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

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Abstract:

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

Faced with the problem that 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 to not reevaluate the harvesting decisions, a mitigation of the effect of present bias on the 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 derive from present-biased preferences in the intergenerational renewable resources management. Besides the model defines the necessary and the sufficient conditions so 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, some 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 start to show the dichotomy between the present-biased agents and the rational ones (Hepburn et al., 2010; Winkler, 2006). However, as Gsottbauer and van den Bergh (2011) remarked, the studies that investigate non-constant discounting in resource management have excluded from their analysis the other-regarding preferences. The assertion is well-founded, and the reasons of 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, there are several robust studies that show the validity for an inclusion of the other-regarding motives in the study of the economic behaviors (Fehr and Gächter, 2002, 2000; Gächter, 2007; Gintis et al., 2005).

Often renewable resources assume an intergenerational dimension due to their intrinsic nature. The activity of harvesting from 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 take their actions at the same time. But frequently, negative externalities can affect future generations whose welfare depends on the level of impoverishment to which the resources were previously exposed.

When the 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 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 resources for future generations. For these reasons, the purpose of this work is to investigate the effects of present bias in renewable resource management, analyzing the impact of myopic behaviors on the transfer of resources from the current generation to the next one, taking care of other-regarding and social preferences of the first generation. Besides, this paper focuses on the different ways in which an agent can express her social and other-regarding preferences. In fact, 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 human society to define social norms is one of the elements that characterize the sociability itself. In fact, communities and individuals express their other-regarding preferences also through social norms. In this paper one of the main aims is the definition of the properties that a social norm need to have to avoid the negative effect of present-biased preferences on the transfer amount of future generations. For this reasons, this work will provide a model that introduce a social norm in the context in which present-biased preferences can affect the intergenerational equity in presence of other-regarding preferences of the present generation. The results will address the opportunity to adopt social norms that sustain the intergenerational distribution of the resources, keeping in mind that the capability of building a behavioral norm inside a community is one of the most important and peculiar features of human sociability.

2. Intertemporal myopia in resource management

Resources management is not an easy task for individuals, in particular when they have important decisional myopia (Pevnitskaya and Ryvkin, 2013). The intergenerational management of resources can suffer the conflict between long-run preferences and immediate choices when due to the present-biased preferences there emerges a conflict between the early intention of the agent and the choice made in the present. The conflict arises due to 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 possible revaluation of the choices made, changing it from what was estimated before. Behaviors that contradict the time-consistency assumption are 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 one is a consequence of people's impulsiveness and lack in self-control (Laibson, 1997; O'Donoghue and Rabin, 1999), and it is clear that 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). As well as the areas just mentioned, resource management is a field where present bias has a strong potential impact. In fact, 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 can typically emerge in all the fields of public and common goods — in public goods, this is emphasized by Winkler (2006), while 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 the 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 is 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) showed that non-constant discounting affects the optimal resource management because it makes possible offering a justification of a future change in the decisions of the policymaker. Therefore, in the 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 — 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 merely to the impoverishment of the stock of resources for effect of the allocation of the harvesting amounts over the time by the present generation for their own consumption preferences. In 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 the welfare of future generations. In fact, as it will be discussed in the next section, individuals have social preferences such that they assign a positive value to the welfare of the future generations. Therefore, in the intertemporal resource management, present generations also include the welfare of the future generations in their decision process. In this manner, the present generation has the aim of behaving 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, it is clear that the outcome of the decision taken also responds to the social preferences of the individual himself. But, in the absence of time-consistency, when the agent behaves myopically under the effect of present bias, the coherence between improved action and early intention of the individual can fade away.

3. A retrospective on other-regarding motives

In a common resource dilemma, the 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 take decisions exclusively based on their own self-interest without caring about 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 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 the others one exists, and this is the foundation of human society. Hence, economic issues that involve the social dimension of human behavior require to economists to relax the assumption that agents are only self-interested.

Several studies have investigated the real foundation of economics when the agents take 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, there are abundant contributions in the literature that show that fairness principles contribute to the formulation of the agents 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).

The other-regarding motives have an important 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 in order to behave in conformity to one's own other-regarding preferences. The others are not only those that simultaneously harvest the same resources but also the successors who will harvest in the future, when the resources are assigned for an 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.

Because on one side, there are no doubts about the existence of cooperation and equity distribution capabilities of people: these capabilities are part of the success of human evolution (Gintis, 2009); on the other side, the reason why societies sometimes fail to reach 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 will be investigated in relation to the welfare of future generations and on the role that social norm can have in the maintenance of the 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 following:

$$R(t+1) - R(t) = f\big(g, R(t)\big)R(t) - h(t), \tag{1}$$

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, so it is not possible to have a negative stock of resources, and the initial level of the stock is strictly positive:

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

with

$$R(0) = R_0 \, , \; R_0 > 0. \tag{3}$$

The amount harvested is not restorable such that:

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

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

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

In the model, there are two generations, a first one that harvests for *T* periods, and a second one that receives the resources leaved 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:

[1] The 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 a constant exponential one.

[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 on 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 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 will be used 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 the condition (9) holds. Instead $\beta = 1$ is the specific case of absence of present bias, such that the discounting is the classic exponential one.

The second generation in the model is the future generation that for obviously reason has not decision making roles, it is the receiver of the residual stock of resources left unharvested by the first generation. Thus, there is an intergenerational transfer, 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, as 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 has social preferences about the intergenerational distribution. So, 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, 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 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 presence of other-regarding preferences

The issue that it is questioned in this paragraph is how the adoption of the harvesting strategy influenced by present-biased preferences affects the intergenerational transfer, given the assumption of 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 lifetime:

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

But, the agent adopts present-biased decisions so there are no guarantees about 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, so the harvesting plan implemented will be a biased one, expressed as:

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

where H_{bias} is defined as the amounts that are 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:

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

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 we are in presence of just 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 consistently with Persichina (2019a), will be that 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 one expected at the beginning, π_{opt}. So the present bias can create inefficiency in the intertemporal management of the resources. How it will be showed soon this inefficiency persists even if the naive agent has spontaneous other-regarding preferences like in this model in which the first generation desires to leave some resources to the following generation but the amount to transfer depends on the revenue of the first generation itself.

Hence, considering that at time 0 the agent had defined a given harvesting plan, H_{opt}, such that she 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:

$$D_{opt} = f(\alpha, \pi_{opt}). \qquad (21)$$

At time t_b, the present bias induces the agent to reevaluate her 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}:

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

Thus, taking into account (14), a decrease in π determines a decrease in the transfer amount such that:

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

At this point, it is easy to 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 move her away from her 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 the 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 originally desired. In this case having the support of social norms that can induce her to apply a sort of self-commitment to her original choices it may be decisive. In fact, the compliance to 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 initial intention (Sunstein, 2014).

The implementation of a social norm that prescribes to follow the initial harvesting plan can improve the intergenerational equity. In fact, when individuals act in accord with their own spontaneous intergenerational preferences, without being bound by any social norms, there is not a constraint that avoids the revaluation of the transfer amount. So the conservation of resources for future generations is not guaranteed. Conversely, the situation of the transferred amount could be different if the agent manifests her own intergenerational preferences with the compliance to a social norm that prescribes to donate to the future generation 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, here an analysis of the presence of this kind of social norm is conducted. The goal is to define the main properties of a model that includes the disutility that derives 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 in the moment in which 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:

$$u(t) = u\big(h(t)\big) - \eta_t. \tag{24}$$

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

$$\frac{\partial \eta}{\partial \gamma} \geq 0, \tag{25}$$

Moreover, η is also 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 violates the norm, $f(\alpha^*, \gamma)$,[4] increases with an increasing of α^*:

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

Such that the disutility at time t_b will be given by:

[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.

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

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

So, the total expected utility of the agent at time t_b is:

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

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

Given the model just described, here the analysis is interested in define 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 generates 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 $h_{bias}(t_b)$. In fact, to have positive effects on the agent's harvesting, the agent's utility must be reduced when she 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 $h_{bias}(t_b)$.

Here the necessary condition is enunciated:[5]

Proposition 1:

It is considered time t_b in which $h_{bias}(t_b) > h_{opt}(t_b)$ in absence of social norm. Defining with {H} the set of all feasible harvesting strategy defined for the interval $[t_b, \mathrm{T}]$, and with $\{H_i\} \subset \{\mathrm{H}\}$ the subset of all the feasible alternative strategies to H_{bias}. Assuming the presence of 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 η_{t_b} is defined as in (27), and defining with $h_i(t_b)$ the amount that the agent harvests in 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

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

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

It is so possible to assert that the social norm, in order to have the possibility to reduce the effect of present bias on the harvesting amount and consequently on the transferred amount

[5] The proof is presented in the appendix.

to the future generation, needs to generate a strictly marginal increasing disutility on the increasing of the difference between the amount effectively harvested and the amount initially planned. In fact, a strictly increasing disutility on the amount harvested in excess to $h_{opt}(t)$ in no cases will induce the agent to move further 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 the focus is on the definition of the condition in which the existence of a social norms that prescribe to avoid the revaluation can guarantee the optimal harvesting path defined at the beginning, guaranteeing the optimality of the harvesting amount over the 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.

It is assumed 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 deriving from the social norm, such that $\frac{\partial \eta}{\partial \gamma} > 0$, and this guarantees the condition expressed in the proposition 1.

The time horizon $[t_b, T]$ is considered, because as explicated before it is assumed that time t_b is the earlier period in which the agent reevaluate her harvesting amount for effect of the present bias, so the harvesting path adopted doesn't differ from H_{opt} until time $t_b - 1$.

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

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

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 one even at time t_b.

This condition is always guaranteed when the marginal disutility for a marginal increasing 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. It is so possible to 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 showed in the appendix):

Proposition 2:

Given the presence of present-biased preferences represented by the parameter β as expressed in the utility function in (10) and the existence of social norms that affect the utility of the agent has express in (27) and (28) with $\frac{\partial \eta}{\partial \gamma} > 0$. Defining in the interval $[0, T]$ the optimal harvesting strategy H_{opt}, defining with {H} the set of all the feasible strategy for the interval $[t_b, T]$, defining with $\{H_j\} \subset$ {H} the subset of {H} that include all the strategy alternative to H_{opt}, 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 :

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

The proposition just defined clarifies the sufficient condition that guarantees, in presence of the social norm that prescribe 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 is also the condition that can guarantees the sustainability of the resources if the amount initially planned to transfer to the following generation is defined in accord to intergenerational social preferences that ensure the sustainability of the resources.

Hence, In the case of a social norm that, like 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 the behavior of the agent. So, the presence of constraint 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 express in the 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 effect of the intertemporal myopia of a naive present-biased agent.

7. Discussion and final remarks

It is clear that in the context of renewable resources the action of one generation imposes externalities on the subsequent generations. This work has discussed that the choices influenced by present-biased preferences can lead the first generation to leave to the second one less than what the first generation itself wanted. It is essentially an intergenerational preference reversal, in which the original intentions of people managing resource stocks get influenced by the strong temptation of the present, eroding the resource volumes to leave to future generations. In fact, it is observed the conflict between the individual's preferences when they are not subject to pressures from the present and the choices actually made when preferences are influenced by present bias. Thus, the strategic short-sightedness imposed by the "dictatorship of the present" can cause the agents choices to divert away from optimal choices causing a reduction in the well-being of future generations despite the existence of strong social preferences.

Thus present bias can imply serious damages in terms of intergenerational equity and sustainability of resources level 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, which could not be fully solved by the spontaneous behavior of naive agents who are 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 resources amount initially suggested. If this amount had been defined in terms of sustainability for the future generation, the very sustainability of resources, even if desired by the present generation, would be compromised.

Faced with 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 can represent the individuals 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 about to compliance/no-compliance to given social norms are part of the decision making process of the agent and it is also part of her preferences. In fact, individuals also express their preferences through specific social norms that they believe in. Hence, by compliance with these norms, individuals express their own 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 human 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 in very specific terms. The compliance with social norms, in fact, 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. So compliance to social norms is in this way an expressive utility (Sunstein and Reisch, 2014). Furthermore, the 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).

Consistently with this approach, the Analysis of the role of the social norm conducted in this paper shows that to have the possibility to 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 by the increase of the difference between the amount effectively harvested and the amount initially planned. So the disutility of a non-compliant behavior to the norm has to target the present behavior of the agent by reducing her utility in relation to the increase of her present harvesting compared to the amount initially planned.

One of the main contribution that this paper are also offered is the definition of the condition in which the adoption of social norm can guarantees the neutralization of the effect of present bias on the transferred amount to the future generation. Specifically, it is been proofed 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. It is so showed 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 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 the she can keep the harvesting path as close as possible to the optimal one with a high compliance to the social norm. In fact, if the presence of the other-regarding preferences - that are necessary and essential - is not sufficient to guarantee the intergenerational equity, the agent's behavior need to 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 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:

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

Where with {H} is defined the set of all feasible harvesting strategy 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}.

So, taking into account 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 $\eta \geq 0$.

It is taken into account all the alternative strategies to H_{bias} in the subset $\{H_i\}$ that imply:

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

Remembering that at time t_b:

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

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

The model assumes $\frac{\partial \eta}{\partial \gamma} \geq 0$ so if $\frac{\partial \eta}{\partial \gamma} = 0$ then $\eta_{h_i} = \eta_{h_{bias}}$, in this second case the harvesting decision is neutral to the social norm, while if $\frac{\partial \eta}{\partial \gamma} > 0$ then $(\eta_{h_{bias}} - \eta_{h_i}) < 0$, 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:

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

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

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

(*ii*) is true when:

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

So if:

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

from which:

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

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

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

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

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

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