Public Provision of Private Goods, Self-Selection and Income Tax Avoidance

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ABSTRACT

Redistributive taxation should benefit those with low earnings capacity rather than those who *choose* a lower income to obtain tax savings. Several contributions have highlighted how public provision of work complements can discourage people from lowering labour supply to diminish taxable income. We show how tax avoidance, previously neglected, can alter the conclusions regarding public provision. Tax avoidance breaks the link between labour supply and reported income. An agent reducing his reported income to escape taxes may no longer forego a publicly provided labour complement because he may now lower his income by avoiding more rather than working less.

Keywords: optimal nonlinear income tax; tax avoidance; income misreporting.

JEL Classification: H21; H26; H42

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I. INTRODUCTION

A key issue in public economics is how to combine taxes and public expenditures to achieve the desired redistribution and revenue-raising at low efficiency costs. Within the optimal tax literature, several contributions have highlighted the welfare-enhancing role of using public provision of certain private goods as an instrument to alleviate labour supply discouragement and other tax-induced distortions, for instance by lowering the cost of working.[1] So far, however, the literature on this topic has largely abstracted from any tax evasion or avoidance. In this paper we integrate the research on taxes and public provision with the research on how people evade taxes by underreporting true income, or find more sophisticated and elaborate ways to shelter income from taxation – known as tax avoidance. We find that tax avoidance affects how we would like to use public provision as part of redistributive policy.

A basic insight from the conventional literature is that public provision of a good should favour those who *actually have* a low earnings capacity rather than those who *choose* a low income through low labour supply despite having a higher earnings capacity. For this reason there is a case for supplying goods that are complements with labour supply. However, when avoidance is possible, agents with higher earnings capacity can choose lower reported income by underreporting income without lowering labour supply, or even in combination with increased labour supply. They could work more to earn what is now tax-free income at the margin. Working more, agents with high earnings ability but low observable income will benefit more from the publicly provided commodity. Also without working more, these

[1] The literature on the welfare-enhancing role of public provision of private goods as a policy instrument in Mirrleesian optimal tax models has been developed in a series of papers since the mid-Nineties. The main contributions include Blomquist and Christiansen (1995), Boadway and Marchand (1995), Cremer and Gahvari (1997), Balestrino (2000), Pirttilä and Tuomala (2002) and Blomquist *et al.* (2010).

agents may value the good more since they have more (evaded) income to spend. In either case, a good appropriate for public provision with full income reporting may no longer be suitable when there is tax avoidance.

Even where those able agents who *choose* a low income would like to consume more than those with lower earnings ability, public provision may be socially efficient in certain circumstances. Suppose that an agent has to choose between accepting an amount that is publicly provided free of charge or fully acquiring the commodity in the market (say choosing public *or* private health care). Then, the agent with the lower valuation of the commodity may be the beneficiary if a small amount (or a low quality) is provided. The reason is that the agent with the higher valuation may find the public provision inadequate and opt for the market alternative, foregoing the benefits of public provision. However, who are the agents with a low valuation, preferring public provision, may in some cases depend on whether people have the possibility to engage in tax avoidance or not. Suppose that high-wage non-avoiders *choosing* a low income have a low valuation while avoiders *reporting* a low income have a high willingness to pay due to a large hidden income, and hence prefer market purchases. Then it is only in the avoidance case that public provision of this good is efficiently targeted at the people who actually have low earnings ability. Drawing such lessons is clearly of relevance for policy advice.

A further result that we highlight in our analysis is that, even when welfare-enhancing, public provision *may* induce larger evasion. The reason is that it can make working easier or less costly, which in turn can stimulate efforts to earn unreported income.

To prepare the ground for our formal analysis of taxes, public provision and avoidance, we shall first elaborate on each of them separately, and then give an introduction to our general approach.

Our starting point is that taxation is based on the ability principle, that is, people with higher earnings capacity (skills) should pay more taxes than those who are less able. Modern tax theory (pioneered by Mirrlees, 1971) has modelled the problem involved as one of asymmetric information. The government does not know who are high-skilled and who are low-skilled. The simplest model of this kind assumes two types of individuals (see, e.g., Stiglitz, 1982, and Stern, 1982): high-skilled and low-skilled with the former being more productive and obtaining a higher wage rate than the latter. Since the government does not directly observe the individual characteristics, taxes or transfers cannot be conditioned on innate ability. The government can only design combinations of gross income and taxes, and hence disposable income, and let agents choose their preferred income point. To achieve redistribution, one tax must be lower than the other, and conceivably negative. Then a problem is that high-skilled agents may mimic low-skilled agents by lowering their labour supply to earn the income qualifying for the lower tax. The tax must then be designed in such a way that mimicking is deterred, otherwise no redistribution is achieved.

Public provision of goods and services can take different forms. One type of provision scheme will give everybody the amount that he or she needs. This need is well defined only if there is satiation in the sense that a person wants only a limited amount of the commodity. An example may be child care since parents will want to substitute only part of the time they can spend with the children by care given by other people or because provision of child care is confined to the number of working hours of the parents, which is indeed the Swedish scheme.

Another set of provision schemes gives everybody a fixed amount, say a fixed amount of primary education, or a fixed amount of health services in case of some illness. A crucial question is whether the recipient can resell the commodities. If reselling is possible, the public provision is tantamount to a transfer in cash as the recipients can obtain the same cash value by selling the commodity. One may therefore want to have public provision of commodities

that cannot be resold, typically services received directly by the beneficiaries, or designing the scheme to make reselling difficult.

Another important question is which market opportunities the recipient has for obtaining a consumption bundle that is not constrained to the publicly provided amount. When market alternatives exist, there are two ways in which a consumer may benefit from them. In brief, one can purchase an amount in the market *instead of* or *in addition to* the amount that one can get from the government. In the former case, one will forego the public provision in order to get a larger quantity obtained by purchases in the market.[2] One may choose a private school, hospital or child care centre rather than the public offer. The alternative is that it is possible to take the publicly provided ration and supplement it with additional purchases in the market. The most clear-cut example may be where the government issues a voucher giving the recipient a minimum amount free of charge and allowing the consumer to get a larger quantity by paying out of pocket for an additional amount. To distinguish the various kinds of public provision schemes by conceivable interactions with market supply, we will use the following terminology. A *no upper bound system* is one in which each individual gets exactly the desired quantity. Where the consumer is faced with a choice between either accepting public provision or foregoing it to rely solely on market purchases, we will refer to *opting-out schemes*. Finally, arrangements allowing consumers to supplement public provision with market purchases are termed *topping-up schemes*.

Without avoidance, earlier studies have shown that public provision is welfare-enhancing only if preferences are such that there is non-separability between labor and other goods. When the demand for the publicly provided good is decreasing in labor supply, a high-

[2] To simplify the exposition, we will only speak about differences in quantities even though in some cases it might be more fitting to conceive of differences in quality. However, even quality has a quantitative dimension as higher quality means more of some favourable property of a commodity, e.g. more pedagogical content in an hour of child care.

skilled mimicker wants more of the commodity than a true low-skilled agent, and therefore an opting-out system is optimal. If instead demand is increasing in labour supply, a mimicker demands less than the mimicked and a topping-up or a no upper bound system is optimal. If, for given hours of work, there is satiation, then the no upper bound system can dominate the topping up system, since the former can mitigate more self-selection constraints (in models with more than two types of agents).

Several approaches exist in the literature on evasion and avoidance - with evasion normally referring to illegal and avoidance to legal tax-escaping activities. Most of the early evasion literature, following Allingham and Sandmo (1972), assumes that decisions about underreporting income involve risk. Evasion may be detected with some probability, for instance due to random audits by the tax authorities, in which case a sanction applies.[3]

An alternative approach, proposed by Usher (1986) and adopted in our analysis, assumes a riskless setting where a *certain* tax saving is attainable by combining underreporting with a costly concealment activity. The concealment cost function may be implicitly assumed to capture some of the elements from the uncertainty model, for instance to be higher the more extensive is the auditing activity of the tax collector. As in the

[3] In the context of the normative theory of optimal redistributive taxation, Cremer and Gahvari (1995) and Schroyen (1997) are the two main contributions modelling (income tax) evasion as a risky activity. As our paper, these contributions use a two-type model where agents are heterogeneous in terms of labor productivity. In contrast to our paper, where we focus on the effects of evasion for the optimal design of public provision schemes, their focus is on characterizing the optimal enforcement policy and the optimal progressivity of the nonlinear income tax.

uncertainty case, there is a trade-off between the gain from shrinking the tax by underreporting and the cost incurred, which is now modelled as a pure concealment cost.[4,5]

Compared with analyses of public provision in the no-avoidance case, the possibility of income misreporting implies two main consequences. First, a high-skilled mimicker and a low-skilled agent no longer have the same disposable income. This means that the income effect on the demand for the publicly provided good now comes into play. Second, it is no longer necessarily true that a mimicker works fewer hours than a low-skilled agent. Both these facts are of importance for whether the mimicker or the mimicked has the larger demand for the publicly provided good.

We obtain three main results. First, earlier studies of public provision schemes have shown that public provision is welfare enhancing only if preferences are such that there is non-separability between labor and goods. We show that income tax avoidance implies that non-separability between labor and other goods is neither a necessary nor a sufficient condition to make public provision of private goods a welfare enhancing policy instrument. Second, income misreporting tends to make schemes where individuals are not allowed to top up the publicly provided quantity welfare-superior to schemes where topping up is allowed. Third, a further result that we highlight in our analysis is that public provision may be welfare enhancing even in cases when it leads to an increase in income misreporting.

Theory and empirical evidence indicate that tax avoidance/evasion opportunities depend on features of a country's economic structure such as the extent to which income is

[4] Within the literature on the normative theory of redistributive optimal taxation, previous contributions adopting the riskless approach include Boadway *et al.* (1994), Kopczuk (2001), and Gahvari and Micheletto (2014). Examples from other contexts are Mayshar (1991), Slemrod (2001) and Chetty (2009).

[5] Regardless of whether we have evasion or avoidance in mind, the activity is assumed to involve a (private and social) cost to be traded off against the tax saving. As we model them, the two activities become very similar and we find it convenient to use hereafter "avoidance" as a uniform term for these activities.

subject to information reporting from public registers and third parties (employers and even financial institutions), the average size of firms, the importance of self-employment, and the extent of public disclosure of taxable income (see, Kleven *et al.*, 2009, Kleven *et al.*, 2011, and Slemrod *et al.*, 2013). Therefore, tax avoidance might not be very important in countries like the Nordic countries, and earlier analyses of public provision of private goods are probably relevant for these countries. Our results should instead be relevant for non-developed countries,[6] where tax avoidance/evasion problems often are big, as well as for those developed countries where avoidance/evasion is a widespread phenomenon.[7]

The rest of the paper is organized as follows. In Section 2 a simple two-type optimal tax model is set up to show that, when agents have access to an avoidance technology, the case for supplementing the nonlinear income tax with topping-up public provision schemes is somewhat weakened and the case for an opting-out scheme strengthened. Section 3 investigates the effects of public provision on avoidance. Section 4 discusses how the results generalize to a setting where agents differ both in terms of market productivity and concealment costs. Finally, Section 5 offers concluding remarks.

II. THE MODEL

The economy has two types of agent distinguished by their innate earnings ability (output per unit of work effort), which is reflected in the wage rate. The wage rate of an agent of type k

[6] It is true that many of these countries do not yet have a well-working income tax system and therefore rely on various inefficient sources of revenue (see, e.g., Gordon and Li, 2009). However, it is also plausible that some of these countries will in due time develop welfare systems of the Western type.

[7] For instance, according to the data for selected OECD countries in 2000 in Parker (2009), the self-employment rate was about 25% in Italy, and empirical evidence for this country finds estimates of the rate of under-reporting of self-employment income in the range of around 30%-55%; an estimate for Greece reports a shortfall in tax receipts, due to tax evasion, of nearly 30%. For further details on these countries, see Fiorio and D'Amuri (2005), Marino and Zizza (2012), De Gregorio and Giordano (2014), and Matsaganis *et al.* (2012).

(k=1,2) is denoted w^k, with $w^2 > w^1$. Thus, agents of type 1 are low-skilled and agents of type 2 are high-skilled. The total population is normalized to unity and π^k represents the proportion of agents of type k. Two goods (X_1 and X_2) are produced by a linear technology using labor as the only input;[8] the producer price of good X_1 is denoted by p and that of good X_2 is normalized to 1. Preferences are represented by the quasi-concave utility function $u(x_1, x_2, h)$, where x_i denotes the consumption of commodity i and h denotes labor supply. All goods (including leisure) are assumed to be normal throughout the analysis.

The government aims at redistributing from those who are better-off in the laissez-faire equilibrium to those who are worse-off. The informational structure of the problem is the following. The government knows the distribution of types in the population, but it does not know the identity of the types. Therefore, type-specific lump-sum taxes are ruled out by assumption. The usual asymmetric information assumption is that the government can observe gross income, wh, but it cannot observe separately w and h. In our model, however, not even earned income is observable as we allow for the possibility of tax avoidance. The government has to rely on reported income, denoted by M, and has at its disposal a general income tax $T(M)$.

To model income-misreporting, we follow the riskless approach outlined in the introduction. Misreporting is denoted by a and defined as $a \equiv wh - M$. In principle, both under-reporting ($a > 0$) and over-reporting ($a < 0$) are conceivable depending on the shape of the tax schedule.[9] The cost of misreporting is expressed by means of the function $g(a)$, which is assumed to be non-negative, increasing in the absolute value of a and strictly convex; we also assume that $g(0)=g'(0)=0$. We will refer to $g(a)$ as the concealment cost.

[8] The assumption of two commodities is made to keep notation simple. The model can easily be generalized to more than two commodities.

[9] Over-reporting is an optimal strategy when an agent faces a negative marginal income tax rate.

Even though we adopt the riskless approach it is important to emphasize that the qualitative results that we obtain regarding the optimal design of public provision schemes can be generalized to the case where income misreporting is a risky activity. The reasons for this are discussed at the end of Section 2.

A pure income tax optimum

Since there are only two types in our model, only two points on the optimal tax schedule are of interest. Denoting reported (taxable) income by *M* and after tax (reported) income by *B* (with *B* being defined as the difference between *M* and the corresponding tax payment *T(M)*), the problem for the policy maker is therefore to design one point M^1, B^1 intended for the low-skilled type and another point M^2, B^2 intended for the high-skilled. Since individuals are free to choose the point they prefer, these must be designed by the policy maker subject to a budget constraint and a self-selection constraint to be described below.

The government's problem is to design a Pareto-efficient tax schedule, which can be derived by maximising the utility of a given type of agent, subject to the other type's utility being fixed at a pre-set level, and subject to self-selection and revenue constraints. The self-selection constraints arise since the government must design the tax system so that each ability type (weakly) prefers the (*M*,*B*)-bundle intended for him to that intended for the other type. An agent that misrepresents his type is called a mimicker.

Before formalizing the government's problem, we address the optimization problem solved by the agents. It is helpful to divide this problem into two stages. In the first stage, for given values of *M* and *B*, the agent chooses his labor supply and consumption of the two goods. This gives a conditional labor supply function and conditional demand functions for x_1 and x_2. The budget available for purchasing the two commodities is the true labour earnings (*wh*) minus the tax based on reported income (*T*=*M*-*B*) and minus the concealment cost

($g(a)$). Formally, the individual optimization problem (suppressing type superscript) in the first stage is:

$$\max_{x_1,x_2,h} u\left(x_1,x_2,h\right) \text{ s.t. } px_1+x_2=wh-M+B-g\left(wh-M\right),$$

for which the following first order conditions are obtained:

$$\left(\frac{\partial u}{\partial x_1}\right)/\left(\frac{\partial u}{\partial x_2}\right)=p, \tag{1}$$

$$-\left(\frac{\partial u}{\partial h}\right)/\left(\frac{\partial u}{\partial x_2}\right)=\left[1-g'\left(wh-M\right)\right]w. \tag{2}$$

Denoting by $V(M, B;w)$ the maximum value function of the problem above, in the second stage the agent determines how much income to report, i.e. he chooses his preferred (M,B)-bundle, subject to the link between M and B implied by the income tax schedule: $B=M-T(M)$. This allows us to implicitly define the marginal income tax faced by an agent as:

$$T'\left(M\right)=1+\frac{\partial V/\partial M}{\partial V/\partial B}=1-MRS, \tag{3}$$

where MRS denotes the marginal rate of substitution between M and B.

Notice also that, by invoking the envelope theorem, we have $\partial V/\partial M=-\left(1-g'\left(a\right)\right)\partial u/\partial x_2$ and $\partial V/\partial B=\partial u/\partial x_2$. Therefore, we also have:

$$1+\frac{\partial V/\partial M}{\partial V/\partial B}=g'\left(a\right), \tag{4}$$

implying:

$$T'\left(M\right)=g'\left(a\right).^{10} \tag{5}$$

Using $V^k\left(M,B\right)$ to denote $V\left(M,B;w^k\right)$, the government's problem can be formally

[10] Both (4) and (5) crucially hinge on our assumptions about the cost of avoidance function, and in particular on the assumption that $g\left(0\right)=g'\left(0\right)=0$.

stated as:

$$\max_{M^1,B^1,M^2,B^2} V^1\left(M^1,B^1\right)$$

s.t.:

$$V^2\left(M^2,B^2\right)\geq \overline{V^2} \qquad (\delta)$$

$$V^2\left(M^2,B^2\right)\geq V^2\left(M^1,B^1\right) \qquad (\lambda)$$

$$\sum_{k=1}^{2}\left(M^k-B^k\right)\pi^k \geq R, \qquad (\mu)$$

where Lagrange multipliers are within parentheses, the first constraint requires a minimum utility for the high-skilled agents, the second is the self-selection constraint preventing high-skilled agents from mimicking the low-skilled agents, and the last constraint is the government's budget constraint, with *R* being an exogenous revenue requirement.[11]

Using a "hat" to denote a variable pertaining to a mimicker, the definition $T'\left(M\right)=1-MRS$ and $\lambda*$ as shorthand for $\lambda(\partial\hat{V}/\partial B^1)/\mu\pi^1$, standard manipulations of the first order conditions of the government's problem allow deriving the following results:

$$T'\left(M^2\right)=1+\frac{\partial V^2/\partial M^2}{\partial V^2/\partial B^2}=1-MRS^2=0 \qquad (6)$$

$$T'\left(M^1\right)=1+\frac{\partial V^1/\partial M^1}{\partial V^1/\partial B^1}=\lambda*\left(\frac{\partial\hat{V}/\partial M^1}{\partial\hat{V}/\partial B^1}-\frac{\partial V^1/\partial M^1}{\partial V^1/\partial B^1}\right)=\lambda*\left(MRS^1-M\hat{R}S\right) \qquad (7)$$

Equation (6) implies the standard result that the marginal tax rate faced by the high-skilled agents is equal to zero. By (5) this also means that $g'(a^2)=0$, and accordingly $a^2=0$. Thus, the high-skilled agents truthfully report their earned income.[12]

[11] The self-selection constraint requiring that type 1 does not mimic type 2 can be safely neglected due to our assumption that the government redistributes from the high-skilled to the low-skilled agents.

[12] This result deserves some comments since its relevance might easily be misperceived. The result descends from the fact that it is optimal not to distort the bundle offered to the most skilled agents, since nobody is tempted to mimic them. Since in our simple setting we have only two types of agent, we also get that high-

The term within parentheses on the right hand side of (7) measures the difference between the marginal rate of substitution between M and B for a low-skilled agent and a high-skilled mimicker, at the (M,B)-bundle intended for the low-skilled agents. In standard optimal tax models without tax avoidance, a monotonicity property (single-crossing condition) guarantees that, at any bundle in the (earned income, net-of-tax income)-space, the indifference curve of a high-skilled mimicker is flatter than the corresponding curve for a true low-skilled agent.[13] The intuition for the result is that an agent with lower skill needs to supply more labor both to achieve the initial level of earnings and in order to increase his gross earnings by one unit, and therefore he requires a larger compensation in terms of net-of-tax income. In our model with tax avoidance, agents choose among bundles in the (reported income, net-of-tax reported income)-space, and reported income may differ from true earned income. Nonetheless, the same type of monotonicity property that applies in standard optimal tax models also applies in our model with tax avoidance. To show this, we first need to establish the following Lemma.

Lemma 1.

A high-skilled mimicker under-reports more (or over-reports less) income than a low-skilled agent: $\hat{a} > a^1$.

Proof: See the Appendix**.**

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skilled agents truthfully report their earned income. However, in a richer setting with several types of agents, or in a model with a continuum of types, the no-distortion and no-avoidance result would only apply to a tiny fraction of the population. Its role would then appear more modest than in the two type model where all high-skilled individuals are by assumption at the very top of the skill distribution.

[13] Non-inferiority of consumption is a sufficient condition for this result.

Armed with Lemma 1, the following Corollary shows that the agent monotonicity condition is preserved in our model with tax avoidance.

Corollary 1.

The agent monotonicity condition holds even in the presence of tax avoidance.

PROOF: Rewriting (4) as $-\frac{\partial V / \partial M}{\partial V / \partial B} = 1 - g'(a)$, we have:

$$\frac{\partial}{\partial w}\frac{dB}{dM} = \frac{\partial}{\partial w}\left(-\frac{\partial V / \partial M}{\partial V / \partial B}\right) = -g''(a)\frac{\partial a}{\partial w}. \qquad (8)$$

Due to the convexity of $g(a)$, $-g''(a) < 0$; moreover, from Lemma 1 we have that $\hat{a} > a^1$, implying $\partial a / \partial w > 0$. Therefore, for any given (*M,B*)-bundle, the right hand side of (8) takes a negative sign as required by the agent monotonicity condition.

We can now go back to eq. (7) which expresses the optimal marginal tax rate faced by the low-skilled agents. Given that in (7) the sign of the difference within parentheses is positive by the agent monotonicity assumption, we can conclude that the low-skilled agents face a positive marginal tax rate at an optimum. This also implies that $g'(a^1) > 0$, i.e. $a^1 > 0$. Thus, at a pure income tax optimum the low-skilled agents will under-report their income.

Another corollary of Lemma 1 which will be important in our subsequent analysis is the following.

Corollary 2.

Allowing for the possibility of tax avoidance implies that the disposable income of a high-skilled mimicker exceeds that of a low-skilled agent.

PROOF: Denoting disposable income $B + a - g(a)$ by Z, we have that $dZ / da = 1 - g'(a) > 0$. The inequality follows from the fact that $g'(a)$ is equal to the marginal tax rate that is always less than one. Since $B^1 = \hat{B}$ and $\hat{a} > a^1$, it follows that $\hat{Z} > Z^1$.

Finally, the possibility to engage in tax avoidance implies that it is no longer possible to unambiguously rank the labor supply of a high-skilled mimicker and of a low-skilled agent. This result is expressed in Lemma 2, which will also be important in our subsequent analysis, and which stands in contrast with the result obtained in models without tax avoidance where the labor supply of a high-skilled mimicker is necessarily lower than that of a low-skilled agent.

Lemma 2.

With tax avoidance the labor supply of a high-skilled mimicker might be larger than the labor supply of a low-skilled agent.

Proof: At any given (*M*,*B*)-bundle an agent's problem is: $\max_{x_1,x_2,h} u(x_1,x_2,h)$ subject to $px_1 + x_2 = wh - M + B - g(wh - M)$, which is a utility maximization problem subject to a nonlinear budget constraint. Linearizing the budget constraint we can define the local (marginal) price of leisure as $w^* = (1 - g'(a))w$. An increase in *w* exerts both an income and a substitution effect. The income effect on labor supply is unambiguously negative assuming leisure is normal. The substitution effect depends on the change in the marginal wage rate, i.e. the sign of $\partial w^* / \partial w = 1 - g'(a) - whg''(a)$. With $1 - g'(a) > 0$ and $g''(a) > 0$, the substitution effect can be either positive or negative. Where it is negative, both income and substitution effects on labor supply are negative. However, if the substitution effect is positive, whether the labor supply increases or diminishes depends on the relative magnitude of the two conflicting effects. If the substitution effect is positive and it dominates the income effect, the labor supply of a high-skilled mimicker will exceed the labor supply of a low-skilled agent: $dh(M,B;w)/dw > 0$.

Supplementing the income tax with public provision of private goods

As mentioned in the introduction, there are three types of public provision schemes. One is the *topping-up system*; a fixed quantity is provided to each agent and the agents can top up by buying additional amounts in the market if they find the ration too low. A second is the *opting-out system*; a fixed quantity is provided to everyone, and agents cannot top up. If they do not like the publicly provided quantity they can opt out and buy the desired quantity in the market instead. In that case, however, they completely forego the publicly provided quantity. A third form is the *no upper bound system*; in this system each agent gets exactly the desired quantity. This system is only viable if, for given hours of work, there is satiation. In other words, the consumer's need for the good is strictly determined by labour supply.

Let us briefly describe how public provision of a private good can mitigate the self-selection constraint in the optimal taxation problem where there are no opportunities for tax avoidance. (Note that when there are no opportunities for tax avoidance $M = wh$ and the disposable income is given by B.) We do this for the case where the demand for the publicly provided good is increasing in hours of work and a topping up system is used. The general idea is similar for the other types of public provision schemes. The maximization problem $\max_{x_1,x_2} u(x_1,x_2,h)$ s.t. $px_1 + x_2 = B$ yields the demand functions $x_1(B,h)$ and $x_2(B,h)$. Consider the optimal taxation problem with a binding self-selection constraint requiring high-skilled agents not to mimic low-skilled agents. Let $x_1^1 = x_1\left(B^1, Y^1/w^1\right)$, $\hat{x}_1 = x_1\left(B^1, Y^1/w^2\right)$ and $x_1^2 = x_1\left(B^2, Y^2/w^2\right)$, where we let $Y(=wh)$ denote labor income. Since $w^2 > w^1$ it follows that $x_1^1 > \hat{x}_1$. Since $B^2 > B^1$ and $Y^2 > Y^1$ it follows that $x_1^2 > \hat{x}_1$.[14] Set the public provision level to $\bar{x}_1 = \min\left\{x_1^1, x_1^2\right\}$ and decrease the disposable incomes B^1 and B^2 by the

[14] Because of the binding self-selection constraint the points Y^1,B^1 and Y^2,B^2 are on the same indifference curve for a high-skilled agent, but Y^2,B^2 are to the north-east of Y^1,B^1, it follows that $Y^2 > Y^1$ and $B^2 > B^1$.

market value of the public provision. Then the person with the higher demand can top up, meaning that both persons will have the same undistorted consumption bundles as before. However, due to the no reselling constraint, a mimicker is forced to over-consume the publicly provided good and under-consume the other good,[15] implying that his utility decreases; the self-selection constraint slackens and we can increase the before and after tax income of type one to a less distorted point. A strict Pareto improvement obtains.[16]

Disregarding the possibility of tax evasion/avoidance, earlier contributions have characterized the conditions under which each of the three systems is optimal (see e.g., Blomquist and Christiansen 1995, 1998 and Blomquist *et al.* 2010). For later purposes, we summarize these earlier results in a proposition that rephrases them so they are valid both for the case without and the case with income misreporting.

Proposition 1.

If, at a given taxable income, the high-skilled mimicker demands more of the commodity than the low-skilled being mimicked, then an opting-out system is optimal. If there is no satiation and the mimicker demands less than the mimicked, then a topping-up system is optimal. If, for given hours of work, there is satiation and the mimicker demands less than the mimicked, then a no upper bound system is optimal. This characterization holds true whether there are opportunities for tax evasion/avoidance or not.

When there are no possibilities for tax evasion/avoidance this characterization can be rephrased in terms of properties of the demand function $x(B,h)$. In the standard optimal tax model the mimicker and the mimicked have the same disposable income B^1 and the mimicker

[15] By under-consumption (over-consumption) we refer to a situation where the marginal valuation of the good exceeds (falls short of) its price.

[16] See Blomquist and Christiansen (1998) for a more formal analysis.

works less, $\hat{h} < h^1$. Therefore, if $\partial x / \partial h < 0$, the mimicker wants more of the commodity than the person he mimics and an opting-out system is optimal. If instead $\partial x / \partial h > 0$, the mimicker demands less than the mimicked and a topping-up or a no upper bound system is optimal. If, for given hours of work, there is satiation, then the no upper bound system can dominate the topping up system, since the former can mitigate more self-selection constraints.

When the agents can avoid taxes there are two major changes to the characterization in the preceding paragraph. First, as shown in corollary 2, the mimicker and the mimicked no longer have the same disposable income. This means that the income effect on the demand for the publicly provided good now comes into play. Second, in the standard model without tax avoidance the mimicker works fewer hours than the low skilled agent. As shown in Lemma 2, with tax avoidance the mimicker can work more hours than the low skilled agent. Both these facts are of importance for whether the mimicker or the mimicked has the larger demand for the publicly provided good.

Let us now elaborate on the relations between commodity demand and the wage rate, i.e, dx / dw, when there are possibilities to avoid tax. To give a characterization of the conditions under which dx / dw is positive/negative, and the various public provision schemes are warranted when there is a tax avoidance technology available, it is useful to note that the first order condition (1) and the budget constraint $Z=px_1+x_2$ implicitly define demands for X_1 and X_2 as functions of disposable income $Z\left(= B + wh - M - g\left(wh - M\right)\right)$ and labour supply h. We express the demand for X_1 as $x_1\left(Z, h\right)$. Next we take into account that h is a function of the wage rate due to condition (2), as discussed above. Denote by $\varepsilon_{h,w}$ the elasticity of

labor supply with respect to the wage rate (i.e. $\varepsilon_{h,w} = (w/h)(dh/dw)$).[17] Differentiating with respect to the wage rate, gives:

$$\frac{dx_1(Z,h)}{dw} = (1-g'(a))(1+\varepsilon_{h,w})h\frac{\partial x_1}{\partial Z} + \frac{\partial x_1}{\partial h}\frac{dh}{dw}. \qquad (9)$$

Since $(1-g'(a))$ and $(1+\varepsilon_{h,w})$ are both positive, the first term on the right hand side is positive if X_1 is a normal good. The second term is positive if $\partial x_1 / \partial h$ and dh/dw have the same sign, otherwise it is negative. Assuming X_1 not to be inferior, a necessary condition for dx_1/dw to be negative is therefore that $\partial x_1 / \partial h$ and dh/dw are of opposite signs. A negative sign for dx_1/dw could occur if, for example, the income effect on the demand for X_1 is small, X_1 is strongly complementary with h and hours of work are decreasing in the wage rate (reflecting a small and conceivably negative substitution effect and a strong income effect on labor supply). Based on (9) and proposition 1 we can state the following Proposition.

Proposition 2.

a *If there is nonsatiation, the good is noninferior, $\partial x_1 / \partial h$ and dh/dw are nonzero and have the same sign, or the good is normal and $\partial x_1 / \partial h = 0$, then dx_1/dw is positive. A topping up system cannot mitigate the self-selection constraint but an opting out system can and is the optimal choice of public provision scheme.*

b *If there is nonsatiation, the good is normal, $\partial x_1 / \partial h$ and dh/dw are nonzero and of opposite signs, then dx_1/dw is in general indeterminate, and what is the proper public provision scheme depends on which one of the two terms in eq. (9) is larger in absolute terms.*

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[17] Notice that $\varepsilon_{h,w} > -1$. This is because, as we have shown in Lemma 1, *da/dw>0* which implies $d(wh)/dw > 0$.

c *If there is nonsatiation, the income effect on the demand for X_1 is zero, and $\partial x_1 / \partial h$ and dh / dw are nonzero and of opposite signs, then dx_1 / dw is negative and a topping up system is optimal.*

d *If there is satiation, the income effect on the demand for X_1 is zero, and $\partial x_1 / \partial h$ and dh / dw are nonzero and of opposite signs, then dx_1 / dw is negative and a no upper bound system is optimal.*

Proof: The results follow directly from Proposition 1 and eq. (9).

The information requirement is largest in case ***b***, since we need to know which one of the two terms that dominates. In all other cases only knowledge of signs is needed to determine what kind of public provision scheme that is optimal.

It can be worth to comment further on the two special cases where the demand only depends on a single argument, i.e. when either $\partial x_1 / \partial h = 0$ or $\partial x_1 / \partial Z = 0$. The case $\partial x_1 / \partial h = 0$ occurs when agents' preferences are weakly separable between leisure and other goods. Where the good is normal and demand only depends on disposable income, dx / dw will be positive and a mimicker will have a larger consumption. In this case a topping-up provision scheme, or a no-upper-bound scheme, cannot improve upon a pure income tax optimum. The self-selection constraint cannot be relaxed since the mimicker can undo any rationing of the publicly provided good by topping up. However, supplementing the income tax with an opting-out provision scheme will be welfare-improving.

The income effect is zero when $\partial u\left(x_1, x_2, h\right) / \partial x_1 \equiv 0$ and $x_2 = wh - M + B - g\left(wh - M\right) - px_1\left(h\right)$. The interpretation is that no direct benefit is derived

from good X_1 which is instead a necessary "intermediate good" required for working, say child care needed by working parents. The fact that the demand for X_1 does not depend on disposable income removes one channel by which tax avoidance contributes to raise the mimicker's demand beyond that of a low-skilled agent. This suggests that tax avoidance in this case is less likely to reverse the order between the amount demanded by a mimicker and the one demanded by a true low-skilled. Thus, for a purely labor-related good a topping-up provision, or a no-upper-bound scheme, still stands a good chance of being a welfare-enhancing device through its effect on the self-selection constraint.

Three insights from the above analysis are central. First, unlike in the conventional (no-avoidance) case, differential treatment of the mimicker and the true low-skilled may be possible and there may be a case for public provision even where labour is (weakly) separable from other goods in the agents' utility function.[18] This is because when there is tax avoidance the mimicker and the mimicked will have different disposable incomes. Second, the case for a topping-up public provision scheme or a no-upper-bound scheme is weakened by tax avoidance when the publicly provided good is a normal good. Third, tax avoidance may require using an opting-out scheme where a topping-up scheme or a no-upper-bound scheme would otherwise be desirable. Thus, tax avoidance can make a substantial difference for the desirability and optimal design of a public provision scheme.

A last point that we would like to briefly discuss regards the importance of modelling income misreporting as a riskless (but costly) activity or as a risky activity which may be detected through costly audits and punished along a penalty function. As mentioned in

[18] This result relates to the Boadway *et al.*'s (1994) finding that the Atkinson and Stiglitz (1976) theorem no longer holds when income taxes are vulnerable to evasion. In particular, as shown by Boadway *et al.* (1994), the possibility of income misreporting implies that, even in the presence of a nonlinear income tax, proportional commodity taxes are no longer a redundant policy instrument when labour is (weakly) separable from other goods in the agents' utility function.

the Introduction, the latter approach was used by Cremer and Gahvari (1995) and Schroyen (1997). As in our model, these papers adopt a two-type version of the optimal tax model. In Schroyen's model workers may work in the official market paying taxes, but may also allocate labour to an irregular market where earnings go unreported. Cremer and Gahvari assume that agents can simply misreport income earned in a single labour market. The two papers derive very similar results. Modelling evasion as a risky activity, the focus of these papers is very much on auditing and penalties. These phenomena are obviously absent in our riskless model. Our primary purpose is not to contribute to the theory of tax avoidance, but rather to examine conceivable consequences of tax avoidance for the optimal use of public provision schemes to alleviate tax distortions. To encompass this additional instrument, we have chosen a more tractable way to model avoidance. However, the two approaches share many results, most easily seen by considering marginal taxes. In either set of models high-wage persons optimally face a zero marginal tax (are undistorted**)**; where the standard self-selection is binding, the low-skilled type faces a positive marginal tax.

Most importantly, for the qualitative results on public provision that we have described above, it makes no important difference whether one models income misreporting as a riskless (but costly) activity or as a risky activity. The main difference is that in the latter case, allowing for a nonlinear penalty policy, no agent is misreporting income at an equilibrium optimum (see, e.g., Cremer and Gahvari, 1995). This is obtained by designing the optimal income tax subject to a set of three moral hazard constraints. The first two require that both the low-skilled agents and the high-skilled agents are at least as well off by earning and reporting the income intended by the planner for them rather than reporting the income intended for them by the planner but at the same time engaging in tax evasion. The last moral hazard constraint requires that high-skilled agents are at least as well off by earning and reporting the income intended by the planner for them rather than reporting the income

intended for the low-skilled and at the same time engaging in tax evasion. As shown by Cremer and Gahvari (1995), at least one of the three moral hazard constraints is binding at an optimum. High-wage persons optimally face a zero marginal tax (are undistorted), as in our model. High-wage reports are never audited. Low- wage reports face random audits and may be fined, imposing a cost of avoidance. Where the standard self-selection is binding the low-skilled type faces a positive marginal tax, as in our model. Moreover, as in the self-selection constraint focused on in our model, at each of the moral hazard constraints the deviating agent has a larger disposable income than the agent he pretends to be for tax purposes. Also, as in our model, the labor supply of a deviating agent can be either larger or smaller than that of the agent he pretends to be for tax purposes. In particular, the labor supply of a deviating agent will be larger at the first two moral hazard constraints described above (since the deviating and the mimicked agents have the same skill but the former evades while the latter doesn't), whereas it may be either larger or smaller at the third moral hazard constraint described above (since the deviating agent is a high-skilled whereas the mimicked is a low-skilled).

III. AVOIDANCE EFFECTS OF PUBLIC PROVISION SCHEMES

The distortion introduced by the positive marginal tax on type-1 agents in the optimal taxation solution implies that they both avoid taxes and work too little. Since we study a public provision scheme which is Pareto-improving, and in that sense makes the allocation less distorted, it may be tempting to believe that both distortions are mitigated and that tax avoidance unambiguously decreases when the nonlinear income tax is supplemented with public provision. However, this is not always true. In this section we shed light on this issue by considering two different public provision schemes.

The simplest case to consider is the no upper bound system. Blomquist *et al.* (2010) analyse this system in detail and show that, under this provision scheme, the cost of providing the public good should be mirrored in the marginal tax. For the high-skilled type the marginal

tax is zero at the pure tax optimum. Thus, when the public provision scheme is introduced, the marginal tax increases from zero to a positive number and tax avoidance unequivocally increases. This follows from the condition that at a utility maximum the marginal concealment cost associated with tax avoidance should be equal to the marginal tax (see eq. (5)). For the low-skilled type there are two influences on the marginal tax; it rises because the cost of the publicly provided good is mirrored in the marginal tax, while a second influence is that the distortionary part of the marginal tax decreases. The net effect on the *marginal* tax is ambiguous, and hence the impact on tax avoidance for the low-skilled type is ambiguous too.

Now consider a topping-up scheme and assume that, as in Section 2, the government's problem is to maximize the utility of low-skilled agents subject to a self-selection constraint, a public budget constraint and a constraint specifying a pre-set utility level for high-skilled agents. As above, the avoidance level is positively associated with the marginal tax rate (through eq. (5)). The crucial question is then how the marginal tax rate, as implicitly defined by eq. (3), is affected by the public provision. We first note that for an agent topping up, the public provision is just like a lump sum gift, and the relevant disposable income will now include the market value of the transfer in kind, and be defined as $\tilde{B} = B + p\bar{x}_1$. As long as an agent tops up we can express the indirect utility function as $V(M, \tilde{\mathrm{B}})$, and the indifference map associated with this function will be identical to the one associated with the indirect utility function $V(M, B)$ in the pure tax optimum. However, this will no longer be the case where agents are no-reselling constrained and forced to overconsume commodity 1, even though eq. (3) still applies. When the publicly provided good is complementary to labor supply, the agents will accept a smaller compensation in terms of disposable income to be willing to increase their labor supply. This means that, for a given value of $\tilde{B}$, the indifference curves get flatter, implying a larger marginal tax rate according to eq. (3). It is conceivable that this effect will be the prevailing one even when public provision enables the

government to increase the utility of low-skilled agents by offering them a bundle with higher $\tilde{B}$ and M. Then the effect of public provision is to enhance the amount of income concealed by the low-skilled agents.[19]

The important lesson that can be drawn from the analysis of this Section is that, from a welfarist standpoint, it would be misleading to gauge the desirability of public provision based on its effect on tax avoidance. The key aspect is whether or not mimicking can be made less attractive by using a public provision scheme. If this is the case, public provision represents a Pareto-improving device even though it may lead to an increase in the level of tax avoidance.[20]

IV. HETEROGENEOUS CONCEALMENT COSTS

Assuming that everybody has the same avoidance technology is clearly restrictive. However, a full-fledged discussion of the case where agents with the same skill in the labour market may have different avoidance technology, and, accordingly, different concealment cost,

[19] The analytical details are provided in the Appendix. Notice also that, in a two-type model with redistribution from the high- to the low-skilled agents, the high-skilled agents face a zero marginal tax rate both under a pure income tax optimum and under an optimum where the income tax is supplemented with a topping-up provision scheme. Thus, in both cases they truthfully report their income to the tax authority. For this reason, we can confine our attention to the effects of public provision on the avoidance choice of the low-skilled agents.

[20] This result is different than Kopczuk's (2001) finding that avoidance may be welfare-improving because it may serve as a cheaper, though still wasteful, instrument of redistribution. Kopczuk's finding is based on a model where the government can affect how easy is for people to misreport earned income for tax purposes and where private agents differ both in terms of labor productivity and either opportunities for evasion or attitudes towards paying taxes. His result highlights the fact that avoidance may serve to redistribute income even though further redistribution by standard (tax) instruments is inefficient due to incentive constraints. Our result, instead, points to the fact that supplementing an optimal nonlinear income tax with other standard policy instruments may be welfare-enhancing even in cases when, by doing so, the overall level of income tax evasion is driven up.

would require an extensive analysis. As a compromise, we shall only briefly consider some features of the heterogeneous case. Expressing the concealment cost as $\gamma g(a)$, the difference can be modelled as different values of γ, say $\gamma = 1$ versus $\gamma < 1$, where the latter reflects the more efficient concealment technology. A stricter distinction would be to assume that one type cannot at all avoid (having prohibitively large concealment cost) and are non-avoiders, while the other type can, and are avoiders. As either alternative will convey the same basic insights we will for simplicity refer to avoiders and non-avoiders without necessarily having in mind the stricter case.

Assume first that only high-skilled people have different concealment costs. In the *M,B*-space they will have indifference curves that have slope one and coincide at a point where no avoidance takes place (the marginal tax is zero). For all other *M,B*-combinations the indifference curve of the avoider will be located beneath that of the non-avoider as a lower formal after-tax income *B* is needed to achieve the same utility level since the avoider also has some unreported income. Hence the point where the curves coincide is a tangency point. In the *laissez-faire* market allocation, low-skilled agents are worse off, the usual case for transfers is valid, and a self-selection constraint must hold. The standard no distortion at the top implies that both high-skilled types are undistorted, not avoiding and equally well off. To deter mimicking, the high-skilled avoider must be no worse off than if mimicking the low-skilled. The high-skilled non-evader would then be strictly worse off mimicking, as, having no unreported income, he would be even worse off than the mimicking avoider. For simplicity assuming that the low-skilled is an avoider we have exactly the same kind of self-selection constraint as in the homogenous case above and the same discussion will be relevant.

Now consider a setting with an avoiding high-skilled type, an avoiding low-skilled type and a non-avoiding low-skilled type. Since inability to avoid makes an agent worse off there would be a case for a transfer from the avoiding to the non-avoiding low-skilled type.

However, we can show that only pooling of the two types is feasible. To show that, we start out by assuming there is a separating allocation. Denote by (M^n, B^n) and (M^a, B^a) the income bundles of the non-avoider and the avoider, respectively. The transfer to the non-avoider implies that his tax payment is smaller, i.e. $M^n - B^n = T^n < T^a = M^a - B^a$. With obvious meaning, we briefly refer to the respective types as *a* and *n*, respectively. Now consider *a*'s indifference curve through (M^a, B^a) and imagine a movement along this indifference curve towards the *M,B*-line, called ℓ, where $M - B = T^n$, and where the bundle (M^n, B^n) must be located. This will obviously be a movement to the left since $T^n < T^a$. The bundle (M^n, B^n) must then be located (weakly) below the point of intersection between ℓ and *a*'s indifference curve through (M^a, B^a) since by assumption the latter bundle is preferred to (M^n, B^n) by *a*. Type *n*'s indifference curve through (M^a, B^a) is flatter than that of *a* and hence will be located above the latter when moving to the left from (M^a, B^a). This means that the point of intersection just discussed will be located strictly below *n*'s indifference curve through (M^a, B^a) and therefore *n* will prefer (M^a, B^a). It follows that a separating allocation is not feasible. There will be pooling of *a* and *n*.

Let us just confine attention to a topping up public provision scheme of a good that is complementary to labour. It is easy to realise that this would favour the low-skilled avoiders more than the low-skilled non-avoiders since they are pooled together, but the avoiders supply more labour. This feature of the public provision scheme is unattractive. To assess the effect of the provision scheme on the self-selection constraint, two cases need to be distinguished. Where the high-skilled agents do not have avoidance opportunities, the provision scheme softens the self-selection constraint. This occurs because a mimicker is forced to pay for more than the publicly provided good that he consumes. However, where the high-skilled agents have avoidance opportunities, it is conceivable that the ability of this type of provision

scheme to relax the self-selection constraint is being eroded since high-skilled mimickers may not be working less than the low-skilled agents. Indeed, if they work strictly longer hours, this particular public provision scheme will tighten rather than soften the self-selection constraint with detrimental effects on welfare.

V. CONCLUDING REMARKS

In this paper we have investigated how tax avoidance affects the desirability to use public provision of private goods as a redistributive device in optimal nonlinear income tax models.

A first result of our analysis is that income tax avoidance implies that non-separability between labor and other goods is neither a necessary nor a sufficient condition to make public provision of private goods a welfare-enhancing policy instrument. In particular, an opting-out provision scheme can be welfare-enhancing, if the publicly provided good is a normal good, even when preferences are separable between labor and other goods.

A second result is that income misreporting tends to make opting-out provision schemes welfare-superior to topping-up schemes. Given that the empirical evidence indicates that tax dodging opportunities depend on features of a country's economic structure such as the extent to which earned income is subject to information reporting from third parties and the average size of firms (see, e.g., Kleven *et al.* (2009) and Kleven *et al.* (2011)), a potential policy implication of our analysis is that topping-up public provision schemes have a better chance of being welfare-enhancing in countries where the share of self-employed is relatively small and the average size of firms is relatively big.

Finally, we have investigated how public provision interacts with the agents' incentives to misreport income and we have emphasized that public provision may be welfare-enhancing even in cases when it leads to an increase in income misreporting.

A last point which is worth mentioning is that the circumstances that the disposable income of a mimicker is larger than that of the agent being mimicked and that his labor supply may exceed that of the agent being mimicked have not only important implications for the optimal design of public provision schemes but also for the design of an optimal commodity tax structure. In fact, one of the main results of the literature on optimal commodity taxation in the presence of a nonlinear income tax is that, for mimicking-deterring reasons, the goods that are complements with leisure ought to be taxed relatively more than the goods that are complements with labor.[21] This is because a mimicker, working less than the type that he mimics, tends to spend more on goods which are complements with leisure. However, when labor income cannot be perfectly and costlessly monitored by the tax authority, abiding by this rule is no longer necessarily optimal.

APPENDIX

Proof of Lemma 1

Consider the problem of a *k*-type individual choosing x_1^k and x_2^k to maximize $u\left(x_1^k, x_2^k, \left(M^k + a\right)/w^k\right)$ subject to the budget constraint $px_1^k + x_2^k = B^k + a - g\left(a\right)$ and conditional on a given value for a. This optimization problem yields $x_i^k = x_i\left(B^k, M^k, w^k; a\right)$ with *i=1,2*. This allows, through the composite commodity theorem, to define a conditional utility function in the (*B,M*)-space:

$$v\left(B, M, w^k; a\right) \equiv u\left(x_1\left(B^k, M^k, w^k; a\right), x_2\left(B^k, M^k, w^k; a\right), \left(M^k + a\right)/w^k\right).$$

Next define the (conditional) marginal rate of substitution between net-of-tax reported income and before-tax reported income for an agent of type *k* as:

[21] For a recent example of this kind of result, see Kaplow (2010).

$$MRS_{BM}\left(B^k, M^k, w^k; a\right) \equiv -\frac{\partial v\left(B^k, M^k, w^k; a\right)/\partial M^k}{\partial v\left(B^k, M^k, w^k; a\right)/\partial B^k} =$$

$$= -\frac{1}{w^k}\frac{\partial u\left(x_1\left(B^k, M^k, w^k; a\right), x_2\left(B^k, M^k, w^k; a\right), \left(M^k + a\right)/w^k\right)/\partial h^k}{\partial u\left(x_1\left(B^k, M^k, w^k; a\right), x_2\left(B^k, M^k, w^k; a\right), \left(M^k + a\right)/w^k\right)/\partial x_2^k}.$$

Observe that normality of x_1 and x_2 also implies normality of B^k which in turn implies that $MRS_{BM}\left(B^k, M^k, w^k; a\right)$ is increasing in *a*. This happens both because an increase in *a*, for given M^k and w^k, implies a higher labor supply, and because it implies a larger disposable income $B^k + a - g(a)$. Finally, from (2), $MRS_{BM}\left(B^k, M^k, w^k; a\right) = 1 - g'(a)$. Hence, a low-skilled agent, when faced with $\left(B^1, M^1\right)$, chooses *a* to satisfy

$$MRS_{BM}\left(B^1, M^1, w^1; a\right) = 1 - g'(a). \qquad \text{(a1)}$$

On the other hand, a high-skilled mimicker chooses *a* such that

$$MRS_{BM}\left(B^1, M^1, w^2; a\right) = 1 - g'(a). \qquad \text{(a2)}$$

Denote the solution to (a1) by a^1 and the solution to (a2) by $\hat{a}$. It follows from (a1)-(a2) that

$$MRS_{BM}\left(B^1, M^1, w^1; a^1\right) + g'\left(a^1\right) = MRS_{BM}\left(B^1, M^1, w^2; \hat{a}\right) + g'\left(\hat{a}\right). \qquad \text{(a3)}$$

At the same time we also have that, for a given value of *a*, $MRS_{BM}\left(B^1, M^1, w^1; a\right) > MRS_{BM}\left(B^1, M^1, w^2; a\right)$; or, choosing $a = a^1$,

$$MRS_{BM}\left(B^1, M^1, w^1; a^1\right) + g'\left(a^1\right) > MRS_{BM}\left(B^1, M^1, w^2; a^1\right) + g'\left(a^1\right). \qquad \text{(a4)}$$

Substituting from (a3) for the left hand side of (a4),

$$MRS_{BM}\left(B^1, M^1, w^2; \hat{a}\right) + g'\left(\hat{a}\right) > MRS_{BM}\left(B^1, M^1, w^2; a^1\right) + g'\left(a^1\right).$$

Now, with $MRS_{BM}\left(B^k, M^k, w^k; a\right)$ increasing in *a* as shown earlier, and $g'(a)$ increasing in *a* due to convexity of $g(a)$, it follows from the above inequality that $\hat{a} > a^1$.

Appendix to Section 3

Consider first the topping-up regime where only type-1 agents top up whereas type-2 agents are no-reselling constrained so that their consumption bundle is distorted as a result of the transfer in kind. To offset this inefficiency and keep type-2 agents at the pre-set utility level, their net-of-transfer tax burden must be lowered and, accordingly, that on type-1 agents will have to be increased (relative to the levels prevailing at a pure income tax optimum). Considering the changes $d\tilde{B}^1$ and dM^1, a larger net-of-transfer tax burden on type-1 agents means:

$$dM^1 - d\tilde{B}^1 > 0. \qquad \text{(a5)}$$

As we are interested in the case where public provision is desirable because it makes type-1 agents better off, we have for these increments that

$$dV^1 = V^1_{\tilde{B}}\left(d\tilde{B}^1 - \frac{-V^1_M}{V^1_{\tilde{B}}} dM^1 \right) > 0, \qquad \text{(a6)}$$

where subscripts denote partial derivatives. This is equivalent to:

$$d\tilde{B}^1 - \frac{-V^1_M}{V^1_{\tilde{B}}} dM^1 > 0. \qquad \text{(a7)}$$

Using (a5) and (a7) implies

$$\left(1 - \frac{-V^1_M}{V^1_{\tilde{B}}} \right) dM^1 > 0, \qquad \text{(a8)}$$

and, with low-skilled agents facing a positive marginal tax, $\frac{-V^1_M}{V^1_{\tilde{B}}} < 1$, it follows that $dM^1 > 0$ and $d\tilde{B}^1 > 0$.

Now define $v^1 = v^1(Y^1 - (M^1 - \tilde{B}^1) - g(Y^1 - M^1), Y^1) \equiv v^1(C^1, Y^1)$ as the maximal value function obtained by maximising $u(x^1_1, x^1_2, Y^1)$ subject to $px^1_1 + x^1_2 = C^1$ and subject to the constraint $x^1_1 - \overline{x}_1 \geq 0$. Relating to our previous notation, $C^1 = Z^1 + p\overline{x}_1$. Assume for simplicity that the wage rate of low-skilled agents is equal to one, so that the argument Y^l becomes a measure of the labour supply of a low-skilled agent.

Differentiating with respect to Y^l, we get the first order condition for an agent's optimisation:

$$(v^1)' = -v_C^1(-\frac{v_Y^1}{v_C^1} - (1 - g'(a^1))) = 0.$$

The equation above is equivalent to

$$-v_C^1(m^1 - (1 - g'(a^1)) = 0, \qquad \text{(a9)}$$

where $m^1 = m^1\left(C^1, Y^1\right) = -\frac{v_Y^1}{v_C^1}$, i.e. the compensation required to be willing to increase labour supply in order to earn an extra unit of (gross) income. We note that $m^1 = (1 - g'(a^1))$. Standard normality assumptions imply that $m_C^1 > 0$ and $m_Y^1 > 0$, where subscripts denote partial derivatives.

The second order condition of the optimisation problem is

$$(v^1)'' = -v_C^1(m^1 m_C^1 + m_Y^1 + g''(a^1)) < 0. \qquad \text{(a10)}$$

Doing comparative statics, we find:

$$Y_{\tilde{B}}^1 = \frac{v_C^1 m_C^1}{(v^1)''} < 0. \qquad \text{(a11)}$$

Combining (a10) and (a11) gives:

$$Y_{\tilde{B}}^1 = -\frac{m_C^1}{m^1 m_C^1 + m_Y^1 + g''(a^1)}. \qquad \text{(a12)}$$

$$Y_M^1 = -\frac{v_C^1}{(v^1)''}(m_C^1(1 - g'(a^1)) + g''(a^1)) = \frac{m_C^1 m^1 + g''(a^1)}{m_C^1 m^1 + g''(a^1) + m_Y^1}. \qquad \text{(a13)}$$

From (a13) we get:

$$Y_M^1 - 1 = \frac{m_C^1 m^1 + g''(a^1)}{m_C^1 m^1 + g''(a^1) + m_Y^1} - \frac{m_C^1 m^1 + g''(a^1) + m_Y^1}{m_C^1 m^1 + g''(a^1) + m_Y^1} = \frac{-m_Y^1}{m_C^1 m^1 + g''(a^1) + m_Y^1}. \qquad \text{(a14)}$$

Then consider the following expression for the change in avoidance by a low-skilled agent:

$$da^1 = d(Y^1 - M^1) = dY^1 - dM^1 = (Y_M^1 - 1)dM^1 + Y_{\tilde{B}}^1 d\tilde{B}^1. \qquad \text{(a15)}$$

Substituting from (a12) and (a14), we get:

$$da^1 = \frac{-m_Y^1}{m_C^1 m^1 + g''(a^1) + m_Y^1} dM^1 + \frac{-m_C^1}{m_C^1 m^1 + g''(a^1) + m_Y^1} d\tilde{B}^1 < 0 . \qquad \text{(a16)}$$

Now consider the topping-up regime where type-1 agents are no-reselling constrained whereas type-2 agents are topping up. Then the net-of-transfer tax burden on type-2 agents is unaffected; the higher transfer (in kind) due to public provision is exactly offset by a higher gross tax payment. With an unchanged government's net tax revenue requirement, the net tax liability of type-1 agents will remain unchanged too, i.e. $M^1 - \tilde{B}^1 = k$, where k is a positive constant.

With public provision and a binding no-reselling constraint, $x_1 \geq \overline{x}_1$, we can write the utility of a low-skilled agent as:

$u^1(\overline{x}_1, Y^1 - k - p\overline{x}_1 - g(Y^1 - M^1), Y^1)$.

With public provision being desirable because it enhances the utility of type-1 agents, differentiation yields $du^1 = u_2^1 \left(\frac{u_1^1}{u_2^1} - p + g'(a^1) dM^1 \right) > 0$, where $d\overline{x}_1 = 1$. Since the no-reselling constraint implies that $\frac{u_1^1}{u_2^1} < p$, an increase in utility requires that $dM^1 > 0$. To find how Y^l is affected we derive the first order condition for the optimal choice of Y^l. For this purpose, define $m^1 = m^1\left(\overline{x}_1, x_2^1, Y^1\right) = m^1\left(\overline{x}_1, Y^1 - k - p\overline{x}_1 - g(Y^1 - M^1), Y^1\right) = \frac{-u_Y^1}{u_2^1}$, where, as above, subscripts denote partial derivatives. We find:

$\left(u^1\right)' = -u_2^1\left(m^1 - \left(1 - g'(a^1)\right)\right) = 0$,

and the second order condition:

$$(u^1)'' = -u_2^1 (m_2^1 (1 - g'(a^1)) + m_Y^1 + g''(a^1)) < 0 . \qquad \text{(a17)}$$

Doing comparative statics, we can derive the effects of increasing the public provision. First, notice that we have:

$$dY^1 = \frac{u_2^1(m_1^1 d\bar{x}_1 - pm_2^1 d\bar{x}_1 + m_2^1 g'(a^1)dM^1 - g''(a^1)dM^1)}{(u^1)''}$$

$$= \frac{u_2^1(-m_1^1 d\bar{x}_1 + pm_2^1 d\bar{x}_1 - g'(a^1)m_2^1 dM^1 + g''(a^1)dM^1)}{u_2^1(m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1))}$$

which simplifies to:

$$dY^1 = \frac{-m_1^1 d\bar{x}_1 + pm_2^1 d\bar{x}_1 - g'(a^1)m_2^1 dM^1 + g''(a^1)dM^1}{m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1)}.$$

We can then proceed to calculate the effect on evasion by the low-skilled as follows:

$$da^1 = dY^1 - dM^1 = \frac{-m_1^1 d\bar{x}_1 + pm_2^1 d\bar{x}_1 - g'(a^1)m_2^1 dM^1 + g''(a^1)dM^1}{m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1)} - dM^1$$

$$= \frac{-m_1^1 d\bar{x}_1 + pm_2^1 d\bar{x}_1 - g'(a^1)m_2^1 dM^1 + g''(a^1)dM^1}{m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1)} - \frac{m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1)}{m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1)} dM^1, \quad \text{(a18)}$$

implying:

$$da^1 = \frac{-m_1^1 d\bar{x}_1 + pm_2^1 d\bar{x}_1 - m_2^1 dM^1 - m_Y^1 dM^1}{m_2^1(1-g'(a^1)) + m_Y^1 + g''(a^1)}. \quad \text{(a19)}$$

Consider the case where the direct effect of public provision is to stimulate labour supply by reducing the marginal work compensation required, while an increase in other consumption raises the required marginal compensation, i.e. $m_1 < 0$ and $m_2 > 0$. Then, the denominator of the term on the right hand side of (a19) is positive whereas, given that $dM^1 > 0$, the third and the fourth term at the numerator are negative. However, the first term at the numerator is positive, and, overall, it is conceivable that the effect is large enough to make public provision drive up tax evasion when type-1 agents are no-reselling constrained.

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