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Visibility Bias in the Transmission of Consumption Norms and Undersaving

Bing Han*

David Hirshleifer**

We study how bias in the social transmission process affects the spread of time preference norms. In the model, consumption is more salient than non-consumption. This visibility bias causes people to perceive that others are consuming heavily and to infer that a high discount rate is normative. The transmission of norms for high discounting increases consumption and the interest rate. Information asymmetry about the wealth of others dilutes the inference from high observed consumption that the discount rate is high. In consequence, in contrast with the Veblen wealth-signaling approach, information asymmetry about wealth *reduces* overconsumption.

*Rotman School of Management, University of Toronto
**Merage School of Business, UC Irvine

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1 Introduction

In acquiring attitudes, people are heavily influenced by their cultural milieu, and by interactions with other individuals. We would expect such influence to be stronger when it is hard to form a clear assessment through introspection. For example, several authors have argued that people find it hard to decide how heavily to discount the future in making savings decisions (e.g., Akerlof and Shiller (2009)). People may lack relevant information, or be unwilling to process publicly available information such as mortality tables and health statistics. So people can't be sure what stream of satisfaction will actually result from a consumption/savings rule chosen today.[1]

This suggests that people may 'grasp at straws' by relying on noisy cues, including the behavior of others. A great deal of evidence suggests that people do make basic mistakes and rely on noisy cues in their savings decisions.[2] There is also considerable evidence that social interactions affect several dimensions of consumption and saving choices, sometimes in dysfunctional ways.[3] Surprisingly, however, there has been little formal modeling of how social processes affect consumption choices over time.

In our model, social learning about the time preferences of others is biased by the fact that consumption is more salient than non-consumption. For example, a boat parked in a neighbor's driveway draws more attention than the absence of a boat. Similarly, it is more noticeable and memorable when a friend or acquaintance wears designer apparel or reports taking an expensive trip than when not, or acquires an unusual or interesting product as

[1]Allen and Carroll (2001) point out that "...the consumer cannot directly perceive the value function associated with a given consumption rule, but instead must evaluate the consumption rule by living with it for long enough to get a good idea of its performance. ... it takes a very large amount of experience ... to get an accurate sense of how good or bad that rule is." They go on to argue that social learning is the most plausible explanation for how individuals derive their consumption rules.

[2]Investors are very heavily influenced by default choices in their retirement investment decisions (the status quo bias; Samuelson and Zeckhauser (1988), Madrian and Shea (2001), Beshears et al. (2008)), and small shifts in cues have substantial effects on retirement savings (Choi et al. (2013)). Simplified presentation of savings options also have very large effects on the amount invested (Beshears et al. (2012)). Economically meaningless mental accounts affect people's willingness to consume and invest out of income (Shefrin and Thaler (1988), Benhassine et al. (2013)). The low financial literacy of individual investors (Lusardi and Mitchell (2011)) also suggests a possible susceptibility to noisy cues and social influence.

[3]Individual investment decisions are influenced by interactions with other individuals (see Duflo and Saez (2002, 2003)), Hong, Kubik, and Stein (2004), Brown et al. (2008), Kaustia and Knüpfer (2012)), Georgarakos, Haliassos, and Pasini (2014), and the evidence reviewed in Hirshleifer and Teoh (2009)). These interactions seem to involve more than just rational information transmission, as they include contagion of behaviors about which there is ample public information (participating in the stock market), and there is transmission of trading in individual stocks, an activity which individual investors are not, on average, good at. In an experimental consumption/savings setting, social interaction caused subjects to deviate more from the optimal consumption path over time (Carbone and Duffy (2013)).

compared with not doing so. We call this effect of differential salience on attention *visibility bias*. In addition, we assume that people do not adequately adjust for the selection bias in favor of noticing the consumption rather than nonconsumption events of others. This results in overestimation of others' consumption expenditures.

These key premises of our model—that consumption is more salient than nonconsumption; and that people do not adequately adjust for the selection bias in their attention toward consumption—are motivated by the psychology of attention and salience. There is extensive evidence that occurrences are more salient and easier to process than nonoccurrences (e.g., Neisser (1963), Healy (1981), and the review of Hearst (1991)). A likely explanation is that occurrences provide sensory or cognitive cues that trigger attention. In the absence of such triggers, an individual will only react if (as is usually not the case) the individual was actively monitoring for a possible absence.[4]

Visibility bias in our model is a bias in the *social transmission* of information. It is not inherently an error. For example, being prone to noticing a neighbor's new car rather than the old one need not signify any cognitive failure. There may be good reasons to allocate attention to occurrences (or more generally, to salient events). However, failing to adjust appropriately for this selection bias in attention/observation is a mistake that biases inferences.

An opportunity cost is a non-occurrence of a benefit that would be received under an alternative course of action. Most people seem to underweight opportunity costs in making economic judgements. Economics instructors are well aware that the opportunity cost concept is something that students only master with effort, if at all.[5]

There is evidence from both psychology, experimental economics, and field studies that observers do not fully discount for data selection biases, a phenomenon called *selection neglect* (see, e.g., Nisbett and Ross (1980) and Brenner, Koehler, and Tversky (1996)).[6]

[4]This is why the famous phrase in the Sherlock Holmes story about "The dog that did not bark" is memorable; it seems surprising to readers that the absence of an event (an absence noticed only by a detective of extraordinary intellect) would prove to be crucial for the solution of a problem.

[5]Another example of underweighting nonoccurrences relative to occurrences is omission bias. Omission bias is the strong tendency of people to dislike and disapprove of actions that can result in adverse consequences as compared wtih refraining from taking actions, even when refraining has a higher risk of adverse consequences. This can result, for example, in an irrational reluctance to vaccinate (Ritov and Baron (1990)).

[6]People often naively accept sample data at face value (Fiedler (2008)). Mutual fund families advertise their better-performing funds; in the experimental laboratory both novice investors and financial professionals misinterpret fund performance owing to selection neglect (Koehler and Mercer (2009)). Auction bidders in economic experiments tend to suffer from a winner's curse (neglect of the selection bias inherent in winning), and hence tend to lose money on average (Parlour, Prasnikar, and Rajan (2007)).

Selection neglect is natural given the need to process information quickly with limited cognitive resources; adjusting for selection bias requires attention and effort. Selection bias is especially hard for people to correct for because adjustment requires attending to the *non-occurrences* that shape a sample. The evidence mentioned above that people underweight non-occurrences is therefore consistent with the low salience of non-occurrences together with selection neglect.

The combination of visibility bias and selection neglect in our model explains the *availability heuristic* of Kahneman and Tversky (1973), so overestimation of consumption can be viewed as a consequence of this heuristic. According to the availability heuristic, people overestimate the frequency of events that come to mind more easily, such as events that are highly memorable and salient. For example, people overestimate the frequency of shark attacks because such attacks are vivid and heavily reported in the media relative to other causes of death such as auto accident.

Visibility bias makes consumption more available than non-consumption for later retrieval and cognitive processing. In consequence, people infer high consumption and low savings rates by others, and conclude that a high discount rate is appropriate. Observers in our model therefore increase their own subjective discount rates accordingly, which increases actual consumption.

Consistent with our premises of visibility bias and selection neglect, consumption activity is more salient than non-consumption in experiments in the field. Consistent with the model's implication that this results in overestimation of others' consumption, in the field this salience results in overestimation by observers of how much other individuals value certain consumer products (Frederick (2012)). Frederick concludes that "purchasing and consumption are more conspicuous than forbearance and thrift."[7] Also consistent with visibility bias is evidence that people are influenced in car purchases decisions by the purchases of others (Grinblatt, Keloharju, and Ikäheimo (2008), Kuhn et al. (2011), Shemesh and Zapatero (2011)) most strongly in areas where commuting patterns make the automobile purchase choices of others more visible (McShane, Bradlow, and Berger (2012)).

In the model, overestimation of the consumption of others is self-reinforcing, as each individual becomes an overconsuming model for others. So misperceptions of consumption norms can result in severe undersaving in society as a whole. A corollary of this reluctance

[7] He explains the difference in salience between consumption and non-consumption in the context of two well-known consumer products: "Customers in the queue at Starbucks are more visible than those hidden away in their offices unwilling to spend $4 on coffee. We are repeatedly exposed to commercials of people enthusiastically gulping soda and gyrating to their iPods, but the large segment of nonusers is not so memorably depicted."

of individuals to save is a higher equilibrium interest rate.

In the model, each individual ends up viewing the discount rates of others as higher than his own. This comes from overestimation of others' discount rate, and the fact that each individual shifts only partially in the direction of the perceived norm.

Such a mismatch between beliefs and social reality, wherein everyone individually rejects a norm (in this case, a norm of high discount rates), yet believes that others embrace it, is called *pluralistic ignorance* (Katz and Allport (1931)). For example, social psychology studies find that college students overestimate how much other students engage in and approve of heavy alcohol use (Prentice and Miller (1993)) and uncommitted or unprotected sexual practices (Lambert, Kahn, and Apple (2003)). These studies argue that pluralistic ignorance encourages such behaviors. In our model it is overconsumption that is promoted by pluralistic ignorance.

This feature of our model can also help explain why parents, social observers, and religious leaders tend to preach in favor of thrift, and to criticize consumer culture. To the extent that society is subject to pluralistic ignorance, people will believe that others have an unduly high discount rate. Moral authorities will therefore believe that they can improve matters by using their influence against current consumption.

There are notable differences in savings rates across countries and ethnic groups which are not well-explained by traditional economic models (Bosworth (1993)), and evidence that language, a cultural trait, affects time preference and savings rates (Chen (2013)).[8] An implication of the visibility bias approach to time preference is that relatively modest differences in inherent discount rates can be amplified through social influence. This can help explain the extremity of inter-group differences.

The reasoning we have described suggests that advertising and media biases can further reinforce overconsumption. Advertisers have an incentive to depict consumers using their products heavily (as implicitly alluded to in the quotation from Frederick above). News media serve their clientele by highlighting interesting consumption of high-end products or of consumption events (consider, e.g., the "Travel" section of newspapers). These further contribute to the higher visibility of consumption than nonconsumption. Of course, there is advertising of financial products as well. But it is much easier to vividly depict individuals consuming heavily at restaurants or exotic locations than to depict individuals saving

[8] Carroll, Rhee, and Rhee (1994) do not find an effect of culture on savings. The authors describe this as a tentative conclusion owing to data limitations. In contrast, using a similar methodology, Carroll, Rhee, and Rhee (1999) conclude that there *are* cultural effects, but that these effects do not explain patterns in cross-country differences in savings rates.

heavily.

The occurence versus non-occurence distinction that we focus upon is not the only source of differences in the salience of different consumption behaviors. For example, information that is more action-relevant tends to be more salient. Extreme outcomes tend to be more salient. Other things equal, this will cause observers to notice especially when others have either unusually low or unusually high consumption, with no clear overall bias toward either over- nor under- estimation of others' consumption. Such effects (which we do not model) would basically be orthogonal to those we focus on. In contrast, the neglect of nonoccurences that we focus upon causes systematic overestimation of others' consumption.

A plausible alternative theory of overconsumption and undersaving is that people are present-biased (i.e., subject to hyperbolic discounting, Laibson (1997)). Present bias is a preference effect, whereas visibility bias approach is based on belief updating. Also, present bias is an individual-level bias, whereas the visibility bias approach is based upon social observation and/or interaction. The visibility bias approach therefore has the distinctive implications that the intensity of social interactions, shifts in the technology for observing the consumption of others, and wealth dispersion affect the extent of overconsumption. It also offers sharply different policy implications.

Another appealing approach to overconsumption is based on Veblen effects (Cole, Mailath, and Postlewaite (1995), Bagwell and Bernheim (1996), Corneo and Jeanne (1997), Charles, Hurst, and Roussanov (2009)), wherein people overconsume to signal high wealth to others. In wealth signaling models, beliefs are rational, whereas the visibility bias approach is based upon biased inferences. The visibility approach has distinct empirical implications as well. For example, if all wealths were equal, Veblen effects would be eliminated, but the effects in our approach still apply. So in a visibility bias approach we expect to see overconsumption even within peer groups with low wealth inequality.

More generally (as discussed in Section 5), an intuitive implication of the Veblen approach is that the incentive to signal is stronger when observers face greater information asymmetry about the wealth of others, as occurs with high wealth dispersion. This must happen on average, in the sense that there is no overconsumption motivated by wealth signaling when there is zero wealth dispersion, and positive overconsumption when there is wealth signaling owing to positive wealth dispersion.

In contrast, in the visibility bias approach, greater information asymmetry dilutes the inference that can be drawn from (perceived) high consumption of others that their discount rates are high. In consequence, under high information asymmetry about wealth, equilibrium consumption is lower, the opposite of the Veblen-style prediction. The distinctive implications of the visibility bias theory are as yet untested.

A third approach is based on investors deriving utility as a function of deviations of their wealths from the wealths of other investors (e.g., Abel (1990), Campbell and Cochrane (1999)). Since consumption reduces future wealth, such 'keeping up with the Joneses' preferences affect consumption/savings choices.[9] This is a preference approach, as contrasted with our belief-based approach. Also, the primary focus of this literature has been on asset pricing puzzles rather than under- versus oversaving.

A further empirical and policy implication of the visibility bias approach is that eqxposing pluralistic ignorance by disclosing and saliently emphasizing information about the actual consumption or consumption attitudes of others will reduce overconsumption. This is a distinctive impication as compared with the other three approaches. Overconsumption in the visibility bias approach derives from mistaken beliefs about others that can potentially be corrected. In contrast, the present bias approach is not based on social observation, and the other two approaches are based upon rational beliefs.

2 The Basic Model

We first consider the effects of visibility bias in learning about the consumption of others with no uncertainty or production.

2.1 Optimal consumption of individuals

There are two consumption dates. At date 0, the individual chooses how much to consume and how much to borrow or lend at the riskfree interest rate r. Each individual i solves

$$\max_{c_{i0},c_{i1}} U(c_{i0}) + \delta_i U(c_{i1})$$

subject to the intertemporal budget constraint

$$c_{i0} + \frac{c_{i1}}{1+r} = y_{i0} + \frac{y_{i1}}{1+r}, \tag{1}$$

where the y_i's are endowed levels of the consumption good at the two dates.[10] The first order condition is

$$u'(c_{i0}) = \delta_i(1+r)u'(c_{i1}). \tag{2}$$

[9] In DeMarzo, Kaniel, and Kremer (2004, 2008) 'keeping up with the Joneses' effects can arise in settings with conventional preferences.

[10] The subjective discount factor δ_i should be distinguished from the subjective discount rate, which can be defined as $(1/\delta_i) - 1$. It is common to refer to discount rates in intuitive discussions; we do so at several points in the paper.

For most of the paper we assume logarithmic utility, $U(c) = \log(c)$. Then optimal consumptions c_{i0} and c_{i1} satisfy

$$\frac{c_{i1}}{c_{i0}} = \delta_i(1+r). \tag{3}$$

Define wealth as

$$W_i = y_{i0} + \frac{y_{i1}}{1+r}.$$

Combining (3) with the budget constraint (1) gives the individual's optimal consumption

$$c_{i0} = \frac{W_i}{1+\delta_i}, \tag{4}$$

so heavier subjective discounting (lower δ) causes current consumption to increase. (The absence of r in this log utility setting comes from the cancellation of the income and substitution effects as r varies.)

In the rest of this section, our focus is on the determination of date 0 consumption c_{i0}. For ease of notation, we omit the time subscript 0.

2.2 Visibility bias and learning about others' consumption

Suppose that there are N potential publicly observable consumption activities. Let the consumption intensity c be the propensity to engage in each of the N available consumption activities, where the probability that individual i undertakes any given activity is increasing in c. For any given activity, the probability that it is engaged in is $p(c) = c/\kappa$, where $0 \leq c \leq \kappa$. Each activity costs $K = \kappa/N$, $\kappa > 0$. (Having a different multiplied constant here would not qualitatively affect the results.) So the total expected consumption expenditure is

$$Np(c)K = c, \tag{5}$$

which is independent of N. In other words, we allow the number of activities to grow and the cost per activity to shrink correspondingly so that the expected cost remains unchanged. As N become large, the expenditure on consumption is close to its expectation c almost surely. We therefore refer to c henceforth as 'consumption' rather than 'consumption intensity.'

An individual randomly selects a target individual to observe, draws a sample of these potential consumption activities, and observes whether the target did or did not undertake each. (In the basic model, we will assume identical individuals, so that it would make no difference if an individual were to observe a sample from several targets.) Crucially, observation is tilted toward those activities in which consumption did occur. This derives from what we call *visibility bias*, the tendency to notice and recall events that are vivid and salient. We view the event of engaging in a consumption activity as generally more salient to others than the event of not doing so.

One reason that consumption activities are highly visible is that many are social, such as eating at restaurants, wearing stylish clothing to work or parties, and travelling. Furthermore, physical shopping for consumption goods is itself a social activity. Both physical and electronic shopping shopping and product evaluation are also engaging topics of conversation. In contrast, saving is often a private activity between an individual and his bank, brokerage, or retirement account software. There are exceptions of course, such as investment clubs, but overall, consumption tends to be more observable and salient to others than is saving.

In particular, the probability that the observer samples any given potential activity is q^H if the individual did undertake the consumption activity and q^L if the individual did not, where $q^H > q^L$.[11] The intensity of visibility bias is captured by $\tau \stackrel{def}{=} q^H/q^L$.

Letting $f(c)$ be the fraction of the activities sampled by the observer in which consumption occurs, the expected fraction is therefore

$$E[f(c)] = \frac{p(c)q^H}{p(c)q^H + [1-p(c)]q^L} \quad (6)$$

$$= \frac{p(c)\tau}{p(c)\tau + [1-p(c)]} > p(c). \quad (7)$$

The numerator in the first line is the probability that in any given activity consumption occurs and is detected, and the denominator is the probability that anything is detected—either consumption or non-consumption.

In the model, the observer fails to discount fully for the selection bias in observation, so the observer uses $f(c)$ to evaluate the frequency of the target's consumption activities. So visibility bias causes the observer to overestimate the fraction of the time that the target engages in consumption activity. As N, the number of activities observed, becomes large, $lim_{N\to\infty} E[f(c)] = f(c)$, so that the fraction of activities sampled in which consumption occurs, as given by (6), is nonstochastic.

The observer inverts from the consumption activity fraction given in (6) to infer the target's total consumption. When the true consumption of others is c, the inferred con-

[11] We refer to the observer as observing a biased sample of target activities. However, the algebra of the updating process in the model can equally be interpreted as reflecting a setting in which observers draw unbiased random samples of observations, but where there is a bias in the ability to *retrieve* different observations for cognitive processing and the formation of beliefs.

sumption is

$$\hat{c} = h(c) \overset{def}{=} p^{-1}(f(c)) = \frac{cq^H\kappa}{cq^H + (\kappa - c)q^L} = \frac{c\kappa}{c + (\kappa - c)/\tau} > c. \tag{8}$$

So owing to visibility bias, observers overestimate others' consumption levels. Moreover, the amount of overestimation increases with visibility bias:

$$\frac{\partial h(c)}{\partial \tau} > 0. \tag{9}$$

2.3 Updating Discount Rates Based upon Observation of Others

Let $\hat{c}_{\bar{i}}$ denote individual i's inference about the level of others' consumptions, and suppose that all individuals have the same wealth, $W_i = W$ for all i. Then by (4), the time preference parameter $\hat{\delta}_{\bar{i}}$ inferred by i satisfies

$$\hat{c}_{\bar{i}} = \frac{W}{1 + \hat{\delta}_{\bar{i}}},$$

so

$$\hat{\delta}_{\bar{i}}(\hat{c}_{\bar{i}}) = \frac{W}{\hat{c}_{\bar{i}}} - 1. \tag{10}$$

Let δ^* be the common *inherent* time preference parameter for all individuals. (In a review of literature in consumer psychology, Simonson (2008) argues that preferences do have an 'inherent' core as well as constructed aspects.) After learning about others' consumption and time preference, the individual updates his own time preference parameter to δ_i by taking a weighted average of his inherent time preference, δ^*, and the inferred time preference of others, $\hat{\delta}_{\bar{i}}$:

$$\delta_i = g(\hat{\delta}_{\bar{i}}) \equiv (1 - \gamma)\delta^* + \gamma\hat{\delta}_{\bar{i}}, \tag{11}$$

where $0 \leq \gamma < 1$, and where γ depends on the degree of social interactiveness/observability.

This updating rule is based on the idea that an individual who thinks that others are consuming heavily infers that consuming heavily is a good idea. This could be a reduced form for a setting in which the individual is acquiring information about the opportunity set, such as the probability of dying at a young age or about how consumption needs will change in retirement. Alternativly, the inference could be moralistic, i.e., learning about whether being a good person demands providing for the future (as with Aesop's fable of the ant and the grasshopper). Akerlof (2007) emphasizes that moral attitudes affect consumption decisions; under the moralistic interpretation of our model, such attitudes are influenced by the perceived consumption of others.

We refrain from imposing a rational-expectations-like condition that an individual understands that others share the individual's time preferences. Also, we do not think of individuals as even recognizing the distinction between others' inherent and actual time preferences. Each individual simply updates based upon inferences about the actual time preferences of others. Such simplified reasoning, wherein an observer fails to take into account fully the thought processes of other individuals, is broadly consistent with models and experimental studies of limited cognition in economic settings (e.g., Hirshleifer and Teoh (2003), Camerer, Ho, and Chong (2004) and Eyster and Rabin (2005)).[12]

Also, our model captures conformism by assuming that observation of others causes people to update their discount factors. An alternative approach would be based on a direct preference for consuming to match the consumption timing of others. That approach, however, is likely to generate multiple equilibria with early or late consumption, whereas our approach predicts a specific direction, overconsumption.

The updating rule (11), together with (4), implies that individual i selects a current consumption level of

$$c_i = \frac{W}{1 + g(\hat{\delta}_{\bar{i}})}. \tag{12}$$

2.4 The Symmetric Equilibrium

Assume that all individuals have identical utility functions, inherent discount factors, and consumption endowments. We seek a symmetric equilbrium, i.e., a fixed point in consumption and discount factor, for given wealth W and model parameters: $0 < \delta^* < 1$ (inherent discount factor), γ (weight on the inferred discount factor of others); and r riskfree rate.

We define (symmetric) equilibrium as follows.

Definition of Equilibrium *In an equilibrium, for all i, $c_i = c$, $\hat{\delta}_{\bar{i}} = \hat{\delta}$ satisfy:*

$$(1 + g(\hat{\delta}))c = W \tag{13}$$

$$(1 + \hat{\delta})h(c) = W, \tag{14}$$

[12]Even if an observer were to distinguish between actual and inherent discount rates and conform to the inferred *inherent rate*, effects of the type we focus on would arise in a setting that reflects the fundamental attribution error from social psychology. This is the tendency of observers to unduly attribute the behavior of others to inherent personal characteristics rather than to environmental circumstances (Nisbett and Ross (1980)). In the current context, this would mean attributing a target individual's high consumption to a high inherent discount rate rather than to the target individual merely conforming to the perceived consumption levels of others. An observer who is subject to the fundamental attribution error will infer that the *inherent* discount rate of others is high, and update his own discount rate accordingly. (This argument does, however, require that the observer not understand that everyone has the same inherent discount rate.)

with the functions g and h defined as

$$g(\hat{\delta}) \stackrel{def}{=} (1-\gamma)\delta + \gamma\hat{\delta},$$

and

$$h(c) \stackrel{def}{=} p^{-1}(f(c)).$$

In this definition of equilibrium, (13) is the requirement that the individual optimize based upon the individual's updated discount rate as in (12), and (14) is the requirement that the individual draws inferences about others' discount rates recognizing that others are optimizing in their consumption choices, i.e., follow the solution as given in (4) with δ_i replaced with $\hat{\delta}$.

This is an equilibrium in the sense that individuals are satisfied given their observations of others and the exogenous interest rate. But this is still a partial equilibrium setting; we do not impose market clearing.

Consistent with intuition, in this setting visibility bias causes overconsumption.

Proposition 1 *In a setting with exogenous interest rate and with visibility bias, under log utility and the other assumptions of the model:*

1. *There exists a unique symmetric equilibrium.*
2. *The consumption level c is higher than that without visibility bias.*
3. *The amount of overconsumption increases with visibility bias (τ) and with social interactiveness/observability (γ).*

Proof: From (14), $\hat{\delta} = W/h(c) - 1$. Substituting this into (13), equilibrium consumption c satisfies

$$[1+(1-\gamma)\delta^*]\, c + \gamma\left(\frac{W}{h(c)} - 1\right) c = W. \tag{15}$$

Let c_{δ^*} denotes the optimal consumption level corresponding to the inherent time preference δ^*,

$$c_{\delta^*} = \frac{W}{1+\delta^*}. \tag{16}$$

Let

$$F(x) \stackrel{def}{=} [1+(1-\gamma)\delta^*]\, x + \gamma\left(\frac{W}{h(x)} - 1\right) x - W \tag{17}$$

be the difference between the LHS and RHS of (15) as a function of possible consumption levels x. F is a continuous function with the property that

$$F(c_{\delta^*}) = \frac{\gamma W}{1+\delta^*}\left(-\delta^* + \frac{W}{h(c_{\delta^*})} - 1\right) = \frac{\gamma W^2}{1+\delta^*}\left(\frac{1}{h(c_{\delta^*})} - \frac{1}{c_{\delta^*}}\right) < 0,$$

because $h(c_{\delta^*}) > c_{\delta^*}$; and $F(W) = g(\hat{\delta})W > 0$. Therefore, there exists at least one $c \in (c_{\delta^*}, W)$ satisfying $F(c) = 0$. Hence, the equilibrium exists, i.e., there exists a fixed point in consumption c and discount factor $\hat{\delta}$ satisfying (13) and (14).

Uniqueness of the equilibrium follows from the fact that F is monotonically increasing, so that there can be at most one solution to $F(c) = 0$. To verify monotonicity, differentiate F to get

$$F'(c) = (1-\gamma)(1+\delta^*) + \gamma W \frac{h(c) - ch'(c)}{h^2(c)}.$$

By (8),

$$h(c) - ch'(c) = \frac{c^2 q^H (q^H - q^L)\kappa}{[cq^H + (\kappa - c)q^L]^2} > 0,$$

so $F' > 0$.

To verify Part 2, recall by (8) that $h(c) > c$. Substituting for $h(c)$ and c from (13) and (14), it follows that

$$\hat{\delta} < g(\hat{\delta}) = (1-\gamma)\delta^* + \gamma\hat{\delta}.$$

So $\hat{\delta} < \delta^*$, and hence $g(\hat{\delta}) < \delta^*$. By (13) and (16), we conclude that $c > c_\delta$.

To verify Part 3, observe that the overconsumption ratio is

$$c/c_{\delta^*} = \frac{1+\delta^*}{1+g(\hat{\delta})},$$

so it suffices to show that $\partial g(\hat{\delta})/\partial\tau < 0$ and $\partial g(\hat{\delta})/\partial\gamma < 0$. This follows from

$$\begin{aligned} \frac{\partial g(\hat{\delta})}{\partial \tau} &= \gamma\frac{\partial\hat{\delta}}{\partial\tau} = -\gamma\frac{W}{h(c)}\frac{\partial h(c)}{\partial\tau} < 0 \quad \text{(by (8))} \\ \frac{\partial g(\hat{\delta})}{\partial \gamma} &= -\delta^* < 0. \end{aligned} \tag{18}$$

||

Intuitively, owing to visibility bias in what is observed, and neglect of sample size/use of the availability heuristic in assessing frequences, people overestimate others' consumption, and therefore overestimate others' discount rates. Based on a misperception that the social norm is less thrifty than it really is, people update their own time preferences toward current consumption.

The assumption that individuals are identical, yet misperceive the attitudes of others, is stark. However, similar findings would apply in settings with heterogeneous individuals. Furthermore, as mentioned earlier, such mismatches between beliefs and social reality are consistent with the phenomenon of pluralistic ignorance, wherein everyone individually rejects a norm, yet believe that others favor it.

The social influence parameter γ is identical across individuals. With diverse γ's, we conjecture that individuals with greater susceptibility to social influence will overconsume more than those with lower γ. Such individuals update their preferences more in the direction of their overestimated perception of the consumption norm. It is evident that this is true for the special case in which γ is identical for almost everyone.

Result 1 *For given social influence parameter γ of other investors, an individual with zero mass with parameter γ' consumes more than others if and only if $\gamma' > \gamma$, and less than others if and only if $\gamma' < \gamma$. This individual's consumption is increasing with γ'.*

2.5 Comparative statics on varying endowments

Omitting i subscripts, let y_0 and y_1 be dates 0 and 1 endowed income. We now consider the comparative statics on varying y_0, the individual's date 0 income endowment, in settings with and without visibility bias.

Without visibility bias, by (4), an increase in the current income y_0 or future income y_1 increases current consumption:

$$\frac{\partial c_0}{\partial y_0} = \frac{1}{1+\delta^*}. \tag{19}$$

With visibility bias, the sample of others' consumption activities, and hence overestimation of their consumption levels, does not depend on y_0 or y_1. By (12), an increase in current income y_0 still increases current consumption:

$$\frac{\partial c_0}{\partial y_0} = \frac{1}{1+g(\hat{\delta})}. \tag{20}$$

Since $g(\hat{\delta}) < \delta^*$, it follows that visibility bias and resulting misperceptions of social norms cause the individual's current consumption c_0 to be more sensitive to changes in income than without visibility bias.

Proposition 2 *Under log utility, visibility bias increases the marginal propensity to consume from current income.*

This comparative statics is based upon an exogenous interest rate r, as marginal propensity to consume is defined based on variation of a single individual's income.

Intuitively, higher wealth tends to increase both current and future consumption, and with homothetic preferences (in this case log utility), the ratio between the two is constant. Social influence and visibility bias in our setting increase the ratio of current to future consumption, and therefore also the marginal propensity to consume out of income (or wealth).

2.6 The Equilibrium Interest Rate

The reasoning so far focuses on individual decisions with the riskfree rate r taken as given. We next solve for r by clearing the bond market. Intuitively, since visibility bias in social observation results in too low a time discount factor (δ), the equilibrium interest rate (r) is too high.

In a pure exchange economy, people can't all consume more today. The pro-consumption effects of visibility bias on δ are offset by a corresponding rise in r, so that the representative individual consumes the (exogenous) per capita income (although each individual thinks that his neighbors consume more than himself). In Section 4, allowing for intertemporal production reinstates the result that visibility bias increases current consumption, as individuals are able to satisfy their amplified preferences for current consumption by investing less.

From the optimization condition (3) and the budget constraint (1), the optimal consumption of the representative individual at date 0 satisfies

$$c_0(1+\delta) = y_0 + \frac{y_1}{1+r}.$$

In the symmetric equilibrium, each individual perceives that others use a time discount parameter $\hat{\delta}$, and updates his own discount factor to $g(\hat{\delta}) = (1-\gamma)\delta^* + \gamma\hat{\delta}$. By (13), equilibrium satisfies

$$c_0(1+g(\hat{\delta})) = y_0 + \frac{y_1}{1+r}. \tag{21}$$

Since individuals are identical, the interest rate r is set to zero out borrowing and lending. In equilibrium this implies that $c_0^* = y_0$, so by (21),

$$1+r = \frac{y_1}{y_0 g(\hat{\delta})}. \tag{22}$$

Since $\hat{\delta} < \delta^*$, $g(\hat{\delta}) < \delta^*$. So comparing the cases with and without visibility bias (where without visibility bias instead of the g function, $\hat{\delta} = \delta^*$), it is evident that visibility bias raises the interest rate.

Proposition 3 *Under pure exchange and log utility, the equilibrium riskfree interest rate is higher when individuals are subject to visibility bias in social observation than when they are not.*

This also implies that even if individuals are in principle subject to visibility bias, if its effects are eliminated owing to an absence of social interactions or social observation, the interest rate is lower.

3 General utility function and income uncertainty

There is no uncertainty in the model of previous sections, and the results relied on log utility. The result that visibility bias causes overconsumption generalizes to a setting with uncertainty about future income and to any utility function $U(c)$ that satisfies $U'(c) > 0$ and $U''(c) < 0$. We examine this issue in a partial equilibrium with exogenous interest rate r. In such a setting, as an individual becomes more impatient (δ becomes smaller), he consumes more today:

$$\frac{dc_0}{d\delta} < 0. \tag{23}$$

Once this is established, it is straightforward to show that the optimal consumption c_0 with biased social transmission is higher than the case without visibility bias, because in the former case, the individual uses an updated discount factor $g(\hat{\delta})$ that is lower than the discount factor δ^* that obtains without visibility bias.

Suppose now that at date 0, y_1 is uncertain. Each individual solves

$$\max_{c_0} \; U(c_0) + \delta \mathrm{E}[U(c_1)]$$

subject to the intertemporal budget constraint

$$c_0 + \frac{c_1}{1+r} = y_0 + \frac{y_1}{1+r}. \tag{24}$$

Optimal consumption satisfies

$$u'(c_0) = \delta(1+r)\mathrm{E}[u'(c_1)]. \tag{25}$$

Parametrically differentiating both sides of this equation with respect to δ gives

$$u''(c_0)\frac{\partial c_0}{\partial \delta} = (1+r)\mathrm{E}[u'(c_1)] + \delta(1+r)\mathrm{E}[u''(c_1)]\frac{\partial c_1}{\partial \delta}. \tag{26}$$

The budget constraint (1) implies that

$$\frac{\partial c_1}{\partial \delta} = -(1+r)\frac{\partial c_0}{\partial \delta}.$$

Substituting this into (26) yields

$$\left(u''(c_0) + \delta(1+r)^2\mathrm{E}[u''(c_1)]\right)\frac{\partial c_0}{\partial \delta} = (1+r)\mathrm{E}[u'(c_1)]. \tag{27}$$

The RHS of (27) is positive because $u' > 0$; the coefficient on $\partial c_0/\partial\delta$ on the LHS is negative because $u'' < 0$. Hence (23) follows.

Supressing the dependence of c_0 on the other model parameters, let the optimal date 0 consumption be $c_0 = C(\delta)$. Each individual observes a sample of another individual's activities, biased toward activities in which consumption took place. From this sample he infers others' consumption level, and back out others' time discount parameter; then he updates his own time preference, and uses it in determining own consumption level.

Without visibility bias, the equilibrium consumption at date 0 is

$$c_0^R = C(\delta^*),$$

where R denotes 'rational', and δ^* is the individual's inherent discount factor.

With visibility bias, in a symmetric equilibrium, the consumption at date 0 is $c_0^B = C(g(\hat{\delta}))$, where B denotes 'biased', $g(\hat{\delta})$ is as defined in (11), $\hat{\delta} = C^{-1}(\hat{c}_0)$, and where $\hat{c}_0$ is the inferred consumption level of others. By (23), $C(\delta)$ is decreasing function of δ. Since $\hat{c}_0 > c_0^B$, $\hat{\delta} < g(\hat{\delta})$, and thus $\hat{\delta} < \delta^*$, and also

$$g(\hat{\delta}) < \delta^*. \tag{28}$$

This in turn implies that

$$c_0^B = C(g(\hat{\delta})) > c_0^R = C(\delta^*).$$

So visibility bias and social influence increases equilibrium consumption.

Proposition 4 *In a setting with general von-Neumann Morgenstern risk averse utility and uncertain future income y_1 and exogenous interest rate, visibility bias increases consumption relative to a setting with no visibility bias.*

4 The Model with Production

We have shown in a setting with interest rate exogenously fixed that visibility bias increases consumption; and, in a pure exchange equilibrium setting, that visibility bias increases the interest rate, where equilibrium consumption is fixed by the market clearing condition at endowed consumption.

We now extend the basic model to allow for productive transformation between current and future consumption. In addition to the riskfree asset, individuals can invest some of their savings in a production technology which produces Y_1 units of future consumption goods using I units of investment. At date 0, each individual chooses the amount of consumption (c_0), allocates a positive or negative amount to riskfree bonds (b) and to real investment (I). Each individual is endowed with exogenous incomes y_0 and y_1 at the two dates.

Individual i solves the optimization problem

$$\max_{c_0,c_1} U(c_0) + \delta U(c_1)$$

subject to the productive technology constraint

$$Y_1 = H(I) \stackrel{def}{=} AI^{\alpha}, \quad 0 < \alpha < 1, \tag{29}$$

and the budget constraints

$$\begin{aligned} c_0 &= y_0 - I - b & (30) \\ c_1 &= Y_1 + y_1 + b(1+r). & (31) \end{aligned}$$

The optimization can be done over two controls c_0 and b. Once these two are chosen, by (30), the initial investment in the production technology is

$$I = y_0 - c_0 - b.$$

Together with (29) and (31), this implies that the date 1 consumption is

$$c_1 = H(y_0 - c_0 - b) + y_1 + b(1+r). \tag{32}$$

Substituting (32) into the objective function $L = U(c_0) + \delta U(c_1)$ of the maximization problem, we obtain the first order conditions with respect to c_0 and b:

$$\begin{aligned} \frac{\partial L}{\partial c_0} &= U'(c_0) - \delta U'(c_1)H(I) = 0 & (33) \\ \frac{\partial L}{\partial b} &= \delta U'(c_1)[-H'(I) + 1 + r] = 0. & (34) \end{aligned}$$

Equation (34) and the definition of $H(I) = A(I)^{\alpha}$ imply that

$$\alpha A I^{\alpha-1} = 1 + r, \quad \text{or} \tag{35}$$

$$I = \left(\frac{1+r}{\alpha A}\right)^{\frac{1}{\alpha-1}}. \tag{36}$$

The log utility function $U(c) = \log(c)$ and (33) imply that

$$c_1 = \delta H'(I) c_0 = \delta(1+r)c_0. \tag{37}$$

By (30), it follows that

$$c_0 + b = y_0 - \left(\frac{1+r}{\alpha A}\right)^{\frac{1}{\alpha-1}} = y_0 - I. \tag{38}$$

By (31) and (37),

$$\delta c_0 = \frac{y_1 + H(I)}{1+r} + b. \tag{39}$$

We can solve for date 0 optimal consumption c_0 and allocation to riskfree asset b from (38) and (39).

Let W be the individual's wealth, defined as the discounted value of the sum of present and future endowment y's and of production of future consumption $Y = H(I)$, net of expenditure on investment:

$$W = y_0 + \frac{y_1 + H(I)}{1+r} - I.$$

Adding (38) and (39), and cancelling b from both sides gives

$$c_0 = \frac{W}{1+\delta}. \tag{40}$$

By (38) and (40), the optimal bond investment is

$$b = \frac{\delta}{1+\delta}(y_0 - I) - \frac{1}{1+\delta}\frac{y_1 + H(I)}{1+r}. \tag{41}$$

In equilibrium, the bond market clears, $b = 0$, so the equilibrium interest rate satisfies

$$1 + r = \frac{y_1 + H(I)}{\delta(y_0 - I)}. \tag{42}$$

Corresponding to this interest rate, the optimal consumption is $c_0 = y_0 - I$. Since a log utility investor will never consume a negative amount, the equilibrium condition that $b = 0$ implies that $I < y_0$.

Combining (36) and (42), the equilibrium level of investment I satisfies

$$G(I;\delta) = 0, \tag{43}$$

where the function G is given by

$$G(I;\delta) \stackrel{def}{=} AI^{\alpha}(1+\alpha\delta) - \alpha\delta A y_0 I^{\alpha-1} + y_1. \tag{44}$$

Differentiating shows that

$$\frac{\partial G}{\partial \delta} = \alpha A I^{\alpha-1}(I - y_0) < 0 \tag{45}$$

$$\frac{\partial G}{\partial I} = \alpha A I^{\alpha-2}[(1+\alpha\delta)I - (\alpha-1)\delta y_0] > 0, \tag{46}$$

because $I < y_0$ and $0 < \alpha < 1$. To see that this implies a solution for I within its support $(0, y_0)$, observe that $\lim_{I\to 0} G(I;\delta) = -\infty$, that $G(y_0;\delta) > 0$, and that $\partial G/\partial I > 0$.

By (45), (46), and the implicit function theorem, $\partial I/\partial\delta > 0$. Since, by (28), visibility bias reduces δ, the equilibrium investment I is lower, and hence the consumption level $c_0 = y_0 - I$ is higher.

Let equilibrium be defined by each individual's date 0 consumption c_0 and his inference of others' time preference $\hat{\delta}$ satisfying

$$(1+g(\hat{\delta}))c_0 = W \tag{47}$$

$$(1+\hat{\delta})h(c_0) = W, \tag{48}$$

with the function g given by

$$g(\hat{\delta}) \stackrel{def}{=} (1-\gamma)\delta^* + \gamma\hat{\delta},$$

and the inferred consumption of others $h(c)$ by

$$h(c) \stackrel{def}{=} p^{-1}(f(c)).$$

Here owing to visibility bias $h(c) > c$.

Then the following proposition summarizes these results.

Proposition 5 *In an equilibrium setting with log utility, visibility bias and intertemporal production:*
(1) There exists a unique symmetric equilibrium. At date 0 all individuals invest

$$I = \left(\frac{1+r}{\alpha A}\right)^{\frac{1}{\alpha-1}}.$$

Each individual invests b in the riskfree asset at date 0*, where*

$$b = \frac{g(\hat{\delta})}{1+g(\hat{\delta})}(y_0 - I) - \frac{1}{1+g(\hat{\delta})}\frac{y_1 + AI^{\alpha}}{1+r},$$

and where the riskfree rate r is

$$1 + r = \frac{y_1 + A(I)^{\alpha}}{g(\hat{\delta})(y_0 - I)}.$$

(2) With visibility bias, the equilibrium consumption level c_0 is higher and investment I is lower, than in the absence of visibility bias.

So as in the basic setting with exogenous interest rate of Subsection 2.4, visibility bias increases consumption, and as in the equilibrium analysis of Subsection 2.6 (in which the pure exchange setting precluded an effect on equilibrium consumption), visibility bias increases the interest rate. Here visibility bias also decreases saving and real investment.

5 Information Asymmetry

We now generalize to allow for wealth dispersion in the population, and for individuals not knowing the wealths of others. Intuitively, the inference an observer draws about the discount rate of others based on observation of another's consumption is weaker if the observer does not know the target's wealth, owing to conflation between the possibilities that the discount rate is high or that wealth is high. In consequence, wealth dispersion reduces equilibrium overconsumption. This contrasts sharply with the Veblen wealth-signaling approach, in which it is precisely the fact that there is uncertainty about wealth that causes overconsumption to serve as a signal.

To model information asymmetry, we assume that each individual, as an observer, has a nondegenerate prior distribution over the common actual discount rate of others. As in the earlier sections, the setup reflects pluralistic ignorance; an observer does not understand that everyone is essentially similar to the observer with respect to discount rate. This creates an opening for visibility bias and the availability heuristic to influence perceptions.

We grant individuals enough rationality to understand that when they see high consumption, this could come from either a high discount rate or high wealth. As a simple benchmark to highlight the effects of visibility bias, we assume that people have correct prior beliefs about the joint distribution of others' wealths and their actual discount rate. People update from this correct prior to an incorrect posterior about these variables.

As in the earlier sections, observers draw inferences about others' actual discount rate, not their inherent discount rate. Observers views others' actual discount rate as normative, and update their own discount rates in the direction of their inferences. However, here even after observing others an individual does not feel sure about others' discount rate, so the indivdiual updates in the direction of the conditional expected discount rate of others. We return to the pure exchange setting of Section 2, except that we allow for wealth dispersion. Let $f_\delta(\delta)$ be the prior probability density that each individual has about the common actual discount factor of others. All observers share this prior about possible targets of observation, and this density matches the true underlying density. Similarly, let $g_W(W)$ be the prior density for individuals' wealths (independently distributed across targets of observation). Wealth and actual discount factors are independently distributed, and everyone correctly perceives this to be the case. An observer makes observations of a single target; since the wealth distribution is identical across individuals, we omit subscripts identifying which target.

For notational simplicity we now omit hats for variables indicating individual perceptions. By (4) and independence of δ and W, an observer who infers that a target's consumption is c for sure updates his belief about δ to

$$\begin{aligned} f_\delta(\delta|c) &= \frac{f_{\delta,c}(\delta,c)}{f_c(c)} \\ &= \frac{f_\delta(\delta)g_W((1+\delta)c)}{\int_\delta f_\delta(\delta)g_W((1+\delta)c)d\delta}. \end{aligned} \tag{49}$$

Assume that $\delta \sim U[0,1]$ and $W \sim U[1,2]$. By (4), $c \in [0.5, 2]$. In the numerator of the RHS of (49), $f_\delta(\delta) = 1$ on the support of δ, and $g_W((1+\delta)c) = 1$ iff $(1+\delta)c \in [1,2]$, and otherwise is zero.

The condition that $W \geq 1$ implies that $(1+\delta)c \geq 1$, so

$$\delta \geq \max\left(0, \frac{1}{c} - 1\right) \stackrel{def}{=} \underline{\delta}. \tag{50}$$

The condition that $W \leq 2$ implies that $(1+\delta)c \leq 2$, so

$$\delta \leq \min\left(\frac{2}{c} - 1, 1\right) \stackrel{def}{=} \overline{\delta}. \tag{51}$$

We can therefore calculate the expected discount factor as perceived by an observer who believes he has observed another individual with consumption c, as

$$E[\delta|c] = \frac{\int_{\underline{\delta}\leq\delta\leq\overline{\delta}} \delta d\delta}{\int_{\underline{\delta}\leq\delta\leq\overline{\delta}} d\delta}. \tag{52}$$

We consider two cases.

Case 1: $c \leq 1$.

Then the range of the integrals becomes $\delta \in [\frac{1}{c} - 1, 1]$, so

$$\begin{aligned} E[\delta|c] &= \frac{\int_{\frac{1}{c}-1}^{1} \delta d\delta}{\int_{\frac{1}{c}-1}^{1} d\delta} \\ &= \frac{1}{2c}. \end{aligned} \tag{53}$$

We will compare the sensitivity of this expectation of δ to c when there is wealth dispersion to the sensitivity of inferred δ to c when there is no wealth dispersion. Differentiating with respect to c:

$$\frac{dE[\delta|c]}{dc} = -\frac{1}{2c^2}. \tag{54}$$

Case 2: $1 < c \leq 2$.

Then the range of the integrals becomes $\delta \in [0, \frac{2}{c} - 1]$, so

$$\begin{aligned} E[\delta|c] &= \frac{\int_{0}^{\frac{2}{c}-1} \delta d\delta}{\int_{0}^{\frac{2}{c}-1} d\delta} \\ &= \frac{1}{c} - \frac{1}{2}. \end{aligned} \tag{55}$$

Differentiating with respect to c gives

$$\frac{dE[\delta|c]}{dc} = -c^{-2}. \tag{56}$$

As a benchmark for comparison, suppose that there is no wealth dispersion, and that the known level of wealth $\bar{W}$ is equal to the expected value of wealth in the model with wealth dispersion, $\bar{W} = 1.5$. In the model without wealth dispersion, by (4), the inferred value of δ is

$$\hat{\delta}(c) = \frac{\bar{W}}{c} - 1 = \frac{3}{2c} - 1, \tag{57}$$

so

$$\hat{\delta}'(c) = -\frac{3}{2}c^{-2}. \tag{58}$$

Then it is evident by direct comparison that in both Case 1 and Case 2,

$$\hat{\delta}'(c) < \frac{dE[\delta|c]}{dc} < 0. \tag{59}$$

In other words, with wealth dispersion, the discount factor that the observer perceives about the target of observation does not decrease as rapidly with perceived target consumption as in the model without wealth dispersion.

Proposition 6 *In the numerical example of Section 5, comparing the setting with wealth dispersion with a setting with uniform constant wealth equal to the expected wealth in the uncertainty setting, an observer's perception of the target's discount factor is less sensitive to perceived target consumption than when there is no wealth dispersion.*

Empirically, Proposition 6 predicts that savings rates increase with wealth dispersion. This is the opposite of what is expected based upon Veblen wealth-signaling considerations. In the Veblen approach to overconsumption, people consume more in order to signal the level of wealth to others (Bagwell and Bernheim (1996), Corneo and Jeanne (1997)). Greater information asymmetry about wealth intensifies the effect, by increasing the potential improvement in wealth perceptions that can be achieved by signaling. This is reflected, for example, in the finding of Charles, Hurst, and Roussanov (2009) that an increase in wealth dispersion that takes the form of a reduction in the lower support of wealth results in greater signaling.[13]

For example, in the limiting case of no information asymmetry, the Veblen effect would disappear and people would consume only for their direct utility benefits. More generally, in a simple setting in which the upper bound of the support of the wealth distribution becomes higher, then the range of possible equilibrium consumption signal levels is higher, so there will be more overconsumption on average.

Empirically, Jin, Li, and Wu (2014) find that greater income inequality is associated with lower consumption and with greater investment in education, in survey evidence from

[13] A compatible intuition is that when dispersion increases, the lower support of the wealth distribution decreases, so the signalling schedule starts increasing from an earlier beginning (a lower wealth level), raising the signaling schedule for any given wealth level. In their Veblen-style model Charles, Hurst, and Roussanov (2009) show that an increase in the dispersion of the wealth distribution that derives from a reduction in the lower support (making the poorest poorer) causes greater conspicuous consumption. Their explanation is essentially the same: "The intuition is that as poorer people are added to a population, persons of every level of income must now signal more to distinguish themselves from those immediately poorer, because those people are themselves now compelled to spend more to distinguish themselves from persons who are even poorer still." However, Charles, Hurst, and Roussanov (2009) the effect of a more general increase in wealth dispersion is ambiguous. Their model goes beyond the basic intuition here, as it allows for as a non-observable as well as an observable consumption good, and curvature in conspicuous consumption utility as a function of wealth. What we expect to apply quite generally in Veblen-style models is that wealth-signaling through consumption vanishes when wealth dispersion is zero. So such models reflect a general tendency for greater wealth dispersion to induce greater overconsumption, though not necessarily monotonically.

Chinese urban households, where income inequality is measured within age groups by province. This is consistent with the visibility bias approach, as opposed to the implication of wealth-signaling via consumption. The effect is stronger when the head of household is younger, which is consistent with greater suceptibility to social influence causing stronger updating of preferences toward mistaken perception of others' discount rate, as in Result 1 in Subsection 2.4.

The effects of wealth dispersion here derive from the unobservability of others' wealths rather than dispersion per se. The model therefore predicts that when the wealth of neighbors is harder to observe directly, there is less overconsumption.

An additional distinction between the Veblen approach and the social norm transmission approach is that consumption reacts differently to the degree of materialism of the society, and the incentives to obtain high reputation. In the Veblen approach, the greater the extent to which prestige is linked to perceptions of wealth, the stronger the incentive to signal and hence the greater the overconsumption. In contrast, in the social norm transmission approach this parameter is not relevant for overconsumption.[14]

6 Concluding Remarks

We examine how social influence endogenously shapes time preferences. In our model, consumption is more salient than non-consumption, resulting in greater observation and cognitive encoding of others' consumption activities. This visibility bias makes episodes of high consumption by others more salient and easier to retrieve from memory than episodes of low consumption. So owing to neglect of selection bias (and a well-known manifestation of it, the availability heuristic), people infer that low saving is normative and increase their own discount rates accordingly. This effect is self-reinforcing at the social level, resulting in overconsumption and high interest rates. The model therefore results in pluralistic ignorance about the time preferences of others; each person people thinks that the others have a higher discount rates. This ignorance in equilibrium has adverse consequences for resource allocation.

In contrast with the present bias (hyperbolic discounting) theory of overconsumption, the effects here are induced by social observation and interaction. Our approach can therefore be distinguished from present bias using proxies for social interaction and observability,

[14]Although the Veblen approach captures an important aspect of reality, in practice, people do not always seek to signal high wealth by consuming heavily. Olson and Rick (2013) report that individuals seeking to attract romantic partners exaggerate their *saving* behavior when completing dating profiles to enhance the impression of self-control, and that high saving enhances romantic appeal.

such as urban versus rural, and survey questions about sociability (see, e.g., Hong, Kubik, and Stein (2004), Hong, Kubik, and Stein (2004), Brown et al. (2008), Christelis, Georgarakos, and Haliassos (2011), and Georgarakos and Pasini (2011)).

In contrast with Veblen wealth-signaling, which broadly imply greater overconsumption when there is greater information asymmetry about the wealth of others (as occurs with high wealth dispersion), in our setting greater information asymmetry dilutes the inference from high observed consumption that the discount rate of others is high. In consequence, equilibrium consumption is *lower*, the opposite prediction. The visibility bias approach also helps explain high variation in savings rates across countries and ethnic groups, because even modest differences in inherent discount rates can be amplified through social influence.

In contrast with both of these approaches (as well as with 'keeping up with the Joneses' preferences), the model implies that a cheap and easy policy intervention could substantially reduce overconsumption. This is to provide—in highly salient form—accurate information about how much peers save, or their attitudes toward saving versus consumption. This implication about the beneficial effects of salient disclosure could be tested in the field.

In addition to providing insight about undersaving in general, the social interaction approach to consumption/saving norms potentially can contribute to our understanding of dynamic macroeconomic phenomena as well. For example, suppose that there are lags between people observing others and updating their own consumption plans, or lags between their consumption plans and actual consumption. If there are shocks to the system that encourage high or low spending, then the response lags can create momentum in shifts in consumption and consumption norms. This can potentially cause patterns of overshooting and correction, which would provide a possible basis for an overconsumption theory of business cycles.

More generally, our approach to understanding the evolution of consumption and saving attitudes is based upon *misperception of norms*—pluralistic ignorance. This approach is potentially applicable to various other settings, which suggests a rich direction for future research.

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