

An Evolutionary Voting Game for the Supply of Public Goods

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1. Introduction

The public goods theory and the model of the consumer's equilibrium show that the market mechanism cannot efficiently supply the public goods. The standard model concludes that the provision of public goods needs some institution which determines the individual contributions levels to finance their production. The non-excludability of the public goods prevents its voluntary funding. In general, the supply of public goods cannot be based on voluntary gifts but in governmental compulsory exaction.

However, in contrast with the previous conclusion, we actually find numerous non-profit institutions supplying a wide range of public and quasi-public goods. In fact, in the last decades a large number of non-governmental organisations have emerged and developed over the world. At the same time, the literature related to the non-profit organisations has experienced a significant increase, dealing with their operation, funding and performance.

The existence of an unsatisfied demand is in the core of the theories of the autonomous setting up of the non-profit institutions. In this sense, the unsatisfied demand is a consequence of the failures of the public sector in supplying some collective goods in societies with a heterogeneous demand (Weisbrod 1975, 1988). On the other hand, the

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private consumption models (Andreoni 1990, Bernheim 1986, Roberts 1984, or Warr 1982) take into account the consumers' motivations to voluntarily funding non-profit organisations.

There is no conclusive empirical evidence about what kind of models better explain the role of non-profits in the provision of the public goods. The empirical results concerning crowding-out effects between non-profits and government provision are contradictory (Nyborg and Rege 2003). Some studies suggest a "dollar for dollar" crowding-out effect (e.g. Roberts 1984) while other analysis conclude that the crowding-out effects are very small (e.g. Kingma 1989, Ribar and Wilhelm 2002). The problem is somewhat mixed because the non-profit organisations represent a very wide range of possibilities of supplying different kind of goods to a different consumers. The unsatisfied demand hypothesis may explain some non-profits' activities, whereas the altruistic motivations to give would be a better explanation in many other cases.

However, these models do not explain the significant differences in the size and the role of the non-profit sector among countries with similar economic development level. Then an unsolved question is: why in some countries some public goods (or quasi-public) are mainly supplied by private non-profit organisation while in other countries the same goods are totally supplied by government? What does explain the public or private provision of a public good?

Differences in preferences would explain the larger or smaller provision of the public goods, as well as the more or less significance of the non-profits sector. However, only preferences do not explain which type of provision holds. We need to resort also the institutional setting in order to explain which alternative may arise.

In a public choice setting, when simple majority applies, the median voter determines the extent of the provision. The choice of public or private provision must reflect the individual preferences of the agents and the mechanisms by which choices are made. Individuals take their choices in a given institutional framework, the one which is the outcome of an evolutionary process.

Institutional setting may explain the different paths taken by different communities. In this case, initial conditions, i.e. history, and behavioural rules matter. Here, an evolutionary setup may help to explain why there is such a wide range of alternative institutional settings to the

provision of public goods in countries with similar economic development level.

This paper aims at explaining what determines the type of supply for public goods in a community. We use a very simple repeated game in which individuals choices determine output level of a public good supplied both by government or/and by non-governmental organizations.

2. The basic theory of privately supplied public goods

2.1. Altruism and voluntary funding.

The standard public goods model shows that the supply of public goods requires some institution co-ordinating the individual contributions to finance their production. A basic assumption in the model is that the individuals take the supply of public goods by the rest of the community as fixed. Under such assumption, the individuals contribution takes exclusively into account the increase of the public goods provision produced by its own contribution. This individual behaviour leads to an underprovision of the collective good. The extent of such underprovision of the public good depends on the nature of utility functions (Cornes and Sandler 1986), but it tends to rise as the size of the community grows.

Introducing altruistic behaviour allows expanding the voluntary supply of a public good. A selfish consumer only takes into account the benefits his own contribution has for himself. However, individuals might have other motivations. People might care about other people or ideas beyond themselves. Altruism explains voluntary contributions to financing the supply of public goods. However, altruism cannot guarantee an adequate provision of public goods. Applying a Cournot-Nash equilibrium to the pure altruism model leads to an underprovision of public goods (Andreoni 1988, Warr 1982, Roberts 1984, Bernheim 1986). Moreover, the standard model of public goods and the altruistic behaviour model cannot explain the different patterns of public or private provision we find in different countries (Andreoni 1988 Sugden 1982).

A different conception of altruism considers the feelings of the contributors as the motivation to give. This is the case of the impure altruism model (Andreoni 1990), which considers the voluntary

contributions as a private good consumed by the donor. In this private consumption model, the donor obtains some utility from the act of giving itself. The donors get a warm glow feeling from his contributions. The impure altruism model explains voluntary contributions as the act of giving itself motivates to give, as long as gifts fulfil an increase of their psychological welfare. These donors are indifferent about the kind of good that finally their gifts finance because they obtain some utility¹ even though their gifts do not contribute to finance the production of any goods.

In the same sense of the warm glow, social approval (Holländer 1990) or prestige (Harbaugh 1998) can also be considered as a motivation for voluntary contributions. These models are similar to the impure altruism model. The social approval is a by-product of individuals' contributions as the warm glow of Andreoni (1990).

Non-profit organisations can exploit the warm glow feeling in fund raising activities. But to the extent of such contributions are not related to the output of public goods, they can not be considered as a real alternative to the government's provision of public goods.

2.2. Cooperation and moral norms

The underprovision of voluntary supply of public goods derives from the assumption that individuals take the contributions of the others members of the community as fixed, and altruism does not allow overcoming this problem. Only a co-operative behaviour funding voluntary provision would be a real non-governmental alternative to the supply of public goods.

Let us consider, as an example of a pure public good, a dike built of bags of sand (Mueller 1989, p. 17) Each member of the community voluntarily supplies as many bags of sand as he chooses. The total number of bags supplied is the summation of the individuals' contributions of each member. The more bags supplied the higher and stronger the dike and the better off are all member of the community. The standard model of public good supply concludes that the number of bags

¹ The gifts are not conceived as an exchange for the goods supplied, but as private goods, that have a value themselves. The fact that the main motivation to give is not related to the output is coherent with a very low crowding out effect tested in some empirical studies (Ribar and Wilhelm 2002).

of sand will tend to zero. Nevertheless, it is possible, at least under some circumstances, that the attitude of an individual, that begins to carry bags of sand, motivates his neighbours to do the same and, finally, they build a high and strong dike.

Cooperation can be based on a principle of reciprocity (Rabin 1993). Each individual benefits from the whole contributions and the acknowledgement of the economic interdependence involves each participant in modifying (should it be possible) the behaviour of the others. Cooperation has an externality which benefits each participant and which induces cooperation itself. According to a principle of conditional commitment, the contributions of an individual depends on what the others do (Sugden 1984). On the other hand, ethical and religious principles may induce co-operative behaviour not necessarily grounded on reciprocity.

In a model of social commitment, the co-operative behaviour influences the other members of the community and voluntary contributions allow the private supply of public goods (Casas, Puchades and Sajardo 2001). However, as long as free riders cannot totally be avoided, the level of provision is not an optimum one

An implicit agreement supported by social norms might encourage cooperation in a small community. However, in a large community this social commitment may be too costly, as the raising of transaction costs exclude such a complex mutual contract in spite of the potential earnings

If the contractual processes of political or economic exchange are excluded, the natural way to reach co-operation is the investment in some institutions that incorporate no contractual attempts to modify the behaviour of the individuals². Without political or economic exchange, it only leaves ethics as a possible way of appropriation of the potential economic value that exists above and beyond of the ordinary policy (Buchanan 1991, 1996).

² Analysing non-profit institutions we cannot leave out the ideological and religious dimension of a large part of them. This is a way to overcome free-rider problems in the presence of altruism (Collard 1987). It also explains why people form non-profit organisations to redistribute income to the poor, lobby the government on behalf of general causes and so forth.

2.3. Honesty as a behavioural pattern

Ethic and moral constraints make people more determined to behave in a way that insures the smooth running of the economic system. Fortunately, the law is not the main mechanism enforcing peacefully coexistence. Self interest is compatible with cooperative behaviour. The concept of self-interest does not mean a predatory behaviour. Selfishness is not synonymous of stealing, cheating and making defraud as much as you can.

The idea of *honesty* may substitute pure altruism. In this sense, the individual subject to moral constraints does not seek the wellbeing of the other people or to fight against inequality. Honest people do not steal, stop at the traffic lights and pays their taxes *voluntarily*. In addition, they obey the law not mainly to avoid the possible penalties but because they think that it is their duty.

We define the honest consumer as following a Kantian ethic: that is, “*act like you think everyone should*” (Gassler 1998). In order to modelize the behaviour of the honest consumer, we do not need to modify the standard utility function by introducing new variables. The honest consumer behaves rationally and he will try to maximise his utility. But the maximisation is subject to two constraints. The ethic constraint operates in addition to the budget constraint.

A free rider consumer profits from the contributions of other people when exclusion is not applied. Free rider does not take into account the increase of the public good that his contribution would make. Free rider simply is willing to pay nothing. And, in the case of public provision, free riders will try to evade taxes as much as they could. By contrast, the honest consumer, subject to a Kantian ethic constraint, is willing to reveal his real preferences for the public goods.

Morevoer, the ethic constraint is compatible with voluntary agreements to supplement unsatisfied demand and with altruistic or warm glow feelings.

2.4. Clubs and private governments.

A significant Public Choice literature dealing with non-governmental provision of collective goods was centred on the theory of clubs (Buchanan 1965). Many goods supplied by non-profit organisations

embody the characteristics of the club goods, and a number of non-profit organisations are actually clubs. The provision through clubs is an alternative to the provision by government, and clubs' supply should crowd-out public supply.

However, clubs goods are a special case non applicable to voluntary provision³ by non-profits in general. The exclusion is possible in many of the goods supplied by non-profits as well as for goods supplied by governments. In these cases, the presence of either significant externalities or a redistribute goal suggests not to utilise prices as a rationing or as an exclusion element. The theory of clubs does not explain the voluntary provision when institutions do not use prices or fees as a basic criterion of exclusion and they fund from voluntary gifts by donors who do not consume de good supplied.

In addition to clubs, the rational consumers can organise themselves in order to improve their welfare, if they are unsatisfied with the government provision of public goods. This is the case of the so called *private governments*. Voters reject both broad based tax increase and budget deficits, while at the same time demanding improved services. Private governments are voluntary, exclusive organisations that supplement services provided by the public sector. (Helsley and Strange, 1998). According to this approach, the private governments appear because of the failures of the public sector providing public goods to consumers with heterogeneous preferences⁴. In this model, the government replies to private supply by reducing its provision of the collective goods, but the crowding out effect is incomplete. The public sector's action only partially offsets the private provision (Helsley and Strange 1998)

³ Although becoming a member of a club is a voluntary action, the production of clubs goods is not financed through really voluntary gifts. In club goods, it is possible to exclude those people who do no contribute by paying either an admission fee or an utilisation fee. Buchanan (1965) regarded clubs a non-government private alternative for the provision of collective goods, but the model can be considered to be more appropriate for guiding the actions of local governments in this field than for explaining the working and functioning of voluntary non-governmental organisations.

⁴ The private government can be considered as a special kind of club. The collective good exhibits a type of imperfect or coarse exclusion (Helsley and Strange 1991). Specifically, with public provision, there is universal access; the collective good provided by the public sector is available to all consumer. This universal access may be the result of technical difficulties or institutional rigidities (legal guaranties of equal provision). In contrast, with private provision there is restricted access; the private supplement is only available to subscribes (members).

2.5. Voting voluntary provision of public goods

Collective goods can be supplied either by the government or, alternatively, by non-governmental organisation. As the governmental provision is a collective choice, its alternative, the voluntary provision is also a collective choice.

The ethic constraint implies that the honest consumer is willing to give witting contributions as much as he was willing to spend if the good were supplied by the market. Consequently, honest behaviour allows an efficient private provision of public goods.

The honest consumer does not take exclusively into account the increase of the public good supply that his own contribution produces, but he hopes other people will act honestly.

The ethic restriction modifies the maximising rule. Therefore, the voluntary contributions of a consumer i is a function of the marginal utility of the public good and of the quantity of the public good he consumes (or hopes to consume.)

$$g_i = \theta_i \left(G, \frac{\partial U_i}{\partial G} \right) \quad [1]$$

In a community with n honest individuals, the quantity of public goods supplied would be:

$$G^* = \sum_n g_i / C \quad [2]$$

being C the cost per unit of producing the public good G (for simplicity, we assume a constant marginal and average cost C .)

The output level G^* fulfils the familiar Samuelsonian condition for the Pareto-optimal provision of a public good, whenever all individuals behave honestly.

Despite the honest behaviour allows an optimum non-governmental provision of public good, this fact does not imply that the provision of a public good will be voluntary, even in the improbable case that free riding does not exist at all and that all individuals behave under the same ethic constraint. The governmental supply financed by taxes is an alternative so honest as voluntary supply.

Individuals do not know what is the Pareto-optimum output, neither they try to maximise an aggregate welfare function. The consumers purchase goods and vote in the political process according their own preferences. The difference is that the honest consumer behaves subject to an ethic constraint whereas the opportunistic consumer behaves subject only to his budget constraint.

Consider a community of n individuals where at least a share of members are honest consumers in the sense described above. Individuals have different preferences on a public good and they face the following alternative scenarios for a public good supply:

- a) Public provision: government collect a tax t to all individuals and supplies a level of output G^p
- b) Voluntary provision: honest consumers make a contribution g_i to finance a level of output G^v (free riders do not contribute at all).

An honest individual i will prefer voluntary provision as long as G^v was larger than G^p and g_i lower than t , and will prefer public provision in the opposite case⁵.

In a public choice setting, when simply majority applies, the median voter determines the outcome. Therefore, as a result of the collective choice, the supply will be either governmental or voluntary depending on the position of the median voter.

The result will be voluntary provision if the distribution of preferences makes the voluntary contribution of the median voter lower than the average contribution. That is, voluntary provision will occur when

$$g_j < \sum_n g_i / n \quad [3]$$

being j the median voter.

On the contrary, if the distribution of preferences makes the voluntary contribution of the median voter higher than the average contribution the political process will carry to governmental supply financed by taxes.

A change in the preferences distribution may crowd out the supply of public goods from private to public provision or vice versa. In this

⁵ A free rider will prefer voluntary provision except if the supply was so much reduced that his loss of utility exceed his gain from not paying taxes (Casas, Puchades and Sajardo 2001)

sense, the model would be useful to explain the significant differences among countries. That is, why in some countries the governments finance by taxes the provision of many public and quasi-public goods, whereas in other countries these goods are largely supplied by non-profit organisations financed through voluntary contributions.

3. An evolutionary model of voluntary supply of public goods

Citizens of European developed countries are used to the *welfare state*. The public sector provides, to a large extent, a bundle of public goods, quasi-public goods and goods with significant externalities or redistributive impact.

Although the presence of non-profit organisations supplying those kinds of goods is not negligible, in many cases the government contributes largely to finance the working of these non-profits, be it directly⁶ or through fiscal incentives. Most models dealing with non-profit institutions consider either that they supplement the public provision of some goods and services, or that they exist simply because altruist people want to do good things (the warm glow of giving). However, this disregards historical evidence. In past centuries, when the governments neglected the supply of such goods as charitable services, social security, medicare, education, cultural services and so on, their supply was made through non-governmental non-profit institutions, mainly religious institutions.

So, why did this institutional setup breakdown in favour of further governmental intervention? Current levels of governmental supply are a result of the political process in the working of democratic systems, with its formal voting procedures for making and enforcing collective

⁶ Non profits have experienced a significant real income growth. But a big share of such growth comes from governmental sources. In some cases, government delegates the supply of some collective goods, but that production remains mainly financed by government. It is the case of the so called “contract culture” through which the voluntary organisations compete to get the contracts to provide services funded by government and previously supplied by statutory authorities (Harrow, Palmer and Vincent 1999, Wise 1995)

choices. Next we try to explain how, in an evolutionary setup, both collective and voluntary supply may coexist.

3.1. The basic setup

Consider a population of N agents which differ in the extent of their demand for a public good G . For analytical purposes we arrange individuals from lower to higher demand and divide the population in three groups: a group of n low demand agents; a group of n high demand agents; and the median individual, hence $N = 2n + 1$.

The public good can be either supplied by the public sector or privately by non-governmental organisations, or a mixed of both public and private supply.

Government finances public supply by collecting a tax t from each of the N individuals of the community. Given a cost per unit⁷ C , tax determines the output G^p publicly supplied.

$$G^p = t \cdot N / C \quad (4)$$

In order to finance non-governmental provision, the members of the community give voluntary contributions g_i . The output G^v voluntarily supplied is

$$G^v = \frac{\sum_{i=1}^N g_i}{C} \quad (5)$$

and the joint public good output is:

$$G = G^p + G^v \quad (6)$$

Assume that individuals' preferences can be represented by a standard linear demand function. [$G = f(P_g)$]. However, in the case of public goods individuals do not exchange the output at a price per unit (P_g), but they pay a total sum (a tax t plus a voluntary contribution g_i) in exchange of the whole output supplied. Then, we can represent the preferences by a standard consumer's expenditure function.

$$(t + g_i) = \phi(G)$$

⁷ For simplicity, we assume a constant marginal and average cost C .

$$g_i = \phi(G) - t \quad (7)$$

Individuals do not need to maximise utility functions, but they realise whether they are satisfied with the level of public good supplied. Each agent knows his total contribution $(t+g_i)$ and the total output supplied. Therefore, individuals are able to evaluate how their contributions to the output fit with their own preferences.

3.2. A preference's revelation mechanism

Let us assume that individuals behave honestly. An agent might consider that he is giving too much money in exchange for the output supplied. In such a case, he will wish for a reduction of his total contribution (knowing that a lower contribution will reduce the output supplied). On the contrary, an individual might consider that the output supplied is too low and he will be willing to increase his contribution in order to increase the output. In this way, honest consumers reveal their preferences on public goods without a special commitment agreement.

The output level supplied by government is an outcome of the political process, while the sum of individual decision for making voluntary contributions determines overall voluntary supply.

In the political arena, individuals vote higher or lower taxes according to their preferences. In general, consumers with higher demand will vote for higher taxes while lower demand consumer will vote for lower taxes. Under a simple majority decision rule, it is the relative position of the median voter that determines the outcome. Voluntary supply arises as high demand consumers want more output than the government supplies; in such a case some agents are willing to make voluntary contributions in order to obtain an output increase. This is not an altruistic behaviour, neither it is grounded on a reciprocity criterion or on a special commitment. Donors cannot hope that all members make voluntary contributions but, assuming honest agents, it may be reasonable to expect the output to rise more than the increase of ones own contribution. Honest behaviour allows individuals to reveal their preferences.

3.3. Structure of the static game

We modelize the behaviour of individuals as a two stages game.

There are two political parties (L and R). The program of one party (e.g. L) is to increase the public supply of the public good and hence to increase taxes. The program of the other party is to reduce public provision and taxes.

In the first stage of the game, individuals vote according their preferences, and the winner party implements his program (increasing or reducing taxes and public supply of the public good)

In the second stage of the game, individuals decide their contributions to finance voluntary supply.

An equilibrium solution requires that the median voter, as well as high demand voters, adjust their voluntary contributions such that they do not consider that they are paying in excess or that there is an unsatisfied demand.

The equilibrium depends on the structure and distribution of individual preferences and on the cost of production the public good.

For each set of preferences there is not a unique equilibrium point. Since tax level t and the set of voluntary contributions g_i must be simultaneously determined, multiple equilibria may emerge. Under certain assumptions, we can find a set of voluntary contribution g_i that fulfils the equilibrium conditions for different tax levels in a wide range of possible values of t .⁸

Equilibrium requires that agents adjust their witting contributions as the sum of tax plus voluntary contributions equals what they are actually willing to pay for the total output supplied. However, individuals do not know the contributions of the other agents, therefore they can not know the output that will be supplied.

⁸ Possible equilibria can vary from exclusively public provision without voluntary provision to the opposite case of voluntary supply without public provision. Notice that the total output will be different. In the first case, exclusive public provision, the level of total output supplied is the one which fits the preferences of the median voter at a unitary price equal to C/n . This output will be greater or less than the Pareto optimum one depending on whether the median voter demand is greater or less than the average demand. By contrast, voluntary supply leads to an optimum output level as long as all individuals behave so that they reveal their true preferences. In the case of a mixed supply (public and private) the output level will tend to the optimum.

3.4. A dynamic model for public and private provision

Let us consider the dynamic setup from an evolutionary perspective. Starting from the structure of the game depicted above, a repeated game allows us to analyse the evolutionary process leading to the equilibrium solutions. In an evolutionary process agents take decisions and react to the variations in the output levels in each period, showing how equilibrium is reached.

The dynamic framework in the repeated game is as follows:

We start in period $k=0$ from an arbitrary level of individual tax, t , and an arbitrary set of voluntary contributions $g_i, \{1... n\}$.

Next period begins with political choice: elections take place. Individuals vote for the party which promises to increase or to reduce taxes and public supply of public good according to their preferences. Agents take into account their net contributions (tax plus witting contributions) and the output supplied in the previous period. The winner party implements his political program increasing or reducing tax level. Therefore for each period k the tax level is:

$$t_k = t_{k-1} \pm \alpha \quad (8)$$

being α the change in individual tax.

The new elected government does not adjust the tax level to the one the median voter actually prefers, it simply increases or reduces the previous tax level. We can assume that tax variation depends on the extent of the electoral triumph of the party in power. That is, α is a function of the difference of votes of the winner party over the loser party. This way allows a quickly approximation to an equilibrium tax level.

In the second stage of the game agents adjust their voluntary contributions.

Agents take into account their new tax level (and its associated public output level) and their current voluntary contributions (if any). An individual might have motivations for reducing his voluntary contribution if he considers that he is paying in excess for the output level supplied. On the contrary, an individual may experience that his demand remains partly unsatisfied and he is willing to increase his voluntary contributions in order to increase supply.

Therefore, the voluntary contribution of an individual i , in period k , is given by:

$$g_{k(i)} = g_{k-1(i)} \pm \beta_i \quad (9)$$

where the change in voluntary contribution β_i is a function of the total output supplied G , $\{G = G^p + G^v\}$ and the output level the individual wishes in exchange his total contributions, G_i^* .

$$\beta_i = \varphi(G - G_i^*)$$

That is, the change in voluntary contribution β_i depends on the unsatisfied demand of consumer i .

The game is repeated until equilibrium is reached, when tax and the witting contributions remain unchanged in next periods. Equilibrium does not mean that a Pareto-optimum level of output is reached, neither the median voter maximises his utility function. Equilibrium is reached when there are not a majority changing tax level and individuals have not incentives to modify their voluntary contributions.

3.5. Some preliminary results

The repeated game allows us to show the dynamics of the process towards equilibrium. Evolutionary models allow us to focus not only on equilibrium states but also in dynamic issues and how initial conditions affect the outcomes.

Equilibrium cannot be determined unless we give a functional specification of the distribution of the preferences of individuals, the distribution of voluntary contributions, the initial tax and the evolutionary patterns of taxes and contributions..

In general, the equilibrium is determined by the initial distribution of tax and witting contributions, the distribution of individuals' references and by the function which determines how tax and voluntary contributions varies each period in response to the preferences of the agents. Outcome depends on initial conditions but also on the evolutionary path.

The proportion of voluntary provision in the final equilibrium depends on the extent that public provision neglects unsatisfied demand. The equilibrium in each case depends on the distribution of consumer preferences, the initial level of tax and the distribution of voluntary contributions and on the adjustment speed of tax and voluntary contributions to the agents' preferences.

From this, we can get some preliminary conclusions. Equilibrium states are determined by:

– Inequality in the preferences.

Ceteris paribus, the greater is the inequality in the preferences the greater is the proportion of voluntary provision in the final equilibrium. A higher dispersion in demand functions implies larger unsatisfied demand for high demand consumers who, in turn, are willing to make larger witting contributions.

In a community of individuals with homogeneous preferences, equilibrium requires a level of output G^* that fulfils the Samuelsonian optimum condition for the public goods. Under the assumption that all individuals behave honestly, every mixed public supply (G^p) and voluntary supply (G^v) which provides an optimum output level ($G^p + G^v = G^*$) is an equilibrium point.

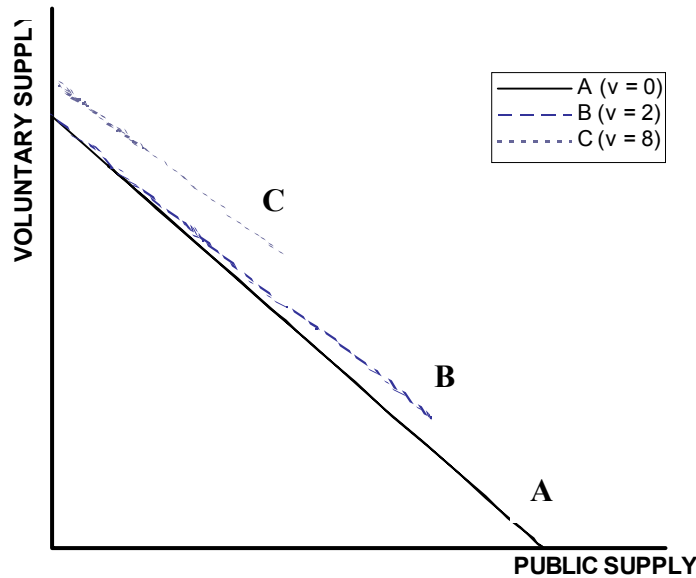


Figure 1. Equilibria for different preferences settings

In figure 1, the line *A* represents the possible equilibria in the case of homogeneous (preferences' variance = 0). As individuals share the same preferences, all of them are willing to give the identical contributions to finance voluntary supply. The crowding out effect is complete; an increase in tax reduces in the same amount witting contributions and vice versa.

However, the outcomes are different in case of heterogeneous preferences. A public provision level that could be voted for a majority cannot satisfy the preferences of individuals with highest demand. The existence of this unsatisfied demand raises the voluntary provision.

In figure 1, curves *B* and *C* represent the possible equilibria points for heterogeneous individual preferences distributions. Curve *B* represents the equilibria for a larger inequality in preferences (preferences' variance = 8) than curve *C* (preferences' variance = 2). In general, a larger inequality in preferences requires larger voluntary provision in equilibrium. Moreover, inequality leads to an oversupply of joint output level. This oversupply is greater as great is the public provision level. This is a consequence of the fact that the individuals of low demand group are forced to pay a tax level higher than the price they would wish to pay for the output. They vote for tax reduction, but they are not a majority to obtain a tax reduction.

– Median voter preferences.

The position of the median voter in the distribution of preferences has particular significance determining the political outcome

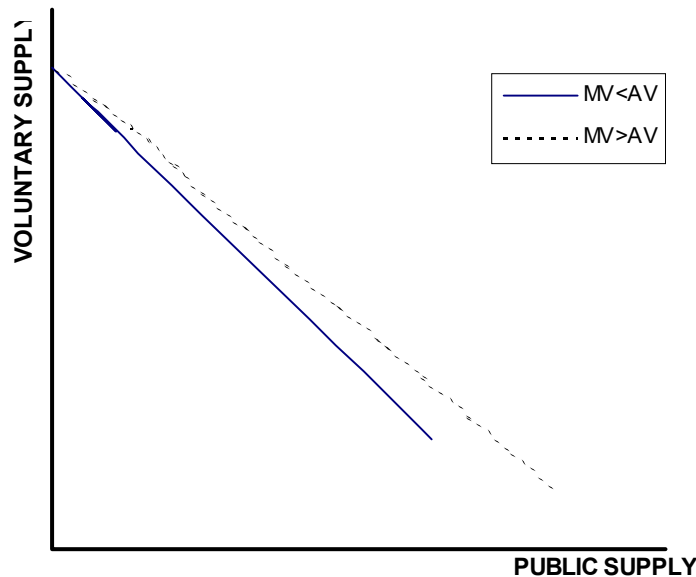


Figure 2. Equilibria for different median voter preferences

Figure 2 shows possible equilibria when the preferences of the median voter are located above and below the average preferences (maintaining the level of preferences dispersion)

The median voter prefers more voluntary supply and lower tax level when his preferences are located below the average. By contrast, when preferences of the median voter are located above the average of population, he will tend to vote more taxes that also pay individuals of low demand group.

– Initial tax level.

The distribution of preferences among individuals and median voter position determine a wide range of possible equilibria, but the final equilibrium also depends on the initial situation.

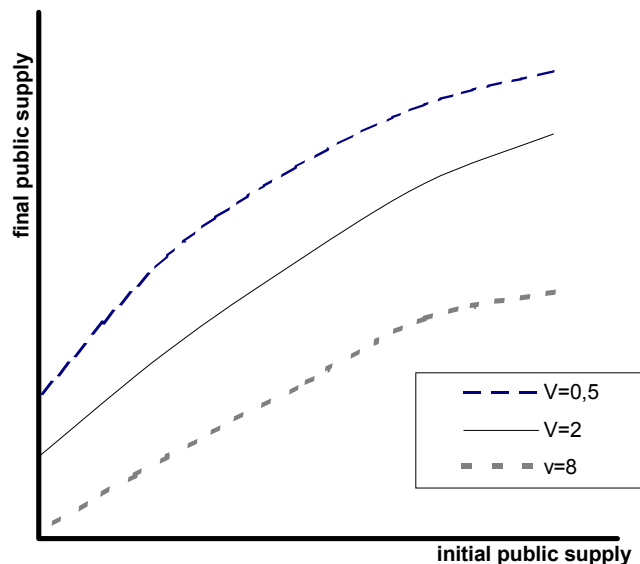


Figure 3. Equilibria for different initial tax level

Figure 3 shows how the final public supply depends on initial situation for different preferences settings.

Low initial tax level encourage rapid increase in voluntary supply. A reduced public provision incentives consumers to adjust their witting contributions rising voluntary supply.

– Flexibility of voluntary contributions.

. Unsatisfied demand can be met either by the public or the private sector, depending on the flexibility of either mechanism to adapt to demand variations. As agents are able to adjust their witting contributions, voluntary provision crowds out public provision and equilibrium with a larger proportion of voluntary provision is possible⁹.

– Free riding.

The model allows the introduction of a share of individuals behaving as free riders. Free riding reduces witting contributions and private provision in favour of public provision. If the proportion of free riders among high demand consumers increases, voluntary provision falls towards zero.

⁹ An alternative assumption on changes in witting contributions is to consider that the consumers who perceive an excess of output are not willing to make any voluntary contributions. In case of an output excess, the consumer instead of cutting down a proportion of his witting contribution, reduces it towards zero. This assumption implies an asymmetric behaviour of the adjustment of witting contributions, which are able to fall very quickly but increase in a gradual way.

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