Relative Consumption, Optimal Taxation and Public Provision of Private Goods.

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Abstract

This paper shows that public provision of private goods may be justified on pure efficiency grounds in an environment where individuals have relative consumption concerns. By providing private goods, governments directly intervene in the consumption structure, thereby having an instrument to correct for the excessive consumption of positional goods. We identify sufficient conditions where public provision of private goods is always part of the optimal policy mix, even when consumption taxes are available. In fact, with public provision of private goods, there are cases where the first-best allocation can be achieved, and (linear) consumption taxes can be redundant.

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1 Introduction

In most countries a significant share of the government budget is devoted to the provision of *private* goods such as health care, child care, education or care of the elderly. Typically, government-provided goods are made available to citizens free of charge or at subsidized prices. Given that these goods are also available on private markets, publicly providing them seems to be puzzling: replacing public provision by equivalent cash payments should increase welfare, since then people can choose their consumption bundles freely. This raises the question as to whether public provision of private goods can be justified on normative grounds.

In recent years, a growing literature has shown that public provision of private goods can be a welfare-enhancing in a setting where governments pursue redistributive goals: when income-generating characteristics are not observable, constraining consumer choices via public provision can make mimicking low-ability types less attractive, thus increasing government's potential to redistribute resources from the rich to the poor (see, e.g., Boadway and Marchand, 1995; Blomquist et al., 2010).

In this paper, we propose an alternative explanation for public provision. Abstaining from redistributive motives, we argue that publicly providing private goods can be desirable on pure efficiency grounds. In fact, the reasoning that public provision is inefficient assumes that consumer choices are solely driven by material self-interest. However, people seem to care not only about the intrinsic benefits derived from consumption of goods and services but also about how their own consumption compares to that of others (Veblen, 1899; Frank, 1985a). As argued by (Frank, 1985b) and meanwhile supported by large empirical evidence (see, e.g., Johansson-Stenman et al., 2002; Alpizar et al., 2005), these relative consumption comparisons are not equally important for all kinds of goods, meaning that some goods are more "positional" than others. For example, goods like cars, TV's or clothes are often more important for social comparisons than food, health care or care of the elderly. If this is the case, individual consumption choices are distorted towards the consumption of the more positional goods and exert negative externalities (social harms) on other individuals (Ireland, 1994). This generates scope for public provision of private goods like health care, care of the elderly or food to be desirable: Though these goods are rather non-positional themselves (Solnick and Hemenway, 2005), by providing them, the government intervenes in the composition of the individuals' consumption bundles, thereby (indirectly) being able to correct for the excessive consumption of positional goods.

In the present paper, we formalize this idea. We show that public provision of private goods can be efficiency enhancing when individuals have preferences over relative consumption – even when an optimal tax system is in place. Moreover, we identify sufficient conditions on status preferences such that public provision is always part of the optimal policy mix.

We consider a simple model with two types of individuals who differ in their exogenous incomes. There are two private goods. For simplicity, one good is completely non-positional, while the other is positional. In the latter case, individuals' satisfaction not only depends on the amount consumed but also on how one's own consumption compares to some reference level, which may differ between individuals. To be general enough, we allow the individual reference levels to be a general function of the consumption of the two income types. This formulation encompasses average consumption as a special case, but can also distinguish between upward-, downward-, or within-group comparisons.

The government seeks to implement Pareto efficient allocations by (potentially) using three policy instruments: a consumption tax on the positional good, lump-sum income taxes and public provision of the non-positional good. We assume that the publicly provided level is the same for both types and can be supplemented/topped up via private market purchases.

Our results are as follows. If consumption taxes are not feasible, we show that public provision of the non-positional good is unambiguously Pareto improving if at least one income type in the economy compares his consumption level with that of low-income people, i.e. if the marginal social "damage" of positional good consumption of low income types is positive. This holds for many commonly used specifications of reference levels including average, within-group or downward comparisons. To get an intuition, assume that the provision level is set equal to the amount low income types would buy in the laissez faire, and financed via a reduction in their net incomes. Now, marginally increasing the provision level leaves the private utility of both income types constant at the laissez faire level. The reason is that low-income type's marginal rate of substitution between the two goods equals the price ratio, while the same is true for high income individuals since they top-up the publicly provided good with private purchases such that they can still reach their laissez faire consumption bundle. However, by marginally increasing the level of the non-positional good, low-income individuals are now forced to consume slightly *less* of the positional good, which in turn reduces the social harm from relative consumption if at least one income type feels in positional competition with the poor.

A positive marginal social "damage" of low income individuals is only a sufficient, but not a necessary condition for public provision to be efficiency enhancing. For example, when people are only concerned with the consumption of those above them in the income hierarchy (upward comparisons), the marginal social "damage" of low income types is zero. Even in this case, we show that public provision can be Pareto improving if relative comparisons are sufficiently strong.

One might object that this result is driven by an arbitrary restriction on the set of available tax instruments. Clearly, if personalized consumption taxes were feasible nothing can be gained by public provision, since then, externalities can be fully internalized. However, personalized consumption taxes are typically not feasible such that the government is restricted to use linear consumption taxes (see, e.g., Micheletto, 2008). For this case, we show that there is still scope for public provision of private goods to be efficiency enhancing. A sufficient condition for this is that the marginal social "damage" of positional consumption is larger for poorer than for richer income types. This, e.g., occurs when poorer individual types have sufficiently strong in-group identity and/or the rich have sufficiently strong motives to separate from the poor. When public provision and consumption taxation are combined in an adequate manner, the first best allocation can be achieved, which is not possible if one uses linear consumption taxes alone. Beyond that, there are even cases where public provision strictly dominates the taxation of positional goods.

We extend this basic framework in several directions. When not allowing individuals to top up public provision with private purchases (opting out system), public provision of non-positional goods can still be welfare-enhancing, though the dependency of reference consumption on low-income individual's consumption as a sufficient condition for public provision is no longer valid – at least in the perhaps less plausible scenario when the rich are also attracted by the public system. In this case, stronger conditions must be imposed in order for public provision to be welfare enhancing. The same applies to the scenario where governments are allowed to provide the *positional* good, which is perhaps the relevant case for goods like education (Frank, 1985b).

Finally, we compare topping-up and opting-out public provision schemes. The relative merits of one system over the other crucially depend on whether the good publicly provided is positional or not. If it is non-positional, a topping-up system weakly Pareto-dominates an opting-out system, while the reverse holds if the good is positional. In this case, only an opting-out system can be beneficial. Thus, in designing appropriate provision schemes for private goods like education or health are, information about the importance of these goods for social comparisons is needed.

Our paper is related to a recent strand in the public economics literature analyzing the implication of relative consumption (or income) preferences for various optimal public policy issues, such income income tax policy (Boskin and Sheshinski, 1978; Blomquist, 1993; Ireland, 2001), commodity taxation (Micheletto, 2008; Eckerstorfer and Wendner, 2013), public good provision (Ng, 1987; Wendner and Goulder; 2007; Aronsson and Johansson-Stenman, 2008) and social insurance (Abel, 2005). However, none of these papers adresses the question as to whether publicly providing private goods can be used to correct for inefficiencies due to status seek. To the to best of our knowledge, the only paper that adresses private good provision under status concerns is Ireland (1994). Using a signaling approach, he shows that in-kind benefits may help to reduce inefficiencies from overconsumption of conspicuous goods, which are consumed to pretend high wealth or social status. While he provides quasi-linear examples, our approach applies uses more general preferences. Moreover, he does not allow for the taxation of the conspicuous good. Third, his analysis does not distinguish between different types of public provision systems but only considers the topping-up case. Finally, our results directly translate to other motives of social comparisons, e.g., envy or relative deprivation (see below).

The paper proceeds as follows. Section 2 sets out the model framework. Section 3 deals with the desirability of public provision of the non-positional good, both in a topping-up and opting-out system. Section 4 considers public provision of positional goods, whereas Section 5 makes a system comparison between topping-up and opting-out. Section 6 concludes.

2 Model Framework

Consider an economy with two types of individuals $i = 1, 2$ who differ in their exogenous incomes y^i, where $y^2 > y^1$. The number of each type is n^i.[1] There are two private goods which are available on private markets. Individuals enjoy both goods *per se*, i.e. they derive utility from the absolute consumption of these goods. In addition, they care about *relative* consumption, i.e. how much they consume compared to others. It has been argued that relative comparisons may not be equally important for all kinds of goods, meaning that some goods are more "positional" than others (see Alpizar et al. 2005; Solnick and Hemenway, 2005). As a matter of simplification, we assume that only one of the goods is positional, while the other is non-positional. Let c denote the positional, and x the

[1]The restriction to a two-type model is only for simplicity. Our results also apply to a model with more than two types.

non-positional good. Both goods are normal and their producer prices are normalized to one.

Preferences of income-type i are represented by the utility function

$$u^i(c^i, x^i, \Delta^i), \tag{1}$$

which is increasing in each argument, twice continuously differentiable and strictly quasi-concave. In (1), Δ^i represents the perceived relative position of an individual. We define Δ^i in terms of an individual's distance of his/her own consumption to that of some reference level, which we allow to differ across individuals. Specifically, we assume that

$$\Delta^i := \Delta^i(c^i, h^i),$$

$$\text{with} \quad \frac{\partial \Delta^i}{\partial c^i} \geq 0, \quad \frac{\partial \Delta^i}{\partial h^i} < 0. \tag{2}$$

By this formulation, we capture two most common forms of relative consumption comparisons, namely difference comparisons, $c_i - h_i$, and ratio comparisons, c_i/h_i.[2] There may be several reasons of *why* individuals care about relativity.[3] In fact, our modeling is compatible with a variety of motives involving social comparisons. E.g., it may capture a desire to display wealth or some other unobservable status-bearing object (assuming that high relative consumption signals a superior position on the underlying status scale). Since subjects' utility is decreasing in the reference consumption level (which might be simply the consumption of the other type), our formulation also may encompass elements of jealousy, envy or relative deprivation.[4] As common in the literature on relative consumption, we assume that consumption variables directly enter utility, without presupposing one or another candidate motive. What is important to our analysis is the hypothesis that an individual suffers utility losses when others' consumption levels rise, because his relative consumption declines.

An individual's reference consumption is assumed to be a function of the consumption

[2]For a discussion of modeling relative consumption concerns, see, e.g., Aronsson and Johansson-Stenmann (2012) and the references cited therein.

[3]See, e.g., Hopkins and Kornienko (2004) or Bilancini and Boncinelli (2012).

[4]For a signaling interpretation of relativity concerns, see, e.g., Arrow and Dasgupta (2009). An envy interpretation is referred to in, e.g., Dupor and Liu (2003); Alvarez-Cuadrado (2007).

choices of the two income types, i.e. $h^i := h^i(c^1, c^2)$, whereas

$$\frac{\partial h^i}{\partial c^i} \geq 0, \quad \frac{\partial h^i}{\partial c^j} \geq 0 \quad \text{for} \quad i \neq j.$$

This formulation is flexible enough to include the average consumption as a reference point (which is often used in the literature), but also allows different individuals to have different reference groups. E.g., $h^1 = h^1(c^2)$ would imply that low-income individuals compare their consumption levels only with those of high-income households (upward comparisons), whereas $h^1 = h^1(c^1, c^2)$ also contains within-group comparisons of low-income individuals. In contrast, $h^2 = h^2(c^1)$ would entail pure downward consumption comparisons of high-income types, i.e. the rich's primary social aspect of consumption behaviour is to separate from the poor.

With relative preferences over good c, individuals' consumption choices impact on the well being of others via the reference levels. However, when choosing their preferred level of good c on private markets, individuals ignore this effect but only take account of the private benefits. Hence, their choice of c exerts externalities on others, and laissez faire allocations are typically inefficient. This generates scope for beneficial government intervention.

Our focus is on whether the public provision of private goods can be part of an efficient policy mix that attempts to mitigate the inefficiencies stemming from the excessive consumption of positional goods. A public provision system can be organized in different ways. Following earlier literature we focus on two polar cases. In the first, individuals can top-up the public provision level via private market purchases, while in the other, such private supplements are not feasible: individuals either have to accept the publicly provided level or, if they want to consume larger amounts of the good, have to forego the publicly provided quantity entirely and buy the good on private markets. Public provision is financed out of general tax revenues. The government levies (lump-sum) income taxes $T(y^i)$, such that individuals net incomes are $b^i = y^i - T(y^i)$. In addition, it may use a linear per-unit tax on good c.

3 Public Provision of the Non-Positional Good

In reality, many of the private goods that governments supply are rather non-positional, in the sense that they are less effective in social competition compared to smart phones, jewelry and cars. This may apply for goods like health care, care for the elderly or food.

We start by asking whether the public provision of these goods can be justified on pure efficiency grounds when people have relative preferences over some other positional good.

3.1 Topping-up system

Consider the case where governments can provide the non-positional good x via a topping-up system. Let g denote the publicly provided amount of good x which individuals can supplement with private purchases, z^i. The total consumption of good x is then $x^i = g + z^i$. We require $z^i \geq 0$, meaning that public provision levels cannot be resold.[5]

3.1.1 Consumption choices

Given a set of policy instruments, individuals decide how to spend their net income b^i on the consumption of the two goods. We assume that individuals behave atomistically in the sense that they consider their contribution to the reference level h^i as negligible. Hence, when making private consumption choices they take their reference level as exogenously given. Each individual solves

$$\max_{c^i, z^i} \quad u^i(c^i, g + z^i, \Delta^i(c^i, h^i)) \quad \text{s.t.} \quad p_c \cdot c^i + z^i = b^i \quad \text{and} \quad z^i \geq 0. \tag{3}$$

Substituting the budget constraint into the utility function, this is equivalent to

$$\max_{z^i} \quad u^i\left(\frac{1}{p_c}(b^i - z^i), g + z^i, \Delta^i\left(\frac{1}{p_c}(b^i - z^i), h^i\right)\right) \quad \text{s.t.} \quad z^i \geq 0. \tag{4}$$

The Kuhn-Tucker first-order conditions for this problem are

$$-\frac{1}{p_c}\left(u_c^i + u_\Delta^i \cdot \frac{\partial \Delta^i}{\partial c^i}\right) + u_x^i \leq 0 \quad ; \quad z^i \cdot \left[-\frac{1}{p_c}\left(u_c^i + u_\Delta^i \cdot \frac{\partial \Delta^i}{\partial c^i}\right) + u_x^i\right] = 0. \tag{5}$$

If $z^i > 0$, this yields individual demand functions $c_s^i = c_s^i(b^i, p_c, g)$ and $z_s^i = z_s^i(b^i, p_c, g)$. In the Appendix, we show that the comparative statics of z_s^i and c_s^i with respect to b^i and g are given by

$$1 > \frac{\partial z_s^i}{\partial b^i} > 0, \quad \frac{\partial z_s^i}{\partial g} = \frac{\partial z_s^i}{\partial b^i} - 1 < 0, \tag{6}$$

$$\frac{\partial c_s^i}{\partial b} = \frac{1}{p_c}(1 - \frac{\partial z_s^i}{\partial b^i}) > 0, \quad \frac{\partial c_s^i}{\partial g} = -\frac{1}{p_c}\frac{\partial z_s^i}{\partial g} > 0. \tag{7}$$

[5] This assumption is standard in the literature on the public provision of private goods. For a discussion, see Blomquist and Christiansen (1995).

To interpret (6), note that when private supplements are positive, expanding the public provision level has two effects on z^i. On the one hand, a higher g raises an individuals purchasing power, such that the demand for good x increases. This also leads to a higher demand for supplements (recall that $x^i = g + z^i$) and is captured by the first term in $\partial z_s^i/\partial g$. However, there is a counteracting effect, since – holding purchasing power constant– the individual substitutes z^i for g on a one-to-one basis. This effect outweighs the first given that both goods are normal, i.e. $\partial z_s^i/\partial b^i < 1$. Thus, increases in g crowd out private purchases of x. The sign of (7) follows by applying analogous arguments. (6) and (7) only apply for $z^i > 0$, however. If g is sufficiently large, a corner solution will arise, where private purchases x are zero. This is shown in

Lemma 1 *For an individual with net income b^i, there exist levels $\bar{g}^i$ of public provision such that for $g \geq \bar{g}^i$, private supplements are fully crowded out, i.e. $z^i = 0$. Since $y^1 < y^2$, we have $\bar{g}^1 < \bar{g}^2$.*

Proof: The proof is the same as in Epple and Romano (1996). •

If $g \geq \bar{g}^i$, demands are given by $z^i = 0$ and $c^i = b^i/p_c$ and public provision of the amount g is *not* cash equivalent to the individual: given the value of g in cash, it would buy less of the good if it were to spend the amount $b^i + g$ on private markets. To summarize, we have

$$c^i(b^i, p_c, g) = \begin{cases} c_s^i(b^i, p_c, g), & \text{if } g < \bar{g}^i, \\ b^i/p_c & \text{otherwise.} \end{cases} \qquad z^i(b^i, p_c, g) = \begin{cases} z_s^i(b^i, p_c, g), & \text{if } g < \bar{g}^i, \\ 0 & \text{otherwise.} \end{cases}$$

Given these demand functions, indirect utility is

$$U^i := u^i(c^i(b^i, p_c, g), g + z^i(b^i, p_c, g), \Delta^i(c^i(b^i, p_c, g), h^i(c^1(b^1, p_c, g), c^2(b^2, p_c, g))). \tag{8}$$

3.1.2 The government's problem

The government seeks to implement Pareto efficient policies by maximizing the indirect utility of income type 1 individuals, given that utilities of type 2 do not fall below a predefined level $\bar{U}$ and the government budget is balanced. The optimization problem of the government is[6]

$$\max_{b^1,b^2,t,g} \quad U^1 \quad \text{s.t.} \tag{9}$$

$$U^2 \geq \bar{U},$$

$$n^1(y^1 - b^1 + t \cdot c^1) + n^2(y^2 - b^2 + t \cdot c^2) - (n^1 + n^2)g \geq 0.$$

The Lagrangian is

$$L = U^1 + \mu(U^2 - \bar{U}) + \lambda(n^1(y^1 - b^1 + t \cdot c^1) + n^2(y^2 - b^2 + t \cdot c^2) - (n^1 + n^2)g).$$

We provide the first-order conditions with respect to b^1, b^2, t and g in the Appendix. The question is whether the public provision of the non-positional good x can be an appropriate instrument to mitigate the externalities caused by the consumption of the positional good. We consider different scenarios depending on which policy instruments are available to the government.

3.1.3 Scenario I: no consumption taxes available

First, consider the case without consumption taxes, $t = 0$. This may be relevant in situations where taxation of positional goods is not feasible due to administrative or political economy reasons (see, e.g., Ireland, 1998, 2001; Hopkins and Kornienko, 2004). To study whether public provision of g is desirable for efficiency reasons, set the first-order conditions with respect to b^1 and b^2 equal to zero and substitute them into $\partial L/\partial g$, the derivative of the Lagrangian with respect to g. This gives

$$\begin{aligned} \frac{\partial L}{\partial g} = &\left(-\frac{1}{p_c}\left(u_c^1 + u_\Delta^1 \cdot \frac{\partial \Delta^1}{\partial c^1}\right) + u_x^1\right) + \mu\left(-\frac{1}{p_c}\left(u_c^2 + u_\Delta^2 \cdot \frac{\partial \Delta^2}{\partial c^2}\right) + u_x^2\right) \\ &+ \left(\frac{\partial c^1}{\partial g} - \frac{\partial c^1}{\partial b^1}\right) n^1\Omega^1 + \left(\frac{\partial c^2}{\partial g} - \frac{\partial c^2}{\partial b^2}\right) n^2\Omega^2, \end{aligned} \tag{10}$$

[6] Actually, the government chooses the income tax schedule $T(y^i)$. In our model with exogenous incomes, this can be stated as if the government directly chooses individuals' net incomes.

where

$$\Omega^1 = \tfrac{1}{n^1}\left(u^1_\Delta \tfrac{\partial \Delta^1}{\partial h^1}\tfrac{\partial h^1}{\partial c^1} + \mu u^2_\Delta \tfrac{\partial \Delta^2}{\partial h^2}\tfrac{\partial h^2}{\partial c^1}\right) \leq 0, \tag{11}$$

$$\Omega^2 = \tfrac{1}{n^2}\left(u^1_\Delta \tfrac{\partial \Delta^1}{\partial h^1}\tfrac{\partial h^1}{\partial c^2} + \mu u^2_\Delta \tfrac{\partial \Delta^2}{\partial h^2}\tfrac{\partial h^2}{\partial c^2}\right) \leq 0. \tag{12}$$

By the envelope theorem, (10) gives the change of the objective function when the public provision level is marginally increased and financed through a reduction in individual net incomes. Therefore, public provision is Pareto improving for given g if (10) is positive in sign. The first two terms in (10) show the impact of increased public provision on private utility for given reference levels. To interpret terms 3 and 4, notice that the expressions in brackets represent the compensated change in consumption of good c when the public provision level is increased but net income adjusted to finance the higher g. Ω^1 and Ω^2 indicate the marginal social "damage" resulting from the last unit of the consumption of good c of income types 1 and 2, respectively. These appear since private consumption choices have an impact on (other) individuals' reference levels, which in turn affects their relative positions. Together, terms 3 and 4 measure the "social" valuation of changed consumption of the positional good, caused by an increase in the public provision level.

Using (10) and Lemma 1, we can derive a necessary condition for public provision to be part of an effcient policy

Lemma 2 *If the optimal public provision level g^* is positive, we have that $g > \hat{g}^1$, such that $z^1_s = 0$.*

Proof: Consider a situation where $g = 0$ and both income types consume strictly positive amounts of good x. Then, marginal increases in g have no effect: the first two terms in (10) vanish by the first-order conditions (5). The same holds for terms 3 and 4, since, by (6) and (7):

$$\left(\frac{\partial c^i}{\partial g} - \frac{\partial c^i}{\partial b^i}\right) = -\frac{1}{p_c}\frac{\partial z^i_s}{\partial g} - \frac{1}{p_c}\left(1 - \frac{\partial z^i_s}{\partial b^i}\right) = -\frac{1}{p_c}\left(\frac{\partial z^i_s}{\partial b^i} - 1\right) - \frac{1}{p_c} + \frac{1}{p_c}\frac{\partial z^i_s}{\partial b^i} = 0.$$

Hence, if $z^i > 0$ for $i = 1, 2$, we have $\frac{\partial L}{\partial g} = 0$. Since $\bar{g}^1 < \bar{g}^2$, this holds for all $g \in [0, \bar{g}^1)$. As a consequence, for $\frac{\partial L}{\partial g} > 0$, which is a necessary condition for g^* to be positive, $g \geq \hat{g}^1$.
•

Thus, for public provision to have any beneficial effects, at least income type 1 must be constraint in his consumption choice. The intuition is that when both income types supplement, i.e. $z^i > 0$, marginal increases in g leave the consumption bundles of both types unchanged compared to the laissez faire situation: individuals simply take the additional publicly provided unit and reduce their private supplements z^i by an equal amount. As a result, private utilities remain constant for given reference consumption levels h^i. The second implication of c and x staying constant is that the negative externalities imposed by the two individuals are unaffected by public provision.

Setting $g > \bar{g}^i$ has opposing effects on individuals' utility. One the one hand, there is a negative impact on private utility since individuals are forced to "overconsume" good x. In (10), this is reflected by the first and second term which are then negative by (5). On the other hand, public provision now has positive efficiency effects. If private supplements are zero, individuals spend their entire net income on good c. Here, increases in g financed by higher income taxes reduce the consumption of the positional good. This mitigates the negative externality due to excessive consumption from status seeking. These effciency gains from reduced positional good consumption are given by the term 3 and 4 in (10).

Generally, in an optimum the efficiency losses from constraining individual choices have to be weighted against the efficiency gains from reduced consumption of positional goods. While the above considerations make clear that, in an optimum with positive public provision, at least one individual must be constrained, Proposition 1 sets out a sufficient condition for public provision to be always part of the optimal policy mix.

Proposition 1 *If consumption taxes are not feasible* ($t = 0$)*, a sufficient condition for public provision to be part of the optimal policy mix is that relative preference are such that* $\frac{\partial h^1}{\partial c^1} \geq 0$ *or* $\frac{\partial h^2}{\partial c^1} \geq 0$ *with one inequality strict.*

Proof: From the proof of Lemma 1 we know that $\frac{\partial L}{\partial g} = 0$ for all $g \in [0, \bar{g}^1)$. Assume that the provision level is $g = \bar{g}^1$. Here, public provision is cash-equivalent for individuals of type 1: they would buy exactly $\bar{g}^1$ units of good x if net income were $b^i + g$. At $g = \bar{g}^1$, their marignal willingness to pay is equal to the price ratio. Thus, the first term in (10) vanishes. The second and fourth terms are zero since, using that $\bar{g}^1 < \bar{g}^2$, $z^2 > 0$. Hence, (10) becomes

$$\frac{\partial L}{\partial g} = -\frac{1}{p_c} \cdot \Omega^1 \tag{13}$$

at $g = \bar{g}^1$. Consequently, if $\Omega^1 < 0$, we have $\frac{\partial L}{\partial g}$. This is satisfied if $\frac{\partial h^1}{\partial c^1} > 0$ or $\frac{\partial h^2}{\partial c^1} > 0$. Thus, setting g at a level slightly above $\bar{g}^1$ yields a higher value of the Lagrangian compared to the laissez faire situation which proves the proposition. •

According to Proposition 1, constraining the consumption choices of type 1 individuals at $g = \bar{g}^1 < \bar{g}^2$ is desirable from an efficiency perspective – provided that the reference level of at least one income type depends on c^1.[7] This dependence is a rather weak assumption about individual's relative preferences. It means that lower-income types must have at least some degree of within-group comparisons, or that high-income households value to some extent a consumptive segregation from the poor. Moreover, no information about the intensity or strength of relative concerns is needed, a positive derivative suffices.

Notice that $\Omega^1 < 0$ is a sufficient, but not a necessary condition for public provision to be Pareto-superior to the laissez faire case. Suppose this condition is violated such that L is decreasing in g in the interval $g \in (\bar{g}^1, \bar{g}^2)$. However, at $g = \bar{g}^2$ a positive effect kicks in since type 2 individuals get just crowded out, having ceteris paribus positive welfare effects as long as $\Omega^2 < 0$. This would, e.g., hold under pure upward-comparisons of the poor or within-group comparisons of the rich, since then, $\frac{\partial h^1}{\partial c^2} \geq 0$ or $\frac{\partial h^2}{\partial c^2} \geq 0$ with one inequality strict. If the resulting efficiency gain is sufficiently strong, $\frac{\partial L}{\partial g}$ may increase in some interval above $g = \bar{g}^2$ such that setting g above $g = \bar{g}^2$ might be Pareto-superior to the laissez faire case.

That this is not entirely implausible is shown by means of the following example where we enforce $\Omega^1 = 0$ and $\Omega^2 < 0$ by imposing upward comparisons of the poor.

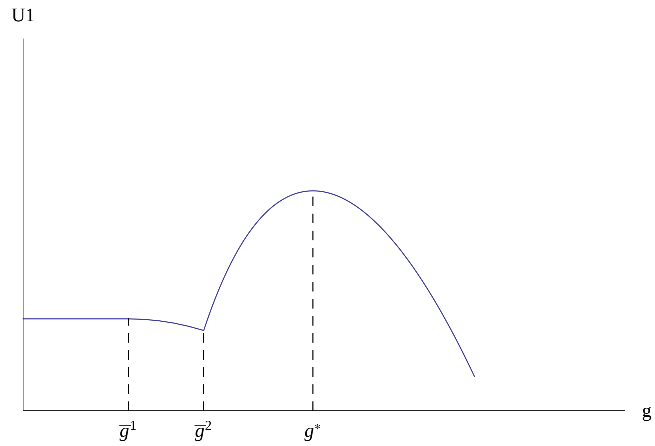
Example 1: Assume that preferences are represented by $u^i(c^i, x^i) = c^i \cdot x^i + \beta(c^i - h^i)$, where $h^1 = (c^2)^2$ and $h^2 = 0$. Set parameters $\beta = 3$, $n^1 = n^2 = 1$, $y^1 = 10$, and $y^2 = 15$. As can be seen from Figure (1), there is an inner maximum, denoted by g^*, of the Lagrangian beyond $g = \bar{g}^2$ where the target value is higher than at $g = 0$.

3.1.4 Scenario II: consumption taxes feasible

One might object that the welfare-enhancing role of public provision is driven by an unrealistic assumption on available policy instruments. Indeed, the "principle of targeting" known from the literature on consumption externalities states that the inefficiencies stemming from excessive consumption of positional goods are best addressed by taxing the externality-generating good directly (see, e.g., Dixit, 1985). In this section, we therefore analyze whether public provision of private goods can be beneficial even if taxing good c is possible. We consider linear consumption taxes, the common scenario in the literature on optimal mixed taxation even under externalities (see, e.g., Cremer et al., 1998). The

[7] Below, we discuss cases where this assumption is met and where it is not.

Figure 1: Upward comparisons



reason for restricting ourselves to this scenario is that personalized consumption taxes could principally fully internalize the externality from relative consumption, but these policy instruments would require that the government has access to information about each individual's personal consumption levels, which seems rather demanding. With linear consumption taxes only aggregate transactions have to be observable, which we think to be the natural case.

We can state

Proposition 2 *When linear taxation of the positional good is feasible.*

(i) a necessary condition for public provision of the non-positional good to be efficiency-enhancing is that relative preferences are such that $\Omega^1 \neq \Omega^2$*;*

(ii) a sufficient condition is that $\Omega^1 < \Omega^2$*.*

Proof: See Appendix. •

To interpret the proposition, recall that Ω^1 and Ω^2 indicate the marginal social "damage" resulting from the last unit of the consumption of good c of income types 1 and 2, respectively. If the marginal social damage is identical for both income types, i.e. $\Omega^1 = \Omega^2$, public provision cannot complement an otherwise optimal tax system. In this case, a linear (Pigouvian) tax on good c is sufficient to internalize the external effects stemming from the consumption of positional goods. Conversely, as long as $\Omega^1 \neq \Omega^2$, a uniform tax on good c cannot perfectly internalize consumption externalities, opening the door for public provision as an efficiency-enhancing device.

To understand item (*ii*) of Proposition (2), note that there must be sufficiently high efficiency gains from public provision at the point where type 1 is just crowded out since only then g is set slightly above that point ($g = \bar{g}^1$). The efficiency gains from public provision are proportional to Ω^1. Without taxation there are no efficiency losses from public provision at $g = \bar{g}^1$, since only non-distortive income taxes are adjusted. Now, when commodity taxes are allowed and set at positive levels, there are also social losses from public provision since dampening the consumption of the positional good shrinks the tax base. These costs only depend on Ω^2 at $g = \bar{g}^1$.[8] The reason is that individual 1's substitution effect for good c is zero since he just begins to spend his whole income on that good. Thus, public provision is beneficial at $\bar{g}^1$ if $|\Omega^1|$ is sufficiently large compared to $|\Omega^2|$.

From the definitions of Ω^1 and Ω^2, it is clear that the specification of the reference level, i.e. the function $h^i(c^1, c^2)$ plays a crucial role in whether public provision should supplement an otherwise optimal tax system. In fact, there is only one class of relative preferences when there is no room for public provision, namely when every individual takes the average consumption as a reference point which is perhaps a rather special case. Thus, for a wide range of relative preferences, public provision can be Pareto-improving, which may perhaps may explain why there is public provision of non-positional goods in reality. The sufficient condition in Proposition (2) says that public provision is always part of the optimal policy mix if individuals have sufficient degrees of downward comparisons or the poor show sufficiently high in-group orientation.[9] This is not an unrealistic scenario. For example, many psychological studies find that people have strong tendencies to refer downward, i.e. to compare their own consumption to that of those behind them in the income hierarchy (see, e.g., Falk and Knell, 2004, and the references therein).[10] Likewise, the importance of in-group comparisons is one of the basic assumptions of every identity theory, recently found entrance into economics (Akerlof and Kranton, 2000).

The case that $\Omega^1 < \Omega^2$ deserves further interest. Under relative preferences meeting this assumption, we can show that with public provision of the non-positional good the first best allocation can be achieved.

Proposition 3 *If $\Omega^1 < \Omega^2$ and linear taxation of the positional good is feasible, then public provision of the non-positional good achieves the first best allocation as long as the*

[8]Formally, from equation (26) and (27) in the Appendix, it follows that the net gain from g boils down to $\frac{\partial L}{\partial g} = -\frac{1}{p_c}\, n_1(\Omega^1 + \lambda t)$ at $g = \bar{g}^1$ with $\lambda t = \Omega^2$ representing the marginal costs of public provision.

[9]In that sense, Proposition (2) is just a qualification of Proposition (1).

[10]Self-enhancement theory agues that downward-comparisons are a relatively costless strategy to increase self-esteem (see, e.g., Wood and Taylor, 1991).

crowding out level of high-income types is sufficiently high.

Proof: Denote the first-best consumption levels of goods c and x of the two types by x_*^1, c_*^1, x_*^2 and c_*^2, respectively. Let $x^1(y^1, p_c)$, $c^1(y^1, p_c)$, $x^2(y^2, p_c)$ and $c^2(y^2, p_c)$ denote the laissez faire demands when the price is $p_c = 1 + t$. The linear income tax rate can always be set at a level such an level that type two individuals will choose their first best bundle. Then $c^2(y^2, p_c) = c_*^2$, but $c^1(y^1, p_c) > c_*^1$ since $\Omega^1 < \Omega^2$. Then the public provision level can be set at $g = x_*^1$ without inducing individual 2 to choose a different consumption level than c_*^2, as long as $g = x_*^1 < \bar{g}^2$.

Using a similar kind of argument, we can show that under relative preferences a consumption tax on good c can be completely redundant:

Corollary 1 *When individuals make pure downward comparisons ($\Omega^2 = 0$), public provision is strictly better than taxation of good c.*

Proof: With downward comparisons, we have $\Omega^2 = 0$. As a consequence, only the consumption decisions of income types 1 exert a negative externality on type 2 individuals, while the reverse does not hold. Thus in first-best allocation, the consumption choice of type 2 must be undistorted. Setting $t = 0$ and $g = x_*^1$, individuals of type 1 are forced to accept the first best consumption bundle. Moreover, since $g < \bar{g}^2$ and individuals are allowed to top-up, type 2 individuals are undistorted in their consumption choice. This allocation is not attainable through a uniform tax on good c, since, then, individuals of type 2 are necessarily distorted. •

3.2 Opting-out system

So far, we considered public provision of non-positional goods in topping-up systems. However, sometimes public provision of private goods is organized via opting out systems, where an uniform level is offered to all individuals free of charge, but cannot be supplemented with private market purchases. Mostly, these systems co-exist with private markets such that individuals can decide whether to take the publicly provided quantity, or to by their desired level on the private sector (see, e.g., Besley and Coate, 1991; Blomquist and Christiansen, 1995). In this section, we analyze whether the welfare enhancing property identified in the previous chapter carries over to this mode of public provision. To do so, we focus on a dual system without consumption taxes. However, the basic insights survive when allowing for (linear) commodity taxation.

Consider the following chronology of events: First, the government chooses incomes taxes and the public provision level. Then, individuals decide whether to consume the non-positional good x in the public system or opt out and buy it on private markets. Solving the model backwards, we start with consumption choices for given policy variables.

For a given set of policy variables, net income $b^i = y^i - T(y^i)$ is fixed. When an individual stays in the public system, her consumes the publicly offered amount g of the non-positional good and spends his entire net income on the consumption of the positional good c. Thus, taking the reference level h^i as given, indirect utility amounts to $U^i_{in} := u^i(b^i/p_c, g, \Delta^i(b^i/p_c, h^i))$. An individual's indirect utility when opting out of the public system is given by $U^i_{out} := u^i(c^i(b^i, p_c), x^i(b^i, p_c), \Delta^i(c^i(b^i, p_c), h^i))$, where $c^i = c^i(b^i, p_c)$ and $x^i = x^i(b^i, p_c)$ are the demand functions.

Individuals opt to consume in the public sector if $U^i_{in} \geq U^i_{out}$. It can be shown that for every income type $i = 1, 2$ there exist a level $\hat{g}^i$ such that the individual is just indifferent between g and opting out. These are determined by

$$u^i(\frac{b^i}{p_c}, \hat{g}^i, \Delta^i(\frac{b^i}{p_c}, h^i)) = u^i(c^i(b^i, p_c), x^i(b^i, p_c), \Delta^i(c^i(b^i, p_c), h^i)). \tag{14}$$

Since in the opting out case individuals must buy the good x on their own, consumption of the positional good is necessarily higher when staying in the public system for given b^i. This implies that $\hat{g}^i < x^i(b^i, p_c)$. By normality, we have $\hat{g}^1 < \hat{g}^2$.

The allocations obtained with public provision have to be compared to those without public provision. The latter are the same as in the laissez faire case, and hence, given by $c^i = c^i(y^i, p_c)$ and $x^i = x^i(y^i, p_c)$ since in our scenario without redistribution motives income taxes are not levied and net incomes are equal to gross incomes when public goods are not provided. The previous analysis has shown that public provision of private goods may serve as a means to distort individuals' consumption choices, thereby reducing the excessive consumption of the positional good. To have any such effect in the opting out case, public provision levels must be higher than $\hat{g}^1$, the level at which income type 1 individuals opt into the public system. However, setting $\hat{g}^1 < g < x^1(y^1, p_c)$ would have only undesirable effects. Individuals who are attracted in the public system would consume even *more* of the positional good c compared to the laissez faire case. Moreover, there are additional inefficiencies since these individuals would not receive their preferred consumption bundles. Thus, only $g \geq x^1(y^1, p_c)$ is a candidate for improving efficiency.

The welfare effects of public provision crucially depend on the behaviour of high-income individuals when the public provision level is $x^1(y^1, p_c)$. In case when high-income individuals opt out at this level, i.e. $x^1(y^1, p_c) < \hat{g}^2$, we are able to derive a sufficient condition for public provision to be Pareto-improving.

Proposition 4 *Assume that $x^1(y^1, p_c) < \hat{g}^2$. Then, public provision is always part of an efficient policy if $\frac{\partial h^1}{\partial c^1} > 0$ or $\frac{\partial h^2}{\partial c^1} > 0$ or both.*

Proof: See Appendix. •

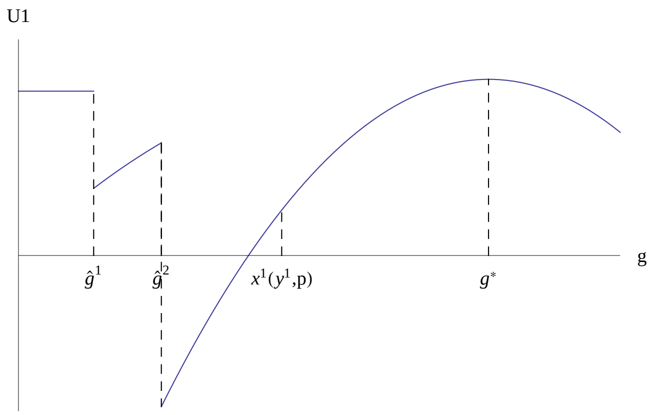
The intuition is similar to the topping-up case: marginally increasing g from $g = x^1(y^1, p_c)$ reduces the positional good consumption of income type 1 while leaving his private utility unaffected, which benefits at least one income type if $\frac{\partial h^1}{\partial c^1} > 0$ and/or $\frac{\partial h^2}{\partial c^1} > 0$.
However, when preferences are such that high-income individuals jump into the public system at or before $g = x^1(y^1, p_c)$, it is not possible to derive a sufficient condition for Public Provision to be efficiency enhancing which relies on the partial derivates of reference levels h^i alone. The reason is that in this case there are additional effects causing a downward shift in individual's 1 utility at $g = x^1(y^1, p_c)$ compared to laissez faire. First, high-income individuals are forced to overconsume the positional good, which is harmful via an increased reference level. Second, since high income type's consumption decision is distorted, more resources are needed to achieve their required utility level.
Nevertheless, public provision *can* achieve Pareto-improvements even in this scenario. This is illustrated by means of

Example 2: Assume that preferences are represented by $u^i(c^i, x^i) = c^i \cdot x^i + \beta(c^i - \bar{c})$, where $\bar{c}$ is the average consumption of the positional good. We set parameters to $\beta = 3$, $n^1 = n^2 = 1$, $y^1 = 10$ and $y^2 = 15$. In Figure (2), we depict utility of type 1 for different values of g, given that income taxes are chosen optimally. As can be seen, there is an inner solution of the public provision level, which yields a higher utility for individual 1 than in the laissez faire case, namely at $g = g^*$. This illustrates that public provision can optimal even when both income types would be attracted by the public system.

4 Public provision of the positional good

In the previous sections the publicly provided goods were *non-positional*. Given recent empirical evidence (see, e.g., Solnick and Hemenway, 2005), this characteristic can be reasonably attributed to goods like health care, day care or care of the elderly. However, in most countries, a large part of the public budget is used for the provision of education,

Figure 2: Pareto Improvement when both types are attracted by public provision.



which seems to be highly positional. In his famous book, Frank (1985b) argues that it is precisely the positional aspects of education that may justify the huge government interventions we observe in the educational sector. In this section we ask whether public provision of the positional good can be an efficiency enhancing policy device.[11]

Denote the public provision level of the positional good c by e. Our benchmark is the situation with no public provision, where individuals' consumption levels are $x^i(y^i, p_c)$ and $c^i(y^i, p_c)$, respectively. Since a reduction in the consumption of positional goods is the rationale for public provision of private goods in our model, a public provision system of a topping-up type *cannot* achieve improvements in efficiency: If the provision level is set at $e < c^i(y^i, p_c)$ and individuals are allowed to top-up, their total consumption of the positional good does not change. For $e > c^i(y^i, p_c)$ public provision would even exacerbate the inefficiencies of the laissez faire since individuals consume *more* of good c. Thus, only an opting-out system may be efficiency enhancing.

The model proceeds as in section 3.2: First, net incomes b^i and the public provision level e are chosen by the government. Given a set of policies, individuals decide whether to take-up the publicly provided level or to buy good c on private markets. As before, we start backwards. If an individual with net income b^i chooses e, indirect utility is $V^i_{in} := u^i(e, b^i, \Delta^i(e, h^i))$, while it amounts to $V^i_{out} := u^i(c^i(b^i, p_c), x^i(b^i, p_c), \Delta^i(c^i(b^i, p_c), h^i))$, when the individual opts out. To have any effect on consumption allocations, e has to be high enough to induce at least one income type to stay in the public system. Thus, public provision must be higher than $\hat{e}^i$, the level where individuals are indifferent between public

[11] Again, we focus our analysis to situations without consumption taxes.

provision and opting out. This level satisfies

$$u^i(\hat{e}^i, b^i, \Delta^i(\hat{e}^i, h^i)) = u^i(c^i(b^i, p_c), x^i(b^i, p_c), \Delta^i(c^i(b^i, p_c), h^i)), \tag{15}$$

where $\hat{e}^1 < \hat{e}^2$. The question is whether public provision of the positional good can be welfare improving when compared to the situation where no public provision is used. Since the provision system is of an opting-out type, one has to distinguish between cases where individuals of type 2 stay in the public system or opt out when the provision level is equal to the laissez faire demand of type 1, i.e. $e = c^1(y^1, p_c)$. First, assume that $c^1(y^1, p_c) < \hat{e}^2$. We can derive

Proposition 5 *Suppose that $c^1(y^1, p_c) < \hat{e}^2$. Then, public provision of the positional good is part of an efficient policy if*

$$\frac{\partial h^1}{\partial c^1} > 0 \quad or \quad \frac{\partial h^2}{\partial c^1} > 0 \quad or\ both. \tag{16}$$

Proof: Assume that $e = c^1(y^1, p_c)$ and $\frac{\partial h^1}{\partial c^1} > 0$ or $\frac{\partial h^2}{\partial c^1} > 0$. Then, individuals of type 1 obtain the same utility as in the laissez faire. Now, marginally reducing e would reduce type 1's consumption of good c, while leaving him otherwise unaffected. Thus, a Pareto improvement can be achieved. •

Again, if high income individuals stay out of the public system, we have a sufficient condition for public provision to be a component of an efficient policy. However, if both individuals are attracted to use public provision at $e = c^1(y^1, p_c)$, additional efficiency effects emerge: One the one hand, high income type now consume less of the positional good, but at the same time, they are constrained in their consumption choice. The latter effect may be strong enough so that individuals of type 1 are worse off at $e = c^1(y^1, p_c)$ compared to the laissez faire. Consequently, it is not possible to derive sufficient conditions which only exploit the properties of the reference function $h^i(c^1, c^2)$. For public provision to be efficiency enhancing, the positive effects of reducing positional good consumption have to outweigh the efficiency losses from constraining individual choices.

5 Choice of Systems: Opting-out or topping-up?

In the preceeding sections, we established conditions under which public provision of private goods can be part of an effcient policy – both for a topping-up and an opting-out system. We can now compare the two systems. It turns out that the relative merits of one system over another crucially depend on whether the good publicly provided is positional or not.

Proposition 6 *Assume that public provision is part of an optimal policy mix.*

(i) If the good is non-positional, a topping-up system (at least weakly) Pareto-dominates an opting out system.

(ii) If the good is positional, an opting out system strictly Pareto-dominates a topping-up system.

Proof: To prove item (i), consider a Pareto optimal allocation in an opting-out system where individuals of type 1 stay in the public sector and those of type 2 opt out. Formally, we have $g^* < \hat{g}^2$. From the above arguments we know that in such an optimum, type 1 individuals overconsume good x, in the sense that they would choose less of it if they receive an equivalent cash transfer. Therefore, offering those individuals the opportunity to top-up has no effect, since they would not use this option. Now, if individuals of type 2 were able to supplement, they would choose the publicly provided amount and top it up via private market purchases. This would increase public expenditures since more people use public provision. However, these additional expenditures can be financed through increased income taxes (or reduced net incomes) of type 2 individuals. Given that, in this case, public provision and private market purchases are perfect substitutes, such a policy reform would leave these individuals equally well-off. Now, consider the case where type two individuals are also in the public system, i.e. $\hat{g}^2 < g^*$. Then, offering them the opportunity to top-up can only increase efficiency: if it is optimal to set $g^* > x^2(y^2, p_c)$, both income types would not want to supplement. However, the analysis above has shown that it may be optimal to set $g^* < x^2(y^2, p_c)$. Here, high income individuals will top-up and thus buy more of the non-positional good, which benefits both individuals via a lower reference level. Moreover, they have more freedom in choosing their preferred consumption bundle. Thus, a topping-up system at least weakly Pareto dominates the opting out system. The proof of item (ii) directly follows from the arguments provided in section 4. •

6 Conclusion

In this paper we provide reasons for the public provision of private goods which purely rest on efficiency grounds. When individuals have relative consumption concerns, public provision may serve as an instrument to reduce inefficiencies stemming from an overconsumption of positional goods. Depending on the specification of individuals reference levels this holds even if an otherwise optimal tax system is available. Moreover, the relative merits of alternative public provision system depend on whether the good publicly provided is positional or not. In the first case, an opting-out system is unambiguously Pareto-superior to a topping-up system, while the reverse holds if the publicly provided good is non-positional.

Appendix

Comparative statics of (6) and (7).

Implicitly differentiating (5) with respect to b^i and g, we obtain:

$$\frac{\partial z^i}{\partial b^i} = \frac{\frac{1}{p_c}\left(u^i_{cc}+u^i_{c\Delta}\frac{\partial \Delta^i}{\partial c^i}+\frac{\partial \Delta^i}{\partial c^i}\left(u^i_{c\Delta}+u^i_{\Delta\Delta}\frac{\partial \Delta^i}{\partial c^i}\right)+u^i_{\Delta}\frac{\partial^2 \Delta^i}{\partial (c^i)^2}\right)-u^i_{x\Delta}\frac{\partial \Delta^i}{\partial c^i}-u^i_{xc}}{D} > 0 \tag{17}$$

$$\frac{\partial z^i}{\partial g} = \frac{u^i_{xc}+u^i_{x\Delta}\frac{\partial \Delta^i}{\partial c^i}-u^i_{xx}}{D} = \frac{\partial z^i}{\partial b^i} - 1 < 0, \tag{18}$$

where

$$\begin{aligned} D = {} & \frac{1}{p_c}\left(u^i_{cc}+u^i_{c\Delta}\frac{\partial \Delta^i}{\partial c^i}+\frac{\partial \Delta^i}{\partial c^i}\left(u^i_{c\Delta}+u^i_{\Delta\Delta}\frac{\partial \Delta^i}{\partial c^i}\right)+u^i_{\Delta}\frac{\partial^2 \Delta^i}{\partial (c^i)^2}\right) \\ & - 2u^i_{xc} - 2u^i_{x\Delta}\frac{\partial \Delta^i}{\partial c^i} + p_c u^i_{xx}. \end{aligned} \tag{19}$$

First-order conditions of Problem (9).

$$\begin{aligned} \frac{\partial L}{\partial b^1} = {} & \frac{1}{p_c}\left(u^1_c + u^1_{\Delta}\frac{\partial \Delta^1}{\partial c^1}\right) + u^1_{\Delta}\frac{\partial \Delta^1}{\partial h^1}\frac{\partial h^1}{\partial c^1}\frac{\partial c^1}{\partial b^1} + \mu u^2_{\Delta}\frac{\partial \Delta^2}{\partial h^2}\frac{\partial h^2}{\partial c^1}\frac{\partial c^1}{\partial b^1} \\ & + \lambda n^1\left(-1 + t\frac{\partial c^1}{\partial b^1}\right), \end{aligned} \tag{20}$$

$$
\begin{aligned}
\frac{\partial L}{\partial b^2} &= u_\Delta^1 \frac{\partial \Delta^1}{\partial h^1}\frac{\partial h^1}{\partial c^2}\frac{\partial c^2}{\partial b^2} + \mu\left[\frac{1}{p_c}\left(u_c^2 + u_\Delta^2 \frac{\partial \Delta^2}{\partial c^2}\right) + u_\Delta^2 \frac{\partial \Delta^2}{\partial h^2}\frac{\partial h^2}{\partial c^2}\frac{\partial c^2}{\partial b^2}\right] \\
&\quad + \lambda n^2\left(-1 + t\frac{\partial c^2}{\partial b^2}\right),
\end{aligned}
\tag{21}
$$

$$
\begin{aligned}
\frac{\partial L}{\partial t} &= -\frac{1}{p_c}\left(u_c^1 + u_\Delta^1 \frac{\partial \Delta^1}{\partial c^1}\right)\cdot c^1 - \mu\frac{1}{p_c}\left(u_c^2 + u_\Delta^2\frac{\partial \Delta^2}{\partial c^2}\right)\cdot c^2 \\
&\quad + u_\Delta^1\frac{\partial \Delta^1}{\partial h^1}\left(\frac{\partial h^1}{\partial c^1}\frac{\partial c^1}{\partial p_c} + \frac{\partial h^1}{\partial c^2}\frac{\partial c^2}{\partial p_c}\right) + \mu u_\Delta^2 \frac{\partial \Delta^2}{\partial h^2}\left(\frac{\partial h^2}{\partial c^1}\frac{\partial c^1}{\partial p_c} + \frac{\partial h^2}{\partial c^2}\frac{\partial c^2}{\partial p_c}\right) \\
&\quad + \lambda n^1\left(c^1 + t\frac{\partial c^1}{\partial p_c}\right) + \lambda n^2\left(c^2 + t\frac{\partial c^2}{\partial p_c}\right),
\end{aligned}
\tag{22}
$$

$$
\begin{aligned}
\frac{\partial L}{\partial g} &= u_x^1 + \mu u_x^2 + u_\Delta^1\frac{\partial \Delta^1}{\partial h^1}\left(\frac{\partial h^1}{\partial c^1}\frac{\partial c^1}{\partial g} + \frac{\partial h^1}{\partial c^2}\frac{\partial c^2}{\partial g}\right) + \mu u_\Delta^2\frac{\partial \Delta^2}{\partial h^2}\left(\frac{\partial h^2}{\partial c^1}\frac{\partial c^1}{\partial g} + \frac{\partial h^2}{\partial c^2}\frac{\partial c^2}{\partial g}\right) \\
&\quad + \lambda t\left(n^1\frac{\partial c^1}{\partial g} + n^2\frac{\partial c^2}{\partial g}\right) - \lambda n^1 - \lambda n^2.
\end{aligned}
\tag{23}
$$

Proof of Proposition 2.

Setting the first-order conditions (20) and (21) equal to zero and combining them with (22), we get

$$
\frac{\partial L}{\partial t} = \frac{\partial \widetilde{c}^1}{\partial p_c}n^1\Omega^1 + \frac{\partial \widetilde{c}^2}{\partial p_c}n^2\Omega^2 + \lambda\cdot t\left[n^1\frac{\partial \widetilde{c}^1}{\partial p_c} + n^2\frac{\partial \widetilde{c}^2}{\partial p_c}\right],
\tag{24}
$$

where $\frac{\partial \widetilde{c}^1}{\partial p_c}$ is the Hicksian compensated demand given by

$$
\frac{\partial \widetilde{c}^i}{\partial p_c} = \frac{\partial c^i}{\partial p_c} + \frac{\partial c^i}{\partial b^i}\cdot c^i \leq 0.
\tag{25}
$$

Combining the first-order conditions (20) and (21) with (23) gives

$$
\begin{aligned}
\frac{\partial L}{\partial g} &= \left(-\frac{1}{p_c}\left(u_c^1 + u_\Delta^1\cdot\frac{\partial \Delta^1}{\partial c^1}\right) + u_x^1\right) + \mu\left(-\frac{1}{p_c}\left(u_c^2 + u_\Delta^2\cdot\frac{\partial \Delta^2}{\partial c^2}\right) + u_x^2\right) \\
&\quad + \left(\frac{\partial c^1}{\partial g} - \frac{\partial c^1}{\partial b^1}\right)n^1(\Omega^1 + \lambda t) + \left(\frac{\partial c^2}{\partial g} - \frac{\partial c^2}{\partial b^2}\right)n^2(\Omega^2 + \lambda t).
\end{aligned}
\tag{26}
$$

Next, set (24) to zero and solve for t to obtain:

$$
t = -\frac{1}{\lambda}\cdot\frac{\frac{\partial \widetilde{c}^1}{\partial p_c}n^1\Omega^1 + \frac{\partial \widetilde{c}^2}{\partial p_c}n^2\Omega^2}{n^1\frac{\partial \widetilde{c}^1}{\partial p_c} + n^2\frac{\partial \widetilde{c}^2}{\partial p_c}}.
\tag{27}
$$

Plugging (27) in (26) gives the change in the objective function resulting from increased

g given that income and consumption taxes are set optimally:

$$\frac{\partial L}{\partial g} = \left(-\frac{1}{p_c}\left(u_c^1 + u_\Delta^1 \cdot \frac{\partial \Delta^1}{\partial c^1}\right) + u_x^1\right) + \mu\left(-\frac{1}{p_c}\left(u_c^2 + u_\Delta^2 \cdot \frac{\partial \Delta^2}{\partial c^2}\right) + u_x^2\right) + n^1 n^2 \frac{\left(\frac{\partial c^1}{\partial g} - \frac{\partial c^1}{\partial b^1}\right)\frac{\partial \tilde{c}^2}{\partial p_c}(\Omega^1 - \Omega^2) + \left(\frac{\partial c^2}{\partial g} - \frac{\partial c^2}{\partial b^2}\right)\frac{\partial \tilde{c}^1}{\partial p_c}(\Omega^2 - \Omega^1)}{n^1 \frac{\partial \tilde{c}^1}{\partial p_c} + n^2 \frac{\partial \tilde{c}^2}{\partial p_c}}. \tag{28}$$

$\frac{\partial L}{\partial g}$ can only be positive when $\Omega^1 \neq \Omega^2$ which proves item (i) of proposition (2). Individuals of type 1 are firstly crowded and until that level of public provision, $\bar{g}^1$, we have $\frac{\partial L}{\partial g} = 0$. At $\bar{g}^1$, however, (28) becomes

$$\frac{\partial L}{\partial g} = -\frac{1}{p_c} n^1 \left(\Omega^1 - \Omega^2\right) \tag{29}$$

which is greater than zero iff $\Omega^1 < \Omega^2$. •

Proof of Proposition 5.

Assume that $x^1(y^1, p_c) < \hat{g}^2$ such that only individuals of income type 1 consume in the public system. Then, the government's problem is:

$$\max_{b^1, b^2, g} \quad U_{in}^1 \quad \text{s.t.} \tag{30}$$

$$U_{out}^2 \geq \bar{U} \tag{31}$$

$$n^1(y^1 - b^1) + n^2(y^2 - b^2) - n^1 g \geq 0 \tag{32}$$

Define the Lagrangian as

$$L = U_{in}^1 + \mu(U_{out}^2 - \bar{U}) + \lambda(n^1(y^1 - b^1) + n^2(y^2 - b^2) - n^1 g). \tag{33}$$

The first-order conditions are

$$\frac{\partial L}{\partial b^1} = \frac{1}{p_c}\left(\bar{u}_c^1 + \bar{u}_\Delta^1 \frac{\partial \Delta^1}{\partial c^1}\right) + \frac{1}{p_c}\left[\bar{u}_\Delta^1 \frac{\partial \Delta^1}{\partial h^1}\frac{\partial h^1}{\partial c^1} + \mu u_\Delta^2 \frac{\partial \Delta^2}{\partial h^2}\frac{\partial h^2}{\partial c^1}\right] - \lambda n^1 \tag{34}$$

$$\frac{\partial L}{\partial b^2} = \mu \frac{1}{p_c}\left(u_c^2 + u_\Delta^2 \frac{\partial \Delta^2}{\partial c^2}\right) + \mu \left[\bar{u}_\Delta^1 \frac{\partial \Delta^1}{\partial h^1}\frac{\partial h^1}{\partial c^2}\frac{\partial c^2}{\partial b^2} + u_\Delta^2 \frac{\partial \Delta^2}{\partial h^2}\frac{\partial h^2}{\partial c^2}\frac{c^2}{\partial b^2}\right] - \lambda n^2 \tag{35}$$

$$\frac{\partial L}{\partial g} = \bar{u}_x^1 - \lambda n^1 \tag{36}$$

where $\bar{u}_c^i := u_c^i(\frac{b^i}{p_c}, g, \Delta^i(\frac{b^i}{p_c}, h^i))$, $\bar{u}_x^i := u_x^i(\frac{b^i}{p_c}, g, \Delta^i(\frac{b^i}{p_c}, h^i))$ and $\bar{u}_\Delta^i := u_\Delta^i(\frac{b^i}{p_c}, g, \Delta^i(\frac{b^i}{p_c}, h^i))$, respectively.

Setting (34) and (35) equal to zero, combining them with (36) and usind the definition of Ω^1, we get

$$\frac{\partial L}{\partial g} = \left(-\tfrac{1}{p_c}\left(\bar{u}_c^1 + \bar{u}_\Delta^1 \tfrac{\partial \Delta^1}{\partial c^1}\right) + \bar{u}_x^1\right) - \tfrac{1}{p_c} n^1 \Omega^1 \tag{37}$$

Consider $g = x^1(y^1, p_c)$. Here, the first term in (37)is zero. Thus, $\frac{\partial L}{\partial g} > 0$ if $\Omega^1 < 0$, which is the case if $\frac{\partial h^1}{\partial c^1} > 0$ or $\frac{\partial h^2}{\partial c^1} > 0$ (or both) •

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