

CONTEXTUAL CHOICE, IMPERFECT ATTRIBUTE PERCEPTION, AND DECISION DESIGN IN MANAGEMENT AND PLANNING

David Black

Managers, planners, and organizational decision makers frequently evaluate options that differ across multiple attributes, yet observed choices often shift when the surrounding menu changes. Such context effects matter for product-line design, candidate screening, policy communication, and service bundling because they can change outcomes even when underlying objectives remain stable. This article develops a theory-centered account of contextual choice in which decision makers retain a stable utility function but interpret attribute information imperfectly. The framework shows why additional options can alter posterior beliefs about existing options when uncertainty in attribute perception is shared across alternatives. A tractable parametric case is used to clarify the mechanism, state the main comparative statics, and convert the formal results into testable implications for management research. The analysis shows how the same structure accommodates intransitivity, joint-separate evaluation reversal, the compromise effect, the attraction effect, and phantom decoy effects, while also preserving rational regularity when one option dominates another on all attributes. The article further explains how ternary-choice designs can be used to validate the model empirically. By translating a formal choice model into a management and planning context, the manuscript clarifies when context-sensitive choices are expected, when they should not occur, and how decision architectures can amplify, diagnose, or contain them.

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INTRODUCTION

Choice in management and planning is rarely made in isolation. Consumers compare product variants, hiring committees evaluate candidates with mixed strengths, planners assess competing projects with noncommensurate attributes, and executives allocate resources under incomplete interpretive certainty. In all of these settings, the ranking of options can shift when the comparison set changes. These shifts are not merely laboratory curiosities; they can alter prices, staffing decisions, project selection, and public-facing policy choices. A credible management account of contextual choice must therefore explain not only that such reversals occur, but also why they emerge and where their practical limits lie.

The behavioral literature has long documented several such contextual effects. In the compromise effect, a middle option gains appeal when an extreme alternative is added [12]. In the attraction effect, a dominated decoy raises the relative attractiveness of a nearby target [5]. In joint-separate evaluation reversal, an option that is valued more highly when assessed alone can be valued less highly when assessed alongside a comparator [4]. These patterns challenge classical interpretations of stable utility maximization when those interpretations rely on transitivity and context independence [13, 14]. They also make clear that any rigorous account of multi-attribute choice must specify whether context changes preferences, information, or both.

A coherent theoretical resolution is available when the decision maker's utility is stable but the interpretation of attribute labels is imperfect. In that setting, the observed menu supplies information, and the presence of additional options can alter posterior beliefs about the latent qualities of existing options. Contextual choice then arises not because preferences are unstable, but because attribute perception is noisy and comparison itself is informative [3]. This interpretive shift is especially valuable for management and planning because it recasts a behavioral anomaly as a problem of decision design and information architecture.

This article examines that framework as a management and planning model of decision design. The discussion is structured to make three concrete contributions. First, it restates the core analytical architecture in language that is directly usable in management and planning research. Second, it consolidates the main formal results into a single applied argument that highlights scope conditions, boundary cases, and falsifiable predictions. Third, it translates the model's identification logic into an explicit roadmap for empirical and experimental validation in organizational settings. No new dataset is introduced. The contribution is therefore theoretical and integrative: the manuscript converts published analytical results and published illustrative cases into a complete, submission-ready account with clearer managerial motivation and sharper testable implications.

LITERATURE CONTEXT AND MANAGERIAL RELEVANCE

Research on contextual choice is typically divided between models that make utility itself context dependent and models that preserve stable latent preferences while allowing context to change information, salience, or inference. Classical explanations of attraction and compromise effects often rely on comparison-based or reference-dependent valuation [12, 14, 10, 1]. These approaches capture important empirical regularities, but they often embed context directly in the utility representation. For managerial analysis, that distinction matters because it changes whether menu design is interpreted as altering tastes or altering the information used to evaluate alternatives.

A different route is to keep utility stable and allow context to enter through information. That route is especially attractive for management and planning because many organizational decisions rely on labels, ratings, indicators, and technical measurements that are informative but not perfectly interpreted. Decision makers may understand relative differences better than absolute levels, especially when attributes are technical, domain specific, or noisy to interpret. This perspective also aligns with recent evidence that perceptual

imprecision can systematically affect choice [7, 2]. It also fits settings in which product lines, scorecards, or comparison sets themselves reveal information about scale and quality.

For management and planning research, the distinction is consequential. If context effects reflect unstable preferences, then menu engineering primarily manipulates tastes. If context effects reflect imperfect perception, then decision design becomes an informational problem. The latter interpretation is directly relevant to:

- product-line configuration and service bundling;
- hiring, promotion, and procurement evaluation;
- multi-criteria planning and project screening; and
- public communication of alternatives under measurement ambiguity.

Within this frame, contextual choice is not simply a behavioral anomaly. It becomes a structured consequence of how organizations present information, and it yields predictions that can be tested by varying menu composition, evaluation order, and dominance screens.

MODEL AND ANALYTICAL PROCEDURE

Core theoretical setup

The model considers objects with latent attribute vectors $x^* \in \mathbb{R}^2$. The decision maker has a stable von Neumann-Morgenstern utility function over these latent attributes. Preference is assumed to be standard: utility is increasing in each attribute, exhibits diminishing marginal sensitivity, and displays weak complementarity. Formally, the utility function $u : \mathbb{R}^2 \rightarrow \mathbb{R}$ satisfies

$$u_1 > 0, \quad u_2 > 0, \quad u_{11} < 0, \quad u_{22} < 0, \quad u_{12} \geq 0.$$

The latent attributes are not observed directly. Instead, the decision maker observes label information X , which is informative but imperfect. The gap between the observed label and the latent attribute is a perception error:

$$\varepsilon = X - x^*.$$

The decision maker is Bayesian, begins with a normal prior over latent attributes, and chooses the available option with the highest posterior expected utility. The key methodological implication is that the model holds tastes fixed and makes contextual variation traceable to changes in inference.

Imperfect perception

The defining friction is that the perception error is attribute specific but common across alternatives in a given choice problem. This means the decision maker reads relative differences across options more accurately than absolute levels. If the same interpretive bias affects all options, then observing additional alternatives changes posterior beliefs about previously seen alternatives. The mechanism is therefore comparative rather than purely idiosyncratic.

For a choice problem with observed labels X_1, \dots, X_n , the chosen object is determined by posterior expected utility:

$$X_t \in C(\{X_1, \dots, X_i, (X_{i+1}, \dots, X_{i+j})\}) \text{ iff } t \in \arg \max_{s \in \{1, \dots, i\}} \mathbb{E}[u(x_s^*) \mid X_1, \dots, X_{i+j}],$$

where parenthesized options are observed but unavailable.

This structure is especially relevant in management settings where decision makers interpret performance indicators, ratings, or labels under uncertainty. A new option can shift beliefs about the scale or meaning of an attribute, thereby changing the perceived merit of existing options. That prediction is directly testable by holding option labels fixed while varying the surrounding comparison set.

Parametric special case

To make the mechanism transparent, the article adopts the tractable parametric case used in the formal analysis:

$$u(x_1, x_2) = -e^{-3x_1} - e^{-3x_2}.$$

In this special case, the first attribute is perceived without noise and uncertainty exists only in the second attribute:

$$\varepsilon \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}\right).$$

The prior is standard bivariate normal centered at the origin.

This specification is analytically useful because it isolates the managerial logic of contextual choice. One attribute can be interpreted cleanly, while the other remains harder to assess. That mirrors many organizational settings in which one metric is familiar and another is less intuitive. It also creates a transparent benchmark against which later empirical work can evaluate whether the predicted comparative statics are present in observed choice data.

RESULTS

Contrast effect and intransitivity

Under the parametric special case, the contrast effect appears in the noisy second attribute. For two alternatives $\{X, Y\}$, the posterior mean of the second latent attribute is

$$\mathbb{E}[x_2^* | X, Y] = \frac{1}{3}(2X_2 - Y_2).$$

A surprisingly high Y_2 lowers the posterior assessment of x_2^* , because the decision maker infers that the shared interpretive error may be high. The comparison set therefore changes how the same option is perceived. Empirically, this delivers a clean validation target: the same labeled option should be evaluated differently when paired with different comparators in the noisy dimension.

This mechanism generates crossing indifference curves. The model shows that, for any $X \neq Y$ with $X \sim Y$, there exists a third option Z such that transitivity is violated. In practical terms, when one attribute is easier to discriminate and another is harder to interpret, a manager may rank Y above Z , Z above X , and yet X above Y in pairwise comparisons. This is not random inconsistency. It is a structured consequence of posterior inference under common perceptual uncertainty, and it can be evaluated by controlled menu-variation designs rather than inferred from isolated anomalies.

A concrete example used in the analytical derivation sets

$$X = (3, 0), \quad Y = \left(3 - \frac{1}{3} \ln(1 + e^{9/2} + e^{27/2}), 3\right),$$

for which the relevant contextual effects can occur concurrently in the same parametric setting.

Joint-separate evaluation reversal

The framework also accommodates joint-separate evaluation reversal. A canonical illustration comes from programmer-candidate evaluation. In the published example, candidate X has a GPA of 4.9 out of 5 and has written 10 programs in a computer language, whereas candidate Y has a GPA of 3.0 and has written 70 programs. When evaluated separately, the average valuation for X is \$32.7k and for Y is \$26.8k. When evaluated jointly, the ordering reverses: X falls to \$31.2k and Y rises to \$33.2k [4].

In the model, this occurs because the familiar attribute (here, GPA) is easier to interpret than the less familiar one (programming experience). When each candidate is evaluated alone, the easier attribute dominates judgment. When both are evaluated together, comparison improves inference about the noisy attribute, increasing its weight in valuation. The mechanism therefore predicts a systematic protocol effect rather than a purely verbal framing effect.

The analytical expressions in the special case make the logic explicit. For separate evaluation,

$$\mathbb{E}[u(x^*) | X] = -e^{-3X_1} - e^{-\frac{3}{2}X_2 + \frac{9}{8}},$$

whereas for joint evaluation,

$$\mathbb{E}[u(x^*) | X, Y] = -e^{-3X_1} - e^{-(2X_2 - Y_2) + \frac{3}{2}}.$$

The model establishes that there exists a constant d such that joint-separate reversal is satisfied for any pair X, Y with $X \sim Y$, $X_1 > Y_1$, and $Y_2 \geq d$. The result is directly relevant to hiring, procurement, and performance evaluation: separate review can overweight the attribute that is easiest to read, not necessarily the one that is most decision relevant. As a result, evaluation protocol becomes part of the causal design of the decision process.

Compromise, attraction, and phantom decoy effects

The compromise effect appears when a third option makes a previously less preferred alternative look balanced. The article's introductory apartment example shows the mechanism clearly. Apartment X has medium energy efficiency and a neighborhood crime rate of 2%. Apartment Y has low efficiency and a safer crime rate of 1%. In the binary set $\{X, Y\}$, the safer option Y is preferred. When a third apartment Z appears with high efficiency but a 4% crime rate, X becomes the compromise and is chosen. Because only the menu changes, this pattern is particularly well suited to direct experimental validation.

In the parametric analysis, the compromise effect is formalized for triples satisfying

$$Z_1 > X_1 > Y_1, \quad Y_2 > X_2 > Z_2,$$

with $Y \in C(\{X, Y\})$ and $C(\{X, Y, Z\}) = X$. The model proves that for any X, Y with $X_1 > Y_1$ and $Y \in C(\{X, Y\})$, and any $Z_1 > X_1$, there exists $d < X_2$ such that if $Z_2 < d$, the compromise effect is satisfied.

The same logic generalizes to attraction and phantom decoy effects. A dominated or unavailable third option can shift inference in favor of a nearby target. The resulting comparative static is formalized as the decoy choice pattern, which supplies an observable benchmark for menu-design experiments and field audits.

General results: decoy choice pattern and dominance

The general model yields two especially important management results and two corresponding validation benchmarks.

First, any normal-Bayesian agent with standard preferences and imperfect perception displays the decoy choice pattern. In practical terms, movement of an unavailable or rarely chosen decoy in the lower-right region of the attribute space can induce choice of one option, while movement in the opposite direction can induce choice of the alternative. This unifies compromise, attraction, and phantom-decoy logic under one informational mechanism.

Second, the model preserves rational regularity under dominance. If Z dominates X in both attributes, then the decision maker chooses Z :

$$Z > X \Rightarrow C(\{X, Z\}) = Z.$$

This matters for management and planning because it imposes a boundary condition. Context effects arise where trade-offs are genuine; they do not justify choosing dominated options. In organizational practice, this implies that well-designed dominance screens remain normatively robust even when broader context effects are expected elsewhere.

Identification for managerial research design

The article also provides a tractable identification result for empirical work. For the parametric class

$$u(x) = -\alpha e^{-\gamma_1 x_1} - e^{-\gamma_2 x_2}, \quad \Omega = I_2, \quad T^{-1} = \begin{bmatrix} 1/t_1^2 & 0 \\ 0 & 1/t_2^2 \end{bmatrix},$$

the parameters $\alpha, \gamma_1, \gamma_2, t_1^2$, and t_2^2 are jointly point-identified from idealized data on all ternary choice problems.

For management and planning scholars, this result does more than show theoretical estimability. It specifies a concrete validation protocol: repeated ternary-choice designs with randomized menu placements and recorded choice frequencies can, in principle, recover the preference and information parameters governing contextual choice. The framework is therefore not only interpretive; it generates observables, identifies boundary conditions, and offers a disciplined bridge from formal theory to testable choice-research design.

IMPLICATIONS FOR MANAGEMENT AND PLANNING PRACTICE

The theory has direct implications for decision architecture.

First, product assortment and service design should be treated as informational systems, not merely collections of options. A newly introduced option may alter how customers interpret price, quality, risk, or convenience even if that option is rarely selected. Managers should therefore evaluate not only direct demand substitution, but also perception spillovers across the entire menu, ideally through pilot tests that compare otherwise identical menus with different decoys or anchors.

Second, comparative evaluation procedures in organizations require careful sequencing. In hiring, scholarship review, procurement, and performance appraisal, separate evaluation can overemphasize attributes that are familiar or easy to interpret, whereas joint evaluation can elevate the importance of attributes that become

Table 1: Core contextual patterns and source-grounded illustrations

Phenomenon	Observed pattern	Published illustration or formal condition
Intransitivity	$C(\{Y, Z\}) = Y,$ $C(\{Z, X\}) = Z,$ yet $X \in C(\{X, Y\})$	Can arise when attribute one is easier to discriminate than attribute two and indifference curves cross; the parametric example uses $X = (3, 0)$ and a corresponding Y on the same indifference set.
Joint-separate evaluation reversal	Separate evaluation favors one option; joint evaluation reverses the ordering	Programmer-candidate example: \$32.7k versus \$26.8k in separate evaluation; \$31.2k versus \$33.2k in joint evaluation.
Compromise effect	Y is chosen in $\{X, Y\}$, but X is chosen in $\{X, Y, Z\}$	Apartment example: X has medium efficiency and 2% crime, Y has low efficiency and 1% crime, and extreme option Z has high efficiency and 4% crime.
Decoy choice pattern	Shifting an unavailable or rarely chosen third option changes the preferred alternative	A lower-right decoy tends to favor the option stronger on attribute one; an upper-left decoy tends to favor the option stronger on attribute two.
Dominance regularity	Dominated options are not chosen	If $Z > X$ in both attributes, then Z is chosen; contextual effects are therefore bounded by dominance.

Table 2: Formal analytical results and managerial implications

Result	Substantive meaning	Management and planning implication
Proposition 1	Crossing indifference curves generate intransitivity under trade-offs.	Pairwise rankings may shift systematically in multi-criteria review when one metric is harder to interpret.
Proposition 2	Joint-separate reversal occurs when comparison improves assessment of a noisy attribute.	Separate screening can overweight easy-to-read indicators in hiring, promotion, and vendor review.
Proposition 3	An extreme third option can induce selection of a compromise target.	Product-line or policy-menu design can steer selection toward a middle option without changing the target itself.
Proposition 4	Preference and information parameters are point-identified from ternary-choice data in the parametric class.	Structured ternary experiments can be used to estimate contextual choice parameters in applied research.
Theorem 1	The general model predicts a decoy choice pattern.	Unavailable or rarely chosen options can still shape demand, attention, and selection outcomes.
Theorem 2	Dominating alternatives are always chosen.	Dominance checks remain a reliable design safeguard against pathological choice outcomes.

clearer through comparison. This implies that the order and grouping of comparisons are part of the evaluation mechanism itself, and they should be documented rather than treated as neutral administrative details.

Third, planners should distinguish between legitimate trade-off domains and dominance domains. Context effects are most likely when alternatives exchange strengths across dimensions. They should not be used to rationalize choices among options where one alternative is strictly better on all relevant criteria. A robust planning process should therefore separate screening for dominated alternatives from later trade-off analysis, which also creates a clear falsification boundary for applied tests of the model.

Fourth, empirical researchers in management and planning can use ternary-choice designs to investigate whether observed context effects are consistent with stable latent preferences under imperfect perception. Combining randomized ternary menus, separate-versus-joint protocols, and explicit dominance checks creates a practical bridge between formal theory and applied decision research.

LIMITATIONS AND RESEARCH AGENDA

The framework is analytically powerful but intentionally stylized. It assumes Bayesian updating, normal priors, and a common component in perception error across alternatives. Real decision makers may use heuristics rather than explicit Bayesian reasoning, and organizational settings may introduce strategic communication, endogenous attention, or selective information acquisition. These assumptions should therefore be read as disciplined starting points rather than exhaustive behavioral claims.

Even so, the model remains valuable because it identifies a clear mechanism: context changes choice when it changes inference. That mechanism can be tested, relaxed, or embedded in richer institutional settings. The most credible next step is to confront the model with designed evidence that varies menu composition, evaluation order, and attribute transparency. Future work in management and planning research may fruitfully examine:

- empirical estimation with experimentally designed ternary menus;
- committee decisions in which different members interpret attributes differently;
- digital interfaces that amplify or dampen perception spillovers; and
- planning environments with more than two salient attributes.

The most immediate empirical opportunity lies in designing decision studies that separate dominance screening from trade-off evaluation, compare separate versus joint assessment protocols, and record whether the predicted menu-dependent reversals occur with the sign and magnitude implied by the model.

CONCLUSION

Context effects are often treated as evidence that preferences are unstable. The framework examined here supports a more disciplined and empirically usable interpretation. Stable preferences can coexist with contextual choice when the decision maker interprets attribute labels imperfectly and uses the available comparison set to update beliefs about latent qualities.

This perspective is highly relevant to management and planning. It explains why menu design, comparative evaluation, and information presentation can materially alter choices even when the underlying objective

function is unchanged. It also clarifies when such effects should be expected, namely in genuine trade-off settings, and when they should not, namely under dominance. That combination of mechanism and boundary condition strengthens the model's value for both theory and applied decision design.

As a result, the article offers a coherent foundation for studying decision design as an informational problem. For managers, it highlights the strategic importance of menu architecture and evaluation protocol. For planners, it offers a principled way to separate contextual sensitivity from irrationality. For researchers, it provides a tractable path from formal theory to identifiable and testable choice design.

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David J. Black, Co-founder and Chairman of Edinburgh's Southside Association

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