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EQUITY VERSUS WARM GLOW IN INTERGENERATIONAL GIVING

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Equity versus Warm Glow in Intergenerational Giving

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Abstract

In different treatments of an intergenerational common resource experiment, monetary payoff maximization by each generation causes either negative or positive externalities for future generations. Two behavioral types have been observed previously in single generation games: equity motivated individuals enjoy giving to the needy and taking from (not giving to) the prosperous, while warm glow altruists enjoy giving unconditionally. In the examined intergenerational game, observed behavior is not consistent with the equity motive. Roughly half of the subjects maximize own monetary payoffs, while the others exhibit altruistic behavior consistent with a model of warm glow giving with constant altruistic sacrifices across treatments.

Keywords

intergenerational equity, altruism, sustainable development, resource exploitation

JEL Classification Codes

C73, C92, D64, Q01, Q20

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“We can do something for posterity, but it can do nothing for us.” (Rawls 1971)

1. Introduction

Decisions taken by the generation of people living today can have significant positive or negative economic consequences for the generations to come. On the one hand, our generation may invest in the development of new technologies that improve the quality of life or increase productivity for all future generations. On the other hand, some of our activities, such as the exploitation of natural resources, may decrease the consumption possibilities of future generations. In either case, the current generation is a dictator to future generations, because the externalities of today’s actions are *faît à complis* for the unborn future generations. In the absence of intergenerational altruism, each generation will simply maximizes the own consumption without taking any of the intergenerational externalities into account. While there has been no dispute concerning the existence of intergenerational altruism, some substantial differences have appeared in the literature concerning the structural details of intergenerational altruism. Yet, I am not aware of any previous empirical or experimental work that has attempted to uncover the type of altruism that governs intergenerational giving. This paper presents such an attempt.

Most contributions concerned with intergenerational altruism have followed Solow’s (1974) concept of *intergenerational equity* that is based on Rawls’ (1971) maximin criterium. In essence, the assumption is that preferences are governed by a desire to maximize the minimum level of (expected) consumption across all generations. Although the idea is normatively quite appealing[1], a number of authors - including Solow (1974) himself - have noted that intergenerational equity may prove to be too severe empirically.[2] There is, however, evidence from experimental studies of single generation games indicating that people may have a strong

1) Intergenerational equity is very close to the notion of “sustainable development” that has gained major political impact (e.g. United Nations Agenda 21 “Sustainable Development” at http://www.un.org/esa/sustdev/agenda21.htm.) The *Brundtland Report*, “Our Common Future”, (United Nation's World Commision on Environmental and Development 1987) defines “sustainable development” as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

2) An especially troubling consequence of this norm is that the current generation must refrain from making any costly long-term investments (e.g. basic research) in growing economies. Since in growing economies, the current generation is always the poorest, investments that pay back only to future generations in fact increase inequality. Hartwick (1977), however, has shown that long-term investments can be consistent with intergenerational equality, when the positive externality of today’s investments for future generations is offset by the negative externality of today’s exploitation of exhaustible resources.

taste for equitable distributions of payoffs that may even be stricter than the maximin criterium (Selten 1988; Ochs and Roth 1989; Bolton 1991; Andreoni and Miller 1993; Forsyth Güth 1995; Fehr and Schmidt 1999; Bolton and Ockenfels 2000). In fact, in a number of experiments it has been observed that subjects are willing to sacrifice substantial amounts of money to reduce (or to prevent) inequality in payoffs (Hoffman, McCabe, and Smith 1996a; Slonim and Roth 1998; Abbink, Irlenbusch, and Renner 2000; Fehr and Gächter 2000; Bosman and van Winden 2002). Putting the preferences for distributional equality that are found in these studies into the perspective of the intergenerational setting, we might expect today's generation not only to incur a cost to increase the payoff of needier successors, but also to incur a cost to decrease the income of wealthier successors. In both cases, there is a costly reduction of income inequality.

A widely acknowledged alternative to intergenerational equity is a concept often referred to as the *warm glow of giving*. The idea is that an altruist derives utility from the mere act of giving and not from the extent of increased utility (or consumption) of the recipients.[3] Hence, in contrast to equity motivated behavior, warm glow altruism is insensitive to any comparisons of payoff (or wealth) levels - be it comparing the donor to the recipient or be it comparing the recipients amongst each other. There is ample experimental support for the warm glow hypothesis, especially in single generation public goods games (Andreoni 1993 and 1995; Offerman, Sonnemans, and Schram 1996; Palfrey and Prisbrey 1997).[4]

Although the evidence on equity and warm glow type preferences in single generation games seems mixed, only very few attempts have been made to identify the features of the interaction or the environment that may affect the relevance of the different types of preferences.[5] It seems therefore difficult to anticipate whether equity or altruistic preferences will dominate decisions in an intergenerational setting. What complicates predictions even more are the structural

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3) The idea of a warm glow of giving has been mentioned by a number of authors in different contexts under differing captions (e.g. "joy of giving" or "impure altruism"). The earliest references that I am aware of are Yaari (1964) and Becker (1974). But, it is Andreoni (1988, 1989, 1990, 1993, 1995) who has made the most audible and convincing case for warm glow altruism in a series of theoretical and experimental studies.

4) There is also evidence from other experiments and from empirical work. The experiments of Bolton, Katok, and Zwick (1998) and of Selten and Ockenfels (1998), for example, both show that donors keep the total amount of altruistic "gifts" constant, independently of the distribution of the gifts to recipients and of the number of recipients. Kingma (1989) and Thorpe and Phelps (1991) provide empirical evidence for warm glow altruism by showing that private donations to charity are hardly crowded out by (tax financed) public subsidies.

5) The most notable contributions in this respect are Andreoni (1995) and Goeree, Holt, and Laury (2002). But unfortunately, neither piece can really deliver a final answer to all the open questions.

differences that set the intra- and intergenerational approaches apart. While in the single generation setting, the care for others concerns a well-defined set of other individuals, whose comfort or distress are immediately present, in the intragenerational setting the care for others concerns an indefinite number of individuals, who are effected in the future. Thus, intergenerational dynamics may create decisively different emotional and cognitive structures than those found in single generation settings that have been examined so far.

This paper presents an experiment that is designed to distinguish altruistic behavior consistent with intergenerational equity from altruistic behavior consistent with the warm glow hypothesis. The experimental setup is novel in that it solves the problem of installing an intergenerational common pool resource game with generational chains of indefinite length. Each generation in the chain is represented by a single subject, who decides how much to extract from the common pool resource.[6] The more is extracted, the less is left for future generations. Hence, intergenerational "giving" in the context of the experiment means extracting less than a monetary payoff maximizer would.

Extraction behavior is compared across four treatments, that differ only in the "natural" growth rate of the common pool resource. In the *slow* and the *very slow* growth treatments, the stock of the resource diminishes (and is ultimately depleted), if every generation chooses the payoff maximizing extraction level. In the *fast* and *very fast* growing treatments, the stock of the resource increases, if every generation chooses the payoff maximizing extraction level.

On the one hand, if subjects' behavior is guided by the concern for intergenerational equity, then we should observe extraction levels smaller than the payoff maximizing level (i.e. "inter-generational gifts") only in the slow treatments. In the fast treatments, however, subjects may extract even more than prescribed by payoff maximization (i.e. they might waste resources), in order to inhibit an inequitable growth of income to the future generations. On the other hand, if subjects' preferences corresponds to the warm glow of giving hypothesis, we should observe intergenerational gifts in all slow and fast treatments. In fact, if altruism is a normal good, as the experimental evidence found by Anderoni and Miller (2001) suggests, we should even expect

6) In a companion paper (Fischer, Irlenbusch, Sadrieh 2002), we present an experiment with a similar inter-generational setup, but with each generation being represented by three subjects, who play an intragenerational common pool resource "stage game." That more complicated game allows us to study the interaction of intra- and intergenerational effects. Here I'm only interested in studying the pure effects of intergenerational giving.

larger intergenerational gifts in the fast than in the slow growth treatments, since the average income of subjects will tend to be higher in the fast compared to the slow growth treatments.

It is important to emphasize that the gifts are being given from one generation to the next, but not exchanged between the generations. Like in the single generation dictator game introduced by Forsythe, Horowitz, Savin, and Sefton (1994), one party gives without the possibility of being rewarded or being punished by the recipient. This setup allows us to single out the characteristics of intergenerational altruism without having to worry about reputational or reciprocal effects.[7] Furthermore, even social history effects are avoided, because players are not informed on the existence or extent of altruistic behavior exhibited by preceding generations. In this sense, the experiment presented here is a straightforward extension of the single generation dictator game to an intergenerational setting.

The experimental observations show little support for behavior guided by intergenerational equity, but are well in line with the warm glow hypothesis. Most subjects fall into one of two categories. About half of the subjects are non-altruistic and simply choose the strategy that is dominant in monetary payoffs. The other half of the subjects exhibit intergenerational altruism by sacrificing own payoff for the benefit of later generations. The behavior of the altruistic subjects does not reveal a preference for intergenerational equity. In the slow growth settings, in which income opportunities deteriorate from generation to generation, subjects' sacrifices are not sufficiently large to guarantee a constant stock of the common pool resource across generations. Even altruistic subjects in these settings tend to deplete the resource more (i.e. enjoy more own monetary payoff) than intergenerational equity prescribes. In the fast growth settings, in which income opportunities expand from generation to generation, subjects' do not destroy the inter-generational resources in order to equalize payoff opportunities of today's and tomorrow's generations. Instead, many subjects actually increase inequality across generations by sacrificing

7) Sugden (1984) presents a theory of reciprocal provision of public goods. Weimann (1994) checks for reciprocal behavior in single generation public goods games and observes asymmetric behavior: Information on extremely low cooperation leads to reciprocal responses, but information on extremely high cooperation does not. Heijden, Nelissen, Potters, and Verbon (1998) check for the effect of social history on intergenerational transfers in an overlapping generations experiment. Their setup and their research interest differs from ours in many ways. Most importantly, they are interested in the consumption smoothing effects of intergenerational transfers from the "young" to the "old" (as in public pension systems), while we are interested in the positive and negative intergenerational externalities caused by actions of the "old" on the consumption opportunities of the "young" (as in R&D or environmental issues). Because each generation in their experiment "lives" for two periods, there is room for reputational and reciprocal effects connected to the social history. But, they do not find strong evidence of subjects' transfer behavior being affected by intergenerational reputation and reciprocity.

some of their own income to the benefit of the future generations. They do so, knowing that this decreases the payoff of the poorest generation (namely the own generation) and amplifies the intergenerational inequality to the advantage of the future generations.[8] Thus, intergenerational equity is neither supported in its weak form (maximin) nor in its strict form (constant stock).

But, there is support for warm glow altruism. The distribution of the amount of money sacrificed by altruistic subjects is practically the same in all slow and fast growth settings. This means that the observed altruistic intergenerational sacrifices are more or less independent of the neediness of the future generations. This type of an invariance of the observed sacrifices to the welfare effects of the gifts is a central feature of models of warm glow altruism.

The rest of the paper is organized as follows. In the next section, the intergenerational extraction game is defined formally and the parameters and hypotheses are presented. Then, a brief description of the experimental procedure follows in section three. The results of the experiments are presented in section four and section five concludes.

2. The Game, the Parameters, and the Hypotheses

In the *intergenerational extraction game,* each generation is represented by a single player, who can choose to extract some part of an intergenerational common pool resource for the own immediate consumption. The part of the resource that is not extracted grows and is then available to the next generation. Let $t \in \{1,...,T\}$ denote a generation (a player), with T being the last generation in the game. Let x_t be the extraction level chosen by t. The action set is restricted to 15 extraction levels, i.e. $x_t \in \{1, ..., 15\}$. Let F_t be the resources available to the generation t. (Since the resources are represented in monetary terms, F_t is often called the “funds” that are available to t.) The payoff π_t of t, given the extraction level x_t and the funds F_t, is:

$$\pi_t = (.95 - .05 \cdot |x_t - 8|)\ F_t \qquad (1)$$

Player t achieves the maximum payoff (95 percent of the funds F_t) by choosing the mid-level extraction $x_t = 8$. For each step below or above this individually optimal choice there is 5 percent

8) This type of behavior may be attributed to “efficiency motivation,” i.e. the willingness to incur a small cost in exchange for a substantial increase in total welfare (Güth and Tietz 1990; Charness and Rabin 2002).

payoff reduction. The idea is that harvesting too little represents an immediate consumption loss, while harvesting too much represents an indirect loss of consumption, due to the increasing marginal cost of harvesting (e.g. it is never optimal to take every single fish out of the lake). Any deviation from the individually optimal extraction level is costly to the current generation, but the direction of deviation is crucial for the effect on the funds of the following generations. The greater the chosen extraction level x_t, the less funds are left for the next generations.

Let $g \in [0,1]$ denote the "sensitivity" of the resource to extraction. Let $c \in \{1, ..., 15\}$ denote the *growth compensating extraction level*, i.e. the level at which resource extraction just neutralizes the natural resource growth. The funds F_t available to player t are then defined as follows:

$$F_{t+1} = (1 + g \cdot (c - x_t)) \; F_t \qquad (2)$$

If the chosen extraction level x_t is greater than the growth compensating level c, the funds of the next generation are reduced by g times the deviation from c. If the chosen extraction level x_t is smaller than the growth compensating level c, the funds of the next generation increase by g times the deviation. Note that choosing any extraction level greater than the individually optimal level (i.e. $x_t > 8$) is pareto dominated by the choice of the individually optimal extraction level (i.e. $x_t = 8$), which leads both to a higher payoff for t and for the future generations. In other words, extracting more of the resource than is individually optimal is a strictly wasteful activity that can only be motivated by the desire to diminish future generations payoff opportunities, perhaps in an attempt to equalize payoffs across generations.

Table 1 shows the four parameter sets used in the *Very Slow*, the *Slow*, the *Fast*, and the *Very Fast* growth treatments of the experiment. The treatments vary in the sensitivity parameter g and in the growth compensating extraction level c. In the two slow growth treatments, c is small and well below the individually optimal extraction level. Thus, keeping the resource constant across generations requires a very restrictive resource extraction in the slow treatments. In the two fast treatments, c is large and well above the individually optimal extraction level. Hence, keeping the resource constant across generations requires costly wasteful extraction in the fast treatments.

The sensitivity of the funds to extraction is also varied across treatments. The *Very Slow* and the *Very Fast* treatments have a high sensitivity of g = .05 to extraction. This means that any deviation from the growth compensation level c has a 5 percent effect on the size of the funds. Extracting one level less than the growth compensation level c leads to a 5 percent increase in the funds, while extracting one level more leads to a 5 percent decrease in the funds. In the less sensitive treatments, *Slow* and *Fast,* the changes in the funds are only at a rate of 2.5 percent for each step of deviation from the growth compensating extraction level.

Table 1. Treatments and Parameters

treatment	sensitivity of the funds to extraction (g)	individually optimal extraction level	growth compensating extraction level (c)
Very Slow	.050	8	3
Slow	.025	8	3
Fast	.025	8	13
Very Fast	.050	8	13

Table 2 displays the payoff and the growth effects of all possible choices for the four treatments. Three things are worth noting. First, note that all payoff and growth effects are given in relative terms, i.e. in percent of the current funds. This was also the case in the experiment (see the decision sheet in the appendix). The subjects could easily calculate the absolute values. The size of the own generation's funds was displayed at the top of their decision sheets. Second, note that the own payoff effect of an extraction level choice was exactly the same for subjects in all treatments. The only difference between the treatments was the effect of the extraction level choice on the funds of the future generations. Third, note that subjects in each treatment only received the information on their own treatment. Every subject saw the column containing the own payoff effects and only one of the four columns containing the growth effects.

If only monetary payoffs count, the game has a unique game theoretic solution. Each player has a single strictly dominant strategy, namely choosing the individually optimal extraction level $x_t = 8$. This is true no matter how many generations have preceded and no matter how many will follow. The dominant strategy argument leads to the following basic hypothesis.

H1 Behavior is consistent with monetary payoff maximization. Observed deviations of choices from the individually optimal extraction level, $x_t = 8$, are neither systematic nor substantial.

Note that the interaction between generations only runs through the development of the funds and is forward oriented, i.e. every player is a dictator to his successors. There are no reciprocity or reputation effects across generations that could create monetary incentives to deviate from the dominant strategy. Kindness cannot be returned and greed cannot be punished by future generations. Thus, not choosing the dominant strategy reveals a subject's altruistic preference.

Table 2. Payoff and Growth Effects of Extraction Level Choices

extraction level	payoffs in percent of the available funds	change of the funds available to the next generation			
		Very Slow	Slow	Fast	Very Fast
1	60%	+10%	+5.0%	+30.0%	+60%
2	65%	+5%	+2.5%	+27.5%	+55%
3	70%	**±0%**	**±0%**	+25.0%	+50%
4	75%	−5%	−2.5%	+22.5%	+45%
5	80%	−10%	−5.0%	+20.0%	+40%
6	85%	−15%	−7.5%	+17.5%	+35%
7	90%	−20%	−10.0%	+15.0%	+30%
8	**95%**	−25%	−12.5%	+12.5%	+25%
9	90%	−30%	−15.0%	+10.0%	+20%
10	85%	−35%	−17.5%	+7.5%	+15%
11	80%	−40%	−20.0%	+5.0%	+10%
12	75%	−45%	−22.5%	+2.5%	+5%
13	70%	−50%	−25.0%	**±0%**	**±0%**
14	65%	−55%	−27.5%	−2.5%	−5%
15	60%	−60%	−30.0%	−5.0%	−10%

If subjects deviate from the dominant strategy, due to their concern for future generations, then their behavior may either be in line with *(strict) growth compensation* for achieving (strict) intergenerational equity or with *invariant sacrifices* for receiving a warm glow of giving. Growth compensation prescribes offsetting the natural growth of the funds such that the income opportunities across generations are all above the minimum or in the strict version are all strictly equalized. Growth compensation seems to be a straightforward intergenerational extension of the single generational concept of distributional fairness.

H2 Behavior is consistent with (strict) intergenerational equity. Observed choices deviate neither systematically nor substantially from the (strict) growth compensating extraction levels, i.e. $x_t = 3$ in *Very Slow* and *Slow* and $x_t = 8$ ($x_t = 13$) in *Fast* and *Very Fast*.

Alternatively, if behavior is in line with the invariant sacrifices concept, then the observed deviations from the dominant strategy should be independent of the treatment (after correcting for income effects). Subjects motivated by a warm glow of giving only care to give, but do not care about the magnitude of the positive effects of their gifts. More specifically, deviations from the individually optimal extraction level are expected to be towards less extraction (i.e. altruistic) in all treatments, even though this means that the future generations in the *Fast* and *Very Fast* treatments will have dramatically better income opportunities than the current generation.

H3 Behavior is consistent with warm glow altruism. Observed choices are skewed to levels below the individually optimal extraction level ($x_t < 8$) in all treatments. The distributions of sacrifices show neither systematic nor substantial differences across treatments.

3. Experimental Procedure

The experiment was conducted at the cafeteria of the University of Bonn. Students walking in and out were encouraged to participate. Participation was restricted to one instance only. A total of 117 subjects took part in the experiment; about 30 per treatment. Subjects on average spent 15 minutes for the entire procedure. Average earnings were 12.54 Deutsche Marks.[9] The experiment in total took 3 - 4 hours. The procedure used was “double-blind,” as in Hoffman, McCabe, Shachat, and Smith (1994).[10] Subjects were aware of the fact that, although all decisions were recorded, decisions could not be traced back to the person who had made them.

Each subject received instructions after being seated in one of the four “cubicals” that were set up in the cafeteria by placing wooden dividers on four desks. The subject was told to study the instruction sheet and the decision sheet (see the appendix) carefully. Questions were answered. Once the subject had asserted having understood the decision problem and the procedure, he/she

9) One Deutsche Mark was equivalent to .51 Euros and ca. $.49 at the time of the experiment.

10) There has been some debate on whether or not the double-blind procedure really results in less other-regarding behavior or does not. A affirmative account is given in Hoffman, McCabe, and Smith (1996). A critical report is given by Bolton and Zwick (1995), who find no evidence supporting the *social distance* hypothesis.

was left alone to make the decision. After the subject had made his/her decision, he/she folded the decision sheet and left the cubical for the cashier’s box. There, the subject slipped his/her decision sheet through a small slit into the box. The cashier, who was sitting inside the box (also a cubical) and who could not see the subject, passed a “General Participation Form” (see the appendix) to the subject. This was signed by the subject with his/her actual name. The subject dropped the signed participation form into a sealed urn. On the participation sheet the subject declared having taken part in an experiment, having received cash, and having signed a receipt with a code name. The 26 code names with which subjects could sign the receipts were posted at the cashier's box and also indicated on the general participation form. Subjects were free to choose any one of these for signing the receipt. This procedure was required by the university’s accounting officers.

The subjects were informed that the number of generations was fixed and limited. They, however, neither knew the number of generations, nor did they know which position they had in the generational chain. Towards the end of the experiment subjects could have noticed that the number of new recruits was dropping. The very last four subjects, in fact, could see that the cubicles were no longer being used. To avoid difficulties with uncontrolled effects concerning the last generations of subjects, the last 18 subjects are completely omitted from the analysis.

This leaves us with 99 subjects (43 females and 56 males); 24 subjects in the *Very Slow* treatment and 25 in each of the other treatments. The experimental protocol was fixed for 5 chains of 5 generations (subjects) to be used for each treatment and 1 chain to be disposed of. One of the chains in the *Very Fast* treatment was mistakenly stopped after 4 generations. In the *Fast* treatment a mistake led to a chain with 6 generations and a chain of only 4 generations.

The actual length of the generational chain, however, cannot have affected behavior, since subjects were neither informed of the length of the chains nor of their position therein. They received no information on pervious choices or the history of the funds. The only piece of information that was not identical for all subjects in a treatment was the current size of the funds. However, since subjects were not informed of the initial size of the funds with which a chain started, it was impossible for them to derive any information their position from the size of the funds they faced. Furthermore, the initial size of the funds was set to 9.20, to ensure that the subjects at the beginning of a chain would not be able to infer their position from the fact that size of their funds coincided with a “round” number such as a 10.

4. Results

The first important result of the experiment is that intergenerational altruism affects behavior, even in the absence of reciprocity. Table 3 shows average deviations of observed from the individually optimal extraction level and the number of subjects deviating in each treatment. The average extraction level is lower than the individually optimal (payoff maximizing) level $x_t = 8$ in all four treatments. Thus, more resources are left to future generations than predicted by the game theoretic equilibrium of the game with non-altruistic players.

However, although the average behavior is altruistic, table 3 also reveals that roughly one half of the subjects simply maximize the monetary payoffs. Thus, the evidence concerning hypothesis H1 is mixed: Payoff maximization does explain the behavior of almost half of the subjects, but substantial and systematic deviations from payoff maximizing behavior are observed in the behavior of a majority of subjects.

Table 3. Deviations from the Individually Optimal Extraction Level

treatment	average deviation of the observed extraction levels from x = 8	number of subjects deviating
Very Slow	−3.12	16 (64%)
Slow	−1.92	13 (52%)
Fast	−1.48	11 (44%)
Very Fast	−1.04	13 (54%)

The impression that the deviations from the payoff maximizing behavior are systematic, with extraction level choices being lower than individually optimal, proves to be correct. Figure 1 displays the distribution of extraction level choices in all treatments. The vast majority of deviating subjects chooses an extraction level that is below the payoff maximizing extraction level (i.e. $x_t < 8$), i.e. subjects exhibit intergenerational altruism. Only 4 of the 53 deviating subjects choose extraction levels greater than the payoff maximizing level (i.e. $x_t > 8$). Three of the four are in the fast growing treatments, in which growth compensation can be evidence for strict intergenerational equity. Only one subject, however, chooses exactly the growth compensating extraction level of $x_t = 13$.

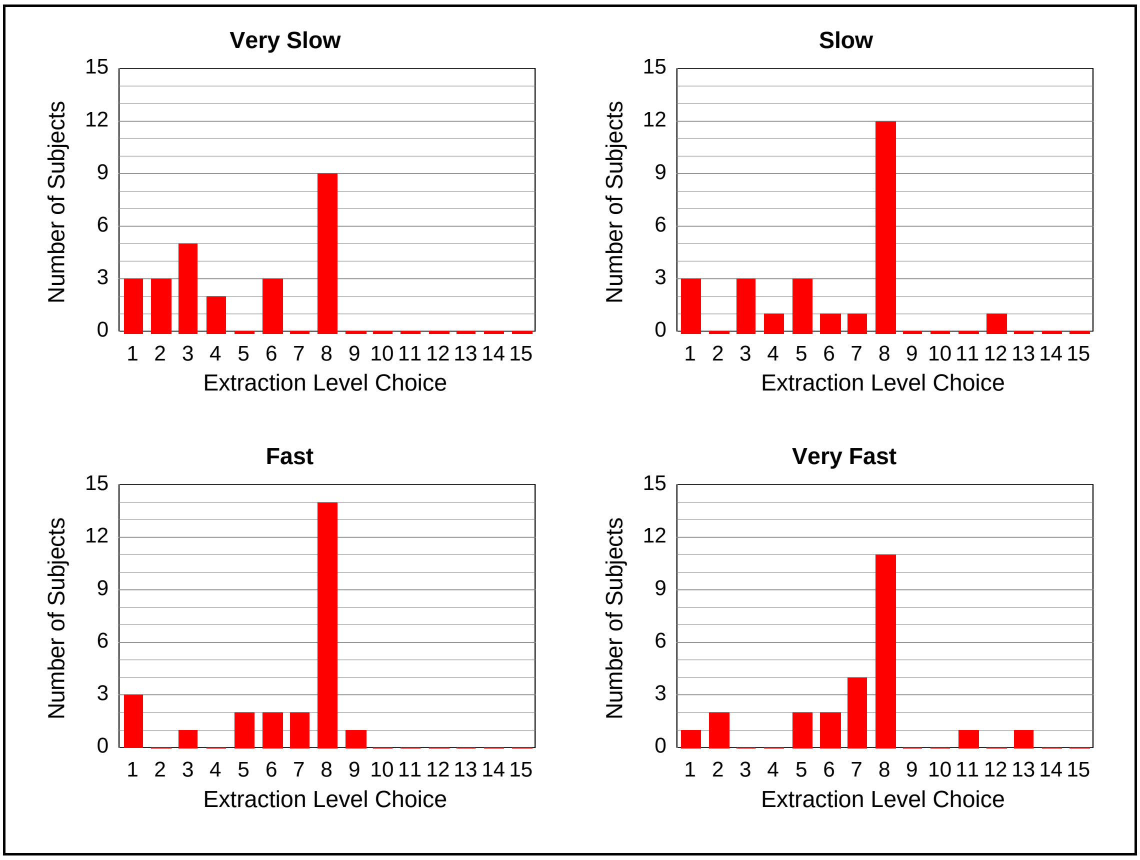

Figure 1. Distribution of Extraction Level Choices

Remember that hypothesis H2 predicts that subjects will try to equalize intergenerational income opportunities by choosing the growth compensating extraction levels $x_t = 3$ in the slow and $x_t = 8$ (or $x_t = 13$ for the strict equality case) in the fast treatments. Obviously, there is no support whatsoever for the strict version of hypothesis H2 in the fast treatments, in which the growth compensation outcome is strictly pareto dominated.[11] But, there is also little support for the weaker version of H2, since about one half of the subjects in the fast growth treatments sacrifice own payoff to increase the future generations' payoff by choosing extraction levels below the payoff maximizing level, i.e. choosing $x_t < 8$. In the slow treatments, 8 of 50 subjects choose

11) Note that subjects in other experiments do choose pareto dominated outcomes. In the ultimatum game, for example, many responders reject positive offers of proposers. Since such a rejection leads to the destruction of the entire cake in that game, both the responder and the proposer incur a loss (Güth, Schmittberger, Schwarze 1982; Ochs and Roth 1989; Güth 1995). This phenomenon is also known in other games (Hoffman, McCabe, and Smith 1996a; Slonim and Roth 1998; Fehr and Schmidt 1999; Abbink, Irlenbusch, and Renner 2000; Bolton and Ockenfels 2000; Fehr and Gächter 2000; Bosman and van Winden 2002).

x_t = 3 (i.e. 16 percent of all subject and 27.6 percent of the deviating subjects). These numbers do not provide much support for growth compensation either. All in all, it seems quite clear that there is basically no evidence in support of the intergenerational equity hypothesis H2.

The average deviations from payoff maximizing behavior - shown in table 3 - suggest that the faster the resource growth is, the lower is the average deviation of the observed extraction levels from payoff maximization. Notice, however, that no such correlation can be found when comparing the counts of deviating subjects across treatments. Also, the extraction level distributions displayed in figure 1 do not show strong differences across treatments. The only exception is the *Very Slow* treatment, in which more subjects exhibit strong negative deviations from payoff maximization than in the other three treatments. Comparing extraction level choices across every pairing of treatments with the Mann-Whitney U-test, we finds the extraction levels in *Very Slow* to be lower than those in any of the other treatments (the differences are significant in the comparisons with the two fast treatments at α =.05, two-tailed, and weakly significant in the comparison with the *Slow* treatment at α =.20, two-tailed). No other comparison reveals a significant difference. Thus, although there seems to be some evidence for an increased care for the future when the growth is very slow, a strong systematic effect all across treatments cannot be found.

The warm glow hypothesis H3 predicts that altruistic behavior will be observed in all treatments and that the distribution of altruism is invariant to the treatment (i.e. to the neediness of the future generations). As shown above, the first statement of the hypothesis H3 is clearly supported by the observed data. There is a substantial amount of altruism observed in all treatments. The treatment differences in the distribution of extraction levels, however, seem to contradict the warm glow hypothesis on first sight. However, the question is whether the extraction level *per se* is the right measure of altruism. Note that the same extraction level choice can lead to very different payoff consequences, depending on the treatment and the current size of the funds. Hence, it seems that the *altruistic sacrifice*, i.e. the payoff disadvantage of the chosen extraction level compared to the non-altruistic benchmark, presents a better measuring for the extent of intergenerational altruism in this game.

Table 4 shows the average sacrifices of altruistic subjects in the four treatments. The average altruistic sacrifices are displayed both in absolute monetary terms and relative to the size of the current generation's funds. The monotonously falling sequence of average relative sacrifices seems to indicate a positive correlation of observed relative sacrifices and the neediness of future generations. This hypothesis is support only partially by the observations. Relative sacrifices in the *Very Slow* treatment are significantly greater than in the *Very Fast* treatment (U-Test, α =.05, two-tailed), but not greater than in either of the other two treatments. Furthermore, there is the weakly significant effect (U-Test, α =.20, two-tailed) of the relative sacrifices in the *Slow* treatment being greater than in the *Very Fast* treatment.

Table 4. Altruistic Sacrifices

treatment	average altruistic sacrifice in percent of the current funds (standard deviation)	average altruistic sacrifice in Deutsche Marks (standard deviation)
Very Slow	24% (8)	1.86 (0.73)
Slow	22% (10)	1.73 (0.81)
Fast	19% (12)	2.54 (1.69)
Very Fast	15% (11)	2.10 (1.26)

While there are signs that subjects' relative sacrifices decrease as the income opportunities of future generations go up, the average absolute sacrifices does not seem to exhibit such a correlation. The average absolute sacrifices of the altruistic subjects displayed in table 5 are smaller in the two slow treatments than in the two fast treatments. Statistical tests, however, reveal that no significant differences can be detected concerning the extent of altruistic sacrifices in absolute terms (no pairwise U-Tests is significant - not even at α =.20, two-tailed).

The results of the non-parametric analysis are confirmed by a simple linear regression analysis. Table 5 displays the coefficients, standard errors, t-values, error probabilities, and 95% confidence intervals when using a simple OLS to regress the absolute sacrifice of each subject on the size of funds available to the subject, the treatment dummies (where the very slow treatment is the omitted default case), and the gender. The t-values leave no doubt that the altruistic sacrifice in absolute terms is neither affected by the size of the funds, nor by any of the treatments, nor by the gender of the subject. Only the regression constant is significant, indicating that subjects on average sacrifice about 1.78 Deutsche Mark (somewhat less than one Euro or one US Dollar) no matter how much endowment was available and no matter how fast it grew from one generation to the next.

Table 5. Absolute Altruistic Sacrifice as a Function of Funds Size, Treatment Indicators, and Gender

simple OLS	coefficient	std. error	t	p > | t |	95% confidence interval	
constant	-1.776894	.5478389	-3.24	0.002	-2.881716	-.6720714
funds	-.0108129	.0622189	-0.17	0.863	-.1362892	.1146634
slow	.1300862	.460005	0.28	0.779	-.7976023	1.057775
fast	-.6111678	.6202155	-0.99	0.330	-1.861952	.639616
very fast	-.1447732	.693657	-0.21	0.836	-1.543666	1.25412
male	-.002636	.3605251	-0.01	0.994	-.7297042	.7244322

Thus, the absolute altruistic sacrifice can be considered as the one measure of intergenerational altruism that is invariant to the treatment parameters. This observation seems perfectly in line with the warm glow hypothesis H3, because the extent of subjects' altruism seems unaffected by the extend of later generations' neediness.

Since the absolute income level of subjects is higher the faster the resource grows, one possible explanation for the decreasing relative sacrifices is that the warm glow of the altruistic sacrifices enters subjects' utility functions as an inferior good. Hence, as income increases the part of the budget spent on intergenerational altruism decreases, while the absolute level of expenditure remains almost unchanged across treatments. Evidence in support of this interpretation comes from a rank correlation analysis of the altruistic subjects' behavior across all treatments. The Spearman rank correlation coefficient relating relative altruistic sacrifices to the size of the available funds is negative (-.32) and significant (α = .05, two-tailed). Thus, the greater the funds that are available to a subject, the smaller the altruistic sacrifice in relative terms. The size of altruistic sacrifices in absolute terms, however, is not correlated to the size of the available funds. The Spearman rank correlation coefficient in that case is close to zero and not significant.

5. Summary and Conclusions

Many activities of the current generation entail positive or negative externalities for the generations to come. There is no dispute in the literature that individuals are the willing to sacrifice some of their current consumption to the advantage of their successors. The structure of this intergenerational altruism, however, has not been throughly studied yet. This paper presents a first experimental inquiry into that issue.

Two prime candidates for the structure of intergenerational altruism have emerged from the theoretical literature and from previous experimental observations in single generation games. One possibility is that altruistic behavior in intergenerational interaction is equity motivated, i.e. aimed at sustaining minimum payoff across all generations. Equity is not only the most frequently used theoretical concept, but there is also support for equity motivated behavior from experimental work on some single generation games. The second candidate considered is warm glow altruism, which assumes that individuals enjoy the mere act of giving without taking the extent of the positive external effects of their gifts into account. This concept has also found experimental support in single generation experiments, especially experiments on the voluntary provision of public goods.

The multi-generational experiment presented here discriminates between the two types of altruism by varying the growth rate of the intergenerational common pool resource. Equity models predict intergenerational sacrifices only in the slow growth treatments in which resource growth is too slow to guarantee intergenerational sustainability with non-altruistic players. In contrast, warm glow models predict intergenerational sacrifices both in the slow growth treatments and in the fast growth treatments in which resource growth is faster than is required for a sustainable resource exploitation of non-altruistic players.

We observe that in every treatment about half of the subjects non-altruistically maximize their own payoffs, while the others deviate towards altruistic restraint in resource extraction. This means that there is no support for equity motivated altruism, which would have resulted in extraction restraint only in the slow growth treatments. Instead, observed behavior seems well in line with the predictions of the warm glow hypothesis. While altruistic sacrifices in relative terms fall as income rises, indicating that warm glow may be an inferior good, the distributions of altruistic sacrifices in absolute terms are statistically indistinguishable across all income levels and treatments. On average, altruistic subjects sacrifice roughly two Deutsche Marks (ca. one US Dollar) in order to increase the income opportunities of future generations. They do so no matter whether the successors are better off or worse off than they are themselves.

The implications of these results are two-fold. First, the results suggest that the standard approach to intergenerational issues in economic theory should be reconsidered. The lack of behavioral evidence in support of intergenerational equity suggests that it may be worthwhile to rethink a substantial part of the theoretical work on intergenerational resource use in which the "optimal" intergenerational allocation is based on the concept intergenerational equity. Here a number of new theoretical results and empirical implications may be derived from a new framework based on warm glow altruism.

The second implication of the results is practical. Since the magnitude of altruistic sacrifices to the benefit of future generations seems basically unaffected by the income possibilities of the future generations, there is reason to believe that public subsidies (mandatory contributions) towards endangered resources will not crowd out the voluntary contributions. This is good news, because it implies that sustainable resource development might be achieved by complementing the individual voluntary altruistic efforts with government action that is more intensive, the more dramatic the decline of the resource is.

6. References

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Appendix

Instructions for the Experiment

General Situation

In addition to you, there are others participating in this experiment.

A group of participants forms a chain.

Each chain consists of a first participant, a last participant, and an undisclosed number of participants in between.

None of the participants knows, which position he or she has in the chain.

There are many such chains in the experiment, so that it is certain that all participants, who are currently at the decision stand, are assigned to different chains.

Funds

Each participant's earning potential depends on the amount of funds available to him or her.

A specific amount of funds is made available to the first participant of each chain.

The amount of funds available to each of the next participants in a chain depends on the decision of all preceding participants in that chain, i.e. it can vary from participant to participant in a chain.

The decision situation is identical for all participants in a chain, except for the possibly different amounts of funds that are available.

The amount of funds available to you is indicated on the top of your decision sheet.

Decision Situation

Each participant is to choose one of the 15 options: A, B, C, D, E, F, G, H, I, J, K, L, M, N, or O.

Each option has two consequences:

1. one for the own payoff, which increases from A to H and then decreases again from H to O;
2. one for the funds of the following participant in the chain - and thus, for the payoffs of all following participants in the chain -, with A having the most and O having the least beneficial consequence for the funds of the following participant in the chain.

The extent of these two consequences is indicated in the table on the decision sheet:

In the first column, *My Decision*, each of the options A to O, of which you are to choose one by marking it with a cross, is displayed in one line.

In each line of the second column, *My Payoff*, the payoff you achieve with the corresponding option is displayed as a percentage of the funds available to you.

In each line of the third column, *Change of the Funds Available to the Following Participant of the Chain*, the displayed figure indicates by how many percent the funds available to the following participant will rise (if a "+" is displayed) or will fall (if a "-" is displayed), if you choose the corresponding option. (A "± 0%" indicates that the choice of this option leads to no change of the funds available to the following participant.)

Anonymity and Payment

To ensure perfect anonymity of your decision, please follow these directions:

1. Draw a closed envelope with a decision sheet.
2. Take a seat in a free cubicle and make your decision there.
3. You may indicate your gender and your field of study in the voluntary information part on the bottom of the decision sheet. (But, please, do not disclose any other personal information!)
4. Proceed to the cashier's box and slide your decision sheet under the slit into the box.
   (The cashier cannot see you.)
5. Sign the general participation form, that is passed to you by the cashier and drop it into the box in front of the cashier's box that is marked correspondingly.
6. Choose one - whichever you want - of the 26 code names displayed at the cashier's box and sign the receipt passed to you by the cashier with the chosen code name.
7. Collect your payoff.

Thank you for participating!

Decision Sheet

(This is the decision sheet for the *Very Slow* treatment. The others were identical except for the numbers in the last column.)

Funds in DM

my decision (Please, mark only one letter!)		my payoff (in percent of the funds)	change (in percent) of the funds for the next participant in the chain
☐	A	60%	+10%
☐	B	65%	+5%
☐	C	70%	±0%
☐	D	75%	−5%
☐	E	80%	−10%
☐	F	85%	−15%
☐	G	90%	−20%
☐	H	95%	−25%
☐	I	90%	−30%
☐	J	85%	−35%
☐	K	80%	−40%
☐	L	75%	−45%
☐	M	70%	−50%
☐	N	65%	−55%
☐	O	60%	−60%

Please, mark your choice in the table above.
Next, indicate your gender and your field of study in the table below.
Please, fold this sheet and proceed to the cashier's box.

Information on Gender and Field of Study This information is only used for the purpose of statistical analyses. The information will not affect your payoff.			
Gender	☐ male	☐ female	
Field of Study			
Number of Semesters			
Have taken the course "Game Theory"	☐ yes	☐ no	☐ don't know

(The following general participation form had to be signed and dropped by every participant after having received the payoff and having signed the receipt of the payoff anonymously.)

I herewith declare that I have participated in an experiment of the Laboratorium für experimentelle Wirtschaftsforschung on May 18, 1998. Due to my participation, I received a payment for which I signed a receipt with one of the following names:

Agen, Bale, Camo, Dabo, Ehus, Faro, Gent, Hova, Imon, Jult, Kaja, Lina, Marn, Nesu, Oden, Poku, Quar, Renk, Salo, Tamo, Ubis, Veku, Wika, Xedi, Yabo, Zoba.

Please sign this form with your own name and drop it into the urn next to the cashier's box.

Bonn, May 18, 1998 ______________________________