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Status competition, endogenous risk attitudes, and the insurance–lottery puzzle

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Abstract

Individuals purchase insurance while buying lottery tickets, contradicting expected utility's prediction of globally concave preferences. This paper provides a structural explanation for the coexistence of risk attitudes commonly associated with insurance purchase and lottery participation. An agent's utility combines a concave consumption component with a contest-based status component derived from the difference-form Tullock–Hirshleifer contest success function. Risk curvature is endogenous: weak agents are strictly risk-loving under re-optimization, while all agents are strictly risk-averse over background risks at fixed status expenditure, so any weak agent simultaneously exhibits both risk attitudes. This coexistence rests on irreversibility: background risks destroy assets that cannot be instantly reallocated, while lottery prizes arrive as liquid cash permitting immediate reallocation toward status expenditure. Indirect utility is globally S-shaped around an endogenously determined reference wealth level that shifts one-for-one with rival expenditure, sharing the S-shaped curvature and endogenous reference point properties of the prospect theory value function, while remaining silent on loss aversion and probability weighting.

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1. Introduction

Why do individuals simultaneously purchase insurance and buy lottery tickets? This coexistence is a long-standing paradox, since standard expected utility theory predicts globally concave preferences under risk. Classic explanations posit non-concave utility functions: Friedman and Savage (1948) propose an S-shaped utility over wealth, while prospect theory (Kahneman and Tversky, 1979) introduces reference-dependent curvature. In both, mixed risk attitudes arise from assumed features of preferences.

This paper offers a structural alternative requiring neither assumption. The agent's utility combines a concave consumption component with a status component derived from the difference-form Tullock–Hirshleifer contest success function (Hirshleifer, 1989), which is convex for weak agents and concave for strong ones. Utility curvature is therefore not assumed but emerges mechanically from the structure of status competition.

This reverses the usual causal order in the literature on relative standing. Models of relative income and positional concerns (Duesenberry, 1949; Frank, 1985; Bernheim, 1994; Postlewaite, 1998) specify social preferences directly, leaving curvature implicit or imposed; the contest literature with risk-averse agents (Konrad and Schlesinger, 1997; Treich, 2010; Cornes and Hartley, 2012) treats risk preference as exogenous.

Teng (2013) derives a single power-induced Arrow-Pratt measure from the contest success function's curvature alone, under linear consumption utility and no consumption–status optimization. The present paper differs in two respects: the agent here optimizes status expenditure against a strictly concave consumption component, so two distinct Arrow-Pratt measures emerge — one fixed, one re-optimized — that can differ in sign for the same agent, the mechanism behind the insurance–lottery coexistence result; and it establishes a globally S-shaped indirect utility function with an endogenously determined reference point shifting one-for-one with rival expenditure. Neither result appears in Teng (2013).

Robson (1992) derives S-shaped utility as an evolutionary equilibrium rather than from contest-based status competition. Absent there are the endogenous reference point shifting one-for-one with rival expenditure, and the distinction between background risks — over which the agent is unconditionally risk-averse — and adjustable risks — over which relative standing alone governs the sign of risk attitude — the mechanism behind the insurance–lottery coexistence result.

The model yields six closed-form implications spanning fixed versus re-optimized risk preferences, the insurance–lottery coexistence conditions, the endogenous S-shaped indirect utility function, and comparative statics linking contest intensity to risk polarization.

2. The Model

An agent with wealth W chooses status expenditure F, with consumption

$$C = W - F. \tag{1}$$

Utility consists of a concave consumption component and a contest-based status component:

$$U(F) = a(W - F) - \frac{b}{2}(W - F)^2 + vP(F), a, b, v > 0. \tag{2}$$

where the contest success function is

$$P(F) = \frac{e^{m(F-F_j)}}{1 + e^{m(F-F_j)}}, m > 0, \tag{3}$$

and F_j is exogenous reference expenditure.

The consumption component is strictly concave, $u''(C) = -b < 0$, while the contest component is convex for $F < F_j$ (i.e., $P < 1/2$) and concave for $F > F_j$. Intuitively, weak agents face accelerating returns to status expenditure when behind, while strong agents face diminishing returns as they pull ahead.

This convexity–concavity split is a property of the logistic difference-form contest success function (Hirshleifer, 1989). Other contest success function specifications can produce a qualitatively similar S-shape with a different inflection location, so the exact reference wealth level W° and its comparative statics (Corollaries 2–3) are specific to (3) rather than general across CSF families. The substantive content lies elsewhere: how this curvature, filtered through optimal status expenditure and the envelope theorem, generates curvature in indirect utility over wealth W, together with the comparative statics of contest intensity in Proposition 2.

Interior solution. If $-b + vm^2P(1 - P)(1 - 2P) < 0$, the agent has an interior optimal status expenditure F^* satisfying

$$\frac{dU}{dF} = -a + b(W - F) + vmP(1 - P) = 0. \tag{4}$$

Call the agent weak if $P^* < 1/2$ and strong if $P^* > 1/2$. Equivalently, $F^* = W - \frac{a}{b} + \frac{vm}{b}P^*(1 - P^*)$, where $P^* = P(F^*)$. The second-order condition is $\frac{d^2U}{dF^2} = -b + vm^2P(1 - P)(1 - 2P) < 0$ under the stated condition.[1] We maintain $C < a/b$ throughout, ensuring $a - bC, a - bC^* > 0$, as required for positive marginal utility of consumption, well-defined Arrow–Pratt measures, and a strictly increasing indirect utility $V(W)$.

Proposition 1 (Risk Preference with Fixed and Variable Status Expenditure)
Holding status expenditure fixed, the utility function satisfies $U(W) = a(W - F) - (b/2)(W - F)^2 + vP(F)$, where $vP(F)$ is constant with respect to W. Therefore:

$$U'(W) = a - b(W - F) = a - bC$$
$$U''(W) = -b$$
$$A_{fixed}(W) = -\frac{U''(W)}{U'(W)} = \frac{b}{a - bC} > 0$$

[1] To verify joint satisfiability, set $a = 2$, $b = 1$, $v = 1$, $m = 1$, $F_j = 1$. At $F^* = 0$, the contest success function gives $P^* = e^{-1}/(1 + e^{-1}) \approx 0.269 < \frac{1}{2}$, confirming the weak-agent case. The FOC (4) yields $W = a/b - vmP^*(1 - P^*) + F^* \approx 1.803$, giving $C^* = W - F^* \approx 1.803 < a/b = 2$, so marginal utility is positive. The curvature term is $\gamma^* = vm^2P^*(1 - P^*)(1 - 2P^*) \approx 0.091 < 1 = b$, so the SOC and the condition $b > \gamma^*$ both hold. All conditions are therefore simultaneously satisfied.

The agent is always strictly risk-averse over background risks at fixed status expenditure.

Let $V(W) = U(F^*(W))$ denote indirect utility after re-optimization of status expenditure. Then absolute risk aversion is:

$$A^{ind}(W) = \frac{-b\gamma^*}{(b-\gamma^*)(a-bC^*)}$$

where $\gamma^* = vm^2P^*(1-P^*)(1-2P^*)$. Under an interior solution:

(i) If $P^* < 1/2$ (weak agent), then $\gamma^* > 0$, so $A^{ind}(W) < 0$: the agent is strictly risk-loving.
(ii) If $P^* > 1/2$ (strong agent), then $\gamma^* < 0$, so $A^{ind}(W) > 0$: the agent is strictly risk-averse.
Proof. For the first part, since F is fixed, the contest term $vP(F)$ is constant with respect to W and its derivatives vanish identically. Differentiating the consumption component twice yields $U''(W) = -b < 0$. The denominator $a - bC$ is positive for $C < a/b$. Hence $A_{fixed}(W) > 0$ unconditionally.

For the second part, by the envelope theorem $V'(W) = a - bC^*$. Differentiating and substituting $dF^*/dW = b/(b-\gamma^*)$ yields $V''(W) = b\gamma^*/(b-\gamma^*)$. To obtain dF^*/dW, apply the implicit function theorem to the first-order condition (4). Define $\Phi(F, W) \equiv -a + b(W-F) + vmP(F)(1-P(F)) = 0$. Differentiating gives $\Phi_W = b$ and $\Phi_F = -b + vm^2P^*(1-P^*)(1-2P^*) = -b + \gamma^*$. The implicit function theorem then yields $dF^*/dW = -\Phi_W/\Phi_F = b/(b-\gamma^*)$, where the second-order condition $\Phi_F < 0$ ensures the denominator is positive. The sign of $A^{ind}(W)$ is determined solely by $-\gamma^*$ (since the denominator is strictly positive under the maintained assumptions), which is negative when $P^* < 1/2$ and positive when $P^* > 1/2$. ■
Remark. At fixed expenditure, consumption shocks generate unconditional risk aversion; under re-optimization, relative standing alone determines the sign of risk attitude.
Corollary 1 (Insurance–Lottery Risk-Attitude Coexistence)
Distinguish two classes of wealth risk according to whether status expenditure can be immediately re-optimized in response:

(i) Background consumption risks (e.g., sudden loss of housing or durables) do not permit instant re-optimization of F. By Proposition 1 (first part), the agent is unconditionally risk-averse over such risks.

(ii) Adjustable risks (e.g., a lottery ticket whose prize can be immediately redirected toward status expenditure) permit full re-optimization. By Proposition 1 (second part), the agent is strictly risk-loving over such risks whenever $P^* < 1/2$.

The coexistence of (i) and (ii) rests on a timing distinction grounded in irreversibility: background risks such as housing losses destroy durable assets that cannot be instantly liquidated or reallocated, so status expenditure remains fixed and consumption curvature governs. This is consistent with evidence that illiquid consumption commitments generate locally elevated risk aversion to wealth shocks, since committed spending cannot be readjusted in the short run (Chetty and Szeidl, 2007). Lottery prizes, by contrast, arrive as liquid cash before any consumption commitment is made, permitting immediate reallocation toward status expenditure, so contest curvature dominates. Consequently, the model provides a structural basis for the coexistence of the risk attitudes commonly associated with insurance purchase and lottery participation within a single agent.

Proof. Risk aversion over background risks follows directly from Proposition 1 (first part): since $A_{fixed}(W) = b/(a - bC) > 0$ unconditionally, the agent is always risk-averse over background consumption shocks. Risk-loving behavior over lottery-type risks follows directly from Proposition 1 (second part): $A^{ind}(W) < 0$ if and only if $P^* < \frac{1}{2}$. Both hold simultaneously whenever $P^* < \frac{1}{2}$ within the interior solution domain. ■

Remark. The coexistence region requires only $b > 0$, a maintained assumption. Larger v or m widens it by amplifying γ^* for any $P^* < \frac{1}{2}$, making the agent more risk-loving over adjustable risks while risk aversion over background risks remains intact. This result characterizes risk attitudes rather than deriving insurance or lottery demand from first principles; a complete demand derivation would require specifying the pricing and availability of insurance and lottery contracts, which lies beyond the scope of the present model.

Corollary 2 (Endogenous S-Shaped Indirect Utility)

Under an interior solution satisfying $b > \gamma^*$, there exists a unique reference wealth level

$$W^\circ = F_j + \frac{a}{b} - \frac{vm}{4b}$$

such that $F^*(W^\circ) = F_j$ and $P^*(W^\circ) = \frac{1}{2}$. The indirect utility $V(W)$ is:

(i) strictly convex for $W < W^\circ$ (i.e., $P^* < \frac{1}{2}$),

(ii) strictly concave for $W > W^\circ$ (i.e., $P^* > \frac{1}{2}$),

(iii) has an inflection point at $W = W^\circ$.

Consequently, $V(W)$ is globally S-shaped around W°, sharing the curvature property of the prospect theory value function without imposing non-concave primitive preferences. This result does not address loss aversion or probability weighting, which are additional features of prospect theory lying beyond the scope of the present model.

Proof. From the proof of Proposition 1, the second derivative of indirect utility is:

$$V''(W) = \frac{b\gamma^*}{b - \gamma^*}$$

where $\gamma^* = vm^2P^*(1 - P^*)(1 - 2P^*)$ and $(b - \gamma^*) > 0$ throughout. The sign of $V''(W)$ depends entirely on the sign of γ^*:

When $P^* < 1/2$: $(1 - 2P^*) > 0$, so $\gamma^* > 0$, giving $V''(W) > 0$ — strictly convex.

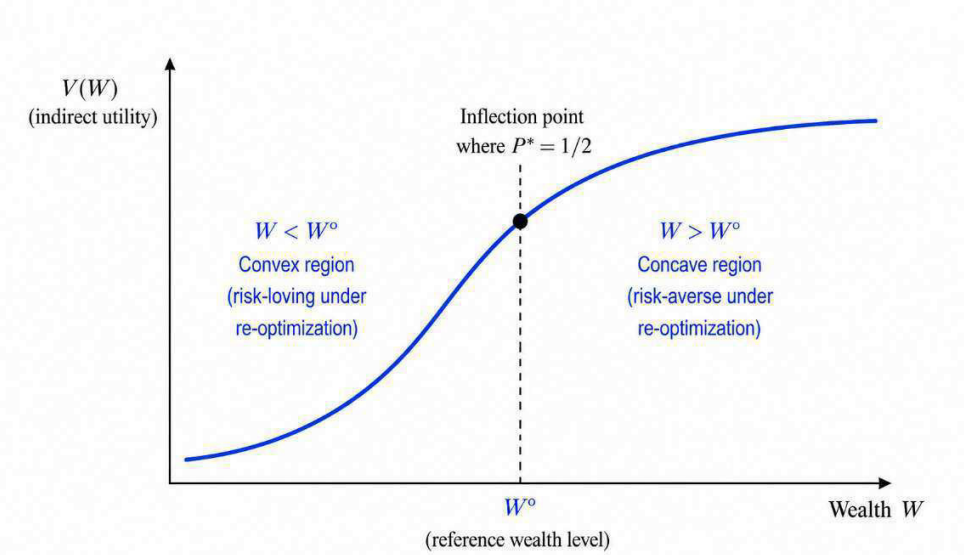
When $P^* > 1/2$: $(1 - 2P^*) < 0$, so $\gamma^* < 0$, giving $V''(W) < 0$ — strictly concave.

When $P^* = 1/2$: $\gamma^* = 0$, giving $V''(W) = 0$ — an inflection point.

Evaluating the first-order condition (4) at $P^* = 1/2$ gives $F^* = W - \frac{a}{b} + \frac{vm}{4b}$. Setting $F^* = F_j$ and solving for W yields $W^\circ = F_j + \frac{a}{b} - \frac{vm}{4b}$. Since $dF^*/dW = b/(b - \gamma^*) > 0$ throughout, $P^*(W)$ is strictly increasing in W, so the crossing of $P^* = 1/2$ occurs at exactly one wealth level. Since $V'(W) = a - bC^* > 0$ throughout, $V(W)$ is strictly increasing. Combined with the convexity–concavity partition above, $V(W)$ is globally S-shaped around W°. ■

Figure 1 illustrates the qualitative shape implied by Corollary 2 under representative parameter values.

Figure 1. Indirect Utility $V(W)$: S-Shaped Around the Reference Wealth Level W°



The indirect utility function $V(W)$ is S-shaped around the endogenous reference wealth level W°, defined by the condition $P^* = 1/2$. For $W < W^\circ$, the agent is below the reference point ($P^* < 1/2$) and indirect utility is locally convex, implying risk-loving behavior under re-optimization. For $W > W^\circ$, the agent is above the reference point ($P^* > 1/2$) and indirect utility is locally concave, implying risk-averse behavior under re-optimization. The inflection point at W° separates these regions and arises endogenously from the contest structure.

Corollary 3 (Reference Point Anchoring)
The reference wealth level satisfies $\partial W^\circ / \partial F_j = 1$: it shifts one-for-one with rival expenditure.

Proof. Direct differentiation of $W^\circ = F_j + \frac{a}{b} - \frac{vm}{4b}$ with respect to F_j. ■

Proposition 2 (Comparative Statics of Status Competition)
Under an interior solution satisfying $b > \gamma^*$:

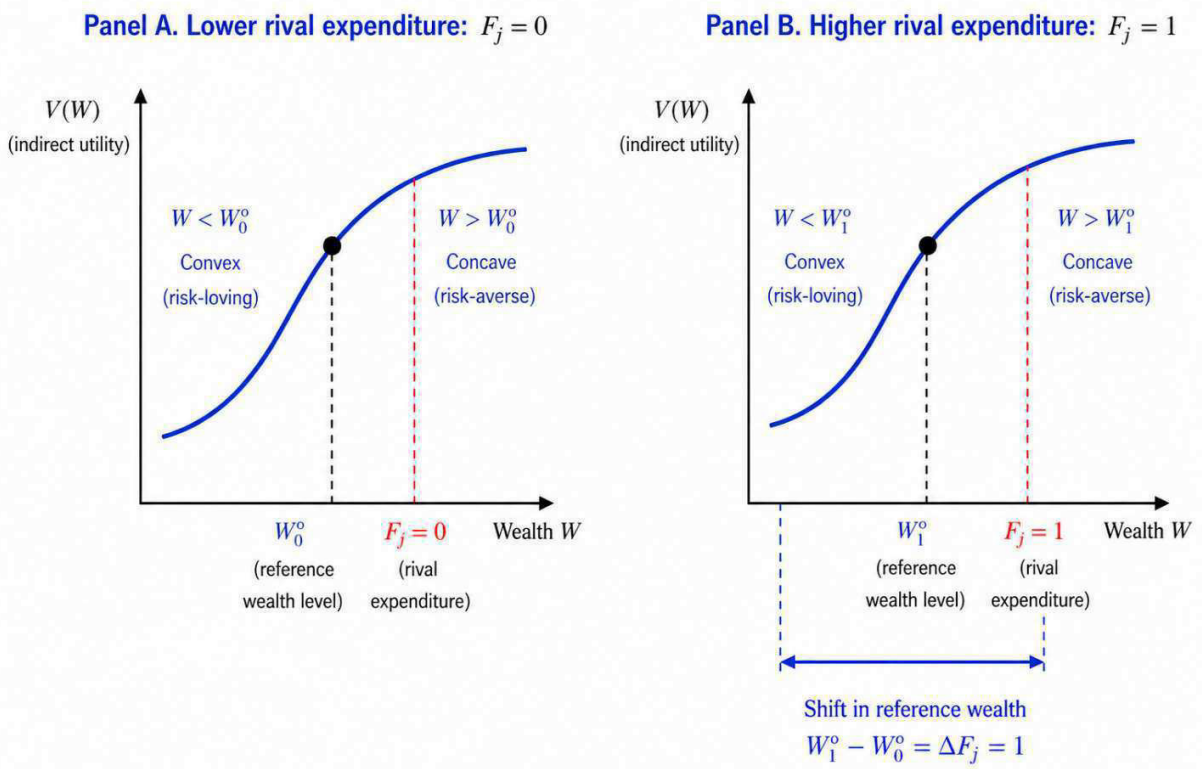
(i) Marginal Propensity: If and only if $P^* < 1/2$, then $dF^*/dW > 1$ and $dC^*/dW < 0$. Weak agents channel more than the full marginal unit of wealth into status expenditure.

(ii) Contest Intensity: For $P^* < 1/2$, the curvature term $\gamma^* = vm^2P^*(1-P^*)(1-2P^*)$ is increasing in both m and v. Hence stronger contest precision or status salience amplifies the sign of indirect risk attitudes: weak agents become more risk-loving, while strong agents become more risk-averse.

Proof. Differentiating the first-order condition gives $dF^*/dW = b/(b-\gamma^*)$. When $P^* < 1/2$, $\gamma^* > 0$, so dF^*/dW >1 and $dC^*/dW < 0$. For part (ii), since $\gamma^* = vm^2P^*(1-P^*)(1-2P^*)$, direct differentiation gives $\partial\gamma^*/\partial v = m^2P^*(1-P^*)(1-2P^*) > 0$ and $\partial\gamma^*/\partial m = 2vmP^*(1-P^*)(1-2P^*) > 0$ for all $P^* \in (0,1/2)$, confirming strict monotonicity throughout the weak-agent

region. Increases in either parameter therefore magnify $|\gamma^*|$, reinforcing the sign of indirect risk aversion established in Proposition 1. These are partial derivatives holding P^* fixed. The directional conclusion — that higher m or v amplifies the sign of indirect risk attitudes — holds at any given $P^* \in (0,1/2)$; equilibrium adjustment of P^* affects magnitude but not the sign result. ■

Figure 2. Rightward Shift of the Reference Wealth Level with Rival Expenditure



Panels A and B illustrate how an increase in rival expenditure F_j shifts the indirect utility function $V(W)$ through its effect on the endogenous reference wealth level. In Panel A ($F_j = 0$), the reference level is W_0°; in Panel B ($F_j = 1$), it shifts to W_1°, with $W_1^\circ - W_0^\circ = \Delta F_j = 1$. The S-shaped curvature is preserved and the inflection point shifts as established in Corollary 3.

3. Empirical Relevance

The model generates three testable predictions. First, risk-taking varies with relative standing rather than absolute wealth. Second, contest intensity amplifies risk polarization across agents. Third, risk aversion toward background risks and risk-loving behavior toward lottery-type risks coexist within the same individual without non-concave primitive preferences.

Existing evidence is broadly consistent with these predictions, although it does not directly identify the mechanism proposed here. Guiso and Paiella (2008) document that measured risk aversion varies systematically across households in ways not fully explained by wealth levels alone — consistent with relative standing as the operative variable. The concentration of lottery participation among lower-income households aligns with the model's prediction that agents below their reference group face locally convex status payoffs. Chevalier and Ellison (1997) document the same risk-polarization pattern among mutual fund managers; while their explanation

invokes convex incentive contracts, the present framework offers an alternative preference-based account requiring no such contracts. These comparisons are suggestive rather than definitive: each pattern is also consistent with alternative explanations — background income risk, liquidity constraints, and convex incentive contracts, respectively — and isolating the relative-standing channel from these competing mechanisms remains an open empirical challenge.

The marginal propensity result of Proposition 2 reinforces this picture: among households below their reference group, each marginal dollar of income is more than fully absorbed by status expenditure, providing a structural explanation for the elevated leverage ratios and compressed saving rates documented among lower-income households in status-competitive environments (Frank et al. (2014); Bertrand and Morse (2016); Charles et al. (2009); Dynan et al. (2004)), without recourse to myopia or behavioral frictions.

Finally, Corollary 1 requires only the structural distinction between risks that permit immediate re-optimization and those that do not to establish both risk attitudes within a single preference framework. All three patterns arise as structural consequences of strategic status competition rather than from auxiliary behavioral assumptions.

4. Conclusion

This paper offers a structural mechanism capable of rationalizing the coexistence of risk attitudes commonly associated with insurance purchase and lottery participation within a standard expected-utility framework. When preferences include a concave consumption component and a contest-based status component derived from the difference-form contest success function (Hirshleifer, 1989), utility curvature becomes endogenous and state-dependent. The key insight is that risk attitudes differ fundamentally depending on whether status expenditure can be immediately re-optimized in response to a wealth shock: consumption curvature governs when status spending is fixed, while contest curvature dominates when status spending adjusts freely.

The framework yields six main implications. Agents are unconditionally risk-averse over background consumption risks, while relative standing alone determines the sign of risk attitude under re-optimization. Together these generate a coexistence of risk aversion toward background risks and risk-loving behavior toward adjustable risks among weak agents. Indirect utility is further globally S-shaped around an endogenously determined reference point that shifts one-for-one with rival expenditure. Comparative statics further show that stronger contest intensity amplifies risk polarization, and that status expenditure responds more than proportionally to wealth gains among weak agents. Mixed risk attitudes and the S-shaped value function may therefore be structural outcomes of strategic competition for relative standing, rather than psychological anomalies or departures from rationality.

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