Public Goods:
Review of Privately Provided Public goods Literature

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Abstract: *The intention is to do a summary of the private provision of public goods literature*; *it also has the goal of seeing that there is no match between the classic theory predictions and the reality and empirical data*. *Another objective is to find within the literature aspects not studied yet*, *and so indicate future research topics*

Introduction

A public good, G, has two important characteristics that distinguish them from the private goods:

(i)-non rival - the consumption of the good from one individual does not change the utility that other can take from consuming the same good

(ii)-non exclusive - impossibility of excluding someone of consuming it.

Given this two characteristics the optimal provision of the public good is different from the efficient provision of a private good . The logic is the same, a unit should be provided if the benefit for the individuals is higher than the cost of provision of that unit, the difference is that now the marginal benefit is the sum of the individual benefits, since the unit of G is consumed by all the individuals in the society.

So the social optimal provision is given by what is called Samuelson Condition,(Samuelson,1969):

$$\sum_j \frac{\text{MBen(G)}_i}{\text{Mben}(x_j)_i} = \text{marginal cost (in terms of the private good)}$$

where x_j is the private good consumed by agent j.

This condition says also that the optimal social amount of G is Pareto optimal, and suppose not, then it was possible to increase the utility of one person without decreasing other agents utilities, but because the social welfare function is increasing in one's utility, this allocation could not be social optimal.

We must say that this optimal social G, depends on the distribution of private goods among the individuals in the society, so it is not unique, there is an exception although, if we have quasilinear preferences with x_j as the linear good, one unit of x is one unit of utility so this imply no redistribution issues, and therefore the optimal G is unique.

One way to provide the optimal amount of public good,G, is the Lindhal solution, (Lindhal,1958),where each individual contribute with a share , s_i, of the cost of G- which is $p(G)$.

In this situation each individual max his utility $u_i(x_i, G_i)$ s.t $x_i + s_i.p(G_i).G_i = m_i$ where the agent sees G_i as a private good to consume.

The Lindhal solution is such that $\text{G}_i = \text{G}_j = \text{G}$ for all i, j and $\sum s_i = 1$. Although this solution is Pareto optima in the sense that satisfies the Samuelson condition is not applicable in the reality, the problem with this solution is that it is not a nash equilibrium, it means that given that the other agents are acting accordingly with the lindhal solution, each individual has incentive to deviate, in this case to contribute less amount than what is needed to provide the social amount of public good- each individual has incentive to free ride.

Private Provision

From what we have said, one question may arise. Is it possible to provide privately a public good, and if so, is this provision efficient?

Lets suppose that each individual can contribute g_i such that the total amount of G is $\sum_{i.} g_i$ so the problem that each agent faces is

max $u(x_i, G)$ - this functional form is called the altruist utility function

s.t

$x_i + G = m_i + G_{-i}$ - where m_i is agent i income and G_{-i} is others agents contributions, and $m_i + G_{-i}$ is called the social income.

Given that this is a simultaneous game, the solution of this maximization problem, faced by all agents, is a Nash equilibrium, i.e., a vector of individual contributions where each individual contribution g_i^* is a best-response to others players contributions G. This Nash equilibrium exists, proved by the brower fixed point theorem, and its unique if we consider the private and public good, normal goods.(to see the proof- Bergstrom,Blume and Varian,1986 or Andreoni 1985)

But the private provision of the public good is not Pareto optima, mathematically we can see that it doesn't satisfy the Samuelson condition,

for each agent the foc are

$\frac{u'_G}{u'_{xi}} = 1 \Rightarrow \sum_i \frac{u'_G}{u'_{xi}} > 1$, if and the Samuelson condition is $\sum_i \frac{u'_G}{u'_{xi}} = 1$

intuitively, suppose the NE is Pareto optima, then at least one agent will be better off contributing less- is the same idea behind the failure of imposing the Lindhal solution - there exist incentive to free riding.

Joint Provision

This lead us to other question, given that private provision is not efficient, can the joint provision, where the government does also contribute- subject to the budget constraint, so that its policies are credible- produce a public good provision closer to the optimal allocation? Well, the answer is dubious, it depend on the assumptions we make, so it depends on the reality we face.

First lets assume the government determines lump sum taxes on the individuals,T, where the tax revenue collected, is used in the provision of G(see Bergstrom,Blume and Varian,1986) .

(i) if there is one public good, and if the agent is making a initial contribution of $g_i > 0$ (in our private NE provision), and is introduced taxes such that $T_i < g_i$, then there is a total crowding out, and the total public good provision still remains the same. This occurs because each agents understand what is happening, so given that he wants some G^*, and knowing that the taxes are going entirely to the provision of public good he just reduce his contribution in the amount of T_i, so that the public good that is provided is G^*.

(ii) if the agent is not initially contributing to the public good $g_i^* = 0$, or if $T_i > g_i$, then the tax system is not neutral, and the total public good provided, G, increases if the private and public good are normal goods. If the government taxes in this way, this agent after the tax determines is optimal contribution as $g_i^{*'} = 0$, but in reality he is contributing more via taxes, T_i, than he was before taxes. The social income of the others agents is higher now,($m_i + G_{-i} + T_{-i}$) and so given that both private and public goods are normal goods the optimal amount of g_i^* is higher.

By these two effects the level of G is increasing with this policy.

(iii) if the $\sum_i T_i = 0$, and there is only a redistribution reason for this tax system then if $T_i < g_i$, the tax system is neutral– since a redistribution of income can be rebuilt as a series of tax changes, one agent is taxed, and that revenue goes to the provision of public good, but then they take this same money and give it to other agent .So the story can be tell by (i) - but now if he receives a lump sum subsidy, he will give, by the same reasons, more contributions to the public good, since he knows that the government contribution was reduced.

if $T_i > g_i$, then the effect is not neutral, like in (ii)

(iv) If we maintain the assumption that taxes have only redistributive reasons, if we have more than one public good, two situations can appear:

(a) if there is no link between individuals, such that agent one contribute only to G1, agent 2 only to G2,..., agent N only to N,..., then this tax system not a neutral intervention by the government, and the levels of public good will shift, some will go down–the public goods that tax agents like–some will go up– public goods that subsidized agents like.

(b) if there is a link between agents, then its neutral, again a redistribution of income can be rebuilt as a story similar to one public good in

Distorcionary taxes

Another question is what happens if the taxes used for the reasons previously mentioned are distorcionary.

Suppose we have identical individuals in respect to their preferences, and we introduce a subsidy, s_i, for each unit of contribution g_i, this will reduce the ”price” of the public good for this agent.

For this policy to be credible the government budget must be balanced so he must obtain revenue equal to the value of expenditure used with the subsidy policy. One way is to lump-sum tax the agents .

In this situation the policy can be neutral or have an impact, it depend on how the agents understand the problem.

If after collecting the revenue and giving subsidies the government increases or decreases the public good provision by the amount of the superavit or deficit, $\sum_i (T_i - s_i.g_i)$, then by rational behavior, the agent will, when making his/her decision about how much to contribute, incorporate this knowledge, such that he changes the contribution such that the total G still remains the same- of course like in the previous cases, where were only lump-sum taxes the neutrality requires that $t_i < g_i^*$.

But even with rationality of the agents, there exist (Andreoni & Bergstrom- 96) a scheme that is not neutral, what we need is that the real ”price” of the public good is really changed.

If b is the subsidy for each agent–for each unit of g_i—and $s_i.bG^*$ the tax that each agent pays, such that $s_i < 1$, $\sum_i s = 1$, the real price will be now reduced to $1 - b(1 - s_i) < 1$, and there is budget balanced. In this case this policy system is credible and not neutral.

If there is one person that tell the others that they can get the same G as in the past, and if the other agents can figure out that this is true, another possible NE of this tax system is neutrality.

Level of contributions and Who contribute(Andreoni, 1987)

Another characteristic of this model with altruistic preferences - the same max problem earlier seen-(Andreoni JPE 88) is that if preferences are equal, and the private and public goods are normal goods, then as the population increases– and also the rich population–, the level of optimal contribution of each individual tend to zero, and only the more richest persons are the ones that contribute to the provision of the public good,G^*.

The idea is that initially we have the same problem earlier mentioned and so a nash equilibrium where $g_i^* = \max(m_i - x_i^*, 0)$, where x_i^* is the optimal private good consumption.

Then if the richer class increases, as a consequence of the increase of total population, their $g_i^* > 0$ and these new agents will contribute to the public good provision.

As a consequence the social income for each individual,$m_i + G_{-i}$, becomes higher, and as x and G are normal goods, the optimal x_i and G increases for each agent, but if x_i^* increases , giving m_i fixed, the optimal g_i^* decreases, and the percentage of the society that contribute is reduced

In the limit– when the population increases indefinitely, using the same reasoning, only the richest class contribute and their $g_i^* \to 0$.

If we have different preferences, by the same arguments, only the richest and with higher preferences in respect to G contribute, in the limit.

Provision by one individual (wars of attriction)

Another important issue came when we have a public good that can be provide by just one individual, like opening a window, jumping in to save a drowning swimmer, became the first dancer in a disco, and so on.

Bliss and Nalebuff (1984), use a infinite time model, where after the public good is provided it exist forever. And where the agents have equal benefits but different costs of providing the public good.

In this type of game the set of sub-game perfect equilibrium is not unique, any agent providing the public good is an equilibrium - if everyone thinks that agent$_i$ is providing the good the best response is not provide, agent$_i$ knowing that no one is providing the good his best response is to provide the public good.

Bliss and Nalebuff center their attentions in the sub-game perfect equilibrium where the agent with less ratio cost/ benefit will provide the good, and where each agent has incentives to behave as non-liar in respect to his cost.

In this case each agent has a optimal waiting time function, that determines the moment at which each agent provides the public good iff no one else did already provided it.

The most important results are what we could expect:

(a) the optimal waiting time increases with the cost of the good and with the number of agents -there is an increase in the expected value of free-riding.

(b) in the limit as the population size approaches infinity, the free rider problem vanishes- this happens because the probability that there exist one individual with 0 cost tends to 1.

Bilodeau and Slkivinski (1994), have created a different model, where the time is finite, in this case the non-uniqueness problem in the set of sub game perfect equilibrium disappear, the SPE is unique.

In this case the agent with less cost/ benefit ratio (agent$_j$) immediately provides the good - this follows by backward induction, being $t_i = T_i - \frac{\cos t}{benefit}$ the last moment at which agent$_i$ is still considering to provide the public good, the best response of every agent is to not provide immediately the public good, he expects that someone else will provide it.

Putting the agents in a game where the agents with less cost/benefit ratio decide first to provide or not, we have that each agent when deciding to provide or not knows that if he doesn't provide the good, there will be another agent that will provide it since *benefit*$_i$ > cost , for all *i*– of course we need a continuo of individuals such that each agent prefers to wait– by this reasoning any agent will expect that other agent will provide the public good after his t_i passed.

The last agent is agent$_j$– the agent with higher t_j, that knowing that he is the last person that can provide the good, and that no one else have provide it until now, his best-response is to provide the public good.

Knowing this story, the maximization problem of his utility make him deliver the public good immediately at period 0, so that he have more time to benefit the public good.

Empirical Results

The predictions of the model with altruistic preferences– $u(x_{i,}G)$ –(the model we have seen until now) are not seen completely in the data.

The data seems to show a vast participation of the society in the charitable sector, they also show that both aggregate and individual contributions are large (2% of GNP), and by last, government donations incompletely crowd out private sector donations. As we have seen the model we've been studying predict the opposite.

Another issue is that if the some individual increases his contribution, the model predict a crowding out of this increase ,the total $G = \sum_i g_i$ does not increase in the same amount, the proof is simple, given a increase in the amount of the contribution, g_i, from some individual, the social income of other agents increase, if we assume normal goods, the optimal private good quantity,x_i^*, increases and then $g_i = m_i - x_i^*$ decreases.

As the number of individuals in this society increase the crowding out increase too. In the limit there could exist a total crowding out.

So these facts lead us to a study of different models that can also study public good provision, but, we expect, with more realistic predictions.

Sequential Provision(Varian,1992)

One possibility ,studied by Varian, is the sequential provision of public goods, where our equilibrium concept is now, the sub game perfect equilibrium, he has shown that

(i) the sequential eq. of the contribution game will provide the same or less than our previous nash equilibrium, and is also neutral to small redistributions of income- what is not a famous result giving our empirical data.

(ii) in two players game where players can choose a subsidy rate that they will give to the other player, where the sequence is first they choose this subsidy and then play the contribution game, the eq. will be the lindhal solution- but this results exists only with small players game

(iii) If we include uncertainty about others players utility- a more realistic framework in a society- , the amount each individual contributes gets smaller- hopes that other agent has higher utility from the public good and then he expect more benefits from free riding.

Warm Glow (Andreoni 89)

In this case agents have two reasons to contribute to a public good: altruism- as in the previous cases–, and private goods benefits from the gifts per se (this is the warm glow)

In this model the utility is

$u_i = u_i(x_i, Y, g_i)$ where g_i enters twice in the utility function, it enters also in Y =public good= $\sum_i g_i + \textit{government contributions}$.

Since in this model people are not indifferent about the source of the contribution, there will be some stickiness in each individual contribution g_i^*.

What implies that lump-sum taxes will, in general, only incomplete crowd out private giving, and that a redistribution of income will increase the total supply of Y if the person receiving the transfer is more altruistic than the person that loses income..

Then free riding is not pervasive and crowding out is not complete, what is more close to what data tell us.

The main idea is that if we reduced income of a person whose utility is mainly explained by warm-glow, then he will be more stick to his initial contribution, g_i^*, he cares less about total public good provision and more with his contribution.

If we increase the income, by the same reasoning, he will not increase is contribution as one more altruistic agent, now as we have said he cares more about his contribution to the public good provision, and less with the total public good provided.

Conclusion

We have seen that the private provision of public goods theory needs a reformulation, empirical data and reality don't fit with total government or private crowding out. In reality we see that all social classes tend to contribute where the poorest and the richest of this classes are the ones that most contribute, our traditional model of privately provided public goods is incapable of explaining this facts.

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