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Positional and conformist effects in voluntary public good provision

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Abstract
The literature featuring game–theoretical models aimed at explaining the effect of the status concerns on the voluntary provision of a public good is generally focused on snob agents, driven by a desire for exclusiveness. However, the social context literature highlights that status concerns can give rise to a desire, in some individuals to be different from the "common herd," and in some others to conform with other people. We analyze a two-player public good game under two different settings: The standard case with two positional players (PPs), versus the case in which the positional player faces a conformist player (PC). Giving entrance to conformism has two main implications. Strong status concerns by both players can lead to a virtuous cycle in which the conformist player wishes to imitate the contributing behavior of the positional player, and the latter wishes to increase contribution to distinguish herself from the former. Then, the contribution to the public good can be higher than in the case with only snob agents. This higher contribution can increase social welfare, but only if endowments are not too large and the status concern of the positional player is not excessively high.

KEYWORDS
conformist agent, inertia, positional agent, public good, social context, static and dynamic game

1 | INTRODUCTION

One of the fundamental aspects of human nature, previously neglected by the traditional economic theory, is the status concern in a social context. For positional goods, the utility of consumers depends not only on the absolute quantity consumed but also on how this quantity compares with the quantities consumed by others. Due to this concern about status, each agent's effort to climb the social ladder imposes a negative externality on all other agents. This can lead to "Red Queen" effects[1]: when all agents embark on a race on conspicuous consumption of a private good to signal wealth, too much is spent to maintain social status. The result is an inefficient situation and a loss in social welfare.[2]

When the positional good is represented by the private provision of a public good, Muñoz-García (2011) and Bougherara et al. (2019) show that the contest for positional status can have a different effect. In their quest for status, one agent's contribution to a public good can induce others to do the same. The public good represents a positive externality on all other agents, possibly enhancing social welfare.

We revisit this emerging literature and characterize the conditions under which status concern/social approval leads standard selfish agents to contribute to a public good game, and further, whether this contribution improves social welfare. Agents' preferences are characterized by a utility function linear in private consumption, concave and increasing in public good consumption, and additively separable with respect to the payoff from relative contribution (i.e., associated with status concerns). Our analysis covers two types of agents: positional and conformist.

In this literature, it is commonly assumed that the status-seeking behavior of the agents is governed by snobbism, that is, a desire for uniqueness/exclusiveness. Following the status concern literature, we give entrance to an additional type of agent in a game of voluntary contribution to a public good. As already commented by Leibenstein (1950), in their search for status, agents can be driven by a desire for exclusiveness (snobs), but also a wish to imitate or follow the behavior of others (conformists). We do not consider here, as Corneo and Jeanne (1997), a universal snob/conformist character of the agents, stemming from the social norm governing the allocation of status. Instead, we believe that their character is the consequence of individual tastes for distinction or imitation. Some agents are more biased towards distinction and some others towards imitations. For simplicity, we consider that agents are driven only by exclusiveness or only by imitation. The main objective of the paper is to compare the effect of the status concern on the private provision of a public good when all agents are driven by a desire for exclusiveness, or when (as we consider more realistic) some agents are snob while

[1]This name is taken from Lewis Carroll's book *Through the Looking-Glass*. It takes all the running you can do to keep in the same place.

[2]The idea that the existence of status concerns is potentially welfare-reducing because agents may devote too much effort to acquire status has been known ever since Becker (1974) and his theory of social interaction.

others are conformists. It is also shown that no private contribution would take place in a world populated only by conformist agents.

We can particularize the quest for status considered in this paper in two examples. As a first example, consider the ecofriendly behavior of some agents. Consumers can opt for more expensive green goods, knowing that their productive process or life-cycle is less harmful to the environment than alternative less expensive brown goods (e.g., the commercial success of the Toyota Prius hybrid car). Likewise, farmers involved in agroenvironmental schemes (policies in the United States and EU that subsidize farmers to adopt greener practices) can obtain satisfaction from being more zealous than their peers. Similarly, households can wish to be more zealous than their neighbors in their recycling behavior. In all these examples, agents who contribute to environmental protection incur a private cost in terms of time, effort, or a premium price. In all these cases, one can defend that agents do not decide to contribute only by looking at the aggregate level of public good (environmental quality), which is difficult to measure. Rather, they importantly react to what they observe their neighbors contribute. A second example in which the quest for status fosters private contributions to a public good is charitable giving by competing firms. Take, for example, possible donations by Google or Apple. Their donation decisions are no doubt importantly driven by the magnitude of the social problem at stake. However, maybe no less important is the comparison against the contribution made by the competitor.

We define a game of voluntary contribution to a public good, first between two conformist players (CC case), later between two positional players (PPs case), and finally between a positional player and a conformist player (PC case). In the standard formulation of the game, players enjoy public good consumption but dislike contributing to the public good. Moreover, when social context is considered, players can show status concerns. Hence, the preferences of a player are also affected by the comparison of her contribution against her opponent's contribution. This comparison represents a gain or a loss for the positional player, depending on whether she contributes above or below the other player. However, the conformist player can only lose from this comparison, and the loss is higher the wider the gap between contributions, regardless of whether she contributes more or less than her opponent.

Status concerns of the players determine whether no one, only one, or both players contribute and in the latter case, whether some players contribute their total endowment. In the PP case, some private contribution is feasible if at least one of the players has a sufficiently large positional concern. In the most interesting equilibrium, this player contributes a positive amount of public good, while the player with the lowest positional concern free-rides and does not contribute. This latter only contributes if she wishes more public good than the amount that can be paid by the former's endowment. Two other extreme equilibria are possible: both players contribute zero/in full when they both have low/high status concerns.

In the PC case, the positional agent contributes if she has a sufficiently large status concern. Likewise as in the PP case, the conformist free-rides on the other player's contribution if she is not strongly influenced by the social context. Conversely, with a large degree of conformism, this player regards private contributions as strong complements and starts contributing (before the positional player contributes her total endowment). Then, a virtuous sequence of private provisions is opened by the snob agent and followed by the conformist player. The contribution of the positional agent induces some contribution to the conformist agent. Likewise, by closing the gap, the conformist agent also obliges further contribution to the positional agent. In the PC case, the equilibrium where both players contribute in full is not feasible because the conformist player contributes less than the positional player, except in the zero contribution equilibrium.

We center our analysis on the equilibria where no player contributes her total endowment, which we believe to be the most realistic. Having characterized the equilibria of the game, we turn to the analysis of social welfare. Then, with only positional players, the global contribution is upper bounded by the endowment of the player with the highest positional concern. By contrast, when a snob player interacts with a conformist player, since this latter also contributes, the global contribution can surpass the endowment of the snob player, assuming both types of players have strong status concerns. When no player contributes in full, a higher positional concern of the player with the highest positional concern in the PP case or the positional player in the PC case undoubtedly raises the global contribution. The utility associated with the absolute quantities contributed by the two players, which disregards positional payoffs, is denoted here as "intrinsic utility." The effect of a higher contribution on the intrinsic utility crucially depends on the global level of contribution. With low positionality, the global contribution is in shortage and further contributions increase intrinsic utility. The opposite applies if the level of positionality is high and contributions are already in excess. Social welfare is composed of the intrinsic utility but also the positional payoffs. For this broader measure, in the PP case, social welfare worsens only when both agents' positional concerns are large and close to one another.

In the PC case, a higher status concern of the positional agent typically represents greater social welfare. This is true unless the snob player has a strong positional concern and, at the same time, the conformist has a strong willingness to conform with the other player's contribution. Thus, the rise in the contribution made possible when the positional player confronts a conformist player instead of another positional one (assuming both players show strong status concerns), can be social welfare-reducing. This higher contribution can also be social welfare-enhancing if the agents have small endowments. On the other hand, a higher status concern of the conformist does not modify global contribution and it can lead to a reduction in the contribution gap when the conformist player contributes. A greater degree of conformism does not affect intrinsic utility and by reducing the global positional payoffs undoubtedly reduces social welfare.

The remainder of the paper is organized as follows. Next we present a brief review of the literature regarding social context and public good provision. In Section 3, we present the public good game and distinguish between the intrinsic utility and the payoffs associated with status concerns for the positional player as well as for the conformist player. Section 4 shows that a positive contribution is not feasible in a game with two conformist players. Sections 5 and 6 characterize the different Nash equilibria of the game and the effect of the status concerns of the players on intrinsic utility and social welfare for the PP and the PC cases. Conclusions and extensions are presented in Section 7. Technical details are explained in the appendix.

2 | LITERATURE REVIEW

Status-seeking behavior or the influence of social context on people's behavior was already highlighted by Adam Smith, who noted the propensity of individuals to expend effort to attain status. Due to social context, people's preferences are not exclusively determined from absolute consumption, relative consumption also matters. Duesenberry (1949) suggested the idea that agents' preferences are interdependent. Leibenstein (1950) showed that status‐seeking individuals, signal wealth through their consumption decisions. He distinguishes between snobbism and conformism. The bandwagon effect—or conformism—occurs when the agent seeks to follow the consumption behavior of others; the snob effect, contrarily, refers to the agent's desire for exclusiveness. Following this interpretation we will define conformity as the act of changing behavior to match the behavior of others; see, for example, Ding (2017). On the other hand, snob agents denoted here simply as positional agents, wish to behave better than their peers.[3] In a slightly different manner, Corneo and Jeanne (1997) identify the snob/bandwagon effect with the desire to be identified with the rich/not to be identified with the poor. Also of interest is the definition of vanity and conformity presented by Grilo et al. (2001) as dependent on the number of consumers of a specific good in a situation of product differentiation and spatial preferences.

The dichotomy between the wish for uniqueness and the desire to conform with others is also present in social psychology and social influence literature. Kim and Markus (1999) analyze whether uniqueness is more common in Western culture, while conformity is more typical in East Asian culture. From the two behavioral alternatives, normative and counternormative, Blanton and Christie (2003) predict that people attend to the second.

This dual vision can also be found in the theory of fashion, which by definition is consumed conspicuously and satisfies two social needs: the need to be similar to their social counterparts and the need for differentiation or uniqueness (see Brewer, 1991; Simmel, 1904) and, more recently, Yoganarasimhan (2012).

Interestingly, social context can also be associated with the literature on positive or negative network effects, as mentioned in Amir et al. (2023). In this literature the value of a product or service increases (or deceases) when the number of people who use that product or service increases. The notion of bandwagon is associated with a positive network effect, while snobbery is associated with a negative one.

In the literature on optimal public good provision. Aronsson and Johansson‐Stenman (2008) analyze how the optimal (nonlinear) income tax and the optimal public good provision are modified under status concerns. They conclude that marginal income tax should be higher than in the standard analysis. The analysis is extended to an overlapping‐generations model in Aronsson and Johansson‐Stenman (2014).

The effect of positional considerations on the optimal tax policy in a model with vertical differentiation is analyzed in Karakosta and Zacharias (2023). Interestingly, positionality can turn the standard result of subsidization into taxation.

Status concerns and the voluntary provision of public good have been analyzed from an empirical/experimental viewpoint. Laury et al. (1999) present an experiment studying the voluntary provision of a pure public good. It is shown that participants consistently allocate resources to the public good when the Nash prediction is zero contribution. In another field experiment, Huck et al. (2015) analyze different fundraising schemes with or without the presence of a lead donor. They show that individuals are subject to focal point influences in giving behavior.

Grolleau et al. (2012) present a simple theoretical framework to model status preferences (positional, conformist, and prosocial). They show that the private provision of public goods is influenced by status concerns. This theoretical finding is supported by empirical evidence.

[3]In the words of Blanton and Christie (2003), "People try to stick out from others in good ways but not in bad ways." This points towards the possibility of an important effect of snobbism on charitable giving.

From a more theoretic perspective, Romano and Yildirim (2001) study the effect of status concerns on charitable giving. Utility depends on private and public good consumption, but also on social context. The warm glow and snob effects can explain why charities announce the contributions they receive from donors. Then, playing a sequential-move game after announcing the receipts can increase the total contributed amount.

In another theoretical study, Muñoz-García (2011) explores the role of the status concern as an incentive for the private provision of a public good. These concerns can induce selfish agents to privately provide a public good. This study is supported by references on experimental studies. We support the hypothesis that social status enters into agents' preferences. However, we relax the assumption that status reduces the marginal utility of public good consumption. We consider, instead, separability between the public good consumption and the positional payoffs associated with an agent's relative contribution. Moreover, while Muñoz-García analyzes the effect of status-seeking behavior on contributions, we also analyze its effect on social welfare.

The competition for social status and its effect on the private provision of a public good as well as on social welfare are also explored in Bougherara et al. (2019). They analyze the interaction between status-seeking agents and give results on total contribution and social welfare assuming a simultaneous rise in all agents' positional concerns. We explicitly characterize the equilibrium in a two-agent game and focus on the effect of one agent's positional concern on total contribution and social welfare.

The literature on the private provision of a public good and status effect, modeled as a game, is scarce. To the best of our knowledge, this is the first analysis considering two types of agents: positional and conformist.

3 | PUBLIC GOOD GAME

This section describes the strategic interaction in a static public good game between two individuals: the positional player, P, who seeks exclusiveness, and the conformist player, C, who "follows the herd" and tries to mimic other people's behavior.

Player $i \in \{P, C\}$ is endowed with w, contributes $g_i \in [0, w]$ to a public good, and consumes $w - g_i$ in other private goods. This player's total utility is the addition of the intrinsic utility plus the social concern payoff (SCP):

$$U_i(g_i, g_j) = u_i(g_i, g_j) + V_i(g_i, g_j), \tag{1}$$

where the subindex "$j \in \{P, C\}$" refers to the opponent of player i. In line with Grilo et al. (2001), Bougherara et al. (2019), or Grolleau et al. (2012), we assume additive separability between absolute effects (of private and public good consumption) and status concerns from agent's relative contribution.[4]

Each player $i \in \{P, C\}$ solves a maximization problem:

$$\max_{g_i} U_i(g_i, g_j) \tag{2}$$

[4]We deviate from the nonadditivity assumption in Muñoz-García (2011), because we do not see whether the marginal utility of public good should be increasing or decreasing with relative contribution, or not depend on it at all.

$$\text{s.t. } 0 \le g_i \le w. \tag{3}$$

The global utility or social welfare is defined as the addition:

$$SW(g_i, g_j) = U_i(g_i, g_j) + U_j(g_j, g_i).$$

3.1 | Intrinsic utility

Both players obtain intrinsic utility from absolute consumption, defined as a quasilinear function. Following Varian (1994) the intrinsic utility is linear in private consumption and concave and increasing in the total amount of public good. This same quasilinear structure is assumed in Muñoz-García (2011) and Laury et al. (1999). The latter considers a quadratic utility from public good consumption likewise as Bougherara et al. (2019). As observed by Laury et al. (1999), the marginal utility from public good consumption decreases, as well as the marginal utility from private consumption. However, the rate of decay is much less pronounced for the latter than the former. We find adequate the assumption of a linear effect of private consumption on utility, based on the idea that the noncontributed amount can be used for many different purposes, which can help escape the decay in the marginal utility. In consequence, we assume the following expression for the intrinsic utility:

$$u_i(g_i, g_j) = w - g_i + b(G), \quad i, j \in \{P, C\}, \;\; G = g_i + g_j \tag{4}$$

with

$$b(G) = \begin{cases} \alpha\left(G - \frac{1}{2}G^2\right) & \text{if } G < 1, \\ \frac{\alpha}{2} & \text{if } G \ge 1 \end{cases} \tag{5}$$

with $\alpha > 0$.

Global intrinsic utility for society is

$$u(g_i, g_j) = u_i(g_i, g_j) + u_j(g_j, g_i) = 2w - G + 2b(G). \tag{6}$$

Because $b(G)$ is increasing and concave, every player i has incentives to free-ride on her rival's contributions, $\partial u_i/\partial g_j \ge 0$, and contribution are strategic substitutes, $\partial^2 u_i/(\partial g_i \partial g_j) \le 0$.

The public good game is defined assuming that the intrinsic utility satisfies two additional properties.

(C1) No one wishes to contribute

$$\frac{\partial u_i}{\partial g_i}(g_i, g_j) \le 0 \Leftrightarrow \alpha(1 - G) \le 1, \forall\, G \in [0, 2w].$$

(C2) Some private contributions to the public good but also some private consumption are socially desirable

$$\frac{\partial u}{\partial g_i}(0,0) > 0, \quad \frac{\partial u}{\partial g_i}(w,w) < 0 \Leftrightarrow 2\alpha(1-2w) < 1 < 2\alpha.$$

The free-riding incentive, substitutability of contributions, and conditions C1 and C2 are satisfied under the following assumptions:

Assumption 1. $\frac{1}{2} < \alpha \le 1, i \in \{P, C\}$.

Assumption 2. $w > \frac{2\alpha - 1}{4\alpha}$.

Assumption 1 guarantees C1 and Assumptions 1 and 2 guarantee C2. By condition C1, no player would individually contribute in a Nash equilibrium, even if by Condition C2 positive contributions are socially desirable. From (6), the global intrinsic utility for the two players only depends on the global amount of public good and can be written (with a slight abuse of notation) as $u(G)$. We define as G^{SO} and G^{E0} the maximum of the global intrinsic utility and a contribution level above which intrinsic utility falls below the utility at zero contribution, respectively. With our functional form they read:

$$G^{SO} \equiv (2\alpha - 1)/(2\alpha), \quad G^{E0} = 2G^{S0}. \tag{7}$$

From condition C2, the maximum global intrinsic utility is reached at an interior contributed amount, $0 < G^{SO} < 2w$. Moreover, although $b'(G) \ge 0$, given the assumption of diminishing marginal utility, there exists a contribution level, G^{E0}, above which intrinsic utility falls below the utility at zero contribution, $u(G^{E0}) = 2w$ and $u(G) < 2w, \forall\, G > G^{E0}$. From the point of view of the intrinsic utility, contributions can be in shortage $G < G^{SO}$, in excess $G > G^{SO}$, or at its efficient level, $G = G^{SO}$. Under shortage, additional contributions improve the intrinsic utility. However, under excess, contributions reduce intrinsic utility and indeed, if contributions are very high, intrinsic utility would fall below $2w$. Thus, contributions are intrinsic welfare improving when $G < G^{E0}$ (IW-I), or intrinsic welfare reducing when $G > G^{E0}$ (IW-R). These two situations are feasible since $1/2 < \alpha \le 1$, and then $0 < G^{SO} < G^{E0} \le 1$.

As defined in (4), the positional and the conformist player share the same intrinsic utility. Next, we show that they are asymmetric in their social concerns.

3.2 | Positional player

A positional or snob agent, P, seeks social status by contributing more than others. This agent gains (loses) an SCP, defined as a constant fraction of her contribution above (below) that of the other player:

$$V^P(g_P, g_j) = v^P(g_P - g_j), \quad j \in \{P, C\}. \tag{8}$$

Parameter v^P will be called the player's positional concern. The functional form in (8) satisfies the properties required in Grolleau et al. (2012). Net utility from status increases with the contributions of the positional player and decays with the contributions of the other player. They also suppose that marginal utility from status does not increase with the relative status level. We have considered that it is zero for simplicity.[5]

When $G = g_P + g_j \leq 1$, the marginal utility of a positional player is

$$\frac{\partial U_P}{\partial g_P}(g_P, g_j) = -1 + \alpha(1 - G) + v^P = -\theta(G) + v^P \tag{9}$$

with[6]

$$\theta(x) = 1 - \alpha + \alpha x. \tag{10}$$

If $G \geq 1$, this marginal utility is simply $-1 + v^P$. In the absence of positional concerns, $-\theta(G) < 0$ denotes the marginal utility ($\theta(G)$ the marginal dis-utility) from contributing an additional unit, assuming a level of public good equal to G. It is given by the marginal loss of contributing, -1, plus the marginal gain from an additional unit of public good, $b'(G) \geq 0$. Hence, an agent with a positional concern greater or equal to one would always contribute her total endowment, regardless of what the other player might do. To avoid this extreme situation, we introduce an additional assumption:

Assumption 3. $0 \leq v^P < 1$.

From now on, we assume that Assumptions 1–3 are satisfied.

From (9) it straightforwardly follows that $\partial^2 U_P(g_P, g_j)/(\partial g_P \partial g_j) = -\alpha < 0$, and hence, private contributions are regarded as substitutes by the positional player.

Under Assumption 3, the function $U_P(g_P, g_j)$ is increasing in g_P for $g_P \leq 1 - (1 - v^P)/\alpha - g_j$ and decreasing above this threshold, in particular, when $g_P \geq 1 - g_j$. Then it follows that the best-response function of a positional agent playing a public good game reads

$$g_P^b(g_j) = \begin{cases} 0 & \text{if } v^P \leq \theta(g_j), \\ r^P(g_j) \equiv A - g_j & \text{if } \theta(g_j) < v^P < \theta(w + g_j), \\ w & \text{if } \theta(w + g_j) \leq v^P \end{cases} \tag{11}$$

with

$$A = \frac{v^P - (1 - \alpha)}{\alpha}. \tag{12}$$

Note that A represents the total amount of public good where marginal benefit equals marginal cost for the positional player at the interior. The analysis simplifies in the particular case, $\alpha = 1$, in which the utility from public and private good consumption weighs the same,

[5]A linear concern will be enough to induce positive contributions on the positional player (see equation (9)).

[6]Under Assumption 1, $\theta(x)$ is strictly increasing in x and $\theta(0) = 1 - \alpha > 0$. Therefore, $\theta(x)$ will be strictly positive for positive contributions x.

then $A = v^P$. The best response would be zero contribution if $v^P < g_j$, full contribution if $v^P > w + g_j$, or $v^P - g_j$ in the interior case.

The properties of the positional player's best response can be summarized in the following proposition. The proofs of all nonstraightforward propositions are presented in the appendix.

Proposition 1.

(i) *A positional player never contributes more than the total amount A where marginal cost and marginal benefit equate for this player.*
(ii) *If $v^P \leq 1 - \alpha$, she never contributes.*

If $0 \leq v^P < 1 - \alpha$, the marginal utility from public good consumption never surpasses the marginal cost from its private provision, and the positional player would not be willing to privately provide the public good. Conversely, if $v^P > 1 - \alpha$, the agent is willing to privately provide some public good.

3.3 | Conformist player

The second type of player is also influenced by social context, although in a different way than the positional player. Conformist agents feel better if their behavior fits the average behavior in society. In our formulation, the well-being of the conformist player decreases if her contribution deviates (above or below) from the contribution level of the other player. For the conformist player, the SCP always represents a loss which enlarges with the contribution gap, regardless of whether she contributes above or below her opponent:

$$V^C(g_C, g_j) = -\frac{v^C}{2}(g_C - g_j)^2, \quad j \in \{P, C\}. \tag{13}$$

Parameter $v^C \geq 0$ denotes this agent's degree of conformism.

Again following Grolleau et al. (2012) we consider that the well-being of a conformist decreases if her contribution is lower or higher than that of the other player. Likewise, an increase in the other's contribution will raise (resp., harm) the utility of an individual if her contribution is above (resp., below) the other player's contribution. Moreover, the marginal utility from conformism increases with the other player's contribution. This allows players' contributions to become complements.[7]

Note that expressions (8) and (13) are asymmetric in two regards. The positional player enjoys gains when she contributes more than her opponent, and suffers losses when she contributes less than her opponent. By contrast, the conformist suffers symmetric losses regardless of whether she contributes above or below her opponent. On the other hand,

[7]We consider the case where the marginal utility from conformism strictly increases with the other player's contribution. A linear conformist SCP (based on the absolute value of the difference) would lead to no contribution from the conformist.

The SCP are linear for the positional and quadratic for the conformist in the contribution differential.

Introducing conformism to intrinsic utility, the marginal utility from private contributions to the public good reads

$$\frac{\partial U_C}{\partial g_C}(g_C, g_j) = -1 + \alpha(1 - G) - \nu^C(g_C - g_j) = -\theta(G) - \nu^C(g_C - g_j). \tag{14}$$

The marginal utility from private provision can be greater or lower than in the case without concern for social status, depending on whether the conformist player contributes less or more than her opponent. If the other player provides more public good than the C player, the latter has an incentive to increase contributions, which increases the marginal utility of the private provision. Under these circumstances, status concerns can make some contributions individually desirable for the conformist player. However, the opposite reasoning applies when the other player provides less than the C player.

From (14) it straightforwardly follows that $\partial^2 U_C(g_C, g_j)/(\partial g_C \partial g_j) = \nu^C - \alpha \gtrless 0$ and hence, private contributions are regarded as substitutes by a conformist player who is not too strongly affected by the social context, $\nu^C < \alpha$. Conversely, with a strong degree of conformism, $\nu^C > \alpha$, private contributions become complements.

From the first order conditions (FOC) of the problem (2) and (3) for the C player, the best response of a conformist player reads

$$g_C^b(g_j) = \begin{cases} 0 & \text{if } g_j = 0 \text{ or } g_j > 0 \wedge \nu^C \leq \alpha + (1-\alpha)/g_j, \\ r^C(g_j) \equiv \frac{\nu^C g_j - \theta(g_j)}{\nu^C + \alpha} = r(g_j - B) & \text{if } g_j > 0 \wedge \nu^C > \alpha + (1-\alpha)/g_j \end{cases} \tag{15}$$

with

$$B = \frac{1-\alpha}{\nu^C - \alpha}, \quad r = \frac{\nu^C - \alpha}{\nu^C + \alpha}. \tag{16}$$

In the particular case of $\alpha = 1$, the best response to a positive contribution of the other player is not to contribute if $\nu^C < 1$. By contrast, the best response would be linear (i.e., $B = 0$) and with a positive slope if $\nu^C > 1$.

This best-response function enjoys some properties,

Proposition 2.

(i) *The conformist will contribute a smaller amount than the other player, or an equal amount when no player contributes.*

(ii) *The conformist never contributes her total endowment.*

(iii) *Under substitutability ($\nu^C \leq \alpha$) the best response is zero contribution.*

Under complementarity ($\nu^C > \alpha$) the best-response function is upward-sloping. In this case, B represents the value of g_j above which the conformist player will contribute a positive amount.

In the following sections, we study the game between two conformist players, two positional players, and the game with one positional and one conformist player.

4 | TWO CONFORMIST PLAYERS

If we consider the game between two conformist players the Nash equilibrium is no contribution. From (15) we observe that the best response of a coformist player to an increment in the other player's contribution is to raise her own, but only if $v^C > \alpha$ (complementarity). Even in that case, it would be a less than one-to-one response. In fact by Proposition 2(i) the sequence of best responses of both players converges. Players underbid each other until all contributions are zero. Thus, the Nash equilibrium in this case is stated as:

Corollary 3. *In a game with two coformist players, the unique Nash equilibrium is no contribution.*

The case of two coformist players leads to zero contribution, but this result is not necessarily true when a positional player enters the game.

5 | TWO POSITIONAL PLAYERS

In this section we consider the game between two positional players. We denote with $v_i^P, i \in \{1, 2\}$ the positional concerns. Hence, the global contributed amount from the FOC of each positional player is

$$A_i = \frac{v_i^P - (1-\alpha)}{\alpha}. \tag{17}$$

From (11), if follows that the intercept, $A_i > 0$, of the interior downward-sloping best response by the ith positional player is positive under the condition:

$$v_i^P > 1 - \alpha. \tag{18}$$

Henceforth, in this section and with no loss of generality, we denote by 1 (resp., 2) the player with the highest (resp., lowest) positional concern, that is,

$$v_1^P \geq v_2^P.$$

Note that $A_1 \geq A_2 \Leftrightarrow v_1^P \geq v_2^P$.

In the rest of the paper, we focus the analysis on the solution with a positive public good but where no player contributes her total endowment (i.e., we assume that endowments are sufficiently large). We believe that they are the most interesting cases because they highlight the less intuitive theoretical result. Moreover, they are interesting in practical situations. For the global analysis of the different equilibria see the appendix.

5.1 | Nash equilibria

Proposition 4 (Nash equilibria, PP case). *Let* $\left(g_1^N, g_2^N\right)$ *denote a Nash equilibrium of the game* (2) *and* (3) *with two positional players.*

Under assumption $1 - \alpha < v_1^P < \theta(w)$ *then*

(I) *If* $v_1^P = v_2^P$ (*i.e.*, $A_1 = A_2 = A > 0$), *the set of Nash equilibria is given by*

$$\mathcal{N} = \left\{\left(g_1^N, g_2^N\right) \middle| \; g_1^N + g_2^N = A \wedge \left(g_1^N, g_2^N\right) \in [0, A]\right\}.$$

(II) *If* $v_1^P > v_2^P$ (*i.e.*, $A_1 > 0$ *and* $A_1 > A_2$),

$$\left(g_1^N, g_2^N\right) = (A_1, 0). \tag{19}$$

Assumption $1 - \alpha < v_1^P < \theta(w)$, considered henceforth for the PP case, implies a sufficiently large v_1^P to allow positive contribution by the player with the highest positional concern and at the same time, a sufficiently large endowment for this player not to contribute it all. This region is depicted in Figure 1 in the (v_2^P, v_1^P) plane. In the bisector $v_1^P = v_2^P$ there are a multiplicity of solutions. When the positional concerns of the two players are different, with no loss of generality we study the region above the bisector, with $v_1^P > v_2^P$.

In either case, the total contribution, $G = A_1$, corresponds to the first-order condition of the player with the highest positional concern, player 1. Only this player contributes, while the other positional player does not contribute. This result comes from the fact that both the cost of contributing and the benefit from the positional preferences are linear. Hence, if $v_1^P > v_2^P$, player 1 stops contributing when his marginal benefit from contributing (including the linear benefit from the positional preferences) equals his marginal cost. At this point, the marginal benefit for player 2 is strictly lower than the marginal cost, and this player does not contribute.

Corollary 5. *In the particular case* $\alpha = 1$, *Nash equilibria exist whenever* $0 < v_1^P < w$. *The total contribution equates* v_1^P. *Further, the region with no contribution disappears.*

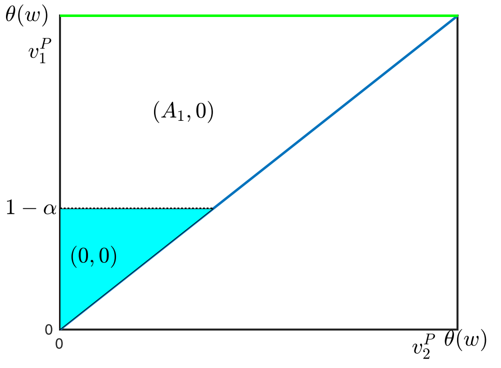


FIGURE 1 Regions with different equilibria for PP case (bII) $A_1 > A_2$.

5.2 | Welfare analysis

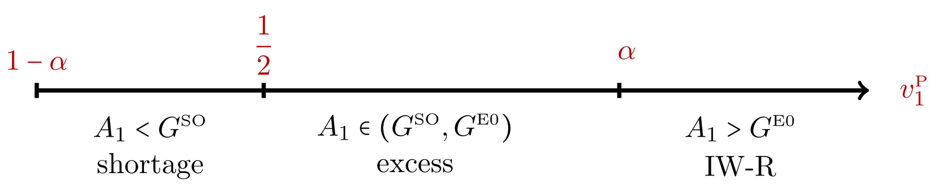
In the global utility or social welfare, two parts can be distinguished: the intrinsic social welfare, $u(G)$, and the aggregate positional payoffs, $V(g_1, g_2) = V_1(g_1, g_2) + V_2(g_2, g_1)$. Social welfare can be written as

$$SW(A_1) = u(A_1) + V(A_1, 0) = 2w - A_1 + 2A_1\alpha\left(1 - \frac{A_1}{2}\right) + \left(v_1^P - v_2^P\right)A_1. \tag{20}$$

Positional concerns have a double effect on social welfare. On the one hand, the positional concern of player 1, by inducing public good provision, A_1, indirectly influences the intrinsic utility. On the other hand positional concerns also directly determine positional payoffs. Moreover, these payoffs crucially depend on the players' relative contribution, A_1, which, in turn, is also affected by the positional concern of player 1. In the next propositions, we characterize the conditions under which the positive contributions made possible by the existence of positional concerns can improve the intrinsic utility (net of positional payoffs) and the social welfare (introducing positional payoffs).

Proposition 6. *Global contribution, A_1, is, in shortage, $A_1 < G^{SO}$, if $v_1^P \in (1 - \alpha, 1/2)$; in excess, $A_1 \in (G^{SO}, G^{E0})$, if $v_1^P \in (1/2, \alpha)$, or intrinsic welfare reducing; $A_1 > G^{E0}$, if $v_1^P \in (\alpha, 1)$.*

Proposition 6 states that the global contribution is in shortage, in excess, or intrinsic welfare reducing, depending on whether the positional concern of player 1 is low, medium, or high. This result is summarized in the next diagram



Corollary 7. *In the particular case $\alpha = 1$, shortage occurs for $v_1^P \in (0, 1/2)$ and excess for $v_1^P \in (1/2, 1)$. Contributions associated with the existence of a social context are never intrinsic welfare reducing.*

Next, we analyze the effect of the positional concern of player 1 on the global intrinsic utility, the global SCP, and the social welfare. The subscript "$A0$" refers to the equilibrium of Proposition 4(II).

Proposition 8. *The positional concern of player 1, v_1^P, affects:*

(i) *the global intrinsic utility,*

$$\frac{\partial u_{A0}}{\partial v_1^P} = \frac{1 - 2v_1^P}{\alpha} \gtrless 0 \Leftrightarrow v_1^P \lessgtr \frac{1}{2},$$

(ii) *the global SCP,*

$$\frac{\partial V_{A0}}{\partial v_1^P} > 0,$$

(iii) *and the social welfare,*

$$\frac{\partial SW_{A0}}{\partial v_1^P} \gtreqless 0 \Leftrightarrow v_2^P \lesseqgtr \alpha.$$

A higher positional concern of player 1 enhances global contribution, and a greater contribution increases global intrinsic utility if the marginal cost of providing it is lower than the global marginal benefit. This occurs when the contribution is in shortage, that is, iff $v_1^P < 1/2$. Opposite reasoning applies under excess contribution, $v_1^P > 1/2$.

Moreover, the SCP to both players is also influenced by a higher v_1^P from price and quantity effects. The price effect only affects player 1 (positively because the gap between player's contributions is always positive, A_1). The quantity effect of a wider gap between the players' contributions enhances the social concern gains for player 1 but also the social concern losses for player 2. Because player 1 has stronger positional concern than player 2, the quantity effect is also positive, and hence the global SCP rises with v_1^P.

Under a shortage in contributions, the higher positional concern of player 1 raises contributions, intrinsic utility, and global SCP, hence implying greater social welfare. Under excess contributions, a rise in v_1^P worsens intrinsic utility although it improves global SCP. On aggregate, the second effect is stronger, and social welfare increases except when both players have large and similar positional concerns, $v_1^P \geq v_2^P > \alpha$.[8] This result is illustrated in Figure 2, which represents the level curves of the social welfare in the (v_2^P, v_1^P) plane, in the general case with $v_1^P > v_2^P$, as well as in the limiting case with symmetric players, represented by the bisector $v_1^P = v_2^P$.

Up-left movements (orthogonal to the $v_1^P = v_2^P$ line) in Figure 2 show that the more unequal the distribution of positional concerns (the stronger the role played by the positional payoffs), the greater the social welfare.

Figure 2 also draws the u^0 level curve, where the global utility equates the utility of zero contribution. The utility of zero contribution is attained when player 2 has a positional concern equal to α. Contributions improve global utility above the u^0 level for positional concerns pairs to the left of this curve, but lead utility below this level to the right of this curve.

Corollary 9. *In the particular case $\alpha = 1$, social welfare always increases with v^P.*

6 | ONE POSITIONAL AND ONE CONFORMIST PLAYER

6.1 | Nash equilibria

Likewise as in the case of two positional players, a positive contribution by the positional player requires condition (18) of a sufficiently large positional concern: $v^P > 1 - \alpha$. This opens up the possibility for positive contributions for the conformist player as well. But, assuming (18) is satisfied, under what circumstances would the conformist player imitate the positional player and contribute?

[8] On the other hand, a higher positional concern of player 2 always reduces social welfare because it does not affect total contribution while it narrows the contribution gap.

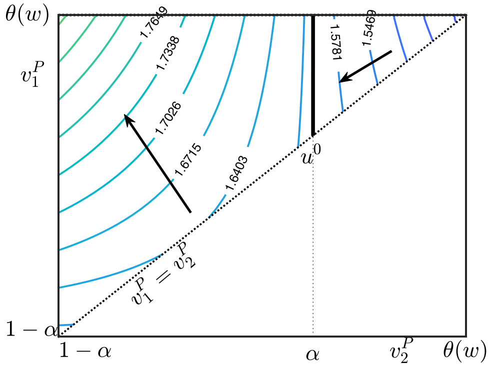


FIGURE 2 Level curves for social welfare for $\alpha = 2/3$, $w = 0.8$.

According to Proposition 2, for a moderate degree of conformism, $v^C < \alpha$, this player regards g_P and g_C as substitutes and would contribute nothing, no matter how much the positional player contributes. Interestingly, if the degree of conformism is above α, complementarity can induce the conformist player to contribute, following the behavior of the positional one. However, the conformist player imitates the positional one only if the contribution of this latter is large enough; in particular, greater than B, which marks the minimum contribution by the positional player to induce positive contributions from the conformist (positive marginal utility of the first unit contributed by this player). The positional player never contributes above her endowment or the interior amount. Hence, $0 < B < \min\{A, w\}$ is a necessary condition, or equivalently,

$$v^C > \underline{v}^C(v^P) \equiv \begin{cases} \alpha + \frac{1-\alpha}{A} = \frac{v^P}{A} & \text{if } 1 - \alpha < v^P < \theta(w), \\ \alpha + \frac{1-\alpha}{w} = \frac{\theta(w)}{w} & \text{if } v^P \geq \theta(w). \end{cases} \tag{21}$$

Given that the threshold $\underline{v}^C(v^P)$ is larger than α, condition (21) can be interpreted as a strong complementarity requirement for the conformist player to contribute a positive amount. Conversely, weak complementarity is defined as $v^C \in (\alpha, \underline{v}^C(v^P))$. In this case, complementarity is not enough to induce the conformist agent to contribute.

As in the case of two positional players, we focus the analysis on the solution with a positive public good but where no player contributes to her total endowment. The global analysis of the different equilibria can be found in the appendix.

Proposition 10 (Nash equilibria, PC case). *Let (g_P^N, g_C^N) denote a Nash equilibrium of the game* (2) *and* (3) *with one positional and one conformist players.*

Then this Nash equilibrium is unique.

Assume $v^P > 1 - \alpha$

(I) *If $v^C \leq \underline{v}^C$ and $v^P < \theta(w)$ then*

$$\left(g_P^N, g_C^N\right) = (A, 0).$$

(II) *If* $v^C > \underline{v}^C$, *then there exists an interior equilibrium*, $g^N_{int} = (g^N_{Pint}, g^N_{Cint})$,

$$g^N_{Pint} = \frac{1}{2}\left(A + \frac{v^P}{v^C}\right), \quad g^N_{Cint} = \frac{1}{2}\left(A - \frac{v^P}{v^C}\right), \quad \text{if} \\ v^P < \bar{v}^P(v^C) \equiv \theta(2w)\frac{v^C}{v^C + \alpha}. \tag{22}$$

An interior solution arises when positionality does not push the positional player to contribute her total endowment, or the conformism is strong enough so that the positional player can rely on some contribution by the conformist player and does not need to contribute in full.

It is now possible to have a positive contribution for both players. The reason is that the SCP for the conformist is quadratic, and not linear. Hence, for a given contribution of the positional player, the marginal benefit for a conformist in terms of SCP decreases with her own contribution. This means that, while the total contributions continue to correspond to the FOC of the positional player $G = A$, the case with a positional and a conformist player has an interior equilibrium in which both players contribute a strictly positive amount. Figure 3 depicts, in the (v^C, v^P) plane, the regions for the different Nash equilibria depending on the degree of conformism and the positional concern, considering the same parameter values as in the case of two positional players. The figure illustrates, in red, the line $v^P = \bar{v}^P(v^C)$ in (22), which represents the positional concern at which the interior solution of the positional player reaches her total endowment, $g_{Pint} = w$. It also features, in green, $\theta(w)$ which is the minimum positional concern at which the public good provided exclusively by the positional player equals her endowment. The intersection between $v^P = \theta(w)$ and $v^C = \underline{v}^C(v^P)$ is the point $(\theta(w)/w, \theta(w))$.

Moreover, it is straightforward to prove the following properties for contributions:

Proposition 11. *Global contribution matches the amount of public good which satisfies the FOC of the positional player,* $G^N = A$. *The contribution gap is given by* A *in the* $(A, 0)$ *case and by* v^P/v^C *in the interior case.*

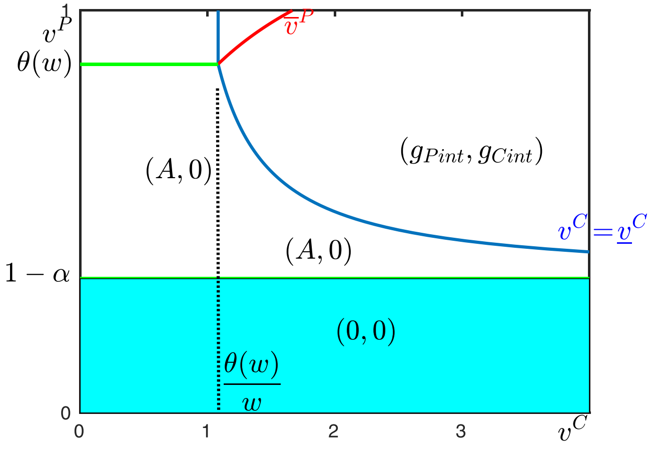


FIGURE 3 Regions with different equilibria for PC.

Remark 1. An interior solution is compatible with a global contribution above the endowment within the set:

$$\Omega = \{(v^C, v^P) | v^C > \underline{v}^C(v^P) \;\text{ and }\; v^P \in (\theta(w), \bar{v}^P)\}.$$

The set Ω corresponds to the up-right region in Figure 3 where the positional player does not contribute in full ($v^P < \bar{v}^P$), the conformist is willing to contribute ($v^C > \underline{v}^C$) and $A > w$ (i.e., $v^P > \theta(w)$). Note that this situation (global contribution greater than the endowment) was not possible in the PP case.

6.2 | Welfare analysis

This section analyzes the effect of v^P and v^C on the private provision of the public good and social welfare. We first characterize how one player's positionality/conformism affects her as well as her opponent's contribution. The proof of the following properties is straightforward.

Proposition 12.

- A greater positional concern, v^P, implies

$$\frac{\partial g_{Pint}}{\partial v^P} = \frac{\partial g_{PA0}}{\partial v^P}, \frac{\partial g_{Cint}}{\partial v^P}, \frac{\partial G_{int}}{\partial v^P} = \frac{\partial G_{A0}}{\partial v^P}, \frac{\partial \Delta g_{int}}{\partial v^P}, \frac{\partial \Delta g_{A0}}{\partial v^P} > 0, \frac{\partial g_{CA0}}{\partial v^P} = 0.$$

- A greater degree of conformism, v^C, implies

$$\frac{\partial g_{Pint}}{\partial v^C} < 0, \quad \frac{\partial g_{Cint}}{\partial v^C} > 0, \quad \frac{\partial \Delta g_{int}}{\partial v^C} < 0, \quad \frac{\partial G_{int}}{\partial v^C}, \frac{\partial g_{PA0}}{\partial v^C}, \frac{\partial g_{CA0}}{\partial v^C}, \frac{\partial G_{A0}}{\partial v^C}, \frac{\partial \Delta g_{A0}}{\partial v^C} = 0.$$

A stronger positional concern will increase the contribution of the positional player. In the interior case, the contribution of the conformist player also increases due to the strong complementarity. The contribution rise is stronger for the positional player than for the conformist one. As a result, the gap between players' contributions always widens.

A higher degree of conformism will not affect players' contributions in the $(A, 0)$ case, while it will induce the conformist player to increase her contribution in the same amount as the positional player reduces her contribution in the interior case. Hence, in this case, the distribution of contributions between the two players becomes more equalitarian, although the global contribution remains unchanged.

Depending on the value of v^P, the global contribution is in shortage, in excess, or leads the global intrinsic utility below its zero-contribution value. Conditions are given in Proposition 6, just replacing v_1^P with v^P.

Next, we analyze the effect of the positional concern, first, and the degree of conformism, later, on the global intrinsic utility (which is the same in the $(A, 0)$ or the interior case), the global SCP, V_{int} or V_{A0}, and the global social welfare, $SW_{int} = u + V_{int}$ or $SW_{A0} = u + V_{A0}$. Their values can be written as

$$u = 2w - A + \alpha(2A - A^2), \quad V_{int} = \frac{(v^P)^2}{2v^C}, \quad V_{A0} = A\frac{2v^P - v^C A}{2}. \tag{23}$$

Proposition 13. *The positional concern, v^P, has an effect on:*

(i) *the global intrinsic utility,*

$$\frac{\partial u}{\partial v^P} = \frac{1 - 2v^P}{\alpha} \gtrless 0 \Leftrightarrow v^P \lesseqgtr \frac{1}{2},$$

(ii) *the global SCP,*

$$\frac{\partial V_{int}}{\partial v^P}, \frac{\partial V_{A0}}{\partial v^P} > 0$$

(iii) *and the social welfare,*

$$v^P \leq \frac{1}{2} \Rightarrow \frac{\partial SW_{int}}{\partial v^P} > 0, \qquad \frac{\partial SW_{A0}}{\partial v^P} \gtrless 0 \Leftrightarrow v^C \lesseqgtr B_{A0}^{SW}(v^P),$$
$$v^P > \frac{1}{2} \Rightarrow \left(\frac{\partial SW_{int}}{\partial v^P} \gtrless 0 \Leftrightarrow v^C \lesseqgtr B_{int}^{SW}(v^P)\right),$$

where

$$B_{int}^{SW}(v^P) \equiv \frac{\alpha v^P}{2v^P - 1}, \quad B_{A0}^{SW}(v^P) \equiv \frac{\alpha^2}{v^P - (1 - \alpha)}.$$

To analyze the effect of the positional concern on the intrinsic utility and social welfare, we distinguish three cases depending on the player's endowment: high, $\alpha \leq \theta(w)$, medium, $1/2 \leq \theta(w) \leq \alpha$, or low $\theta(w) \leq 1/2$.

As in the PP case, intrinsic social welfare increases (resp., decreases) with the positional concern when $v^P < 1/2$ (resp., when $v^P > 1/2$). The large global contribution in region Ω, is intrinsic utility reducing with large or medium endowment ($\theta(w) > 1/2$), but intrinsic utility enhancing with low endowment (see Figure 4). What matters is the position of $\theta(w)$ with respect to 1/2.

Note that in the $(A, 0)$ case, $v^C \leq \underline{v}^C = v^P/A$. Then, a positional concern smaller than the weight given to the utility from public good consumption ($v^P < \alpha$) is a sufficient condition for $dSW_{A0}/(dv^P) > 0$.

The effect of a higher positional concern on the global intrinsic utility mimics the effect of v_1^P in the case of two positional agents. Under a shortage in contributions, higher positional concern raises contributions, intrinsic utility, and global SCP, hence implying greater social welfare. Under excess contributions, a rise in v^P worsens intrinsic utility although it improves

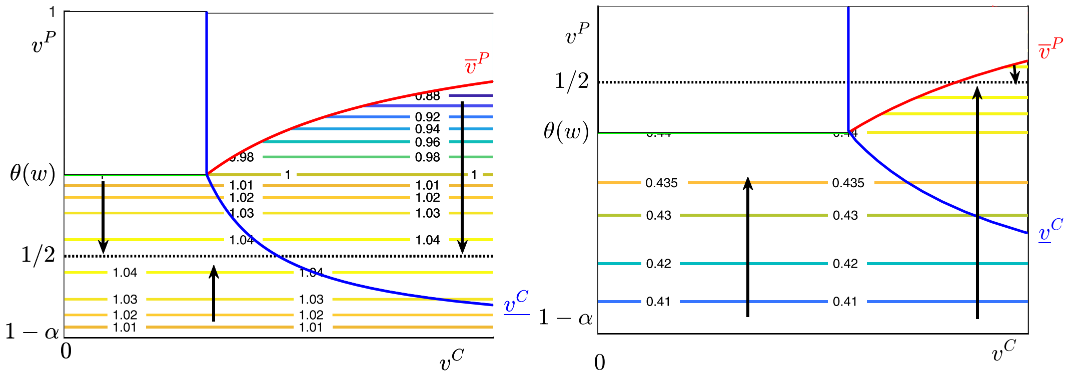


FIGURE 4 Level curves for intrinsic social welfare for $\alpha = 2/3$, $w = 0.8$ (left) and $w = 0.2$ (right).

global SCP. On aggregate, the second effect is stronger, and social welfare increases except if both players show large status concerns, $v^C > B_{A0}^{SW}(v^P)$ in the $(A, 0)$ case, or $v^C > B_{int}^{SW}(v^P)$ in the interior case. As shown in Figure 5, the level curves for social welfare increase with v^P to the left of these curves but they decrease with v^P to the right of them.[9] Moreover, the greater the degree of conformism, the narrower the region where higher positionality raises social welfare. In particular, the large contribution in region Ω reduces social welfare in the case with large endowment as shown in Figure 5 (left). Conversely, this large contribution can be social welfare enhancing in the case of medium or low endowment whenever the positional concern is not too large, laying below B_{A0}^{SW} or B_{int}^{SW} as shown in Figure 5 (right) for low endowment.[10]

Second, we analyze the effect of a higher degree of conformism, which only affects the social context payoffs. From the definitions in (23), for the interior and the $(A, 0)$ cases, we obtain the following results.

Proposition 14. *The degree of conformism, v^C, does not affect intrinsic utility. Therefore its effect on social welfare matches its effect on global SCP, given by*

$$\frac{\partial SW_{int}}{\partial v^C} = \frac{\partial V_{int}}{\partial v^C} = \frac{-(v^P)^2}{2(v^C)^2} < 0, \qquad \frac{\partial SW_{A0}}{\partial v^C} = \frac{\partial V_{A0}}{\partial v^C} = \frac{-A^2}{2} < 0.$$

The degree of conformism does not affect the total contributed amount. Hence, neither the intrinsic utility of the two players altogether is affected by conformism. However, a higher v^C influences the SCP. The "price" effect of a rise in the degree of conformism affects the conformist player negatively. This effect implies a reduction in social welfare in the $(A, 0)$ case. In the interior case, a higher degree of conformism has an additional effect: it narrows the gap between the players' contributions, which reduces the social concern gains for the positional player and the social concern losses for the conformist player. Thus, the total effect for society will be positive (negative) if the gain from a narrower gap for the conformist player is larger

[9]Some comments about the figure: the curve $v^C = B^{SW}(v^P)$, if depicted as a function of v^C, is decreasing with respect to v^C, and goes to 1/2 when v^C goes to infinity. Moreover when $\alpha < \theta(w)$ the point $(\alpha^2/(2\alpha - 1), \alpha)$ is the intersection of the curves, $v^C = \underline{v}^C$, $v^C = B_{int}^{SW}$ and $v^C = B_{A0}^{SW}$.

[10]Note that when $\alpha < \theta(w)$ the set Ω is placed above the curve $v^C = B^{SW}(v^P)$, but conversely when $\alpha > \theta(w)$ part of the set Ω is placed below this curve.

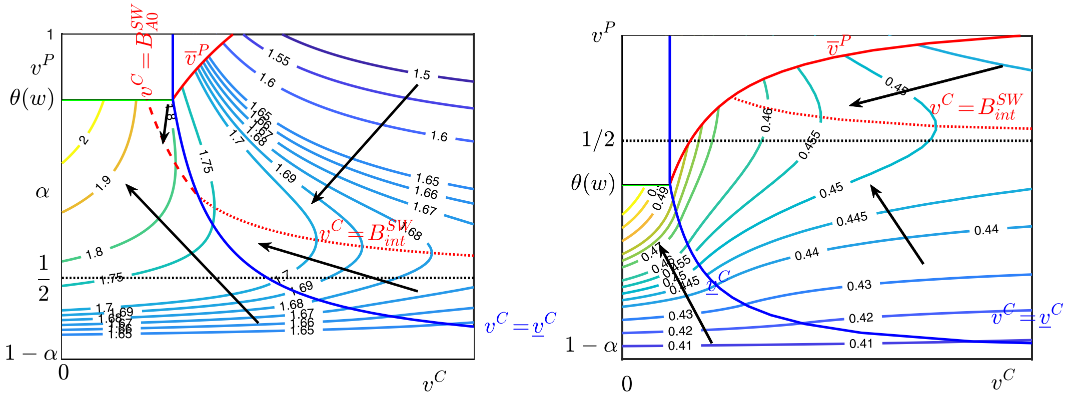


FIGURE 5 Level curves for social welfare for $\alpha = 2/3$, $w = 0.8$ (left) and $w = 0.2$ (right).

(smaller) than the addition of two negative effects: the negative "price effect" for this player from a more costly status concern plus the negative effect of a narrower gap on the positional player. Because we are assuming for simplicity of the exposition that the two players equally value public good consumption, the two negative effects are stronger than the positive effect and the net effect of a higher degree of conformism is a net loss in aggregated SCP, and hence a loss in social welfare also in the interior case.[11]

7 | CONCLUDING REMARKS AND EXTENSIONS

The paper analyzes the effect of status concerns on the voluntary provision of a public good. Two types of agents are considered depending on how they are affected by the social context. On the one hand, positional agents get utility from contributing more than their peers. On the other hand, conformist agents get dis-utility if they deviate from other agents' contributions.

The Nash equilibrium of the two-player game without social context effects would be zero contribution. We observe that this result would remain if both players wish to imitate one another. Positive contribution requires that at least one of the players shows positional concern and this concern is strong enough.

The main contribution of the paper is the analysis of the contributing behavior and the social welfare outcome under two specifications. Either a positional agent faces another positional agent (with smaller concern) or she faces a conformist agent. Focusing on the equilibria with positive global contribution but where no player contributes in full, we observe that:

- The social context can induce positive contribution, even when players wish to free-ride on other players' contributions. With two positional players only the player with the highest positionality contributes (except if they are both symmetric). With one positional player and one conformist player, either only the positional player contributes, or the two players

[11] A more general analysis, omitted here for simplicity, would assume different marginal utility from public good consumption for the two players. In that case, a higher degree of conformism could increase aggregated SCP if the PP values the public good more than the conformist and her positional concern is sufficiently small.

contribute (when they both have strong social concerns). In the latter case, the contribution of the conformist player is still the smallest.

- The global contribution is the same under both specifications when at least one of the players is not too much influenced by the social context. However, if both players have strong status concerns, the global contribution is upper bounded by the endowment of the positional player when she faces another positional player. Conversely, the global contribution can surpass her endowment when she faces a PC (in this case both agents contribute to the public good).
- This large contribution when both players show strong status concerns in the conformist player case:
  - is feasible because the conformist player's desire to imitate is stronger than her free-riding incentive. Interestingly, the positional player still enjoys some private consumption.
  - can lead to higher or lower intrinsic utility. It will be intrinsic welfare improving if endowment is low and positional concern is not excessively high.
  - can lead to higher or lower social welfare. It will improve social welfare if the endowment is not too high and positional concern is not excessively high.

We believe that one interesting extension would be an experiment joining the analysis of Laury et al. (1999) and Grolleau et al. (2012). Laury et al. (1999), in a lab experiment, show that agents consistently contribute above the zero contribution thesis predicted by the Nash equilibrium. Grolleau et al. (2012) propose a query to classify participants as positional or conformist. It would be interesting to define an experiment in which we first identify positional and conformist agents and let them play as in Laury et al. (1999) to check our predictions.

Other possible extensions of this paper are numerous. The zero contribution result in the case of two conformist players would not necessarily be true if there was also a gain for being the largest contributor. Realistically, people might care a lot about being the biggest donor to a cause, see, for example, d'Adda (2017). Thus the introduction of an agent that is a mix between a positional and a conformist at the same time seems an interesting extension for future research. Another line of research is the extension of the static game to a dynamic setting, considering that people's social concerns are built by comparing their current contribution to what they saw their peers contributed in the past. Alternatively, one could define a dynamic game in which dynamics is given by the stock of contribution that agents can observe. Like in Muñoz-García (2011) and Romano and Yildirim (2001), we can consider Stackelberg games but in a dynamic setting. It would also be interesting to consider several players, asymmetric situations, and the introduction of different types of agents like prosocial agents.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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APPENDIX A: PROOFS OF GENERAL PROPERTIES

A.1 | Proof of Proposition 1

If Assumption 3 holds, then the player's best response is given in (11). In the first two cases, the value of g_P^b is clearly less than A. In the third case, the contribution is w under the condition $\theta(w + g_j) \leq v^P$ which is equivalent to $w + g_j \leq A$. If it holds, then $w \leq A$ and the statement is proved.

Finally, statement (ii) follows from an increasing θ: the condition $v^P \leq 1 - \alpha = \theta(0)$ implies $v^P \leq \theta(g_j)$. Since it also implies Assumption 3, the player's contribution is given by the first line in (11).

A.2 | Proof of Proposition 2

Statement (i) is obvious if $g_C^b(g_j) = 0$. In the other case, we have $g_C^b(g_j) - g_j = -\theta(2g_j)/(v^C + \alpha)$ and we know that $-\theta(2g_j) < 0$.

Statement (ii) trivially follows from the previous statement since both players have the same endowment: since the contribution of the conformist is smaller than the contribution of the other player, and the other player greatest contribution is w, $r^C(g_j) < w$.[12]

Under substitutability $v^C \leq \alpha$ and hence $g_C^b(g_j) = 0$ trivially follows from (15) in which only the first condition can hold. Under complementarity $(r^C)'(g_j) = r > 0$. Moreover $r^C(g_j) = 0$ for $g_j = B$. This proves statement (iii).

A.3 | Proof of Corollary 3

Assume by contradiction that both players contribute an amount $g_i > 0, i = 1, 2$. By Proposition 2(i), we should have $g_i < g_j$ and $g_j < g_i$, which is a contradiction. Then one player must contribute $g_i = 0$, and we must have $g_j \leq g_i$, hence $g_j = 0$.

APPENDIX B: PROOFS FOR THE PP CASE

B.1 | Proof of Proposition 4 for all possible cases

Proposition 15 (Nash equilibria, PP all possible cases). *Let Assumptions 1 and 3 (for both, v_1^P and v_2^P) hold and let (g_1^N, g_2^N) denote a Nash equilibrium of the game (2) and (3) with two positional players.*

[12]When the endowments of the players are not equal, it becomes possible that the conformist player contributes her total endowment. Details can be found in Cabo et al. (2022).

(a) *If* $v_2^P \geq \theta(2w)$, *then* $(g_1^N, g_2^N) = (w, w)$.

(b) *If* $v_2^P < \theta(2w)$ *and*
(bI) $1 - \alpha < v_1^P = v_2^P$ (*i.e.*, $A_1 = A_2 = A > 0$), *the set of Nash equilibria is given by*

$$\mathcal{N} = \left\{\left(g_1^N, g_2^N\right) | g_1^N + g_2^N = A \wedge \left(g_1^N, g_2^N\right) \in [0, \min\{A, w\}]\right\}.$$

(bII) *If* $1 - \alpha < v_1^P$ *and* $v_1^P > v_2^P$ (*i.e.*, $A_1 > 0$ *and* $A_1 > A_2$),

$$\left(g_1^N, g_2^N\right) = \begin{cases} (w, A_2 - w), & \theta(w) < v_2^P < \theta(2w) \quad \text{(bII. 1)}, \\ (w, 0), & v_2^P \leq \theta(w) < v_1^P \quad \text{(bII. 2)}, \\ (A_1, 0), & v_1^P \leq \theta(w) \quad \text{(bII. 3)}. \end{cases} \tag{B1}$$

(c) *If* $v_1^P \leq 1 - \alpha$ (*i.e.*, $A_1 \leq 0$): $(g_1^N, g_2^N) = (0, 0)$.

The Nash equilibrium is unique, except in case (bI).

The following proof depends only on the numbers A_i. It applies also to the case where the function $b(\cdot)$ is increasing and concave in general (not necessarily of the form equation 5) and where each player has her own function $b_i(\cdot)$. Also, Proposition 4 is easily generalized to the case where endowments w_i are not the same for both players. Details are provided in Cabo et al. (2022).

As preliminary, recall that the best response of player i to player j's play g_j (see Equation 11 now written as a function of A_i) is

$$g_i^b(g_j) = \begin{cases} 0 & \text{if } A_i \leq g_j, \\ A_i - g_j & \text{if } A_i - w \leq g_j \leq A_i, \\ w & \text{if } g_j \leq A_i - w. \end{cases} \tag{B2}$$

Recall the assumption that $A_1 \geq A_2$. Assume first that $A_2 > 2w$. Then for every $g_i \leq w$, we have $g_i + w < A_j$. Therefore, $g_j^b(g_i) = w$. Similarly, $g_i^b(g_j) = w$ for all $g_j \leq w$. Then (w, w) is a Nash equilibrium, and it is the only possible one. We have proved statement a(a) of the proposition.

Assume next that $A_1 \leq 0$, which implies $A_2 \leq 0$. Then from Proposition 1i(i), $g_i^b(g_j) = 0$ for all $g_j \geq 0$ and $i \neq j$. This implies that $(0, 0)$ is a Nash equilibrium, and it is the only possible one. We have proved statement (c).

Next, assume that $A_1 = A_2 = A > 0$. Then for every $g_i \in [0, \min\{A, w\}]$, we have $g_j^b(g_i) = A - g_i$ and $g_i^b(g_j^b(g_i)) = A - (A - g_i) = g_i$. Then all feasible pairs of the form $(g_i, A - g_i)$ are Nash equilibria. We argue that no other equilibrium is possible. Assume for instance that $w > g_j > A$. Then $g_i^b(g_j) = 0$. But $g_j^b(0) = A$, so that $(0, g_j)$ is not an equilibrium. Other cases are similar. We have proved statement (bI).

There remains to prove statement (bII), in which $A_1 > 0$ and $A_2 < 2w$. The different situations are illustrated in Figure B1. When $A_2/2 < w \le A_2$, we deduce from (B2) that $g_2^b(g_1) = A_2 - g_1$ for all $g_1 \in [0, w]$. Indeed, since $g_1 \le w$, we have $g_1 \le A_2$ and the best response of player 2 cannot be 0, unless $A_2 = w = g_1$, in which case $g_2^b(g_1)$ is $A_2 - g_1$. Similarly, $g_2^b(g_1)$ cannot be w because $A_2 - w \le 0$, except if $A_2 = w$ and $g_1 = 0$. Consider now the best response of player 1 to $g_2 = A_2 - w$. It is w, since the condition $A_2 - w \le A_1 - w$ holds. This proves that $(A_2 - w, w)$ is a Nash equilibrium. To prove that it is the only one, assume that $g_1^N < w$: this would mean that $g_1^N = g_1^b(g_2^N) = A_1 - g_2^N$ (we know that $g_2^N \le w < A_1$) and consequently that $g_1^N + g_2^N = A_1$. Clearly (from Figure B1 left) there are no such pairs (g_1^N, g_2^N) that also satisfy $g_i^N \le w$ and $g_2^N = g_2^b(g_1^N)$. This proves statement (bII. 1).

Consider now the case $A_2 \le w < A_1$. All points (g_1^N, g_2^N) such that $g_2^N = g_2^b(g_1^N)$ and $g_2^N > 0$ are such that $g_1^N + g_2^N \le A_2$ and in particular, $g_2^N < A_2 < w$. From (B2), this implies that $g_1^b(g_2^N) = \min\{w, A_1 - g_2^N) = g_1^N$, then that $g_1^N + g_2^N = \min\{w + g_2^N, A_1\} \ge w$. This is a contradiction with $g_1^N + g_2^N \le A_2$, so that $g_2^N > 0$ cannot be true. Therefore, $g_2^N = 0$ and $g_1^N = g_1^b(0) = w$. Thus, $(w, 0)$ is the unique Nash equilibrium, and statement (bII. 2) is proved.

Finally, assume that $A_1 \le w$, which implies that $A_2 < w$. Then $g_i^b(g_j)$ cannot be w so that $g_i^b(g_j) = \max\{A_i - g_j, 0\}$ for $i = 1, 2$. But from Proposition 1(i), $g_2 \le A_2 < A_1$: therefore $g_1^b(g_2) = A_1 - g_2$. Consequently, $g_2^b(g_1^b(g_2)) = \max\{A_2 - (A_1 - g_2), 0\} = \max\{A_2 - A_1 + g_2, 0\}$. Because $A_2 \ne A_1$, the only way this expression can be equal to g_2 is when $g_2 = 0$. Thus, $(A_1, 0)$ is the unique Nash equilibrium, and statement (bII. 3) is proved.

B.2 | Proof of Proposition 8

The result follows from the definition of the utility in the $(A_1, 0)$ case in (20):

$$u_{A0}(A_1) = 2w - A_1 + 2A_1\alpha\left(1 - \frac{A_1}{2}\right), \quad V_{A0} = \left(v_1^P - v_2^P\right)A_1,$$

and the definition of the total contributed amount in (17). In particular for (iii), we have

$$\frac{\partial SW_{A0}}{\partial v_1^P} = \frac{1 - 2v_1^P}{\alpha} + A_1 + \frac{v_1^P - v_2^P}{\alpha} = \frac{\alpha - v_2^P}{\alpha}.$$

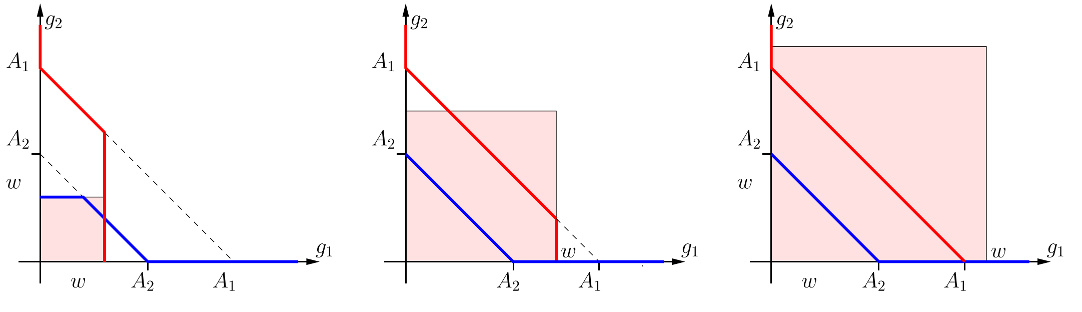

FIGURE B1 Superposition of best responses: $w < A_2$ (left), $A_2 < w < A_1$ (center), and $A_1 < w$ (right).

APPENDIX C: PROOFS FOR THE PC CASE

C.1| Proof of Proposition 10 for all possible cases

Proposition 16 (Nash equilibria, PC case). *Under Assumptions 1 and 3, there is a unique Nash equilibrium:*

(a) *If* $v^P \leq 1-\alpha$,

$$\left(g_P^N, g_C^N\right) = (0,0).$$

(b) *If* $v^P > 1-\alpha$ *and* $v^C \leq \underline{v}^C$, *then*

$$\left(g_P^N, g_C^N\right) = \begin{cases} (A,0) & \text{if } v^P < \theta(w), \\ (w,0) & \text{if } v^P \geq \theta(w). \end{cases}$$

(c) *If* $v^P > 1-\alpha$ *and* $v^C > \underline{v}^C$, *then*

– *an interior equilibrium,* $g_{int}^N = \left(g_{Pint}^N, g_{Cint}^N\right)$,

$$g_{Pint}^N = \frac{1}{2}\left(A + \frac{v^P}{v^C}\right),\quad g_{Cint}^N = \frac{1}{2}\left(A - \frac{v^P}{v^C}\right),\quad \text{if} \quad v^P < \bar{v}^P(v^C) \equiv \theta(2w)\frac{v^C}{v^C+\alpha}, \tag{C1}$$

– *an equilibrium where only the positional player contributes her total endowment:*

$$\left(w, g_C^b(w)\right) \quad \text{if } v^P \geq \bar{v}^P(v^C).$$

From (11) (which holds under Assumptions 1 and 3) and (15), the potential interior solution can be written as in (C1):

$$g_{Pint}^N = \frac{1}{2}\left(A + \frac{v^P}{v^C}\right),\quad g_{Cint}^N = \frac{1}{2}\left(A - \frac{v^P}{v^C}\right). \tag{C2}$$

Depending on the positional concern and the degree of conformism, we have three main cases:

Case (a). When $v^P \leq 1-\alpha \equiv \theta(0) \leq \theta(g_C)$, then $g_P^b(g_C) = 0, \forall\, g_C \in [0,w]$. Then, for any Nash equilibrium, $g_P^N = 0$ and $g_C^N = g_C^b(0)$. Because $\alpha - 1 < 0, g_C^b(0) = 0$. In that case, the unique Nash equilibrium is $(g_P^N, g_C^N) = (0,0)$. This proves statement (a).

In the rest of this proof, we assume that $v^P > 1-\alpha$. Then $A > 0$. From (C2), since $v^P, v^C > 0, g_{Pint}^N > g_{Cint}^N$, and $g_{Pint}^N > 0$.

Case (b). Note first that in this case, g_P cannot be 0 at the equilibrium. Indeed, if it were the case, then $g_C^N \geq A > 0$. However, when computing $g_C^b(0)$, only the first case in (15) is satisfied. This is a contradiction, hence the impossibility.

Consider now the possibility that $g_C^N = 0$. We have $g_C^b(g_P) = 0$ if $v^C \leq \alpha + (1-\alpha)/g_P$. From (11), $g_P \leq \min\{A, w\}$, and then $g_C^b(g_P) = 0$ for all g_P satisfying the previous condition if:

$$v^C \leq \alpha + \max\left\{\frac{1-\alpha}{A}, \frac{1-\alpha}{w}\right\} = \underline{v}^C(v^P).$$

Then necessarily $g_C^N = 0$ and $g_P^N = g_P^b(0)$. Accordingly, when $v^C \leq \underline{v}^C(v^P)$, there is a unique Nash equilibrium which is

$$\left(g_P^N, g_C^N\right) = \begin{cases} a_{int} \equiv (A, 0), & v^P < \theta(w), \\ a_P \equiv (w, 0), & v^P \geq \theta(w). \end{cases}$$

This proves statement (b).

Case (c). From (C1) it follows that $g_{Pint}^N > 0$ and $g_{Cint}^N < g_{Pint}^N$ (in accordance with Proposition 2(I)). Moreover, $g_{Cint}^N > 0$ implies $g_{Pint}^N > 0$, and $g_{Pint}^N < w$ implies $g_{Cint}^N < w$. This implies that it is sufficient to prove that $g_{Cint}^N > 0$ and $g_{Pint}^N < w$ to conclude that both belong to $[0, w]$.

Assume finally that $v^P > 1-\alpha$ and $v^C > \underline{v}^C(v^P)$. Under these conditions, it is easy to see that $0 < B < \min\{A, w\}$. As a preliminary, we prove now that $g_{Cint}^N > 0$ when $0 < g_{Pint}^N \leq w$. Indeed, when $A \leq w$

$$g_{Cint}^N > 0 \Leftrightarrow v^C > \frac{v^P}{A} = \alpha + \frac{1-\alpha}{A}.$$

This last condition is satisfied because $v^C > \underline{v}^C(v^P)$. When $A > w, g_{Cint}^N \leq 0$ implies $g_{Pint}^N \geq A$ (because $g_{Pint}^N + g_{Cint}^N = A$) which is a contradiction.

In this case, one interior and one boundary equilibria are feasible. To analyze how these equilibria depend on v^P and v^C notice first the requirement for an interior solution:

$$g_{Pint}^N < w \Leftrightarrow A + \frac{v^P}{v^C} < 2w \Leftrightarrow v^P < \bar{v}^P(v^C) := \theta(2w)\frac{v^C}{v^C + \alpha} < \theta(2w). \tag{C3}$$

Note that $\bar{v}^P(v^C)$ is an increasing function that goes to $\theta(2w)$ when v^C tends to infinity. Now we can analyze the different equilibria.

- (g_{Pint}^N, g_{Cint}^N) is an equilibrium if and only if (C3) holds.
- $(w, r(w-B))$ is an equilibrium if and only if (C3) does not hold, or equivalently:

$$v^P \geq \bar{v}^P(v^C).$$

This concludes the proof.

C.2| Proof of Proposition 13

The proof of (i) is straightforward. Next, we prove (ii). On the one hand, we have

$$\partial V_{int}/(\partial v^P) = v^P/v^C > 0.$$

On the other hand,

$$\frac{\partial V_{A0}}{\partial v^P} = A + \frac{v^P - Av^C}{\alpha} = \frac{2v^P - 1 + \alpha - Av^C}{\alpha},$$

so that $\partial V_{A0}/(\partial v^P) > 0$ iff $v^C < (2v^P - (1-\alpha))/A$. But in case $(A, 0)$ $\quad v^C < \underline{v}^C \equiv v^P/A$. And it is easy to see that $v^P < 2v^P - (1-\alpha)$. Finally, to prove (iii) note that in the interior case, the effect of v^P on social welfare can be written as

$$\frac{\partial SW_{int}}{\partial v^P} = \frac{v^C(1-2v^P) + \alpha v^P}{v^C\alpha}.$$

The first result in Proposition 13(iii) straightforwardly follows.

In the $(A, 0)$ case, the effect of v^P on social welfare can be written as

$$\frac{\partial SW_{A0}}{\partial v^P} = 1 - \frac{v^C A}{\alpha} \gtrless 0 \Leftrightarrow v^C \lesseqgtr \frac{\alpha}{A} = B_{A0}^{SW}(v^P).$$