Endogenous Preferences and Private Provision of Public Goods: a 'Double Critical Mass' Model

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Abstract

In this paper we set up an evolutionary game-theoretic model aimed at addressing the issue of local public good provision via direct commitment of voluntary forces (namely, private donors and nonprofit providers) only. Two classes of agents are assumed to strategically interact within a 'double critical mass' model, where the provision and maintenance, on voluntary bases, of a public-type good is concerned. Uncertainty as to equilibrium outcomes emerges as within both categories a positive proportion of agents faces the temptation to opportunistically free ride on others' efforts. Further, private donors and nonprofit providers' payoff functions are interdependent, in the sense that (a) potential donors decide to be actual donors only insofar as a 'large enough' proportion of nonprofit organizations provides a high effort level, otherwise they act as free riders; (b) nonprofit organizations, in turn, prefer to exert a high productive effort only insofar as a 'large enough' proportion of potential donors acts as actual donors, otherwise they exert a low effort level. Through this analytical framework, we are able to focus on the critical factors affecting the dynamic outcome of such interaction: under certain conditions, in a medium-long run perspective, even in contexts where, initially, either a large proportion of agents behaves as free riders or a large proportion of nonprofit organizations exerts a low effort level, the local public good may be provided.

1 Introduction

As far as private provision of collective goods is concerned, most part of the theoretical models dealing with such issue tend to explain it by exclusively focusing on the features of the demand side, namely individual donors.[1] The basic goal of our model is to take a step further, at both methodological and substantive

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[1] It is worth specifying that it may sound puzzling to consider individual contributors to nonprofit organizations as part of the 'demand side'. The point is that, though they may not be

level, in order to broaden the demand-focused framework prevailing in the literature by including also the supply side into the picture. More specifically, we will assume that demand and supply strategically interact within an evolutionary context, so that the possibility to effectively produce a given collective good will turn out to be critically dependent on the nature of such interaction. Ben-Ner (2002) points out the main difficulties nonprofit organizations may encounter in pursuing their social mission, by reflecting on the following five requirements to be met for their establishment and operation:

> "The first requirement for the establishment of an organization is the availability of entrepreneurial initiative. A nonprofit organization cannot attract entrepreneurs who seek profits. The initiative must therefore come from charitable entrepreneurs, or individuals with demand for the nonprofit form of organization. The second requirement for the emergence of an organization is the availability of funding, which again must come from either those with demand for the organization, or those who care about them. Third, production of products with significant nonrivalry and nonexcludability attributes must be funded not only through the ordinary sale of goods and services on the market, but also through additional voluntary contributions. Fourth, the organization must be able to commit credibly to its customers to maintain its form as an alternative to the for-profit type of organization, in order to retain their support. Finally, the survival of an organization is predicated on its ability to produce efficiently: at the very least, the organization's efficiency disadvantage must not exceed whatever other advantages it enjoys relative to other firms".

Ben-Ner's contribution then suggests that a nonprofit organization must, at the same time, (a) rely on special voluntary contributions and (b) act credibly and efficiently. In this work, we would like to explore, within a strategic, evolutionary scenario, the bi-directional link between (a) and (b), by emphasizing its critical role in the provision of a given collective-type good: being able to create a virtuous relationship between donors' propensity to contribute and nonprofit's level of efficiency in pursuing its socially-charged goals appears to be crucial in order to make individual donations a central and stable source of funding for the organization. In other words, two important variables such as the level of individual donations and the level of nonprofits' efficiency, seem to be mutually dependent: (1) individuals appear to often act in a *consequentialistically*-oriented way, i.e. to condition their donations to the level of efficiency

actual consumers of the good or service provided by the supported organizations, they clearly provide an important source of income for such organizations, so that, conventionally, they have been placed within this side of economic interaction. Analogously, nonprofit institutions are part of the 'supply side' as they provide collective goods, though they may partially rely on economic contributions by donors and, to some extent, 'demand' this form of support (e.g. by means of fundraising efforts).

the beneficiary organization can actually reach; in turn, (2) nonprofit institutions' independence and ability to pursue their social mission critically depends on making individuals' donations a major and stable source of income, i.e. on being able to continuously raise a relatively large amount of income from private donations over time. More specifically, as far as (1) is concerned, by simultaneously focusing on demand and supply characteristics, we are able to account for the following fact: it seems to be frequently the case that individuals' propensity to donate critically depends on the expectation that the overall contributions raised by the nonprofit institution will be effective, i.e. that an efficient technology is at work in the provision process of the public good. In other words, individuals' disposition to give may be characterized by a strong consequentialist attitude, regardless of its being pure or impure, i.e. driven mainly by truly selfish, genuinely altruistic or mixed motives.

In this light, in our model, the only 'constraint' donors require to be respected by nonprofit providers is the efficient pursuit of their social mission: this sounds like a rather minimal, reasonable constraint, as it does *not* affect the *content* of nonprofits' mission and, therefore, it is not controversial in ethical terms.[2] Further, there is some evidence that this constraint may actually increase the level of funding for such organizations: "Constraints on how contributions are used may actually augment the supply of funds. This could occur if informational asymmetries (i.e. donors not knowing how funds would be used) would cause donors to give less unless the use of funds was appropriately restricted. A university alumnus, for example, might wish to earmark a gift for financial aid, to be certain that the money would not go for a football-stadium scoreboard. At the same time, the fungibility of money can have a net effect quite different from that reflected in the donor's restriction" (Weisbrod 1998). In other words, donors may well accept not to participate in the nonprofit firm's control and management, but, in return to their financial support, they require that the money will not be wasted but used according to appropriate criteria. While nonprofits are in principle trustworthy, right because of their very nature (specifically, thanks to the well-known 'Non Profit Distribution Constraint'), public provision would probably find it difficult to gain private donors' trust (see, e.g., Santagata and Signorello 2000). In this regard, a relevant distinction has been introduced between *exogenous* and *endogenous* donative revenues, where the latter, unlike the former, are, to some extent, affected by the nonprofit's activities. In our model, donations are assumed to be endogenous, but, as we made clear, the constraint imposed on nonprofit's activity is really a minimal one and simply reflects the consequentialist nature of donors' propensity to support the organization. Weisbrod (1998) correctly

[2] In general, serious ethical problems may arise as "too much donor control is hazardous to a nonprofit organization's integrity. When the terms of a proposed gift would redirect an institution's core mission, that gift usurps control that rightfully belongs to the nonprofit, for which image and branding are sine qua non. For example, a gift endowment of a university chair that is contingent on naming specific faculty members or on teaching a particular point of view would be an inappropriate donor infringement on academic freedom" (Emerging issue: how much donor involvement is too much?, Advancing Philanthropy, Nov/Dec 2000).

remarks that "Not surprisingly, donations have been found to be responsive to fund-raising efforts (Weisbrod and Dominguez 1986), but they may also respond to other organization activities. Surely, charitable contributions respond to a nonprofit's mission-related outputs, to its reputation for efficiency and integrity, and hence to its trustworthiness to use donated funds effectively, although there has been little research on these relationships". A relatively specific but relevant point that still awaits deeper investigation is whether donors' propensity to contribute depends *more* on nonprofits' *efficiency* in pursuing their institutional goals or on their level of *fundraising* efforts (which represents an ancillary activity with respect to their social mission); further, we cannot rule out that the latter variable might be perceived by the donors as a good proxy of the former, acting as a *signal* of nonprofit's will to act according to efficiency standards.[3] According to Ben-Ner (2002), in the U.S. nonprofit organizations may benefit from the recent tendency of some large for-profit financial institutions to rapidly turn into important fund-raising channels.[4]

Nonprofits may rely, in principle, on multiple, distinct sources of funding: beside individual donations, further significant channels are income from the sale of goods and/or services, user fees and (direct and indirect) public subsidies. In the U.S., where nonprofit revenues make up about 10% of the GNP, it is increasingly harder to precisely define the boundaries between for-profit and nonprofit sectors (Arrow 1998) and the essence of such phenomenon is well captured by Weisbrod (1998), as he notices that nowadays "Many nonprofits face increasing financial pressure because the gap between their resources and what they see as social "need" is growing. (. . .) "Need" is difficult to define and measure, but if nonprofits search for new revenues, they have few choices: to increase private donations and/or to increase income from the sale of goods or services – that is, "commercial" activity". The problem is that if nonprofits choose to mainly rely on user fees, i.e. on revenues from the sale of goods or services on the market, they run the risk to lose their specific identity and not to differentiate themselves anymore from for-profit firms, by ending up mimicking their status of private goods sellers and *profit-oriented* organizations. Commenting on this phenomenon, which seems to be characteristic of the current phase of rapid growth of the nonprofit sector in the U.S., Weisbrod (1998) points out that such trend risks to induce people to perceive nonprofit organizations as 'for-profits in disguise'. Therefore, as to the issue of how to balance nonprofits' pursuit

[3] Segal and Weisbrod (1998) show, through an empirical study on tax-return data regarding large charitable U.S. organizations and covering the period 1985-1993, that fundraising plays a very important role in actually enhancing the level of individual donations. In particular, they reach the conclusion that current and lagged values of fundraising expenditures, together with firm-specific effects and lagged contributions, succeed in explaining about one third of the year-to-year variation in donations.

[4] He provides the interesting example of Fidelity Investment, a very large for-profit financial institution, that "has become the second largest recipient (actually, a channel like a community foundation) of charitable giving in the United States in 2000, after the Salvation Army (The Chronicle of Philanthropy, November 1, 2001). Fidelity's Charitable Gift Fund website (. . .) also offers information that allows potential donors to understand better the organizational and financial affairs of the nonprofit organizations to which they consider making donations".

of their institutional mission with growing financial constraints, he argues that such organizations would be really free to autonomously pursue their social missions only insofar as they were able to rely on income from individual donations without being conditioned to any specific behaviour in return. By contrast, if they mainly depended on either user fees or subsidies by (local and/or national) Government, they would risk to be forced to re-define their goals and, in the medium-long term, to lose their original identity. Such compromising of mission in the interest of revenue has been described as *mission displacement* (Weisbrod 1998).[5] This is why the growing tendency, in the U.S., for nonprofits to receive less and less support in the form of private donations (with a fall in their relative importance as a source of funding from 53% to 24% in less than thirty years) and to conversely obtain more and more of their income from the sale of goods and services on the market sounds as a somewhat worrying perspective to many observers.[6] Further, Ben-Ner (2002) points out that a great deal of recent, important technological changes are going to bring about negative consequences as to the future of nonprofit organizations. Some of them, for example, seem to contribute to reduce the degree of nonrivalry and nonexcludability of certain products, so further broadening the space for for-profit firms. As to the issue of nonprofits' funding, it should be clear, however, that the crucial distinction to be drawn is not simply between one source of revenue and another, but rather between restricted and unrestricted support (Weisbrod 1998). With respect to consequentialistically-oriented donors, their donations can certainly be seen as basically unrestricted donations: as we clarified above, the 'efficiency constraint' is a rather minimal requirement and does not affect at all nonprofit's freedom of choice as to where and how to operate in pursuing its social mission. The remainder of the paper is as follows: Section 2 contains the evolutionary model; Section 3 introduces the notion of evolutionary crowding-out; Section 4 draws the main conclusions.

2 The Model

We consider two continuous populations (potential donors and nonprofit organizations), both split in turn into two groups (actual donors and free riders, and high and low effort level nonprofits, respectively). This means that we are dealing with a 'very large' number of nonprofit organizations (the supply side) and, at the same time, with a 'very large' number of individuals potentially inter-

[5] With regard to this 'tragic' scenario, Weisbrod (1998) asserts that "When it occurs, it is likely to take subtle forms that are hard to observe. Rarely will an organization reject its mission outright, for even if the nonprofit's leadership were willing to do so, such a rejection would have vast consequences for them in terms of their fiduciary responsibility, as well as for the organization's tax-exempt status and its donative revenues. Nonetheless, the potential for mission to be compromised, albeit in less direct forms, exists, particularly so in light of the breadth of many nonprofits' missions, which can make it difficult to define operationally when an action is inconsistent with the mission".

[6] Hansmann (1980) introduced the useful distinction between 'donative' and 'commercial' nonprofits, depending on the relative importance of donations and user fees as a source of revenue for the organization.

ested in economically supporting such organizations (the demand side). Time is continuous. Such interaction has to do with the familiar issue regarding the private provision of public-type goods, as nonprofit organizations are assumed to be directly committed to the provision of a *single, threshold public good*. In the strategic framework under exam, by referring to a 'threshold public good' we mean a collective good which will be provided only if a certain amount is both (a) collected (i.e. 'many' donors actually contribute) and (b) efficiently used by nonprofit operators (i.e. 'many' nonprofits productively utilize the available amount of funding).[7] Further, we assume that the public good will increase in both quality and quantity the larger the proportion of actual donors (on the demand side) and efficient nonprofits (on the supply side). In the light of this, as both actual donors and efficient nonprofits need to be in large proportions in order for the public good to be provided, we may even more precisely refer to the strategic environment under study as to a 'double threshold public good' scenario. Besides, we assume that donors' contributions are of the binary, 'all-or-nothing' type: either a single potential donor contributes to financing the public good by a certain, pre-determined positive amount (by acting as an actual donor) or she gives nothing (by acting as a free rider). As it can be easily verified, the strategic scenario considered in this paper is a generalization of the relatively specific analysis developed in Antoci and Sacco (1996) and in Antoci, Sacco and Zarri (2003). In those works, the double threshold public good to be provided is given by an art city (such as Paris, Florence or Barcelona), as its preservation over time may entail the simultaneous commitment of a large number of local cultural operators and a large number of individual donors generously contributing to economically support the project. Clearly, the public nature of the good under consideration (restoring historical monuments and/or enhancing the quality of cultural activities within the city) may induce some potential donors to free ride on others' efforts and abstain from contributing, so jeopardizing the provision of the good itself – despite the possible presence of a large proportion of efficient cultural operators. In a totally symmetric way, some local operators may be unable and/or unwilling to efficiently use the amount of resources provided by private donors: even in this case, the private provision of the public good may be seriously at risk, despite the potentially large amount of available funds. In the following section, we make use of the same assumptions and basic framework introduced in the above cited papers. However, we provide here a far more general interpretation and we proceed by considering some specific scenarios we had not dealt with in the previous works. Further, a notion such as 'evolutionary crowding-out' is introduced and analyzed within the current framework.

2.1 Behavioral Assumptions and Social Dynamics

The classical models based on the so called 'pure altruism hypothesis' (or on, as Sugden (1982) – perhaps more appropriately – prefers to term it, the 'publicness

[7] The subsequent formalization will make clear that such statements can be provided with a rigorous characterization within the evolutionary framework set up here.

assumption') represent a satisfactory default option in the aim to provide convincing answers to the voluntary public goods provision issue, as by definition no donations would occur in a world of individuals pursuing their material self-interest in the strict sense of the word. In such a framework, free riding would be an extensive phenomenon and no public good would be privately provided – insofar as nonprofit organizations exclusively relied on any source of income but private donations. However, we need to take a step even further and set up a more complex picture in order to account for the important and growing insights coming from experimental and empirical contributions on the theme. Specifically, as far as the demand side is concerned, it is necessary to depart from the 'representative agent' assumption implicit in most of the models characterizing the existing theoretical literature in the field: our market economies are embedded in increasingly *motivationally heterogeneous* societies which do possess such complex features as a result of several cultural, social and economic factors that historically affected the motivational profile of economic agents as well. In this light, we assume here that potential donors fall into two somehow opposite categories: actual donors and free riders. More specifically, we rely on the following assumption:

Assumption 1. Private donors can either be actual donors (D) or act as free riders, i.e behave opportunistically (O) towards actual donors.

In a sense, such a distinction is implicit in several models relying on the pure altruism hypothesis, as even there the free riding phenomenon is a far from excluded behavioral alternative (implying that some agents are driven by 'enlightened self-interest' and that, therefore, social interaction takes the form of a Chicken Game in the altruists' eyes, caring about the provision of the collective good but, at the same time, preferring that others will carry the burden of contribution costs). Here we make it explicit, by assuming that the overall population of potential donors is initially split into two very different groups such as (consequentialistically-oriented) actual donors and free riders.[8] Symmetrically, we draw a similar distinction with regard to the supply side, within the (infinite) set of nonprofit institutions. As anticipated above, we discriminate between nonprofits exerting a 'high' productive effort and nonprofits producing only a 'low' effort. In other words, a proportion of firms is assumed to be efficient, whereas all the others are 'lazy' and have no incentives to use the collected resources in an efficient way. Therefore, we make the following assumption:

Assumption 2. Nonprofit organizations can exert either a high-level effort (H) or a low-level effort (L) in privately providing the collective good.

As far as the demand side is concerned, potential donors' payoff functions are described by the following two linear functions (1) and (2), referred to actual

[8] The risk that free riding occurs is a rather plausible possibility in a strategic interaction scenario where the provision of a public good is involved, as Ben-Ner (2002) asserts by commenting on the requirements nonprofit organizations need to meet in order to keep on surviving within a complex economic system: "These requirements determine the likelihood of the existence – that is, the supply, of a nonprofit organization. Each of these depends on successful collective action, and is vulnerable to free-ridership or social loafing exactly by the very individuals who desire the existence of the nonprofit organization".

donors (D) and free riders (O), respectively. Analogously, on the supply side, nonprofits' payoff functions are captured by functions (3) and (4), representing high level effort (H) and low level effort (L) nonprofit organizations, respectively:

$$\Pi(D) = \alpha q - \theta \quad (1)$$
$$\Pi(O) = \beta q \quad (2)$$
$$\Pi(H) = \gamma p - \eta \quad (3)$$
$$\Pi(L) = \varepsilon p \quad (4)$$

where $\alpha - \beta > \theta > 0$ and $\gamma - \varepsilon > \eta > 0$.[9]

The variables q and p indicate the proportion of H-type nonprofits and D-type donors respectively (consequently, it holds $0 \leq q, p \leq 1$);

$1 - q$ and $1 - p$ represent the proportion of L-type nonprofits and O-type donors respectively. We assume further that both potential donors and nonprofit organizations are able to observe in any moment the actual level of both q and p (and, as a consequence, of $1 - q$ and $1 - p$ as well). In the light of this, it is then straightforward to realize that payoff functions (1)-(4) incorporate the relation of strategic interdependence connecting individual donors and nonprofit organizations illustrated above. Specifically, equations (1) and (2), by making donors' payoffs positively depend on the proportion of high effort level (H-type) nonprofits, convey the hypothesis that donors' propensity to contribute is positively related to the expectation that an efficient technology is at work for the public good to be voluntarily provided. Analogously, equations (3) and (4), by making nonprofits' payoffs proportional to the proportion of actual donors (D-type, i.e. non-free riding agents), imply that nonprofit providers' propensity to be productive is positively related to the expectation that a sufficiently high level of contributions is available for the pursuit of their institutional goals.

Following Taylor and Jonker (1978) and Hofbauer and Sigmund (1988), we suppose that the dynamincs of p and q is given by the replicator equations:

[9] Through these restrictions over parameter values, we make sure that no option dominates the alternative one regardless of the other class of agents' behaviours. Specifically, if we refer, say, to individual donors, we notice that by assuming $\alpha - \beta > \theta > 0$, it is the case that when $q = 0$, then $\Pi(O) > \Pi(D)$, but when $q = 1$, then $\Pi(D) > \Pi(O)$. This clearly implies that a 'critical threshold' $q*$ exists (with $0 < q^* < 1$) such that when $q < q^*$, then free riders prevail over actual donors, but when $q > q^*$, then actual donors get a higher reward (and spread over in the population) than free riders. The same holds true as far as the two types of nonprofit organizations are concerned. As we pointed out above, so far the formal structure of the model perfectly coincides with the one already illustrated in Antoci, Sacco and Zarri (2003) – though the current version calls for a more general interpretation of the whole interaction problem.

$$\dot{p} = p\left[\Pi(D) - \bar{\Pi}_p\right]$$
$$\dot{q} = q\left[\Pi(H) - \bar{\Pi}_q\right]$$

where $\dot{p}$ and $\dot{q}$ are the time derivatives of the variables p and q, respectively, and $\bar{\Pi}_p$ and $\bar{\Pi}_q$ represent average payoffs:

$$\bar{\Pi}_p = p \cdot \Pi(D) + (1-p)\Pi(O)$$
$$\bar{\Pi}_q = q \cdot \Pi(H) + (1-q)\Pi(L)$$

In other words, we are assuming here that the relative frequencies of types are driven by their relative performances within the strategic scenario under study: in such a social learning process, the most rewarding strategies are imitated at the expense of non successful ones. By Cressman (1997) we know that the (local) stability results regarding the replicator dynamics carry over to any payoff-monotonic dynamics (see also Björnerstedt and Weibull (1996) and Samuelson (1997) for some rigorous microfoundations). In this model, this implies that, say, free riders (low-effort nonprofits) may turn into actual donors (high-effort nonprofits) – or viceversa – insofar as their 'alternative' type happens to better perform in social interaction in terms of payoffs: in other words, both classes of agents (potential donors and nonprofit organizations) are assumed to act on the basis of *endogenous preferences*[10], so that shifting between types may take place within each of the two classes of agents. Specifically, social dynamics is driven here by the following equations:

$$\dot{p} = p(1-p)\left[(\alpha - \beta)q - \theta\right] \tag{5}$$
$$\dot{q} = q(1-p)\left[(\gamma - \varepsilon)p - \eta\right] \tag{6}$$

Therefore, the interior fixed point, identified by (p^*, q^*), has coordinates:

$$p^* = \frac{\eta}{\gamma - \varepsilon}, \text{ where } 0 < \frac{\eta}{\gamma - \varepsilon} < 1 \text{ always holds}$$
$$q^* = \frac{\theta}{\alpha - \beta}, \text{ where } 0 < \frac{\theta}{\alpha - \beta} < 1 \text{ always holds}$$

[10] "The possibility that endogenous preferences may be driven by an evolutionary dynamics has been already suggested by Becker (1976a). The evolutionary approach does not necessarily advocate a biologically based preference dynamics although recent studies have shown the existence of genes that determine preference attributes like risk aversion. While the setup is based on evolutionary dynamics, the mechanism that governs these dynamics may be rooted in behavior such as imitation and education. For evolutionary models that endogenize preferences see Basu (1995), Bester and Güth (1998), Dekel and Scotchmer (1999), Fershtman and Weiss (1997, 1998), Huck and Oechssler (1999), Kockesen et al. (2000), Robson (1996), and Rogers (1994)" (Bar-Gill and Fershtman 2001).

The analysis of dynamics of system (5)-(6) is straightforward and the phase diagram is represented in figure 1.[11] As we can see from the phase diagram in figure 1, the 'default' scenario contains two *attractive* fixed points (namely, $(0, 0)$ and $(1, 1)$), two *respulsive* fixed points (namely, $(1, 0)$ and $(0, 1)$) and one *saddle* point (p^*, q^*). The basins of attraction of the two attractive fixed points are separated by the stable manifold Γ of (p^*, q^*): the trajectories starting above Γ reach $(1, 1)$, the others reach $(0, 0)$. The intuitive meaning of such a diagram can be explained as follows. When both p and q are high enough, then the system converges to the attractive fixed point $(1, 1)$, which represents the best social outcome, that is the social configuration where all potential donors are actual donors ($p = 1$) and all nonprofit organizations are high-effort level nonprofits ($q = 1$). Provided our basic assumptions, this entails that the public good will be voluntarily provided at the highest possible level, as all nonprofits behave efficiently and have access to a large amount of voluntarily provided funds. By contrast, the other attractive fixed point $(0, 0)$ depicts the worst social outcome, as in this case all potential donors prefer to act as free riders and all nonprofits exert a low effort level. As a consequence, no public good provision occurs. In this light, it is straightforward to characterize the stable manifold Γ of (p^*, q^*) as the 'critical threshold' which turns out to be decisive in order to discriminate between dynamic paths leading to social optimality and dynamic paths leading to social inefficiency. Observe that Γ can be considered as the graph of a strictly decreasing function $q = f(p)$; consequently, to reach the socially desirable outcome, the lower is the initial proportion p of potential donors which are ready to actually donate, the higher must be the initial proportion q of nonprofits which efficiently manage the funds raised through private donations (and vice-versa).

3 The relationship between Government and Voluntary Sector: Evolutionary Crowding-out

In order to rigorously recall the major conclusions obtained so far in the theoretical literature dealing with the issue of the Crowding-in/Crowding-out relationship between Government grants and private contributions to nonprofits, it may be helpful to start from the following definition of the so called *classic Crowding-out hypothesis*:

Definition 1 *Givers (who may or, more likely, may not coincide with the taxpayers) perceive their tax-financed, involuntary donations as a (perfect or imperfect) substitute for their voluntary donations to nonprofit organizations.*

Individuals' contributions to the Voluntary Sector (charities) has often been seen as a reliable indicator of the extent of voluntary provision of public goods.

[11] In all figures, an attractive fixed points is indicated by a full dot (•), a repulsive one by an open dot (◦) and a saddle point by tracing its stable and unstable manifolds, that is by drawing the (two) trajectories converging to it and the (two) trajectories diverging from it.

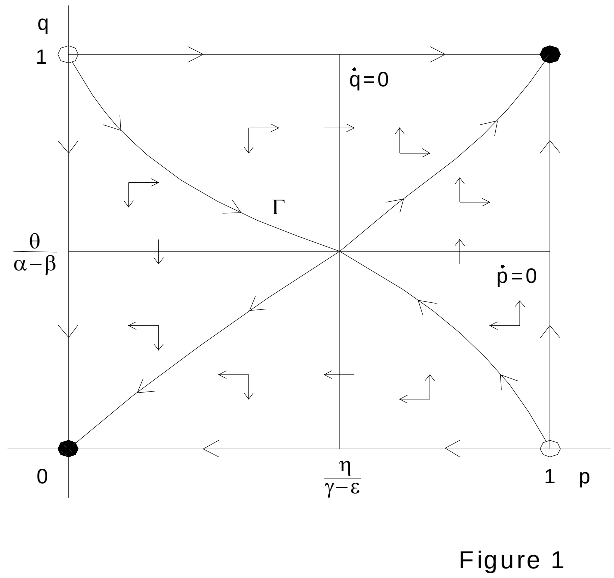

Figure 1:

The extreme prediction of complete Crowding-out tends to be rejected by empirical studies: a negative correlation tends to emerge, but it appears to be partial, rather than one-to-one. Specifically, data from Abrams and Schmitz (1984) and Steinberg (1985) seem to confirm that a partial Crowding-out effect often occurs. In fact, the overall picture is more complex and blurred, as some authors report Crowding-*in* effects (see on this e.g. Sugden (1982), Khanna, Posnett and Sandler (1995) and Connolly (1997)). Both Rose-Ackerman (1981) and Payne (1998) provide a rationale for these effects on the grounds that Government's donations act as a signal of the quality of the charitable good to be provided. However, as we specified above, the main lesson emerging from most of the studies on Crowding-in / Crowding-out seems to be that the relationship between Government grants and individual donations to nonprofits is not a positive but a negative one but that, at the same time, Crowding-out is not complete but partial. However, regardless of empirical analyses, it is crucial to properly address this issue at theoretical level: in order to do this, we claim that traditional demand-side explanations (based on specific assumptions on individual motivational systems and on the effects of donors' behavioural response to Government grants), need to be integrated with founded supply-based analyses focused on the nature of nonprofits' behavioural response to Government grants. In other words, both Charities' as well as private donors' strategic behaviours matter and ought to be studied together by means of a unified approach to economic interaction taking place among three classes of agents, i.e. (i) Government (or, more generally, public actors), (ii) private donors and (iii) nonprofit institutions. Further, in the framework of our game-theoretic model, in order to focus on the critical relationship between private donors and nonprofit organizations within the strategic scenario under study, where both classes of agents exhibit endogenous preferences, an appropriate notion of Crowding-out is called for. Specifically, we decided to introduce the idea of *Evolutionary Crowding-out*, on the grounds that it provides the natural extension of the classic Crowding-out notion within the evolutionary social context at stake:

Definition 2 *Evolutionary Crowding-out occurs when, after a change in one of the parameters affecting either potential donors' or nonprofit organizations' payoffs, the attraction basin of* $(0,0)$ *expands at the expenses of that of* $(1,1)$*; in other words, all the trajectories which used to converge to* $(0,0)$ *will still converge to the socially sub-optimal configuration and at least one trajectory which used to converge to* $(1,1)$ *will converge to* $(0,0)$.

In a totally analogous way, we then define Evolutionary Crowding-in as follows:

Definition 3 *Evolutionary Crowding-in occurs when, after a change in one of the parameters affecting either potential donors' or nonprofit organizations' payoffs, the attraction basin of* $(1,1)$ *expands at the expenses of that of* $(0,0)$*; in other words, all the trajectories which used to converge to* $(1,1)$ *will still converge to the socially optimal configuration and at least one trajectory which used to converge to* $(0,0)$ *will converge to* $(1,1)$.

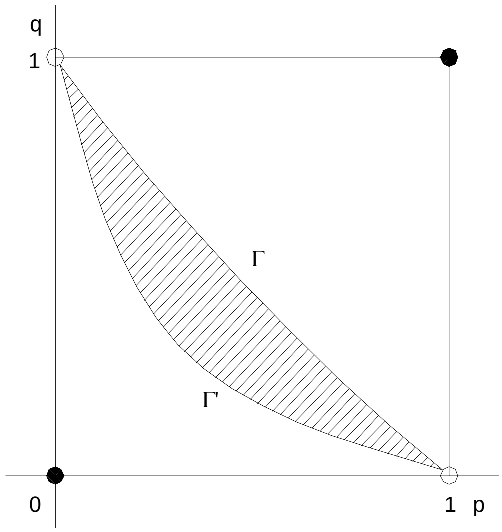

Figure 2

Figure 2:

In the light of the above definitions, we can easily draw a first unambiguous conclusion, as far as strategic interaction among the classes of agents under exam is concerned:

Proposition 4 *If a subsidy is given by the Government to H-type nonprofit providers such that* η *shifts to* $\acute{\eta}$ *with* $\acute{\eta} < \eta$ *(or, equivalently,* $\gamma - \varepsilon$ *increases), then Evolutionary Crowding-in occurs.*

For the proof of the above proposition see the appendix. In figure 2, the shaded area within the unit square clearly provides us with the extent of Evolutionary Crowding-in. It may be of interest to remark that a subsidy given to H-type but not to L-type nonprofits constitutes an instance of what Olson (1965) defines as a 'positive selective incentive', which is able to mobilize latent groups. Let us now turn to the demand side and make the following assumption:

Assumption 3. A subsidy $s = \delta p$ is given by the Government to individual donors deciding to actively play their role (i.e. being actual donors D).

Bar-Gill and Fershtman (2001) set up a similar, evolutionary model with endogenous preferences and a public good to be accumulated. Their analysis focuses on the effects of subsidization on the preference dynamics as well as on the equilibrium level of the public good. Individuals are assumed to interact within a random matching structure and play a PD-like game, but nonprofit institutions are not included in the model. Within such a framework, it is the case that while in the short-run (when preferences are taken as given) the subsidy policy actually succeeds in increasing the level of the public good, by contrast in the long-run such a policy induces a shift in the distribution of individual preferences, which, in turn, provokes a reduction in the number of socially minded agents[12] and, eventually, a lower level of the collective good to be provided. As they explain, "The decline in the share of socially minded individuals, and the corresponding decrease of social incentives, more than offsets the initial rise in the monetary incentives induced by the subsidy policy" (Bar-Gill and Fershtman 2001). In our model, analogously to the case where H-type nonprofits are the recipients of the subsidy, Government's economic support to the privately provided public good takes the form of a 'positive selective incentive', as it is given to D-type but not to O-type donors.[13] Further, the above specification of the subsidy policy implies that the level of s is not fixed but positively related to the proportion of D-type donors, conveying the intuitive idea that the higher the level of funds raised through individual donations, the higher the incentive for the Government to keep on indirectly supporting public good provision through such a policy. In order to rigorously predict what happens under this assumption, it is necessary to see how payoff functions get modified and to separately analyze several cases according to parameters relationships:

$$\begin{aligned}\Pi(D) &= \alpha q - \theta + \delta p \\ \Pi(O) &= \beta q \\ \Pi(H) &= \gamma p - \eta \\ \Pi(L) &= \varepsilon p\end{aligned}$$

whe $\alpha > \beta > 0$, $\delta > 0$ and $\gamma - \varepsilon > \eta > 0$.

Therefore, replicator equations take the following form:

$$\begin{aligned}\dot{p} &= p(1-p)\left[(\alpha-\beta)q + \delta p - \theta\right] \\ \dot{q} &= q(1-p)\left[(\gamma-\varepsilon)p - \eta\right]\end{aligned}$$

and the coordinates of the interior fixed point (p^*, q^*) are $p^* = \dfrac{\eta}{\gamma-\varepsilon}$ and $q^* = \dfrac{\theta - \dfrac{\delta\eta}{\gamma-\varepsilon}}{\alpha-\beta}$, where $0 < \dfrac{\eta}{\gamma-\varepsilon} < 1$ always holds while $0 < q^* < 1$ if and

[12] In their model, 'socially minded agents' are defined as agents caring about status, i.e. about a social reward perceived as positively related to their effort towards the provision of the public good.

[13] By contrast, in Bar-Gill and Fershtman (2001) model, the subsidy does not act as a selective incentive, as both socially minded as well as non-status-seeking agents take advantage of it.

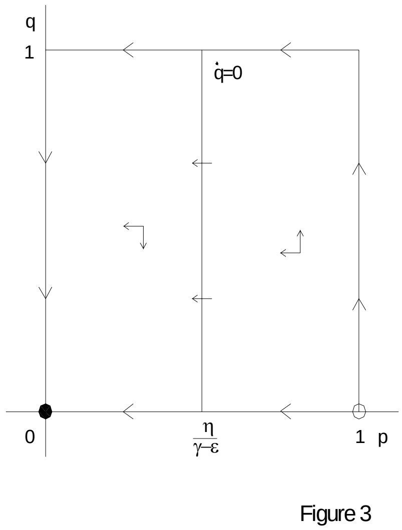

Figure 3:

only if $\dfrac{\delta\eta}{\gamma-\varepsilon} < \theta < \dfrac{\delta\eta}{\gamma-\varepsilon} + \alpha - \beta$.

Observe that the other fixed points under these equations are $(0,0)$, $(1,0)$, $(0,1)$, $(1,1)$ and the intersection points of the straight line $q = \dfrac{\theta}{\alpha-\beta} - \dfrac{\delta}{\alpha-\beta}p$ (where $\dot{p} = 0$) with the edges of the unit square where $q = 0$ and $q = 1$. The interior fixed point is always a saddle point.

It is easy to check that the following classification of cases holds.

CLASSIFICATION OF CASES:

Case 1: $\alpha - \beta \leq \theta - \delta$

This case is very easy, as the socially suboptimal configuration $(0,0)$ turns out to be *globally attractive*, i.e. no other attractive fixed points emerge within this dynamic scenario.

Case 2: $\alpha - \beta < \theta < \alpha - \beta + \delta$ and $\theta \geq \delta$

Here we need to distinguish between two sub-cases, depending on the value of q^* (see figures 4.a and 4.b). Figures 4.a and 4.b show the dynamics when $q^* \geq 1$ and $0 < q^* < 1$ hold respectively (case $q^* \leq 0$ is ruled out under the parameters configuration concerning case 2).

In both sub-cases, only two attractive fixed points are present, that is (0,0) and (1,1), and their attraction basins are separated by the stable manifold Γ of the fixed point on the edge with $q = 1$ (in figure 4.a) or by the stable manifold Γ of the interior fixed point (p^*, q^*) (in figure 4.b).

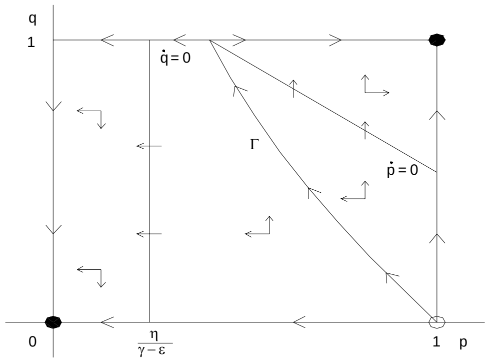

Figure 4a

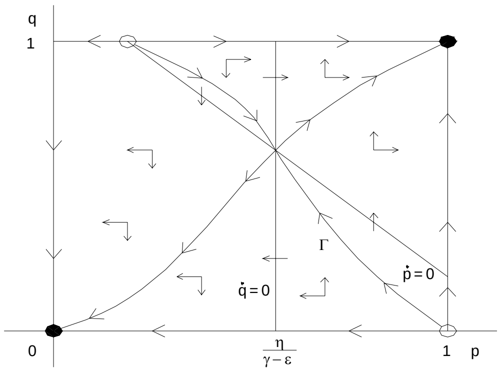

Figure 4b

Figure 4:

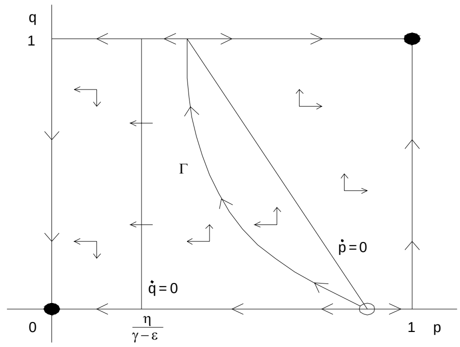

Figure 5a

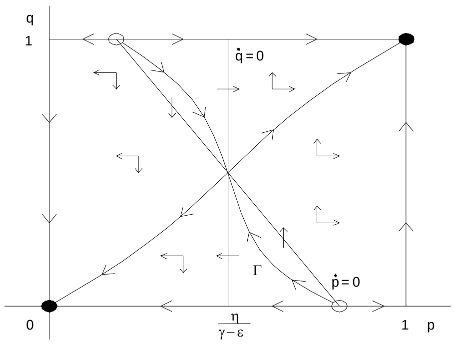

Figure 5b

Figure 5:

Case 3: $\alpha - \beta < \theta < \delta$

In this case we have three possible sub-cases; figures 5.a, 5.b and 5.c show the dynamic regimes in sub-cases $q^* \geq 1$, $0 < q^* < 1$ and $q^* \leq 0$, respectively. In all these sub-cases the 'usual' two attractive fixed points emerge (i.e. $(0,0)$ and $(1,1)$), whose attraction basins are separated by the stable manifold Γ.

Case 4 ('Small' subsidy): $\delta \leq \theta \leq \alpha - \beta$

The dynamic regime is showed in figure 6.

Case 5 ('Large' subsidy): $\theta \leq \alpha - \beta$ and $\theta < \delta$

The dynamic regimes are showed in figures 7.a and 7.b (which concern sub-cases $0 < q^* < 1$ and $q^* \leq 0$, respectively). Once again, in both the 'small' as well as in the 'large' subsidy case, $(0,0)$ and $(1,1)$ emerge as the only two attractive fixed points.

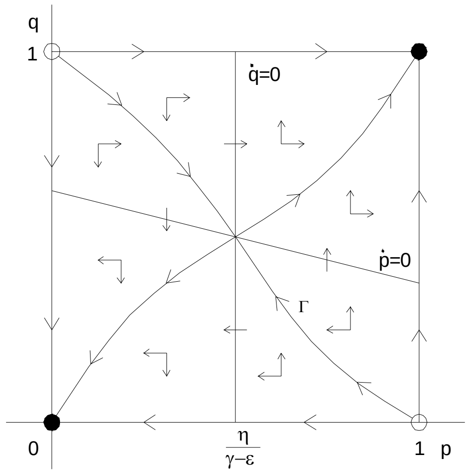

Figure 6:

3.1 Selective Crowding-in and p-dependent Opportunism

In this Section, we focus on a version of the model where two different behavioural assumptions are made, as far as both classes of potential altruists are concerned. In particular, we will analyze the different cases arising when *actual donors* (D) behave according to the Selective Crowding-in prediction (see Assumption 4 below) and, at the same time, *free riders* (O) exhibit what we define below as 'p-dependent Opportunism' (see Assumption 5 below).

Assumption 4. Actual donors (D) behave according to the *Selective Crowding-in* hypothesis, i.e. their payoff positively depends on the overall proportion of actual donors in the population.

Palfrey and Rosenthal (1988) incorporate in their model of social dilemmas a notion of 'conditional altruism', defined in terms of general non-monetary utility payoffs as a function of how many other individuals are contributing. Such an assumption represents an interesting form of consequentialist pro-social attitude, which turns out to be different from the one considered here in the basic framework of the model. However, it is definitely compatible with the 'efficiency constraint' imposed by individual donors on nonprofit organizations in our model, as it can succeed in augmenting the likelihood of public good provision. In their model, such an assumption leads to rather intuitive results: by assuming that agents gain no altruistic benefit from contributing unless the public good is actually provided, they show that contribution levels turn out to be lower with respect to the unconditional altruism scenario. As they conclude, in a sense "conditional altruism is 'less altruistic' than unconditional altruism". Palfrey and Rosenthal's notion of conditional altruism is totally analogous to the more

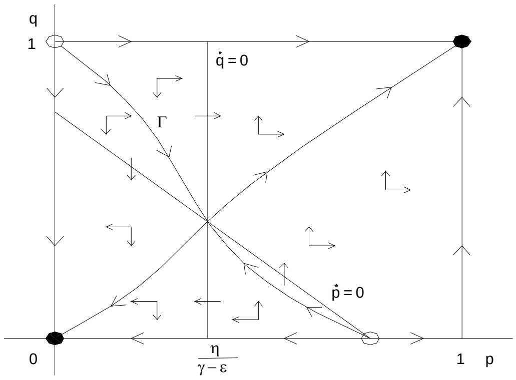

Figure 7a

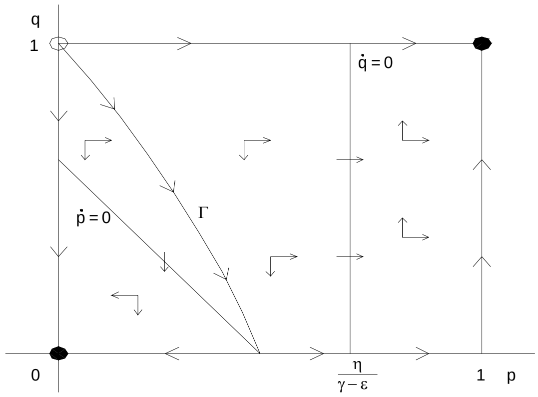

Figure 7b

Figure 7:

widespread notion of Selective Crowding-in used in the literature on voluntarily provided public goods. In particular, substantial economic and psychological evidence (mostly deriving from laboratory experiments) exists supporting the Selective Crowding-in Hypothesis (see, e.g., Cialdini (1993), on the relevance of conformistic behaviour). In this light, it seems plausible to include this type of assumption also in the evolutionary model presented here, in order to get some insights about the model's behavioural predictions. As anticipated above, we further add the following assumption, regarding free riders' behaviour:

Assumption 5. Free riders (O) behave according to the *p-dependent Opportunism* hypothesis, i.e. their payoff depends positively on the proportion p of actual donors (D) in the population when this proportion is small, but depends negatively on p when p is large.

The rationale behind Assumption 5 is as follows: when the proportion of actual donors is small, the majority of agents are riding free on others' efforts, so that the public good will be likely not to reach the provision-point. By knowing that this is the more likely scenario, free riders believe that contributing would be not only 'individually counterproductive' (due to material costs), but also *ineffective*, as far as the aim of collective good provison is concerned; therefore, in this case they get a further psychological reward from free riding. By contrast, when the majority of agents is composed by actual donors, the opposite holds true and free riders 'feel guilty' for their selfish choice not to contribute to the public good provision process.

After including Assumptions 4 and 5 into the picture, payoff functions take the following form:

$$\begin{aligned} \Pi(D) &= \alpha q + \xi p - \theta & (7) \\ \Pi(O) &= \beta q + \delta p - \omega p^2 & (8) \\ \Pi(H) &= \gamma p - \eta \\ \Pi(L) &= \varepsilon p \end{aligned}$$

where $\alpha > \beta > 0$, $\xi > 0$ and $\gamma - \varepsilon > \eta > 0$.

As we can see, Assumptions 4 and 5 have been incorporated in payoff functions (7) and (8), respectively. The replicator equations are now as follows:

$$\begin{aligned} \dot{p} &= p(1-p)\left[(\alpha-\beta)q + (\xi-\delta)p + \omega p^2 - \theta\right] \\ \dot{q} &= q(1-p)\left[(\gamma-\varepsilon)p - \eta\right] \end{aligned}$$

Therefore, $\dot{q} = 0$ when $q = 0, 1\ \forall p$ and when $p = \dfrac{\eta}{\gamma-\varepsilon}\ (< 1)\ \forall q$ while $\dot{p} = 0$ when $p = 0, 1\ \forall q$ and when p and q are such that $(\alpha-\beta)q + (\xi-\delta)p + \omega p^2 - \delta = 0$. Thus, beyond pure population states, fixed points on the edge of the unit square are the intersection points of the parable with the edges of the square where $q = 0$ and $q = 1$; by contrast, on the edges where $p = 0$ and $p = 1$ there are never interior fixed points.

Whenever it exists, the interior fixed point has coordinates:

$$p^* = \frac{\eta}{\gamma - \varepsilon} \text{ and } q^* = \frac{1}{\alpha - \beta}\left(\theta - (\xi - \delta)\frac{\eta}{\gamma - \varepsilon} - \omega\frac{\eta^2}{(\gamma - \varepsilon)^2}\right)$$

where $0 < \frac{\eta}{\gamma - \varepsilon} < 1$ always and $0 < q^* < 1$ if and only if:

$$\frac{\eta}{\gamma - \varepsilon}\left[(\xi - \delta) + \omega\frac{\eta}{\gamma - \varepsilon}\right] < \theta < \frac{\eta}{\gamma - \varepsilon}\left[(\xi - \delta) + \omega\frac{\eta}{\gamma - \varepsilon}\right] + \alpha - \beta$$

POSSIBLE DYNAMIC REGIMES

For simplicity, we limit ourself to consider the most interesting cases only; the dynamic regimes concerning omitted cases are (qualitatively) the same as those encountered up to now. In particular, the possible dynamic regimes are two: the regime where the fixed point (0,0) is globally attracting and the regime where both (0,0) and (1,1) are attracting and their attraction basins are separated by a strictly decreasing curve Γ.

Case 1: $\alpha - \beta > \theta$, $\xi - \delta < 0$, $\alpha - \beta + \xi - \delta + \omega < \theta$

The possible dinamic regimes are represented in figures 8.a and 8.b, concerning the cases $0 < q^* < 1$ and $q^* \geq 1$, respectively.

In figure 8.a we obtain two attractive fixed points: $(0,0)$ and $(\overline{p},1)$ with $0 < \overline{p} < 1$. In figure 8.b, (0,0) is a globally attractive fixed point within the unit square. As far as the case in figure 8.a is concerned, it is of interest to point out that, for the first time, we observe an attractive fixed point where $q = 1$ but $0 < p < 1$. The intuition behind this dynamic feature of the model is as follows: such 'mixed configurations' emerge because, despite contributions being very productive ($q = 1$), the proportion of actual donors is not sufficiently large to induce free riders to 'feel guilty' and shift to the alternative behavioural option. As a result, actual donors and free riders coexist in a social configuration where, as far as the other class of agents is concerned, all nonprofit institutions reach the highest possible level of efficiency.

Case 2: $\alpha - \beta > \theta$, $\xi - \delta < 0$, $\xi - \delta + \omega > \theta$, $\delta - \xi < 2w$ and $\alpha - \beta - \frac{(\xi - \delta)^2}{4\omega} < \theta$

The possible dinamic regimes are represented in figures 9.a-9.d; in figures 9.a and 9.c the dynamic regimes where $0 < q^* < 1$ are represented while figures 9.b and 9.d show the dynamic regimes corresponding to the sub-cases $q^* \geq 1$ and $q^* \leq 0$, respectively. Note that in the regime illustrated in figur 9.a there are three attractive fixed points namely, $(0,0)$, $(1,1)$ and $(\overline{p},1)$ with $0 < \overline{p} < 1$. For the same reasons recalled above, we observe even in this case a social configuration where all nonprofits are very efficient but potential donors are not motivationally homogeneous (being split between actual donors and free riders). As far as the other three sub-cases are concerned, we see that the usual two attractive fixed points (0,0) and (1,1) appear.

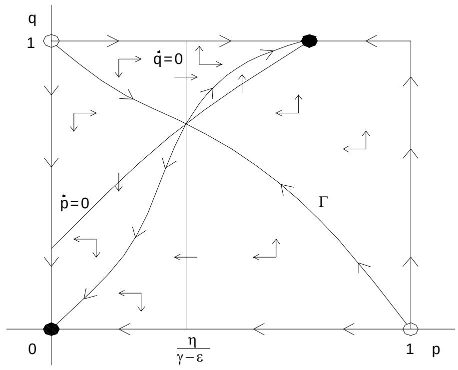

Figure 8a

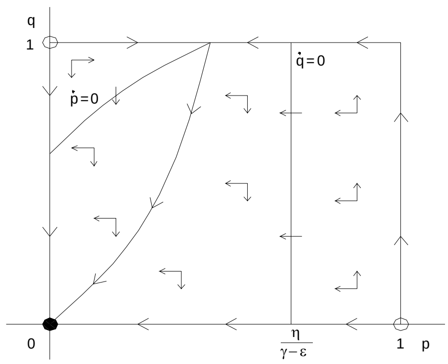

Figure 8b

Figure 8:

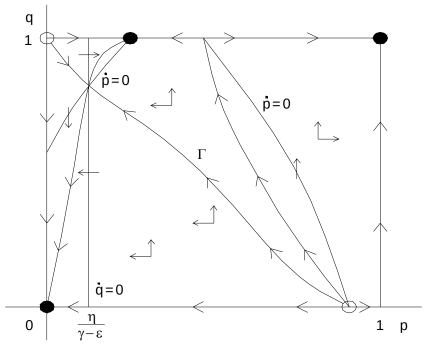

Figure 9a

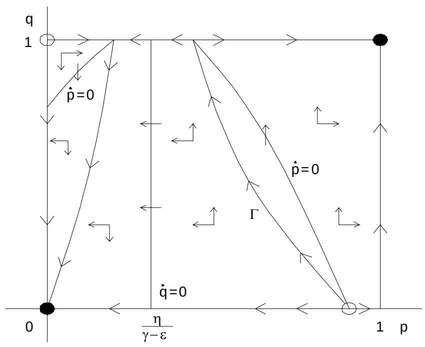

Figure 9b

Figure 9:

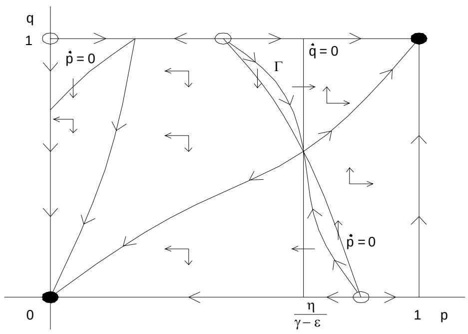

Figure 9c

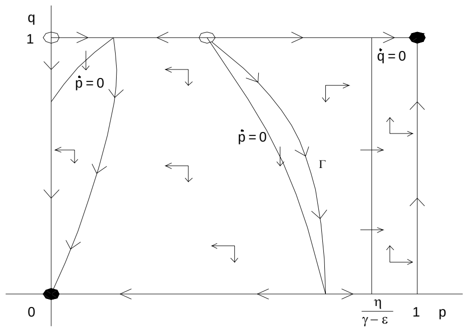

Figure 9d

Figure 10:

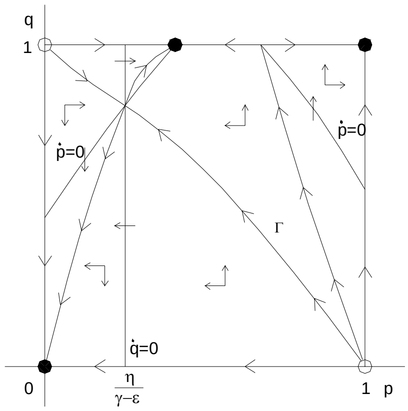

Figure 10

Figure 11:

Case 3: $\alpha-\beta>\theta$, $\xi-\delta<0$, $\xi-\delta+\omega\leq\theta<\alpha-\beta+\xi-\delta+\omega$, $\delta-\ \xi<2w$ and $\alpha-\beta-\dfrac{(\xi-\delta)^2}{4\omega}<\theta$

The dynamic regimes corresponding to this case are very similar to those of case 2. The only (qualitative) difference is that, in this case, the fixed point (1,0) is a source and that the repulsive interior fixed point in the edge with $q=1$ doesn't exist. For example, in figure 10 the case where three attractive fixed points exist is illustrated.

4 Comparative Dynamics: Basic Results and Concluding Remarks

In the light of the above analysis, including the most significant cases with respect to the major relationships among parameters, we are able to reach the following, general conclusions.

Proposition 5 *In all the versions of the model, (0,0) is always an attractive fixed point. In other words, regardless of any other consideration on parameter relationships, a positive probability exists in all scenarios under study that convergence to the socially suboptimal configuration occurs: this means that in all scenarios examined here a non-zero set of 'initial' pairs (p,q) exists, such that starting from there strategic interaction leads – in the medium-long run – to the socially inefficient no-provision outcome.*

When $(0,0)$ is not the unique attractive fixed point, then one or two further attractive fixed points exist where $q = 1$ and $p > 0$.

This is a general conclusion we are capable of drawing on the basis of the analysis of all the dynamic scenarios considered above: in all the versions of the model, whenever an attractive fixed point exists where the level of contribution is positive (with a non-zero set of actual donors, i.e. $p > 0$), productive efficiency reaches the highest possible level (with all nonprofits exerting a high-level effort, i.e. $q = 1$). Further, in all dynamic regimes where two or three attractive fixed points exist, the basin of attraction of $(0,0)$ is separated from those of the other attractive fixed points by an inset Γ (stable manifold) along which it holds $\frac{dq}{dp} = \frac{\dot{q}}{\dot{p}} < 0$ for $\dot{p} \neq 0$. This property of the curve Γ enables us to draw some implications, in terms of comparative dynamics. In particular, following the same method used in the appendix to prove proposition 4, it is easy to check that any variation of parameters that rises the values of $\dot{p}$ and/or $\dot{q}$, has as a consequence the expansion of the attraction basins of the fixed points where $q = 1$ and $p > 0$, at the expenses of the attraction basin of $(0,0)$. This means that the basin of attraction of fixed points where $p > 0$ increases as $\alpha - \beta$, ω, $\xi - \delta$, $\gamma - \varepsilon$ increase and/or θ and η decrease.Therefore, the following propositions hold:

Proposition 6 *As far as nonprofit organizations are concerned, Evolutionary Crowding-in can occur as a consequence of a Subsidy to H-type providers reducing the cost of being productive (i.e.$\uparrow \gamma$ or $\downarrow \eta$).*

Proposition 7 *As far as individual donors are concerned, Evolutionary Crowding-in can occur as a consequence of one of the following variations:*

(i) An increase in the degree of Selective Crowding-in between D-type donors (i.e. in the degree of conformism, $\uparrow \xi$).

(ii) A decrease in the overall Cost of contributing to the Public Good on the part of D-type donors (caused e.g. by a Subsidy or a 'Warm Glow' component and measured by $\downarrow \theta$).

(iii) An increase in the degree of p-dependent Opportunism, on the part of free riders, i.e. O-type donors (measured by either $\uparrow \omega$ or $\downarrow \delta$).

Such conclusions sound rather intuitive: as far as voluntary provision of public good is concerned, variations such as (1) a subsidy to efficient nonprofits, (2) an increase in the degree of Selective Crowding-in among actual donors and (3) a decrease in the cost of contributing to the good on the part of actual donors (either because of a subsidy or of 'warm glow' motives), all increase – ceteris paribus – the probability that collective good provision actually occurs. In this regard, it is important to remark that all these three factors act as 'positive selective incentives', i.e. selectively affect either the pro-social group on the demand side (actual donors, D) or the efficient institutions on the supply side (high-effort level nonprofit organizations, H). Finally, the analysis has shown that also an increase in the degree of p-dependent Opportunism will determine an Evolutionary Crowding-in effect: this means that when free riders do condition their behavioural choice to the proportion of actual donors present in the overall population, the probability for the public good to be provided – other things equal – increases.

5 Appendix: proof of proposition 4

In this appendix we prove proposition 4. As we have seen, the attraction basins of the fixed points $(0,0)$ and $(1,1)$ are separated by the stable manifold Γ of the saddle (p^*, q^*) (see figure 1) and Γ can be considered as the graph of a function $q = f(p)$ along which it holds (for $\dot{p} \neq 0$) $\frac{df(p)}{dp} = \frac{\dot{q}}{\dot{p}} < 0$.An increase of $\gamma - \epsilon$ (or a reduction of η) produces an increase of $\dot{q}$ which becomes $\dot{q} + \sigma$, where $\sigma > 0$ (while $\dot{p}$ does not change) Consequently, after the increase of $\gamma - \epsilon$, the curve Γ is no more an invariant curve and it can be crossed by the trajectories of the 'new' dynamical system; we aim to prove that it is crossed from the left to the right; this result would imply that the increase of $\gamma - \epsilon$ generates an expansion of the attraction basin of $(1,1)$; in other words, with the new parameter values, there exists a new separatrix Γ' of the two attraction basins lying on the left of the old separatrix Γ (see figure 2).

To see in what direction the curve Γ is crossed, note that the slope of a trajectory evaluated at a given point (p,q) is given by $\frac{dq}{dp} = \frac{\dot{q}}{\dot{p}}$ (where $\dot{q}/\dot{p}$ is evaluated at (p,q)) and that it holds $\frac{\dot{q}+\sigma}{\dot{p}} > \frac{\dot{q}}{\dot{p}}$ if $\dot{p} > 0$ and $\frac{\dot{q}+\sigma}{\dot{p}} < \frac{\dot{q}}{\dot{p}}$ if $\dot{p} < 0$; this proves the proposition.

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