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Local status and prospect theory*

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Abstract

People are sometimes risk-averse in gains but risk-loving in losses. Such behavior and other anomalies underlying prospect theory arise from a model of local status maximization in which consumers compare their wealth with other consumers of similar wealth. This social explanation shares key features with the psychological explanation offered by Kahneman and Tversky.

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1 Introduction

Rather than being consistently risk-averse, people are sometimes risk-averse in gains but risk-loving in losses (Markowitz, 1952; Kahneman and Tversky, 1979). In their formulation of prospect theory, Kahneman and Tversky explain this anomaly by arguing that people tend to perceive changes rather than absolute values and have diminishing marginal sensitivity to changes. The utility function is therefore steepest in the region closest to current wealth where marginal sensitivity to change is greatest and flattens in either direction as the change in wealth becomes larger and marginal sensitivity diminishes. Since small changes in either direction have a disproportionate impact on utility, consumers are more attracted to a certain small gain than the chance of a larger gain and are also more repelled by a certain small loss than the possibility of a larger loss.

We show that a social explanation based on local status maximization shares key similarities with Kahneman and Tversky's psychological explanation. Rather than assuming that people derive utility from their global status among the entire population (Frank, 1985a; Robson, 1992; Kornienko, 2000), we assume they are concerned with their status among others with similar wealth.[1] In a global status model if the distribution of wealth is single-peaked the cumulative density function shifts from convexity to concavity at the mode, implying the modal person is risk averse in gains and risk loving in losses. In our local status model a much stronger result holds. We find that for any distribution of wealth everyone is risk averse in gains and risk loving in losses if they are concerned with their status among a sufficiently homogenous group centered around their current wealth. Since small changes around current wealth induce disproportionately large changes in status, small gains and losses have a disproportionate impact on

[1] Concern for status can arise from signaling games (Veblen, 1899), competition for limited resources such as mates (Cole, Mailath, and Postlewaite, 1992), and other factors. Frank (1985b) has emphasized the importance of local status.

utility. Just as in Kahneman and Tversky's model, the result is people are risk averse in gains but risk loving in losses.

A second behavioral regularity addressed by prospect theory is the tendency to turn down any fair gamble with an equal chance of winning or losing (Markowitz, 1952; Kahneman and Tversky, 1979). To reconcile such "loss aversion" with risk-loving behavior in losses, prospect theory assumes a kink in the utility function at current wealth. Local status maximization does not produce this same kink but still offers insight into the phenomenon. If the wealth distribution is unimodal then the utility function's inflection point is between modal and current wealth, implying consumers with above-modal wealth have a locally concave utility function and will display some loss aversion. More generally, if the reference group is sufficiently concentrated around current wealth then for any wealth distribution the gains to anyone from a symmetric gamble are either negative or arbitrarily small.

Local status may also offer some insight into the popularity of insurance and lottery tickets. The tendency for consumers to simultaneously purchase both led Friedman and Savage (1947) to suggest a utility function that was first concave and then convex, the opposite of prospect theory. Kahneman and Tversky argue that such behavior arises not from the shape of the utility function but because people overweight both the small probability of winning a lottery and the small probability of events covered by insurance.[2] In a local status model the shape of the utility function may still be relevant in explaining why some consumers purchase insurance while others purchase lottery tickets. If a consumer's reference group is not concentrated around her own wealth but is sufficiently concentrated around a higher wealth level the consumer will purchase a lottery ticket with a payoff exceeding that wealth level. Likewise, if the reference group

[2] This approach distinguishes prospect theory from Markowitz's (1952) theory which explains all three anomalies by a more complicated utility function centered around current wealth. Cumulative prospect theory (Tversky and Kahneman, 1992; Tversky and Wakker, 1995; Prelec, 1998) relies even more on the weighting function rather than the shape of the utility function to explain observed anomalies.

is sufficiently concentrated around a lower wealth level the consumer will purchase an insurance policy which prevents wealth from falling below that level.[3]

Regarding the general connection between status and nonstandard risk behavior, introducing status into the utility function clearly allows for a wide range of complicated utility functions, especially if people care about both status and absolute wealth. For instance, Robson (1992) shows that the simultaneous purchase of insurance and lottery tickets is possible if utility is convex in status and concave in wealth. And Coelho and McClure (1998) show that, among other possibilities, the Markowitz (1952) utility function with three inflection points can arise if people are interested in absolute wealth, wealth relative to peers, and wealth of one's peer group relative to non-peers.[4] By concentrating on limiting behavior as status becomes more localized, we are able to make more specific predictions. We show that concern for local status produces a particular set of behavior that, to varying degrees, is consistent with each of the principle anomalies underlying prospect theory.

2 The Model

We consider a simple one period model in which an individual chooses whether or not to take a gamble. Since there is only one period, consumption and wealth are synonymous. Wealth y is distributed in the population according to the density function $f(\cdot)$ which is continuous, bounded, and has support on $\mathbb{R}$.[5] We assume that the reference group for each individual is different and in particular that individuals are more likely to compare their position with other individuals of similar wealth levels. The distribution

[3]In this context "framing" (Kahneman and Tversky, 1979) can be interpreted as affecting what reference group a person uses.

[4]They follow Duesenberry (1949) in measuring status by wealth relative to a mean rather than position in the wealth distribution so their results are not directly comparable with ours.

[5]Negative values are included to reflect the possibility of indebtedness. Restricting wealth to be non-negative does not change the analysis.

of individuals in the reference group for a person with wealth level y_o is a weighted function of the overall distribution of wealth where the weights depend on y_o. Let $g(\cdot)$ represent the weight placed on wealth y in the reference group for a person with initial wealth y_o. We refer to this weighting function $g(\cdot)$ as the comparison density and assume it is independent of the wealth distribution, is symmetric around mean and mode μ_g, has variance σ^2, and has support on $\mathbb{R}$. We will initially consider the case where $\mu_g = y_o$ so that the comparison density is centered around current wealth. Later we will allow the comparison density to be centered elsewhere. Combining the wealth and comparison densities, the utility of wealth $\widehat{y}$ for a person with wealth y_o is defined as

$$U(\widehat{y}) = C \int_{-\infty}^{\widehat{y}} f(y)g(y)dy,$$

where $C = (\int f(y)g(y)dy)^{-1}$ is a normalizing constant. Note that utility is simply the fraction of people in one's reference group who have lower wealth.[6] If the comparison density were completely diffuse then the reference group would be the entire population and the utility function would be the same as that of a global status model.

Our local status utility function clearly allows for a wide range of possible shapes and could change between convexity and concavity an unlimited number of times depending on the shapes of the wealth and comparison densities. To make clearer predictions we investigate behavior as the variance σ^2 of the comparison density becomes smaller so that the reference group becomes more homogeneous. In particular we consider limiting behavior as σ^2 approaches 0.

In order to investigate limiting behavior, we are interested in any sequence of symmetric mean-preserving comparison densities $\{g_n(\cdot)\}$ with mean μ_g and variance σ_n^2, such that the variances converge to zero, i.e. $\lim_{n\to\infty} \sigma_n^2 = 0$. The corresponding sequence of

[6]Robson's (1992) global status model assumes utility is a convex rather than linear function of status. As long as utility is a continuous function of status, allowing for convexity or concavity does not affect any of the results except Proposition 2(i) which is overturned by sufficient convexity (or concavity).

utility functions $\{U_n(\cdot)\}$ is then

$$U_n(\widehat{y}) = C_n \int_{-\infty}^{\widehat{y}} f(y) g_n(y) dy,$$

where $C_n = (\int_{-\infty}^{\infty} f(y) g_n(y) dy)^{-1}$. To evaluate the behavioral implications of this sequence of utility functions we will use the following Lemma.[7]

Lemma *For a bounded and continuous function* $f(\cdot)$ on $\mathbb{R}$**,** *if a sequence of symmetric comparison densities* $\{g_n(\cdot)\}$ *on* $\mathbb{R}$ *with mean* μ_g *for all* n *satisfies* $\lim_{n\to\infty} \sigma_n^2 = 0$ *then*

$$\lim_{n\to\infty} \int_{-\infty}^{\mu_g} f(y) g_n(y) dy = \lim_{n\to\infty} \int_{\mu_g}^{\infty} f(y) g_n(y) dy = f(\mu_g)/2$$

and therefore

$$\lim_{n\to\infty} \int_{-\infty}^{\infty} f(y) g_n(y) dy = f(\mu_g).$$

Proof: Define $h(y) = f(y) - f(\mu_g)$, so that

$$\begin{aligned} \int_{-\infty}^{\mu_g} f(y) g_n(y) dy &= \int_{-\infty}^{\mu_g} f(\mu_g) g_n(y) dy + \int_{-\infty}^{\mu_g} h(y) g_n(y) dy \\ &= \frac{f(\mu_g)}{2} + \int_{-\infty}^{\mu_g} h(y) g_n(y) dy, \end{aligned}$$

where we have used the fact that $\int_{-\infty}^{\mu_g} g_n(y) dy = 1/2$ by the symmetry of the comparison density. For any arbitrary $A > 0$,

$$\int_{-\infty}^{\mu_g} h(y) g_n(y) dy = \int_{-\infty}^{\mu_g - A} h(y) g_n(y) dy + \int_{\mu_g - A}^{\mu_g} h(y) g_n(y) dy = I_1 + I_2.$$

[7] The lemma implies the sequence $\{g_n(\cdot)\}$ is a delta(-convergent) sequence, i.e. it converges to the Dirac delta function. For more information on the Dirac delta function and delta sequences see, for example, Kanwal (1997).

Let the maximum of $\mid h(y) \mid$ for $x \in [\mu_g - A, \mu_g]$ be denoted $M(A)$. Then

$$\mid I_2 \mid \leq \int_{\mu_g - A}^{\mu_g} \mid h(y) \mid g_n(y)dy \leq M(A) \int_{\mu_g - A}^{\mu_g} g_n(y)dy \leq M(A).$$

Since $h(\mu_g) = 0$ and $h(y)$ is continuous at $x = \mu_g$, we have $\lim_{A \to 0} M(A) = 0$. Consequently, for any $\epsilon > 0$, there exists a real number A sufficiently small that $\mid I_2 \mid < \frac{\epsilon}{2}$, and this holds independent of M.

With the number A so chosen, it remains to be shown that $\mid I_1 \mid$ is sufficiently small for sufficiently large n. Since $f(y)$ is bounded and $\mid h(y) \mid < \mid f(y) \mid + \mid f(\mu_g) \mid$, it follows that $\mid h(y) \mid$ is bounded in $[-\infty, \mu_g]$, say $\mid h(y) \mid < B$. Then, using Chebyshev's inequality,

$$\mid I_1 \mid \leq B \int_{-\infty}^{\mu_g - A} g_n(y)dy \leq B \frac{\sigma_n^2}{2A^2}.$$

With the number A fixed, $\lim_{n \to \infty} \frac{\sigma_n^2}{A^2} = 0$. This means that we can find N such that

$$\mid I_1 \mid \leq B \frac{\sigma_n^2}{2A^2} < \frac{\epsilon}{2}, \qquad n > N.$$

With this choice of N, we have

$$\mid \int_{-\infty}^{\mu_g} h(y) g_n(y)dy \mid \leq \mid I_1 + I_2 \mid \leq \mid I_1 \mid + \mid I_2 \mid < \epsilon, \qquad n > N,$$

implying $\lim_{n \to \infty} \int_{-\infty}^{\mu_g} f(y) g_n(y)dy = f(\mu_g)/2$. By the same logic $\lim_{n \to \infty} \int_{\mu_g}^{\infty} f(y) g_n(y)dy = f(\mu_g)/2$. ■

The following considers two different decisions facing an individual with wealth y_o.[8] The first is to take either a certain gain or a gamble offering a chance at a larger gain. The second is to take either a certain loss or a gamble with the possibility of a larger loss.

[8] To avoid consideration of strategic interactions, we assume that only one individual faces a decision. Some of the complexities of strategic interactions are explored in Robson (1992), Harbaugh (1996), and Hopkins and Kornienko (2000).

If concern for status is sufficiently localized around current wealth then any individual chooses the certain smaller gain in the first case but the uncertain larger loss in the second case.

Proposition 1 *For any given y', y'', y_o, y^*, and y^{**} where $y' < y'' < y_o < y^* < y^{**}$ and any given $\alpha \in (0,1)$, if $\mu_g = y_o$ then (i) $\lim_{n\to\infty}(\alpha U_n(y_o) + (1-\alpha)U_n(y^{**}) - U_n(y^*)) < 0$ and (ii) $\lim_{n\to\infty}(\alpha U_n(y') + (1-\alpha)U_n(y_o) - U_n(y'')) > 0$.*

Proof: (i) Since $\lim_{n\to\infty}\sigma_n^2 = 0$, therefore $\lim_{n\to\infty} C_n = 1/f(y_o) > 0$ by the Lemma. Since $f(y)$ is bounded, let $f(y) \leq \overline{f}$ for all y. By Chebyshev's inequality,

$$\begin{aligned} 1 - \overline{f}C_n\frac{\sigma_n^2}{(y^* - y_o)^2} &\leq U_n(y^*) \leq 1 \Rightarrow \lim_{n\to\infty} U_n(y^*) = 1, \\ 1 - \overline{f}C_n\frac{\sigma_n^2}{(y^{**} - y_o)^2} &\leq U_n(y^{**}) \leq 1 \Rightarrow \lim_{n\to\infty} U_n(y^{**}) = 1. \end{aligned}$$

Since $\lim_{n\to\infty} U_n(y_o) = (f(y_o)/2)/f(y_o) = 1/2$ by the Lemma, $\lim_{n\to\infty}(\alpha U_n(y_o) + (1 - \alpha)U_n(y^{**}) - U_n(y^*)) = -\alpha/2 < 0$.

(ii) By Chebyshev's inequality,

$$\begin{aligned} 0 &\leq U_n(y') \leq \overline{f}C_n\frac{\sigma_n^2}{(y' - y_o)^2} \Rightarrow \lim_{n\to\infty} U_n(y') = 0, \\ 0 &\leq U_n(y'') \leq \overline{f}C_n\frac{\sigma_n^2}{(y'' - y_o)^2} \Rightarrow \lim_{n\to\infty} U_n(y'') = 0, \end{aligned}$$

so $\lim_{n\to\infty}(\alpha U_n(y') + (1-\alpha)U_n(y_o) - U_n(y'')) = (1-\alpha)/2 > 0$. ■

The example of Figure 1 shows the impact of local status. Wealth follows a normal distribution with mean 10 and standard deviation 1 while the comparison density is a normal distribution with mean y_o and standard deviation 1. Combining these two factors, the utility function for an individual with wealth y_o is $U(\widehat{y}) = \int_{-\infty}^{\widehat{y}} \phi(10,1)\phi(y_o,1)dy / \int \phi(10,1)\phi(y_o,1)dy$ where $\phi(\mu,\sigma)$ is the normal distribution with mean μ and standard deviation σ. The three curves represent utility functions for

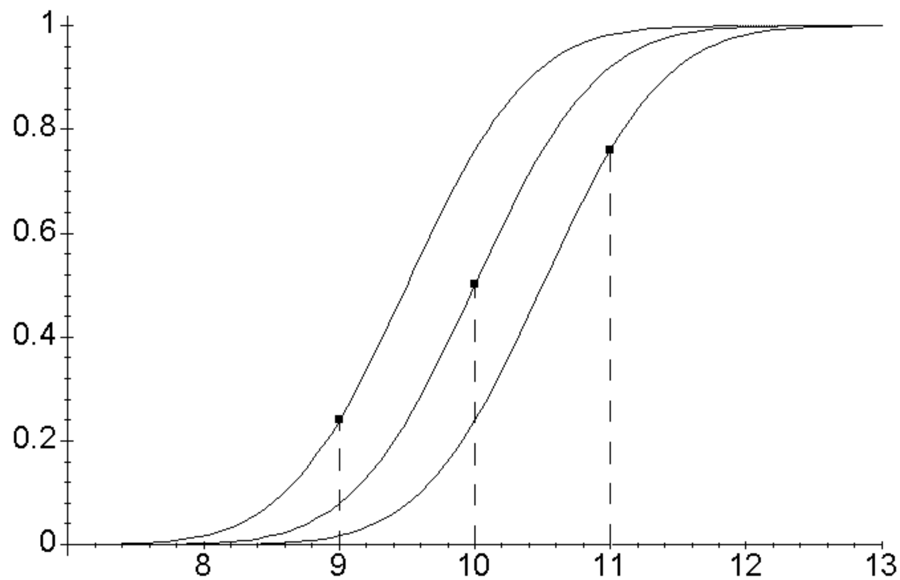

Figure 1: Utility functions with local status

individuals with wealth levels $y_o = 9$, $y_o = 10$, and $y_o = 11$ as shown from left to right. Note that under global status maximization everyone shares the same utility function $U(y) = \int_{-\infty}^{\widehat{y}} \phi(10, 1)dy$ so individuals with wealth above the inflection point at the mean of 10 tend to be risk averse while individuals with wealth below the inflection point tend to be risk loving. Under local status maximization people are more likely to compare themselves with others of similar wealth so position in the overall wealth distribution is less important. As status concerns become increasingly localized the inflection point for each individual's utility function becomes closer and closer to y_o and individuals become more generally risk averse in gains and risk loving in losses.

The fact that the inflection point is not exactly at y_o is relevant for loss aversion. Prospect theory argues that marginal utility is steeper in losses than in gains in the area of y_o, implying symmetric gambles are rejected. For individuals with above-modal wealth the inflection point can be arbitrarily close to y_o but is below y_o, implying the utility function is concave at current wealth. Looking at Figure 1, it is apparent that the comparatively wealthy individual with wealth $y_o = 11$ is locally risk averse.[9] The first part of the following proposition shows that individuals will avoid symmetric gambles in the range where the wealth distribution is decreasing, as occurs for individuals with above-modal wealth when the wealth distribution is unimodal. The second part shows more generally that any symmetric gamble offers no better than arbitrarily small gains if the comparison density is sufficiently concentrated around current wealth. This weaker statement holds regardless of the distribution of wealth and regardless of the individual's wealth level.[10]

Proposition 2 *For any given $x > 0$ if $\mu_g = y_o$ then (i) $\frac{1}{2}U(y_o - x) + \frac{1}{2}U(y_o + x) - U(y_o)$ is negative (positive) if $f(y)$ is decreasing (increasing) on $[y_0 - x, y_0 + x]$ and (ii) $\lim_{n\to\infty}(\frac{1}{2}U_n(y_o - x) + \frac{1}{2}U_n(y_o + x) - U_n(y_o)) = 0$.*

Proof: (i) For decreasing $f(y)$, the net gain from the gamble is

$$\begin{aligned}
& \frac{1}{2}U(y_o - x) + \frac{1}{2}U(y_o + x) - U(y_o) \\
= \; & \frac{C}{2}\left(\int_{-\infty}^{y_o - x} f(y)g(y)dy + \int_{-\infty}^{y_o + x} f(y)g(y)dy - 2\int_{-\infty}^{y_o} f(y)g(y)dy\right) \\
= \; & \frac{C}{2}\left(\int_{y_o}^{y_o + x} f(y)g(y)dy - \int_{y_o - x}^{y_o} f(y)g(y)dy\right) \\
\leq \; & \frac{C}{2}\left(\int_{y_o}^{y_o + x} f(2y_o - y)g(y)dy - \int_{y_o - x}^{y_o} f(y)g(y)dy\right) \\
= \; & \frac{C}{2}\left(\int_{y_o}^{y_o + x} f(2y_o - y)g(2y_o - y)dy - \int_{y_o - x}^{y_o} f(y)g(y)dy\right) = 0.
\end{aligned}$$

[9] If, unlike this example, the distribution of wealth were skewed so that the mode was below the median, then the utility function would be concave at current wealth for most consumers.

[10] The simplest way to explain any residual aversion to symmetric gambles is a healthy skepticism that the gamble is really fair. Alternatively, the utility function may include a non-status component that incorporates global risk aversion. For instance, the utility function could be $U(\widehat{y}) = C\int_{-\infty}^{\widehat{y}} f(y)c(y)dy + v(\widehat{y})$ where $v(\cdot)$ is concave.

Proof for the case with increasing $f(y)$ is identical except the inequality is reversed.

(ii) Again $\lim_{n\to\infty} C_n = 1/f(y_o) > 0$ by the Lemma. Since $f(y)$ is bounded, $f(y) \leq \overline{f}$ for all y. By Chebyshev's inequality,

$$\begin{aligned} 0 \leq U_n(y_o - x) \leq \overline{f} C_n \frac{\sigma_n^2}{x^2} \quad &\Rightarrow \quad \lim_{n\to\infty} U_n(y_o - x) = 0, \\ 1 - \overline{f} C_n \frac{\sigma_n^2}{x^2} \leq U_n(y_o + x) \leq 1 \quad &\Rightarrow \quad \lim_{n\to\infty} U_n(y_o + x) = 1. \end{aligned}$$

Since $\lim_{n\to\infty} U_n(y_o) = 1/2$ by the Lemma, $\lim_{n\to\infty}(\frac{1}{2}U_n(y_o - x) + \frac{1}{2}U_n(y_o + x) - U_n(y_o)) = 0$. ■

To explain the popularity of both insurance and lotteries, prospect theory argues that people overweight small probabilities. Status models offer a more limited explanation that may capture why some people are willing to gamble while others take insurance. As mentioned, if status concerns are global and the wealth distribution is single-peaked, people below the mode are in the convex region of the utility function and people above the mode are in the concave region, suggesting the former will be more disposed toward gambling and the latter toward insurance, though exact behavior will depend on the odds and payoffs. If the comparison density is sufficiently diffuse then local status and global status are equivalent so the same property holds in our model. As status becomes more concentrated around current wealth Proposition 1 implies neither gambling nor insurance has much appeal. Proposition 1 assumed that the comparison density was centered around current wealth. The following proposition considers what happens when the comparison density is centered elsewhere. We find that when individuals compare themselves to a group with higher wealth they will gamble and when they compare themselves to a group with lower wealth they will purchase insurance.[11]

[11] For symmetry we are taking the case of buying insurance as the status quo so that y_o is wealth when insurance is bought. If not buying insurance were the status quo then the result would be that the consumer will buy insurance if the reference group is below the consumer's wealth after purchasing insurance.

Proposition 3 *For any given y', y_o, y'' where $y' < y_o < y''$ and any given $\alpha \in (0,1)$, then (i)* $\lim_{n\to\infty}(\alpha U_n(y') + (1-\alpha)U_n(y'') - U_n(y_o)) > 0$ *if $\mu_g \in (y_o, y'')$ and (ii)* $\lim_{n\to\infty}(\alpha U_n(y') + (1-\alpha)U_n(y'') - U_n(y_o)) < 0$ *if $\mu_g \in (y', y_o)$.*

Proof: Again $\lim_{n\to\infty} C_n = 1/f(y_o) > 0$ and $f(y) \leq \overline{f}$ for all y. By Chebyshev's inequality,

$$\begin{aligned} 0 &\leq U_n(y') \leq \overline{f}C_n \frac{\sigma_n^2}{(\mu_g - y')^2} \Rightarrow \lim_{n\to\infty} U_n(y') = 0, \\ 1 - \overline{f}C_n \frac{\sigma_n^2}{(y'' - \mu_g)^2} &\leq U_n(y'') \leq 1 \Rightarrow \lim_{n\to\infty} U_n(y'') = 1. \end{aligned}$$

(*i*) For $y_o < \mu_g$ Chebyshev's inequality implies

$$0 \leq U_n(y_o) \leq \overline{f}C_n \frac{\sigma_n^2}{(\mu_g - y_o)^2} \Rightarrow \lim_{n\to\infty} U_n(y_o) = 0,$$

so that $\lim_{n\to\infty}(\alpha U_n(y') + (1-\alpha)U_n(y'') - U_n(y_o)) = 1 - \alpha > 0$.

(*ii*) For $y_o > \mu_g$ Chebyshev's inequality implies

$$1 - \overline{f}C_n \frac{\sigma_n^2}{(y_o - \mu_g)^2} \leq U_n(y_o) \leq 1 \Rightarrow \lim_{n\to\infty} U_n(y_o) = 1,$$

so that $\lim_{n\to\infty}(\alpha U_n(y') + (1-\alpha)U_n(y'') - U_n(y_o)) = -\alpha < 0$. ■

3 Conclusion

By introducing local status into a status utility model this note revealed a close connection between status concerns and prospect theory. Prospect theory argues that individuals are disproportionately concerned with small gains and small losses since their sensitivity to change decreases as changes become larger. We showed that a similar effect arises in a model of local status maximization for social rather than psychological reasons. Since individuals are most likely to compare their status with others of comparable wealth, they are most concerned with small changes around their current wealth, and are therefore risk loving in losses and risk averse in gains. We also showed that other anomalies underlying prospect theory may reflect local status concerns. Regarding loss aversion, sufficient concern for local status implies that symmetric gambles either reduce utility or offer arbitrarily small gains. Regarding the coexistence of insurance and lotteries, individuals whose reference group is wealthier than they are will tend to buy lottery tickets, while individuals whose reference group is poorer than they are will tend to buy insurance.

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