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RELATIVE CONCERNS ON VISIBLE CONSUMPTION: A SOURCE OF ECONOMIC DISTORTIONS

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Relative Concerns on Visible Consumption: A Source of Economic Distortions*

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Abstract

Do relative concerns on visible consumption give rise to economic distortions? We re-examine the question posited by Arrow and Dasgupta (2009) building upon their theoretical framework *but* recognizing that relative concerns can only apply to visible goods (e.g., cars, clothing, jewelry) and that households consume both visible and non-visible goods. Contrary to Arrow and Dasgupta (2009), the answer to this question turns to be *always affirmative*: the competitive equilibrium marginal rate of substitution between the visible and non-visible goods will always be different than the socially optimal one, since individuals do not take into account the negative externality they exert on others through the consumption of the visible good, while the social planner does. If one is willing to invoke separability assumptions, then the steady state competitive equilibrium consumption of non-visible goods will be strictly *lower* than the socially optimal one, consistent with expenditure patterns both in developed and developing countries.

JEL Classification Codes: D6, E2.
Keywords: visible goods, non-visible goods, conspicuous consumption, inconspicuous consumption, conspicuous leisure, inconspicuous leisure, labor supply, market distortions.

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1 Introduction

The thesis that economic agents care not only about their own consumption, but also about their consumption relative to others can be traced back to Adam Smith (1776), Veblen (1899) and Duesenberry (1949). Over the last 15 years economists and sociologists have provided considerable empirical support for the notion that individuals care about their *relative* positions in their communities, often using subjective well-being evidence (Clark and Oswald, 1996; McBride, 2001; Luttmer, 2005; Kahneman and Krueger, 2006), but also linking consumption patterns to relative concerns. Regarding the latter, Charles, Hurst, and Roussanov (2009), using US data from the CEX 1985-2002, show that, controlling for differences in permanent income, Blacks and Hispanics devote larger shares of their expenditure bundles to *visible* goods (clothing, jewelry, and cars) than do comparable Whites. Evidence from the developing world also reveals that poor people tend to spend large fractions of their budgets on conspicuous items such as phones, funerals and festivals (Banerjee and Duflo, 2007; Case et al., 2013).

Given these empirical findings, one natural question to ask is: *Do relative concerns for visible consumption have negative welfare consequences?*, where visible consumption can be understood as the consumption of goods that are readily observable in anonymous social interactions and that are portable across those interactions (Charles, Hurst and Rousanov, 2009).[1] While the empirical apparatus is not well suited to answer this question, one can nevertheless, from a theoretical perspective, analyze the role of relative concerns regarding visible consumption on the allocation of resources in the economy, a direction followed by Arrow and Dasgupta (2009). Here, we build upon the work by Arrow and Dasgupta (2009) *but recognize that not all goods are visible.* If relative concerns are to be relevant, these concerns can only apply to visible goods. This basic insight proves to have dramatic consequences, leading to crucial differences regarding our conclusions on the distortional

[1]Heffetz (2011, 2012) defines socio-cultural visibility of consumer expenditures as the speed with which members of a society notice a household's expenditure on different commodities.

power of relative concerns and those in Arrow and Dasgupta (2009).

Following Arrow and Dasgupta (2009), we analyze a competitive economy where individual felicities depend not only on absolute consumption but also on relative consumption. Crucially, relevant concerns are *only* possible if consumption is *visible* (observable, or conspicuous in Veblen's terminology). Precisely, our twist and extension with respect to Arrow and Dasgupta (2009) is the inclusion of two types of consumption goods: *visible* and *non-visible*. Indeed, not all consumption is visible. In the US, for example, visible expenditures represent 12% of the mean quarterly expenditure (Charles, Hurst, and Roussanov, 2009). In our model households felicities depend on visible consumption through its absolute and relative aspects, while depending *only* on the absolute aspect of non-visible consumption. Thus, while a household suffers a felicity loss when others' *visible* consumption levels rise, because his relative visible consumption now declines, others' non-visible consumption is immaterial to household satisfaction.[2]

We characterize the competitive equilibrium and socially optimal paths, as well as, the steady state equilibrium, studying the effects of relative concerns of visible consumption on the mix of personal consumption of visible and non-visible commodities, leisure and saving in an inter-temporal economy to reexamine the question posited by Arrow and Dasgupta (2009): Do relative concerns on visible consumption give rise to economic distortions? Contrary to the finding in Arrow and Dasgupta (2009), we show that, when households derive utility from *both* visible and non-visible consumption goods and visible consumption of others enters the household utility, the answer to this question turns to be always affirmative: the competitive equilibrium is distorted. In addition, we show that the economic distortion

[2]In the economics literature, a standard explanation for why households might care about relative consumption of visible commodities is based on a signaling-by-consuming Veblen's (1899) explanation: conspicuous consumption describes the advertisement of one's income and wealth through lavish spending on visible commodities. In this regard, Charles, Hurst, and Roussanov (2009) find that visible consumption is declining in reference group income, a crucial prediction of "demonstration effect" via status-signaling. More recently, Moav and Neeman (2012) construct a theoretical model and show that if human capital is observable and correlated with income, then a signalling equilibrium in which poor individuals tend to spend a large fraction of their income on conspicuous consumption can emerge. This would explain why poor educated people can kept locked in poverty, and would be consistent with the expenditure patterns across the developing world.

must take the form of people consuming *less* of the non-visible good, no matter whether labor supply is endogenously determined and/or leisure is conspicuous, as long as the felicity function is *separable* in own consumption of visible and non-visible goods (and in own consumption of non-visible and others' consumption of visible goods).

Our basic argument can be easily illustrated with a timeless, competitive economy that produces two commodities, a non-visible x and a visible one c. The visible commodity is subject to conspicuous consumption, while the non-visible one is not. Let us consider the maximization problem of a representative household with a utility function $U(c, C, x)$ and a budget constraint $c + x = m$. The competitive equilibrium first order condition is given by $U_c/U_x = 1$. However, the socially optimal equilibrium first order condition is given by $(U_c + U_C)/U_x = 1$. In other words, the competitive equilibrium is not Pareto optimal: households consume more of the visible good and less of the non-visible good than the optimal would be. This is consistent with the recent findings by Charles et al. (2009), who find that controlling for differences in permanent incomes, Blacks and Hispanics spend about 30 percent more on conspicuous consumption (e.g., cars, jewelry) than Whites, and that the higher spending on conspicuous consumption is at the expense of inconspicuous consumption (e.g., expenditures on education and health).

As in Arrow and Dasgupta (2009), we work with a convex technology that involves a single type of labor and a single reproducible non-deteriorating capital good that serves also as a consumption (visible or non-visible to others) good. Propositions 1, 2 and 3 establish that, under relative concerns regarding visible consumption, as long as the felicity function includes also non-visible consumption, the market equilibrium and the socially optimal paths *cannot* coincide. In other words, there is *no* felicity function satisfying regularity conditions that avoids market distortions.

In addition, proposition 1, where labor supply is taken as given, shows that in the steady state competitive equilibrium visible consumption is strictly *larger* than the socially optimal one, whereas the non-visible consumption is strictly *lower* than the socially optimal one.

Propositions 2 and 3 consider the case where labor supply is endogenously determined, with inconspicuous and conspicuous leisure, respectively. Each of these propositions has its own corollary: corollaries 1 and 2. In both corollaries, separability assumptions in own consumption of visible and non-visible goods (and in own consumption of non-visible and others' consumption of visible goods) are invoked. When leisure is inconspicuous, we obtain the same economic distortions characterized by Proposition 2 in Arrow and Dasgupta (2009) regarding visible consumption, capital and labor supply, plus an additional new qualitative result: the steady state competitive equilibrium level of non-visible consumption is *lower* than the socially optimal one. When leisure is conspicuous, the only unambiguous economic distortion is that, again, the steady state competitive equilibrium level of non-visible consumption is *lower* than the socially optimal one.

Our analysis applies to any context where relative concerns are important, including a world where conspicuous consumption is a signal of unobservable wealth, but more generally any environment where people feel bad if their consumption of visible goods is less than that of others. Section 2 analyzes economic distortions when labor supply is exogenous. In section 3 labor supply is taken to be subject to household choice, and economic distortions are analyzed, first with inconspicuous leisure, then with conspicuous leisure. Finally, section 4 concludes.

2 Distortions with Exogenous Labor Supply

There is a continuum of infinitely lived and identical households, indexed by $i \in [0,1]$. Time is continuous and labor is supplied inelastically. The economy consists of two different goods: a visible good, c_i, and a non-visible one, x_i. Both are non perishable, and therefore can be either consumed or accumulated. Let $K(t)$ denote the stock of capital at t. We assume that both goods are produced with the same technology given by $F(K(t))$, where F is an increasing and strictly concave function of K, such that $F(0) = 0$. Let $c_i(t)$ denote household i's visible consumption rate at t. Define

$$C(t) = \int_0^1 c_i(t)\, di \tag{1}$$

as the average visible consumption of the population at t.

Assumption 1. *Let $U(c_i, C, x_i)$ define the household felicity function. We assume that U satisfies the following conditions:*

(i) $U_c(c_i, C, x_i) > 0$, $U_C(c_i, C, x_i) < 0$, $U_x(c_i, C, x_i) > 0$, *and* $U_{ss}(c_i, C, x_i) < 0$, $s = \{c, x\}$

(ii) $U_c(\cdot)$ *and* $U_x(\cdot)$ *are respectively strictly decreasing and strictly increasing when* c_i, C *and* x_i *move together. Moreover,* $\lim_{c_i \to \infty} U_c(\cdot) = 0 \ \forall \ (C, x_i)$, *and* $\lim_{x_i \to \infty} U_x(\cdot) = 0 \ \forall \ (c_i, C)$.

(iii) $U_c(\cdot) + U_C(\cdot) > 0$ *when* c_i, C *and* x_i *move together.*

The interpretation of assumption 1 is as follows. Condition (i) describes regularity conditions of the utility function with respect to visible, c_i, and non-visible consumption, x_i, and implies that the average visible consumption of the population, C, is a negative externality for each household i (i.e. $U_C(c_i, C, x_i) < 0$). Conditions (ii) and (iii) guarantee the existence and uniqueness of both the decentralized and the socially optimal equilibria.

In particular, condition (iii) says that the absolute value of the negative effect of other's visible consumption is less than the gains from one's own visible consumption.[3]

Household i seeks to maximize the following (inter-temporal) utility function at $t = 0$

$$W_i = \int_0^\infty exp(-\delta t)U(c_i(t), C(t), x_i(t))\, dt,\ \delta > 0. \tag{2}$$

Social welfare at $t = 0$ is the sum of household utilities

$$W = \int_0^1 \left[\int_0^\infty exp(-\delta t)U(c_i(t), C(t), x_i(t))\, dt \right] di. \tag{3}$$

Let us now characterize the market equilibrium and socially optimal paths.[4] Assumption 1 and the concavity of F imply that households behave identically, so we can focus on the symmetrical equilibrium, that is $c_i(t) = c(t) = C(t)$ and $x_i(t) = x(t)$. Then, given that goods are non perishable (non-deteriorating), the accumulation equation for the representative household can be expressed as

$$\dot{K}(t) = F(K(t)) - c(t) - x(t), \text{ where } K(0) > 0 \text{ is given.} \tag{4}$$

Hence, the first order conditions for an interior maximum of the household optimization problem are

$$U_c(C^m(t), C^m(t), x^m(t)) = p^m(t) \tag{5}$$

$$U_x(C^m(t), C^m(t), x^m(t)) = p^m(t) \tag{6}$$

$$\frac{\dot{p}^m(t)}{p^m(t)} = \delta - F_K \tag{7}$$

where the superscript m denotes market equilibrium and $p^m(t)$ is the costate variable associated with the constraint (4). As for the socially optimal path, this is characterized

[3] See Arrow and Dasgupta (2009), page 504, proof of corollary.
[4] See Arrow and Dasgupta (2009), page 502, footnote 10.

by

$$U_c(C^o(t), C^o(t), x^o(t)) + U_C(C^o(t), C^o(t), x^o(t)) = p^o(t) \tag{8}$$

$$U_x(C^o(t), C^o(t), x^o(t)) = p^o(t) \tag{9}$$

$$\frac{\dot{p}^o(t)}{p^o(t)} = \delta - F_K \tag{10}$$

The effects of visible consumption relative concerns can be derived by comparing the equilibrium conditions in the decentralized economy with the socially optimal plan. The results of this comparison, as well as the characterization of the steady state equilibrium, are presented in the following proposition.

Proposition 1. *Assume that the felicity function of the representative household satisfies assumption 1. Then the socially optimal and market equilibrium paths cannot coincide. Moreover, at the steady state, consumption of the visible good is strictly larger than the socially optimal one, whereas consumption of the non-visible good is strictly lower than the socially optimal one.*

Proof. Assume that $C^m(t) = C^o(t)$ and $x^m(t) = x^o(t)$. Then equations (6) and (9) imply $p^o(t)/p^m(t) = 1$. Given equations (5) and (8), it follows that

$$1 = \frac{U_c(C^o(t), C^o(t), x^o(t)) + U_C(C^o(t), C^o(t), x^o(t))}{U_c(C^m(t), C^m(t), x^m(t))}. \tag{11}$$

This requires $U_C(C^o(t), C^o(t), x^o(t)) = 0$, which is a contradiction given assumption 1. Hence, the socially optimal and the market equilibrium paths cannot coincide.

To show that visible consumption at the steady state ($\dot{p}(t) = 0$) market equilibrium is strictly larger than the socially optimal one, notice first that, given equations (7) and (10), $K^m = K^o = K^*$. Now, assume that $C^{m^*} \leq C^{o^*}$. The resources constraint $F(K^*) = C^{s^*} + x^{s^*}$, $s = \{o, m\}$, implies $x^{m^*} \geq x^{o^*}$. In addition, from equations (5)-(6) and (8)-(9) it follows that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) = U_x(C^{m^*}, C^{m^*}, x^{m^*})$$

$$U_c(C^{o^*}, C^{o^*}, x^{o^*}) + U_C(C^{o^*}, C^{o^*}, x^{o^*}) = U_x(C^{o^*}, C^{o^*}, x^{o^*})$$

Combining the two previous equations and using the resources constraint yield

$$\left[U_c(C^{m^*}, C^{m^*}, F(K^*) - C^{m^*}) - U_c(C^{o^*}, C^{o^*}, F(K^*) - C^{o^*})\right] - U_C(C^{o^*}, C^{o^*}, F(K^*) - C^{o^*}) =$$
$$U_x(C^{m^*}, C^{m^*}, F(K^*) - C^{m^*}) - U_x(C^{o^*}, C^{o^*}, F(K^*) - C^{o^*})$$

However, given assumption 1, the right-hand side (RHS) and the left-hand side (LHS) of the previous expression have different signs: the LHS is strictly positive and the RHS is non-positive. This contradicts $C^{m^*} \leq C^{o^*}$. Therefore, at the steady state equilibrium it must be true that $C^{m*} > C^{o*}$ and $x^{m*} < x^{o*}$. This proves the statement.

□

In contrast with the results of Arrow and Dasgupta (2009), Proposition 1 establishes that, when we allow for the presence of both visible and non-visible consumption goods, and visible consumption is subject to relative concerns, there is *no* felicity function satisfying regularity conditions that avoids market distortions. In particular, at the steady state competitive equilibrium, individuals devote too much resources to conspicuous consumption at the expense of inconspicuous consumption.

3 Distortions with Endogenous Labor Supply

In this section labor supply is taken to be subject to household choice. We first consider that leisure is inconspicuous. Then we analyze the case with conspicuous leisure.

3.1 Distortions with Inconspicuous Leisure

Suppose that leisure is inconspicuous. Let e_i ($0 \leq e_i \leq 1$) be the labor supply of household i, so the leisure it enjoys is $1 - e_i$.

Assumption 2. *The household felicity function is given by:*

$$U(c_i, C, x_i) - V(e_i). \tag{12}$$

where:

(i) U satisfies the conditions in assumption 1.

(ii) $V'(e_i) \geq 0$, $V''(e_i) > 0$.

(iii) $\lim_{e_i \to 1} V'(e_i) = 0$ *and* $\lim_{e_i \to 0} V'(e_i) = \infty$.

The interpretation of condition (i) has been already discussed. Condition (ii) implies that the disutility of labor is a strictly convex function. Condition (iii) guarantees the existence and uniqueness of the equilibrium with endogenous labor supply.

Household i seeks to maximize the following (inter-temporal) utility function at $t = 0$

$$W_i = \int_0^\infty exp(-\delta t) U(c_i(t), C(t), x_i(t)) - V(e_i(t))\, dt,\ \delta > 0. \tag{13}$$

Social welfare at $t = 0$ is the sum of household utilities

$$W = \int_0^1 \left[\int_0^\infty exp(-\delta t) U(c_i(t), C(t), x_i(t)) - V(e_i(t))\, dt \right] di. \tag{14}$$

We now characterize the market equilibrium and socially optimal paths. As before, households behave identically, so we can focus on the symmetrical equilibrium, that is $c_i(t) = c(t) = C(t)$, $x_i(t) = x(t)$ and $e_i(t) = e(t)$. Output at t is now produced by combining both capital, $K(t)$, and aggregate labor, $E(t)$

$$E(t) = \int_0^1 e_i(t)\, di \tag{15}$$

and the production function is $F(K(t), E(t))$, where F is assumed to be concave, increasing and homogenous of degree 1 in $K(t)$ and $E(t)$.[5]

The first order conditions for an interior maximum of the household optimization problem are

$$U_c(C^m(t), C^m(t), x^m(t)) = p^m(t) \tag{16}$$

$$U_x(C^m(t), C^m(t), x^m(t)) = p^m(t) \tag{17}$$

$$V'(E^m(t)) = p^m(t) F_E(K^m(t), E^m(t)) \tag{18}$$

$$\frac{\dot{p}^m(t)}{p^m(t)} = \delta - F_K(K^m(t), E^m(t)) \tag{19}$$

The socially optimal path is characterized by

$$U_c(C^o(t), C^o(t), x^o(t)) + U_C(C^o(t), C^o(t), x^o(t)) = p^o(t) \tag{20}$$

$$U_x(C^o(t), C^o(t), x^o(t)) = p^o(t) \tag{21}$$

$$V'(E^o(t)) = p^o(t) F_E(K^o(t), E^o(t)) \tag{22}$$

$$\frac{\dot{p}^o(t)}{p^o(t)} = \delta - F_K(K^o(t), E^o(t)) \tag{23}$$

By comparing the equilibrium conditions of the decentralized economy with the socially

[5] See Arrow and Dasgupta (2009), page 505, footnote 12.

optimal plan, we find that the socially optimal and the market equilibrium paths cannot coincide. This result is contained in the following proposition.

Proposition 2. *Assume that the felicity function of the representative household satisfies assumption 2. Then the socially optimal and the market equilibrium paths cannot coincide.*

Proof. The result follows immediately from the proof of proposition 1. □

In addition, an important corollary of this proposition allows us to characterize the economic distortions of the steady state competitive equilibrium.

Corollary 1. *If the felicity function is separable in c_i and x_i ($U_{cx} = 0$) and separable in x_i and C ($U_{xC} = 0$), then the steady state equilibrium is characterized by the following economic distortions:*

$$C^{m^*} > C^{o^*}\,,\ x^{m^*} < x^{o^*}\,,\ E^{m^*} > E^{o^*} \text{ and } K^{m^*} > K^{o^*}\,.$$

Proof. See the Appendix. □

Proposition 2 conforms to the result of Arrow and Dasgupta (2009): when labor supply is endogenous, leisure in inconspicuous, and visible consumption is subject to relative concerns, there is *no* felicity function that can avoid market distortions. In addition, as long as the *separability* assumption holds, Corollary 1 displays the same economic distortions as that of Proposition 2 in Arrow and Dasgupta (2009) regarding visible consumption, labor supply and saving. However, a new insight emerges. The addition of non-visible consumption allows us to highlight a new economic distortion: the steady state competitive equilibrium non-visible consumption is strictly *lower* than the socially optimal one.

3.2 Distortions with Conspicuous Leisure

Suppose now that leisure is conspicuous, that is, individuals are also subject to relative concerns regarding leisure.

Assumption 3. *We assume that the household felicity function is given by:*

$$U(c_i, C, x_i) - V(e_i, E). \tag{24}$$

where:

(i) U satisfies the conditions in assumption 1.

(ii) $V_e(\cdot) > 0$ and $V_E(\cdot) < 0$.

(iii) $V_e(E, E) + V_E(E, E) > 0 \; \forall \; E$.

(iv) $V_{ee}(E, E) + V_{eE}(E, E) > 0 \; \forall \; E$.

(v) $\lim_{e_i \to 1} V_e(e_i, E) = 0$ and $\lim_{e_i \to 0} V_e(e_i, E) = \infty$.

Condition (i) has been previously discussed. Condition (ii) implies that, all else being equal, the disutility of labor is larger when the average leisure $(1-E)$ in the society increases. This is the negative externality due to relative concerns regarding leisure. Condition (iii)-(v) guarantee that both the decentralized and the socially optimal equilibria exist and are unique.

Household i seeks to maximize the following (inter-temporal) utility function at $t = 0$

$$W_i = \int_0^\infty exp(-\delta t) U(c_i(t), C(t), x_i(t)) - V(e_i(t), E(t)) \, dt, \; \delta > 0. \tag{25}$$

Social welfare at $t = 0$ is the sum of household utilities

$$W = \int_0^1 \left[\int_0^\infty exp(-\delta t) U(c_i(t), C(t), x_i(t)) - V(e_i(t), E(t)) \, dt \right] di. \tag{26}$$

The market equilibrium path is characterized by

$$U_c(C^m(t), C^m(t), x^m(t)) = p^m(t) \tag{27}$$

$$U_x(C^m(t), C^m(t), x^m(t)) = p^m(t) \tag{28}$$

$$V_e(E^m(t), E^m(t)) = p^m(t)F_E(K^m(t), E^m(t)) \tag{29}$$

$$\frac{\dot{p}^m(t)}{p^m(t)} = \delta - F_K(K^m(t), E^m(t)) \tag{30}$$

The socially optimal path is characterized by

$$U_c(C^o(t), C^o(t), x^o(t)) + U_C(C^o(t), C^o(t), x^o(t)) = p^o(t) \tag{31}$$

$$U_x(C^o(t), C^o(t), x^o(t)) = p^o(t) \tag{32}$$

$$V_e(E^o(t), E^o(t)) + V_E(E^o(t), E^o(t)) = p^o(t)F_E(K^o(t), E^o(t)) \tag{33}$$

$$\frac{\dot{p}^o(t)}{p^o(t)} = \delta - F_K(K^o(t), E^o(t)) \tag{34}$$

As before, we compare the equilibrium conditions of the decentralized economy with the socially optimal plan. The following proposition describes the result of such a comparison.

Proposition 3. *Assume that the felicity function of the representative household satisfies assumption 3. Then the socially optimal and the market equilibrium paths cannot coincide.*

Proof. The result follows immediately from the proof of proposition 1. □

Finally, an important corollary of this proposition allows us to characterize the economic distortions of the steady state competitive equilibrium.

Corollary 2. *If the felicity function is separable in c_i and x_i ($U_{cx} = 0$) and separable in x_i and C ($U_{xC} = 0$), then the steady state equilibrium is characterized by the following unambiguous economic distortion:*

$$x^{m^*} < x^{o^*}.$$

Proof. See the Appendix. □

4 Conclusion

Our paper relies on a very simple idea: not all goods are visible; some of them are, some others not. If relative concerns are to be relevant, which is consistent with a bulk of empirical studies, these concerns can only apply to visible goods (i.e., goods that are readily observable in anonymous social interactions and portable across those interactions). However, once we allow for this basic *distinction* between visible and non-visible goods, then it must be the case that the competitive equilibrium is distorted, in the sense that the competitive equilibrium marginal rate of substitution between the visible and non-visible goods will *always* be different than the socially optimal one, since individuals do not take into account the negative externality they exert on others through the consumption of the visible good, while the social planner does.

In general, it is not possible to provide an unambiguous characterization of the levels of consumption (and other economic variables) in the steady state competitive equilibrium with respect to their socially optimal levels. Still, if one is willing to assume that, first, the marginal utility of own consumption of visible goods is independent of the consumption of non-visible goods, and second, that the marginal utility of own consumption of non-visible goods is independent of others' consumption of visible goods, the steady state competitive equilibrium consumption of non-visible goods will be strictly lower than the socially optimal one. This assumption does not appear to be ill-suited, at least given the empirical evidence showing that higher spending on conspicuous consumption is at the expense of inconspicuous consumption, both in developed and in developing countries.

We conclude with an important remark. The existence result of a utility function satisfying regularity conditions such that the competitive equilibrium is socially optimal in Arrow and Dasgupta (2009) requires that *all* goods are visible, so that *all* goods are subject to relative concerns. This is, of course, a very strong assumption. Once we relax it, we are back to a world where relative concerns on visible consumption are a source of economic distortions.

A Appendix

Proof of corollary 1

Suppose that the utility function is separable in c_i and x_i, and in x_i and C, that is $U_{cx} = U_{xC} = 0 \; \forall \; (c_i(t), x_i(t), C(t))$. We want to prove that, under this condition, at the steady state it must be true that

$$C^{m^*} > C^{o^*} \, , \; x^{m^*} < x^{o^*} \, , \; E^{m^*} > E^{o^*} \text{ and } K^{m^*} > K^{o^*} \, .$$

To this end, we write the production function in intensive form as $f(k)$, where $k = K/E$. Given the assumptions on F, f is an increasing and concave function of k, with $f(0) = 0$. In addition, $F_K(K, E) = f'(k)$ and $F_E(K, E) = f(k) - kf'(k)$. From equations (19) and (23), it follows that $k^{o^*} = k^{m^*} = k^*$. Moreover, the resources constraint can be written as

$$E^{s^*} f(k) = C^{s^*} + x^{s^*} \text{ with } s = \{m, o\}$$

Let us define $dS = S^{m^*} - S^{o^*}$ as the change in the variable S between the two equilibria. We first consider the case with $dE = E^{m^*} - E^{o^*} = 0$. Given equations (18) and (22) and given that $k^{o^*} = k^{m^*}$, the costate variable must be the same in both equilibria. This contradicts proposition 2. Therefore, we must have $dE \neq 0$.

Consider now the case with $dE < 0$. Since $V(E)$ is a strictly convex function of E, this implies $V_e(E^{m^*}) < V_e(E^{o^*})$. Therefore $P^{m^*} < P^{o^*}$. Given the first order conditions (16)-(23), this requires that the consumption allocations pairs (C^{m^*}, x^{m^*}) and (C^{o^*}, x^{o^*}) satisfy

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) < U_C(C^{o^*}, C^{o^*}, x^{o^*}) \quad \text{(A.1)}$$

$$U_x(C^{m^*}, C^{m^*}, x^{m^*}) < U_x(C^{o^*}, C^{o^*}, x^{o^*}) \quad \text{(A.2)}$$

To verify the aforementioned conditions, we proceed by totally differentiating U_c, U_x and the resources constraint. In doing so, we make use of the separability assumptions. Hence,

$$dU_c = (U_{cc} + U_{cC})dC \tag{A.3}$$

$$dU_x = U_{xx}dx \tag{A.4}$$

$$dEf(k) = dC + dx \tag{A.5}$$

Given (A.5), $dE = E^{m^*} - E^{o^*} < 0$ requires that dC and dx cannot be both non-negative at the same time. Moreover, in order to satisfy conditions (A.1) and (A.2), we must have $dU_x < 0$ and $dU_c < 0$. Because of item (ii) in assumption 1 and $U_{cx} = 0$, $(U_{cc} + U_{cC}) < 0$ which implies $dC > 0$ by (A.3). In addition, because of item (i) in assumption 1, $U_{xx} < 0$ which implies $dx > 0$ by (A.4). But this is a contradiction, since dx and dC cannot be both non-negative at the same time.

Finally, let us consider the case when $dE = E^{m^*} - E^{o^*} > 0$. From the first order conditions, this requires

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) > U_C(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.6}$$

$$U_x(C^{m^*}, C^{m^*}, x^{m^*}) > U_x(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.7}$$

Now, in order to satisfy condition (A.7), in equilibrium we must have $dU_x > 0$. Hence, given that $U_{xx} < 0$, equation (A.4) implies $dx < 0$. Moreover, given (A.5), assuming $dE > 0$ requires that dC and dx cannot be both non-positive at the same time. Therefore, $dC > 0$, which implies $dU_c < 0$, and this is compatible with equation (A.6). Therefore, in the steady state equilibrium it must be true that $E^{m^*} > E^{o^*}$, $C^{m^*} > C^{o^*}$ and $x^{m^*} < x^{o^*}$. Finally, since $k^m = k^0$, it follows that $K^{m^*} > K^{o^*}$. This proves the statement.

Proof of corollary 2

Suppose that the utility function is separable in c_i and x_i, and in x_i and C, that is $U_{cx} = U_{xC} = 0 \; \forall \; (c_i(t), x_i(t), C(t))$. We want to prove that, under this condition, at the steady state it must be true that

$$x^{m^*} < x^{o^*}.$$

As before, it is convenient to write down the production function in intensive form as $f(k)$, where $k = K/E$. From equations (30) and (34), it follows that $k^{o^*} = k^{m^*} = k^*$. Moreover, the resources constraint can be written as

$$E^{s^*} f(k) = C^{s^*} + x^{s^*} \text{ with } s = \{m, o\}$$

Let us define $dS = S^{m^*} - S^{o^*}$ as the change in the variable S between the two equilibria. The total differential of U_c, U_x, V_e and the resources constraint are given by

$$dU_c = (U_{cc} + U_{cC})dC \quad \text{(A.8)}$$

$$dU_x = U_{xx}dx \quad \text{(A.9)}$$

$$dV_e = (V_{ee} + V_{eE})dE \quad \text{(A.10)}$$

$$dEf(k) = dC + dx \quad \text{(A.11)}$$

Suppose that $dE = 0$. From equation (A.10), $dV_e = 0$, and from equation (A.11), $dC = -\, dx$. Hence, we can distinguish three cases: (i) $dC > 0$ and $dx < 0$, (ii) $dC < 0$ and $dx > 0$, and (iii) $dC = dx = 0$. Let us start with (i). From equation (A.8), $dU_c < 0$. From equation (A.9), $dU_x > 0$, which implies $P^{m^*} > P^{m^o}$, because of (28) and (32). In addition, from conditions (27) and (31) and conditions (29) and (33), $P^{m^*} > P^{m^o}$ requires that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) > U_C(C^{o^*}, C^{o^*}, x^{o^*}) \quad \text{(A.12)}$$

$$V_e(E^{m^*}, E^{m^*}) - V_e(E^{o^*}, E^{o^*}) > V_E(E^{o^*}, E^{o^*}) \quad \text{(A.13)}$$

which are compatible with $dU_c < 0$ and $dV_e = 0$.

Consider now (ii): $dC < 0$ and $dx > 0$. From equation (A.8), $dU_c > 0$. From equation (A.9), $dU_x < 0$, which implies $P^{m^*} < P^{m^o}$, because of (28) and (32). But then, from conditions (27) and (31), $P^{m^*} < P^{m^o}$ requires that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) < U_C(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.14}$$

which is a contradiction, since the LHS of (A.14) is strictly positive ($dU_c > 0$) and its RHS is strictly negative ($U_C < 0$).

Finally, consider case (iii). $dE = dC = dx = 0$ contradicts proposition 2, and therefore cannot be an equilibrium. Hence, we conclude that if $dE = 0$, then $x^{m^*} < x^{o^*}$.

Suppose now that $dE > 0$. From equation (A.10), $dV_e > 0$, and from equation (A.11), dC and dx cannot be both negative at the same time. Again, we can distinguish three cases: (i) $dC > 0$ and $dx \geq 0$, (ii) $dC > 0$ and $dx < 0$, and (iii) $dC \leq 0$ and $dx > 0$. Let us start with (i). From equation (A.9), $dU_x \leq 0$, which implies $P^{m^*} \leq P^{m^o}$, because of (28) and (32). But then, from conditions (29) and (33), this requires that

$$V_e(E^{m^*}, E^{m^*}) - V_e(E^{o^*}, E^{o^*}) \leq V_E(E^{o^*}, E^{o^*}) \tag{A.15}$$

which is a contradiction, since the LHS of (A.15) is strictly positive ($dV_e > 0$) and its RHS is strictly negative ($V_E < 0$).

Consider now (ii): $dC > 0$ and $dx < 0$. From equation (A.8), $dU_c < 0$. From equation (A.9), $dU_x > 0$, which implies $P^{m^*} > P^{m^o}$, because of (28) and (32). In addition, from conditions (27) and (31) and conditions (29) and (33), $P^{m^*} > P^{m^o}$ requires that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) > U_C(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.16}$$

$$V_e(E^{m^*}, E^{m^*}) - V_e(E^{o^*}, E^{o^*}) > V_E(E^{o^*}, E^{o^*}) \tag{A.17}$$

which are compatible with $dU_c < 0$ and $dV_e > 0$.

As for the case (iii), $dC \leq 0$ and $dx > 0$, from equation (A.9), $dU_x < 0$, which implies $P^{m^*} < P^{m^o}$, because of (28) and (32). But then, from conditions (29) and (33), this requires that

$$V_e(E^{m^*}, E^{m^*}) - V_e(E^{o^*}, E^{o^*}) < V_E(E^{o^*}, E^{o^*}) \tag{A.18}$$

which is a contradiction, since the LHS of (A.18) is strictly positive ($dV_e > 0$) and its RHS is strictly negative ($V_E < 0$). Hence, we conclude that if $dE > 0$, then $x^{m^*} < x^{o^*}$.

Finally, suppose that $dE < 0$. From equation (A.10), $dV_e < 0$, and from equation (A.11), dC and dx cannot be both positive at the same time. Hence, we can distinguish three cases: (i) $dC \geq 0$ and $dx < 0$, (ii) $dC < 0$ and $dx < 0$, and (iii) $dC < 0$ and $dx \geq 0$. Let us start with (i). From equation (A.8), $dU_c \leq 0$. From equation (A.9), $dU_x > 0$, which implies $P^{m^*} > P^{m^o}$, because of (28) and (32). In addition, from conditions (27) and (31) and conditions (29) and (33), $P^{m^*} > P^{m^o}$ requires that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) > U_C(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.19}$$

$$V_e(E^{m^*}, E^{m^*}) - V_e(E^{o^*}, E^{o^*}) > V_E(E^{o^*}, E^{o^*}) \tag{A.20}$$

which are compatible with $dU_c \leq 0$ and $dV_e < 0$.

Let us now consider (ii). From equation (A.8), $dU_c > 0$. From equation (A.9), $dU_x > 0$, which implies $P^{m^*} > P^{m^o}$, because of (28) and (32). In addition, from conditions (27) and (31) and conditions (29) and (33), $P^{m^*} > P^{m^o}$ requires that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) > U_C(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.21}$$

$$V_e(E^{m^*}, E^{m^*}) - V_e(E^{o^*}, E^{o^*}) > V_E(E^{o^*}, E^{o^*}) \tag{A.22}$$

which are compatible with $dU_c > 0$ and $dV_e < 0$.

As for the case (iii), $dC < 0$ and $dx \geq 0$, from equation (A.8), $dU_c > 0$. From equation (A.9), $dU_x \leq 0$, which implies $P^{m^*} \leq P^{m^o}$, because of (28) and (32). But then, from conditions (27) and (31), $P^{m^*} \leq P^{m^o}$ requires that

$$U_c(C^{m^*}, C^{m^*}, x^{m^*}) - U_c(C^{o^*}, C^{o^*}, x^{o^*}) \leq U_C(C^{o^*}, C^{o^*}, x^{o^*}) \tag{A.23}$$

which is a contradiction, since the LHS of (A.23) is strictly positive ($dU_c > 0$) and its RHS is strictly negative ($U_C < 0$). Hence, we conclude that if $dE < 0$, then $x^{m^*} < x^{o^*}$. Thus, in all of the feasible cases, $x^{m*} < x^{o*}$. This proves the statement.

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