incentives to exceed the capacity and thereby alter the climate.

Given this analysis, other things being equal, it is reasonable to expect that the commons will be deeply harmed by the present generation. Furthermore, the same reasoning will apply to each future generation as it comes into being. However much it may deplore the effects of the previous generations decisions on it, each generation will face the same decision situation with respect to generations later than it. Hence, each generation will pollute, and the pollution will continue as long as the earth can bear it.

This analysis shares with Hardin's tragedy of the commons the claim that a suboptimal outcome might eventuate even if collectively all generations would agree that it would be better if the atmosphere were not so exploited. For this agreement would be based on what is better for the human race as a whole, or better for each generation bar the first if all others do the same. But this qualification about the first generation is extremely important. It makes the current problem worse than a prisoner's dilemma, for restricting pollution is not better for the first generation. And then, provided each generation takes its starting position as a given, it is not better for subsequent generations either. So, we get a sequential motive towards noncooperation and overpollution.

In short, the intergeneration problem has the following general features:

Intergenerational-1: It is *collectively rational* for most generations to cooperate: (almost) every generation prefers the outcome produced by everyone restricting pollution over the outcome produced by everyone overpolluting.

Intergenerational-2: It is *individually rational* for all generations not to cooperate: when each generation has the power to decide whether or not it will overpollute, each generation (rationally) prefers to overpollute, whatever the others do.

This structure is worse than the prisoner's dilemma structure in the following ways. First, *Intergenerational-1* is worse than *PD₁* because it is not true that everyone prefers cooperation (hence, the "almost"). The first generation capable of overexploiting the atmosphere will prefer to do so, since it experiences no gains from cooperation. Second, *Intergen-*

erational-2: is worse than *PD2* because the reason for it is deeper. In the prisoner's dilemma, *PD2* arises because there is *in fact* no way for each prisoner or herdsman to ensure that the behavior of others is beneficial so long as his is beneficial. But here, *Intergenerational-2* arises because the situation is such that it is *in principle* impossible for one generation to ensure that the behavior of the others is beneficial so long as theirs is beneficial.

The intergenerational problem not only has a more tragic structure than Hardin's tragedy of the commons, it is also more resistant to solution. Earlier I argued, contrary to Hardin, that his problem could be resolved by standard noncoercive means, e.g., by appeal to broad self-interest or to a sense of fairness. But here such solutions are problematic. First, the usual appeals to broad self-interest rely on there being repeated interactions between the parties where mutually beneficial behavior is possible. But between present and future generations there is neither repeated interaction (by definition, there is no interaction at all), nor mutual benefit (there is little future generations to can do benefit present generations).⁴¹ Second, similar difficulties arise for standard appeals to reciprocity: future people cannot reciprocate. Still, perhaps one could argue that if the first generation capable of serious long-term pollution unilaterally restricts its activities, then subsequent generations can owe the obligation to their forefathers to restrict their pollution for the sake of future generations. (Subsequent generations get a benefit from not inheriting an overpolluted planet, but then must, out of fairness, pass this on, so that there is a kind of indirect reciprocity.) Unfortunately, this solution faces both theoretical and practical problems. The theoretical problem is that we need to assume that the initial generation makes a pure sacrifice of self-interest, with no compensation. So, their action cannot be justified by an appeal to (even indirect) *reciprocity*. The practical problem is that the antecedent is not satisfied: significant long-term pollution has already occurred.⁴²

These problems reflect the difference in structure of the cases already mentioned. For, in the prisoner's dilemma case, most of the proposed

41. They might continue certain traditions and projects. See John O'Neill, "Future Generations: Present Harms," *Philosophy* 68 (1993): 35–51.

42. Perhaps it could be weaker. Perhaps all that is required is that some generation capable of making a difference make the sacrifice. Still, the theoretical problem remains. Presumably it is to be resolved at least in part by appeal to purely altruistic moral reasons.

solutions rely on rearranging the situation so as to provide some kind of guarantee of the behavior of others when one cooperates. But in the intergenerational problem, there is no way to rearrange the situation in this way.⁴³ It is essential to the problem that the parties cannot interact, and so that the future generations are in no position to benefit nor to engage in reciprocal acts with their forbears.

VII. TWO INTERPRETATIONS OF THE INTRAGENERATIONAL PROBLEM

Suppose for the moment that the intergenerational problem can be overcome, and people in the present generation agree that they have a reason not to overpollute. Still there is a problem. For there remains a collective action problem at the intragenerational level. Again, let us take climate change as our example.

Now, there is some controversy about how to characterize the intragenerational aspect of the global warming problem. In particular, there seems to be some case for describing it as a Prisoner's Dilemma, and some for describing it as a Battle of the Sexes.⁴⁴ A full account of these

43. Perhaps the point can be made clearer by looking at the preference structures which underlie the tragic situation. The intergenerational problem begins with a prisoner's dilemma structure:

- 1st preference: I pollute, previous generation does not.
- 2nd preference: Neither I nor previous generation pollutes.
- 3rd preference: I pollute, previous generation pollutes.
- 4th preference: I don't pollute, previous generation pollutes.

But for the first generation capable of serious overpollution, this becomes simply:

- 1st preference: I pollute.
- 2nd preference: I don't pollute.

So, this fixes the third option for the next generation, and so on for subsequent generations.

44. Climate change is explicitly described as a prisoner's dilemma by Marvin S. Sooros, *The Endangered Atmosphere: Preserving a Global Commons* (Columbia, S.C.: University of South Carolina Press, 1997); pp. 260–261. It seems to be implicit in many other analyses. By contrast, Jeremy Waldron makes the case for a Battle of the Sexes in an unpublished research paper kindly supplied to me by an anonymous referee for this journal. (Waldron, "Who is to Stop Polluting? Different Kinds of Free-Rider Problem," June–July 1990. A Contribution to a project Ethical Guidelines for Global Bargains undertaken by the Program on Ethics and Public Life, Cornell University with support from the Rockefeller Foundation. Waldron is applying a general approach to collective action problems put forth by Jean Hampton, "Free-Rider Problems in the Production of Collective Goods," *Economics and Philosophy* 3 [1987]: 245–73; and *Hobbes and the Social Contract Tradition* [Cambridge: Cambridge University Press, 1986].) The Battle of the Sexes analysis is also briefly sug-

matters would be beyond the scope of this article.⁴⁵ However, for current purposes we can make do with something more limited. I shall argue that, even without decisively resolving the theoretical dispute, in practice the intragenerational problem is best treated *as if* it were a prisoner's dilemma, and so as adding a further tragic structure to the general problem of global warming.⁴⁶

To make this argument, I shall present a brief case for three claims: first, that, seen from a long-term perspective, there is a strong case for characterizing the intragenerational global warming problem as a prisoner's dilemma; second, that if there is uncertainty about whether it is a battle of the sexes or prisoner's dilemma, it should be treated as if it were a prisoner's dilemma; and, third, that in any case the importance of classifying it as a battle of the sexes instead of a prisoner's dilemma is undercut by the background presence of the intergenerational problem.

Let us begin with a preliminary case for a prisoner's dilemma interpretation. Consider the circumstances facing *individual members* of the present generation (or individual firms).⁴⁷ On the surface, these appear to generate a prisoner's dilemma. To begin with, even if the members of the present generation care about future generations, the marginal effects of any individual's pollution are small. Furthermore, there are powerful incentives to cheat. First, not polluting involves an absolute sacrifice of energy consumption, and so of self-interest. Second, it is cheaper to pollute than not to pollute; and the cheaper energy is a comparative

gested by some remarks of Nick Mabey, Stephen Hall, Claire Smith and Sujata Gupta, *Argument in the Greenhouse: The International Economics of Controlling Global Warming* (London: Routledge, 1997), pp. 356–59; 409–10; and, for the specific issue of ratification of the Kyoto Protocol, Scott Barrett, "Political Economy of the Kyoto Protocol," *Oxford Review of Economic Policy* 14 (1998): 20–39; 36–37.

45. I hope to pursue the issues in more detail, and as applied to the Kyoto Protocol in particular, in a future paper tentatively entitled "The Global Warming Tragedy." Some discussion of the Kyoto context is to be found in Barrett, "Political Economy."

46. There are two basic reasons why the structure of the intragenerational problem is unclear. First, solving the problem requires resolving a number of other collective action problems that are subordinate, or otherwise closely related, to it. Second, because of the uncertainty surrounding the magnitude and distribution of the various costs and benefits of climate change, the dynamics of the intragenerational and related problems are all subject to considerable uncertainty.

47. The writers noted above are all concerned with countries. But I begin with individuals for the sake of simplicity, since I believe that a prisoner's dilemma analysis would be widely accepted at that level. I make a case for extending the analysis to countries below.

advantage when one is producing things in the market place.⁴⁸ Third, cheating might be difficult to identify. Carbon dioxide emissions, for example, are very difficult to monitor and detect.⁴⁹ Fourth, policing will be difficult in another way: so long as everyone cheats, cheating does not harm anyone around at the moment; so there is no one presently around with a powerful interest in stopping it. Indeed, as we have already seen, all the present people have a powerful interest in polluting, no matter what others do, and so have an incentive to turn a blind eye to the pollution of others so long as others turn a blind eye to them.

If this is right, even without considering the intergenerational problem, members of the present generation seem to have the following preference structure:

- 1st preference: I pollute, you don't.
- 2nd preference: No one pollutes.
- 3rd preference: Everyone pollutes.
- 4th preference: You pollute, I don't.

But this, of course, is a prisoner's dilemma preference structure. Hence, other things being equal, left to their own devices each individual will choose a strategy of polluting, since it gets better outcomes than not polluting. But then everyone will pollute, which gives everyone only their third preference, and not their second.

Now, it is tempting to suppose that the prisoner's dilemma analysis applies not only to individuals and individual firms, but also to countries. But this extension may be questioned.⁵⁰ For it may be said that it

48. This is in part because externality effects imply that compliance costs are likely to be high, and in part because there is an entrenched competitive advantage based on current patterns of energy use.

49. Things might be more promising if one considers the sources of carbon dioxide, namely the fossil fuels themselves. For most individuals have to buy their fuel from others; and most countries have to import much of their fuel from elsewhere. (But note that: [a] some countries do have significant fossil fuels of their own, e.g., China's coal reserves; [b] monitoring and enforcing limits on oil production, although one of the easier fuels to monitor, has proved difficult in the past, e.g., for OPEC, and for those imposing sanctions on Iraq; and [c] the emissions produced by any given unit of, say, oil vary considerably depending on use, in ways which make calculations of overall emissions levels difficult, even when the agents involved are compliant.)

50. Note that it would be possible to hold that countries confront a battle of the sexes, even if individuals confront a prisoner's dilemma. There are two reasons. First, the number of actors is very different, making it more plausible in the individual case that decisions made by one party do not directly affect decisions made by the others. Second, on the one

neglects the fact that perhaps the collective good at stake can be achieved without *everyone* cooperating, and therefore that it may be rational for a subgroup to produce the good alone.⁵¹ In this case, there will be a situation where, for N players:

Partial Cooperation: There is a number M (such that $M < N$) that is the minimum number of players whose cooperation is necessary if some situation, which is bad for all, is to be avoided.

Marginal Cooperation: If the number of others who are willing to cooperate is just short of M , then a given party prefers to cooperate, since he is better off enjoying the benefits of cooperation and paying his share of the cost than he is in the situation where not enough people cooperate.⁵²

hand, a many-person collective action problem often has the character of a prisoner's dilemma as far as a chooser is concerned if: (a) it involves an incremental good with indiscernible contributions; or (b) a step good, *and* either the threshold is indiscernible or it is not particularly proximate in terms of my choice (i.e., if I do not perceive the crossing of the threshold as a close thing, then what happens is that the effect of my contribution becomes less and less discernible). But, on the other hand, it has the character of a battle of the sexes for the individual if: (c) the good is incremental and contributions are discernible; or (d) there is a discernibly close threshold. Arguably, the intragenerational problem facing individuals seems best characterized by either (a) or (b): (b) with remoteness seems to be the way most people see it; or else (a) with fatalistic attitude. Hence, they are more likely to face a prisoner's dilemma. But one might argue that (c) or (d) is more likely for countries, since they are in a better position to gather information, make agreements, and guarantee certain levels of reduction. Hence, countries might face a battle of the sexes. (For this method of classification, I rely on Waldron, who relies on Hampton.)

51. Hampton says that many actual problems are mislabeled as prisoner's dilemmas when they really have this structure. See Hampton, "Free-Riding."

52. Waldron characterizes the global warming problem as follows in "Who Is to Stop Polluting," pp. 34–35:

- (a) There are more than two players. Call the number of players N .
- (b) There is a number M (such that $M < N$), which is the minimum number of players whose cooperation is necessary if some situation, which is bad for all, is to be avoided.
- (c) If M players cooperate, all N players benefit.
- (d) Each player prefers the situation in which M players cooperate but he is not one of them to the situation in which he is one of the M cooperators. In other words, cooperation is costly.
- (e) The greater the number of cooperators, the smaller the cost to each of cooperating. Thus each, if he is a cooperator, prefers that the number of cooperators be as large as possible.
- (f) If any cooperate, and the number of cooperators is less than M , then the coopera-

This situation is not a prisoner's dilemma. It is distinctive of a prisoner's dilemma that each party does at least as well by not cooperating as he does by cooperating, no matter what the others do. But in this situation, if the number of other cooperators is just short of M , then a given player does better by cooperating than not cooperating. This kind of situation is usually termed a many-person battle of the sexes.⁵³

Interpreting the intragenerational global warming problem as a battle of the sexes has some initial appeal.⁵⁴ Principally, it reflects the undoubted theoretical fact that it is *total* global emissions that need to be

tors suffer the cost and enjoy none of the benefits of cooperation. Each would prefer not to cooperate than to be in this situation.

(g) If the number of others who are willing to cooperate is just short of M , then a given party prefers to cooperate, since he is better off enjoying the benefits of cooperation and paying his share of the cost than he is in the situation where not enough people cooperate.

So, I have picked out Waldron's (b) and (g).

53. See Hampton, 1987. The basic structure of the Battle of the Sexes can be gleaned from the (unfortunately sexist) story from which it gets its name. A couple are deciding whether to go out on a date. The man would most prefer to go to see a game of baseball; the woman would most prefer a trip to the theater. But both prefer to go on the date rather than to go to their own favorite event (or stay at home) alone. This yields the following preference structure:

Battle of the Sexes

	Woman	
	Baseball	Theater
Man		
Baseball	1, 2	3, 3
Theater	4, 4	2, 1

In this situation, there is no natural equilibrium position, but the two cooperative solutions are better than either noncooperative solution. Hence, both players are motivated to compromise because both want to avoid the noncooperative outcome. (Note: the phrase 'many-person battle of the sexes' is unfortunately ambiguous between a situation in which all prefer to cooperate, and one where all prefer that some cooperate. Hampton intends the latter.)

54. For example, it preserves the insight that climate change involves some form of collective action problem involving a strong incentive to try to free ride (in this case, by getting others to form the subgroup). Furthermore, it appears to be supported by some aspects of recent real world events. Even in the face of the decision by the United States—the world's single largest emitter—to refuse to support the Kyoto agreement, the other countries of the world have made an agreement that involves significant reductions in projected emissions for the other large emitters (prominently, the European Union and Japan). This suggests both the Partial and Minimal Cooperation claims.

cut, so that in principle there is no physical reason why the costs of any given percentage reduction need to be borne by all.⁵⁵ Furthermore, if the intragenerational problem were a battle of the sexes, this would be welcome news, practically speaking. For, unlike a prisoner's dilemma, a battle of the sexes may have internal solutions: that is, solutions that do not require a change in the payoffs available to the players, or to the basic psychology of self-interest.⁵⁶ So, solving the intragenerational problem would be easier than if it were a prisoner's dilemma.⁵⁷

VIII. THE INTRAGENERATIONAL PROBLEM IN PRACTICE

Nevertheless, there are some reasons for concern about the battle of the sexes analysis. First, the idea of a fixed global percentage reduction does not adequately capture the dynamic nature of the problem and the exponential nature of growth.⁵⁸ To begin with, any actual talk of stabilization or a percentage reduction is relative to a fixed point (under Kyoto, 1990) where not all countries are making maximum use of fossil fuels (or, more broadly, of CO₂ emissions themselves), and it is quite likely that none are.⁵⁹ So what really needs to be looked at is the percentage reduc-

55. This is mentioned by both Mabey et al. and Waldron, and seems to support the Partial Cooperation claim.

56. In particular, a battle of the sexes can be resolved if (a) a particular outcome is salient to both parties as the likely cooperative resolution (and so can act as a rallying point), and (b) for the party who must give up his most favored outcome to secure the salient one, the expected utility of conceding to the salient outcome is greater than that of holding out and so risking a noncooperative outcome.

57. Again, this initially appears to be supported by recent events.

58. The basic battle of the sexes analysis ignores some (further) important strategic factors that emerge once only some countries comply, namely the competitive advantages internal to not making cuts. (For example, one's energy costs are cheaper than one's competitors' not only because they are spending money cutting emissions that will be passed on to consumers in higher prices, but also because these efforts will lower the price of fossil fuels on the world markets by reducing demand for them and encourage emissions-intensive industries to migrate to countries with no restrictions.) And it is possible that they make at least some of the attempt to reduce total emissions self-defeating. (Interestingly, Mabey et al. consider the current scenario unstable, for they believe that defection the United States will make energy-intensive industries leave the cooperating countries in such numbers that the benefits of cooperation for those countries would be outweighed by their costs. See Mabey et al., *Arguing*, pp. 266, 299, 410.)

59. Of course, CO₂ is not the only greenhouse gas whose emissions are useful to humans; it is merely the one presently most important. (Methane is also very important; bringing the slightly comical problem of bovine flatulence to global prominence.) So, in the end, an even more comprehensive agreement is needed, as Kyoto envisages.

tion needed over the global total for maximum usage. This is unknown, as we don't know what possible uses of CO₂ emissions technological developments might make open to us. However, if, as a rough (and probably extremely conservative) estimate, we take current U.S. emissions as the maximum per capita, based on current technology, we would get an astronomical total from which to cut back to, say, 1990.⁶⁰ Furthermore, this means that the costs must be borne by anyone with the potential ability to bring the global total above the optimal level of emissions. But (depending on the figures above, and especially if the gains in terms of self-interest from fossil fuel use have not yet been fully realized) this means everyone, or almost everyone.⁶¹ Without full cooperation one is at best delaying global warming, not arresting it.⁶²

If all this is right, it casts doubt on the partial compliance assumption. For it suggests one of two possibilities. If the size of the smallest player is large enough that it alone could ensure that the ceiling is broken regardless of what the others do, then the Partial Compliance Assumption is false. Alternatively, if *M* is large, and close to *N*, then the Partial Compliance Assumption is misleading in the context. For the nations excluded must have small populations and/or current emissions. Therefore, they

60. Very roughly, for a world population of 6 billion people, this would amount to 123 billion tons of carbon dioxide annually (based on 20.5 tons per capita emissions for the United States, the figure for 1995). This rises to 184.5 billion tons for a world population of 9 billion, which is projected by the U.S. Census Bureau for mid-century.

Total projected emissions from energy consumption for 1991 was a mere 26.4 billion tons. (Hence, continuation at 1991 levels would allow a per capita average for emissions of 4.4 tons, which is only 20 percent of the U.S. figure.) Hence, China alone (with a population of 1.2 billion in 1995, rising to 1.5 billion in 2025) could break the 1991 total, even if (as would never happen) other countries emitted nothing. (Slightly) more realistically, and simplifying considerably, even if all other countries cut back 20 percent from their levels in the early nineties—a huge reduction over projected “business-as-usual” growth—to a total of 21.1 billion tons), a bloc of countries with very low current emissions and a combined population of over 250 million (i.e., 4 percent of the world's population) could conceivably break the 1991 total if they emitted at current U.S. levels. As, of course, would the United States alone if it were the defector. (Figures from the World Resources Institute, as cited by the UNEP Climate Change Kit, <http://www.unfccc.int/resource/iuckit/index.html>.)

61. This is especially so if the marginal costs of reduction get higher and higher, which they do, so that the costs to a cooperating group goes up the more other countries pollute. This effect would be exacerbated by a reduction in the price of fossil fuels brought about by the withdrawal of demand by the core group.

62. And one might not be delaying it very much. Some say that the current agreement between Europe and Japan will only slow the growth in atmospheric carbon dioxide by six years. (This, of course, ignores the fact that the current agreement only covers emissions from 2008 to 2012, and envisions new targets for future years.)

will not be major players in the climate change problem, nor indeed in the wider international arena.⁶³ The focus on partial compliance is thus at best misleading.

Second, the Marginal Cooperation claim is also dubious. Consider it first in relation to Hardin's commons. In Hardin's commons, it is not true that only a subgroup of cooperators is required to secure the collective good. Instead, any attempt by a subgroup to secure the optimal productivity of the commons will be undermined by the remaining noncooperators. For it is true both (a) that it is possible for any noncooperating herdsman to increase his herd without limit, and (b) that each has an incentive to do so, since the benefits accrue only to him whereas the costs are shared by all. Indeed, this is just the fundamental dynamic that creates the commons problem in the first place.⁶⁴

The lesson here is that one has a prisoner's dilemma, not a battle of the sexes, if it is possible for noncooperators to undermine the collective good produced by a subgroup, and if they have a strong enough incentive to do so. But just these features seem to be present in the global warming case. For, given what we have already said, it is empirically likely both that noncooperators can disrupt the ceiling of emissions, and that they have the incentive to do so.⁶⁵ Hence, the subgroup cannot

63. There are still problems in leaving such nations out of an agreement over the long term. If they could increase population by reproduction or by immigration over time, then they might become a threat to the agreement; and there would be an incentive for individuals to emigrate there so long as an advantage existed for doing so: i.e., for CO₂ rich ways of life. This would imply that partial cooperation is false after all.

Waldron's (e) also suggests that N-M will be small; (e) states that the greater the number of cooperators, the smaller the cost to each of cooperating. Thus each prefers that, if he is a cooperator, the number of cooperators be as large as possible. Hence, each cooperator has an incentive to use any other means at his disposal to put pressure on other countries outside the subgroup to join. Since the cooperation of the large and potentially economically powerful nations is required for success (given the dynamic problem), it will be small and economically not-so-powerful nations who fall into N-M, but these are the most susceptible to external pressure from these nations. Hence, it is to be expected that M will be equal, or very close, to N.

64. It is also worth noting that the more successful the subgroup is to begin with, the greater incentives to the noncooperators to do this, as the better the quality of the commons they can exploit. Furthermore, to maintain the commons, the M are under progressive pressure to do more and more, so that the costs on them in a dynamic context increase dramatically.

65. The theoretical difficulty here may be in treating total abatement as a step, rather than incremental, good. If abatement at some percentage of global 1990 levels really represented a threshold that benefited all, then one might argue that even noncooperators

enforce a ceiling, and would incur large costs if it tried. It seems, then, that the intragenerational global warming problem will be a prisoner's dilemma.

Now, the above constitutes a strong case for a prisoner's dilemma interpretation. Nevertheless, in the end, it is an empirical matter whether this interpretation is correct, or whether global warming turns out to be some other kind of collective action problem; and the empirical issues are complex and shrouded in uncertainty. So, it is helpful to have a secondary practical argument at hand. This goes as follows. If it is an empirical matter whether global warming is, say, a battle of the sexes or a prisoner's dilemma, then it is at least *possible* that the problem is a prisoner's dilemma (or worse). But then there are grounds to treat it *as if* it were a prisoner's dilemma. There are three reasons.

First, if it is possible that global warming is a prisoner's dilemma, this undermines the practical advantage of classifying the problem as a battle of the sexes, which was that such problems may have internal solutions.⁶⁶ For if the problem may turn out to be a prisoner's dilemma, we should not rely on internal solutions because they are unavailable for prisoner's dilemma. Instead, we should seek external solutions, such as payoff changes and motivation changes, because these can resolve *both* prisoner's dilemma and battle of the sexes. In general, if there is doubt about whether a situation is prisoner's dilemma or battle of the sexes, and if the noncooperative outcomes are potentially catastrophic, it seems to make sense to employ those solutions that apply to both; if one tries only battle of the sexes methods, then one might fail.

Second, even if the intragenerational problem were a battle of the sexes, the relevance of this fact would be undermined by the background presence of the intergenerational problem. So far, we have sim-

would have an incentive not to disrupt it. But this argument would be a mistake, for two reasons. First, the influence of emissions is, as far as anyone knows, or at least as far as it is treated in the models of the problem, incremental, not a matter of threshold. Hence, there is a threat at the margin. Second, and even more importantly, since "disruption" here simply involves continuing to pollute on a business-as-usual basis (i.e., to the extent that it is a benefit irrespective of concerns about climate), this "solution" would actually turn noncooperators into cooperators. For bearing some of the costs of abatement here simply means not polluting on a business-as-usual basis.

66. Notice the 'may' here. Internal solutions require the identification of a salient solution. But in the case of global warming, this is undermined by the complex nature of the problem. In particular, the identification of a relevant subgroup is undermined by uncertainty about the distribution of costs and by the range of potential contributors.

ply assumed that problem away in this Section, but in practice it will likely corrupt the presence in the current generation of concerns for the distant future.

Third, a similar undermining occurs due to the presence within the present generation of localized variants of the intergenerational problem. For example, governments and businesses are typically headed by elites whose time-horizons are extremely limited. They have a strong incentive to ignore altogether, or at least defer action on, problems whose solutions demand high costs to be instituted on the present set of voters and other politically influential groups for the sake of benefits to those who do not currently have any political power.

If these arguments are correct, then there are strong reasons for treating the intragenerational global warming problem as if it were a prisoner's dilemma. This news is bad enough. But matters are made worse by the fact that the usual solutions to prisoner's dilemma situations also tend to be undermined by the background presence of the intergenerational problem. First, the appeal to broad self-interest is problematic. Although the current generation do interact repeatedly, so that there are many gains to be made through cooperation, the accessibility of these gains does not depend on cooperation about pollution. In fact, restricting pollution actually lessens the potential gains of cooperation, perhaps even to the point where from a self-interested point of view it is better to pollute and not cooperate than to cooperate and not pollute. So, the potential gains to be made from cooperation do not have the same status as in normal prisoner's dilemma cases.⁶⁷ Second, the problem of monitoring compliance suggests that the appeal to fairness also may not work.⁶⁸ Hardin may be wrong that natural selection eliminates conscience, but it does seem plausible to say that, without an effective method of ensuring compliance, the market eliminates a sense of fairness, or at least a competitively disadvantageous sense of fairness. If some producers cheat on energy consumption, they will have a compet-

67. Note that if the intergenerational problem is to be solved, the first generation is already making an absolute sacrifice in terms of self-interest. This makes things difficult in dealing with noncooperators. Suppose they seem quite happy to pollute and not cooperate. Am I supposed to offer them further incentives to come back into the fold? But then I am giving up both my potential gains from polluting (to the future generations), and some of the further gains from cooperation (to the reluctant cooperators). This is a lot to ask. Just overpolluting myself will look very tempting.

68. The problem is that noncompliance, even global noncompliance, is actually a benefit to the present generation so the incentives to enforce are not high.

itive advantage, through exploiting the externality costs. Hence, over time, they will eliminate more restrained competitors.⁶⁹

IX. IMPLICATIONS

If my analysis of the inter- and intragenerational problems surrounding global warming are correct, two of Hardin's main claims are right after all. First, strong coercive regulatory regimes may be needed in order to stop overpollution, and so to address the pressing problem suggested by population growth.⁷⁰ Second, the benign demographic transition hypothesis should be treated with suspicion.

Nevertheless, Hardin and I differ in our reasons for making these claims, and this has practical consequences. In the first case, Hardin is not correct about who the primary subjects of coercion should be. For it is people in the rich countries who presently cause most of the pollution I have been concerned with, not those in the poor countries. Hence, while it is true that it would be disastrous for the poor countries to adopt the more energy- and pollution-intensive lifestyles of the West (and, as a result there is reason to prevent this happening), it is also true, and more important, that even without their contribution, the existing patterns of behavior in the West will have serious consequences, and must be stopped. This should be the political priority.⁷¹

In the second case, Hardin is skeptical about the benign demographic transition hypothesis because he doubts the scientific evidence, and is inclined towards a strong evolutionary account of human reproductive behavior. But I am skeptical because, although the empirical evidence for a decline in population seems compelling, I doubt that the expected transition will be benign. For it comes at the price of increased development, and so increased energy consumption and pollution. This locates the problem not in the deep nature of human beings and their germlines, but rather in ways of life which all of us could, and should, give up.

69. The competitive pressures argument does not work in all contexts, but it does seem operative here. For some doubts about its general application, see Daniel Hausman and Michael McPherson, *Economic Analysis and Moral Philosophy* (Cambridge: Cambridge University Press, 1996), chap. 4.

70. In addition, note that the problem of overpollution would remain even in the absence of population growth, since energy consumption per capita is on an upward spiral.

71. Furthermore, it is probably a politically necessary prerequisite to preventing the developing countries from following a Western path.