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Status Consumption in Networks: a Reference Dependent Approach†

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We introduce loss aversion into a model of conspicuous consumption in networks. Agents allocate heterogeneous incomes between a conventional good and a status good. They interact over a connected network and compare their status consumption to their neighbors' average consumption. We find that aversion to lying below the social reference point has a profound impact. If loss aversion is large relative to income heterogeneity, a continuum of conformist Nash equilibria emerges. Agents have the same status consumption, despite differences in incomes and network positions, and the equilibrium is indeterminate. Otherwise, there is a unique Nash equilibrium and status consumption depends on the interplay between network positions and incomes. Our analysis extends to homothetic and heterogeneous preferences.

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1 Introduction

The pursuit of social status appears to be a main determinant of consumption, in particular for visible goods such as clothing, phones, and cars. Following Veblen (1899), a vast literature has documented the importance of conspicuous consumption (Charles et al. (2009), Heffetz (2011), Kuhn et al. (2011), Bertrand and Morse (2016)). The empirical literature provides insights into its social and psychological dimensions. Socially, status related comparisons are deeply rooted in the structure of society. People tend to have distinct reference groups, which may encompass family, friends, and colleagues. Our consumption patterns are often shaped by the standards set within our reference group, serving as a benchmark against which we evaluate our own consumption choices (Clark and Oswald (1998), Neumark and Postlewaite (1998), Luttmer (2005), Clark and Senik (2010)). And this tendency to depart from comparisons to the society at large seems amplified by the advent of social media (Bazaarvoice (2021)). Psychologically, individuals seem to attach more importance to relative deprivation rather than relative abundance, in comparisons to these reference points (Drechsel-Grau and Schmid (2014), Bertrand and Morse (2016)). In other words, the cognitive bias of loss aversion, which affects many aspects of decision-making (Kahneman and Tversky (1979), Tversky and Kahneman (1992), Loewenstein et al. (1989), Ferrer-i Carbonell (2005), Brown et al. (forthcoming)), also affects conspicuous consumption. The combined effects of loss aversion and network interactions have been largely overlooked, however, by the literature on conspicuous consumption.

Our aim is to address this research gap. In this study, we provide the first analysis of the impact of loss aversion on conspicuous consumption within a network context. We study how consumption behavior is shaped by the interplay between social networks of status comparisons and the psychological aversion to lying below a reference point. We find that a main consequence of loss aversion is to give rise, under some conditions, to a continuum of conformist Nash equilibria, wherein heterogeneous individuals all consume exactly the same level of status good. This emergence of global conformism is surprising at first glance, since individuals do not have conformist preferences and may have different incomes and network positions. What happens is that loss averse individuals are extra motivated not to consume less than their network neighbors. We show that when the comparison network is connected and when loss aversion is large relative to income heterogeneity, the interplay of these local motives gives rise to global conformism. These conformist equilibria are indeterminate, and the absence of a selection mechanism paves the way for what is commonly referred to as "animal spirits". Any governing institution must then factor this element into the formulation of fiscal policies. And indeed, we show that because of this indeterminacy, income redistributions that reduce inequality can aggravate status consumption and reduce welfare.

We develop our formal model in Section 2 by integrating loss aversion into the network framework of conspicuous consumption introduced by Ghiglino and Goyal (2010). Agents allocate their income between a conventional commodity and a status-enhancing commodity to maximize a Cobb-Douglas utility subject to a budget constraint.[1] Agents have heterogeneous incomes and are embedded into a social network of status comparisons. They assess how their own status consumption compares to a benchmark equal to the mean status consumption of their network peers. The utility loss from a negative difference to this social reference point is larger than the utility gain from a positive difference of the same magnitude. Agents' consumption decisions then depend on the consumption decisions of their network peers. Our main objective is to analyze the Nash equilibria of the resulting network game.

Overall, we find that loss aversion has a profound impact on outcomes. An important preliminary observation is that the formal analysis is much more involved under loss aversion. Without loss aversion, the consumption game has linear best responses, there is a unique Nash equilibrium, and status consumption is related to network centrality. None of these properties holds under loss aversion. We develop our analysis in several stages. We analyze best responses in Section 3.1, Nash equilibria in Section 3.2, welfare in Section 3.3, comparative statics with respect to incomes and to the network in Section 4, and extensions to heterogeneous preferences in Section 5.1 and to general utility functions in Section 5.2.

Our first main result establishes the existence of two mutually exclusive domains. In the conformism domain, there is a continuum of Nash equilibria where all agents have the same status consumption. In the differentiated domain, there is a unique Nash equilibrium

[1] We extend the analysis to general utility functions in Section 5.2. We notably show that our equilibrium characterization extends to heterogeneous and homothetic utilities.

where agents have different status consumption. Conformist equilibria appear whenever loss aversion is large enough relative to income heterogeneity, measured by the ratio of highest to lowest income. In our second main result, we show that there is excessive status consumption in any equilibrium. This is intuitive, as status concerns generate negative externalities and play no useful social role in this framework. Welfare of conformist equilibria also decreases with status consumption, leading to potentially large welfare differences between the best and the worst equilibrium.

Our analysis reveals qualitative differences between the two domains in the impacts of networks and incomes. Status consumption in the conformism domain is characterized, quite remarkably, by a form of network neutrality. The whole set of Nash equilibria is unaffected by network geometry, as long as the network is connected.[2] Nash equilibria are also unaffected by income changes which hold the lowest and highest incomes constant. This does not mean, however, that these income changes have no impact. In a conformist equilibrium, an income difference between two agents is passed on one-to-one into a difference in conventional consumption. Uniformity in status consumption is then associated with excess variation in conventional consumption. This may have severe consequences for poorer agents, who may have to drastically reduce consumption of necessities in order to maintain status.

By contrast status consumption is not uniform in the differentiated domain, and some individuals earn strict status gains while others earn strict status losses. In this domain, status consumption and individuals' positions relative to their reference points are determined by complex interactions between the network structure and the income distribution. We generalize the formula connecting status consumption to network centrality in the absence of loss aversion. This allows us to generically quantify the impact of small income shocks on the whole system. Consider an initial Nash equilibrium and some agent i whose status consumption differs from her reference point. We show that a small increase in i's income leads to an increase in the status consumption of every agent j, as the initial shock spills over indirect connections. This impact is higher when there are more walks connecting i to j in the network and when there are more agents earning status losses along these walks.

[2] By contrast, status consumption is not network neutral when considering potentially disconnected networks, as illustrated in our discussion of bridges below.

The reason is that under loss aversion, agents are more reactive when they lie below their reference points, leading to greater amplification of spillovers.

This does not mean, however, that conformism plays no role in the differentiated domain. In our third main result, we show that for every agent, there exists an intermediate income range where status consumption is precisely equal to the reference level. Within this range, the agent acts as a pure conformist and her status consumption is invariant to changes in her own income. In other words, we show that the demand elasticity of the status good is equal to zero for intermediate income levels.[3] This is an interesting, and quite surprising, prediction, since luxury goods typically exhibit high income elasticity.

We then analyze comparative statics related to transitions *between* domains. We consider both income and network changes. We first look at income redistributions that reduce inequality and the ratio of highest to lowest income. These redistributions can steer society away from the differentiated domain and towards the conformism domain. As a consequence, they carry the trade-off of introducing equilibrium ambiguity and potentially reducing overall welfare. Second, we consider the impact of adding bridges between previously disconnected communities. These bridges could represent, for instance, inter-caste marriages in an Indian context. When communities are homogeneous in terms of income, adding even one bridge can steer society away from community conformism and towards the differentiated domain. Underprivileged agents then loose while affluent agents gain, and the magnitude of these losses and gains can be substantial.

Finally, we extend our analysis in two directions. We introduce heterogeneity in preferences, and in degrees of loss aversion in particular. We find that preference heterogeneity tends to dampen the emergence of global conformism when agents have homogeneous incomes. In the presence of income inequality, by contrast, preference heterogeneity can counterbalance the effect of income heterogeneity and facilitate the emergence of conformism. We also consider more general utility functions. We show that our main results extend to homothetic preferences, a class that contains Cobb-Douglas utilities and utilities with Constant Elasticity of Substitution (CES). While we leave a full-fledged analysis of general utility func-

[3]The existence of this conformist range holds for every connected network and every position within the network. The precise values of the range, however, depend on the agent's network position, on the broader network structure and on incomes.

tions for future research, we establish some preliminary results and show that the emergence of a continuum of conformist equilibria is a robust phenomenon.

Related Literature. Our analysis contributes to the literature on games played on networks[4] and, in particular, on status games, see Ghiglino and Goyal (2010), Immorlica et al. (2017) and Langtry (2022). In Immorlica et al. (2017), an agent's utility depends linearly on a weighted sum of differences between own costly action and the actions of neighbors taking a higher action, an assumption akin to an extreme form of loss aversion. There is no social reference point and individual incomes play no role. Authors notably analyze properties of Nash equilibria where players take the highest action. Langtry (2022) modifies Immorlica et al. (2017)'s framework and assumes that agents form a social reference point based on their neighbours consumption. However, because of constant marginal cost, the introduction of loss aversion has no impact in his setup, and there is a unique, non conformist Nash equilibrium. In Sadler and Golub (2023), agents compete for status as in Immorlica et al. (2017) and simultaneously choose their connections which provide a fixed benefit. The focus is on the topology of the endogenous network. Finally, López-Pintado and Meléndez-Jiménez (2021) study a game of effort provision, rather than status. Agents gain an extra utility when producing an outcome above a "comparison threshold" derived from the outcomes of their reference group. The network is a realization of a random process and the authors show that the density of the network may be harmful to effort provision.

By contrast, we analyze the choices of consumers allocating heterogeneous incomes across two categories of goods. There is a possibility of substitution between the two goods, leading to heterogeneous and non linear marginal costs. Together with loss aversion and a societal reference point, this formulation allows us to study how status consumption depends on network positions and income and preference heterogeneity. Overall, it leads to a very different set of results than in the cited works. Formally, our analysis makes progress on the study of network games with non linear best responses.

Our paper is also related to a wider literature on diffuse social effects that abstracts from network and neighborhood effects, as in status games where individuals care about their rank

[4]See Bramoullé and Kranton (2016) and Jackson and Zenou (2015) for reviews of the literature and Ushchev and Zenou (2020) for the analysis of a network game with conformism, where agents compare their own effort to the average effort among their network peers.

(Becker and Tomes (1979), Frank (1985b), Hopkins and Kornienko (2004)). It also relates to models were agents "keep up with the Joneses" by comparing their consumption or income to economy wide references (Duesenberry (1949), Abel (1990), Campbell and Cochrane (1999), Ljungqvist and Uhlig (2000)) and to a literature on consumption with socially determined needs. Bellet and Colson-Sihra (2018) and Lewbel et al. (2022) provide evidence that the perceived needs of consumers may depend on social features of the environment, see Pollak (1976) for an early analysis.

Few works have considered loss aversion in models with diffuse social effect. Friedman and Ostrov (2008) consider a continuum of identical consumers. The comparison of own status consumption with everyone else is weighted differently depending on whether the difference is positive or negative. They show that an interval of symmetric equilibria in pure strategies may exist. Asymmetry in comparison is also present in Frank et al. (2014), who consider upward looking relative concerns rather than downward looking as in rank dependent models. Hopkins (2023) extends Hopkins and Kornienko (2004) and develops a model where agents care, potentially asymmetrically, about their cardinal positions in the status distribution.

Social reference points is a central feature of the literature on aspirations as in Ray (1998), Ray (2006), Appadurai (2004), Genicot and Ray (2020), and Genicot and Ray (2017). Aspirations provide the threshold that separates achievement from failure. Aspirations are determined by own past aspiration and by social actions and importantly payoffs are asymmetric. In the same vein, in Bogliacino and Ortoleva (2014) loss-averse individuals compare own bequests to the average bequest. Equilibrium multiplicity in their framework is related to the overlapping generation structure, and does not deliver conformism.

Compared to this literature, by contrast, we tackle the more realistic, and more technically challenging, case of a finite society, where the action of one agent may have non negligible impacts on others and these interactions are structured through a social network. Furthermore, we fully explore how economic outcomes depend on the interplay between loss aversion, income and preference heterogeneity, and the network structure.

Fehr and Schmidt (1999), and the vast experimental literature that followed, also consider interpersonal comparison of monetary outcomes with loss aversion. Typically, comparisons are with each individual in the economy, rather than with a local social average.

Further away from social interactions, the role of reference points is central in the vast literature issued from prospect theory (Kahneman and Tversky (1979), Tversky and Kahneman (1992)).[5] A central question is how reference points are formed. In the existing literature, reference points are typically either related to own experience as in the habit formation models of Carroll and Weil (1994) and Overland et al. (2000)[6] or equal to agents' expectations as in Kőszegi and Rabin (2006) and Heidhues and Kőszegi (2018). In an important analysis, Heidhues and Kőszegi (2008) study a differentiated good economy with heterogeneous firms and loss averse consumers. They notably show that firms can charge the same "focal" price, even when facing different cost distributions, a form of conformism in firm behavior. The broad intuition is that as marginal utility discontinuously drops at the reference point, the optimal response may deliver the reference point as an equilibrium which, depending on assumptions on how this reference point is formed, can yield conformism.[7]

Our framework shares with these models the general property that, due to loss aversion, there might be bunching at the reference point. We provide, however, the first analysis of the impact of loss aversion when the reference point is endogenously determined by simultaneous choices of peers. This yields novel insights on how conspicuous consumption and the emergence and features of conformism depend on incomes, preferences, and social networks.

2 The Model

We introduce loss aversion into a network model of status consumption. We consider a society of n consumers. Each agent i allocates her budget $w_i > 0$ between the consumption of a standard good, $x_i \geq 0$, and of a status good, $y_i \geq 0$. The price of the standard good is normalized to 1 and let p denote the relative price of the status good. The budget constraint is $x_i + py_i \leq w_i$.

Agents are embedded in a directed social network, describing comparison relationships.

[5] This literature has extended far beyond the initial focus on decisions under risk, see Thaler (1980) and Barberis (2013) for a survey.

[6] See Andersen et al. (2022) for a recent application to the housing market.

[7] See also Bhaskar (1990) for an analogous mechanism operating in a unionised wage setting model when workers are worried of being underpaid and Segal and Spivak (1990) for an analysis of how kinks in the utility function affect decisions under risk.

Denote by N_i the comparison group of agent i, of size $|N_i|$. We consider a connected network; any agent can be reached from any other agent through an indirect path in the network. This implies that no agent is socially isolated, $\forall i, N_i \neq \emptyset$. Each agent compares her consumption of the status good, y_i, to the average consumption in her comparison group, $\bar{y}_i = \frac{\sum_{j \in N_i} y_j}{|N_i|}$. Denote by $\mathbf{G}$ the interaction matrix such that $g_{ij} = \frac{1}{|N_i|}$ if $j \in N_i$ and $g_{ij} = 0$ if $j \notin N_i$, with $\bar{y}_i = \sum_j g_{ij} y_j$.

Agents' preferences are described by the following Cobb-Douglas utility function, which depends on own consumption of the standard good and of own and peers' consumption of the status good,

$$u_i(x_i, y_i, \mathbf{y}_{-i}) = x_i^{\sigma} \varphi(y_i, \mathbf{y}_{-i})^{1-\sigma} \tag{1}$$

with

$$\varphi(y_i, \mathbf{y}_{-i}) = y_i + \alpha(y_i - \bar{y}_i) \text{ if } y_i \leq \bar{y}_i$$

$$\varphi(y_i, \mathbf{y}_{-i}) = y_i + \beta(y_i - \bar{y}_i) \text{ if } y_i \geq \bar{y}_i$$

where $\sigma \in (0, 1)$ represents the consumption elasticity of the standard good and $\alpha \geq \beta \geq 0$ capture how much agents compare their consumption of the status good to others' consumption. Note that this utility function is well-defined, and greater than or equal to zero, when $\varphi(y_i, \mathbf{y}_{-i}) \geq 0$. For completeness, we assume that $u_i = -U < 0$ when $\varphi(y_i, \mathbf{y}_{-i}) < 0$. This means that agent i "needs" to consume at least $\frac{\alpha}{1+\alpha}\bar{y}_i$ units of status good before starting to consume the standard good.

This formulation nests well-known cases. When $\alpha = \beta = 0$, there is no social comparison. Agents have standard Cobb-Douglas preferences and $x_i = \sigma w_i$ and $y_i = (1 - \sigma)\frac{w_i}{p}$.

When $\alpha = \beta > 0$, there is social comparison without loss aversion. This is the benchmark case analyzed in Ghiglino and Goyal (2010). An agent's consumption depends on her peers' consumption, defining a simultaneous, complete information network game. The budget constraint binds, implying $x_i = w_i - py_i$. The utility as a function of status consumption only is $u_i(y_i, \mathbf{y}_{-i}) = (w_i - py_i)^{\sigma}((1 + \alpha)y_i - \alpha\bar{y}_i)^{1-\sigma}$ with $y_i \in [0, \frac{w_i}{p}]$. This yields, $\frac{\partial u_i}{\partial y_i} =$

$(-\frac{p\sigma}{w_i - py_i} + \frac{(1+\alpha)(1-\sigma)}{(1+\alpha)y_i - \alpha\bar{y}_i})u_i$. And $\frac{\partial u_i}{\partial y_i} = 0 \Leftrightarrow y_i = (1-\sigma)\frac{w_i}{p} + \sigma\frac{\alpha}{1+\alpha}\bar{y}_i$ when $u_i > 0$.

When α is not too high, individual best response is linear and there exists a unique Nash equilibrium to the consumption game. Denote by $\mathbf{I}$ the identity matrix. The unique equilibrium is interior and equal to

$$\mathbf{y} = \frac{1-\sigma}{p}(\mathbf{I} - \sigma\frac{\alpha}{1+\alpha}\mathbf{G})^{-1}\mathbf{w} \tag{2}$$

This notably implies that $\frac{\partial y_i}{\partial w_j} > 0$ for any pair i, j. When w_j increases, agent j increases her consumption of the status good. Because of social comparisons, agent j's peers then increase their status consumption. In turn, agent j's peers of peers increase their consumption and since the network is connected, everyone is eventually affected.

Our main contribution is to introduce loss aversion in status concerns. When $\alpha > \beta$, the status losses from having a consumption level of the status good below peers' average are larger in absolute value than the status gains from having a status consumption above peers' average of the same magnitude. This introduces a kink in the utility function, which is not differentiable around the reference level $y_i = \bar{y}_i$. Our main objectives are to characterize the Nash equilibria of the consumption game and to understand how loss aversion affects equilibrium behavior. We will see below that loss aversion introduces significant complexities in the analysis and has first-order impacts on outcomes.

3 Equilibrium characterization

We develop our analysis in three stages. First, we show that the best response is an increasing piecewise linear function with three pieces. A key implication of loss aversion is to induce pure conformist behavior over an intermediate range. Second, we present our main characterization result. We uncover the existence of two mutually exclusive domains. In the conformism domain, there is a continuum of Nash equilibria where all agents have the same status consumption. In the differentiated domain, there is a unique Nash equilibrium where agents consume different quantities of the status good. Third, we analyze welfare and show that agents consume excessive amounts of status goods in equilibrium.

3.1 Best response

As a preliminary remark, note that the budget constraint implies that $y_i \in [0, \frac{w_i}{p}]$ and hence that $\bar{y}_i \in [0, \frac{\bar{w}_i}{p}]$. Therefore, an agent can afford the minimal level of consumption of status good $\frac{\alpha}{1+\alpha}\bar{y}_i$ for every possible consumption levels of her peers if and only if $w_i \geq \frac{\alpha}{1+\alpha}\bar{w}_i$ and we maintain this assumption in what follows.

We next derive the individual best response in the consumption game. Denote by $f_i(\mathbf{y}_{-i})$ the best response of agent i, i.e., the solution to the problem of maximizing $u_i(y_i, \mathbf{y}_{-i}) = (w_i - py_i)^\sigma \varphi(y_i, \mathbf{y}_{-i})^{1-\sigma}$ under the constraint that $y_i \in [0, \frac{w_i}{p}]$. Note that u_i is continuous, and hence admits a maximum on the compact interval $[0, \frac{w_i}{p}]$. Further, we show that $ln(u_i)$ is strictly concave on this interval's interior, and hence u_i admits a unique maximum. Let $a = \frac{\alpha}{1+\alpha}$ and $b = \frac{\beta}{1+\beta}$, such that $0 \leq b \leq a \leq 1$. Detailed proofs are provided in the Appendix.

Proposition 1. *The best response of agent i in the consumption game is equal to:*

$f_i(\mathbf{y}_{-i}) = (1-\sigma)\frac{w_i}{p} + \sigma b\bar{y}_i$ *if* $\bar{y}_i \leq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$

$f_i(\mathbf{y}_{-i}) = \bar{y}_i$ *if* $\frac{1-\sigma}{1-\sigma b}\frac{w_i}{p} \leq \bar{y}_i \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$

$f_i(\mathbf{y}_{-i}) = (1-\sigma)\frac{w_i}{p} + \sigma a\bar{y}_i$ *if* $\bar{y}_i \geq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$

We illustrate Proposition 1 in Figure 1. We depict how agent i's consumption of the status good y_i depends on the average consumption among her peers, $\bar{y}_i$. Three domains appear. When the social reference level is low, the agent is in a domain of status gains. Her consumption level is linear in $\bar{y}_i$ with slope $\sigma b < 1$. When the social reference level is high, the agent is in a domain of status losses. Her consumption level is also linear in $\bar{y}_i$ with slope $\sigma a < 1$. The slope in the loss domain is higher than in the gain domain due to loss aversion, $a > b$. Note, also, that these two straight lines have the same intercept, equal to status consumption in the absence of social comparison, $(1-\sigma)\frac{w_i}{p}$. Crucially, we see the emergence of an intermediate domain, when $\bar{y}_i \in [\frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}, \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}]$. In this domain, the agent behaves as a pure conformist and sets her consumption level equal to the social reference level, $y_i = \bar{y}_i$. Intuitively, the agent in this domain can avoid status losses, but cannot afford status gains. This conformism domain only appears under loss aversion when $\alpha > \beta$ and its size increases when the wedge between status gains and status losses expands.

An important implication of Proposition 1 is that the best response of an agent is strictly

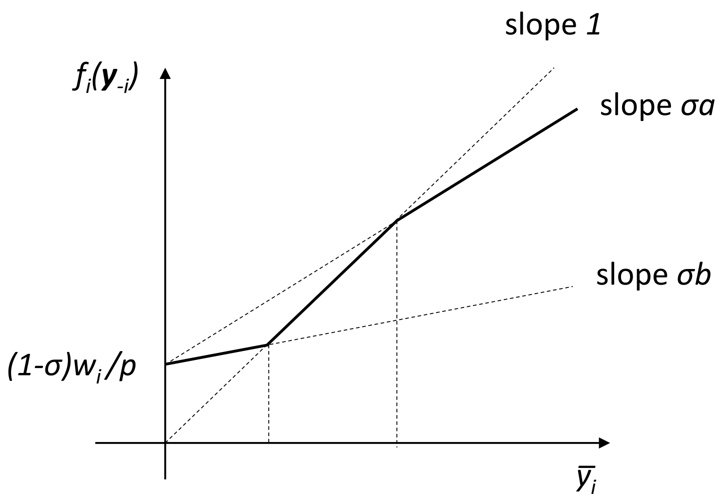


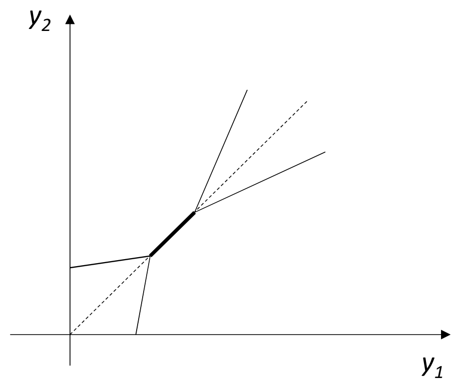
Figure 1: Individual best response under loss aversion

increasing over her strategy space. This implies that the consumption game is supermodular.[8] A well-known consequence is that there exists a lowest and a highest Nash equilibrium, $\mathbf{y}^{min}$ and $\mathbf{y}^{max}$, such that for any Nash equilibrium $\mathbf{y}$, $\forall i, y_i^{min} \leq y_i \leq y_i^{max}$. In addition, an increase in w_i leads to a weak increase in the best response of agent i, and hence to a weak increase in the action of every agent in both the lowest and highest Nash equilibrium. We will be using these properties in the proof of our next result below.

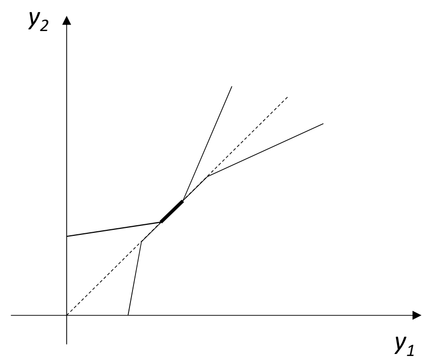
3.2 Nash equilibria

To provide some intuition for our next result, we show how to determine Nash equilibria graphically with two agents. We depict the best responses of the two agents in the same graph and under three scenarios in Figure 2. A profile is a Nash equilibrium if it lies at the intersection of the two curves. In the upper panel, the two agents have equal incomes, $w_1 = w_2$. We see that there is a continuum of Nash equilibrium, where both agents choose the same level of status good, and this continuum corresponds precisely to the conformist portions of the best responses. In the middle panel, we assume that agent 2 is now richer than agent 1, $w_2 > w_1$, and that the income difference is not too high. Agent 2's best response is now shifted upwards. We see that there is still a continuum of conformist Nash equilibria,

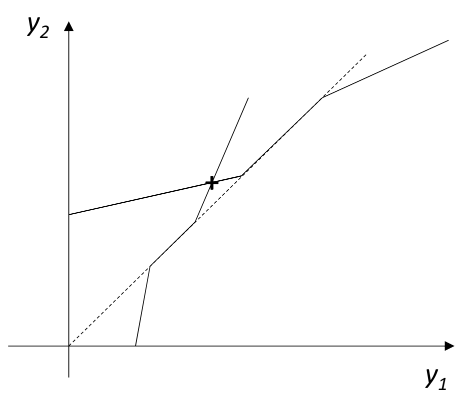
[8]See e.g. Milgrom and Roberts (1990) and Vives (1990) for classical references on supermodular games.



(a) Equal incomes



(b) Low income inequality



(c) High income inequality

Figure 2: Nash equilibria with two agents

corresponding to the intersection of the two conformist domains. In the lower panel, we depict a case where agent 2 is now much richer than agent 1. Agent 2 best response is shifted upwards even further. The intersection of the conformist domains is now empty. There is a unique Nash equilibrium where $y_2 > y_1$, and the richer agent earns strict status gains while the poorer agent earns strict status losses.

We can now state our characterization Theorem, which shows that the logic of this example extends to any connected network. Let w_{min} and w_{max} denote the lowest and highest wealth levels among agents. A richest agent is an agent with wealth w_{max} while a poorest agent has wealth w_{min}. Say that agent i earns status gains in Nash equilibrium $\mathbf{y}$ when $\bar{y}_i \leq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$, and hence by Proposition 1, $y_i = \sigma b \bar{y}_i + (1-\sigma)\frac{w_i}{p} \geq \bar{y}_i$. These status gains are strict if $\bar{y}_i < \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$, and hence $y_i > \bar{y}_i$. Similarly, agent i earns status losses when $\bar{y}_i \geq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$ and $y_i = \sigma a \bar{y}_i + (1-\sigma)\frac{w_i}{p} \leq \bar{y}_i$. She earns strict status losses when $\bar{y}_i > \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$, and $y_i < \bar{y}_i$.

Theorem 1. *Consider any connected comparison network.*
(Conformism and Indeterminacy) If $\frac{w_{max}}{w_{min}} \leq \frac{1-\sigma b}{1-\sigma a}$, *then a profile* $\mathbf{y}$ *is a Nash equilibrium if and only if* $\mathbf{y} = (y, y, ..., y)$ *with* $y \in [\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}, \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}]$.
(Differences and Uniqueness) If $\frac{w_{max}}{w_{min}} > \frac{1-\sigma b}{1-\sigma a}$, *then there is a unique Nash equilibrium* $\mathbf{y}$ *and* $\forall i, \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq y_i \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. *Richest agents earns strict status gains while poorest agents earn strict status losses.*

The proof in Appendix unfolds in several steps. In a conformist profile, the best response of every agent lies in the conformist domain. And hence conformist profiles are Nash equilibria when the intersection of the conformist domains is not empty, which happens when $\frac{w_{max}}{w_{min}} \leq \frac{1-\sigma b}{1-\sigma a}$. Next, we show that in this case they are the only equilibria. We exploit the fact that the lowest (highest) equilibrium must be lower than or equal to (higher than or equal to) the lowest (highest) conformist equilibrium and the following elementary graph property. If in a connected network, $y_i \geq \bar{y}_i$ for every i, then $y_i = y$ for every i. Agents cannot all consume more than their neighbors. Finally when conformist equilibria do not exist, we show that Nash equilibria must lie in a restricted subset and that the best response is contracting over this subset. Contraction holds here because the slopes of the best responses are always lower than or equal to 1, and must be strictly lower than 1 for poorest and richest agents in this restricted subset.

Theorem 1 uncovers the existence of a domain with conformism and indeterminacy. In this domain, all agents consume the same level of status good, even when they have different incomes and network positions. This level is indeterminate and varies within an interval. Interestingly, conformism appears even though agents do not derive utility from conforming to others' actions. Rather, they have status concern and display loss aversion with respect to their reference level. All agents are thus extra motivated not to fall below their neighbors' average consumption. We show that the interplay of these incentives over a connected network leads to global conformism when income heterogeneity is not too high. Conformism in status consumption does not mean that all agents have the same outcomes, however. Since $x_i = w_i - py$, an income difference between two agents is passed on one-to-one into a difference in conventional consumption. Poorer agents have lower conventional consumption and lower utility. Status concerns and loss aversion then induce excess variation in conventional consumption across agents.

Theorem 1 identifies some remarkable network neutrality properties. Conditional on being connected, the precise structure of the network does not affect actions in the conformism domain, nor the condition separating the two domains. By contrast, network structure matters when considering potentially disconnected networks or in the differentiated domain, and we analyze both features in more detail below.

The key condition separating the two domains is whether $\frac{w_{max}}{w_{min}}$ is lower or higher than $\frac{1-\sigma b}{1-\sigma a}$.[9] The ratio of highest to lowest income is a measure of income heterogeneity. Other income levels do not affect this condition, since in a conformist profile poorest and richest agents have the strongest incentive to deviate. The ratio $\frac{1-\sigma b}{1-\sigma a}$ is equal to 1 when there is no loss aversion and $\alpha = \beta$. This ratio increases with loss aversion, when α becomes higher than β. This key condition thus compares income heterogeneity with loss aversion.

When income heterogeneity is high relative to loss aversion, the consumption game has a unique Nash equilibrium. Theorem 1 shows that poorest agent always have a status con-

[9] In the knife-edge case where $\frac{w_{max}}{w_{min}} = \frac{1-\sigma b}{1-\sigma a}$, there is a unique equilibrium where all agents have the same status consumption.

sumption lying strictly below their reference level while richest agent always have a status consumption lying strictly above their reference level. For all other agents, the relative position with respect to the reference level - above, below, or equal to - depends on the parameters.

Conditional on which agent lies in which domain, Proposition 1 shows that equilibrium consumption levels solve a linear system of equations. More precisely, consider a Nash equilibrium $\mathbf{y}$. Let $D = \{i : y_i \neq \bar{y}_i\}$ and $C = \{i : y_i = \bar{y}_i\}$. Define the matrix $\mathbf{H}$ as $h_{ij} = \sigma a g_{ij}$ if $y_i < \bar{y}_i$, $h_{ij} = \sigma b g_{ij}$ if $y_i > \bar{y}_i$ and $h_{ij} = g_{ij}$. This matrix is obtained from $\mathbf{G}$ by premultiplying rows by σa, σb or 1, and note that $\mathbf{I} - \mathbf{H}$ is invertible.[10] Let $\mathbf{w}_D$ denote the vector of incomes of agents in D and $\mathbf{0}_C$ a vector of zeros of dimension $|C|$. Proposition 1 implies that the unique Nash equilibrium $\mathbf{y}$ satisfies

$$\mathbf{y} = \frac{1-\sigma}{p}(\mathbf{I} - \mathbf{H})^{-1} \begin{pmatrix} \mathbf{w}_D \\ \mathbf{0}_C \end{pmatrix} \tag{3}$$

Equation (3) represents a variant of the usual matrix inverse formula obtained in equation (2). The matrix inverse $(\mathbf{I} - \mathbf{H})^{-1}$ can be written as an infinite series $(\mathbf{I} - \mathbf{H})^{-1} = \mathbf{I} + \mathbf{H} + \mathbf{H}^2 + ...$, and its elements are equal to weighted averages of numbers of walks in the network. A key difference, however, is that the matrix $\mathbf{H}$ depends on agents' relative positions to their reference levels, and these positions are endogenous. In other words, equation (3) can generally not be used directly to compute equilibrium consumption. It can be used to analyze comparative statics, however, as shown in Section 4 below.

One interesting exception is when there are only two income levels. In that case, any agent is either a poorest agent or a richest agent and by Theorem 1, their relative positions are known. Matrix $\mathbf{H}$ is then predetermined, set C is empty, and equation (3) can be used to compute equilibrium consumption. In more general situations, we can compute the unique Nash equilibrium by leveraging algorithmic results from the literature on supermodular games. We know, in particular, that a process of synchronous, iterated best responses starting at $\mathbf{y} = \mathbf{0}$ converges fast, and via an increasing sequence, to the equilibrium.

[10] We show in the proof of Theorem 1 in Appendix that the spectral radius of $\mathbf{H}$ is strictly lower than 1.

3.3 Welfare

We now analyze welfare properties of Nash equilibria. Say that profile $\mathbf{y}$ is strictly Pareto dominated if there exists a profile $\mathbf{y}'$ such that $\forall i, u_i(\mathbf{y}') > u_i(\mathbf{y})$.

Theorem 2. *Starting from any Nash equilibrium, a small common reduction of status consumption increases every agent's utility. Thus, every Nash equilibrium is strictly Pareto dominated.*

In the conformism domain, a Nash equilibrium with common status consumption y is strictly Pareto dominated by another Nash equilibrium with consumption y' if $y' < y$.

Theorem 2 shows that there is excessive status consumption in equilibrium. This result is in line with existing results in the literature on status and with the fact that the consumption game displays negative externalities, u_i is decreasing in y_j for any i and $j \in N_i$. Status concerns play no useful social role in this static framework, and lead to collective over-consumption of status goods. A more novel implication is that in the conformism domain, status consumption and welfare can vary significantly across Nash equilibria. The negative consequences of status concerns can be benign or severe depending on which equilibrium is selected, and we provide numerical examples of these differences below.

4 Comparative statics

In this Section, we analyze how equilibrium behavior is affected by parameters of the model and, in particular, by incomes and by the network. As a starting point, we make use of standard results of comparative statics for supermodular games. From Proposition 1, we know that the whole best response of agent i increases weakly following an increase in w_i, α, β or a decrease in p. Therefore, the actions of all agents in the lowest and in the highest Nash equilibrium also increase weakly following an increase in w_i, α, β or a decrease in p.

Corollary 1. *Let $\mathbf{y}_{min}$ and $\mathbf{y}_{max}$ denote the lowest and highest Nash equilibrium. Let $\hat{\mathbf{w}} \geq \mathbf{w}$, $\hat{\alpha} \geq \alpha$, $\hat{\beta} \geq \beta$ and $\hat{p} \leq p$. Then, $\mathbf{y}_{min}(\hat{\mathbf{w}}, \hat{\alpha}, \hat{\beta}, \hat{p}) \geq \mathbf{y}_{min}(\mathbf{w}, \alpha, \beta, p)$ and $\mathbf{y}_{max}(\hat{\mathbf{w}}, \hat{\alpha}, \hat{\beta}, \hat{p}) \geq \mathbf{y}_{max}(\mathbf{w}, \alpha, \beta, p)$.*

A direct implication of Corollary 1 is that in the uniqueness domain, status consumption of i is weakly increasing in w_j for any pair i, j. By contrast, we know that in the absence of loss aversion, y_i is *strictly* increasing in w_j for any pair i, j in a connected network. Does consumption also increase strictly with income under loss aversion?

The answer to this question turns out to be negative. We next show that under loss aversion, the unique Nash equilibrium in the differentiated domain displays *inaction bands*, i.e., zones of the parameter space of positive measure where actions are invariant to changes.

Proposition 2. *Consider agent i in a connected network with $n \geq 3$, and $\mathbf{w}_{-i}$ such that $\frac{w_{max}}{w_{min}} > \frac{1-\sigma b}{1-\sigma a}$. There exists w_i^1, w_i^2 such that $w_{min} < w_i^1 < w_i^2 < w_{max}$ and the unique Nash equilibrium $\mathbf{y}$ is invariant, and satisfies $y_i = \bar{y}_i$, when $w_i \in [w_i^1, w_i^2]$.*

Our proof in Appendix combines two arguments. First from Theorem 1, we know that when i's income is lowest, i's status consumption lies strictly below his neighbors' average consumption while when i's income is highest, his status consumption lies strictly above his neighbors' average consumption. By continuity, this implies that at some intermediate income level, i's status consumption must be equal to his neighbors' average. Second, the kink in the utility function induced by loss aversion implies that when i's reaches this conformity domain, she actually stays in it over an interval of positive measure.

Proposition 2 identifies a novel testable implication of loss aversion with respect to a socially defined reference level. It shows that demand elasticity of status goods with respect to income must be equal to zero over intermediate ranges of income levels. This shows that loss aversion also deeply affects behavior in the differentiated domain. In general when demand elasticity is positive, we can make use of the matrix inverse formula, equation (3), to compute marginal effects of incomes on consumption. There is some empirical evidence that income elasticity of conspicuous goods is affected by social concerns. Indeed, using a model of relative deprivation (i.e., without loss aversion), Bellet and Colson-Sihra (2018) find that in India inequality exposure increases the need for the poor to consume luxury goods, lowering their income elasticity.[11]

Consider an income profile $\mathbf{w}$ such that $\frac{w_{max}}{w_{min}} > \frac{1-\sigma b}{1-\sigma a}$ and $\forall i, \bar{y}_i \neq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}, \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$. By

[11] Heffetz (2011) finds that income elasticity for a given good is related to its visibility, an indirect indication of a link between income elasticity and social effects.

Proposition 1, this means that no agent is on the edge of switching domains. Thus, relative positions with respect to the reference level are unchanged following small changes in incomes. If j lies in the conformist domain, $y_j = \bar{y}_j$, taking the derivative of equation (3) yields

$$\frac{\partial y_i}{\partial w_j} = 0$$

which is consistent with Proposition 2. If $y_j \neq \bar{y}_j$, we obtain the following explicit formula.

Proposition 3. *Consider the unique Nash equilibrium in the differentiated domain, and assume that no agent is on the edge of switching domains and that agent j is not in the conformist domain. Then,*

$$\frac{\partial y_i}{\partial w_j} = \frac{1-\sigma}{p}(\mathbf{I}-\mathbf{H})^{-1}_{ij} = \frac{1-\sigma}{p}\Big(I_{ij} + h_{ij} + \sum_{l=2}^{\infty} \sum_{i_1=i, i_2, \ldots, i_l=j} h_{i_1 i_2} \ldots h_{i_{l-1} i_l}\Big). \tag{4}$$

Each positive term in the sum on the right hand side corresponds to a walk between i and j in the network. The weight associated to the walk, $h_{i_1 i_2} \ldots h_{i_{l-1} i_l}$, is greater if there are more agents earning strict or zero status losses among agents $i_1, \ldots, i_{l-1}$ in the walk. The reason is that $h_{kl} = g_{kl}$ when $y_k = \bar{y}_k$, $h_{kl} = \sigma a g_{kl}$ when $y_k < \bar{y}_k$ and $h_{kl} = \sigma b g_{kl}$ when $y_k > \bar{y}_k$. Reaction to shocks is then greatest for agents in the conformist domain, and greater for agents in the loss domain than for agents in the gain domain due to loss aversion. Agents in the conformist and loss domain thus provide more amplification of indirect effects. Overall, this shows that the impact of j's income on i's status consumption depends on the walks between i and j in the network and on the relative positions that agents in these walks have with respect to their reference level.

We next highlight comparative statics implications of Theorem 1 that arise from jumps *across* domains. We consider two different changes: income redistributions that tip society towards conformism and the addition of bridges across disconnected communities that pushes society away from community conformism.

Progressive income redistributions reduce inequality and the ratio of highest to lowest income. By Theorem 1, income redistributions can then get society out of the differentiated domain and into the conformism domain, at the cost of equilibrium indeterminacy and poten-

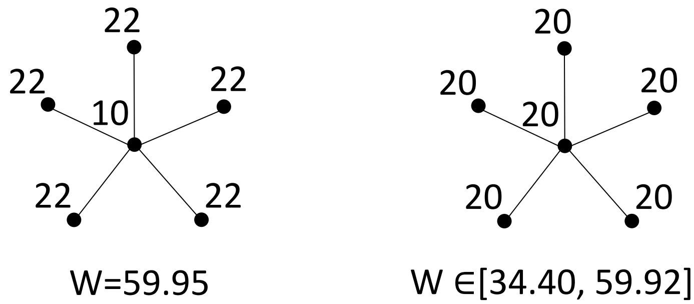


Figure 3: Welfare effect of redistributions

tially significant welfare loss. Formally, consider the following simple redistribution scheme. Agents are taxed at rate $\tau \in [0,1]$ and tax earnings $\tau \sum_i w_i$ are redistributed equally among agents. Income after redistribution is

$$\hat{w}_i = (1-\tau)w_i + \tau\bar{w}. \tag{5}$$

This scheme compresses the whole distribution around the mean while preserving income ranks. The ratio of highest to lowest income after redistribution is equal to $\frac{\hat{w}_{max}}{\hat{w}_{min}} = \frac{(1-\tau)w_{max}+\tau\bar{w}}{(1-\tau)w_{min}+\tau\bar{w}}$ and is decreasing in the tax rate. Suppose that income inequality is initially high and that society is in the differentiated domain, $\frac{w_{max}}{w_{min}} > \frac{1-\sigma b}{1-\sigma a}$. Then, there exists τ_0 such that $0 < \tau_0 < 1$ and society is in the differentiated domain when $0 \leq \tau < \tau_0$ and in the conformism domain when $\tau_0 \leq \tau \leq 1$. Tax rate τ_0 is characterized by

$$\frac{\hat{w}_{max}}{\hat{w}_{min}} = \frac{1-\sigma b}{1-\sigma a} \Leftrightarrow \tau_0 = \frac{(1-\sigma a)w_{max} - (1-\sigma b)w_{min}}{(1-\sigma a)w_{max} - (1-\sigma b)w_{min} + \sigma(a-b)\bar{w}} \tag{6}$$

Once in the conformism domain, multiple equilibria appear. The best equilibrium in terms of welfare is the equilibrium with lowest status consumption $y_{min} = \frac{1-\sigma}{1-\sigma b}\frac{\hat{w}_{max}}{p}$. The worst equilibrium is the one with highest status consumption $y_{max} = \frac{1-\sigma}{1-\sigma a}\frac{\hat{w}_{min}}{p}$. Status consumption decreases with τ in the best equilibrium and increases with τ in the worst equilibrium. Inequality reducing income redistribution can then induce significant welfare losses, as illustrated in the next example.

Example 1. *Let $p = 1, \sigma = 0.5$ and $a = 0.5, b = 0.2$. Consider the star economy of* 6 *individuals depicted in Figure 3. Individual* 1 *at the center has* $w_1 = 10$ *while individuals* $i \in \{2, ..., 6\}$ *at the periphery have* $w_i = 22$*. There is a unique, differentiated equilibrium with* $y_1 = 7.95, y_i = 11.80$ *and utilitarian welfare* $W = 59.95$*. When* $\tau = 1$ *(full redistribution),* $\hat{w}_1 = \hat{w}_i = 20$*, there is a continuum of conformist equilibria with status consumption* $y \in [11.11, 13.33]$ *and utilitarian welfare* $W \in [34.40, 59.92]$*. Perfect equality leads to a drop in welfare in any equilibrium, and to severe welfare losses in the worst equilibrium.*

We sum up the results on income redistributions.

Corollary 2. *Suppose that* $\frac{w_{max}}{w_{min}} > \frac{1-\sigma b}{1-\sigma a}$ *and consider income redistribution* $\hat{w}_i = (1-\tau)w_i + \tau\bar{w}$*. Then, there exists* τ_0 *such that* $0 < \tau_0 < 1$ *and society is in the differentiated domain when* $0 \leq \tau < \tau_0$ *and in the conformism domain when* $\tau_0 \leq \tau \leq 1$*. In the conformism domain, status consumption decreases with* τ *in the best equilibrium and increases with* τ *in the worst equilibrium. A redistribution that decreases income inequality can generate indeterminacy and decrease welfare.*

Finally, we show that bridges between communities can have a critical impact, in particular in the presence of income homophily.[12] Consider two disconnected communities. The network connecting agents within each community is connected, but there is initially no link between the communities. Each community is relatively homogeneous in terms of incomes, one community is poor, the other is rich. Formally, let w_{min} and w_{max} denote the lowest and highest income in the poor community and w'_{min} and w'_{max} the lowest and highest income in the rich community. Assume that $\frac{w_{max}}{w_{min}} < \frac{1-\sigma b}{1-\sigma a}$, $\frac{w'_{max}}{w'_{min}} < \frac{1-\sigma b}{1-\sigma a}$ and $w_{min} < w'_{min}$, $w_{max} < w'_{max}$. The equilibrium displays conformism within each community, with agents in the poor community having indeterminate status consumption $y \in [\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}, \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}]$ and agents in the rich community having status consumption $y' \in [\frac{1-\sigma}{1-\sigma b}\frac{w'_{max}}{p}, \frac{1-\sigma}{1-\sigma a}\frac{w'_{min}}{p}]$.

Consider the addition of one link between the two communities. This could represent, for instance, one inter-caste marriage in an Indian context. The ratio of highest to lowest income in the full population, $\frac{w'_{max}}{w_{min}}$, is much higher than within communities. Assume that $\frac{w'_{max}}{w_{min}} > \frac{1-\sigma b}{1-\sigma a}$. Society is now in the differentiated domain. By Theorem 1, we know that

[12] A bridge is a link whose deletion increases the number of connected components of the network. A network displays income homophile when agents with similar incomes are more likely to be connected.

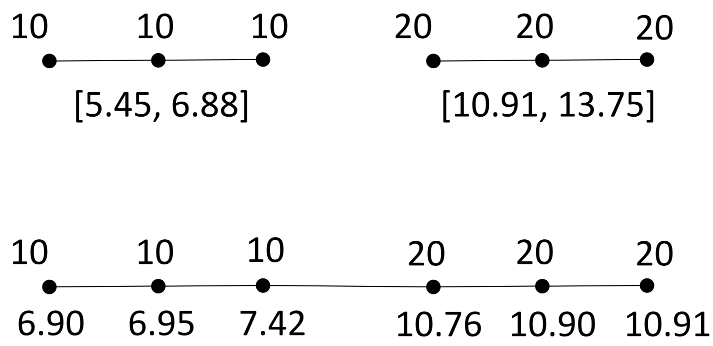


Figure 4: Impact of bridges

for every i, $y_i \in [\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}, \frac{1-\sigma}{1-\sigma b}\frac{w'_{max}}{p}]$. This implies that status consumption of all agents in the poor community is higher than in the highest equilibrium without the bridge, while status consumption of all agents in the rich community is lower than in the lowest equilibrium without the bridge. In short, all poor agents lose and all rich agents gain, and these losses and gains can be substantial depending on initial equilibrium selection. The next example provides a simple illustration.

Example 2. *Consider the situation depicted in Figure 4. There are three agents in the poor community, organized in a line, and with income* $w = 10$*. There are also three agents in the rich community, with income* $w = 20$*. Other parameters are* $\sigma = 0.5, \alpha = 1.2, \beta = 0.2$*. When the two communities are disconnected, Nash equilibria involve separate conformism in each group, with* $y \in [5.45, 6.88]$ *in the poor community and* $y' \in [10.91, 13.75]$ *in the rich community. Utilities vary between* 4.98 *and* 4.64 *in the poor community and* 9.96 *and* 9.27 *in the rich community. Next add a bridge between the communities. There is now a unique Nash equilibrium with status consumption among poor agents, from left to right,* $y_1 = 6.90, y_2 = 6.95, y_3 = 7.42$ *and among rich agents* $y_4 = 10.76, y_5 = 10.90, y_6 = 10.91$*, and utilities* $u_1 = 4.62, u_2 = 4.58, u_3 = 4.26, u_4 = 10.03, u_5 = 9.96, u_6 = 9.95$.

We sum up results on bridges.

Corollary 3. *Consider a poor and a rich community, initially disconnected. If communities are homogeneous in terms of incomes, each community lies in the conformism domain. Consider adding one bridge between the two communities. If the difference in incomes be-*

tween communities is large enough, this pushes society towards the differentiated domain. Consumption status of all poor agents is higher than in the highest equilibrium without the bridge. Consumption status of all rich agents is lower than in the lowest equilibrium without the bridge.

This shows that network structure has a first-order impact on consumption.

5 Extensions

In this Section, we analyze two extensions of the benchmark model. First, we relax the assumption that agents have the same concern for status and loss aversion. Second, we relax the assumption that they have Cobb-Douglas preferences. In both cases, we show that our main characterization result extends .

5.1 Heterogeneity

In our benchmark analysis, agents may differ in their income levels and network positions. We now consider a setup where agents may also differ in how much they care about status and in their level of loss aversion. Formally, assume that agent i has individual specific interaction parameters α_i, β_i with $0 \leq \beta_i \leq \alpha_i$ and $w_i \geq \frac{\alpha_i}{1+\alpha_i}\bar{w}_i$. This notably covers the specifications of peer effects in Ghiglino and Goyal (2010) where the strength of interaction depends on the number of neighbors, through increasing function $S(.)$. In that case, $\alpha_i = S(|N_i|)\alpha$ and $\beta_i = S(|N_i|)\beta$, and heterogeneity in α and β arises from heterogeneity in degree.

Let $a_i = \frac{\alpha_i}{1+\alpha_i}$ and $b_i = \frac{\beta_i}{1+\beta_i}$ and introduce

$$\omega^b_{max} = \max_i \frac{w_i}{1-\sigma b_i} \text{ and } \omega^a_{min} = \min_i \frac{w_i}{1-\sigma a_i} \tag{7}$$

Theorem 1 then extends as follows.[13]

[13] Proposition 1 extends, replacing a by a_i and b by b_i. The proof of Theorem 3 then follows the same steps as the proof of Theorem 1, we omit it for brevity. In the differentiated domain, agents who earn strict status gains are agents with largest value of $\frac{w_i}{1-\sigma b_i}$, while agents who earn strict status losses are those with lowest value of $\frac{w_i}{1-\sigma a_i}$.

Theorem 3. *Consider any connected comparison network and heterogeneous interaction parameters. If $\omega^b_{max} \leq \omega^a_{min}$, then a profile $\mathbf{y}$ is a Nash equilibrium if and only if $\mathbf{y} = (y, y, ..., y)$ with $y \in [\omega^b_{max}, \omega^a_{min}]$. If $\omega^b_{max} > \omega^a_{min}$, then there is a unique Nash equilibrium $\mathbf{y}$ such that $\forall i, \omega^a_{min} \leq y_i \leq \omega^b_{max}$ and some agents earn strict status gains while other agents earn strict status losses.*

Theorem 3 shows that the emergence of two mutually exclusive domains, one with a continuum of conformist equilibria and another one with a unique equilibrium with different actions, is robust to the introduction of heterogeneity in status concerns and loss aversion. How does this heterogeneity then affect equilibrium behavior?

Under income homogeneity, heterogeneity tends to reduce the emergence of conformism. When $w_i = w$, the condition $\omega^b_{max} \leq \omega^a_{min}$ reduces to $\beta_{max} \leq \alpha_{min}$ where $\beta_{max} = \max_i \beta_i$ and $\alpha_{min} = \min_i \alpha_i$. A continuum of conformist equilibria only appears when the heterogeneity in interaction parameters is not too high. By contrast under income heterogeneity, heterogeneity in α and β can expand the parameter range under which conformism appears. This depends on the correlation between α_i, β_i and w_i. Indeed, observe that ω^b_{max} tends to decrease when agents with higher incomes have lower β's while ω^a_{min} tends to increase when agents with lower incomes have higher α's.

5.2 Utility functions

Our benchmark analysis relies on the assumption that agents possess Cobb-Douglas utilities. We now relax this assumption. We show that Theorem 1 and 3 extend to homothetic preferences, a class including both Cobb-Douglas utilities and utilities with a constant elasticity of substitution (CES). We also provide some results valid for general utilities and notably show that the emergence of a continuum of conformist Nash equilibria is a robust phenomenon.

Consider a general utility function $u(x, y)$, increasing and strictly concave in both arguments. Denote by $x(p, w)$ and $y(p, w)$ the usual Walrasian demands in the absence of relative comparisons, i.e., the solutions to the consumer problem $\max_{x,y \geq 0} u(x, y)$ under $x + py \leq w$. With status concerns, a first step of the analysis is to determine an agent's best response in the absence of loss aversion, i.e., when $\alpha = \beta$. Assume then that agent i seeks to maximize $u(x_i, \varphi(y_i, \mathbf{y}_{-i}))$ where $\varphi(y_i, \mathbf{y}_{-i}) = y_i + \alpha\,(y_i - \bar{y}_i) = (1+\alpha)\,y_i - \alpha\bar{y}_i$ under the budget constraint $x_i + py_i \leq w_i$. Let $\varphi_i = \varphi(y_i, \mathbf{y}_{-i})$. The budget constraint can be rewritten as $x_i + \frac{p}{1+\alpha}(\varphi_i + \alpha\bar{y}_i) \leq w_i$ leading to $x_i + \frac{p}{1+\alpha}\varphi_i \leq w_i - \alpha\frac{p}{1+\alpha}\bar{y}_i$. The consumer's maximization program is then equivalent to

$$\max_{x,\varphi\geq 0} u(x,\varphi),\;\; s.t.\; x + \frac{p}{1+\alpha}\varphi \leq w_i - \alpha\frac{p}{1+\alpha}\bar{y}_i$$

This yields

$$\varphi_i = y(\frac{p}{1+\alpha}, w_i - \frac{p\alpha}{1+\alpha}\bar{y}_i)$$

Since $\varphi_i = (1+\alpha)\,y_i - \alpha\bar{y}_i$, agent i's best response is equal to

$$f_i(\mathbf{y}_{-i},\alpha) \;\; = \;\; \frac{1}{1+\alpha}y(\frac{p}{1+\alpha}, w_i - \frac{p\alpha}{1+\alpha}\bar{y}_i) + \frac{\alpha}{1+\alpha}\bar{y}_i \tag{8}$$

which provides an explicit connection between the best response and the Walrasian demand.

Building on equation (8), we show the following properties in Appendix. First, the best response with status concerns but without loss aversion, $f_i(\mathbf{y}_{-i},\alpha)$, is increasing in $\bar{y}_i$ when the conventional good is a normal good, i.e., $\frac{\partial x}{\partial w} > 0$. Second, this best response crosses the 45 degree line precisely once from above when the status good is a normal good, i.e., $\frac{\partial y}{\partial w} > 0$. We then introduce loss aversion $\beta < \alpha$, and show the robustness of the main features of the best response identified in Proposition. More precisely, we show that the utility function under loss aversion is strictly concave, leading to a unique best response. And for every i, there exist two thresholds $0 < y_i^1 < y_i^2$ such that $f_i(\mathbf{y}_{-i}) = f_i(\mathbf{y}_{-i},\beta)$ if $\bar{y}_i \leq y_i^1$, $f_i(\mathbf{y}_{-i}) = \bar{y}_i$ if $y_i^1 \leq \bar{y}_i \leq y_i^2$, and $f_i(\mathbf{y}_{-i}) = f_i(\mathbf{y}_{-i},\alpha)$ if $\bar{y}_i \geq y_i^2$. The lower threshold y_i^1 is precisely equal to the intersection of $f_i(\mathbf{y}_{-i},\beta)$ with the 45 degree line, while the higher threshold y_i^2 is equal to the intersection of $f_i(\mathbf{y}_{-i},\alpha)$ with the 45 degree line. The best response under loss aversion therefore still has three distinct parts, with an intermediate range of pure conformist behavior is robust. This implies that a continuum of conformist Nash equilibria exists when the intersection of these conformist ranges is not empty.

Proposition 4. *Consider a general utility function $u(x,y)$, increasing and strictly concave in both arguments, and such that both goods are normal goods. In the consumption game* *with status concerns and loss aversion, there exists $\delta > 0$ such that there is a continuum of conformist Nash equilibria if $w_{max} - w_{min} < \delta$.*

Extending the equilibrium analysis for general utility functions beyond Proposition 4 is challenging. Nash equilibria depend on the shape of the best response outside of the conformist range and hence, by equation (8), on detailed properties of the Walrasian demands. There is one particular case, however, where Theorems 1 and 3 extend, namely when preferences are homothetic. Under homothetic preferences, Walrasian demands are linear in income. A doubling of income yields a doubling of the demands. We can then write $x(p, w) = x(p)w$ and $y(p, w) = y(p)w$, where $x(p)$ and $y(p)$ are the Walrasian demands for 1 unit of income - and hence satisfy $x(p) + py(p) = 1$. Substituting in equation (8) yields

$$f_i(\mathbf{y}_{-i}, \alpha) = \frac{1}{1+\alpha} y(\frac{p}{1+\alpha}) w_i + \frac{\alpha}{1+\alpha} x(\frac{p}{1+\alpha}) \bar{y}_i$$

which is a linear function of $\bar{y}_i$ with slope strictly lower than 1.

We can now state the extension of Theorem 3. The boundaries of the conformist interval are related to the points where the linear best responses cross the 45 degree line. This leads us to introduce the following notation:

$$\tilde{\omega}^b_{max} = \max_i \frac{y(\frac{p}{1+\beta_i})}{1 + p\frac{\beta_i}{1+\beta_i} y(\frac{p}{1+\beta_i})} w_i \text{ and } \tilde{\omega}^a_{min} = \min_i \frac{y(\frac{p}{1+\alpha_i})}{1 + p\frac{\alpha_i}{1+\alpha_i} y(\frac{p}{1+\alpha_i})} w_i$$

Theorem 4. *Assume preferences are homothetic. Consider any connected comparison network and heterogeneous interaction parameters. If $\tilde{\omega}^b_{max} \leq \tilde{\omega}^a_{min}$, then a profile $\mathbf{y}$ is a Nash equilibrium if and only if $\mathbf{y} = (y, y, ..., y)$ with $y \in [\tilde{\omega}^b_{max}, \tilde{\omega}^a_{min}]$. If $\tilde{\omega}^b_{max} > \tilde{\omega}^a_{min}$, then there is a unique Nash equilibrium $\mathbf{y}$ such that $\forall i, \tilde{\omega}^a_{min} \leq y_i \leq \tilde{\omega}^b_{max}$ and some agents earn strict status gains while other agents earn strict status losses.*

6 Conclusion

We introduce loss aversion into a model of conspicuous consumption in networks. Agents allocate heterogeneous incomes between a conventional and a status-enhancing commodity. They are embedded within an interconnected comparison network and evaluate their personal status spending against the average spending of their network peers. We find that loss aversion has a first-order impact on consumption outcomes. We establish the existence of two distinct and mutually exclusive domains. When loss aversion surpasses a threshold related to income heterogeneity, a range of conformist Nash equilibria emerges. All agents consume the same level of status good, despite differences in incomes and network positions. When this threshold is not met, a unique Nash equilibrium arises. Status consumption then depends on the interplay between the network structure and the income distribution. We analyze comparative statics and show that a redistribution that reduces income inequality can yield equilibrium ambiguity and severe welfare losses. Connecting a poor and a rich community can get society out of community conformism, with significant losses for the poor and gains for the rich. Our main characterization result extends to heterogeneous and homothetic utilities.

Building on this analysis, future research could explore a variety of directions. First in terms of public policies, it would be interesting to also look at taxes targeting status goods, as advocated by Frank (1985a). Second, we focus here on the demand side of the economy, holding the supply side fixed. A natural next step would be to analyze the impact of loss aversion, status concerns, and networks when both demand and supply are endogenous. Third, introducing dynamics is also an important, and challenging, direction for future research. While status concerns only have negative welfare implications in a static framework, this needs not be true in a dynamic framework if current status expenditures affect future productivity.

Our analysis also raises a number of empirical issues. Standard analysis of consumption behavior focuses on households and individuals in isolation, neglecting status concerns and social networks. Some of our results could potentially be tested on classical, individual-level micro data. These include the surprising prediction that demand for status goods may be inelastic over intermediate income ranges. The broader message of our analysis, however, is that consumption is a network phenomenon. To fully understand consumption patterns and how consumption varies with income, we believe that researchers will need to collect and analyze detailed data on social networks. Recent evidence (De Giorgi et al. (2020)) supports the idea that this is an important direction for future research.

7 Appendix

Proof of Proposition 1

We first show that $ln(u_i)$ is strictly concave over $]0, \frac{w_i}{p}[$. When i consumes at least the minimal amount of status good, we have:
$ln(u_i) = \sigma ln(w_i - py_i) + (1-\sigma)ln((1+\alpha)y_i - \alpha\bar{y}_i)$ if $y_i \leq \bar{y}_i$ and $ln(u_i) = \sigma ln(w_i - py_i) + (1-\sigma)ln((1+\beta)y_i - \beta\bar{y}_i)$ if $y_i \geq \bar{y}_i$. This yields $\frac{\partial ln(u_i)}{\partial y_i} = -\frac{p\sigma}{w_i - py_i} + \frac{(1-\sigma)(1+\alpha)}{(1+\alpha)y_i - \alpha\bar{y}_i}$ if $y_i \leq \bar{y}_i$ and $\frac{\partial ln(u_i)}{\partial y_i} = -\frac{p\sigma}{w_i - py_i} + \frac{(1-\sigma)(1+\beta)}{(1+\beta)y_i - \beta\bar{y}_i}$ if $y_i \geq \bar{y}_i$.

Therefore, $\frac{\partial ln(u_i)}{\partial y_i}$ is continuous and strictly decreasing until y_i reaches $\bar{y}_i$ from the left and then, again, continuous and strictly decreasing when y_i increases from $\bar{y}_i^+$. Moreover, $ln(u_i)$ is left and right differenntiable at $y_i = \bar{y}_i$ and

$$\frac{\partial ln(u_i)}{\partial y_i}(\bar{y}_i^-) = -\frac{p\sigma}{w_i - p\bar{y}_i} + \frac{(1-\sigma)(1+\alpha)}{\bar{y}_i} > \frac{\partial ln(u_i)}{\partial y_i}(\bar{y}_i^+) = -\frac{p\sigma}{w_i - p\bar{y}_i} + \frac{(1-\sigma)(1+\beta)}{\bar{y}_i}$$

The left-derivative at $y_i = \bar{y}_i$ is larger than the right-derivative, and hence $ln(u_i)$ is strictly concave.

Since $ln(u_i)$ is a strictly concave function over $]0, \frac{w_i}{p}[$, tends to $-\infty$ at both extremes, and has a kink at $\bar{y}_i$, it has a unique interior maximum and there are two possible cases. Either $\frac{\partial ln(u_i)}{\partial y_i} = 0$ and $y_i \neq \bar{y}_i$. Or $\frac{\partial ln(u_i)}{\partial y_i}(\bar{y}_i^-) \geq 0$ and $\frac{\partial ln(u_i)}{\partial y_i}(\bar{y}_i^+) \leq 0$, and the maximum lies precisely at the kink, $y_i = \bar{y}_i$.

If $y_i < \bar{y}_i$, then $\frac{\partial ln(u_i)}{\partial y_i} = 0 \Rightarrow y_i = \sigma a\bar{y}_i + (1-\sigma)\frac{w_i}{p}$. This is a valid solution only if $\sigma a\bar{y}_i + (1-\sigma)\frac{w_i}{p} < \bar{y}_i$. If $y_i > \bar{y}_i$, then $\frac{\partial ln(u_i)}{\partial y_i} = 0 \Rightarrow y_i = \sigma b\bar{y}_i + (1-\sigma)\frac{w_i}{p}$. This is a valid solution only if $\sigma b\bar{y}_i + (1-\sigma)\frac{w_i}{p} > \bar{y}_i$. Otherwise, the maximum lies at the kink $y_i = \bar{y}_i$. QED.

Proof of Theorem 1

(1) Assume first that $\frac{w_{max}}{1-\sigma b} \leq \frac{w_{min}}{1-\sigma a}$.
(1.1) Consider a profile $\mathbf{y} = (y, y, ..., y)$ where everyone plays the same action and $y \in [\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}, \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}]$. For every i, $\bar{y}_i = y$. By Proposition 1, playing $y_i = y = \bar{y}_i$ is a best response when $\frac{1-\sigma}{1-\sigma b}\frac{w_i}{p} \leq y \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$. These inequalities hold since

$$\frac{1-\sigma}{1-\sigma b}\frac{w_i}{p} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p} \leq y \leq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$$

This shows that the conformist profiles described in the first part of the Theorem are indeed Nash equilibria.
(1.2) Let us show that these are the only Nash equilibria in this domain. Recall, $\mathbf{y}^{min}$ and $\mathbf{y}^{max}$ denote the lowest and highest Nash equilibria of the game. By (1.1) we know that $\forall i, y_i^{min} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. This implies that $\bar{y}_i^{min} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. Since by assumption $\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p} \leq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$, we have $\bar{y}_i^{min} \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$. By Proposition 1, this implies that no agent is in the domain of strict social losses and hence $\forall i, y_i^{min} \geq \bar{y}_i^{min}$. We can then invoke the following elementary graph-theoretic property. Consider a directed, connected network such that $\forall i, y_i \geq \bar{y}_i$. Then $\forall i, y_i = y$.

To see why, let i_0 be an agent with lowest value of y_i. By assumption, $y_{i_0} \geq \bar{y}_{i_0}$. However, $\bar{y}_{i_0} = \frac{\sum_{j \in N_{i_0}} y_j}{|N_{i_0}|}$ and since $y_j \geq y_{i_0}$, $\bar{y}_{i_0} \geq y_{i_0}$. Therefore, $y_j = y_{i_0}$, for every $j \in N_{i_0}$. Apply the same argument to the neighbors of the neighbors of i_0. Then, repeat until the whole network is covered, which is possible since the network is connected.

Therefore, everyone must play the same action in the lowest equilibrium. By (1.1), this implies that $y_i^{min} = \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. Similarly, since $\mathbf{y}^{max}$ is the highest Nash equilibrium, $\forall i, y_i^{max} \geq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$. This implies that $\bar{y}_i^{max} \geq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$, and hence $\bar{y}_i^{max} \geq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$. By Proposition 1, no agent is in the domain of strict social gains and $\forall i, y_i^{max} \leq \bar{y}_i^{max}$. Since the network is connected, all agents also play the same action in the largest equilibrium and $y_i^{max} = \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$.

To conclude, note that any other Nash equilibrium $\mathbf{y}$ must satisfy $y_i^{min} \leq y_i \leq y_i^{max}$. This implies that $\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p} \leq y_i \leq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$ and hence $\frac{1-\sigma}{1-\sigma b}\frac{w_i}{p} \leq y_i \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$. By Proposition 1, every agent is then in the conformist range: $y_i = \bar{y}_i$, implying that everyone plays the same action.

(2) Assume now that $\frac{w_{max}}{1-\sigma b} > \frac{w_{min}}{1-\sigma a}$ and let $S = \{\mathbf{y} : \forall i, \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq y_i \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}\}$.

(2.1). Let us first show that all Nash equilibria belong to S and, moreover, that $\mathbf{f}(S) \subset S$. Consider a decrease in incomes $\mathbf{w}'$ such that $\frac{w'_{max}}{1-\sigma b} = \frac{w_{min}}{1-\sigma a}$ and $w'_{min} = w_{min}$. From the first part of the Theorem, we know that at incomes $\mathbf{w}'$, there is a unique Nash equilibrium where every agent plays $y = \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$. Since the lowest equilibrium decreases weakly when incomes decrease, this implies that $\forall i, y_i^{min} \geq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$. In particular if i is a poorest agent, $\bar{y}_i^{min} \geq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$ and i earns status losses.

Similarly, consider an increase in incomes $\mathbf{w}''$ such that $\frac{w''_{min}}{1-\sigma a} = \frac{w_{max}}{1-\sigma b}$ and $w''_{max} = w_{max}$. At incomes $\mathbf{w}''$, there is a unique Nash equilibrium where all agents play $y = \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. Since the highest equilibrium increases weakly following an increase in incomes, this implies that $\forall i, y_i^{max} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. If i is a richest agent, $\bar{y}_i^{max} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$ and i earns status gains.

Therefore, for any Nash equilibrum $\mathbf{y}$, $\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq y_i^{min} \leq y_i \leq y_i^{max} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. Any Nash equilibrium thus belongs to S.

Next, consider $\mathbf{y} \in S$. We have: $\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq y_i \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. Therefore, since i's best response is increasing, $f_i(\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}) \leq f_i(y_i) \leq f_i(\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p})$. Since $\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$, $\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$ lies in the domain where f_i lies weakly above the 45 degree line. Therefore, $f_i(\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}) \geq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p}$. Similarly, since $\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p} \geq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$, $\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$ lies in the domain where f_i lies weakly below the 45 degree line and hence $f_i(\frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}) \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$. This implies that $\frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} \leq f_i(y_i) \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p}$, and hence $f_i(\mathbf{y}) \in S$.

(2.2) We now show that the overall best response $\mathbf{f}$ is contracting over S. Let i_0 be a richest agent, $w_{i_0} = w_{max}$, and j_0 be a poorest agent, $w_{j_0} = w_{min}$. For any $\mathbf{y} \in S$, $\bar{y}_{i_0} \leq \frac{1-\sigma}{1-\sigma b}\frac{w_{max}}{p} = \frac{1-\sigma}{1-\sigma b}\frac{w_{i_0}}{p}$. By Proposition 1, this implies that $f_{i_0}(\mathbf{y}) = \sigma b \bar{y}_{i_0} + (1-\sigma)\frac{w_{i_0}}{p}$. Similarly, $\bar{y}_{j_0} \geq \frac{1-\sigma}{1-\sigma a}\frac{w_{min}}{p} = \frac{1-\sigma}{1-\sigma a}\frac{w_{j_0}}{p}$ and hence $f_{j_0}(\mathbf{y}) = \sigma a \bar{y}_{j_0} + (1-\sigma)\frac{w_{j_0}}{p}$.

Next, observe that for any i, $\mathbf{y}$, $\mathbf{y}'$, $|f_i(\mathbf{y}) - f_i(\mathbf{y}')| \leq |\bar{y}_i - \bar{y}'_i|$. This holds by Proposition 1 when $\bar{y}_i$ and $\bar{y}'_i$ belong to the same domain. In these cases, f_i is a linear function of $\bar{y}_i$ with slope lower than or equal to 1. This also holds when $\bar{y}_i$ and $\bar{y}'_i$ belong to different domains. For instance, if $\bar{y}_i \leq \frac{1-\sigma}{1-\sigma b}\frac{w_i}{p}$ and $\bar{y}'_i \geq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$, then $f_i(\mathbf{y}) \geq \bar{y}_i$ while $f_i(\mathbf{y}') \leq \bar{y}'_i$. Thus, $0 \leq f_i(\mathbf{y}') - f_i(\mathbf{y}) \leq \bar{y}'_i - \bar{y}_i$.

Introduce h the linear function that $h_i(\mathbf{y}) = \bar{y}_i$ if $i \neq i_0, j_0$, $h_i(\mathbf{y}) = \sigma b \bar{y}_i$ if $i = i_0$ and $h_i(\mathbf{y}) = \sigma a \bar{y}_i$ if $i = j_0$. This function is represented by the matrix $\mathbf{H}$ built from $\mathbf{G}$ by multiplying row i_0 by $\sigma b < 1$, row j_0 by $\sigma a < 1$ and leaving other rows unchanged. Since $\mathbf{G}$ is row-normalized with non-negative entries, the spectral radius of $\mathbf{G}$ is 1. From Corollary 2.6 in Azimzadeh (2019), we know that the spectral radius of $\mathbf{H}$ is strictly lower than 1 if and only if there is a walk connecting every $i \neq i_0, j_0$ to i_0 or to j_0. Since the network is connected, this property holds.

Finally, let $||.||_2$ denote the Euclidean norm. Then, for any $\mathbf{y}, \mathbf{y}' \in S$,

$$||f(\mathbf{y}) - f(\mathbf{y}')||_2^2 = (f_{i_0}(\mathbf{y}) - f_{i_0}(\mathbf{y}'))^2 + (f_{j_0}(\mathbf{y}) - f_{j_0}(\mathbf{y}'))^2 + \sum_{i \neq i_0, j_0} (f_i(\mathbf{y}) - f_i(\mathbf{y}'))^2$$

$$||f(\mathbf{y}) - f(\mathbf{y}')||_2^2 \leq (\sigma b(\bar{y}_{i_0} - \bar{y}'_{i_0}))^2 + (\sigma a(\bar{y}_{j_0} - \bar{y}'_{j_0}))^2 + \sum_{i \neq i_0, j_0} (\bar{y}_i - \bar{y}'_i)^2$$

$$||f(\mathbf{y}) - f(\mathbf{y}')||_2^2 \leq ||h(\mathbf{y}) - h(\mathbf{y}')||_2^2 \leq \rho(H)||\mathbf{y} - \mathbf{y}'||_2^2$$

Therefore, the best response f is contracting with respect to the Euclidean norm on S, and hence has a unique fixed point.

(2.3) Finally, let us show that status losses (gains) earned by poorest (richest) agents are strict. Let i be a poorest agent, $w_i = w_{min}$. Suppose that i's status losses are not strict, $y_i = \bar{y}_i = \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$. Since $\bar{y}_i = \frac{\sum_{j \in N_i} y_j}{|N_i|}$ and $y_j \geq \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$, $y_j = \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$ for every $j \in N_i$. Therefore, $y_j \leq \frac{1-\sigma}{1-\sigma a} \frac{w_j}{p}$ and hence by Proposition 1, $y_j \geq \bar{y}_j$. Thus, $\bar{y}_j \leq \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$ and hence for every $k \in N_j$, $y_k = \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$. Repeating the argument and since the network is connected, $\forall k, y_k = \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$. By (1.1), $\frac{1-\sigma}{1-\sigma b} \frac{w_{max}}{p} \leq \frac{1-\sigma}{1-\sigma a} \frac{w_{min}}{p}$, a contradiction. Therefore, poorest agents earn strict status losses and, through similar arguments, richest agents earn strict status gains. QED.

Proof of Theorem 2

Consider a Nash equilibrium $\mathbf{y}$ and a small common reduction of status consumption. Let $\mathbf{y}'$ be such that $y'_i = y_i - \varepsilon$ for $\varepsilon > 0$. Denote by $\varphi_i(\mathbf{y}) = \varphi(y_i, \mathbf{y}_{-i})$.

A first observation is that $\varphi_i(\mathbf{y}') = \varphi_i(\mathbf{y}) - \varepsilon$. To see why, note that $\bar{y}'_i = \bar{y}_i - \varepsilon$. This implies that agent i's relative position to his reference point is the same in $\mathbf{y}'$ and in $\mathbf{y}$. If $y_i > \bar{y}_i$, then $\varphi_i(\mathbf{y}') = y'_i + \alpha(y'_i - \bar{y}'_i) = y_i + \alpha(y_i - \bar{y}_i) - \varepsilon = \varphi_i(\mathbf{y}) - \varepsilon$. The proof is similar for the two other cases.

Next, compute agent i's log utility

$$ln(u_i(\mathbf{y}')) = \sigma ln(w_i - py_i + p\varepsilon) + (1-\sigma) ln(\varphi_i(\mathbf{y}) - \varepsilon)$$

When ε is small, we can take a first-order Taylor approximation

$$ln(u_i(\mathbf{y}')) \approx ln(u_i(\mathbf{y}')) + \varepsilon(\frac{\sigma p}{w_i - py_i} - \frac{1-\sigma}{\varphi_i(\mathbf{y})})$$

This shows that a small common reduction of status consumption increases i's utility if

$$\sigma p\varphi_i(\mathbf{y}) > (1-\sigma)(w_i - py_i) \tag{9}$$

Consider, first, the unique Nash equilibrium in the differentiated domain. Consider an agent i who earns status gains: $y_i \geq \bar{y}_i$, which implies $\varphi_i(\mathbf{y}) \geq y_i$. Condition (9) is satisfied if $\sigma py_i > (1-\sigma)(w_i - py_i)$, which is equivalent to $y_i > \frac{1-\sigma}{p}w_i$. This always holds in equilibrium, since $\frac{1-\sigma}{p}w_i$ is the intercept of the best response.

Consider next an agent i who earns strict status losses: $y_i < \bar{y}_i$. Then, $\varphi_i(\mathbf{y}) = y_i - \alpha(\bar{y}_i - y_i)$. Condition (9) is equivalent to

$$p(y_i - \frac{1-\sigma}{p}w_i) > \sigma p\alpha(\bar{y}_i - y_i)$$

By Proposition 1, we know that

$$y_i = \frac{1-\sigma}{p}w_i + \sigma a\bar{y}_i$$

and hence the condition is equivalent to $a\bar{y}_i > \alpha(\bar{y}_i - y_i)$, and hence to $y_i > a\bar{y}_i$. This holds because $\varphi_i(\mathbf{y}) > 0$.

Finally, consider a conformist equilibrium with status consumption y and note that $y > \frac{1-\sigma}{p}w_{max}$. In that case, $\varphi_i(\mathbf{y}) = y$ and $u_i = (w_i - py)^\sigma y^{1-\sigma}$. Utility at equilibrium has the same expression as utility in the absence of social comparison. Moreover, u_i is log concave and maximized at $y_i = \frac{1-\sigma}{p}w_i$. Thus, u_i decreases strictly with y over the interval $[\frac{1-\sigma}{p}w_i, \frac{1}{p}w_i]$. QED.

Proof of Proposition 2

Let $\mathbf{y}$ denote the unique Nash equilibrium. From the fact that the Nash equilibrium correspondance is uhc we deduce that $\mathbf{y}$ varies continuously with w_i as w_i varies from w_{min} to w_{max}. By Theorem 1 at $w_i = w_{min}$, $y_i < \bar{y}_i$ while at $w_i = w_{max}$, $y_i > \bar{y}_i$. By continuity, i must reach the conformist domain as he becomes richer. Let w_i^1 denote the first value of w_i such that $y_i = \bar{y}_i$. By Proposition 1, we know that at w_i^1,

$$\frac{1-\sigma}{1-\sigma b}\frac{w_i^1}{p} \leq \bar{y}_i(w_i^1) \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i^1}{p}$$

Moreover, just a bit below, at $w_i^1 - \varepsilon$, we have $y_i < \bar{y}_i$ and hence

$$\bar{y}_i(w_i^1 - \varepsilon) \geq \frac{1-\sigma}{1-\sigma a}\frac{w_i^1 - \varepsilon}{p}$$

By continuity, this shows that

$$y_i(w_i^1) = \bar{y}_i(w_i^1) = \frac{1-\sigma}{1-\sigma a}\frac{w_i^1}{p}$$

Next, define w_i^2 as follows:

$$w_i^2 = \frac{1-\sigma b}{1-\sigma a} w_i^1$$

and note that $w_i^2 > w_i^1$. Then we claim that the Nash equilibrium at w_i^1, $\mathbf{y}(w_i^1)$ is the nash equilibrium for every w_i in $[w_i^1, w_i^2]$. To see why, note that the best response of $j \neq i$ is not directly affected by w_i. So any j still plays a best response. Next for i, we know that $y_i = \bar{y}_i$. And this is a best response iff

$$\frac{1-\sigma}{1-\sigma b}\frac{w_i}{p} \leq \bar{y}_i(w_i^1) = \frac{1-\sigma}{1-\sigma a}\frac{w_i^1}{p} \leq \frac{1-\sigma}{1-\sigma a}\frac{w_i}{p}$$

which is equivalent to

$$w_i^1 \leq w_i \leq \frac{1-\sigma b}{1-\sigma a} w_i^1 = w_i^2.$$

QED.

Proof of Proposition 4

We develop our proof in five stages. (1) Consider, first, the best response with status concerns but without loss aversion. From equation (8), take the derivative with respect to $\overline{y}_i$

$$\frac{\partial f}{\partial \overline{y}_i} = -\frac{p\alpha}{(1+\alpha)^2}\frac{\partial y}{\partial w} + \frac{\alpha}{1+\alpha}$$

And since $\frac{\partial x}{\partial w} + \frac{p}{1+\alpha}\frac{\partial y}{\partial w} = 1$, this yields

$$\frac{\partial f}{\partial \overline{y}_i} = \frac{\alpha}{1+\alpha}\frac{\partial x}{\partial w}$$

This shows that $f(\overline{y}_i, \alpha)$ is increasing in $\overline{y}_i$ when the conventional good is a normal good.

(2) From equation (8), consider the intersection with the 45 degree line, i.e., when $f_i(\overline{y}_i, \alpha) = \overline{y}_i$. Rearranging yields

$$y\left(\frac{p}{1+\alpha}, w_i - p\frac{\alpha}{1+\alpha}\overline{y}_i\right) = \overline{y}_i \tag{10}$$

The function on the left is decreasing in $\overline{y}_i$ if the status good is a normal good. It takes value $y(\frac{p}{1+\alpha}, w_i)$ at $\overline{y}_i = 0$ and reaches 0 if $\overline{y}_i$ is high enough. The function on the right is increasing and start at 0. Therefore, there is a unique intersection with the 45 degree line, happening from above.

(3) Next, introduce loss aversion. Let us show that the utility function is strictly concave despite the kink. The utility of the consumer with relative concerns can be written as $U(y_i, \overline{y}_i) = u(w - py_i, \varphi(y_i, \overline{y}_i))$ where u is a strictly concave and smooth function. Note that U is continuous at the kink, $\overline{y}_i$. To establish the concavity of $U(y_i, \overline{y}_i)$ as a function of y_i we first look at the marginal utility on the two sides of $\overline{y}_i$. The marginal utility evaluated on the left, i.e. $y_i < \overline{y}_i$ is

$$\lim_{y_i \to \overline{y}_i, y_i < \overline{y}_i} \frac{\partial U}{\partial y_i} = -pu_1(w - p\overline{y}_i, \overline{y}_i) + (1+\alpha)\, u_2(w - p\overline{y}_i, \overline{y}_i)$$

while on the right

$$\lim_{y_i \to \overline{y}_i, y_i > \overline{y}_i} \frac{\partial U}{\partial y_i} = -pu_1(w - p\overline{y}_i, \overline{y}_i) + (1+\beta)\, u_2(w - p\overline{y}_i, \overline{y}_i)$$

As $\alpha > \beta$ we obtain

$$\lim_{y_i \to \overline{y}_i, y_i < \overline{y}_i} \frac{\partial U}{\partial y_i}(y_i, \overline{y}_i) > \lim_{y_i \to \overline{y}_i, y_i > \overline{y}_i} \frac{\partial U}{\partial y_i}(y_i, \overline{y}_i)$$

which is consistent with concavity.

Next we prove that U is strictly concave before and after the kink. Before the kink, for instance, we have

$$\frac{\partial^2 U}{\partial y_i^2} = p^2 u_{11} + (1+\alpha)^2 u_{22} - 2p\,(1+\alpha)\, u_{12}$$

and $\frac{\partial^2 U}{\partial y_i^2} < 0$ if

$$\left|p^2 u_{11} + (1+\alpha)^2 u_{22}\right| > 2p\,(1+\alpha)\,|u_{12}|$$

Since $\left(p^2 u_{11} - (1+\alpha)^2 u_{22}\right)^2 > 0$ we obtain

$$p^4 u_{11}^2 + (1+\alpha)^4 u_{22}^2 + 2p^2\,(1+\alpha)^2 u_{11}u_{22} > 4p^2\,(1+\alpha)^2 u_{11}u_{22}$$

As u is strictly concave, we also know that $u_{11}u_{22} > u_{12}^2$, leading to

$$p^4 u_{11}^2 + (1+\alpha)^4 u_{22}^2 + 2p^2\,(1+\alpha)^2 u_{11}u_{22} > 4p^2\,(1+\alpha)^2 u_{12}^2$$

which can be rearranged into

$$\left(p^2 u_{11} + (1+\alpha)^2 u_{22}\right)^2 > \left(2p\,(1+\alpha)\, u_{12}\right)^2$$

and hence

$$\left|p^2 u_{11} + (1+\alpha)^2 u_{22}\right| > 2p\,(1+\alpha)\,|u_{12}|$$

This establishes strict concavity of U, and hence uniqueness of the best response, which solves the problem $maxU(y_i, \overline{y}_i)$ for $y_i \in [0, \frac{w_i}{p}]$.

(4) Next, let us show that the intersection of $f(\overline{y}_i, \alpha)$ with the 45 degree line increases with α. Let $U(y, \overline{y}_i, \alpha) = y(w - py, (1+\alpha)y - \alpha\overline{y}_i)$. We know that $U(y, \overline{y}_i, \alpha)$ and $U(y, \overline{y}_i, \beta)$ are both concave in y. They both admit a global maximum, denoted y_α and y_β. We also know that they intersect at $y = \overline{y}_i$

$$U(\overline{y}_i, \overline{y}_i, \alpha) = U(\overline{y}_i, \overline{y}_i, \beta)$$

There are four possible cases. Suppose that $y_\alpha < \overline{y}_i < y_\beta$ or $y_\alpha > \overline{y}_i > y_\beta$. In the case $y_\alpha < y_\beta$ at $y = \overline{y}_i$ we should have

$$\lim_{y_i \to \overline{y}_i, y_i < \overline{y}_i} U'(y_i, \overline{y}_i, \alpha) < \lim_{y_i \to \overline{y}_i, y_i > \overline{y}_i} U'(y_i, \overline{y}_i, \beta)$$

while in the case $y_\alpha > y_\beta$ at $y = \overline{y}_i$ we should have

$$\lim_{y_i \to \overline{y}_i, y_i < \overline{y}_i} U'(y_i, \overline{y}_i, \alpha) > \lim_{y_i \to \overline{y}_i, y_i > \overline{y}_i} U'(y_i, \overline{y}_i, \beta)$$

However, as shown above the last inequality is the only one holding. Therefore, configuration $y_\alpha < \overline{y}_i < y_\beta$ is not possible while is $y_\alpha > \overline{y}_i > y_\beta$ is possible and delivers the maximal utility at the kink $y = \overline{y}_i$. The third case is $y_\alpha < \overline{y}_i$ and $y_\beta < \overline{y}_i$. Here the maximum is at y_α. Finally the last case is $y_\alpha > \overline{y}_i$ and $y_\beta > \overline{y}_i$ in which case the maximum is at y_β. This implies that the unique intersection of $f(\overline{y}_i, \alpha)$ with the 45 degree line increases with α.

(5) Denote by y_i^1 the intersection of $f(\overline{y}_i, \beta)$ with the 45 degree line and by y_i^2 the intersection of $f(\overline{y}_i, \alpha)$ with the 45 degree line, such that $0 < y_i^1 < y_i^2$. When $\overline{y}_i < y_i^1$, the agent is in the domain of status gains and $f(\overline{y}_i) = f(\overline{y}_i, \beta)$. When $\overline{y}_i > y_i^2$, the agent is in the domain of status losses and $f(\overline{y}_i) = f(\overline{y}_i, \alpha)$. When $y_i^1 \leq \overline{y}_i \leq y_i^2$, the best response for β cannot be the best response (since below the 45 degree line) and similarly the best response for α cannot be the best response (since above the 45 degree line). Since the utility admits a maximum, the agent must be precisely at the kink, i.e., $f(\overline{y}_i) = \overline{y}_i$.

And hence every agent has a conformist range $[y_i^1, y_i^2]$. Since the status good is a normal good, by equation (10), both extremities increase with w_i. The set of conformist Nash equilibria of the form $(y, y, ..., y)$ is equal to the intersection of the individual conformist ranges. This intersection is not empty when the difference between highest and lowest income is not too high.

QED

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