Public goods versus publicly provided private goods in a two-class economy*

by

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ABSTRACT: The two-type model of non-linear income taxation with asymmetric information on individual ability levels is extended to discuss welfare effects of two policy instruments: a pure public good and a publicly provided private good. This latter is interpreted as health care. Three different cases are analysed:\ when each policy instrument is used in turn and when they are jointly used. The publicly provided private good is proved to be welfare enhancing when it is used as the only policy instrument. By contrast, in the mixed case, the publicly provided private good acts as a lump-sum transfer to all individuals.

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1 Introduction

An extensive economic literature exists on the provision of public goods by the private sector [Bergstrom et al., 1986; Andreoni, 1988]. By contrast, the reverse question of the public provision of private goods was oddly neglected until recent years, with the exception of some pioneering contributions.

Two different approaches have been developed to address this question [Boadway and Marchand, 1995; Blomquist and Christiansen, 1999]. The first is represented by the public choice models, which examine the interaction between voter demand and the supply of publicly provided private goods. In this approach, the quantity of publicly provided private goods is determined by the median voter's choice and, consequently, taxes are set at the level required to finance it. In order to be re-elected, the government is forced to maximise the median voter's utility function, since he represents the decisive voter [Meltzer and Richard, 1981; Usher, 1977; Wilson and Katz, 1983; Pauly, 1992; Gouveia, 1996, 1997; Epple and Romano, 1996a, 1996b; Glomm and Ravikumar, 1998].

The second approach is represented by normative models, which focus on the efficiency enhancing role of publicly provided private goods. According to this literature, in the presence of distortionary taxes there is a strong case for the desiderability of in-kind transfers instead of monetary transfers[1].

The basic idea of this literature is that publicly provided goods can be used as a device to select income groups, since the government cannot observe the individuals' incomes. If rich individuals prefer to consume higher quality (or quantity) of a good such as health care, the government can redistribute from high-income to low-income individuals by providing this good publicly. Publicly provided private goods of relatively low quality allow the low-income individuals

[1] For a survey of the literature, see Balestrino (1999).

to consume these goods for free, while higher income individuals will consume them in the private market. Boadway and Marchand (1995), Blomquist and Christiansen (1995, 1998a, 1998b), Cremer and Gahvari (1997), and Boadway, Marchand and Sato (1998) study public provision of private goods in a two-type model with self-selection constraints. More recently, Thum and Thum (1999) examine how redistribution through public provision of private goods can be extended to the case of repeated interactions between the government and transfer recipients. However, all these models do not include public provision of a public good. By contrast, Boadway and Keen (1993) give an excellent account of public provision of a public good in a two-types model with optimal non-linear income tax, but their model is still incomplete since it does not include public provision of a private good.

The purpose of this paper is to generalise this latter approach, by investigating how the simultaneous provision of both a public good and a publicly provided private good can improve the efficiency of redistribution within a model of optimal non-linear income taxation with asymmetric information on individual ability levels.

The remainder of the paper is organised as follows. Section 2 describes the basic model. Section 3 analyses welfare effects of public good provision when the level of publicly provided private good is given. Section 4 analyses the opposite case in which the level of public good is given. Section 5 focuses on the mixed scheme, where both policy instruments are used. Some conclusions are drawn in Section 6.

2 The basic model

Consider an economy consisting of two types of individuals, characterised by two different indexes, w_1 and w_2; with $w_2 > w_1$. The variable w_i may be thought of as the wage rate or as ability, but the analysis is generalisable in this respect. Information about ability and supplied hours of labour is private information not available to the government, which can only observe total individual income. In this setting, the government cannot impose lump-sum taxes conditional on ability. Instead a redistribution scheme must be designed subject to an information constraint in order to prevent high-ability individuals from mimicking low-ability individuals. This occurs when the more able individuals masquerade as low-ability ones by earning the same income. In what follows, I will focus on the 'normal' case in which the government redistribution goes from the high-ability to the low-ability individuals.

In the economy there are four commodities: a private good, x; time spent on work, l; a pure public good, g; and a mixed good[2], z, which is interpreted as health care. The government provides the same level of the public good, g, to all individuals, even if they may value it differently. It also provides some amount of health care, h; uniformly to all individuals. Individuals may supplement it by purchasing health care in the private market, s, but they are not allowed to trade some of the publicly provided quantity[3], so that $z = h + s$; with $s \geq 0$: I assume x; g; z; and leisure to be normal goods. Furthermore, the mixed good and leisure are assumed to be substitutes[4], since an increase in leisure implies

[2] An early definition of mixed good is given by Stiglitz (1974): '...is a private good (a good for which there is a substantial marginal cost of an additional person consuming it) which is provided in equal quantities to all individuals (within a given class)'.

[3] This assumption is necessary to make an in-kind transfer distinguishable from a transfer in cash.

[4] This assumption is equivalent to assuming that the marginal valuation of z is increasing

a decrease in the demand for z, taking consumer prices and disposable income as given [Boadway and Marchand, 1995; Boadway et Al.., 1998].

Type i's before-tax income is $Y_i = w_i l_i$: Each type-i individual has the same quasi-concave and twice differentiable utility function:

$$U^i(x; l; g; z) = U^i(x; \frac{Y}{w_i}; g; z_i) \tag{1}$$

with $@U^i/@x > 0$;$@U^i/@l < 0$;$@U^i/@g > 0$; and $@U^i/@z > 0$.

Each individual maximises utility by choosing x;Y ; and s subject to the budget constraint $Y - T(Y) = x + p_h s$; where $T(Y)$ is a non-linear tax-function[5] and p_h is the price of health care, while the price of x is normalised to one.

Following Christiansen (1984), I assume that the individual's problem can be analysed as a two-stage process. In the first stage, he decides his supply of labour; in the second stage, he allocates his after-tax income between x and s, conditional on the before-tax income which has been earned by supplying l. Solving backward, at stage two labour is treated as fixed. Let $B_i = Y_i - T_i$ be the individual i's after-tax income; by substituting $x_i = B_i - p_h s_i$ in equation (1) and maximising with respect to s_i, the individual's problem may be written as:

$$\max_{(s_i \geq 0)} U^i(B_i - p_h s_i; Y_i; g; s_i + h) \tag{2}$$

in labour, $@MRS^i_{xz}/@l_i > 0$; where MRS^i_{xz} is the marginal rate of substitution of x for z in utility function [Blomqvist and Christiansen, 1998].

[5] The choice of non linear taxation is made to make the self-selection constraint effective. In fact, in the case of linear income taxation, an efficient redistribution is precluded [Wilson, 1991].

The first-order conditions yield the conditional demand function, $s_i(p_h; g; h; Y_i; B_i)$, which expresses the demand for goods conditional upon the value of I_i.

A useful property of the conditional demand functions occurs for $s_i > 0$; as shown in Broadway et Al.. (1998): Suppose h is increased when $s_i > 0$. The change in the demand for z_i may be broken down into two separate effects: an income effect and a substitution effect. The income effect makes the individual's overall demand for z_i increase; by contrast, since h and s_i are assumed to be perfect substitutes, the substitution effect reduces the demand for s_i, so that:

$$\frac{@s_i}{@h} = p_h \left[\frac{@s_i}{@B_i} - 1 \right] \tag{3}$$

Substituting the conditional demand function for s_i into the utility function $U^i(:)$ yields the indirect utility function, which represents type i's utility function when his before- and after-tax income is spent optimally:

$$-^i(p_h; g; h; Y_i; B_i) = U^i[B_i - p_h s_i(p_h; g; h; Y_i; B_i); Y_i; g; h + s_i(p_h; g; h; Y_i; B_i)] \tag{4}$$

This can be represented geometrically by an indifference map in $(B_i; Y_i)$ space, characterised by the single-crossing property, in which low-ability indifference curves are steeper than curves of high-ability individuals.

By applying the envelope theorem, from (4) it follows:

$$-^i_{p_h} = -U^i_x s_i; \quad -^i_g = U^i_g; \quad -^i_h = U^i_z - p_h U^i_x; \quad -^i_{Y_i} = \frac{U^i_l}{w^i}; \quad -^i_{B_i} = U^i_x: \tag{5}$$

where partial derivatives are expressed by appropriate subscripts.

At the first stage of the individual's maximisation, he has to decide the supply of hours of labour, or, which is equivalent, the combination of before- and after-tax income, to maximise (4). In this respect, the government's choice of a non-linear tax schedule may be interpreted as the offering of this combination of before- and after-tax income to individuals.

In what follows, I focus on second-best Pareto-efficient solutions, taking the object of the government to be the maximisation of a social welfare function, defined as the weighted sum of utilities of the two ability types, subject to the self-selection constraint for high-ability individuals and the government's budget constraint. I consider the case in which redistribution is from high- to low-ability individuals to the extent that the self-selection constraint is binding. In order to prevent high-ability individuals from mimicking the before-tax income of low-ability individuals, a self-selection constraint has been introduced: the utility of type-two individuals from being honest must be higher than the utility associated with mimicking. The government's maximisation problem is defined as:

$$\text{Max } V^1(p_h; g; h; Y_1; B_1) + \alpha V^2(p_h; g; h; Y_2; B_2) \tag{6}$$

subject to:

$$V^2(p_h; g; h; Y_2; B_2) \geq V^m(p_h; g; h; Y_1; B_1) \tag{7}$$

$$n_1[Y_1 - B_1] + n_2[Y_2 - B_2] \geq p_h h(n_1 + n_2) + p_g g \tag{8}$$

where α represents the weight given to the high-level individual's utility; n_i is the number of type i-individuals; and p_g is the price of the pure public good, which is assumed to be fixed because of the linearity of the technology. The

superscript 'm_2' to the respective utility functions identifies type-two mimicking individuals.

Three policy instruments are available to the government: a non-linear income tax, a pure public good and a publicly provided private good. Consider first the optimal second best non-linear taxation, which is assumed to be always in place here afterwards. The Lagrangian for the government's maximisation problem may be written as:

$$\begin{aligned} L = & \; \Psi^1(p_h; g; h; Y_1; B_1) + \alpha \Psi^2(p_h; g; h; Y_2; B_2) + \\ & \lambda[\Psi^2(p_h; g; h; Y_2; B_2) - \Psi^{m_2}(p_h; g; h; Y_1; B_1)] + \\ & \mu[\eta_1 (Y_1 - B_1 - p_h h) + \eta_2 (Y_2 - B_2 - p_h h) - p_g g] \end{aligned} \tag{9}$$

where λ and μ are the Lagrangian multipliers respectively associated to the self-selection constraint and the government's budget constraint. Differentiating (9) with respect to $B_1; y_1; B_2; y_2$, yields the following FOCs:

$$\frac{\partial L}{\partial B_1} = U_x^1 - \lambda U_x^{m2} - \mu\eta_1 = 0 \tag{10}$$

$$\frac{\partial L}{\partial y_1} = U_y^1 - \lambda U_y^{m2} - \mu\eta_1 = 0 \tag{11}$$

$$\frac{\partial L}{\partial B_2} = (\alpha + \lambda)U_x^2 - \mu\eta_2 = 0 \tag{12}$$

$$\frac{\partial L}{\partial y_2} = (\alpha + \lambda)U_y^2 - \mu\eta_2 = 0 \tag{13}$$

These represent the standard conditions for optimal taxation in the absence of public goods [Stiglitz, 1982; Boadway and Keen, 1993]. In particular, following Stiglitz (1982), dividing (13) by (12), it follows that the marginal tax

rate faced by the more able individual is zero and dividing (11) by (10) that the marginal tax rate faced by the less able individual will be positive[6]. Hence, the maximum level of welfare attainable through a non-linear income tax system, taking g and h as given, is constrained by self-selection. In this respect, the use of quantity controls can relax the self-selection constraint and allows the government to improve the efficiency of redistribution as shown in the next sections.

[6] See Stiglitz (1982) for a more general analysis of conditions (10)-(13).

3 The welfare effect of the pure public good

Consider the case in which the amount of publicly provided private good is given. Define $W(g;h)$ the maximum value function for the government's optimal income tax problem. This represents the value of social welfare for a given amount of g and h. By applying the envelope theorem and using first-order conditions, we find the following property of $W(g;h)$:

$$\frac{\partial W}{\partial g} = U_g^1 + (\alpha + \beta)U_g^2 - \bar{U}_g^{m_2} - \lambda p_g \tag{14}$$

From which it follows:

Proposition 1 For any value of h,

$$\frac{\partial W}{\partial g} \begin{cases} > \\ = \\ < \end{cases} 0 \quad \text{iff} \quad \sum_i MRS_{gx}^i \begin{cases} > \\ = \\ < \end{cases} p_g + \left[\frac{\bar{U}_x^{m_2}}{\lambda} - 1\right]\left(MRS_{gx}^{m2} - MRS_{gx}^1\right)$$

Proof. Following Broadway and Keen (1993), adding and subtracting $\bar{U}_x^{m_2}\frac{U_g^1}{U_x^1}$ to (14), and using (10) and (12), it follows:

$$\frac{\partial W}{\partial g} = \sum_i MRS_{gx}^i - p_g - \left[\frac{\bar{U}_x^{m_2}}{\lambda} - 1\right]\left(MRS_{gx}^{m2} - MRS_{gx}^1\right) \tag{15}$$

From which it is easy to check for Proposition 1 ■

To get further intuition on Proposition 1, consider the case in which, for a given value of h, the optimal non-linear income tax and public good policy are both in place. This means assuming g as a control variable in the government's

optimisation problem (9), so that the optimality condition on g implies equation (15) equal to zero. When this occurs, the Samuelson rule - according to which the sum of the marginal rate of substitution over all individuals must be equal to the marginal rate of transformation - is violated whenever the mimicker's marginal evaluation of the public good is greater or lower than the low-ability's marginal evaluation. In particular, at second best Pareto efficiency in the level of public good provision, constrained by a binding self-selection constraint on the high-ability individuals, an over-provision/under-provision of public goods occurs if the sum of marginal rates of substitution of g for x is lower/higher than the marginal cost[7].

Consider first the case in which $MRS^1_{gx} > MRS^{m2}_{gx}$, that is, at second best optimum there is an over-production of g (with respect to the first best solution). Following Boadway and Keen (1993), starting at $\sum_i MRS^i_{gx} = p_g$, suppose to increase g incrementally, and, simultaneously, to increase each individual's tax liability by his marginal rate of substitution of g for x: Since the mimicker and low-ability individuals face the same budget constraint and since $MRS^1_{gx} > MRS^{m2}_{gx}$; the mimicker is crowded out at a lower value of g than the value at which low-ability individuals are crowded out. Furthermore, since $B_2 > B_1$ and $Y_2 > Y_1$, and since $\frac{@g}{@B_i} > 0$ and $\frac{@g}{@Y_i} > 0$; the mimicker is also crowded out before honest high-ability individuals. The self-selection constraint on high-ability individuals turns out to be relaxed, so that public good provision is welfare enhancing.

A similar argument applies for the case in which $MRS^1_{gx} < MRS^{m2}_{gx}$: When this occurs, starting at $\sum_i MRS^i_{gx} = p_g$ suppose to reduce g incrementally and, at the same time, to modify the tax structure in such a way that each

[7] As in Boadway and Keen (1993), the concept of over- and under-provision is merely '...shorthand for a central characteristic of the second-best optimum'.

individual's tax liability decreases by his marginal rate of substitution of g for x. Likewise, the mimicker is crowded out before either low-ability and high-ability individuals.

4 The welfare effect of the publicly provided private good

Consider now the case in which the amount of public good is given. By applying the envelope theorem and using first-order conditions, after some manipulations we get the following property of $W(g,h)$:

$$\frac{\partial W}{\partial h} = \left[U_z^1 - p_h U_x^1\right] + (\alpha+\beta)\left(U_z^2 - p_h U_x^2\right) - \beta\left(U_z^{m_2} - p_h U_x^{m_2}\right) + \left[\pm p_h - 1 + p_h\left(\frac{\partial s_i}{\partial B_i} + \frac{\partial s_i}{\partial h}\right)\right] \tag{16}$$

where $\left[1 - p_h\left(\frac{\partial s_i}{\partial B_i} + \frac{\partial s_i}{\partial h}\right)\right]$ is the compensated effect on s_i. From (16) it follows:

Proposition 2 For any value of g, if z is a substitute for leisure, an increase in the level of the publicly provided good is welfare enhancing.

Proof. By substituting (10) and (12) into (16) and rearranging, we have:

$$\frac{\partial W}{\partial h} = \pm\left[n_1\left[MRS_{zx}^1 - p_h\right] + n_2\left[MRS_{zx}^2 - p_h\right] + \pm\beta U_x^{m2}\left[MRS_{zx}^1 - MRS_{zx}^{m2}\right]\right] + \left[\pm p_h - 1 + p_h\left(\frac{\partial s_i}{\partial B_i} + \frac{\partial s_i}{\partial h}\right)\right] \tag{17}$$

Given $\left[1 - p_h\left(\frac{\partial s_i}{\partial B_i} + \frac{\partial s_i}{\partial h}\right)\right] = 0$ for $s_i > 0$; by applying the envelope theorem, it follows that $\frac{\partial W}{\partial h} > 0$ if:

$$\pm\beta U_x^{m2}\left[MRS_{zx}^1 - MRS_{zx}^{m2}\right] > 0 \tag{18}$$

Since z is assumed to be a substitute for leisure, if high-ability individuals mimick low-ability individuals they consume more leisure than low-ability individuals, and consequently less publicly provided private good, so that it must be the case that $MRS^1_{zx} > MRS^{m2}_2$. Hence, since $U^{m2}_x > 0$, follows Proposition 2 ■

This result states that if the assumption on the substituability between z and leisure holds, then additional (with respect to …rst-best optimum) public provision of a private good can relax the high-ability self-selection constraint. Analogously to the previous section, here I only consider the case in which a single policy instrument is used. In so doing, the pure public good is assumed to be given, at least equal to zero. This assumption is relaxed in the next section, where the mixed scheme is analysed.

5 The welfare effects of the mixed scheme

In this section I focus on the mixed scheme, that is, the case in which both a public good and a publicly provided private good are used. To investigate the implications of such a scheme, consider the case in which they are used optimally:

Proposition 3 *In the case in which both a pure public good and a publicly provided private good are used optimally, if z is a substitute for leisure, then h acts as an equal lump-sum transfer to all individuals.*

Proof When optimal pure public good provision and optimal provision of publicly provided good are both in place, the FOCs also include the optimal condition on the choice of h, so that equation (13) must be equal to zero. By applying the envelope theorem and given $1 - p_h \frac{\partial s_i}{\partial B_i} + \frac{\partial s_i}{\partial h} = 0$ for $s_i > 0$, it follows:

$$\bar{\pm} U_x^{m2} \left[MRS_{zx}^1 - MRS_{zx}^{m2} \right] = 0 \tag{19}$$

Likewise, the optimal condition on the choice of g implies equation (15) be equal to zero. Solving (15) for $\bar{\pm} U_x^{m2}$ and substituting into (19) turns it into the condition:

$$\left(\frac{MRS_{gx}^i - p_g}{MRS_{gx}^{m2} - MRS_{gx}^1} \right) \left[MRS_{zx}^1 - MRS_{zx}^{m2} \right] = 0 \tag{20}$$

Consider first the case in which $MRS_{gx}^i \neq p_g$. From Proposition 1 we have that the first term on the LHS of (20) is positive, so that $MRS_{zx}^1 = MRS_{zx}^{m2}$, which corresponds to the case in which neither low- nor high-ability individuals

nor the mimicker are crowded out, so that h works as an equal lump-sum transfer to all individuals. Likewise, in the case in which $MRS^i_{gx} = p_g$, that is, the case in which a first best solution occurs for the pure public good provision, equation (20) implies a first best solution for a publicly provided good, thus concluding the proof■

The case of optimal joint provision leaves open the issue of how to redistribute economic resources from the high-ability individuals to the low-ability individuals, which has been analysed throughout this paper. Starting from the case of optimal joint provision, suppose to increase h incrementally and, at the same time, to modify the tax structure in such a way that each individual's tax liability increases by his marginal rate of substitution of h for x. Since the mimicker and low-ability individuals face the same budget constraint and since $MRS^1_{zx} > MRS^{m2}_{zx}$; the mimicker is crowded out at a lower value of h than the value at which low-ability individuals are crowded out. Furthermore, since $B_2 > B_1$ and $Y_2 > Y_1$, and since $\frac{@s_i}{@B_i} > 0$ and $\frac{@s_i}{@Y_i} > 0$ as long as s_i is not crowded out, the mimicker is also crowded out before honest high-ability individuals. The self-selection constraint on high-ability individuals turns out to be relaxed, so that publicly provided private good is welfare enhancing. However, in the special case in which $MRS^i_{gx} = p_g$, if z is a substitute for leisure, then an increase in h is not welfare enhancing.

6 Conclusions

The two-types model of non-linear income taxation with asymmetric information on individual ability levels is extended to discuss welfare effects of two policy instruments: a pure public good and a publicly provided private good. The latter is interpreted as health care.

Three different cases are analysed. When the level of the publicly provided private good is given, an increase in the level of the pure public good provision may be welfare enhancing if the low-ability marginal rate of substitution of g for x is higher than the mimicker's marginal rate of substitution.

The case in which only the publicly provided private good is considered, given the assumption that z is a substitute for leisure, implies that an increase in the level of it is welfare enhancing by relaxing the self-selection constraint on high-ability individuals.

By contrast, when optimal pure public good provision and optimal provision of publicly provided good are both in place, this latter acts as a lump-sum transfer to all individuals. However, it is still possible to redistribute economic resources from the high-ability individuals to the low-ability individuals by increasing the level of the publicly provided private good as long as an under- or an over-provision of the pure public good (compared with the first best optimum) occurs.

A number of issues remain open for further research. A first issue is to allow for pricing instruments available to the government to be introduced, such as a per unit subsidy on good z. Following Blomquist and Christiansen (1999), a second issue would be the attempt to merge the normative approach and the public choice approach into a single model to derive conditions for an efficient choice of distributional policy within a political economy framework.

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Periodicals:

KLEIN, B. (1980), "Transaction Cost Determinants of 'Unfair' Contractual Arrangements," *American Economic Review*, 70(2), 356-362.

KLEIN, B., R. G. CRAWFORD and A. A. ALCHIAN (1978), "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, 21(2), 297-326.

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NELSON, R. R. and S. G. WINTER (1982), *An Evolutionary Theory of Economic Change*, 2nd ed., Harvard University Press: Cambridge, MA.

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STIGLITZ, J. E. (1989), "Imperfect Information in the Product Market," pp. 769-847, in R. SCHMALENSEE and R. D. WILLIG (eds.), *Handbook of Industrial Organization*, Vol. I, North Holland: Amsterdam-London-New York-Tokyo.

Working papers:

WILLIAMSON, O. E. (1993), "Redistribution and Efficiency: The Remediableness Standard," Working paper, Center for the Study of Law and Society, University of California, Berkeley.