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A General Equilibrium Approach to the Luxury Tax

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Abstract

Individuals care about appearances and buy luxury goods to signal a social status. A widespread opinion is that the production of conspicuous goods is socially undesirable, because it wastes the resources of the economy to implement a sort of vanity game among individuals. A luxury tax could be designed to direct these resources towards more essential productions.

The goal of the paper is to set a general equilibrium model, where the demand of conspicuous good is properly conceived as a signaling game, to compute an optimal luxury tax.

Keywords: conspicuous consumption, luxury tax.

JEL Classification: D11, D50, H20.

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0.1 Introduction

A shared opinion is that goods endowed with a signaling power about the status of the owner, are socially superfluous if they do not provide a “true” utility, and even damaging, if their production requires a resource destruction. How to model this kind of goods and to reduce their consumption through an optimal tax policy are the goals of the paper.

To be more precise we define a pure conspicuous good as a good which does not provide an intrinsic utility but signals a social rank and provides a reputational pleasure. This paper aims at characterizing the demand of conspicuous good as a signaling equilibrium and at determining general equilibrium prices and demands in a simple economy endowed with a conspicuous and an ordinary good. The general equilibrium impact of a luxury tax is also computed and the relevant optimal fiscal policy is eventually designed.

In the last twenty years various definitions of conspicuous goods have been proposed, all of them stressing an essential signaling role. Frank (1985) investigates positional goods whose value depends on goods owned by others. Bagwell and Bernheim (1992) examine a model of conspicuous consumption in a competitive economy with production. They observe Veblen effects (i.e. where utility is positively related to the price of the good). Within the context of the model an appropriately designed luxury tax on pure profits plays a non-distortional role. Corneo and Jeanne (1997) study an indivisible conspicuous good. In their model consumers purchase a conspicuous good in order to signal high income and thereby achieve greater social status. In equilibrium the signaling value of conspicuous goods depends on the number of consumers: the higher the number, the higher the value for conformist agents, the lower the value is though for snobbish consumers. The demand function for conspicuous good may display a positive slope if consumers are conformist. An unusual taxation of luxuries is also proposed by the authors.

A luxury good is basically a signaling good by definition. For instance since the Renaissance the bourgeois mimicked nobility by purchasing the same status symbols and sometimes reversed the hierarchy of appearances. The equilibrium of reciprocal perceptions and misperceptions can be rather sophisticated. For instance a signaling game may generate conformism due to the adoption of the same behavior by more individuals. For clarity we need a precise definition of conformism. Unfortunately several definitions can be found in the literature, which can be referred to either exogenous or endogenous conformism. To the first class belong more traditional theories

associating a utility loss to an individual deviation from the life-style of his reference group. In particular, as Veblen emphasized in 1899, people are concerned about the amount of leisure they consume and the amount consumed by their peers. This social pressure is explicitly exogenous in Hayakawa and Venieris (1977) where the life-style consists in a reference bundle. In contrast, endogenous conformism is specified in the literature as either bandwagon effects (Leibenstein, 1959), informational cascades (Birkhchandani, Hirshleifer and Welch, 1992) or conformity (Bernheim, 1994). The latter form arises in a signaling strategy whenever different agents conform, i.e. choose the same signal. In our paper by contrast the absence of conformity in conspicuous consumption is highlighted at least in the case of equilibria in pure strategy. From a theoretical point of view our work provides an original definition and an existence proof of the demand of conspicuous good. It shows the procedure to solve for the general equilibrium prices and quantities.

In the first section of the paper we shall treat a pure conspicuous good, i.e. that good which provides some rank utility and no intrinsic utility at all. We shall characterize the demand functions and the signaling equilibrium in pure strategies will be shown to be unique and separating. Under the assumptions of the model the conspicuous good will behave like a normal good with respect to the revenue. General equilibrium prices will be obtained as usual, by aggregating demands across the individuals. In the second section we shall deal with an impure luxury good, which has also an intrinsic utility, and the policy maker will levy an optimal tax on the conspicuous consumption to finance the optimal provision of public good.

1 Pure Conspicuous Consumption

1.1 Demand Functions

There is a continuum of consumers, which is normalized to $[0, 1]$ with a uniform distribution density. They purchase a numeraire n and a pure conspicuous good c , which is merely conspicuous, i.e. it signals the social status but provides no intrinsic utility. Each consumer $r \in [0, 1]$ is endowed with a quantity $e_n(r)$ of the numeraire and a quantity $e_c(r)$ of the conspicuous good; r denotes the social rank. Agents are assumed to infer the individual rank r from the signal of the conspicuous good c with a common probability

measure $\mu(r, c)$. Consumers have the same separable utility

$$u(n) + \int_0^1 v(\rho) \mu(\rho, c) d\rho$$

where $u(n)$ is the utility of the numeraire. To be considered of rank r gives utility $v(r)$ to the consumer. More precisely, the signal c is sent by a consumer who has a reputation utility $\int_0^1 v(\rho) \mu(\rho, c) d\rho$ from the judgement of the others about his rank. Consumers face the budget constraint

$$n + pc \leq e_n(r) + pe_c(r) \quad (1)$$

where the price of the numeraire is normalized to one and p is the price of conspicuous good. We assume that $u' > 0$, $u'' < 0$. By integrating the constraint in the objective the consumer r 's program becomes

$$\max_c u(e_n + pe_c - pc) + \int_0^1 v(\rho) \mu(\rho, c) d\rho$$

The demand correspondence is a signaling equilibrium. Three kinds of Nash equilibria may arise.

(i) An equilibrium in mixed strategies is a pair (c, μ) , where $c = c(r)$ is the correspondence associating to each type r an optimal set $c(r)$ of signals over which the agent r randomizes. This randomization must be consistent with the common prior density $\mu = \mu(\rho, c)$, which associates to each signal c the probability measure that this signal is sent by a type¹ ρ .

(ii) An equilibrium is said to be in pure strategies if and only if each consumer chooses a single signal. This can be interpreted as a degenerate equilibrium in mixed strategies: the correspondence $c(r)$ turns out to be a function.

(iii) An equilibrium in pure strategies is said to be separating if and only if two different agents always choose two different signals. In other words, the function $c(r)$ becomes invertible.

In the next section we prove that a demand of conspicuous goods exists as a signaling equilibrium and is unique almost everywhere.

¹More precisely, agent r randomizes over a set $c(r)$ of optimal signals with probability measure $\pi(c, r) = \mu(r, c) / \int_{\gamma \in c(r)} \mu(r, \gamma) d\gamma$. A Nash equilibrium in mixed strategies exists under the assumptions of the Kakutani's fixed point theorem for correspondences. Possibly there exists a continuum of equilibria (c, μ) in mixed strategies, i.e. a continuum of pairs (π, μ) consistent with the individual maximization.

1.1.1 Existence

We want to show that a demand function exists and, more precisely, that there exists a diffeomorphism $c(r)$, which satisfies the first order conditions of consumer's program.

Proposition 1 *If the intrinsic utility function u and the rank utility function v are smooth, strictly increasing and concave and the endowments $e_n(r)$ and $e_c(r)$ are strictly increasing continuous functions, there exists a separating equilibrium which is smooth, strictly increasing and positive.*

Proof. If the equilibrium is separating, the signal c reveals the type r , i.e. there exists a function $r = c^{-1}(c)$, the consumer's utility is $u(n) + v(c^{-1}(c))$. In this case the agent's program becomes

$$\max_c u(e_n + pe_c - pc) + v(c^{-1}(c))$$

where the constraint is integrated. We are interested in finding an equilibrium $c(r)$, which satisfies the following first order condition

$$pu'(e_n(r) + pe_c(r) - pc(r)) = v'(r) (c^{-1})'(c(r))$$

In other words, we are looking for a function $c = c(r)$ which solves a differential equation. We notice that $(c^{-1})'(c(r)) = 1/c'(r)$. Hence

$$c'(r) = \frac{v'(r)}{pu'(e_n(r) + pe_c(r) - pc(r))} \quad (2)$$

This is a non-autonomous differential equation. Let the right-hand side be equal to

$$f(r, c) \equiv \frac{v'(r)}{pu'(e_n(r) + pe_c(r) - pc)}$$

If u and v are smooth (continuously differentiable) and strictly increasing, then u' and v' are continuous and strictly positive. Continuity of u' , v' , e_n , e_c , and strict positivity of u' imply that $f(r, c)$ is a continuous function over $D \equiv [0, 1] \times [0, \infty)$. Peano's theorem (see among others Kolmogorov and Fomin, 1970, p. 104) ensures that at least an integral curve of the differential equation (2) passes through each point of D . This proves that at least a solution $c = c(r)$ locally exists. Continuity of u' , v' , e_n , e_c , c and strict

positivity of u' imply the continuity of c' in (2). Thus, the equilibrium c is continuously differentiable, i.e. smooth. Strict positivity of u' and v' implies $c' > 0$. A strictly increasing continuous equilibrium is separating. In a separating equilibrium everybody recognizes the poorest agent $r = 0$. Bayesian consistency implies that the latter has no reputation to gain from purchasing the conspicuous good, i.e. $c(0) = 0$. As the equilibrium c is continuous and strictly increasing $c(r)$ is strictly positive for every $r \in (0, 1]$. We have proved that a separating equilibrium exists, is smooth, strictly increasing and positive². ■

A general treatment of the existence of a separating equilibrium under incentive compatibility constraints in signaling games with a continuum of types has been provided by Mailath (1987). This paper gives also a full characterization of the second order conditions for maximization by strengthening the usual quasi-concavity assumption for the utility function.

1.1.2 Uniqueness

For the sake of simplicity we shall focus on the equilibria in pure strategies emerging when each consumer chooses a single signal. The following proposition characterizes these equilibria and shows that there is a unique equilibrium in pure strategies, the separating equilibrium of (2).

Proposition 2 *If the intrinsic utility function u is twice continuously differentiable and strictly increasing, the reputation utility v is smooth and the endowments $e_n(r)$ and $e_c(r)$ are strictly increasing continuous functions, then the equilibrium in pure strategies is unique almost everywhere.*

Proof. See the appendix. ■

If the endowments are strictly increasing in the rank, the conspicuous good is a normal good. To see this, let $e'_n, e'_c > 0$ and $y(r) \equiv e_n(r) + pe_c(r)$

²Proposition 1 still holds with a non-separable utility function $U(n, \rho)$. The consumer's program becomes $\max_{(n,c)} \int_0^1 U(n, \rho) \mu(\rho, c) d\rho$ subject to $n + pc \leq e_n + pe_c$. If U is smooth and strictly increasing in n and r , and e_n and e_c are continuous functions, there exists a separating equilibrium which is smooth, strictly increasing and positive. The separating equilibrium solves the following differential equation:

$$c'(r) = \frac{U_\rho(e_n(r) + pe_c(r) - pc(r))}{pU_n(e_n(r) + pe_c(r) - pc, r)}$$

where $U_n \equiv \partial U / \partial n$, $U_\rho \equiv \partial U / \partial \rho$.

be the revenue. Then

$$\frac{dc}{dy} = \frac{dc}{dr} \frac{dr}{dy} = \frac{c'(r)}{y'(r)} > 0$$

1.2 General Equilibrium

The economy is characterized by two goods and a continuum of agents. The general equilibrium prices and quantities are computed as usual, i.e. by aggregating the demand function over r and setting it equal to aggregate supply. The main corollary of Walras' law holds, i.e. that equilibrium of one market implies equilibrium in the other. We focus on the market for conspicuous goods. The equilibrium price p^* solves the market clearing condition

$$\int_0^1 c(r) dr = \int_0^1 e_c(r) dr$$

where the integral aggregates demands and supplies across types. Substituting the equilibrium price p^* in $c(r)$ and $n(r) = e_n(r) + pe_c(r) - pc(r)$, we obtain the equilibrium quantities $c^*(r)$ and $n^*(r)$. To see more in detail the computations of the demand functions and the general equilibrium a simple example is provided.

Example 1 Fundamentals are specified as follows:

$$u(n) = \ln n, v(r) = r, e_n(r) = r, e_c(r) = r$$

The equilibrium condition (2) becomes

$$c'(r) = \frac{1+p}{p}r - c(r)$$

with the initial condition $c(0) = 0$. There is a unique solution

$$c(r) = \frac{1+p}{p} (e^{-r} + r - 1) \tag{3}$$

Function (3) represents the demand for conspicuous good. In a pure exchange economy the aggregate endowments constitute the aggregate supply:

$$\int_0^1 c(r) dr = \int_0^1 \frac{1+p}{p} (e^{-r} + r - 1) dr = \int_0^1 e_c(r) dr = \int_0^1 r dr$$

The market clearing solution provides the equilibrium price:

$$p^* = \frac{e}{2} - 1 > 0 \quad (4)$$

The equilibrium demand is obtained by substituting the equilibrium price (4) in the demand functions:

$$\begin{aligned} c^*(r) &= \frac{e}{e-2} (e^{-r} + r - 1) \\ n^*(r) &= \frac{e}{2} (1 - e^{-r}) \end{aligned}$$

where equilibrium demand for the public good is obtained from the budget constraint (1). Let r^* be the solution of $e_n(r) = c(r)$, i.e. the agent who consumes exactly his endowments. As shown in the figure, the “poor” ($r < 0.6487$) prefer to consume more of the numeraire and sell a part of their conspicuous good. The “rich” ($r > 0.6487$) sell a part of their numeraire endowment to purchase more of the conspicuous good. This result holds because the numeraire utility u is more concave than the rank utility v .

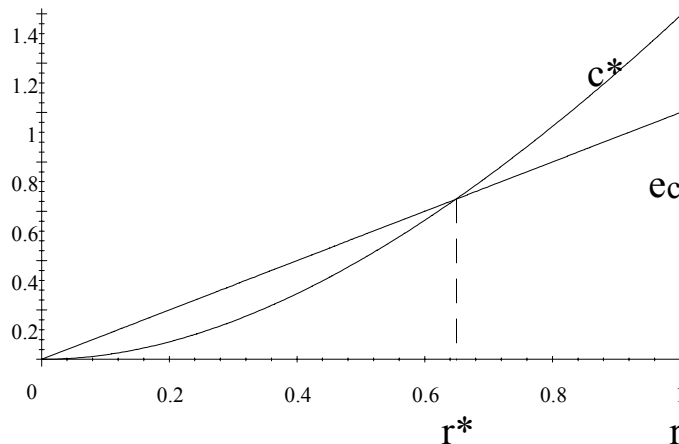


Figure 1. General equilibrium demand.

2 Impure Conspicuous Consumption

The assumption we made in the first part, the existence of a good that is merely conspicuous, is strong enough to justify a natural extension of the

model to take into account an impure conspicuous good. We know from reality that each consumption good has a signaling power and it is informative about the consumer's status. Conversely most conspicuous goods provides also an intrinsic utility and they are not mere signals. Hence a conspicuous good will be said impure if it has a double function. On the one side it signals a status, on the other side satisfies a basic need as well as an ordinary good.

2.1 Signaling Game and General Equilibrium

Now the conspicuous good c provides not only a reputation utility v but also an intrinsic utility u_c . The utility of the ordinary good is denoted by u_n . For the sake of simplicity the separability of the utility function is maintained. Moreover, as above, the intrinsic utility functions u_n, u_c and the rank utility function v are assumed to be smooth, strictly increasing and concave, while the endowments $e_n(r)$ and $e_c(r)$ to be strictly increasing continuous functions.

The consumer objective gets the new shape

$$u_n(n) + u_c(c) + \int_0^1 v(\rho) \mu(\rho, c) d\rho \quad (5)$$

under the budget constraint

$$n + pc \leq e_n + pe_c \quad (6)$$

If an equilibrium demand in pure strategies exists, it is a function $c(r)$. As it is shown in proposition 2 the equilibrium in pure strategies is separating almost everywhere. Therefore if the function $c(r)$ exists, it is invertible and the program (5) becomes

$$\max_c u_n(e_n + pe_c - pc) + u_c(c) + v(c^{-1}(c)) \quad (7)$$

If $c \in C^1$, we obtain

$$c'(r) = \frac{v'(r)}{pu'_n(e_n + pe_c - pc(r)) - u'_c(c(r))} \quad (8)$$

that is a differential equation.

Let $c(r)$ be the solution of (8). If this function is not monotonic, then it does not represent an equilibrium in pure strategies because of proposition

2. If $c(r)$ is decreasing, for individuals of type $r \in [0, 1)$ it is profitable to deviate by purchasing less conspicuous good. Hence the possible demand equilibrium is strictly increasing.

We observe that the differential equation (8) needs an initial condition. If the signaling equilibrium $c(r)$ is strictly increasing, then Bayesian consistency requires that the type $r = 0$ is only interested in the intrinsic utility of the conspicuous good and no longer in the reputation utility. In other words the type $r = 0$ has a reduced program

$$\max_c u_n(e_n + pe_c - pc) + u_c(c) \quad (9)$$

The solution $c(0)$ of this program is the right initial condition for equation (8).

The market clearing provides the general equilibrium price p^* which is computed as follows:

$$\int_0^1 c(r) dr = \int_0^1 e_c(r) dr$$

By substituting p^* in $c(r)$ and $n(r) = e_n + pe_c - pc(r)$ we get the general equilibrium demands.

To check the existence of a general equilibrium compatible with the solution of (8), we must verify that the denominator in the right-hand side of (8) at the equilibrium turns out to be strictly positive. In other terms we must check ex-post a consistency condition:

$$p^* u'_n(e_n + p^* e_c - p^* c^*(r)) - u'_c(c^*(r)) > 0$$

where $c^*(r)$ is the general equilibrium demand specified by p^* .

An example will clarify the procedure.

Example 2 We specify the fundamentals as follows:

$$\begin{aligned} u_n(n) &= an, \quad a > 0 \\ u_c(c) &= bc, \quad b > 0 \\ v(r) &= r^\alpha, \quad 0 < \alpha < 1 \\ e_n(r) &= r \\ e_c(r) &= r \end{aligned} \quad (10)$$

Notice that the marginal intrinsic utility u'_n and u'_c are constant. The strict concavity of the reputation utility v ensures an interior solution. Equation (8) becomes

$$c'(r) = \frac{v'(r)}{pa - b}$$

Integrating both sides, we obtain:

$$c(r) - c(0) = \frac{r^\alpha}{pa - b} \quad (11)$$

The separating equilibrium is strictly increasing. It exists if and only if at the general equilibrium p^* the denominator of the right-hand side of (11) is strictly positive:

$$p^* > b/a \quad (12)$$

If this is the case, type $r = 0$ is not interested in reputation, because he is always recognized to be the poorest. Therefore he maximizes the reduced utility of program (7):

$$an + bc = (-ap + b)c + a(1 + p)r$$

By assumption inequality (12) holds. Then $-ap + b < 0$ and the optimal choice turns out to be the corner solution $c = 0$. Thereby the Bayesian consistency entails that $c(0) = 0$. Eventually we get

$$c(r) = \frac{r^\alpha}{pa - b}$$

The general equilibrium is given by the following aggregation across the types:

$$\int_0^1 c(r) dr = \int_0^1 \frac{r^\alpha}{pa - b} dr = \int_0^1 e_c(r) dr = \int_0^1 r dr$$

Solving for the equilibrium price we obtain:

$$p^* = \frac{b}{a} + \frac{2}{(1 + \alpha)a} > \frac{b}{a} \quad (13)$$

Therefore the consistency condition (12) is satisfied and there exists a separating equilibrium.

The general equilibrium quantities are

$$c^*(r) = \frac{r^\alpha}{p^*a - b} = \frac{1 + \alpha}{2} r^\alpha$$

$$n^*(r) = r + p^*[r - c^*(r)] = r + \left[\frac{b}{a} + \frac{2}{(1 + \alpha)a} \right] \left[r - \frac{1 + \alpha}{2} r^\alpha \right]$$

2.2 Taxing the Conspicuous Consumption

A widespread idea is that the signaling activity is resource-consuming and there is room for a government intervention to drive away the resources destroyed in the production of conspicuous good, towards more useful productions such as a public good provision. To evaluate the impact of a policy design, we consider now a tax on the consumption of conspicuous good to finance a public good³.

We develop here a more general model with impure conspicuous consumption. Both the conspicuous good c and the ordinary good n provides an intrinsic utility, which is respectively said to be u_c and u_n .

In the pure conspicuous good model the optimal tax rate on the conspicuous consumption is always close to 100%. An after-tax arbitrary small aggregate endowment of conspicuous good is enough to implement the signaling game and to rank the individuals.

In the following we find that the purer is the conspicuous consumption and/or the more important is the public good for consumers, the higher the tax must be levied.

Let t be a constant tax rate on conspicuous consumption. The tax tc is paid in real terms, i.e. in terms of conspicuous good by the consumer to the government. The provision of public good is simply obtained by the physical transformation of the tax receipt which enters the production function f as input:

$$G = f\left(t \int_0^1 c(r) dr\right)$$

The consumer's objective (5) is augmented to incorporate the separate utility w of the public good

$$u_n(n) + u_c(c) + \int_0^1 v(\rho) \mu(\rho, c) d\rho + w(G)$$

We notice that G is not a consumers' choice variable, depending only on the fiscal policy.

The budget constraint (6) takes into account the tax:

$$n + p(1 + t)c \leq e_n + pe_c$$

³Various uses of the tax receipts could be designed, such as a redistribution to produce more private good of type n .

We focus on the demand equilibrium in pure strategies. As above we look for a possible choice $c(r)$ which is invertible and solves the new program

$$\max_c u_n(e_n + pe_c - p(1+t)c) + u_c(c) + v(c^{-1}(c)) + w(G)$$

If $c \in C^1$, we have

$$c'(r) = \frac{v'(r)}{p(1+t)u'_n(e_n + pe_c - p(1+t)c(r)) - u'_c(c(r))} \quad (14)$$

Type $r = 0$'s program (9) is now restated. An equilibrium in pure strategies is characterized by

$$c(0) \equiv \arg \max_c u_n(e_n + pe_c - p(1+t)c) + u_c(c)$$

In other words for $r = 0$ reputation does not matter, if $c(r)$ is strictly increasing.

The market clearing takes in account the endowment lack due to the tax.

$$\int_0^1 c(r) dr = \int_0^1 [e_c(r) - tc(r)] dr$$

In words the aggregate demand in the conspicuous good market must equal the aggregate net supply, which is given by the endowments minus the tax⁴.

The equilibrium demands $n^*(r)$, $c^*(r)$ are obtained as usual by substituting the equilibrium prices into the demand functions.

As seen above the solution of the differential equation (14) must be strictly increasing and we must check that at the general equilibrium p^* the denominator is strictly positive:

$$p^*(1+t)u'_n(e_n + p^*e_c - p^*(1+t)c^*(r)) - u'_c(c^*(r)) > 0$$

for every r . Otherwise the equilibrium in pure strategies fails.

We assume that the policy maker has a welfare functional, i.e. a function which maps the entire utility profile of individuals in the real line and provides a global welfare measure.

⁴As Walras' law holds, the equilibrium price p^* clears the numeraire market too:

$$\int_0^1 n(r) dr = \int_0^1 e_n(r) dr$$

In particular we can evaluate the utility of each individual at equilibrium and compute the welfare according to the government's functional. We observe that the public good provides a specific utility at each individual and this effect is also taken in account by the policy maker.

Let W be the equilibrium welfare. Clearly it can be viewed as a reduced function of the tax rate on the conspicuous consumption:

$$W = W(t)$$

The policy maker finally computes the optimal taxation.

$$t^* = \arg \max W(t)$$

The following example will show that this tax is decreasing in the marginal intrinsic utility of the conspicuous good $u'_c(c)$. The less intrinsically useful is the consumption good, the higher the tax is set by the government. To clarify the procedure we introduce a tax in the example 2.

Example 3 The fundamentals are specified as in (10). Equation (14) becomes

$$c'(r) = \frac{v'(r)}{p(1+t)a-b}$$

Integrating both sides, we obtain:

$$c(r) - c(0) = \frac{r^\alpha}{p(1+t)a-b}$$

A separating equilibrium still exists at the general equilibrium if and only if

$$p^* > \frac{b}{(1+t)a} \quad (15)$$

For the type $r = 0$ reputation no longer matters at the signaling equilibrium. Therefore he maximizes the reduced utility

$$an + bc + w(G) = [-ap(1+t) + b]c + a(1+p)r + w(G)$$

For now we assume that the inequality (15) holds. Then $-ap(1+t) + b < 0$ and the optimal choice remains a corner solution: $c(0) = 0$. The demand for conspicuous good is

$$c(r) = \frac{r^\alpha}{p(1+t)a-b}$$

The general equilibrium is given by the aggregation of demands and supplies across the types:

$$\int_0^1 (1+t) c(r) dr = (1+t) \int_0^1 \frac{r^\alpha}{p(1+t)a-b} dr = \int_0^1 e_c(r) dr = \int_0^1 r dr \quad (16)$$

Solving for the equilibrium prices we obtain:

$$p^* = \frac{b}{(1+t)a} + \frac{2}{(1+\alpha)a} > \frac{b}{(1+t)a}$$

which generalizes (13) (by continuity to obtain (13) set $t = 0$). Therefore condition (15) is satisfied and we obtain a separating equilibrium $c(r)$ at the general equilibrium p^* .

The general equilibrium quantities are

$$c^*(r) = \frac{r^\alpha}{p^*(1+t)a-b} = \frac{1}{2} \frac{1+\alpha}{1+t} r^\alpha \quad (17)$$

$$n^*(r) = r + p^*r - p^*(1+t)c^*(r) \quad (18)$$

$$= r + \left[\frac{b}{(1+t)a} + \frac{2}{(1+\alpha)a} \right] \left[r - \frac{1+\alpha}{2} r^\alpha \right] \quad (19)$$

By simplicity the policy maker has a separable welfare functional:

$$W = \int_0^1 U(r) \varphi(r) dr$$

where

$$U(r) \equiv u_n(n(r)) + u_c(c(r)) + \int_0^1 v(\rho) \mu(\rho, c) d\rho + w(G)$$

and $\varphi(r)$ represents the weight the government gives to the agent of type r : $\int_0^1 \varphi(r) dr = 1$.

In our case the general equilibrium demands $c^*(r)$ and $n^*(r)$ are separating and the equilibrium utility under the fundamental specification becomes

$$U^*(r) \equiv an^*(r) + bc^*(r) + v(r) + w(G)$$

We assume that an identity production function transforms one unit of conspicuous good in one unit of public good. The public good provision gets a straightforward form:

$$G = \int_0^1 tc^*(r) dr = \frac{t}{1+t} \int_0^1 e_n(r) dr = \frac{1}{2} \frac{t}{1+t} \quad (20)$$

because of (16).

For the sake of simplicity we assume the weights to be uniform:

$$\varphi(r) = 1$$

for every r , and the utility function of the public good to be a strictly concave power:

$$w(G) = G^\beta, \quad 0 < \beta < 1$$

The welfare functional becomes

$$\begin{aligned} W^*(t) &= \int_0^1 [an^*(r) + bc^*(r) + v(r) + G^\beta] dr \\ &= \int_0^1 \left\{ a \left[r + p^* \left(r - \frac{1+\alpha}{2} r^\alpha \right) \right] + b \frac{1+\alpha}{2(1+t)} r^\alpha + r^\alpha + \left(\frac{1-t}{2(1+t)} \right)^\beta \right\} dr \\ &= \left(\frac{1-t}{2(1+t)} \right)^\beta + \frac{b}{2} \frac{1}{1+t} + \frac{1}{1+\alpha} + \frac{a}{2} \end{aligned}$$

where $c^*(r)$, $n^*(r)$, $v(r)$, and G are respectively given by (17), (18), (10) and (20).

Therefore

$$t^* = \arg \max \left[\left(\frac{1-t}{2(1+t)} \right)^\beta + \frac{b}{2} \frac{1}{1+t} \right] = \left[\frac{1}{2} \left(\frac{b}{\beta} \right)^{1/(1-\beta)} - 1 \right]^{-1}$$

For instance if $b = 2$, $\beta = 1/2$, we obtain $t^* \approx 14.3\%$.

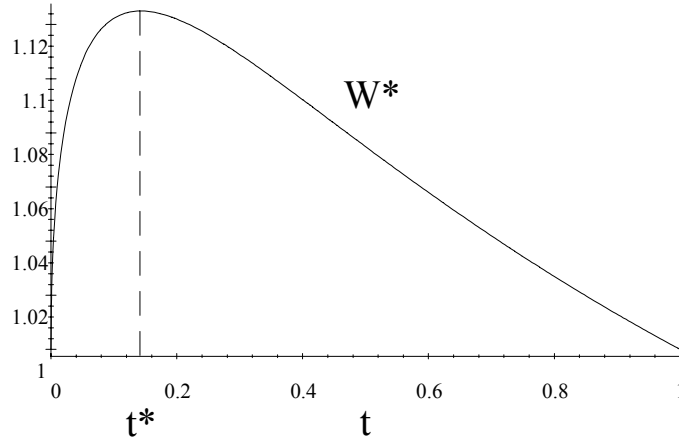


Figure 2. Equilibrium welfare.

We observe that as the utility function of the public good is concave ($\beta \in (0, 1)$),

$$\frac{\partial t^*}{\partial b} < 0 < \frac{\partial t^*}{\partial \beta}$$

In words the optimal tax rate is lower, if $b > \beta$ and if the marginal intrinsic utility $b = u'_c$ is higher. We tax less a more useful (impure) conspicuous good.

The tax rate is higher, if the elasticity of the public good utility β is higher. The more is preferred the public good, the higher is required the tax on the conspicuous consumption.

The general equilibrium demand for the conspicuous good after the optimal tax c^{**} becomes

$$c^{**}(r) = \frac{1}{2} \frac{1 + \alpha}{1 + [(b/\beta)^{1/(1-\beta)} / 2 - 1]^{-1}} r^\alpha$$

Figure 3 compares the general equilibrium demands for conspicuous good before (c^*) and after (c^{**}) the optimal tax under the following parameters specification: $\alpha = \beta = 1/2$, $b = 2$.

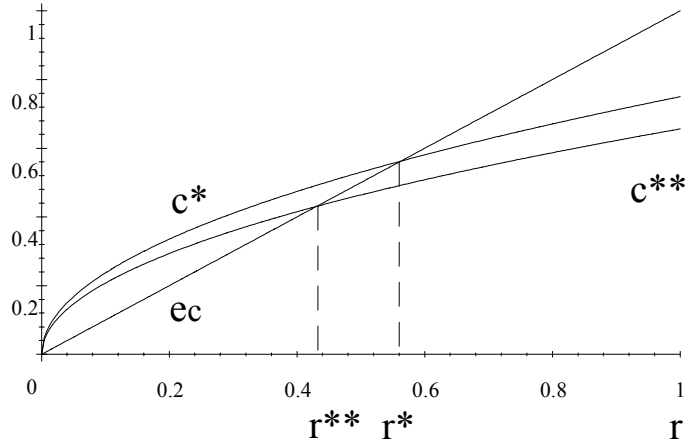


Figure 3. Equilibrium impact of the optimal tax.

The equilibrium consumption of conspicuous good is concave because the rank utility is more concave than the numeraire utility. In particular the

poor ($r < r^*$ or after tax $r < r^{**}$) want more conspicuous good and less numeraire than their respective endowments.

The converse case happened in the first example because the rank and the numeraire utility were respectively linear and strictly concave.

3 Conclusion

The demand for conspicuous good is an equilibrium correspondence associating to each type of agent a set of random signals. In our model within a pure strategy context there is no conformity in conspicuous consumption. More precisely, the set of agents adopting a conformist behavior is negligible. Under mild assumptions the signaling equilibrium is unique almost everywhere, separating and strictly increasing. In other words, the demand function is invertible in the social rank and the conspicuous good is normal.

The aggregation of this signaling equilibrium over types gives the general equilibrium prices and demands. Our examples show that if the endowments are linear and strictly increasing with the social rank, a poor demands more than his endowment of conspicuous good, if the reputational utility function is more concave than the utility function of the common good.

Obviously a pure conspicuous good is a pure abstraction. Thereby to be more realistic, we have introduced an impure luxury good, which signals the status but also provides an intrinsic utility. Moreover the impure good has been taxed to provide a public good.

In the case of a mere reputational good, it should be better to levy a real tax rate close to 100% : the residual amount of conspicuous good should be enough to rank the individuals within a signaling game.

In the case of impure conspicuous good the optimal tax rate is found to be strictly less than one according to our fundamentals specification. We have shown that, as intuition suggests, it is optimal to tax less a more useful (impure) conspicuous good. Moreover the optimal tax increases with the relative consumers' preference for the public good.

4 Appendix

Proof of Proposition 2 The proof is organized in two parts. We show that (i) there is a unique separating equilibrium, (ii) the equilibrium in pure

strategies is separating almost everywhere.

(i) We want to prove that the separating equilibrium is unique. First of all we show that f is locally Lipschitzian⁵ in c . Secondly we apply the theorem of Picard-Lindelöf⁶. To show that f is Lipschitz-continuous in c , it suffices to show that there exists $K > 0$ such that $|\partial f/\partial c| < K$ for every $(r, c) \in [0, 1] \times [0, \max_r \{[e_n(r) + pe_c(r)]/p\}] \equiv D'$. We have that $|\partial f/\partial c| = |\partial \{v'/[pu'(e_n + pe_c - pc)]\}/\partial c|$, i.e. $|\partial f/\partial c| = |v'(r)u''(e_n + pe_c - pc) / [p(u'(e_n + pe_c - pc))^2]|$. D' is a compact set and the continuity of v' , u' , u'' , e_n , e_c and the strict positivity of u' imply the continuity of $|\partial f/\partial c|$. Take $K > \max_{D'} |\partial f/\partial c|$. This proves that f is locally Lipschitzian. Now the theorem of Picard-Lindelöf applies (the Lipschitz-continuity is verified). The continuity of $f(r, c)$ over D is guaranteed by the same arguments adopted in the proof of the existence of a separating equilibrium⁷.

(ii) The equilibrium in pure strategies is a function $c(r)$. Let $c[0, 1]$ be the set of equilibrium signals and $c^{-1} : c[0, 1] \rightsquigarrow [0, 1]$ be the inverse correspondence defined by $c^{-1}(c) \equiv \{r : c(r) = c\}$. If this correspondence is a function, it is always possible to infer the agent from his signal, i.e. the equilibrium is separating. We want to prove that there exists a unique equilibrium in pure strategies and this coincides almost everywhere with the equilibrium of (2). Two cases matter: (1) the set of signals shared by two or more agents has zero measure, i.e. the equilibrium is separating almost everywhere, (2) the set of signals shared by two or more agents has non-zero measure. The second case is investigated: we claim that a non-zero measure set does not exist. Let us assume to the contrary is true. Then there exists an interval in the set of shared signals in which the signals are shared almost everywhere. Let ε be the measure of such an interval and (c_1, c_2) be a sub-interval. Without loss of generality, assume that each common signal is shared by two agents at most. Let the domain $[0, 1]$ be divided

⁵A function $f(r, c)$ defined over a domain $D \equiv [0, 1] \times [0, \infty)$, is said to be locally Lipschitzian, if and only if for every compact set B in D , there exists K_B such that $|f(r, c_0) - f(r, c_1)| \leq K_B |c_0 - c_1|$ for every $(r, c_0), (r, c_1)$ in B .

⁶If $f(r, c)$ is continuous in D and $f(r, c)$ is locally Lipschitzian in $c_0 \in D$, then there exists a unique local solution $c(r)$ of $c'(r) = f(r, c(r))$ such that $c(r_0) = c_0$ is the initial condition.

⁷If a non-separable utility $U(r, c)$ is twice continuously differentiable and strictly increasing in r , and continuously differentiable in c , and e_n and e_c are continuous functions, the separating equilibrium is unique. The proof mimics exactly the previous proof of uniqueness with separable utility.

in n equal parts of measure $1/n$. We want to prove that there exists an N such that there are two signals $c, c' \in (c_1, c_2)$ and two corresponding pairs $(r_1, r_2) = c^{-1}(c)$ and $(r'_1, r'_2) = c^{-1}(c')$ with $|r_2 - r_1|, |r'_2 - r'_1| > 1/N$ and $|r_1 - r'_1|, |r_2 - r'_2| < 1/N$. Let it not be true. Thus for every n there are a finite number of pairs of (r_1, r_2) such that $|r_2 - r_1| > 1/n$ (more precisely $n!/[2!(n-2)!]$ at most). If for every N the number of pairs (r_1, r_2) with $|r_2 - r_1| > 1/N$ is finite, the set of pairs (r_1, r_2) such that $|r_2 - r_1| > 0$ is countable and the set of corresponding shared signals $c(r_1) = c(r_2)$ is countable too, i.e. it has zero measure in (c_1, c_2) , a contradiction. Hence, there exists a partition of $[0, 1]$ in N equal parts and at least two signals c and c' in (c_1, c_2) such that $|r_2 - r_1|, |r'_2 - r'_1| > 1/N, |r_1 - r'_1|, |r_2 - r'_2| < 1/N, (r_1, r_2) = c^{-1}(c)$ and $(r'_1, r'_2) = c^{-1}(c')$.

By equilibrium definition, the type r_j ($j = 1, 2$) does not deviate from c to c' , thereby $\sum_{i=1}^2 \pi_i(c) v(r_i) - \sum_{i=1}^2 \pi_i(c') v(r'_i) \geq pu'(e_n(r_j) + pe_c(r_j) - pc)(c - c')$, if the measure ε of the interval (c_1, c_2) is small enough, i.e. c' is sufficiently close to c . The left hand side of the inequality denotes the reputation loss ($\pi_i(c)$ denotes the probability that the signal c comes from a type r_i); the right hand side is the marginal gain of deviating because of the increase in consumption of the numeraire. Note that $u'(e_n(r_1) + pe_c(r_1) - pc) \neq u'(e_n(r_2) + pe_c(r_2) - pc)$ as $|r_2 - r_1| > 1/N$ by construction. Without loss of generality set $r_2 \equiv \arg \min \{u'(e_n(r_j) + pe_c(r_j) - pc) : j = 1, 2\}$. Hence $\sum_{i=1}^2 \pi_i(c) v(r_i) - \sum_{i=1}^2 \pi_i(c') v(r'_i) > pu'(e_n(r_2) + pe_c(r_2) - pc)(c - c')$. If c' is sufficiently close to c ($|c - c'| < \varepsilon$) and r'_2 is sufficiently close to r_2 ($|r_2 - r'_2| < 1/N$), by continuity $pu'(e_n(r'_2) + pe_c(r'_2) - pc)(c - c')$ is sufficiently close to $pu'(e_n(r_2) + pe_c(r_2) - pc)(c - c')$. Thereby $\sum_{i=1}^2 \pi_i(c) v(r_i) - \sum_{i=1}^2 \pi_i(c') v(r'_i) > pu'(e_n(r_2) + pe_c(r_2) - pc)(c - c')$: type r'_2 has a reputation incentive to deviate by increasing the purchase of the conspicuous good from c' to c . His deviation destroys $c(r)$ as a Nash equilibrium: a contradiction. In other words, the set of shared signals has measure zero, i.e. the equilibrium is separating almost everywhere. Case (2) is ruled out.

Let us now focus on the signaling function $c(r)$. Let $C \subset c[0, 1]$ be the set of signals belonging to the separating equilibrium. As we have seen, $c[0, 1] - C$ has zero measure, so the restriction of the correspondence c^{-1} to C is a function. Moreover, c^{-1} is continuous. Otherwise for each discontinuity point there exists a neighborhood I and an agent $r \in c^{-1}(I)$ with an incentive to deviate. If c is continuous and invertible on the domain $c^{-1}(C)$, then it is monotonic. Thus the Lebesgue theorem applies (see among others Kolmogorov & Fomin, 1970, p. 321) and c is differentiable almost everywhere.

Differentiability implies that the first order condition (2) holds almost everywhere, i.e. the equilibrium in pure strategies coincides by continuity with the separating equilibrium in (2) almost everywhere. ■

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