



Static and dynamic (in)efficiency in public goods provision



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HIGHLIGHTS

- We develop a theoretical model with heterogeneous agents that differ in income.
- We focus on two alternative public choice mechanisms.
- We show that static inefficiency depends on the public choice mechanism.
- We show that it depends also on the income elasticity of the public good.
- We show that a trade-off may be at work between static and dynamic (in)efficiency.

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ABSTRACT

We analyze, with a methodological focus, in which cases and under which hypotheses, the dispersion of the distribution of individual demands affects the provision of public goods. We derive implications in terms of static and dynamic (in)efficiency.

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1. Introduction

An important area of study in public finance is the provision of public goods. The optimal quantity of a public good occurs when the society's willingness to pay for the last unit of the public good equals the marginal cost of the good. Most of the literature on the optimal provision of public goods focuses only on the demand of the average agent, that can be reasonably considered, with symmetric distributions, that of the median voter.

We analyze, with a methodological focus, in which cases and under which hypotheses, the dispersion of the distribution of individual demands affects the provision of public goods and we derive implications in terms of static and dynamic (in)efficiency.

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We develop a theoretical model with heterogeneous agents that differ in income, and we analyze how things change when income elasticity of demand is one or higher than one. Since the preference-revelation mechanism restricts the government to offer a uniform quantity of public good, we focus on two alternative public choice mechanisms that can be at work: the standard public choice mechanism, that is the median voter; but, as stressed by Rubinfeld (1987), another possibility is that the level of public provision would be an average of the demands of the individuals. We rely therefore also on Rubinfeld's suggestion (hereafter the "benevolent maximizer" case), which is different from the standard utilitarian maximizer solution as far as the individual demands are non-linear. Rubinfeld's suggestion seems reasonable as easily implemented.

We show that the degree of the mismatch between individual demands and the provision of the public good depends both on the public choice mechanism and on the income elasticity of the public good. We also show that a trade-off may be at work between static and dynamic (in)efficiency.

The paper is organized as follows: Section 2 presents a static analysis, Section 3 shows the dynamic implications, and Section 4 concludes.

2. (In)efficiency in a static perspective

We assume that the economy is composed of N (fixed) individuals and two final goods: a public good (G) and a private good (X), produced by a single production process. Total income (Y) is exogenous; y_i is the level of income and x_i is the consumption of private good of individual i . The distribution of income among agents is exogenous. We assume that the distribution of income is either symmetric or, more realistically, skewed-right.¹ The production function in the economy is:

$$Y = f(N) \quad \text{where } f_N > 0 \text{ and } f_{NN} < 0. \quad (1)$$

To keep things simple, we assume that the public good is financed by a lump-sum tax, that is $\frac{G}{N}$.²

The individual budget constraint is:

$$y_i = x_i + \frac{G}{N}. \quad (2)$$

The individual utility function is:

$$U_i = U(x_i, G). \quad (3)$$

Agents maximize their own utility under the budget constraint, and individual demands for the private and the public good arise. If the goods are non-inferior, the demands are increasing in individual income. Engel curves³ follow:

$$x_i^* = x\left(\frac{y_i}{+}\right) \quad (4)$$

$$G_i^* = g\left(\frac{y_i}{+}\right). \quad (5)$$

We assume that individuals are heterogeneous in incomes:

$$y_i \neq y_j \quad \forall i \neq j. \quad (6)$$

We assume that the government knows the distribution of income ($f(y_i)$), and hence the average demand for the public good ($E(G_i^*)$), and the demand of the median voter ($G_{\bar{i}}^* = g(y_{\bar{i}})$), which is equal (lower) to the demand of the average agent ($g(\bar{y})$) with symmetric (skewed-right) distributions.

Heterogeneity in income would bring inefficiencies in the provision of public goods. In fact, the efficient provision of the public good would perfectly fulfill individual demands. Since

agents are heterogeneous, individual demands (Eq. (5)) are different across agents. But, since the government is restricted in its policy tools to offer a uniform quantity of public good in the economy, a mismatch (static inefficiency) between individual demands and the provision of public good arises.

We consider public goods with a **unitary income elasticity of demand**, and with an **income elasticity of demand higher than one**.⁴ The literature (see, among others, [Canton and de Jong, 2005](#); and [Healey, 2008](#)) suggests that graduate public education can be a unit elastic public good, whereas post-graduate public education can be a luxury public good (since its income elasticity of demand is higher than one). Henceforth, in the analysis, the public good we consider is mainly public education.⁵

We demonstrate that the degree of static inefficiency depends upon the income elasticity of the public good and upon the public choice mechanism.

If the public good has a **unitary income elasticity of demand**, Engel curves are linear. If income distribution is symmetric, the median voter and the benevolent maximizer solutions (respectively G_{MV} and G_{BM}) coincide. The utilitarian solution is nested in the benevolent maximizer solution: the maximization of the sum of utilities coincides with the maximization of the average utility. Formally:

$$G_{BM} = E(G_i^*) = g(\bar{y}) = G_{MV} = G_{\bar{i}}^* = g(y_{\bar{i}}). \quad (7)$$

The provision of the public good perfectly fulfills individual demand only for the average agent, whereas all other agents bear inefficiencies. The provision of the public good is affected only by the first moment of the distribution of income and not by its dispersion.

If income distribution is skewed-right, the benevolent maximizer provides a higher level of public good than the median voter:

$$G_{BM} = E(G_i^*) = g(\bar{y}) > G_{MV} = G_{\bar{i}}^* = g(y_{\bar{i}}). \quad (8)$$

The dispersion of the distribution does not matter, whereas the difference between the two potential choices is increasing with the skewness of the distribution. The median voter mechanism reduces static inefficiencies, the more the distribution is skewed-right.⁶

If the public good has an **income elasticity of demand higher than one**, Engel curves are increasing and convex. The benevolent maximizer provides a higher level of public good than the median voter:

$$G_{BM} = E(G_i^*) > G_{MV} = G_{\bar{i}}^* = g(y_{\bar{i}}). \quad (9)$$

¹ If the distribution is symmetric, the median voter (hereafter $\bar{i}$) is proxied by the average agent and

$$y_{\bar{i}} = \bar{y}$$

where $\bar{y}$ is the average income.

Instead, with a skewed-right distribution,

$$y_{\bar{i}} < \bar{y}$$

holds.

² We could have assumed a linear income tax. Computations (available upon request) show that the results still hold. See also footnote 3.

³ With a linear income tax an increase in individual income may have several effects on the individual demand: a positive income effect, since an increase in individual income in *absolute terms* allows all agents to demand more of both goods. On the other hand it may imply that the individual becomes richer in *relative terms*, contributing more to the financing of the public good, and generating a negative substitution effect. If the income effect prevails, Engel curves are positively sloped and all the results still hold. See also [Epple and Romano \(1996\)](#). Algebraic analysis is available upon request.

⁴ The analysis for public goods with income elasticity of demand lower than one (necessity public goods) is symmetric to the case of income elasticity higher than one.

⁵ Moreover, education enhances human capital and fosters growth, enabling us to introduce dynamics in the model (see Section 3).

⁶ Assuming that individual income is distributed on the support $[a, b]$, static inefficiencies are in fact

$$\int_a^b |g(\bar{y}) - g(y_i)| f(y_i) dy_i$$

in the benevolent maximizer case; and

$$\int_a^b |g(y_{\bar{i}}) - g(y_i)| f(y_i) dy_i$$

in the median voter case.

From Eq. (8), it follows that

$$\int_a^b |g(\bar{y}) - g(y_i)| f(y_i) dy_i > \int_a^b |g(y_{\bar{i}}) - g(y_i)| f(y_i) dy_i$$

the more $\bar{y}$ is greater than $y_{\bar{i}}$.

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