EUT with Structural Feasibility: A Unified Account of Paradoxical Choice*

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***Abstract*—Expected Utility Theory (EUT) is the canonical framework for rational choice, yet persistent empirical paradoxes challenge its descriptive adequacy. This paper introduces Shaded-EUT, a minimal extension that addresses these anomalies without altering EUT's core axioms. We introduce a single modification: a structural feasibility term, $\lambda(x) \in [0,1]$, which represents the degree to which an option is structurally activated or available at the point of decision. The modified decision rule, $\max_{x \in X} \sum_x \lambda(x) \cdot p(x) \cdot u(x)$, preserves the original utility and probability structures while accounting for choice anomalies through this latent activation filter. We demonstrate how Shaded-EUT provides a unified explanation for the Allais and Ellsberg paradoxes, as well as framing effects, by reinterpreting them as consequences of structural availability rather than preference distortion. Finally, we propose a logit-based framework for empirically estimating $\lambda(x)$ from observable contextual factors, bridging formal rationality with observed choice dynamics.**

***Index Terms*—Expected Utility Theory, Allais Paradox, Ellsberg Paradox, Bounded Rationality, Choice Architecture, Structural Feasibility**

I. Introduction: The Structural Silence of EUT

Expected Utility Theory (EUT) provides a powerful and elegant framework for decision-making under uncertainty. However, decades of empirical research have revealed systematic deviations, most notably the Allais and Ellsberg paradoxes, which challenge its foundational axioms. Most theoretical responses have involved significant modifications to utility functions or probability weighting. This paper proposes a different approach: perhaps EUT fails not because its logic is flawed, but because it is silent about the structural conditions under which its logic can be applied. We argue that EUT implicitly assumes all options in a choice set are fully and equally "activated," a condition rarely met in reality.

II. The Shaded-EUT Model

To address this "structural silence," we introduce a minimal extension to EUT called Shaded-EUT. The core modification is the introduction of a **structural feasibility term**, $\lambda(x) \in [0,1]$, which modulates the contribution of each option to the utility calculation.

A. Revised Formulation

The agent's decision problem is now formulated as:

$$\max_{x \in X} \sum_{x} \lambda(x) \cdot p(x) \cdot u(x) \tag{1}$$

This formulation preserves the original utility function $u(x)$ and probability distribution $p(x)$. The term $\lambda(x)$ acts as a feasibility filter:

- When $\lambda(x) = 1$, the option is fully active and contributes to the calculation as in standard EUT.
- When $\lambda(x) = 0$, the option is structurally inert and is excluded from consideration, regardless of its utility or probability.

This term $\lambda(x)$ is not a psychological bias; it represents objective structural constraints such as framing effects, cognitive load, or institutional rules that determine whether an option is practically available for the agent to act upon.

III. Resolution of Decision Paradoxes

Shaded-EUT provides a unified and parsimonious explanation for major behavioral anomalies without altering preferences or beliefs.

A. Allais Paradox

The observed "certainty effect" is explained by an asymmetry in activation. Options with certain outcomes are assigned a higher feasibility weight ($\lambda(x) \approx 1$), while probabilistic alternatives receive a lower weight ($\lambda(x) < 1$). The paradox is resolved not by non-linear preferences, but by the dominant structural salience of certainty.

B. Ellsberg Paradox

Aversion to ambiguity is interpreted as structural deactivation. Options with ambiguous probabilities are assigned a suppressed feasibility weight ($\lambda(x) < 1$). Agents do not "dislike" ambiguity; rather, ambiguous options are structurally less available for engagement, leading to their avoidance.

C. Framing Effects

Framing effects are captured by allowing $\lambda(x)$ to vary with the presentation of an option, while $p(x)$ and $u(x)$ remain constant. A choice framed as a gain may have a higher $\lambda(x)$ than the same choice framed as a loss. The resulting behavioral shift is due to a change in contextual feasibility, not a change in underlying preferences.

IV. Empirical Viability

The structural feasibility term $\lambda(x)$ is not merely a theoretical construct but an empirically estimable parameter. By holding payoffs and probabilities constant while manipulating contextual variables (e.g., framing, cognitive load, information ordering), we can infer the value of $\lambda(x)$ from observed choice patterns. We propose a logit-based specification to model $\lambda(x)$ as a function of these structural covariates:

$$\lambda(x) = \frac{1}{1 + \exp(-Z(x))} \tag{2}$$

where $Z(x)$ is a latent index of structural accessibility, determined by factors like $Z(x) = \beta_0 + \beta_1 \cdot \mathrm{Frame} + \beta_2 \cdot \mathrm{CognitiveLoad} + \ldots$. This makes the model testable, falsifiable, and integrable with standard discrete choice estimation frameworks.

V. Conclusion

Shaded-EUT offers a structural refinement of EUT that preserves its mathematical core while greatly enhancing its descriptive power. By introducing the concept of structural feasibility, it reinterprets behavioral paradoxes as rational responses within a structurally constrained environment. The theory is intact; the terrain it operates on is now visible. This framework provides a bridge between formal rationality and empirical reality, suggesting that sometimes, extending a theory means not changing its logic, but understanding the boundaries of where it can be applied.

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