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Progressive Taxation, Quality, and Redistribution in Kind *

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Abstract

The redistributive effects of four mixed fiscal system in which redistribution in cash is paired with redistribution in kind are investigated. A private good is offered by both the public and the private sector, at a non-zero price in both cases. Thus, the market is vertically segmented and the quality differences are used to select recipients on the basis of their income. This paper shows how an appropriate selection of recipients can add redistributive power to an already redistributive taxation system, while universal public provision never does. A numerical simulation based on Italian data gives some policy insights.

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1 Introduction

According to the second theorem of welfare economics, the central planner of a "convex economy" can induce any redistribution of initial resources on the frontier of all achievable allocations, by the means of lump sum taxes. This theorem, however, is unhelpful to the central planner whenever the conditions for a market failure occur; in fact, when the government possesses incomplete information about the characteristics of private agents, the optimal redistribution cannot be implemented by a system of lump sum taxes. Thus, in a second best environment, policy instruments for redistribution are both optimal taxation and redistribution in kind, namely public provision of private goods.

The issue of redistribution in kind has been addressed in the economic literature in a rather atypical way: while the applied literature on poverty and income distribution usually considers payments in-kind as a crucial part of total income, the theoretical side of the literature usually neglects them; one of the reasons is a supposed greater efficiency of redistribution in cash, which requires less information and makes the recipients happier because of a greater freedom in the use of the received money.

On the other hand, governments make considerable use of redistribution in kind: the category of merit goods[1] is mostly supplied in kind in many industrialized countries. Considering the case of Italy, 59% of final governments consumption expenditure in 1990 was on goods with some redistributive power[2]; the same category of goods represented 51% of total current outlays[3]. These figures indicate why the cost of universal public provision of medical care and education, for example, is frequently considered unbearable, and why public provision of private goods is often challanged. We believe that the correct question should not be whether or not such public provision is worthwhile , but rather

[1]We interpret merit goods only as goods with some redistributive power.

[2]These figures take the OECD list of social indicators into account.

[3]These include final consumption expenditure, subsidies and other current transfers. (OECD Economic Surveys. OECD Countries National Accounts).

under what conditions it can be worthwhile.

This paper analyzes the progressivity of different fiscal arrangements. The question we address is whether a mixed fiscal system, i.e. a system involving both redistribution in kind and in cash, is able to increase the redistributive effects of income taxation and under what conditions. This question is relevant for several reasons.

First, the disincentive effects induced by high tax rates could be avoided (or lessened) by lowering tax rates in a mixed fiscal policy (where the redistributive target is achieved by combining redistribution in cash and in kind). Second, if the selection of recipients of the publicly offered private good is expanded to consider more than just one parameter (income), the efficiency of the overall tax structure can increase as agents reveal their characteristics more truthfully. Third, a mixed fiscal policy, even with the same degree of progressiveness as a pure taxation structure, makes it possibile to assign private (merit) goods to needy individuals.

We construe redistribution in kind as public provision of a private good at a non-zero price and not rationed. We set up a framework in which the government pursues the redistributive policy both by a progressive system of general taxation (redistribution in cash[4]) and by providing a private good (redistribution in kind). This mix of redistribution in cash and in kind can be of four types since i)redistribution in cash can be carried out through linear income taxes or non-linear taxation and ii) the private good can either be provided universally or selectively[5]. In order to select people with lower income, the public sector may choose to offer the private good at a price and quality lower than that in the private

[4]A progressive income tax can be called redistributive in its own right, regardless of what is done with the revenue. This is because, relative to equal-yield proportional taxation, post tax income is redistributed from rich to poor in the presence of progression. If the tax does not involve any re-ranking of income units (it is incentive preserving), the extent of this redistribution can be seen in the trasformation from the Lorenz curve for pre-tax incomes to the Lorenz curve for post-tax incomes (Lambert, 1993).

[5]A good is publicly universally provided if it is supplied to all individuals. A good is publicly selectively supplied if the market is segmented, so that a not-perfect substitute is available to individuals who can afford it.

sector. The higher quality of the private market encourages richer individuals to choose "private", though they are nonetheless asked to pay general taxes to finance the public supply of the private good.

In section 2 we define a non linear income tax schedule and analyze its progressivity when parameters change. In section 3 we check the validity of the conjecture that uniform public provision of private goods is not a proper system of redistribution . We then analyze the progressiveness of four mixes of redistribution in cash and in kind, where linear and non-linear income tax functions are paired with the two types of public provision of private goods mentioned above. Finally, a numerical simulation is performed to study the role played by quality and price differences in the redistributive policy.

2 Progressiveness in a two brakets income tax system

In this section we analyze the progressiveness of the tax function used in the model described in section 3. We then compare the progressiveness of the original tax function with that of the same tax function in which a parameter has been changed. This analysis is necessary both to ascertain that the tax function by which we define a progressive taxation system is actually progressive, and to read the results of the numerical simulation discussed in section 4, and shown in Appendix 3.

Progressiveness of a tax function is defined as follows

Definition 1 *A tax function is* **progressive** *iff the average tax rate* $t(y) = T(y)/y$ *is increasing in* y.

Let us define a progressive income tax function as

$$T(y) = \begin{cases} t_1 y & 0 < y \leq \hat{y} \\ t_2(y - \hat{y}) + t_1 \hat{y} & y > \hat{y} \end{cases} \tag{1}$$

with $t_1 < t_2$.

Proposition 1 *If y is lognormally distributed, then $T(y)$ is progressive when $\hat{y} < kE(y)$.*

Proof: See appendix 2.

Define two more income tax functions to be compared with $T(y)$ as

$$T_1(y) = \begin{cases} t_1 y & 0 < y \leq \hat{y} \\ t_2'(y - \hat{y}) + t_1 \hat{y} & y > \hat{y} \end{cases} \quad \text{with} \quad t_2' > t_2. \qquad (2)$$

$$T_2(y) = \begin{cases} t_1 y & 0 < y \leq \hat{y}' \\ t_2(y - \hat{y}') + t_1 \hat{y}' & y > \hat{y}' \end{cases} \quad \text{with} \quad \hat{y}' > \hat{y}. \qquad (3)$$

Appendix 1 shows that the lognormal distribution provides the best fit for the available data on incomes in Italy. We therefore assume that income is distributed as a lognormal. A progressive tax function, following Lambert (1989), should satisfy (at least in a weak form) the three properties listed below. A measure of the extent by which the rich pay proportionately more taxes than the poor is given by either the Lorenz curve for tax payments or the Lorenz curve for for pre-tax and post-tax incomes, so that the properties can be formulated as follows:

Property 1 *A tax function T_i has, for all y, a greater* **tax liability progression** *than a tax function T_j iff for every unequal pre-tax income distribution the tax burden resulting from T_i is distributed less equally (in the sense of relative Lorenz domination) than the tax burden resulting from T_j.*

Property 2 *A tax function T_i has, for all y, a lower* **residual income progression** *than a tax function T_j iff for every unequal pre-tax income distribution the post-tax incomes are distributed more equally (in the sense of relative Lorenz domination) for T_i than for T_J.*

Property 3 *Assume equiproportionate pre-tax income growth. Then a tax function T_i has, for all y, a greater* **average tax progression** *than a tax function T_j iff for every unequal pre-tax income distribution the average tax rate responsiveness of T_i is greater than that of T_j.*

$T_1(y)$ has greater tax liability progression, lower residual income progression , and greater average rate progression than $T(y)$. For the sake of readability, we do not prove these assertions formally[6], but a graphical intuition for these properties is given in Appendix 3, figures 1-4.

The behaviour of progressiveness when $T(y)$ becomes $T_2(y)$, namely when $\hat{y}$ changes, has a discontinuity because the two extreme cases, i.e. $\hat{y} = 0$ and $\hat{y} = \infty$, give both a case of non-redistribution in terms of Lorenz curves (when $\hat{y} = 0, \infty$ the non-linear tax schedule is equivalent to a linear one). To the contrary, when $0 < \hat{y} < \infty$, Lorenz curves of income distribution are affected by changes of $\hat{y}$. To our purpose, we limit the attention to those cases for which the progressivity of the tax function is higher when $\hat{y}$ increases (fig.2 and 4).

3 Redistribution in cash and redistribution in kind

Consider the following four mixed fiscal systems where redistribution in cash is paired with redistribution in kind.

i. Linear income tax rates and uniform public provision of a private good.

ii. Non-linear income tax rates and uniform public provision of private good.

iii. Linear income tax rates and selective public provision of private good.

[6] $T_1(y)$ could in fact be shown to have greater average rate progression than $T(y)$ along the lines of the proof. of proposition 1.

iv. Non-linear income tax rates and selective public provision of private good.

Assuming pre-tax incomes unequally distributed, how is the distribution of income affected when redistribution in cash is paired with redistribution in kind? In other words, what is the overall progressiveness in the four cases listed above?

3.1 Uniform public provision of a private good

Consider a progressive income taxation scheme. How is its redistributive power affected if it is paired with a selective supply of a private good, or with a fiscal program whereby the social supply of the same good is universal? In fact, a pure progressive income taxation schedule loses part of its progressivity if paired with uniform public provision of private goods. For example, consider a public supply of health care in terms of its money equivalent transfer, paired with simple progressive income taxation in which marginal tax rates lower with income and are piecewise constant. If an identical money transfer is given to two individuals whose incomes are at two different points at which the tax rate changes both of them will end up having to pay a higher rate when the thresholds are crossed. Thus, if the marginal increase in tax payments are seen as payments for health care, the fiscal schedule loses progressivity since the poorer individual is asked to pay a higher marginal contribution for the socially offered good. Beyond this particular example, it can be argued that a public program of universal provision of a private good does not add redistributive effects to a non-regressive tax program, as shown by the following propositions.

Proposition 2 *A uniform public provision of h does not add any redistributive power to a linear income tax function* [7].

[7] The individual value of the social good h is considered in terms of its money equivalent, M.

Proof: See appendix 2.

Proposition 3 *A uniform public provision of h does not add redistributive power to a non-linear progressive tax function.*

Proof: Along the lines of the proof of Prop. 2

Thus, uniform public provision of a private good does not affect the distribution of income when it is paired with redistribution in cash (via general taxation). In spite of this, the literature has often treated uniform public provision of private goods as a form of redistribution.

3.2 Selective public provision of a private good

Consider now the two mixed fiscal policies defined at points iii) and iv) above. In the remainder of this paper we argue that selective public provision of a private good alongside linear taxation can almost trivially be more redistributive than the basic redistribution in cash, while this is not true in case iv): a non-uniform public provision of h may or may not add redistributive power to a non-linear, progressive income tax function. The model below helps to analyze the case of progressive taxation and selective public provision of a private good. It describes individual optimal choices as responses to a public program of uniform or selective provision of a private good such as health care. When health care is selectively supplied, optimal choices yield a critical income level below which people opt in for the social provision and above which people opt out, i.e. opt for the private market. This income threshold, together with the tax rate cut-off levels, defines a new distribution of income to be compared with the pre-tax distribution.

An index of redistribution is then defined. This index is constructed under the assumption that a necessary condition for redistribution is that richer[8] people opt for the private market.

[8] We refer to "richer" people as to people whose income is beyond the threshold $\hat{y}$.

It should be stressed that this calculation is carried out under the assumption that pre-tax incomes (i.e. labour supply) are fixed; in other words, the problem of optimal taxation will already have been solved. This hypothesis is critical, because people can in fact leave the labour force, and because those who remain in it can adjust the amount of labour they supply and thereby modify the original income distribution: nevertheless we will stick to this hypothesis, in order to focus on the additional effect of redistribution in kind beyond that of a redistribution in cash. For this purpose, we shall assume that the choice between public and private provision takes place only after tax payments have been made, and that no information about the price of privately and socially supplied health care is available before these tax payments.

The model proposed below is positive rather than normative: it is concerned with the identification of the redistributive effects of market segmentation in the provision of a private good, rather than with identifying the welfare implications of alternative fiscal arrangements.

3.2.1 The model

Let us assume that individuals consume a composite private commodity as well as health care. Preferences are defined over these two goods as well as the quality of the latter. Assume a quasi-concave utility function

$$U = U(x, h_j, \theta) \qquad j = s, p \tag{4}$$

where x is the amount of the composite private commodity, h is health care and θ is the quality of h . Whether socially (h_s) or privately (h_p) provided, the amount of h_j is free to vary i.e. it is never rationed. θ takes the values $\theta = \beta$ for h_s and $\theta = \alpha$ for h_p, with $\alpha > \beta$.

Let us also represent the income taxation function by T(y) (described in section 2). T(y) is piecewise linear with two brakets with tax rates t_1 and t_2 ($t_1 < t_2$), applied to incomes respectively smaller and greater than $\hat{y}$. $\hat{y}$ is thus a control variable for the government, and divides people into group 1 and group 2, to which we refer by the index i. The values of the tax rates t_i are assumed to be optimal. From the point of view of this analysis, t_i acts as a poll tax, since labour supply, and thus income, is assumed fixed when the choice between h_s and h_p takes place. Let us finally assume that distribution of income across consumers is distributed as a lognormal [9], with distribution function $\Phi(y)$.

Individuals face the budget constraint

$$y_d^{(i)} = px + q_s h_s + q_p h_p \tag{5}$$

where

$$y_d^{(i)} = \begin{cases} y_d^{(1)} = (1-t_1)y & y < \hat{y} \\ y_d^{(2)} = (1-t_2)(y-\hat{y}) + (1-t_1)\hat{y} & y > \hat{y} \end{cases}$$

is disposable income after tax, h_p and h_s represent health care supplied socially or privately; p is the price of the composite commodity x, q_s is a user charge for h_s and q_p is the price for h_p (q_s is assumed to be smaller than q_p, because of differences in quality and because h_s is assumed to be financed also by tax contributions of individuals who opt out of the public provision). h_s is not retradable[10].

Two additional constraints are necessary to describe the individual's choice: consumption of both social and private provision of h is impossible but one of the two is compulsory. These conditions can be expressed as $h_s \cdot h_p = 0$ and $h_s + h_p > 0$.

There are two possible choices. One is to opt for the social provision and, consequently, for a lower quality of h, at a lower cost q_s, and the

[9] Appendix 1 shows that the lognormal distribution provides the best fit for available data on incomes in Italy. The numerical simulation uses the Italian income distribution.

[10] In the redistribution in kind literature, private goods are assumed to have the property of non-retradability. A private good is non-retradable if the recipient is either entirely unable to resell units of the commodity or would always be unwilling to sell given the discount that would have to be offered (Munro, 1988): if the public provision of in-kind transfers works, in the sense that any needy recipient obtain the transfer, there is no market for those "not needy" who have obtained the transfer to resell it.

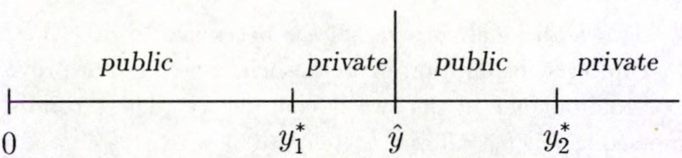
other is to choose the privately offered h, at the higher price q_p to obtain higher quality health care.

The resulting indirect utility functions

$$\begin{aligned} V_s &= U[(y_d^{(i)} - q_s h_s^*)/p, h_s^*, \beta] \\ V_p &= U[(y_d^{(i)} - q_p h_p^*)/p, h_p^*, \alpha] \quad j = s, p. \end{aligned} \tag{6}$$

determine the actual choice of each individual depending on whether $V_s \leq (\geq) V_p$. Thus, if a regularity condition holds [11], there is a value of income ($y^{*(i)}$) which divides people choosing h_s from those choosing h_p, i.e. the income level of the individual indifferent between the two options ($V_s = V_p$).

We have now three thresholds on the support of the income distribution. One is $\hat{y}$, which is a control variable for the government. It divides people into two groups, those paying tax rate t_1 , and those paying t_2. The other two thresholds are $y^{*(1)}$ and $y^{*(2)}$. In both income groups 1 and 2, these thresholds divide people choosing the public option from people choosing the private one.



Our claim is that redistribution takes place if richer people choose the private option. The proportion of richer people who opt out is taken as a measure of redistribution because they pay for the social supply of h without using it. Thus, if we had a linear tax schedule, redistribution could be achieved by setting $\hat{y}$ equal to y^* which, in turn, would be unique.

Proposition 4 *If $t_1 = t_2$ then $y^{*(1)} = y^{*(2)} = y^*$. Thus, redistribution takes place if $\hat{y} = y^*$.*

[11] This condition will be described in section 3.2.2.

Proof: Straightforward.

If, on the other hand, the basic income tax schedule is not proportional, part of the people whose income is less than $\hat{y}$ can afford the private option, while people whose income is just above $\hat{y}$, cannot afford it because of the higher tax rates they are asked to pay.

As for the redistributive power of different mixed fiscal systems involving a progressive tax function, the relevant comparison is between a) a progressive tax paired with universal public provision of h and, b) the same progressive tax paired with selective public provision of h. This is because of proposition 3, for which universal public provision of h is distributionally neutral. Thus, the mixed fiscal system at point b) above is the natural benchmark against which to assess the distributive effects of a selective public provision of a private good.

We build an index of redistribution by computing the expenditures for h of the two income groups in the two systems. Since the price for h is higher for those choosing the private market, a higher expenditure for h in the second income group represent the choice for higher quality. This choice, when it occurs, reveals a greater redistributive power of the second system, as it reveals that richer people opt out of public provision.

3.2.2 The formal analysis

Each individual is supposed to choose between public and private provision of h by solving the following maximization problem:

$$\begin{aligned} \max_{x,h_s,h_p} U(x,h_s,h_p) &= x(h_s^{\beta}+h_p^{\alpha}) \\ s.t. \quad (1-t_i)y+k_i &= px+q_sh_s+q_ph_p \\ h_sh_p &= 0 \\ h_s+h_p &> 0 \end{aligned} \tag{7}$$

where

$$k_i = \begin{cases} 0 & i=1 \\ (t_2-t_1)\hat{y} & i=2, \end{cases}$$

variables are defined as above, and the last constraint implies that one of the two choices is compulsory. It should be stressed that h_s and h_p are two distinct commodities and that the difference in quality is reflected both in the prices ($q_s < q_p$) and in the parameters α and β. α and β enter the utility function indicating different abilities in "processing" the private composite commodity x. In other words, we are assuming that a higher quality of health care gives the recipients higher pleasure from private consumption (hence $\beta < \alpha$).[12]

Thus, each individual, with either tax rate t_1 or t_2 , will compare the utility resulting from optimal choices with the public or private provision of h.

First order conditions in the case of universal public provision and in the case of selective public provision yield:

- Universal public provision of h.

$$x_s = \frac{[(1-t_i)y + k_i]}{(\beta+1)p}, \quad h_s = \frac{[(1-t_i)y + k_i]}{q_s(\beta+1)}, \quad h_p = 0$$

- Selective public provision of h

$$x_s = \frac{(1-t_i)y + k_i}{(\beta+1)p}, \quad h_s = \frac{\beta}{\beta+1}\frac{(1-t_i)y + k_i}{q_s}, \quad h_p = 0 \qquad (8)$$

$$x_p = \frac{(1-t_i)y + k_i}{(\alpha+1)p}, \quad h_s = 0, \quad h_p = \frac{\alpha}{\alpha+1}\frac{(1-t_i)y + k_i}{q_p} \qquad (9)$$

where x_s and x_p differ only by being paired with h_s or h_p. In the latter case, the corresponding optimum values of the utility function (indirect utility functions) are

$$U(x^*, h_s^*, 0) = V(p, q_s, y) = \beta^\beta[(1-t_i)y + k_i]^{\beta+1}/(\beta+1)^{\beta+1}pq_s^\beta$$
$$U(x^*, 0, h_p^*) = V(p, q_p, y) = \alpha^\alpha[(1-t_i)y + k_i]^{\alpha+1}/(\alpha+1)^{\alpha+1}pq_p^\alpha$$
$$i = 1, 2.$$

[12]It is easy to find arguments to support this assumption: for example, if queueing time to obtain some medical treatment is sensibly different between the public and the private option. (Arrow, 1963; Diamond, 1993.)

In turn, these values of the indirect utility functions allow us to find the value of income which partitions all individuals into two groups: one including those who choose the social provision; the other including those who opt for the private one. These two groups are identified by the income level (y^*) of the individual who is indifferent between the two options. This computation, in turn, has to be made for each of the two original groups of individuals, i.e. those facing t_1 and those facing t_2. The equality between indirect utility functions yields

$$y^{*(i)} = \frac{\left[[(1+1/\alpha)^{\alpha}/(1+1/\beta)^{\beta}](q_p^{\alpha}/q_s^{\beta})[(\beta+1)/(\alpha+1)]\right]^{\frac{1}{\alpha-\beta}} - k_i}{(1-t_i)} \qquad (10)$$

$y_d^{*(1)} < y_d^{*(2)}$ as far as $t_1 < t_2$, which is true by construction. In addition, since $y^{*(1)}$ is the income's cut-off level for agents whose income is less than or equal to $\hat{y}$, it cannot be the case that $y^{*(1)} > \hat{y}$ (symmetrically, $y^{*(2)} \geq \hat{y}$).

The necessary and sufficient condition for the indirect utility of the private option to be greater than that of the public option, can be obtained as follows. Let us define a *distance function* $D(y) = V_i(x, h_p) - V_i(x, h_s)$ and differentiate it with respect to y. A sufficient condition for $D(\cdot)$ to be monotonically increasing in y is

$$y_d^{(i)} > \left[[(1+1/\alpha)^{\alpha}]/[(1+1/\beta)^{\beta}][q_p^{\alpha}/q_s^{\beta}]\right]^{\frac{1}{\alpha-\beta}}.$$

As anticipated in the last paragraph of section 3.2.1, in order to see when overall progressiveness is greater than that of the base tax function[13], we define an index of redistri bution by computing the (per capita) expenditures for h of individuals in any of the four income groups[14]. Since the price for h affects only those choosing the private

[13]In this paper we concentrate on the reduction of income inequality as a reasonable property for defining progressiveness. Pfingsten (1986) derives a fairly general equivalence of inequality reduction and tax progression.

[14]We have assumed a continuum of income levels and individuals so income is not uniform within groups.

market, a higher expenditure on h in group 2 than in group 1 is taken as a proxy for the number of individuals choosing h_p. Consequently, an expenditure on h by group 2 greater than by group 1 is interpreted as a proxy for progressiveness. The index defined depends on each parameter of the model, and this helps us to study the sensitivity of different solutions to various parameter values.

Assuming income is lognormally distributed, per capita tax payments can be expressed as

$$\begin{aligned} \Gamma_1 &= \int_0^{\hat{y}} t_1 y dF(y) \\ &= t_1 \exp(\mu + \frac{\sigma^2}{2}) \Phi \left(\frac{\log(\hat{y}) - \mu}{\sigma} - \sigma \right) \end{aligned} \tag{11}$$

for the first income group, and

$$\begin{aligned} \Gamma_2 &= \int_{\hat{y}}^{\infty} \left[t_2(y - \hat{y}) + t_1 \hat{y} \right] dF(y) \\ &= t_2 \exp(\mu + \frac{\sigma^2}{2}) \left[1 - \Phi \left(\frac{\log(\hat{y}) - \mu}{\sigma} - \sigma \right) \right] \\ &\quad + (t_2 - t_1)\hat{y} \left[1 - \Phi \left(\frac{\log(\hat{y}) - \mu}{\sigma} \right) \right] \end{aligned} \tag{12}$$

for the second one.

Per capita expenditures on the private good h are

$$\begin{aligned} E_1 &= \int_0^{y_1^*} q_s h_s dF(y) + \int_{y_1^*}^{\hat{y}} q_p h_p dF(y) \\ &= (1 - t_1) \exp(\mu + \frac{\sigma^2}{2}) \\ &\quad \left\{ \beta^* \Phi \left(\frac{\log(y_1^*) - \mu}{\sigma} - \sigma \right) + \alpha^* \left[\Phi \left(\frac{\log(\hat{y}) - \mu}{\sigma} - \sigma \right) \right. \right. \\ &\quad \left. \left. - \Phi \left(\frac{\log(y_1^*) - \mu}{\sigma} - \sigma \right) \right] \right\} \end{aligned} \tag{13}$$

$$
\begin{aligned}
E_2 &= \int_{\hat{y}}^{y_2^*} q_s h_s dF(y) + \int_{y_2^*}^{\infty} q_p h_p dF(y) \qquad (14)\\
&= (1-t_2)\exp\left(\mu + \frac{\sigma^2}{2}\right) \\
&\quad \left\{\beta^*\left[\Phi\left(\frac{\log(y_2^*)-\mu}{\sigma} - \sigma\right) - \Phi\left(\frac{\log(\hat{y})-\mu}{\sigma} - \sigma\right)\right]\right. \\
&\quad \left. +\alpha^*\left[1 - \Phi\left(\frac{\log(y_2^*)-\mu}{\sigma} - \sigma\right)\right]\right\} \\
&\quad +(t_2-t_1)\hat{y}\left\{\beta^*\left[\Phi\left(\frac{\log(y_2^*)-\mu}{\sigma}\right) - \Phi\left(\frac{\log(\hat{y})-\mu}{\sigma}\right)\right] + \right. \\
&\quad \left. \alpha^*\left[1 - \Phi\left(\frac{\log(y_2^*)-\mu}{\sigma}\right)\right]\right\}
\end{aligned}
$$

where $\alpha^* = \frac{\alpha}{\alpha+1}$ and $\beta^* = \frac{\beta}{\beta+1}$.

Lastly, per capita expenditures in the case of universal public provision are

$$
\begin{aligned}
S_1 &= \int_0^{\hat{y}} q_s h_s dF(y) \qquad (15)\\
&= (1-t_1)\exp(\mu + \frac{\sigma^2}{2})\beta^*\Phi\left(\frac{\log(\hat{y})-\mu}{\sigma} - \sigma\right) \\
S_2 &= \int_{\hat{y}}^{\infty} q_s h_s dF(y) \qquad (16)\\
&= (1-t_2)\exp(\mu + \frac{\sigma^2}{2})\beta^*\Phi\left(\frac{\log(\hat{y})-\mu}{\sigma} - \sigma\right) \\
&\quad +(t_2-t_1)\hat{y}\beta^*\left[1 - \Phi\left(\frac{\log(\hat{y})-\mu}{\sigma}\right)\right]
\end{aligned}
$$

The analysis of progressiveness of the two fiscal arrangements is then based on the comparison between $\Gamma_2/\Gamma_1 + S_2/S_1$ and $\Gamma_2/\Gamma_1 + E_2/E_1$. Thus, if $[(E_2/E_1)/(S_2/S_1)] > 1$ (hereafter $IR(t_1, t_2)$), we can claim that people with income beyond $\hat{y}$ opt out of the public provision, and that redistribution takes place.

4 The numerical analysis

The numerical simulation shown in appendix 3 has been performed to analyze the behaviour of $IR(t_1, t_2)$ in response to quality and quantity differences between h_s and h_p. Our interest is focused on the parameters' values for which IR is greater than one, since it reveals that the program of selective supply of h has a greater redistributive effect than a program of universal public provision of h.

- *Sensitivity analysis of IR with respect to quality variations*

Expectedly, IR's responsiveness to quality changes shows that the index gets higher values when the difference between α and β is higher: the quality of the privately supplied good is so attracting that everyone who can afford the private option chooses it. When β/α is very low and $t_1 = 0.2, t_2 = 0.4$, IR gets values as greater than one as $\hat{y}$ is lower: IR is approximately equal to 2 when $\hat{y}$ is equal to $\frac{1}{2}E(y)$, but it is relatively close to one when $\hat{y}$ is equal to $E(y)$. When β/α gets greater than 0.4, IR's values are higher when $\hat{y} = mode(y)$ which is greater than $\frac{1}{2}E(y)$, and still greater than in the case of $\hat{y} = median(y)$ and $\hat{y} = E(y)$. As β/α gets closer to one, the value of $\hat{y}$ which gives the higher value of IR moves toward $E(y)$.

What do these figures mean? They essentially mean that a) for any ratio between the quality of the public health care and the private health care , there is an optimal value for $\hat{y}$, i.e. a level of $\hat{y}$ for which IR gets the highest feasible value; b) redistribution policies are not "additive": higher values of IR correspond to lower progressive base income taxation schedules, both when tax rates are changed and when $\hat{y}$ varies. As a consequence, a central planner could set different values of $\hat{y}$ or/and t_i as a response to any actual ratio between the quality of public health care and of the private health care (as well as for any other example of private good publicly supplied for a redistributive purpose). Alternatively, he could set the "optimal" quality level for the public service, as well as regulate the quality of the privately supplied service. The numerical analysis depended only on ratios between parameters; this means that there is no need of low values of β to obtain high values of IR. Finally, IR's sensitivity to t_i variations is not very high, but it confirms the behaviour observed in the case of $\hat{y}$'s changes.

- *Sensitivity analysis of IR with respect to prices variations*

IR gets closer to one as the ratio between prices of h_s and h_p approximates one. This is only an extreme case, because if prices were very similar, almost everyone would choose the higher quality option. Unlike the case of quality changes, the index IR is not higher when the difference between prices is greater: when the price for the private option is too high, $y^{*(i)}d$ shifts upwards, as a smaller number of individuals can afford it. There is, thus, an optimal ratio of prices for any given progressive base tax schedule. For example, when $\hat{y} = \frac{1}{2}E(y)$, $t_1 = 0.2$, $t_2 = 0.4$ and $\beta/\alpha = 1/4$, the optimal price ratio, q_s/q_p is approximately 1/3, but becomes even lower when $\hat{y}$ gets higher. IR's highest levels gets lower as basic progressiveness gets higher, both when $\hat{y}$ and t_i varies.

5 Final remarks

Goods like health care and education are 'mixed goods'in that they are only imperfectly "public goods". This is often advanced as one of the arguments in favour of a greater private sector provision of this kind of goods. This issue is heightened by widespread concern at the growth of public expenditure in many countries, especially in Italy . On the other hand, the public nature of such goods lies mostly in their redistributive power, and the arguments in favour of complete privatization ignore the role of redistribution in kind.

In this paper we have investigated the role that the public provision of private goods can play in the redistribution of income. Unlike other papers available in the literature on redistribution in kind, we investigate the issue of the redistributive effects of public provision of private goods in a context in which the base taxation system is already progressive. The two-bracket piecewise linear income tax structure we adopt, replicates, in a simplified version, the Italian income tax system. The model we have outlined was solved under the assumption that income followed a lognormal distribution , which is the best approximation to the real distribution of income in Italy.

Our analysis reveals that while redistributive policy is almost trivial for a government whose basic income taxation scheme is linear, this is not true in the case of a mixed fiscal policy in which a non-linear tax schedule is paired with selective public provision of a private good. We have argued that a social programme which aims at selecting poorer people for the public provision can increase the progressivity of a pure taxation system which is already progressive, while a system of universal public provision of private goods does not affect the progressiveness of the same base system.

A numerical analysis shows that there is an optimal quality and price discrimination for every progressive income taxation schedule, and that a greater redistribution could be achieved by combining selective public provision of a private good with lower tax rates (or a higher threshold). The same kind of exercise could be repeated for any other income distributions, and progressive income taxation schedules.

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Appendix 1

In order to give a simple description of the Italian income distribution curve, two distributions traditionally accounted in such context have been considered: the Pareto distribution and the lognormal distribution.

The data, grouped in 19 classes, are published in ISTAT (1993) and essentially include: compensation of employers, proprietors' income, rental income of persons and of public institutions and other incomes coming from labour, business activities and capital relatively to 1991. Any figure refers to gross incomes.

By using these data, maximum likelihood estimates both for the Pareto and for the lognormal distribution have been computed. The results are reported below:

	Pareto	*Lognormal*	
	α	μ	σ^2
estimate	0.467071	14.752540	0.382076
s.e.	0.279412	0.141807	0.195197

Empirical and theoretical distribution functions both for Pareto and for lognormal are plotted in figures 9 and 10. The values of the actual and estimated relative frequencies for the two distributions are reported in table 1 of Appendix 3. The evidence is clearly in favour of the lognormal curve.

Further evidence is also given by the two goodness-of-fit tests in the table below, in which the Pearson's X^2 test for Pareto distribution rejects the hypothesis at 5% level.

	Pareto	*Lognormal*	*5% crit.val.*
Pearson's X^2	28.2967	0.0864	26.3
Kolmogorov-Smirnov D	0.2646	0.0175	0.301

Appendix 2

Proof of Proposition 1. For $0 < y \leq \hat{y}$:

$$\begin{aligned}\bar{t}' &= \frac{\int_0^{\hat{y}} t(y)\, dF(y)}{\int_0^{\hat{y}} y\, dF(y)} \\ &= \frac{t_1 \int_0^{\hat{y}} y\, dF(y)}{\int_0^{\hat{y}} y\, dF(y)} \\ &= t_1;\end{aligned}$$

for $y > \hat{y}$:

$$\begin{aligned}\bar{t}'' &= \frac{\int_{\hat{y}}^{\infty} t(y)\, dF(y)}{\int_{\hat{y}}^{\infty} y\, dF(y)} \\ &= t_2 - (t_2 - t_1)\hat{y} \frac{\int_{\hat{y}}^{\infty} dF(y)}{\int_{\hat{y}}^{\infty} y\, dF(y)} \\ &= t_2 - (t_2 - t_1)\hat{y} \frac{1 - \Phi\left(\frac{\log(\hat{y}) - \mu}{\sigma}\right)}{\exp(\mu + \frac{\sigma^2}{2})\left[1 - \Phi\left(\frac{\log(\hat{y}) - \mu}{\sigma} - \sigma\right)\right]} \\ &= \frac{1}{k} t_1 + (1 - \frac{1}{k}) t_2,\end{aligned}$$

where $k = \left[1 - \Phi\left(\frac{\log(\hat{y}) - \mu}{\sigma}\right)\right] / \left[1 - \Phi\left(\frac{\log(\hat{y}) - \mu}{\sigma} - \sigma\right)\right]$ and $\Phi()$ indicates the c.d.f. of the standard normal distribution.

Since $t_2 > t_1$ by construction, $\bar{t}'' > \bar{t}'$ when $\hat{y} < kE(y)$, being $E(y) = \exp(\mu + \sigma^2/2)$. □

Proof of Proposition 2. Let us define $y_d = (1 - t)y$ as the post-tax income when the tax function is linear. Let also $y_m = y_d + M$ be the income resulting from a program of uniform social supply of h.

If $Y_d \sim LN(\mu + \log(1 - t), \sigma^2, 0)$ then $Y_M \sim LN(\mu + \log(1 - t), \sigma^2, M)$. Let us define the Lorenz curve for Y_d and Y_M respectively as (F_d, Λ_d), where F_d and Λ_d are the distributions functions of $LN(\mu + \log(1 - t), \sigma^2, 0)$ and $LN(\mu + \log(1 - t) + \sigma^2, \sigma^2, 0)$, and (F_M, Λ_M). Then

$$F_M(y_M) = \int_0^{y_M} \frac{1}{(x - M)\sqrt{2\pi\sigma^2}}$$

$$
\exp\left\{-\frac{[\log(x-M)-\mu-\log(1-t)]^2}{2\sigma^2}\right\}dx
$$

$$
= \int_0^{y_M-M}\frac{1}{x\sqrt{2\pi\sigma^2}}\exp\left\{-\frac{[\log(x)-\mu-\log(1-t)]^2}{2\sigma^2}\right\}dx
$$

$$
= F_d(y_M-M)=F_d(y_d)
$$

and, thus, $\Lambda_M(y_M)=\Lambda_d(y_M-M)=\Lambda_d(y_d)$ for any y_M. □

Appendix 3

Table 1: *Families per monthly income*

Monthly income (It.Liras)	actual	lognormal	pareto
0 ⊣ 600,000	0.012	0.010	0.277
600.000 ⊣ 800.000	0.018	0.021	0.091
800,000 ⊣ 1,000,000	0.035	0.035	0.063
1,000,000 ⊣ 1,200,000	0.044	0.046	0.047
1,200,000 ⊣ 1,400,000	0.057	0.055	0.036
1,400,000 ⊣ 1,600,000	0.05	0.059	0.029
1,600,000 ⊣ 1,800,000	0.066	0.061	0.024
1,800,000 ⊣ 2,000,000	0.043	0.061	0.021
2,000,000 ⊣ 2,200,000	0.064	0.058	0.018
2,200,000 ⊣ 2,400,000	0.052	0.055	0.016
2,400,000 ⊣ 2,600,000	0.053	0.052	0.014
2.600,000 ⊣ 2,800,000	0.058	0.048	0.012
2,800,000 ⊣ 3,000,000	0.04	0.044	0.011
3,000,000 ⊣ 3,200,000	0.049	0.040	0.010
3,200,000 ⊣ 3,400,000	0.045	0.036	0.009
3,400,000 ⊣ 3,600,000	0.037	0.032	0.008
3,600,000 ⊣ 3,800,000	0.035	0.029	0.008
3,800,000 ⊣ 4,000,000	0.024	0.026	0.007
4,000,000 and over	0.218	0.234	0.298

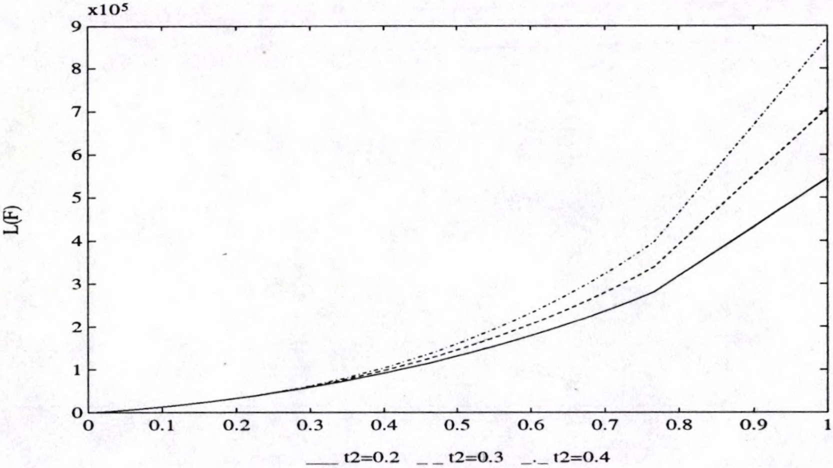


Figure 1: *Generalized Lorenz curve for tax payments with varying tax rates*

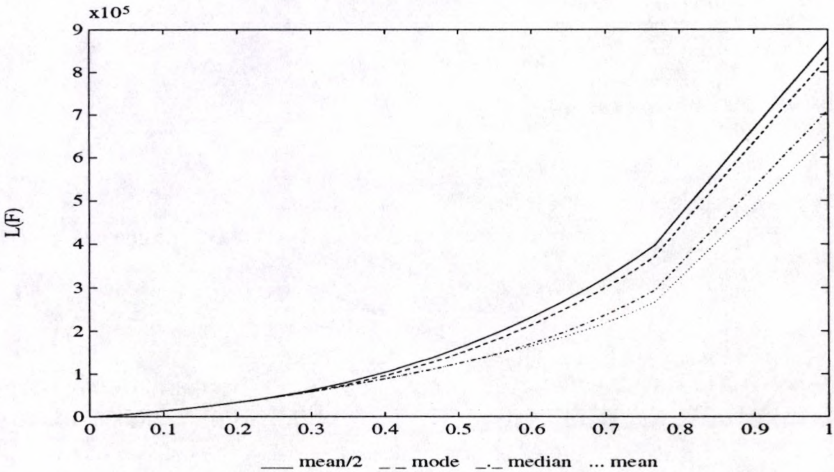


Figure 2: *Generalized Lorenz curve for tax payments with varying threshold* $\hat{y}$

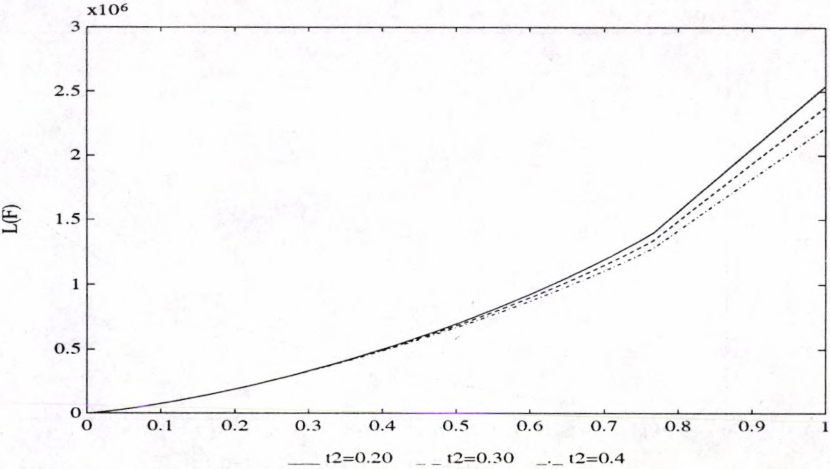


Figure 3: *Generalized Lorenz curve for post tax income with varying tax rates*

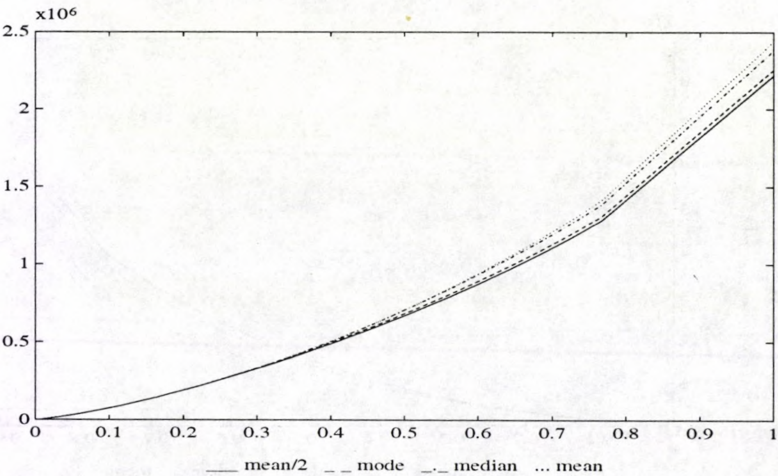


Figure 4: *Generalized Lorenz curve for post tax income with varying threshold* $\hat{y}$

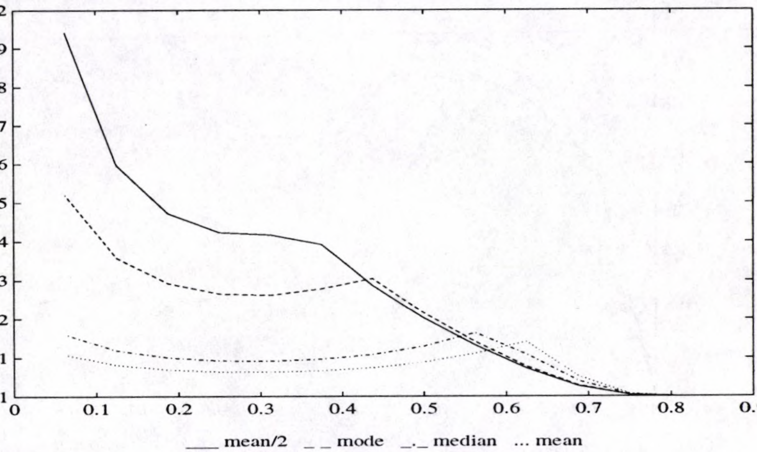
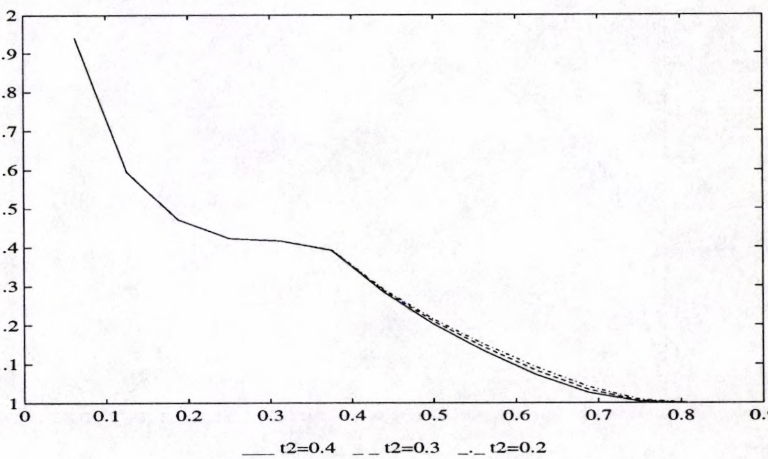


Figure 5: *IR versus health care quality*



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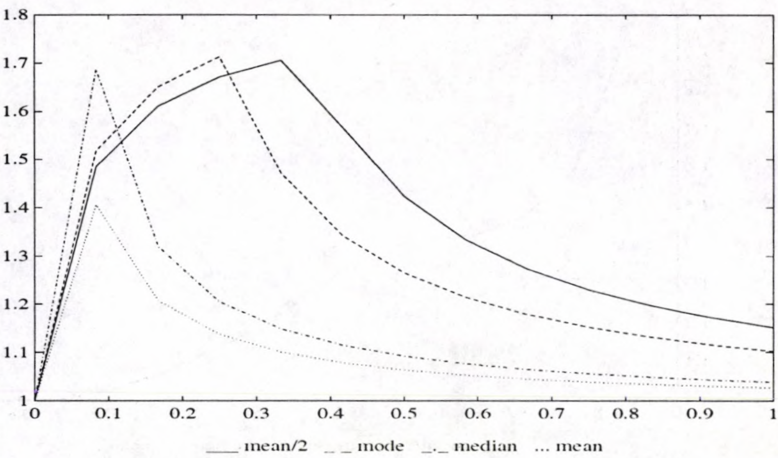

Figure 7: *IR versus health care price*

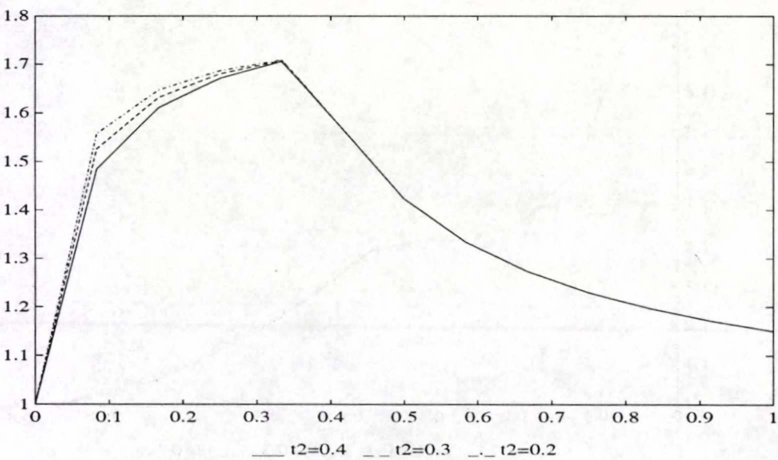

Figure 8: *IR versus health care price*

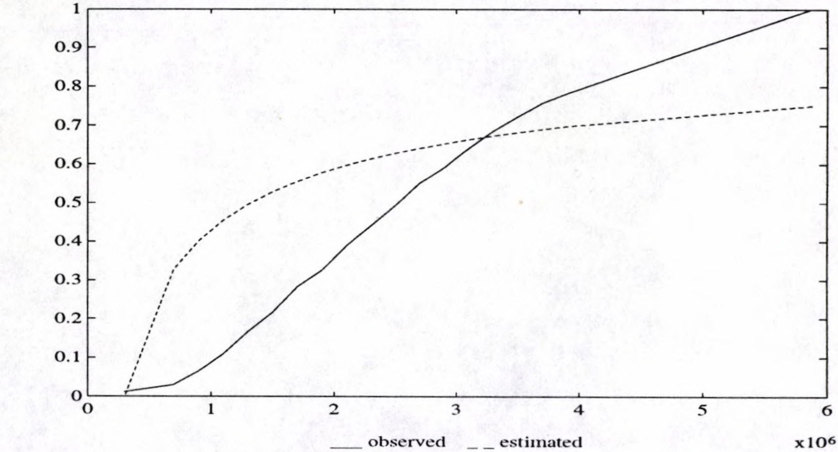

Figure 9: *Pareto distribution*

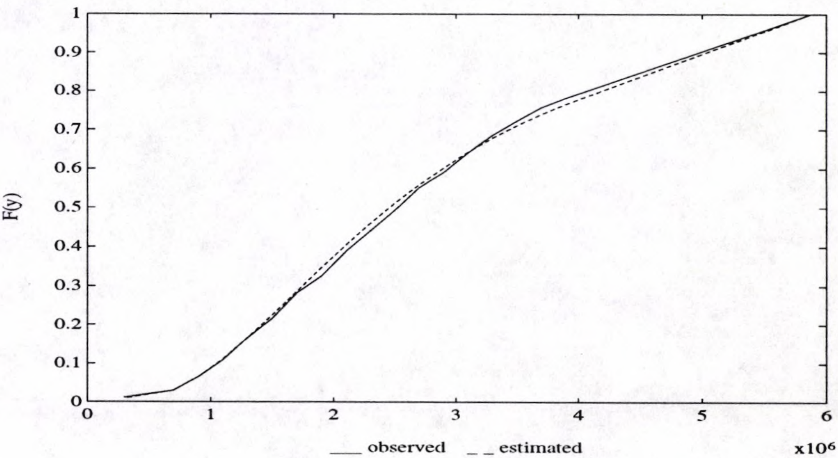

Figure 10: *Lognormal distribution*

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