Abstract

In status competition studies, the utility of heterogeneous individuals typically depends on an economywide average indicator of status. In our model, emulative and jealous agents are embedded in an exogenous network where agent-specific reference group is determined by the direct link emanating from the agent’s links. Similarly to Ghiglino and Goyal (2010) but in a somewhat different framework, we show that individual consumption is proportional to the agent’s “outbound” Katz-Bonacich network centrality measure and equilibrium is in general inefficient. More importantly, the negative externality associated with each agent depends on her “inbound” centrality measure—the conspicuousness index. A tax based on this index combined with a uniform lump-sum transfer can attain efficiency.

JEL classification: D11, D85.
1 Introduction

Social scientists and economists in particular have long recognized that an individual's satisfaction may depend not only on the level of own consumption or income, but also on how that level compares with the consumption or income of others. That is, consumption serves the dual purpose of satisfying objective wants and competing for social rank. At the same time, only a limited number of individuals can have high social rank, and when one individual increases her status thereby enhancing her welfare, somebody else has to be demoted and experience lower welfare. In general, when status is part of the utility function, the fight for status results in negative externalities, and therefore, inefficiencies in a laissez faire environment.

Several different types of models have been developed to examine the effects of interdependent preferences, including general distributional concerns, reciprocal behavior, and status competition. Our model belongs to the status competition literature. One important issue in this literature is how to alleviate the effect of the negative externality created by status competition. Ljungqvist and Uhlig (2000) derive an optimal tax policy in a simple model of an economy with the keeping-up-with-the-Joneses utility function. They also show that the optimal tax policy in catching-up-with-the-Joneses economy (i.e., where utility depends on past average consumption of others) is countercyclical in the sense that it calls for higher taxes during the boom and lower taxes during the recession. While these are conventional Keynesian prescriptions, the underlying reasoning is quite different. Dupor and Liu (2003) distinguish between keeping-up-with-the-Joneses and jealousy. The former raises marginal utility of consumption relative to leisure while the latter means that one's utility negatively depends on the average consumption of others. Dupor and Liu (2003) show that it is jealousy that causes equilibrium overconsumption and derive the same result as Ljungqvist and Uhlig (2000) with respect to optimal tax policy but using a richer modeling framework. An important common feature of all these models is the use of economy-wide average consumption or income as a reference.

The importance and effects of status competition are clearly demonstrated by two strands in the recent empirical literature: laboratory and field experiments, and surveys. Several field experiments investigated how pure status concerns modify individual behavior and subjective well-being. For example, Charness et

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6We do not review the large literature on social interdependence outside of the topic of status competition. Instead, we refer interested readers to some key papers: Sethi and Somanathan (2001), Charness and Rabin (2002), Sethi and Somanathan (2003), Engelmann and Strobel (2004), Sobel (2005), Falk and Fischbacher (2006), Cox et al. (2007), Duffy and Kornienko (2010), and Chen et al. (2010).

7Interested readers are referred to Fehr and Falk (2002) and Eckel et al. (2010) for a comprehensive review of the experimental
al. (2010) provide experimental evidence that status-conscious people are willing to exert significantly more effort to improve their status either by increasing their own output or sabotaging the work of others even though the experiment participants derive no tangible material benefits from their efforts. Charness et al. (2010) also find that agents exert status-enhancing effort even when their relative rank in the reference group is not revealed to others although they exert more effort if the ranking becomes publicly known. Similar results are obtained by Tran and Zeckhauser (2012) who show that Vietnamese students perform significantly better on an English test when they have rank incentives, even in situations where rank incentives bring no tangible benefit. Furthermore, this result holds even when ranking information could not be convincingly communicated to others. Bhattacharya and Dugar (2013) also provide evidence that individuals indeed care for purely nonmonetary ranks and are motivated to invest costly effort to win ranks that only have status value.

The above experimental studies do not address the issue of whether reference groups are specific to an individual although reference groups in experiments are obviously limited to the participants. More explicitly, contrary to the assumption of a common reference point in theoretical literature, empirical studies by Luttmer (2005), Ferrer-i-Carbonell (2005), and Dynan and Ravina (2007) find that individual well-being appears to depend on her consumption relative to own reference group rather than to the societal average. For example, Luttmer (2005) presents evidence of “spiteful equalitarianism” whereby individuals’ self-reported happiness is negatively affected by the earnings of others who are similar to the individual in socioeconomic status. This paper finds that individuals’ happiness decreases if neighbors who have a similar level of education earn more, but is insensitive to the earnings of neighbors with different educational attainment. Ferrer-i-Carbonell (2005) uses a self-reported measure of life satisfaction in Germany as a measure of individual well-being or happiness. Instead of using societal average, they generate 50 different reference groups that are categorized on the basis of age, education, and region of residence. They conclude that the income of an individual’s reference group is about as important as own income for individual satisfaction. Dynan and Ravina (2007) study the evolution of reported happiness for different socioeconomic groups over 25 years. Similarly to Luttmer (2005), they find that individuals compare themselves to those who are geographically close. In general, heterogeneity of individual’s reference groups is commonly found in recent empirical works but not in theoretical analysis.

Our paper represents an attempt to bridge the gap between theoretical and empirical work in status concern evidence about the linkage between status concerns and performance in an organization and in the labor market. Charness et al. (2010) and Bhattacharya and Dugar (2012) together provide excellent reviews about experimental studies in a non-monetary returns environment.
petition, and highlights the effect of status-seeking in an economy with individual-specific reference groups. Our general theme is that the effect of status-seeking on individual behavior and on welfare crucially depends on the individual’s position within the network. More specifically, we derive the following results. First, we show that equilibrium consumption and effort level of an individual are monotonically increasing in her relative *comparison intensity* that represents the strength of connections of the individual to the rest of the society and is defined by the Katz-Bonacich network *outbound* centrality measure. Although this result is similar to Ghiglino and Goyal (2010), we obtain it in a somewhat different model. In particular, our model includes labor and is based on a network with directed links. As one would expect, the more a person is connected to others, the greater will be the positive effect of others’ consumption level on this person. Moreover, in order to achieve higher consumption, agents with higher comparison intensity will divert more of their leisure to work effort. Second, if the real wage is endogenous and depends on society’s marginal product of labor, there is an inverse relationship between real wage and average comparison intensity of the network. This happens because greater average comparison intensity results in greater average effort level which decreases marginal productivity of labor. Third, consistent with the result from Dupor and Liu (2003), jealousy generates a negative externality, resulting in overconsumption and lower social welfare. In our heterogeneous reference setting, we demonstrate that the negative externality generated by a given agent depends on what we call the agent’s *conspicuousness index*. Unlike the outbound Katz-Bonacich measure that determines the agent’s effort and consumption, this index measures *inbound* linkages to the individual in the network, and shows the agent’s importance for consumption and work effort decisions of other agents. In general, if one has inbound links from more agents in the economy, one’s conspicuousness is higher, and it will induce higher overconsumption in the society. We further show that once conspicuousness triggers social inefficiency, comparison intensity exacerbates the overconsumption effect. In other words, an agent who is most central with respect to both outbound and inbound linkages of the network generates the highest overconsumption. Fourth, we study optimal taxation in order to correct for externalities. We consider two methods of taxation aimed at reducing the distortion caused by status competition: one in which the tax is a function of the agent’s comparison intensity, and another in which the tax is a function of the agent’s conspicuousness. Although both methods can reduce inefficiency, only the consumption tax based on the conspicuousness index can be assured to bring the economy to the first-best state. While our results are obtained for a Cobb-Douglas utility function, the results are very intuitive, suggesting that the role of Katz-Bonacich centrality measure and conspicuousness index would be preserved at least approximately for other utility functions as well.

The paper proceeds as follows. Section 2 presents a model of status competition in a network and derives
equilibrium consumption and work effort for linear production functions. Section 3 provides welfare analysis and describes the optimal tax policy to deal with externalities. Section 4 extends the analysis to a non-linear production function setup. Section 5 concludes.

2 The Model

We consider an economy populated with \( N \) agents, \( i = 1, \ldots, N \). The agents form a network. We assume that the network structure is exogenous, and the linkages in the network are directed. The presence of an outbound link from agent \( i \) to agent \( j \) implies that agent \( i \) chooses agent \( j \) as a member of her reference group and an inbound link from agent \( k \) to agent \( i \) means that agent \( i \) is selected as a member of agent \( k \)'s reference group.\(^8\) Let \( N(i) \) denote the set of agents that form agent \( i \)'s reference group and let \( n_i = |N(i)| \). We apply a directed network structure in our analysis with two justifications. First, the directed network shows the asymmetric nature of comparison. For example, an average person, Mrs. Smith, may emulate a celebrity in her behavior, but the celebrity would not bother to emulate Mrs. Smith. Second, the directed network structure allows us to distinguish meaningfully between the effect of the average consumption of others on a given agent and the effect of the agent on the rest of society.

We assume that each agent has a non-wage endowment \( y_i \) denominated in units of the consumption good (numeraire). All agents have identical preferences over consumption and leisure. In order to finance consumption, agents exert \( e \) units of effort. Let \( h_i \) denote the time endowment available for each agent, so that \( h_i - e_i \) is the leisure consumed by agent \( i \). We assume that in addition to good consumption and leisure, agent \( i \)'s utility depends on the distance between her consumption and the average consumption of her reference group. The \( N \times N \) adjacency matrix \( G = [g_{ij}] \) of ones and zeros keeps track of the directed connections in the network. The \( \{i, j\} \)-th element of the matrix has a value of 1 if and only if agent \( i \) chooses agent \( j \) as one of the reference group members. We assume that the diagonal elements of \( G \) are equal to 0.

Let agent \( i \)'s utility have Cobb-Douglas form:\(^9\)

\[
    u_i(e_i, x_i, x_{-i}) = (h_i - e_i)^\sigma \left(f_i(x_i, x_{-i})\right)^{1-\sigma},
\]

\(^8\)The network with undirected links would represent a special case of our model. In this special case, the existence of a link from \( i \) to \( j \) would imply the existence of a link from \( j \) to \( i \).
\(^9\)We apply the Cobb-Douglas function not only because it is particularly convenient for incorporating the network structure into our problem but also because it reflects in a simple and tractable way of the two main characteristics—keeping-up-with-the-Joneses and jealousy—described in Dupor and Liu (2003).
where $0 < \sigma < 1$ and $f_i : R \times R^n \rightarrow R$ with subscript $-i$ denoting the set of agent $i$’s reference group. That is, we suppose that agent $i$’s welfare depends on relative good consumption but is not affected by relative leisure consumption. This setting follows the argument in Solnick and Hemenway (1998) and Ljungqvist and Uhlig (2000), who conclude that relative consumption positions are more important determinants of individuals’ welfare than relative leisure positions. Frank (1999) also argues that consumption externalities are more likely to take place. Finally, we assume away saving for the future and, therefore, income and consumption coincide in our model.

In principle, being poorer than the average of one’s reference group can either lower or enhance one’s welfare. When being poorer than average lowers one’s welfare, this is referred to as the status effect or “jealousy.” This phenomenon is typically found in stable developed economies such as those of Western Europe. However, studies conducted in the economies in transition (Senik, 2004, 2008) and immigrant communities (Alesina et al., 2004) found that an individual can also benefit from being poorer than her reference group average. Presumably, this occurs because the reference group average provides a signal about the individual’s future prospects in an environment of significant uncertainty (Clark et al., 2009). In this paper, we assume that agents experience only jealousy and leave the investigation of the “signal effect” to future work.

Given the status effect, the non-negative function $f_i$ is increasing in $x_i$ and decreasing in each element of vector $x_{-i}$. It is natural to assume that when all agents from the reference groups consume the same amount $x_i$, the effect of the group’s consumption on each agent’s welfare is zero. Further, following the empirical evidence from Luttmer (2005) who shows that the negative relationship between the reference group’s earnings (consumption) and own well-being is stronger for those who socialize with more individuals, we assume that the group’s effect is proportional to the size of the group. A particularly simple function $f_i$ that satisfies these assumptions has the following form:

$$f_i(x_i, x_{-i}) = x_i + \rho n_i (x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j).$$ (2)

This utility function reflects two important characteristics. (1) **Agents are emulative**: i.e., they are trying to “keep up with the Joneses”. This means that “an increase in aggregate consumption raises the marginal utility of individual consumption relative to leisure” (Galí, 1994). An individual receives greater utility

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10We define marginal substitution between leisure and consumption as

$$m = \frac{\partial u_i / \partial e_i}{\partial u_i / \partial x_i} = \frac{-\sigma (x_i + \rho n_i (x_i - \bar{x}_i + \frac{1}{n_i} x_i))}{(1 - \sigma) (1 + \rho n_i) (h_i - e_i)},$$

where $\bar{x}_i = \frac{1}{n_i} (\sum_{j \in N(i)} x_j + x_i)$. Therefore, we have
from additional own consumption relative to leisure when others consume more. (2) *Agents are jealous*: the utility is declining in the reference group’s average consumption level. A higher average consumption of reference group members can result in an individual’s utility reduction if her consumption remains unchanged.

From Eq.(2), Eq.(1), and the budget constraint, consumer $i$’s optimization program is given by

$$
\max_{(e_i, x_i)} u_i(e_i, x_i, x_{-i}) = (h_i - e_i)^\sigma (x_i + \rho n_i (x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma} \tag{3}
$$

$$\text{s.t. } x_i = we_i + y_i$$

$$0 \leq e_i \leq h_i; \quad x_i \geq 0.$$ 

The first-order condition associated with problem (3) is

$$\frac{\partial u_i}{\partial x_i} = -\frac{\sigma}{w} (h_i - e_i)^{\sigma - 1} (x_i + \rho n_i (x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma}$$

$$+ (1 - \sigma)(1 + \rho n_i) (h_i - e_i) \sigma (x_i + \rho n_i (x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma} = 0. \tag{4}$$

Therefore, the supply of effort and demand for good consumption are given by

$$e^*_i = (1 - \sigma)h_i - \sigma \frac{y_i}{w} - \frac{\rho}{w(1 + \rho n_i)} \sum_{j \in N(i)} x_j, \tag{5}$$

$$x^*_i = (1 - \sigma)(h_i w + y_i) + \frac{\sigma \rho}{1 + \rho n_i} \sum_{j \in N(i)} x_j. \tag{6}$$

By rearranging Eq.(6) and using the $i$-th row in adjacency matrix $G$, we have

$$x^*_i - \frac{\sigma \rho}{1 + \rho n_i} G_i X - (1 - \sigma)(h_i w + y_i) = 0, \tag{7}$$

$$\frac{\partial m}{\partial \bar{x}_i} = \frac{\sigma \rho n_i}{(1 - \sigma)(1 + \rho n_i)(h_i - e_i)} > 0.$$ 

$$\frac{\partial u_i}{\partial x_j} = -(1 - \sigma) \rho \left[ \frac{h_i - e_i}{x_i + \rho n_i (x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j)} \right]^\sigma < 0.$$
where $X$ is an $N \times 1$ vector of agents’ good consumption level.

Following Ghiglino and Goyal (2010), we define $G^*$ as an $N \times N$ matrix of connections in which every row is normalized so that $G^*_i = G_i / (1 + \rho n_i)$. We define $Y$ as an $N \times 1$ vector of exogenous income endowments for agents, and $H$ as an $N \times 1$ vector of exogenous time endowments for agents. Thus, Eq. (7) in matrix form can be written as

$$[I - \sigma \rho G^*]X^* - (1 - \sigma)(wH + Y) = 0,$$

implying that

$$X^* = (1 - \sigma)[I - \sigma \rho G^*]^{-1}(wH + Y).$$

(9)

In order to obtain crisp results, we first assume that all agents have identical wealth and time endowments:

$$wh_i + y_i = wh + y,$$

$$wH + Y = (wh + y)J,$$

where $J$ is an $N \times 1$ vector of ones, and therefore, Eq. (9) can be written as

$$X^* = (1 - \sigma)[I - \sigma \rho G^*]^{-1}J(wh + y).$$

(10)

We will now show that the role of status-seeking in this economy crucially depends on the status comparison intensity defined using the outbound Katz-Bonacich network centrality measure\(^\text{12}\). Comparison intensity is supposed to reflect the strength of agents’ connection to the network via outbound links, and therefore, the Katz-Bonacich centrality measure serves as a perfect proxy for comparison intensity. The outbound Katz-Bonacich centrality measure counts not only the direct outbound links between agents but also all paths that emanate from a given individual, and the effect of indirectly linked agents is weighted by a decay factor that decreases with the length of these paths. This reflects the fact that an agent’s behavior in our model depends not only on how many reference members are in her reference group but also on the status comparison intensity of her reference members. Following Ballester et al. (2006) and Ghiglino and Goyal (2010), the Katz-Bonacich network centrality is an $N \times 1$ vector $\beta^*$ defined as

$$\beta^* = [I - \sigma \rho G^*]^{-1}J.$$

\(^{12}\)Because we are using a network with directed links, the outbound centrality is in general different from inbound centrality. We will see later that the inbound centrality measure we define in Section 3 is crucial for determining the welfare effects of status-seeking behavior.
For sufficiently low values of a decay factor \( \rho \), the inverse \( [I - \sigma \rho G^*]^{-1} \) can be expressed as a power series that reflects all the paths emanating from an individual (Currrarini et al., 2009):

\[
[I - \sigma \rho G^*]^{-1} = \sum_{s=0}^{\infty} (\sigma \rho G^*)^s.
\] (12)

Using Eq. (11), we can rewrite Eq. (10) as

\[
X^* = (1 - \sigma)(\text{wh} + y)\beta^*.
\] (13)

For each individual agent, this becomes

\[
x^*_i = (1 - \sigma)(\text{wh} + y)\beta^*_i.
\] (14)

Eq. (14) and the fact that \( e_i = (x_i - y)/(w) \) imply that an agent’s effort and consumption are increasing in her Katz-Bonacich network centrality measure. In a model where agents disregard comparisons with other agents’ consumption (that is, where \( \beta_i = 1 \)), the good consumption level \( x_i \) is the same for each individual. However, when relative consumption is a factor, agents with stronger status comparison intensity work and consume more than agents with lower status comparison intensity.

**Proposition 1.** In a network with agents homogeneous with respect to time and wealth endowment, individuals’ consumption and work effort are proportional to their status comparison intensity defined by the outbound Katz-Bonacich centrality measure.

A more realistic case where agents have endowment heterogeneity represents a fairly straightforward extension of the above model. It is discussed in appendix A in a somewhat more general framework with non-linear aggregate production function (See section 4). Overall, the results of endowment heterogeneity are consistent with those of endowment homogeneity, but the analysis is somewhat more complicated technically.

### 3 Welfare Analysis

Equilibrium overconsumption of a positional good has been widely recognized and its effects on welfare have been studied in a framework where all agents compared their consumption to the economy-wide average. Dupor and Liu (2003) argue that “jealousy” implies that the laissez faire equilibrium consumption level is
greater than the socially optimal level since agents ignore the negative externality of own consumption on the jealous others. This also implies that the agents apply greater than the first-best level of effort and underconsume leisure. As we saw in the previous section, however, the effects of status-seeking on consumption and leisure are not uniform, but are determined by each agent’s out-degree of centrality in the network. Moreover, as we show in this section, the strength of welfare effects of status-seeking depends not on the “outbound” Katz-Bonacich centrality measure, but on the “inbound” centralities of the agents. We begin the examination of the first-best allocation by assuming that a benevolent social planner chooses $x_1, \ldots, x_n$ to maximize social welfare defined as the sum of individual utilities:

$$
\max_{x_1, \ldots, x_n} W = \max_{x_1, \ldots, x_n} \sum_{i=1}^{N} u_i(x_i, x_{-i})
= \max_{x_1, \ldots, x_n} \sum_{i=1}^{N} \{(h - \frac{x_i - y}{w})^\sigma (x_i + \rho n_i(x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma}\}.
$$

(15)

The first-order conditions for problem (15) for each $i = 1, \ldots, n$ are as follows:

$$
\frac{\partial W}{\partial x_i} = \frac{-\sigma}{w} (h - e_i)^{\sigma-1}(x_i + \rho n_i(x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma}
\underbrace{\frac{\partial u_i(x_i)}{\partial x_i}}_{\frac{\partial u_i}{\partial x_i}}
+ (1 - \sigma)(1 + \rho n_i)(h - e_i)^{\sigma}(x_i + \rho n_i(x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{-\sigma}
\underbrace{\frac{\partial u_i(x_i)}{\partial x_i}}_{\frac{\partial u_i}{\partial x_i}}
-(1 - \sigma)\rho \sum_{\{j \in N(i)\}} \{(h - e_j)^{\sigma}(x_j + \rho n_j(x_j - \frac{1}{n_j} \sum_{k \in N(j)} x_k))^{-\sigma}\} = 0.
$$

(16)

A comparison of Eq.(16) and Eq.(4) reveals that the effect of own consumption on other agents is reflected
in the third term of Eq. (16): $\sum_{j\in N(i)} \frac{\partial u_j}{\partial x_i}$. Moreover, since $\frac{\partial^2 u_i}{\partial x_i^2} < 0$ and $\frac{\partial^2 W}{\partial x_i^2} < 0$ we obtain that the socially optimal good consumption ($x_i^{fb}$) of agents that are linked to other agents is less than the equilibrium good consumption ($x_i^*$) for each agent, as shown in Figure 1(a) (see also Dupor and Liu (2003)).

To explore the role of externalities in this network, we introduce a conspicuousness index $\Delta_i$ to represent the degree to which agent $i$ serves as a comparator for other agents in the network. For example, politicians, athletes, and movie stars who have public and media attention would presumably have a high conspicuousness index level independent of their outbound Katz-Bonacich centrality measure. In contrast with comparison intensity, the conspicuousness index serves as the measure of inbound centrality in our network. We define $\Delta_i$ as:

$$\Delta_i = \frac{\rho \sum_{j\in N(i)} \{(h - e_j)^\sigma(x_j + \rho m_j(x_j - \frac{1}{n_j} \sum_{k\in N(j)} x_k))^{-\sigma}\}}{(1 + \rho m_i)(h - e_i)^\sigma(x_i + \rho m_i(x_i - \frac{1}{n_i} \sum_{j\in N(i)} x_j))^{-\sigma}} = \sum_{j\in N(i)} \left(\frac{\partial u_j}{\partial x_i}\right) \frac{\partial u_i}{\partial x_i}. \quad (17)$$

\[\frac{\partial^2 u_i}{\partial x_i^2} = -\frac{\sigma}{w}(1 - \sigma)(1 + \rho m_i)((h - e_i)^\sigma - 1)(x_i + \rho m_i(x_i - \frac{1}{n_i} \sum_{j\in N(i)} x_j))^{-\sigma} - \sigma(1 - \sigma)(1 + \rho m_i)^2(h - e_i)^\sigma(x_i + \rho m_i(x_i - \frac{1}{n_i} \sum_{j\in N(i)} x_j))^{-\sigma} < 0. \quad (13)\]

\[\frac{\partial^2 W}{\partial x_i^2} = \frac{\partial^2 u_i}{\partial x_i^2} - (1 - \sigma)\rho^2 \sum_{j\in N(i)} \{(h - e_j)^\sigma(x_j + \rho m_j(x_j - \frac{1}{n_j} \sum_{k\in N(j)} x_k))^{-1(1+\sigma)}\} < 0. \quad (14)\]
Note that all \(x_i's\) and \(e_i's\) in Eq.(17) refer to the first best values of these variables. That is, \(\Delta_i\) is independent of the agents’ non-first-best consumption and leisure. The numerator of Eq.(17) reflects the effect of agent \(i's\) consumption on the agents who have agent \(i\) in their reference group. The denominator scales this effect by the marginal utility of consumption for agent \(i\). That is, the conspicuousness index relates the negative effect of a marginal increase in agent \(i's\) consumption on others and the positive effect it has for agent \(i\). Agents with a higher \(\Delta_i\) are located in the center of inbound links, and act more like the “Joneses” in the network. From Eq.(17), \(\Delta_i\) is positively related to the number of \(j\) agents (that is, those agents who have agent \(i\) in their reference group: \(\sum_{j \in N(i)} n_j\)), and the average first-best good consumption level of agent \(j’s\) reference members (\(\sum_{k \in N(j)} x_k/n_j\)). In contrast, \(\Delta_i\) is negatively related to the number of reference members that agent \(j\) chooses (\(n_j\)), agent \(j’s\) first-best consumption level (\(x_j\)), and the marginal utility of agent \(i\) from consumption (\(\partial u_i(x_i)/\partial x_i\)).

Using the definition of \(\Delta_i\), Eq.(16) can be rearranged as

\[
\frac{\sigma(x_i + \rho n_i(x_i - \sum_{j \in N(i)} \frac{1}{n_j} x_j))}{w(1 - \sigma)(1 + \rho n_i)(h - e_i)} = 1 - \Delta_i \geq 0. \tag{18}
\]

Simplifying Eq.(18) by applying \(e_i = (x_i - y)/w\), we have

\[
x_{i}^{fb} - \frac{\sigma \rho}{(1 + \rho n_i)(1 - \Delta_i + \sigma \Delta_i)} G_i X = \frac{(1 - \sigma)(1 - \Delta_i)}{1 - \Delta_i + \sigma \Delta_i} (wh + y). \tag{19}
\]

Define modified comparison intensity as

\[
\beta^{fb} = [I - \frac{\sigma \rho}{(1 + \rho n_i)(1 - \Delta_i + \sigma \Delta_i)} G_i]^{-1} J = [I - \rho \sigma G^{fb}]^{-1} J = \sum_{s=0}^{\infty} (\sigma \rho G^{fb})^s J
\]

The socially optimal good consumption level \(x_i^{fb}\) is implicitly defined as

\[
x_i^{fb} = \frac{(1 - \sigma)(1 - \Delta_i)}{1 - \Delta_i + \sigma \Delta_i} (wh + y) \beta_i^{fb}. \tag{20}
\]

Comparing the socially optimal good consumption level \(x_i^{fb}\) with the equilibrium good consumption level from Eq.(14), we obtain

\[
x_i^{*} - x_i^{fb} = (1 - \sigma)(wh + y)(\beta_i^{*} - \frac{1 - \Delta_i}{1 - \Delta_i + \sigma \Delta_i} \beta_i^{fb}). \tag{21}
\]

When \(\Delta_i = 0\), we have both \(\beta_i^{*} = \beta_i^{fb}\) and \((1 - \Delta_i)/(1 - \Delta_i + \sigma \Delta_i) = 1\), and therefore, \(x_i^{*} = x_i^{fb}\). This

\[\footnote{Note the first-best consumption is defined relative to the utility that exhibits jealousy. In the absence of jealousy, i.e., when \(\rho = 0\), first-best consumption would have been simply \((1 - \sigma)(wh + y)\).}
suggests that when no agent chooses agent $i$ as a reference member, agent $i$’s equilibrium good consumption is equal to the first-best consumption level since agent $i$’s good consumption does not impose a negative externality on anybody. In contrast, when $\Delta_i = 1$ and agent $i$’s conspicuousness index reaches its maximum possible value, agent $i$ overconsumes the most: $x_i^* - x_i^{fb} = (1 - \sigma)(wh + y)\beta_i^*$. In general, from the partial derivative of the difference between equilibrium and socially optimal consumption (see Eq. (22) below and Figure 1(b)), we conclude that the overconsumption level is higher for an agent with a higher conspicuousness level $\Delta_i$. A high $\Delta_i$ means that agent $i$ is used by many other agents as a reference, and, therefore, consumption by high-$\Delta_i$ agents results in a large negative externality for others and thus yields greater inefficiencies:

$$\frac{\partial(x_i^* - x_i^{fb})}{\partial \Delta_i} = \frac{(1 - \sigma)(wh + y)}{1 - \Delta_i + \sigma \Delta_i} \left( \frac{\sigma \beta_i^{fb}}{1 - \Delta_i + \sigma \Delta_i} - (1 - \Delta_i) \frac{\partial \beta_i^{fb}}{\partial \Delta_i} \right) > 0.$$  \hspace{1cm} (22)

Eq. (22) also suggests that a positive relationship between equilibrium overconsumption and the conspicuousness level holds even if agent $i$ does not compare her own consumption with consumption of others ($\beta_i^* = 1$). However, once the divergence of equilibrium and optimal consumption exists due to others choosing agent $i$ as part of their reference group ($\Delta_i > 0$), agent $i$’s own status comparison intensity magnifies the externality as shown in Figure 1(b) where agent $i$ who has a higher status comparison intensity creates a higher distortion than agent $j$, given the same conspicuousness level. The combined effect of the inbound (conspicuousness level) and outbound (status comparison intensity) links suggests that an agent with a large number of links in both directions (i.e., a “star” in the network) contributes a great deal to the distortion of the good consumption level.

Since the distortion arises from a negative externality that spreads via a network, a socially beneficial tax policy needs to deal with this externality by either taxing consumption of agents with high conspicuousness level $\Delta_i$ or taxing the agents with high status comparison intensity $\beta_i^*$ or both. Suppose that agent $i$’s good consumption is subject to tax. The agent’s budget constraint becomes $x_i = (1 - t_i)(we_i + y) + l$, where $t$ is the tax rate and $l$ is the lump-sum transfer. The first-order condition for the agent’s optimization problem is

$$\frac{\partial u_i}{\partial x_i} = \frac{-\sigma}{w(1 - t_i)}(h - e_i)^{\sigma - 1}(x_i + \rho n_i(x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma}
+ (1 - \sigma)(1 + \rho n_i)(h - e_i)^{\sigma}(x_i + \rho n_i(x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{-\sigma} = 0.$$  \hspace{1cm} (23)

\hspace{1cm} 16We relegate detailed derivations to Technical Appendix B available from the CJE online archive at cje.economics.ca.

\hspace{1cm} 17Obviously, for any $\Delta_i > 0$, $(\partial(x_i^* - x_i^{fb})/(\partial \Delta_i) > 0.$
Eq. (23) can be simplified as

$$\frac{\sigma (x_i + \rho n_i (x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))}{w(1 - \sigma)(1 + \rho n_i)(h - e_i)} = 1 - t_i.$$  

(24)

Eq. (24) becomes identical to Eq. (18) if \( t_i = \Delta_i \). Therefore, the optimal marginal tax rate for agent \( i \) is her own conspicuousness level. In a network with jealousy, the optimal tax policy is independent of the agent’s status comparison intensity (\( \beta^*_i \)), but is determined by the extent to which the other agents in the network use agent \( i \) as a comparator. Figure 1(b) illustrates the effects of different approaches to taxation. Both a higher tax on agents with a greater status comparison intensity (decreasing the effect of \( \beta^*_i \), pivot at the origin) and a higher tax on agents with a greater conspicuousness level (decreasing the effect of \( \Delta_i \), shift along the x-axis) yields an improvement in the allocative efficiency. However, depressing an agent’s status comparison intensity can at best reach line I in the bottom of the Figure, but cannot fully remove inefficiency. In contrast, a tax rate based on the agents’ conspicuousness levels can serve as a perfect tool to reach social optimum. Although taxing individuals because they are the focus of public attention may not be practical, our analysis provides a theoretical framework for dealing with the distortion arising from status competition. Note also, that it may not be particularly difficult to identify people with relatively high conspicuousness index. For example, movie actors and TV personalities presumably serve as comparators to large groups of people. Moreover, because given the agent’s network centrality, the negative externality created by the agent is positively related to her good consumption (or income) level, fairly conventional public policy instruments, such as a progressive general expenditure tax or a progressive income tax can improve social welfare. Proposition 2 summarizes the main results of this section.

**Proposition 2.** Equilibrium overconsumption is higher for agents with a higher conspicuousness index (\( \Delta_i \)). Given the conspicuousness index, individuals’ comparison intensity (\( \beta^*_i \)) has an amplifying effect on the divergence of equilibrium consumption from the socially optimal consumption level. For agents with non-zero conspicuousness index, both a tax based on individuals’ conspicuousness index and a tax based on their comparison intensity improve efficiency. However, only the tax based on individuals’ conspicuousness index yields the first best consumption level.
4 Non-linear Production Function

The model analyzed above uses linear production functions for all agents. In order to examine status competition in a more general framework with diminishing returns to effort, we assume that the economy-wide output is given by

\[ Q = \left( \sum_{i=0}^{N} e_i \right)^\alpha, \quad (25) \]

where \( \alpha \in (0, 1) \). To simplify the analysis, we assume that the agents have no initial endowments of the consumption good in problem (3), that is, the budget constraint is now \( x_i = we_i \). We still keep the assumption that all agents have homogeneous time endowment and ability in this section, and discuss the heterogeneous case in Appendix A. We define the equilibrium of this economy as a positive wage, \( w \), and the set of allocations \( \{(x_i^*, e_i^*) \in \mathbb{N} \} \) that solve problem (3) for each \( i \) such that aggregate output is as in Eq.(25) and a balance condition \( Q = \sum_{i=0}^{N} x_i \) holds.

From Eq.(13), we have

\[ x_i^* = (1 - \sigma)(wh)^{\beta_i^*}. \quad (26) \]

From budget constraint \( x_i = we_i \), we obtain the equilibrium effort level

\[ e_i^* = \frac{x_i^*}{w} = (1 - \sigma)h^{\beta_i^*}. \quad (27) \]

Define \( \bar{\beta}^* = (\sum_{i=1}^{N} \beta_i^*)/N \) as the average status comparison intensity in the network. Then, from the equilibrium condition, we obtain the following two equations

\[ \sum_{i=1}^{N} x_i^* = w \sum_{i=1}^{N} e_i^* = w \sum_{i=1}^{N} (1 - \sigma)h^{\beta_i^*} = w(1 - \sigma)h(N\bar{\beta}^*), \quad (28) \]

\[ \sum_{i=1}^{N} x_i^* = Q = \left( \sum_{i=1}^{N} e_i^* \right)^\alpha = \left( \sum_{i=1}^{N} (1 - \sigma)h^{\beta_i^*} \right)^\alpha = (1 - \sigma)^\alpha h^\alpha (N\bar{\beta}^*)^\alpha. \quad (29) \]

Combining Eq.(28) and Eq.(29), the equilibrium wage rate is given by

\[ w = \frac{1}{((1 - \sigma)hN\bar{\beta}^*)^{1-\alpha}}. \quad (30) \]

Eq.(30) shows that the real wage \( w \) is independent of individuals’ comparison intensity, but is inversely
related to the average comparison intensity of the society. In a society where the agents on average are linked to many other agents, the real wage is relatively low because status seeking pushes people to raise consumption by overinvesting in work effort causing a decrease in the marginal productivity of labor. Substituting Eq. (30) into Eq. (26), we obtain the equilibrium good consumption level for individual $i$ as

$$x_i^* = \frac{(1 - \sigma)^\alpha h^\alpha \beta_i^*}{N^{1-\alpha} \beta_i^{1-\alpha}}. \quad (31)$$

We now can formulate the following proposition.

**Proposition 3.** In a network with agents homogeneous with respect to time endowment and with production exhibiting diminishing returns to aggregate effort, individuals’ consumption and work effort are proportional to their status comparison intensity and depend inversely on the average value of comparison intensity in the network. The average value of comparison intensity in the society has a negative effect on the real wage.

The welfare effects of status competition in this economy are similar to Proposition 2, but the tax policy to achieve the first-best is more complicated than in an economy with linear production functions. In order to examine the tax policy to achieve the first-best, we assume as before that the social planner calculates the socially optimal consumption level for each agent by solving problem (15) for $y = 0$. We then obtain the first-order condition and conduct welfare analysis along the lines of section 3. The detailed derivations are provided in Technical Appendix C.\(^{18}\)

5 Conclusion

In this paper, we develop a general equilibrium model that incorporates the effect of network structure on status-seeking behavior. Motivated by well-established empirical findings, the utility function in this paper features two effects of consumption externality that are widely observed in stable economies. When agents from the individual’s reference group consume more, the individual derives greater utility from additional own consumption relative to leisure (keeping up with the Joneses). At the same time, given fixed individual consumption, higher average consumption by the reference group lowers individual’s utility—jealousy. Our main contribution is to model the effects of consumption externalities using individual-specific reference groups. In doing so, we bridge the gap between existing theoretical literature that uses economy-wide average as references and the empirical work that clearly shows that reference groups are specific to individuals. In the

\(^{18}\)Available from the CJE online archive at cje.economics.ca.
benchmark version of the model where all agents have the same endowments of time and money, we show that both good consumption and work effort are monotonically increasing in the agent’s outbound Katz-Bonacich network centrality measure. When agents’ endowments are heterogeneous, this effect is further intensified for individuals who are linked to relatively high-endowment agents.

Jealousy leads to overconsumption, since agents’ consumption generates negative externality in a network. The divergence between equilibrium consumption and efficient consumption is especially significant for agents who serve as comparators to many other agents, i.e., agents with a high conspicuousness index defined based on the agent’s in-degree centrality. A tax aimed at either reducing comparison intensity (defined by the agents’ outbound centrality) or conspicuousness level (reflected by the inbound centrality measure) can abate the inefficiency of the economy. However, only a tax policy aimed at individuals’ conspicuousness level can reach the socially optimal consumption level.

The model in this paper is based on an exogenously given network that includes reference group structure. In reality, reference groups in modern mobile societies are to a large extent endogenous. They depend on where the person lives, works, goes to school and other choices the person makes. A potential extension of this paper is to apply network formation methods in a status competition environment in order to derive testable implications about reference group selection, including people’s choices of neighborhoods, churches, and other associations.
Appendices

A Endowment Heterogeneity

We now explore a more general case wherein each agent has a different real wage rate and available time for spending on either effort or leisure \((h_i)\). We assume that individual’s wage rate is proportional to her ability \(v_i\), so that agent \(i\)’s wage is \(w v_i\). Time heterogeneity can be interpreted as the difference in commuting time for agents from home to work (Helsley and Strange, 2007; Helsley and Zenou, 2011). Individuals solve the following problem:

\[
\begin{align*}
\max_{(e_i, x_i)} & \quad u_i(e_i, x_i, x_i) = (h_i - e_i)^\sigma (x_i + \rho n_i(x_i - \frac{1}{n_i} \sum_{j \in N(i)} x_j))^{1-\sigma} \\
\text{s.t.} & \quad x_i = w v_i, e_i,
\end{align*}
\]

with production function \(Q = (\sum_{i=1}^{N} v_i e_i)^\alpha\). In equilibrium, we have \(\sum_{i=1}^{N} x_i = Q\). Let \(V H\) be an \(N \times 1\) vector of heterogeneous ability and time endowment for agents, such that \(V H' = (v_1 h_1, v_2 h_2, ..., v_n h_n)\). The equilibrium consumption level is given by

\[
X^* = (1 - \sigma)\left[ I - \sigma \rho G^* \right]^{-1}(w V H). \tag{A.2}
\]

Let \(B = [I - \sigma \rho G^*]^{-1}\); then, from Eq.(A.2), we have

\[
X^* = (1 - \sigma)B(w VH). \tag{A.3}
\]

In equilibrium we have

\[
X' J = \sum_{i=1}^{N} x_i = Q = (\sum_{i=1}^{N} v_i e_i)^\alpha = (\sum_{i=1}^{N} \frac{x_i}{w})^\alpha = [(1 - \sigma)(BVH)'J]^\alpha = (1 - \sigma)w(BVH)'J, \tag{A.4}
\]

Eq.(A.4) implies that

\[
w = \frac{[(1 - \sigma)(BVH)'J]^\alpha}{(1 - \sigma)(BVH)'J} = \frac{1}{[(1 - \sigma)(BVH)'J]^{1-\alpha}}. \tag{A.5}
\]

Let \(BVH = \beta_{vh}\) be an \(N \times 1\) vector of agents’ status comparison intensities weighted by each reference
member’s ability endowment and time endowment, and let $\beta_{vh} = \beta_{vh}'J/N$ be the average weighted comparison intensity for the network. We then have

$$w = \frac{1}{[(1-\sigma)\beta_{vh}'J]^{1-\alpha}} = \frac{1}{[(1-\sigma)N\beta_{vh}]^{1-\alpha}}. \quad (A.6)$$

Therefore,

$$w_i = wv_i = \frac{v_i}{[(1-\sigma)N\beta_{vh}]^{1-\alpha}}. \quad (A.7)$$

From Eq. (A.3) and Eq. (A.6), we have

$$x_i^* = (1-\sigma)w(BVH)_i = (1-\sigma)w\beta_{vh,i} = \frac{1-\sigma}{[(1-\sigma)\beta_{vh}'J]^{1-\alpha}}\beta_{vh,i} = \frac{(1-\sigma)^{\alpha}}{(N\beta_{vh})^{1-\alpha}}\beta_{vh,i}. \quad (A.8)$$

Finally, from Eq. (A.7) and Eq. (A.8), we have

$$e_i = \frac{x_i}{wv_i} = \frac{(1-\sigma)\beta_{vh,i}}{v_i}. \quad (A.9)$$

The effect of network centrality on effort level and on consumption in the heterogeneous setting is similar to that in the homogeneous setting. From Eq. (A.8) and Eq. (A.9), the positive effect of $\beta_{vh,i}$ on $x_i$ and $e_i$ shows that status-seeking increases agent $i$’s consumption and, therefore, effort level. For agents with higher status comparison intensity, and for agents who keep up with “higher-endowment Joneses” in terms of ability and time, more effort is exerted in status competition. We conclude the heterogeneous setting with Proposition 4.

**Proposition 4.** In a network with agents heterogeneous with regard to ability and time endowment, individuals exhibit economic behavior similar to that in a homogeneous setting. However, the behavior of heterogeneous agents is scaled by endowment differences. Given the same relative link intensity, individuals trying to keep up with higher-endowment agents will spend more on consumption and apply more effort than those keeping up with lesser-endowment agents.
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