Other-Regarding Preferences and Social Norms in the Intergenerational Transfer of Renewable Resources when the Agent has Present-Biased Preferences

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Other-Regarding Preferences and Social Norms in the Intergenerational Transfer of Renewable Resources when the Agent has Present-Biased Preferences

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Abstract:

The paper analyzes the effects of present-biased preferences on the transfer of resources to future generations in the framework of renewable resource harvesting. The paper assumes that the current generation has other-regarding motivations for future generations, expressed through the adherence to spontaneous other-regarding preferences or social norms.

Because the short-sighted behavior imposed by the "dictatorship of the present" can cause a reduction in the well-being of future generations, despite the existence of social preferences, the model presented in this study demonstrates that if the social preferences are also expressed through social norms that prescribe no reevaluation of the harvesting decisions, a mitigation of the effect of present bias on intergenerational equity can occur.

In this paper, the model presented shows the properties that a social norm should have to avoid the intergenerational inequality that can be derived from present-biased preferences in intergenerational renewable resource management. Additionally, the model defines the necessary and sufficient conditions such that the implementation of the social norm can neutralize the effect of present-biased preferences, guaranteeing the optimal harvesting path defined at the beginning.

Keywords: Present bias, naive agent, intergenerational resource management, renewable resources, harvesting, other-regarding preferences, social norms.

JEL Classification : D01**,** D03, D15, D90, D91, Q2

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1. Introduction

In the last few years, studies have started to explore the applications of the non-constant discount rate in resource management (Settle and Shogren, 2004) and in contexts related to the environment (Brekke and Johansson-Stenman, 2008; Karp, 2005). They have started to show the dichotomy between the present-biased agents and the rational agents (Hepburn et al., 2010; Winkler, 2006). As Gsottbauer and van den Bergh (2011) remarked, time preferences has a crucial role in resources conservation. However, the studies that have investigated non-constant discounting in resource management have excluded from their analysis the other-regarding preferences. The assertion is well-founded, and the reasons for the necessity to include them are clear: other-regarding preferences are found in everyday life, with the evidence that individuals have carefulness concepts such as fairness (Gintis, 2000), and they adopt pro-social behaviors in a wide range of situations (Alpizar et al., 2008; Frey and Meier, 2004; Meier and Stutzer, 2008) and in different cultures (Henrich et al., 2005). Furthermore, several robust studies have demonstrated the validity of an inclusion of other-regarding motives in the study of economic behavior (Fehr and Gächter, 2002, 2000; Gächter, 2007; Gintis et al., 2005).

Often, renewable resources assume an intergenerational dimension because of their intrinsic nature. The activity of harvesting renewable resources is the typical context in which the externalities derived from the behavior of a single agent within a community often generate effects not only on other members of the community that act simultaneously. Frequently, negative externalities can affect future generations whose welfare depends on the level of impoverishment to which the resources were exposed.

When resource management can suffer the risk related to the present bias, it is necessary to understand in what manner present-biased behaviors affect the intertemporal dynamics in relation to the intergenerational preferences of a naive agent who has social preferences over her or his successors. Present bias and the resulting reversal preferences can change the outcome of the other-regarding choices posed at the beginning by the agent who has to leave some part of the resources for future generations. For these reasons, the purpose of this work is to investigate the effects of present bias in renewable resource management by analyzing the impact of myopic behaviors on the transfer of resources from the current generation to the next generation while considering other-regarding and social preferences of the first generation. Additionally, this paper focuses on how an agent can express her or his social and other-regarding preferences; notably, they can be expressed with the spontaneous choices taken in accord with other-regarding preferences without social or institutional interventions, but also with the compliance to the specific social norms that the community defines.

The capability of society to define social norms is one of the elements that characterize sociability. Notably, communities and individuals also express their other-regarding preferences through social norms. In this paper, one of the main aims is to define the properties that a social norm must have to avoid the negative effect of present-biased preferences on the transfer amount of future generations. For these reasons, this work provides a model that introduces a social norm in the context in which present-biased preferences can affect intergenerational equity in presence of other-regarding preferences of the present generation. The results address the opportunity to adopt social norms that sustain the intergenerational distribution of resources while considering that the capability of building a behavioral norm inside a community is one of the most notable and peculiar features of human sociability.

2. Intertemporal myopia in resource management

Resource management is difficult, especially in cases of important decisional myopia (Pevnitskaya and Ryvkin, 2013). In intergenerational management of resources, conflicts can occur between long-run preferences and immediate choices because of present-biased preferences; additionally, a conflict emerges between the early intention of the agent and the choice made in the present. The conflict arises because of the time dependency of the discount rate, generating time-inconsistent decisions. A time inconsistency situation implies that an optimal choice defined in the present could be revisited in the future (Strotz, 1955). The origin of this phenomenon is the present bias that determines the emergence of preference reversals. When the task involves intertemporal decisions, the absence of a constant discount rate determines the condition of the possible revaluation of the choices made, changing it from what was estimated before. Behaviors that contradict the time-consistency assumption have been widely studied (Frederick et al., 2002; Loewenstein and Prelec, 1992). The systematic tendency of a greater discount in the near future rather than in the distant future is a consequence of individuals' impulsiveness and lack of self-control (Laibson, 1997; O'Donoghue and Rabin, 1999), and clearly, the exponential discounting cannot represent this phenomenon (Laibson, 1997).

The effects of present bias have been investigated in several areas: low saving rate (Ashraf et al., 2006; Harris and Laibson, 2001; Laibson, 1997; Laibson et al., 1998), health contexts (van der Pol and Cairns, 2002), drugs, smoking or buying addictions (Frederick et al., 2002; Gruber and Koszegi, 2001; Thaler and Shefrin, 1981; Wertenbroch, 1998), and behaviors of procrastination (Benabou and Tirole, 2003; O'Donoghue and Rabin, 1999). In addition to the aforementioned areas, resource management is a field where present bias has a strong potential impact. Notably, the risks associated with preference reversals and the "dictatorship of the present" increase in settings where long-term interests may conflict with immediate consumption. This conflict typically emerges in all fields of public and common goods—in public goods, this is emphasized by Winkler (2006), and in the fields of the common the role of present-biased preferences in the decreasing of cooperation is shown by Persichina (2019b)—and this conflict strongly characterizes intergenerational resource management.

The harvesting of natural resources is a typical area where this conflict can emerge. In this case, present-biased decisions can potentially lead to excessive resource depletion. It was shown that if non-constant discount rates are applied in the management of a stock of natural resources, without a commitment to the policy implemented, the possibility that the governance planner revaluates the plan will lead to a collapse of the resources (Hepburn et al., 2010). Settle and Shogren (2004) demonstrated that non-constant discounting affects optimal resource management because it makes possible the offering of a justification for a future change in the decisions of the policymaker. Therefore, in intergenerational management, present-biased preferences could compromise the wise management of the resource stock. The use of a higher discount rate in the short term can determine that the community's welfare, which also includes the well-being of future generations, which would be jeopardized by the excessive weight of the present.

However, when the query involves renewable resources from the intergenerational perspective, the discussion is not limited to the impoverishment of the stock of resources for effect of the allocation of the harvesting amounts over time by the present generation for their own consumption preferences. In the presence of more generations that harvest in succession from the same stock of renewable resources, the issue also involves the social dimension in relation to the intergenerational equity and welfare of future generations. Notably, as discussed in the next section, individuals have social preferences such that they assign a positive value to the welfare of future generations. Therefore, in intertemporal resource management, present generations also include the welfare of future generations in their decision process. In this manner, the present generation aims to behave in accordance with its own social preferences, leaving a given amount of resources for the consumption of the following generations. As long as the intertemporal choices of the individual are time-consistent, the outcome of the decision taken also clearly responds to the social preferences of the individual. However, in the absence of time consistency, when the agent behaves myopically under the effect of present bias, the coherence between improved action and the early intention of the individual can fade.

3. A retrospective on other-regarding motives

In a common resource dilemma, economic theory prescribes the overexploitation of resources, synthesized by the famous expression "tragedy of the commons" used by Hardin (1968). This phenomenon depends on the benefit that the agent obtains from an extra unit of consumption of the commons when the cost of the reduction of the stock of resources is divided between all the members of the community that can use it, not only between those who consume the extra units. Therefore, agents who make decisions exclusively based on their self-interest without considering the consequences on the wealth of others contribute to the overexploitation of the common resources. The standard assumption about the economic behavior of agents is the axiom of self-interest. This axiom is a behavioral assumption that is defined in the function of a coherent adhesion to the three logical processes that define the behavior of a homo oeconomicus—self-centered welfare, self-welfare goal, and self-goal choice (Sen, 1985)—building a theoretical system of economic interactions composed of exclusive selfish agents. However, events that contradict this assumption are observable daily in the reality of human interactions. The exclusive self-interested axiomatization does not appear to represent the peculiarities of human behavior. Interdependence between one's own wealth and others' health exists, and this is the foundation of society. Hence, economic issues that involve the social dimension of human behavior require economists to relax the assumption that agents are only self-interested.

Several studies have investigated the real foundation of economics when the agents make decisions within a social context, showing with undoubted clarity that individual decisions are mediated by other-regarding motives and by social preferences, such as fairness, cooperation, and reciprocity (Andreoni, 1990; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Falk and Fischbacher, 2006; Fehr and Schmidt, 1999; Rabin, 1993).

To understand the role of other-regarding preferences in social dilemmas, many researchers have demonstrated that fairness principles contribute to the formulation of the agent's choices (Fehr and Gächter, 2000; Gächter, 2007; Ostrom et al., 1992). Several analyses and investigations have confirmed the ability of humans to voluntarily sustain cooperation in the case of resource dilemmas (Andreoni, 1988; Casari and Plott, 2003; Charness and Villeval, 2009; Chaudhuri, 2011; Fehr and Leibbrandt, 2011; Ledyard, 1994; Ostrom et al., 1992). Furthermore, the consequences of the introduction of other-regarding preferences in the theoretical framework of the management of commons and in environmental and resource issues have acquired great attention more recently (Brekke and Johansson-Stenman, 2008;

Carlsson and Johansson-Stenman, 2012; Frey and Stutzer, 2006; Gowdy, 2008; Gsottbauer and van den Bergh, 2011).

Other-regarding motives have a critical role in the management of renewable resources in terms of equity distribution. As Fehr and Fischbacher (2005) pointed out, "other-regarding preferences" means that the agents show these preferences when they give value to the payoffs of the reference agents. In the context of renewable resources, the fairness principle becomes a crucial element in the decision process that occurs to determine how much to harvest and consume to behave in conformity to an individual's other-regarding preferences. The others are not only those that simultaneously harvest the same resources but also the successors who will harvest when the resources are assigned to intergenerational use. Hence, the inclusion of other-regarding preferences is essential for the equity distribution principles that affect the harvesting strategies taking care of the intergenerational externalities.

This occurs because on one side, there are no doubts about the existence of cooperation and equity distribution capabilities of individuals—these capabilities are part of the success of human evolution (Gintis, 2009); on the other side, the reason why societies sometimes do not attain the level of fairness and intergenerational equity that they desire is unclear. For this reason, in the following sections, the effects of the present bias are investigated in relation to the welfare of future generations and on the role that a social norm can have in the maintenance of intergenerational equity when the norm is designed to sustain other-regarding preferences of the agent.

4. Harvesting model and behavioral assumptions

The model involves the harvesting activity from a stock of renewable resources: at time *t*, the stock of resources is $R(t)$ and the amount harvested is $h(t)$, the growth rate is $f\big(g, R(t)\big)$, and the stock grows by following

$$R(t+1) - R(t) = f\big(g, R(t)\big)R(t) - h(t), \qquad (1)$$

where $\big(g, R(t)\big) \geq 0 \; \forall \; t \; \in [0, T]$; g, strictly positive, is the natural growth rate when the stock size does not affect the growth rate.[1] Resources are materials; thus, it is not possible to have a negative stock of resources, and the initial level of the stock is strictly positive:

$$R(t) \geq 0 \; \forall \; t \in [0, T] \qquad (2)$$

with

$$R(0) = R_0 \, , \; R_0 > 0. \qquad (3)$$

The amount harvested is not restorable such that

$$h(t) \geq 0 \;\; \forall \;\; t \in [0, T]. \qquad (4)$$

According to the resource constraint, the agent cannot harvest at time *t* more than the stock of resources available at the same time:

$$h(t) \leq R(t) \; \forall \; t \in [0, T]. \qquad (5)$$

In the model, there are two generations, one that harvests for *T* periods, and a second one that receives the resources left unharvested from the first generation.[2]

The welfare's agent of the first generation depends only on the amount harvested, and the utility function is expressed in the usual form:

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[1]Resources in the stock are not perishable; for this reason, the growth rate is non-negative. And when $\frac{\partial f(g, R(t))}{\partial R(t)} = 0$, the growth rate is constant exponential.

[2] The model focuses on the decision-making process of the first generation.

$$U = \sum_{t=0}^{T} \delta_t u\big(h(t)\big), \tag{6}$$

where $u\big(h(t)\big)$ is monotonic and strictly concave:

$$u'\big(h(t)\big) > 0,\ u''\big(h(t)\big) < 0. \tag{7}$$

Continuity of the harvesting amount is assumed. δ_t represents the discount factor. The cases of neutrality in the harvesting time and of pleasure in procrastination are excluded, such that

$$\delta_t > \delta_{t+1}\ \forall\ t \in [0, T]. \tag{8}$$

The first generation is affected by the present bias, which implies

$$\begin{cases} \dfrac{\delta_t}{\delta_{t+1}} > \dfrac{\delta_s}{\delta_{s+1}} \quad \textit{with}\ \ t < s \ \ \textit{and}\ \ s \in [0, T]\ \textit{for}\ t = 0, \\ \dfrac{\delta_t}{\delta_{t+1}} = \dfrac{\delta_s}{\delta_{s+1}} \quad \textit{with}\ \ t < s \ \ \textit{and}\ \ t, s \in [0, T]\ \textit{for}\ t > 0. \end{cases} \tag{9}$$

Of course, in this condition, time consistency is impossible.

In this work to express the presence of present-biased preferences in the utility function of the agent, we use a $\beta\delta$ model where the present bias factor is defined with β, such that the expected utility of the agent at time *t* is given by

$$U_t = u\big(h(t)\big) + \beta \sum_{t=t+1}^{T} \delta(t) u\big(h(t)\big), \tag{10}$$

with $0 < \beta < 1$.

When β is less than 1, condition (9) holds. Instead, $\beta = 1$ is the specific case of the absence of present bias, such that the discounting is classic exponential.

The second generation in the model is the future generation that, for obvious reasons, has no decision-making roles; it is the receiver of the residual stock of resources left unharvested by the first generation. Thus, an intergenerational transfer occurs, namely, the amount not harvested in the last period by the first generation is the initial stock for the subsequent generation:

$$[1+f(g,R(t))]R(T)-h(T)=D, \tag{11}$$

where *D* represents the initial stock for the second generation.

Of course, if the first generation is absolutely selfish, nothing will be left to the next generation. However, total selfishness is not the real behavior of agents, because it is explicated in the retrospective on the other-regarding behaviors. Hence, in this model, the agent of the first generation takes care of the amount available for the successor because she or he has social preferences regarding intergenerational distribution. Thus, the first generation leaves a given amount, *D*, unharvested at the end of the period *T* for the second generation.

The amount *D* depends on the lifetime-expected enjoyed revenue that the first agent (or generation) obtains, π, given the instantaneous utility of the agent such that

$$\pi=\sum_{t=0}^{T}u(h(t)). \tag{12}$$

The transferred amount also depends on the intergenerational equity of the first generation, represented by a generic constant parameter, α, which is exogenous and unchangeable; hence,

$$D=f(\alpha,\pi). \tag{13}$$

The amount transferred to the second generation increases with the increase in the lifetime enjoyed revenue of the first generation:

$$\frac{\partial D(\alpha,\pi)}{\partial \pi} > 0. \tag{14}$$

At any period, the agent of the first generation defines the harvesting plan, including the expected amount to transfer to the second generation.

5. Consequences of present-biased behaviors on the welfare of future generations in the presence of other-regarding preferences

This paragraph questions how the adoption of the harvesting strategy influenced by present-biased preferences affects the intergenerational transfer, given the assumption of the presence of social preferences. Understanding how the presence of present-biased preferences can affect the transfer amount to the following generation is a necessary step to understand the context in which the social norms should be implemented.

The intertemporal harvesting plan of the agent is given by the maximization of the utility function (10) under the constraints expressed in (2), (3), (4), and (5); the growth of the stock is given by (1); and the agent face the (11). To show the effect of present-biased preferences on the intergenerational transfer, in the first step, the effect on the lifetime-expected revenue enjoyed by the first generation must emerge.

Hence, at time 0, the agent formulates the optimal harvesting plan for her or his lifetime:

$$H_{opt} = \{h_{opt}(0), \dots, h_{opt}(t_b), \dots, h_{opt}(T)\}. \tag{15}$$

However, the agent adopts present-biased decisions; thus, there are no guarantees for the time consistency of the choices time after time. In this manner, the strategy effectively implemented by the naive agent does not coincide with the initial long-run optimal plan formulated at time 0; thus, the harvesting plan implemented will be a biased expressed as follows:

$$H_{bias} = \{h_{bias}(0), \dots, h_{bias}(t_b), \dots, h_{bias}(T)\}, \tag{16}$$

where H_{bias} is defined as the amounts derived time after time by the instantaneous maximization of the utility expressed in (10), under the constraints defined before, when β is lower than 1.

Because (9) implies that, with $0 < t_b < s$, at time 0:

$$\frac{\delta_{t_b}}{\delta_{t_b+1}} = \frac{\delta_s}{\delta_{s+1}}, \tag{17}$$

but later at time t_b is

$$\frac{\delta_{t_b}}{\delta_{t_b+1}} > \frac{\delta_s}{\delta_{s+1}}; \tag{18}$$

then, at time t_b, the agent harvests an amount greater in the biased harvesting plan, such that

$$h_{bias}(t_b) > h_{opt}(t_b). \tag{19}$$

The direct consequence of an increment of the current harvested amount is that because there is one optimal solution at each time, to divert away from the harvesting path that was, guarantees the higher lifetime utility evaluated until the previous period. The consequence is consistent with Persichina (2019a), that is, the lifetime-expected enjoyed revenue that the agent obtains in the biased harvesting plan adopted, H_{bias}, can be lower than in the hypothetical optimal plan evaluated at time 0, H_{opt}:

$$\sum_{t=0}^{T} u\big(h_{bias}(t)\big) < \sum_{t=0}^{T} u\left(h_{opt}(t)\right). \tag{20}$$

Hence, the present bias can induce the agent of the first generation to adopt a strategy that implies an expected enjoyed revenue, π_{bias}, lower than that expected at the beginning, π_{opt}.

Thus, the present bias can create inefficiency in the intertemporal management of the resources. Additionally, will this inefficiency persists even if the naive agent has spontaneous other-regarding preferences such as in this model in which the first generation desires to leave resources to the following generation but the amount to transfer depends on the revenue of the first generation.

Hence, considering that at time 0 the agent had defined a given harvesting plan, H_{opt}, such that she or he had predicted to obtain a given expected enjoyed revenue π_{opt}, the predicted amount to leave for the future generation predicted at time 0 was defined in relation to the predicted revenue π_{opt}, such that

$$D_{opt} = f\left(\alpha, \pi_{opt}\right). \quad (21)$$

At time t_b, the present bias induces the agent to reevaluate her or his harvesting plan. The consequence, expressed in (20), can imply that the enjoyed revenue derived from the biased harvesting plan, π_{bias}, is lower than π_{opt}, such that at time t_b, the transfer amount is reevaluated in the function of the new level of expected enjoyed revenue, π_{bias}:

$$D_{bias} = f(\alpha, \pi_{bias}) \quad (22)$$

Thus, considering (14), a decrease in π determines a decrease in the transfer amount such that

$$D_{bias} < D_{opt}. \quad (23)$$

At this point, we easily understand that when $\pi_{bias} < \pi_{opt}$, period after period, when the effect of present-biased preferences emerges, the predicted transferred amount becomes smaller and smaller. In the final period *T*, the amount effectively left for the future generation will be lower than the amount that the agent would have left given the same intergenerational preferences but without the present bias that moves her or him away from her or his long-run harvesting path.

Therefore, a biased harvesting plan can determine a reduction in the maximum welfare available for the future generation. The second generation, hence, suffers the consequences of a bias that affects the previous generation, with the reduction of the initial stock of resources that the second generation receives despite the initial other-regarding intentions of the first generation. For this reason, this work aims to understand which properties a social norm should have to avoid the intergenerational inequality that can derive from present-biased preferences in intergenerational renewable resources management.

6. Implementation of the social norm

In the context in which the spontaneous social preferences of a present-biased agent are not sufficient to avoid the risks related to the present-biased discounting, an individual harvester could leave to the future generation less than she or he originally desired. In this case, the support of social norms that can induce her or him to apply a sort of self-commitment to her or his original choices may be decisive. Notably, the compliance with social norms that require leaving an amount to the future generation not amenable to revision could offer the opportunity to commit the behavior of the agent to the first intention. The social norm, in this case, will be a nudge to facilitate the agent to behave conformal to her or his initial intention (Sunstein, 2014).

The implementation of a social norm that prescribes to follow the initial harvesting plan can improve intergenerational equity. Notably, when individuals act in accordance with their spontaneous intergenerational preferences, without being bound by social norms, there is no constraint that avoids the revaluation of the transfer amount. Thus, the conservation of resources for future generations is not guaranteed. Conversely, the situation of the transferred amount could differ if the agent manifests her or his intergenerational preferences in the compliance with a social norm that prescribes a donation to the future generation of a determined amount, set out at the beginning of the harvesting periods, and thus defined according to the initial stock of resources. For this reason, we conduct an analysis of the presence of this type of social norm. The goal is to define the main properties of a model that includes the disutility derived from a violation of the social norm that prescribes that the amount transferred, defined at the beginning, must not be subject to revaluation.

The model assumes that the violation of a social norm implies for the agent a disutility that reduces the instantaneous utility at the moment when the violation occurs. The disutility derived by a violation of the social norm is defined with η such that the instantaneous utility of the present harvesting is given by

$$u(t) = u\big(h(t)\big) - \eta_t. \qquad (24)$$

An assumption is that at time t_b, if the agent harvest is not more of the amount initially planned $h_{opt}(t_b)$, the disutility that she or he receives is zero because no violation of social norms occurs. Otherwise, if she or he increases the harvesting above $h_{opt}(t_b)$, she or he receives a disutility η, that is, a no decreasing function in the difference between the current harvesting and the amount in initially planned, $h(t) - h_{opt}(t)$,[3] and this difference is denoted with γ such that

$$\frac{\partial \eta}{\partial \gamma} \geq 0, \qquad (25)$$

Moreover, η is also a function of the parameter α^* that represents the value that the agent assigns to comply with the social norm, such that the disutility that the social norm generates when the agents violate the norm, $f(\alpha^*, \gamma)$,[4] increases with an increase in α^*:

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[3] A higher difference in the amount harvested represents a stronger violation of the social norm; consequently, a bigger difference between the current harvesting and the amount initially planned should imply a higher disutility derived by the social norm, and in no case a decreasing disutility.

[4] α^* is assumed exogenous and unchangeable.

$$\frac{\partial f(\alpha^*,\gamma)}{\partial \alpha^*} > 0, \tag{26}$$

such that the disutility at time t_b will be given by

$$\eta_{t_b} = \begin{cases} 0, & h(t_b) \le h_{opt}(t_b) \\ f(\alpha^*,\gamma), & h(t_b) > h_{opt}(t_b) \end{cases} \tag{27}$$

with $\gamma = h(t_b) - h_{opt}(t_b)$ and $f(\alpha^*,\gamma) > 0$,

Thus, the total expected utility of the agent at time t_b is

$$U_{t_b} = \sum_{t=t_b}^{T} \delta_t u\big(\mathrm{h}(t)\big) - \eta_{h_{t_b}}, \tag{28}$$

with $\frac{\partial \mathrm{U}}{\partial \eta} < 0$ for $\eta > 0$.

Given the model just described, here, the analysis is interested in defining the two main peculiarities of the existence of a social norm that prescribes the non-revaluation: the necessary condition to have positive effects to reduce the overharvesting generated by present-biased preferences, and the sufficient condition to maintain the harvesting at the optimal level initially planned.

6.1. Necessary condition

The necessary condition is the condition such that a disutility derived by the violation of the social norm does not induce the agent to increase the harvesting above $h_{bias}(t_b)$, and at the same time avoid the situation in which independently from the disutility derived by the social norm the agent will continue in any case to harvest $h_{bias}(t_b)$. Notably, to have positive effects on the agent's harvesting, the agent's utility must be reduced when she or he does not behave in compliance with the social norm, but without the situation in which the reduction in the utility generated by non-compliance behavior induces the agent to further increase the harvesting amount, even above $h_{bias}(t_b)$.

In Proposition 1, we enunciate the necessary condition:[5]

Proposition 1:

It is considered time t_b, in which $h_{bias}(t_b) > h_{opt}(t_b)$ in the absence of the social norm. With {H} defined as the set of all feasible harvesting strategies defined for the interval $[t_b, \mathrm{T}]$, and with $\{H_i\} \subset$ {H} the subset of all the feasible alternative strategies to H_{bias}. We assume the presence of the social norm such that the instantaneous utility of the present-biased agent at time t_b is $u(t_b) = u\big(h(t_b)\big) - \eta_{t_b}$, assuming that $\eta_{t_b}$is defined as in (27), and defining with $h_i(t_b)$, the amount that the agent harvests in the presence of the social norm if

$$f(\alpha^*, \gamma) \rightarrow \frac{\partial \eta}{\partial \gamma} > 0 \;\forall\; h(t) > h_{opt}(t), \tag{29}$$

then

$$\nexists\; h_i(t_b) > h_{bias}(t_b) : H_i \succcurlyeq H_{bias} \forall\; H_i \in \{H_i\}. \tag{30}$$

Thus, the necessary condition asserts that if the marginal disutility derived from the violation of the norms is increasing over the marginal increase of the overharvesting in excess to the optimal amount initially planned, $h(t) - h_{opt}(t)$, in presence of social norm does not exist at an amount greater than the present-biased amount harvested in absence of a norm such that a harvesting path with an amount higher than $h_{bias}(t)$ can be preferred by the agent. Hence, under condition (29), the presence of a social norm that prescribes the non-revaluation cannot induce the naive agent to harvest an amount higher than the amount harvested in the absence of that social norm.

The the social norm, to have the possibility to reduce the effect of present bias on the harvesting amount and consequently on the transferred amount to the future generation, needs

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[5] The proof is presented in the appendix.

to generate a strictly marginal increasing disutility on the increasing of the difference between the amount effectively harvested and the amount initially planned. Notably, a strictly increasing disutility on the amount harvested in excess to $h_{opt}(t)$ in no cases will induce the agent to move farther away from the harvesting path. A social norm with this peculiarity could reduce the effect of the present bias on the amount transferred to the future generation.

6.2. Sufficient condition

Now, we focus on the definition of the condition in which the existence of a social norms that prescribe avoiding the revaluation can guarantee the optimal harvesting path defined at the beginning, guaranteeing the optimality of the harvesting amount over time and of the transferred amount to the following generation, given the presence of other-regarding preferences and of social norms even when the agent has present-biased preferences.

We assume that a higher difference in the amount harvested represents a stronger violation of the social norms, and consequently, a bigger difference between the current harvesting and the amount initially planned should imply a higher disutility derived from the social norm such that $\frac{\partial \eta}{\partial \gamma} > 0$, and this guarantees the condition expressed in Proposition 1.

The time horizon $[t_b, T]$ is considered because as aforementioned, we assume that time t_b is the earlier period in which the agent reevaluates her or his harvesting amount to effect the present bias; thus, the harvesting path adopted does not differ from H_{opt} until time $t_b - 1$.

In the model presented, the sufficient condition that guarantees the compliance with the optimal harvesting path defined at the beginning has to satisfy the following:

$$u\big[h_{opt}(t_b)\big] + \beta \sum_{t=t_b+1}^{T} \delta(t_b)^{t-t_b}\, u\big[h_{opt}(t)\big] > u\big[h_j(t_b)\big] + \beta \sum_{t=t_b+1}^{T} \delta(t_b)^{t-t_b}\, u\big[h_j(t)\big] - \eta_j\,, \quad (31)$$

where $h_j(t)$ is the amount harvested at time *t* given the harvesting strategy $H_j \in \{H_j\}$, where $\{H_j\}$ is the set of all the feasible strategies at time t_b alternative to H_{opt}.

When the (31) is satisfied the harvesting strategy defined before time t_b, H_{opt}, is still the dominant strategy even at time t_b.

This condition is always guaranteed when the marginal disutility for a marginal increase of the difference $h_j(t) - h_{opt}(t)$ is larger than the marginal utility evaluated for each harvesting amount in the interval $\left(h_{opt}(t_b),\ h_{bias}(t_b)\right]$ weighted for the present bias factor β. We can also assert the following proposition that express the sufficient condition for the maintenance of the optimal harvesting path, neutralizing the effect of the present bias (the proof is presented in the appendix):

Proposition 2:

Given the presence of present-biased preferences represented by parameter β, as expressed in the utility function in (10), and the existence of social norms that affect the utility of the agent, as expressed in (27) and (28), with $\frac{\partial \eta}{\partial \gamma} > 0$, we define in the interval $[0, T]$ as the optimal harvesting strategy H_{opt}, define with {H} the set of all the feasible strategies for the interval $[t_b, T]$, define with $\{H_j\} \subset$ {H} the subset of {H} that includes all the strategy alternatives to H_{opt} , a subset that includes even the strategy adopted by the agent in absence of social norm, H_{bias}, if

$$\frac{\partial \eta_j}{\partial \gamma} \geq (1-\beta)u'\left[h_j(t_b)\right],\ \ \forall\, h_j(t_b) \in \left(h_{opt}(t_b),\ h_{bias}(t_b)\right], \qquad (32)$$

Then, at time t_b :

$$H_{opt} \succ H_j\ \forall\, H_j \in \{H_j\} \subset \{H\} : E\left[U_{opt}\right] >\ E\left[U_{bias}\ \right] \forall\, t_b \in [0, T] \wedge\ \beta\ \in (0,1). \qquad (33)$$

Proposition 2 clarifies the sufficient condition that guarantees, in presence of the social norm that prescribes the non-revaluation of the amount initially planned, that a naive present-biased agent will maintain the optimal harvesting path defined at the beginning. This condition is also the condition that can guarantee the sustainability of the resources if the amount initially planned to transfer to the following generation is defined in accordance with intergenerational social preferences that ensure the sustainability of the resources.

Hence, in the case of a social norm that, such as in this model, prescribes that the amount defined at the beginning must not be subject to revaluation, the social norm is also an opportunity to commit to the behavior of the agent. Thus, the presence of constraints arising from the social norm can lead the individual to mitigate the reevaluation of the amount to leave to the future generation. Moreover, under the condition expressed in Proposition 2, the implementation of a social norm can avoid the reevaluation of the amount of resources to leave to the future generations, reducing the risk of overexploitation for the effect of the intertemporal myopia of a naive present-biased agent.

7. Discussion and final remarks

Clearly, in the context of renewable resources, the action of one generation imposes externalities on subsequent generations. This work has discussed that the choices influenced by present-biased preferences can lead the first generation to leave to the second generation less than what the first generation wanted. This phenomenon is essentially an intergenerational preference reversal, in which the original intentions of individuals managing resource stocks are influenced by the strong temptation of the present, eroding the resource volumes to leave to future generations. Notably, we observed the conflict between the individual’s preferences when she or he is not subject to pressures from the present and the choices actually made when these preferences are influenced by present bias. Thus, the strategic short-sightedness imposed by the “dictatorship of the present” can cause the agent's choices to divert from optimal choices, reducing the well-being of future generations despite strong social preferences.

Thus, present bias can imply serious damage to intergenerational equity and the sustainability of resources levels for future generations, even when the welfare of future generations is supported by other-regarding preferences. The other-regarding preferences of a naive agent do not guarantee that the harvesting path will match with what is considered desirable and initially optimal. Resource management and conservation for future generations appears to be a complex task that cannot be fully solved by the spontaneous behavior of naive agents unable to self-commit. Even if a generation has spontaneous and intrinsic intergenerational preferences, the sustainability of resources for future generations faces the limit that in the process of decision-making over time, the choices made can be insufficient to keep the harvesting plan that leaves the resource amount initially suggested. If this amount had been defined in terms of sustainability for the future generation, the sustainability of resources, even if desired by the present generation, would be compromised.

Based on this problem, this study has investigated the role of the social norm of no reevaluation of the amount designed for the future generation. The result obtained with the model presented in this paper has shown that if the social preferences of the individual are not left only and exclusively to their own spontaneous behavior, and if these social preferences are expressed by social norms that represent the individual's social preferences, a mitigation and a neutralization of the effect of present bias on the intergenerational equity can occur. This result is related to the idea that decisions on compliance/no-compliance based on given social norms are part of the decision-making process of the agent and part of her or his preferences. Notably, individuals also express their preferences through specific social norms that they believe in. Hence, through compliance with these norms, individuals express their preferences toward other members of the community. Individuals with social preferences do not act in isolation from the community they belong to. The manner in which social norms affect individuals' behavior is one of the prerogatives of society. A community is also based on the relatively widespread adoption of specific social norms and clearly identifiable habits, whose adoption by an individual qualifies her or him in very specific terms. The compliance with social norms notably elicits the self-image of the agents. Agents receive a benefit by expressing themselves through actions that are in compliance with their self-image and social identity. Thus, compliance with social norms is in this manner an expressive utility (Sunstein and Reisch, 2014). Furthermore, social disapproval can induce individuals to conform to the social norm: they obtain utility from the social endorsement or moral utility (Levitt and List, 2007).

Consistent with this approach, the analysis of the role of the social norm conducted in this paper shows that to possibly reduce the effect of present bias on the transferred amount to the future generation, the social norm should generate a strictly marginal increasing disutility that the agent receives based on the increase in the difference between the amount effectively harvested and the amount initially planned. Thus, the disutility of a non-compliant behavior to the norm must target the present behavior of the agent by reducing her or his utility in relation to the increase in her or his present harvesting compared with the amount initially planned.

One of the main contributions of this paper is the definition of the condition in which the adoption of the social norm guarantees the neutralization of the effect of present bias on the transferred amount to the future generation. Specifically, we have proven that if the marginal disutility derived from the violation of the social norm is larger than the present-biased weighted marginal utility, even a naive agent will maintain the harvesting path that guarantees the optimality initially defined. We have demonstrated the positive and important role that social norms that sustain other-regarding preferences of the agents have in the intergenerational equity in the management of renewable resources.

The social constraint that arises from the norm in this model, while an expression of the same other-regarding preferences, offsets the effects of short-sighted behaviors—where a naive agent takes her or his own decisions only under the influence of present bias—that in absence of social norms are without substantial barriers. In the context of intertemporal management of resources, the social norms should have the crucial role of expressing the other-regarding preferences of the agent such that she or he can keep the harvesting path as close as possible to the optimal path with a high compliance with the social norm. Notably, if the presence of the other-regarding preferences—that are necessary and essential—is not sufficient to guarantee intergenerational equity, the agent's behavior must be sustained by specific institutional mechanisms and brought into the community by social norms that suggest the behaviors more appropriately for guaranteeing the equity and availability of the resources between the different generations.

In conclusion, the results obtained suggest that the transfer of resources to future generations can be preserved by respecting the preferences of the current generation and implementing a social norm that defines given behavioral heuristics. The social norm must be implemented in a manner such that the social preferences of the members of the community are expressed not only by the volume of resources they leave to the next generation, but also according to how this amount matches the amount initially assessed. Indeed, this would facilitate the effective maintenance of resource stocks to be allocated to future generations.

Appendix

Proof Proposition 1:

At time t_b, when the agent is induced by the present bias to reevaluate her or his harvesting plan. The amount $h_{bias}(t_b)$, with $h_{bias}(t_b) > h_{opt}(t_b)$, is the only amount harvestable at time t_b such that

$$H_{bias} \succ H_i \;\forall\, H_i \in \{H_i\} \qquad (i)$$

with {H}, we define the set of all feasible harvesting strategies defined for the interval $[t_b, \mathrm{T}]$, and with $\{H_i\} \subset$ {H} , the subset of all the feasible alternative strategies to H_{bias}.

Thus, considering the disutility derived by the violation of the social norm, the condition that guarantees that (i) is still true requires that

$$\sum_{t=t_b}^{T} \delta(t)u\big(h_{bias}(t)\big) - \eta_{h_{bias}} > \sum_{t=t_b}^{T} \delta(t)u\big(h_i(t)\big) - \eta_{h_i}, \qquad (ii)$$

with $\eta \geq 0$.

We consider all the alternative strategies to H_{bias} in the subset $\{H_i\}$ that imply

$h_i(t_b) > h_{bias}(t_b)$

We remember that at time t_b,

$$u\big(h_i(t_b)\big) - u\big(h_{bias}(t_b)\big) < \sum_{t=t_b+1}^{T} \delta(t)u\big(h_{bias}(t)\big) - \sum_{t=t_b+1}^{T} \delta(t)u\big(h_i(t)\big),$$

thus the (ii) is satisfied for every $\eta_{h_i} \geq \eta_{h_{bias}}$.

The model assumes $\frac{\partial \eta}{\partial \gamma} \geq 0$; thus, if $\frac{\partial \eta}{\partial \gamma} = 0$, $\eta_{h_i} = \eta_{h_{bias}}$. In this case, the harvesting decision is neutral to the social norm, and if $\frac{\partial \eta}{\partial \gamma} > 0$, $(\eta_{h_{bias}} - \eta_{h_i}) < 0$; consequently,

If $\frac{\partial \eta}{\partial \gamma} > 0$, then $\nexists\ h_i(t_b) > h_{bias}(t_b)\colon H_i \succcurlyeq H_{bias} \forall\ H_i \in \{H\}$

Proof Proposition 2:

The agent will maintain the harvesting amount defined in the optimal harvesting plan if

$$H_{opt} \succ H_j\ \forall\ H_j \in \{H_j\} \subset\ \{\mathrm{H}\}\ with\ H_j |\ h_{opt}(t_b) <\ h_j(t_b) \qquad (\ i\ )$$

that implies

$$u\big[h_{opt}(t_b)\big] + \beta \sum_{t=t_b+1}^{T} \delta(t_b)^{t-t_b}\, u\big[h_{opt}(t)\big] > u\big[h_j(t_b)\big] + \beta \sum_{t=t_b+1}^{T} \delta(t_b)^{t-t_b}\, u\big[h_j(t)\big] - \eta_j$$

consequently (i) is true if

$$\frac{u\left[h_{opt}(t_b)\right]-u\left[h_j(t_b)\right]+\eta_j}{\beta} > \left\{\sum_{t=t_b+1}^{T}\delta(t_b)^{t-t_b}\,u\left[h_j(t)\right]-\sum_{t=t_b+1}^{T}\delta(t_b)^{t-t_b}\,u\left[h_{opt}(t)\right]\right\} \quad (\,ii\,)$$

because $\eta_j > 0\ \wedge\ \beta < 1$ and because

$$u\left[h_{opt}(t_b)\right]-u\left[h_j(t_b)\right] > \sum_{t=t_b+1}^{T}\delta(t_b)^{t-t_b}\,u\left[h_j(t)\right]-\sum_{t=t_b+1}^{T}\delta(t_b)^{t-t_b}\,u\left[h_{opt}(t)\right]$$

(*ii*) is true when

$$\frac{u\left[h_{opt}(t_b)\right]-u\left[h_j(t_b)\right]+\eta_j}{\beta} \geq u\left[h_{opt}(t_b)\right]-u\left[h_j(t_b)\right] \qquad (\,iii\,)$$

Thus, if

$$\frac{\eta_j}{\beta} \geq \frac{\beta-1}{\beta}u\left[h_{opt}(t_b)\right]+\frac{1-\beta}{\beta}u\left[h_j(t_b)\right]$$

from which

$$\eta_j \geq (1-\beta)\int_{h_{opt}(t_b)}^{h_j(t_b)} u^{'}[h(t)]\,dh(t_b) \qquad (\,iiii\,)$$

From (*iiii*), finally, (*i*) is true when

$$\frac{\partial\eta_i}{\partial\gamma} \geq (1-\beta)u'[h(t_b)],\quad \forall\ h_i(t_b)\in\left(h_{opt}(t_b),h_{bias}(t_b)\right] \qquad (\,iiiii\,)$$

Because of the monotonicity of the utility function and because $\beta < 1$, (*iiiii*) requires

$\frac{\partial\eta_i}{\partial\gamma} > 0$; that it is the necessary condition defined in Proposition 1.

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