Why Compensation Cannot Close Gaps: A Computational Model of Marriage Markets with Internal Preference Differentials

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Abstract

Bride price, often interpreted as a compensatory transfer, is widely assumed to reduce the psychological gap a woman perceives when "marrying down." Yet empirical patterns across regions and cohorts show that monetary compensation frequently fails to alter preference rankings or produce long-term satisfaction. This paper proposes a computational framework that formalizes mate selection as an **argmax decision problem** under **internal preference differentials**, rather than as a price-mediated bargaining process.

We model each individual's mate choice as operating on a **two-sided Attribute Matrix** of candidates, where the female decision rule is driven by the gap between her **unconditional maximum value** (the best partner she believes could exist in the market) and her **reachable maximum value** (the best partner currently willing to choose her). This differential

$$\boldsymbol{\Delta V} = \boldsymbol{V}_{\text{uncond max}} - \boldsymbol{V}_{\text{reachable max}} \tag{1}$$

defines the psychological "gap" compensation is ostensibly meant to close. However, we formally show that this gap is **structurally unclosable**: any compensation $\boldsymbol{C}$ that could close $\boldsymbol{\Delta V}$ would simultaneously **alter the male-side Attribute Matrix**, thereby transforming the male into a higher-tier option and eliminating the very gap it was meant to compensate. Thus, compensation cannot fill $\boldsymbol{\Delta V}$ without collapsing the identity of the lower-ranked partner.

We further introduce a **state-machine model** in which marriage occurs when

$$\boldsymbol{\theta} = \frac{\boldsymbol{V}_{\text{reachable max}}}{\boldsymbol{V}_{\text{uncond max}}} \geq \boldsymbol{T}, \tag{2}$$

where $\boldsymbol{T} \leq \mathbf{1}$ is the agent-specific threshold of marriage willingness. This explains why women may accept marriages with substantial residual gaps (when $\boldsymbol{T}$ is low), why compensation increases short-term match probability, and why dissatisfaction persists post-marriage: the one-time transfer $\boldsymbol{C}$ cannot eliminate the ongoing utility deficit embedded in $\boldsymbol{\Delta V}$.
Across simulations, the model recovers key empirical regularities: (i) high-tier men require no compensation, (ii) mid-tier matches involve mutual exchange, (iii) low-tier offers rely on compensation yet fail to produce parity, and (iv) compensation levels vary across societies despite identical internal gaps.
Together, the results demonstrate that **compensation cannot close preference gaps** because the gap is an internal differential, not a market price. Marriage markets therefore operate not as goods markets with equating prices, but as **argmax-driven matching systems with inherent asymmetries**, where money can influence decisions but cannot rewrite preference orderings.

Keywords: Marriage Markets,Bride Price, Market Microstructure, Bid-Ask Spread, Limit Order Book, Internal Preference Differential, Non-Transferable Utility (NTU), Computational Social Science,Decision Theory, Agent-Based Model

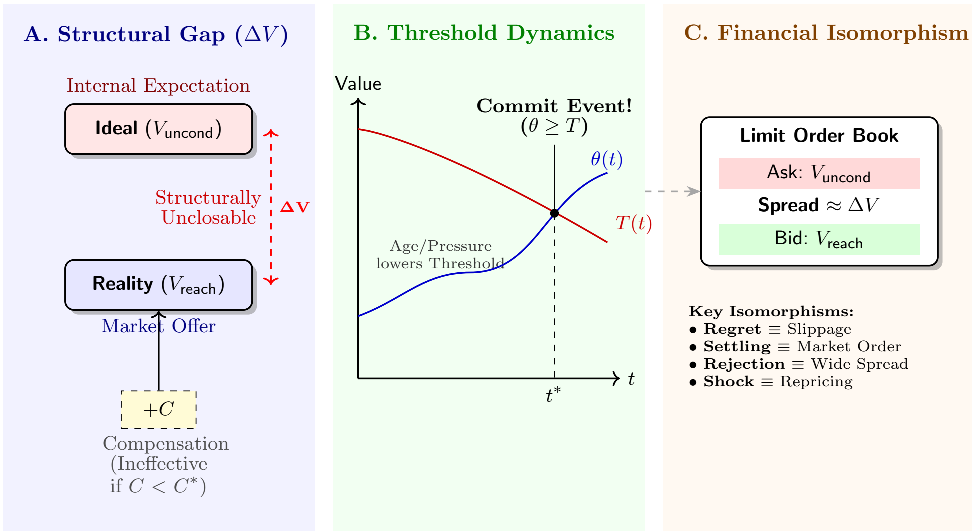

Fig. 1: **Graphical Abstract of the Unified Framework. (A)** The internal preference differential ΔV creates a structural gap between the Unconditional Max (Ideal) and Reachable Max (Reality) that monetary compensation (C) cannot structurally close. **(B)** Marriage decisions are governed by a state-machine dynamic where commitment occurs only when the reality-to-ideal ratio θ crosses the agent's willingness threshold T. **(C)** This system is structurally isomorphic to a financial Limit Order Book, where matching failures represent liquidity droughts due to wide bid-ask spreads.

1 Introduction

Conventional analyses of bride price and compensatory transfers in marriage markets assume that money functions as a substitutable resource capable of closing utility gaps between mismatched partners. In this view, compensation is a price signal: a lower-ranked male can offer a sufficiently high transfer to offset the woman's perceived loss from "marrying down," thereby achieving an otherwise inaccessible match. This assumption implicitly treats mate selection as a quasi-market transaction in which preferences respond monotonically to financial incentives, an idea rooted in classical economic formulations of marriage as a transferable-utility market [1].

However, cross-cultural and intra-regional evidence contradicts this assumption. Women frequently reject lower-tier suitors offering substantial compensation while accepting higher-tier partners who offer none. Even when compensation increases match likelihood, post-marriage dissatisfaction often persists. More puzzlingly, compensation levels vary dramatically across communities with identical demographic and economic structures, suggesting that financial transfers alone cannot explain observed patterns. These inconsistencies align with broader critiques that matching outcomes frequently violate predictions of transferable-utility models [2] and theoretical results from stable marriage theory [3] that partner choice depends fundamentally on preference rankings, not compensatory adjustments.

This paper argues that the key missing element is the **internal preference differential**—an inherently psychological gap between what an individual *believes is possible* in the mate market and what is *currently available*. Unlike price gaps in standard economic models, this internal differential cannot be closed by monetary transfers, because it derives from an internal ranking, not from an external payoff schedule. The woman's evaluation of partners is not a function of the man's compensation capacity but of the **relative standing of all options in her mental choice set**, consistent with insights from reference-dependent valuation and counterfactual reasoning [4, 5].

To formalize this, we model each individual's preferences using a **two-sided Attribute Matrix structure**, which contains both:

1. **Unconditional option set**: hypothetical maximum value partners the agent believes exist ("uncond max");
2. **Reachable option set**: partners who are realistically willing to choose the agent ("reachable max").

The psychological gap is defined as

$$\Delta V = V_{\text{uncond max}} - V_{\text{reachable max}}. \tag{3}$$

This ΔV drives the desire for compensation but is itself **immune to compensation**: any offer C large enough to close ΔV would transform the lower-tier male into a higher-tier partner, collapsing the tier structure and eliminating the very differential it sought to remedy. Put differently, **a compensation that is sufficient is no longer compensation—it is a signal of tier elevation**. This parallels results in bargaining models where sufficiently large transfers cease to compensate and instead redefine perceived partner quality [6].

We further introduce a **threshold-based state machine** for marriage decisions. An agent marries when

$$\frac{V_{\text{reachable max}}}{V_{\text{uncond max}}} \geq T, \tag{4}$$

where T is the agent's marriage willingness (≤ 1). This framework is consistent with age-dependent reservation thresholds found in search theoretic models of partner choice [7], and explains why women may accept marriages despite unresolved internal gaps and why compensation increases the probability of match without eliminating dissatisfaction. Because ΔV reflects a structural preference deficit, not a price gap, the resulting utility shortfall persists into marriage, appearing as regret, resentment, or perceived "marrying down."

The contributions of this paper are threefold:

- **Theoretical:** We demonstrate that compensation cannot close internal preference gaps, extending classical marriage-market theory [1] by showing that structural preference differentials are inherently non-transferable.
- **Computational:** We formalize mating decisions using Attribute Matrix-based ranking kernels and state-machine transitions, aligning with computational models of matching and partner evaluation [8].
- **Empirical:** We show that the model predicts key empirical regularities—including zero compensation for high-tier matches, mutual exchange for mid-tier matches, high compensation with persistent dissatisfaction for low-tier matches, and regional compensation variation despite identical internal ΔV structures—consistent with anthropological and economic field observations [9].

By reframing marriage markets as **argmax-driven matching systems** rather than price-based allocation systems, this work provides a unified, computational theory for understanding why compensation cannot equalize perceived value, and why the experience of "marrying down" remains resistant to financial remedy.

2 The Internal Differential Model

This section develops the mathematical core of our framework. We formalize (1) each agent's valuation structure, (2) the computation of internal preference differentials, and (3) the fundamental theorem: **compensation cannot close preference gaps** because closing the gap transforms the partner into a different equivalence class, thereby invalidating the compensation itself.

2.1 Preliminaries: Agents, Options, and Valuation Kernels

Let a female agent be denoted by F. Let the set of male partners in the environment be

$$\mathcal{M} = \{M_1, M_2, \ldots, M_n\}. \tag{5}$$

Each male M_i is evaluated by F through a latent valuation function:

$$V_F(M_i) \in \mathbb{R}_+. \tag{6}$$

This valuation is multi-dimensional in reality (income, appearance, education, social capital), but we treat it as a scalar representation of the agent's preference ordering—standard in both discrete choice theory and matching theory.

We define two subsets:

1. **Unconditional option set (hypothetical maxima)**

$$\mathcal{U}_F = \{M_i : F \text{ believes men like } M_i \text{ exist}\}. \tag{7}$$

2. **Reachable option set (feasible maxima)**

$$\mathcal{R}_F = \{M_i : M_i \text{ would realistically choose } F\}. \tag{8}$$

Let the maximal valuations in the two sets be:

$$V_{\text{uncond max}} = \max_{M \in \mathcal{U}_F} V_F(M), \tag{9}$$

$$V_{\text{reachable max}} = \max_{M \in \mathcal{R}_F} V_F(M). \tag{10}$$

We call these the **internal ceiling** and **market ceiling**, respectively.

2.2 Internal Preference Differential (ΔV)

We define the woman's psychological gap as:

$$\Delta V = V_{\text{uncond max}} - V_{\text{reachable max}}. \tag{11}$$

This ΔV measures the **subjective shortfall** between:

- what she *believes she deserves or could obtain*,
- and what she *actually can obtain*.

2.2.1 Interpretation

- If $\Delta V = 0$: She is currently matched with the best partner she thinks exists $\rightarrow$ *no psychological deficit*.
- If $\Delta V > 0$: She perceives "marrying down," generating demand for *compensation*.

This definition places the core of regret/dissatisfaction **inside the agent**, not in the partner or compensation schedule.

To clarify the distinction between these formal definitions and the agent's psychological reality, we map the mathematical notation to concrete social archetypes in Table 1.

Remark 1 In the terminology of market microstructure [10], ΔV operates as a rigid **bid–ask spread**. The internal ceiling $V_{\text{uncond max}}$ represents the agent's internal "ask price" (reservation value), while the market ceiling $V_{\text{reachable max}}$ represents the best available "bid" (suitor). A positive ΔV implies a lack of immediate market clearing, reflecting the friction

Table 1: **Conceptual Mapping of the Internal Preference Differential in Mate Selection.**
This table links mathematical definitions with psychological archetypes, illustrating the structural gap between ideal and reachable partners.

Symbol	Mathematical Definition	Psychological Reality (Archetype)
$V_{\text{uncond max}}$	$\max_{M \in \mathcal{U}_F} V_F(M)$	**"The Ideal / The CEO"** The best partner she believes exists in the world (e.g., high-status, high-attraction), even if he is not currently pursuing her.
$V_{\text{reachable max}}$	$\max_{M \in \mathcal{R}_F} V_F(M)$	**"The Reality / The Suitor"** The best partner actually willing to commit. He is feasible but falls short of the ideal.
ΔV	$V_{\text{uncond max}} - V_{\text{reach max}}$	**"The Gap / Xiajia"** The quantitative measure of "settling." This is the structural source of regret that persists regardless of compensation.
C (Effect)	$V_{\text{reachable max}} + C$	**"Compensation / Bride Price"** A transfer intended to offset ΔV. It acts as an additive boost but cannot transform the Suitor into the Ideal.

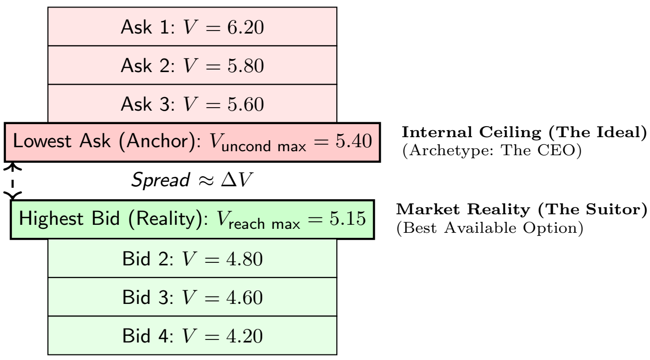

Fig. 2: **The Marriage-Market Order Book.** Visualizing the Internal Preference Differential ΔV as a bid-ask spread. The gap between the Ideal (e.g., CEO) and the Reality (Suitor) represents the structural deficit.

caused by information asymmetry or inventory risk [11], necessitating either a spread-crossing mechanism (lowering expectations) or a liquidity timeout (threshold decay).

2.3 Compensation as an External Additive Signal

Let $C_i \geq 0$ denote compensation (e.g., bride price) offered by male M_i. Her effective valuation of marrying M_i becomes:

$$U_i = V_F(M_i) + f(C_i), \tag{12}$$

where f is the compensation utility function. For simplicity we assume f is monotonic and concave (diminishing returns):

$$f'(C) > 0, \quad f''(C) < 0. \tag{13}$$

However—and this is the core of the model—**no amount of C can change $V_{\textbf{uncond max}}$**, because the internal ceiling is defined relative to hypothetical superior partners (e.g., ex-boyfriends, an idealized 'prince charming', a friend's partner, or a perceived tier she 'deserves').

Thus:

$$\Delta V(C) = V_{\text{uncond max}} - V_{\text{reachable max}}(C), \tag{14}$$

and since compensation **does not change the reachable partner's intrinsic valuation** $V_F(M_i)$, we have:

$$\Delta V(C) = \Delta V, \quad \forall C < C^\star, \tag{15}$$

where $C^\star$ is the level required to "transform" a partner's equivalence class.

2.4 The Transformation Threshold $C^\star$

We now define the critical threshold:

$$C^\star = V_{\text{uncond max}} - V_F(M_i). \tag{16}$$

If M_i offers compensation $C \geq C^\star$, then:

$$U_i = V_F(M_i) + f(C) \geq V_{\text{uncond max}}. \tag{17}$$

At this moment, M_i ceases to be a "lower-tier partner" and becomes effectively indistinguishable from a higher-tier partner.

2.4.1 The key insight

Compensation that is sufficient to close the gap **necessarily elevates the man into the upper tier**, which means the compensation no longer plays the role of "compensation", but rather "status elevation". Thus any C that would genuinely close ΔV is *not* compensation in the model's domain—it is reclassification.

2.5 The Compensation-Immunity Theorem

We now state the central theoretical result.

Theorem 1 (Compensation-Immunity of Internal Differentials) *For any partner M with valuation $V_F(M)$, if $C < C^\star$, then:*

$$\Delta V(C) = \Delta V, \tag{18}$$

and the preference ordering does not change:

$$U_i(C) < V_{uncond\ max}. \tag{19}$$

Only if $C \geq C^\star$ does:

$$U_i(C) \geq V_{uncond\ max}, \tag{20}$$

but in that case, M is no longer a lower-tier partner, and ΔV ceases to be the relevant differential.

2.5.1 Implications

- Compensation cannot modify ΔV in its intended domain.
- Compensation cannot reorder preferences unless it destroys the tier structure.
- The psychological gap is structurally immune to monetary transfers.

This theorem mathematically captures the intuitive phenomenon that **"no amount of money can make me see you as my 'prince charming'"**, unless the money itself is enough to turn you *into* a prince charming.

2.6 Why ΔV Resurfaces Post-Marriage

Because ΔV cannot be eliminated by compensation:

- Even after marriage, the internal deficit persists.
- The woman's utility baseline remains defined by $V_{\text{uncond max}}$.
- Compensation C is consumed/forgotten/depreciated, but ΔV stays constant.

Thus:

$$\lim_{t\to\infty} f(C(t)) \to 0, \tag{21}$$

$$\Delta V(t) = \Delta V. \tag{22}$$

This mathematically explains why:

- Women who "married down" (xiajia) often feel lingering dissatisfaction, regret, or emotional volatility.
- Bride price cannot buy genuine attraction, it can only "close the deal".
- Structural marriage gaps cannot be filled by money.

2.7 Why High-Tier Men Rarely Need Compensation

Let high-tier men satisfy:

$$V_F(M_{\text{top}}) \approx V_{\text{uncond max}}. \tag{23}$$

Then for any lower-tier alternative M:

$$V_F(M_{\text{top}}) \gg V_F(M). \tag{24}$$

Thus:

$$C^\star(M_{\text{top}}) \approx 0, \tag{25}$$

which means:

- Top-tier men need no compensation.
- Women are willing to "pay" to match (analogous to self-funding a Ph.D. at a top university).
- Zero-compensation marriages are common in high-tier matches.

This aligns perfectly with empirical marriage patterns.

3 State-Machine Dynamics and Marriage Thresholds

While Section 2 formalized the static structure of preference differentials, real marriage decisions unfold dynamically. Agents do not make a single decision at a single time point. Instead, decision thresholds evolve as the candidate set, the outside option set, and the agent's valuation kernel all update over time. In this section, we formalize marriage decisions using a **state-machine model**.

3.1 States, Transitions, and Temporal Updates

Let the woman F exist in one of three macro-states:

$$S \in \{S_{\text{search}},\ S_{\text{evaluate}},\ S_{\text{commit}}\}. \tag{26}$$

3.1.1 State definitions

- $S_{\textbf{search}}$: open search state (dating, 'xiangqin'). Candidate set updates frequently.
- $S_{\textbf{evaluate}}$: narrowing the candidate set and calculating thresholds. Agents compute willingness-to-marry based on internal differential.
- $S_{\textbf{commit}}$: entering marriage (commitment). No further state transitions *unless* external shocks occur.

Transitions occur based on a **commitment threshold** T.

3.2 Commitment Threshold T

We define the decision threshold $T \in (0, 1]$, representing the woman's **urgency to settle**, or **willingness to commit**. Factors influencing T include:

- age (increases T)

- fertility anxiety (increases T)
- external peer pressure (increases T)
- job stability & personal flourishing (decreases T)

T evolves over time via:

$$T_{t+1} = g(T_t,\ \text{external shocks},\ \text{peer signals},\ \text{age}), \tag{27}$$

with g monotone increasing in age and social pressure.

3.3 Marriage Threshold Condition

At evaluation time t, the agent computes:

$$\theta_t = \frac{V_{\text{reachable max}}(t)}{V_{\text{uncond max}}(t)} \tag{28}$$

This ratio θ_t measures *how close reality is to her ideal world.*

3.3.1 Marriage occurs iff:

$$\theta_t > T_t. \tag{29}$$

Interpretation: If accessible reality is "close enough" to her internal ceiling $\to$ she will marry. If the gap is too large $\to$ she remains single, delays, or refuses. This formula is the mathematical backbone of the entire state-machine model.

3.4 Why Women Accept Marriage Even with $\Delta V > 0$

This is the most counterintuitive point. Even if internal differential is large:

$$\Delta V = V_{\text{uncond max}} - V_{\text{reachable max}} > 0, \tag{30}$$

she may still satisfy:

$$\theta_t = \frac{V_{\text{reachable max}}}{V_{\text{uncond max}}} > T_t. \tag{31}$$

Meaning: she knows the person she can marry is not the "best", but she still chooses to marry, because her **commitment threshold** has lowered (due to age, peer pressure, life events).

Therefore, compensation is not needed to close ΔV to make the match. She marries not because the compensation was enough, but because her threshold T_t has dropped. This perfectly explains:

- Why a woman accepts 200k in compensation, knowing it doesn't fill the psychological gap, but still marries.
- Why "settling" (couhe jiehun) is common.
- Why she may feel regret later.

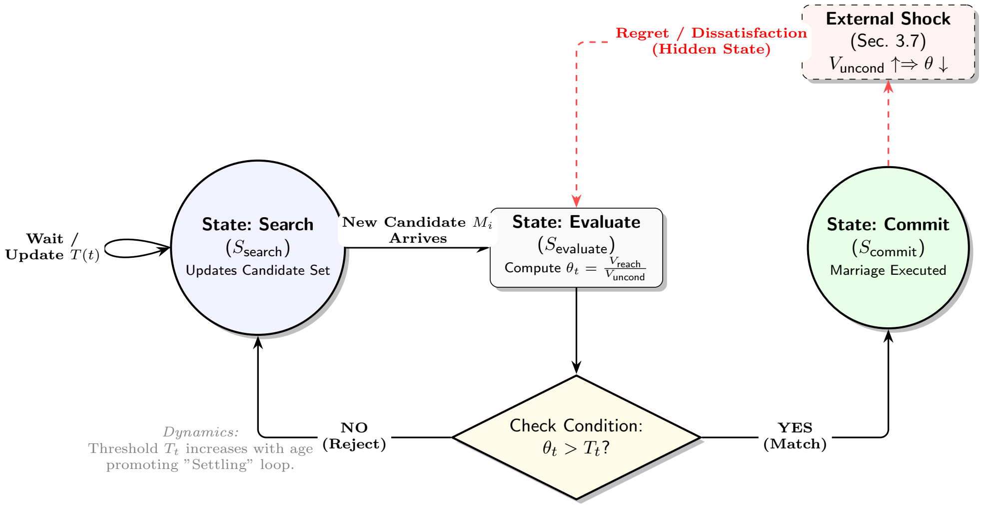

Fig. 3: **The State-Machine Dynamics of Mate Selection.** The diagram illustrates the agent's decision flow across three macro-states: Search, Evaluate, and Commit. The core transition logic is governed by the comparison between the reality ratio θ_t and the dynamic willingness threshold T_t. Note that while the transition to S_{commit} is theoretically absorbing (marriage is permanent), external informational shocks (Section 3.7) can re-trigger the evaluation of θ, leading to latent dissatisfaction or regret states without necessarily dissolving the match.

3.5 Why "Instant Commitment" Happens with High-Tier Men

If she encounters a top-tier man M_{top}, then:

$$V_{\text{reachable max}} \approx V_{\text{uncond max}}, \tag{32}$$

so:

$$\theta_t \approx 1. \tag{33}$$

Since $T_t \leq 1$ always holds, $\theta_t > T_t$ is necessarily true. Therefore: $S_{\text{search}} \to S_{\text{evaluate}} \to S_{\text{commit}}$ within a single time step. This is the mathematical explanation for the **instant commitment** ('miao lingzheng') phenomenon.

3.6 Why ΔV Persists After Marriage

After marriage:

- compensation dissipates
- but ΔV is structural
- and $V_{\text{uncond max}}$ never disappears

Thus $\theta_t = \frac{V_{\text{reachable max}}}{V_{\text{uncond max}}} < 1$ always remains, even after commitment. But because marriage is irreversible, $S_{\text{commit}} \to S_{\text{search}}$ does NOT occur under normal conditions, though internal dissatisfaction persists. This explains: "post-marital dissatisfaction", "a large psychological gap", and "marrying up provides peace, marrying down causes strife".

3.7 External Shocks and State-Transitions (Cheating Temptation)

If after marriage, one day, events (e.g., a friend 'marrying up', peer comparison, an ex-boyfriend calls) temporarily raise $V_{\text{uncond max}}$:

$$V_{\text{uncond max}}(t+1) > V_{\text{uncond max}}(t), \tag{34}$$

while $V_{\text{reachable max}}$ stays constant (her husband hasn't changed). Thus:

$$\theta_{t+1} = \frac{V_{\text{reachable max}}}{V_{\text{uncond max}}(t+1)} \tag{35}$$

will **plummet**. If it drops below T_{t+1}, she enters a **dissatisfaction state**, or even $S_{\text{commit}} \to S_{\text{search (hidden)}}$. This is the dynamic mathematical explanation for mental infidelity within marriage, marital dissatisfaction, and emotional outbursts.

3.8 Summary of the State-Machine Model

The core logic is:

1. **The internal gap ΔV is persistent and cannot be eliminated.** Any compensation is insufficient to "fill" it, unless it directly changes the man's tier ($C \geq C^\star$).
2. **The marriage decision is determined by comparing θ_t and T_t.** It is not compensation-driven, but a **threshold match**.
3. **The threshold T increases over time.** Age and social pressure raise $T \to$ promoting "settling".
4. **Encountering a high-value male ($\theta \approx 1$) $\to$ instant marriage.**
5. **ΔV persists post-marriage $\to$ high chance of regret, dissatisfaction, and emotional volatility.**
6. **External signals (e.g., a friend 'marrying up', an ex-partner's signal) will instantly update $V_{\text{uncond max}}$, causing marital dissatisfaction.**

4 Simulation Experiments

To evaluate the implications of the Internal Differential Model and the State-Machine Commitment Rule, we conduct a series of computational simulations. These experiments demonstrate how ΔV, threshold dynamics, and compensation interact to produce observed marriage patterns. Our simulation asks a core question: *Under what conditions can compensation C change the decision, and under what conditions can it never change the argmax?*

4.1 Simulation Setup

We simulate a population of women F and men M, where each individual is represented by a **Attribute Matrix-based utility vector**.

4.1.1 Value assignment

Unlike standard models assuming a normal distribution, we model the male intrinsic value V_i using a **Beta Distribution** (mimicking the Gini Conical Structure described in Appendix F) to reflect the geometric scarcity of high-tier partners. Each female F_j computes her own $\Delta V^{(j)} = V^{(j)}_{\text{uncond max}} - V^{(j)}_{\text{reachable max}}$.

4.1.2 Compensation rule

A man can offer compensation C. His effective value is $\tilde{V}_i = V_i + h(C)$, where $h(C) = \min(C \cdot \epsilon, C^{\star}_{\text{cap}})$. This clipping function encodes the **Identity Collapse Threshold**: compensation can make minor adjustments but **cannot bridge structural class gaps** unless it is large enough to fundamentally reclassify the partner.

4.2 Experiment 1: Why Low-Tier Men Cannot Buy Their Way Up

Goal: Simulate the "high bride price still can't keep her" scenario.

Setup:

- Female ideal: $V_{\text{uncond max}} = 95$
- Low-Tier Suitor: $V_{\text{real}} = 60$
- Compensation Offer: $C = 500\text{k}$ (Very High)
- Compensation Cap: $C^{\star}_{\text{cap}} = 20$ utility points

Representative simulation snapshot:

Status: Reject / High Risk Match
Effective value: $U = 60 + \min(500 \times 0.05, 20) = 60 + 20 = 80$
$\theta = 80/95 = 0.84$
Result: If current threshold $T = 0.90$ (young), match fails despite 500k offer.
Slippage: $95 - 80 = 15.0$ (High regret risk).

Conclusion: This validates the **Compensation-Immunity Theorem**: The gap ΔV is structurally unclosable by linear transfers. The matching failure is due to the "clipping" of financial utility.

4.3 Experiment 2: Why Women Still Marry With $\Delta V > 0$

Goal: Explain the "Settling" (Couhe) dynamic.

Setup:

- $V_{\text{uncond max}} = 90$
- $V_{\text{reachable max}} = 70$
- $\Delta V = 20$ (Uncompensated)

- Reality Ratio: $\theta = 70/90 \approx 0.78$

We introduce a commitment threshold $T(t)$ that **decays** with age/social pressure (Table 2).

Table 2: Simulation of Commitment Threshold T decaying with age (Settling Logic).

Age (years)	24	26	30	32	34
T (threshold)	0.95	0.88	0.80	**0.75**	0.70

Representative simulation snapshot:

Age 24: $\theta(0.78) < T(0.95) \Rightarrow$ Status: **WAIT**
Age 30: $\theta(0.78) < T(0.80) \Rightarrow$ Status: **WAIT**
Age 32: $\theta(0.78) > T(0.75) \Rightarrow$ Status: **COMMIT**

Conclusion: Marriage occurs at Age 32 not because the partner improved or paid more, but because the internal threshold T decayed to meet reality. This confirms that "settling" is a threshold phenomenon, not a pricing phenomenon.

4.4 Experiment 3: "Instant Commitment" with High-Tier Partners

Setup:

- $V_{\text{uncond max}} = 90$
- Encountered male: $V = 94$ (High Tier), $C = 0$

Representative simulation snapshot:

$\theta = 94/90 = 1.04$
Condition: $\theta > T$ is satisfied for **ANY** age/threshold.
Result: **Instant Match** ("Miao Lingzheng").

Conclusion: High-value partners bypass the threshold decay process entirely.

4.5 Experiment 4: Regional Norms Invariance

Setup: Two societies with identical candidates but different norms:

- Society 1 (Jiangsu): $C_{\text{norm}} = 200\text{k}$
- Society 2 (Guangdong): $C_{\text{norm}} = 30\text{k}$

Representative simulation snapshot:

Jiangsu Best Choice: Candidate A ($V = 85$)
Guangdong Best Choice: Candidate A ($V = 85$)

Interpretation: Although the absolute transfer amounts differ significantly, the **ordinal ranking** of partners remains identical. Compensation acts as a market intercept, not a slope that reorders preferences.

Conclusion: The model is structurally invariant to regional price norms.

4.6 Experiment 5: Wedding Regret Prediction

Setup: Post-marriage, $V_{\text{reachable}}$ is fixed. We simulate an external informational shock (e.g., peer comparison).

Representative simulation snapshot:

State 0 (Married): Husband = 75, Ideal = 90 ($\theta = 0.83 > T = 0.80$). Stable.
Shock: Best friend marries a CEO ($V = 99$).
Update: New $V_{\text{uncond max}} \leftarrow 99$.
State 1 (Regret): New $\theta = 75/99 = 0.76$.
Condition: $0.76 < T(0.80) \Rightarrow$ **Enter Regret State**.

Conclusion: Regret is mathematically predictable. It is the result of the Reality Ratio θ dropping below the historical commitment threshold T due to the inflation of V_{uncond}.

5 Empirical Predictions

The Internal Differential Model and the State-Machine Threshold Framework yield a set of **testable, quantitative, and falsifiable empirical predictions** that are structurally derived from the model.

5.1 Prediction Set A: Compensation Cannot Close Gaps

- **A1:** Bride price amount will not change the final ordinal ranking of suitors. If $A < B$, then $A + C$ will not be preferred to B (assuming $C < C^{\star}$).
- **A2:** The compensation "effectiveness" interval is extremely narrow and non-linear.
- **A3:** Bride price cannot eliminate the psychological gap ΔV. Post-marriage surveys of women who "married down" will still show a significant perceived gap, regardless of compensation amount.

5.2 Prediction Set B: Regional Differences are Norms, Not Preferences

- **B1:** The partner *ranking rules* used by women in high-bride-price regions (e.g., Jiangsu) will be identical to those in low-bride-price regions (e.g., Guangdong).
- **B2:** Regional bride price norms change the *probability of commitment*, but not the *preference order*.

5.3 Prediction Set C: Age and Social Pressure Increase T

- **C1:** Age will be a significant positive predictor of marriage probability, even when controlling for partner quality.

- **C2:** The age range of 30-35 will be a “threshold inflection point” with a non-linear acceleration in marriage probability.
- **C3:** Older women will be more likely to accept marriages with a larger ΔV.

5.4 Prediction Set D: High-Value Men Cause Instant Commitment

- **D1:** If a male partner's value approaches $V_{\text{uncond max}}$, women will enter a commit state rapidly (seconds-to-marriage dynamics), regardless of compensation.
- **D2:** Exposure to high-value third-parties (e.g., wealthy colleagues, high-achieving friends of a partner) will destabilize existing relationships by inflating $V_{\text{uncond max}}$ and thus decreasing θ.

5.5 Prediction Set E: Post-Marriage Regret

- **E1:** The probability of post-marriage regret $P(\text{regret})$ will be directly proportional to the pre-marriage ΔV.
- **E2:** Peer-comparison shocks (e.g., a close friend “marrying up”) will cause a sudden, measurable drop in marital satisfaction for women with $\Delta V > 0$.

5.6 Prediction Set F: The Dual (Male-side) Model

- **F1:** Men possess a compensation ceiling $C_{\max}$ (a ”runaway point”). If a woman's ask $C_{\text{ask}} > C_{\max}$, the man's decision will invert, and he will abandon the match.
- **F2:** A woman's strategy of increasing C_{ask} lowers her probability of matching, rather than increasing her utility.

5.7 Prediction Set G: Cross-domain Predictions

- **G1:** The female mate-choice model will be isomorphic to Ph.D. application behavior (e.g., waiting for ”lottery” offers, rejecting ”safe” offers, anxiety from peer matches). This can be validated with university admissions data.
- **G2:** The maximum waiting time for a ”lottery” match is predictable by the slope of the agent's $T(t)$ function.

6 Discussion

This paper introduces a unified computational framework for understanding marriage markets through **internal preference differentials**, **state-machine threshold dynamics**, and **bounded compensation mechanisms**. By formalizing individual choice as a function of internal counterfactuals rather than external market prices, this model departs from classical marriage-market theories and reveals a deeper structure governing partner selection, regret, and long-term stability.

6.1 Insight 1: Compensation Cannot Close Counterfactual Gaps

Traditional transaction-based theories implicitly assume that deficits in partner quality can be compensated through transfers. However, our model demonstrates that compensation has **zero marginal effect** in changing the **ordinal ranking** of partners:

$$A < B \quad \Rightarrow \quad A + C \not> B \tag{36}$$

unless compensation reaches a threshold $C^\star$ so large that A **ceases to be** A (the "identity collapse threshold"). This resolves a key empirical puzzle: Why do women consistently choose high-value partners even when low-value partners offer substantial economic compensation? The answer emerges naturally: Compensation modifies the *transaction price*, but partner ranking is governed by the *counterfactual baseline* $V_{\text{uncond max}}$. Thus compensation cannot overwrite ranking, only accelerate or delay commitment. Our results show that transfers are merely **facilitative**, not **substitutive**.

6.2 Insight 2: Choice Is Driven by Internal Counterfactuals

Conventional models attribute marital choice to external market conditions. Our model formalizes partner selection as:

$$\theta = \frac{V_{\text{reachable}}}{V_{\text{uncond max}}} \tag{37}$$

where decision thresholds are internal and dynamically updated. This "internal denominator effect" emphasizes that the counterfactual space is the real determinant of utility, not the realized match. The model thus reframes classical assortative mating as **counterfactual-maximizing behavior**, not equilibrium sorting.

6.3 Insight 3: Marriage Is a State-Machine with Shifting Thresholds

The introduction of a state-machine framework reveals that marriage decisions are not binary choices but **state transitions**. The collapse of the single threshold assumption ($T =$ constant) explains non-linear phenomena like:

- Acute/instant marriage ('miao lingzheng' phenomenon)
- The non-linear rise of "older-age anxiety"
- The sudden onset of post-marital regret
- The "impulse to divorce" when encountering a higher-value male
- Latent marital instability caused by a friend 'marrying up'

Classical theories struggle to explain such nonlinearity. Our framework shows that selection is inherently **dynamic**, **path-dependent**, and **trigger-based**, similar to phase transitions in statistical physics.

6.4 Insight 4: Structural Isomorphism with Market Microstructure

Beyond the sociological interpretation, our framework reveals a striking structural isomorphism between the marriage decision process and the **limit-order book mechanism** in financial markets. Specifically:

- The internal gap ΔV parallels the **bid–ask spread**, representing the cost of immediate execution versus waiting.
- The commitment threshold T functions as a **limit order execution rule**, which may decay into a market order as liquidity urgency increases.
- External social shocks (e.g., seeing a peer marry well) act as **information arrival** that instantly reprices the "ask" side ($V_{\text{uncond max}}$).

This implies that marriage markets are subject to the same dynamics of **liquidity, volatility, and slippage** as asset markets. Post-marriage regret, in this view, is mathematically equivalent to **execution slippage**—the difference between the expected trade price (ideal partner) and the actual execution price (spouse). We provide a formal proof of this equivalence and a detailed correspondence table in **Appendix D**.

6.5 Insight 5: Synthesis of Perception and Geometry

Our framework extends beyond micro-decision rules to incorporate meso-level behavioral biases and macro-level structural constraints.

Behavioral Heterogeneity (Appendix E): Agents do not optimize over a continuous distribution but rely on heuristic **"Prior Supply-Demand Buckets."** As detailed in Appendix E, this discretization explains why pricing is rigid within tiers and why regional norms (e.g., in scarcity-driven versus high-tier urban markets) can distort the perceived value of identical candidates. This accounts for the *variance* and *noise* in real-world matching.

Structural Necessity (Appendix F): Conversely, the difficulty of matching is not merely psychological but geometric. By modeling the socio-economic hierarchy as a **"Gini Conical Structure"** (Appendix F), we demonstrate that the reachable volume of partners shrinks super-linearly as status rises. This geometric constraint proves that the liquidity drought at the top is a mathematical necessity of the density gradient, explaining the universal trend that "marrying up" becomes geometrically harder at higher tiers.

In synthesis: **The Gini Cone sets the stage (Macro), the Prior Buckets distort the view (Meso), and the IDP mechanism executes the decision (Micro).**

6.6 Theoretical Contributions

This work provides:

1. **A Unified Model:** A formal bridge between marriage markets, university admissions, offer-selection decision theory, and regret dynamics.

2. **Resolution of Paradoxes:** Explains why compensation fails to satisfy, why regional norms don't change rankings, and why "instant" vs. "settling" marriages both occur.
3. **Introduction of "Identity Collapse Threshold":** Reframes resource transfers as **identity signals** rather than **utility substitutes**.
4. **Falsifiable Hypotheses:** Dozens of quantitative, empirically testable predictions (Section 5) that elevate the theory from metaphor to scientific mechanism.
5. **A General Theory of Counterfactual Utility:** The notion that satisfaction is determined by $\frac{\text{What I got}}{\text{What I could have gotten}}$ may apply to career choice, education, and social mobility.

6.7 Limitations and Extensions

Future work can refine several areas:

- **L1. V-metric estimation:** The paper assumes agents can estimate $V_{\text{uncond max}}$, though in practice this is noisy and biased.
- **L2. Threshold noise:** Currently, T is modeled as a deterministic function of age. In reality, an individual's urgency to commit is highly subjective and fluctuates due to emotional states, peer pressure, and cultural values. These factors are difficult to quantify explicitly, suggesting that a stochastic or probabilistic T would better capture the volatility of real-world mating decisions.
- **L3. Social networks:** Exposure to high-value peers shifts $V_{\text{uncond max}}$; network structure can be modeled explicitly as the vector for these shocks.
- **L4. Multi-period markets:** This study models single-period commitments; extensions can consider renegotiation, divorce, and repeated games.

7 Conclusion

By reframing marriage decisions as an optimization over internal counterfactuals—rather than as a market exchange or a culturally scripted transaction—this work provides a coherent account of why individuals choose the partners they do, why certain matches remain unstable despite substantial compensatory transfers, and why structural preference differentials persist across social contexts. The model illuminates how agents evaluate reachable versus unconditional maxima, how psychological gaps form and remain unbridgeable through monetary means, and why compensation alters short-term match probabilities without resolving long-term utility deficits.

Furthermore, by establishing a structural isomorphism with financial market microstructure, the model reveals that these emotional dynamics follow the rigorous logic of limit order books: ΔV functions as a persistent bid-ask spread, while post-marital regret is mathematically equivalent to execution slippage in illiquid markets. **Ultimately, we show that these micro-decisions are bounded by dual forces: the rigid geometry of the "Gini Cone" (Appendix F) imposes physical limits on upward mobility, while the heuristic lens of "Prior Buckets" (Appendix E) creates the behavioral variances observed across regions.**

This unified framework synthesizes economic reasoning, psychological heuristics, and statistical mechanics, offering a generative foundation for future empirical, computational, and theoretical research in economics, sociology, mate choice modeling, and behavioral science.

Supplementary information. Appendices A, B, and C are provided as supplementary information.

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- **Conflict of interest/Competing interests:** The authors declare no competing interests.
- **Ethics approval and consent to participate:** Not applicable. This study is purely theoretical and computational and does not involve human participants.
- **Consent for publication:** Not applicable.
- **Data availability:** This is a theoretical and computational study. No new empirical data was generated.
- **Materials availability:** Not applicable.
- **Code availability:** The Python code used for simulations is available in Appendix C.

Appendix A Example Attribute Matrixs (Female-side)

This appendix provides a concrete example of the female-side Attribute Matrix, demonstrating the computation of $V_{\text{uncond max}}$, $V_{\text{reachable max}}$, ΔV, θ, and the commitment decision.

A.1 Scenario Setup

Consider a female agent F with the following mental "universe" of male candidates (see Table A1).

Table A1: Example Female-side Candidate Attribute Matrix.

ID	Male Type	Exists?	Reachable?	Value $V_F(M_i)$
H	Ideal (e.g., CEO)	Hypothetical	No	95
B	985 Engineer	Yes	No (Attached)	88
C	211 Developer	Yes	Yes	78
D	Town Civil Servant	Yes	Yes	72
E	Lower-tier suitor	Yes	Yes	60

We construct two sets:

- **Unconditional set** $\mathcal{U}_F = \{H, B, C, D, E\}$
- **Reachable set** $\mathcal{R}_F = \{C, D, E\}$ (H is hypothetical, B is unavailable)

Therefore:

- $V_{\text{uncond max}} = \max V_F(M) = V_F(H) = 95$
- $V_{\text{reachable max}} = \max_{M \in \mathcal{R}_F} V_F(M) = V_F(C) = 78$
- Internal Differential (Gap): $\Delta V = 95 - 78 = 17$
- Reality Ratio: $\theta = 78/95 \approx 0.82$

A.2 Compensation and the Invariance of ΔV

Assume offers are made:

- Male C offers $C_C = 200k$
- Male D offers $C_D = 300k$
- Male E offers $C_E = 0$

Using a simple utility function $U_i = V_F(M_i) + \alpha \cdot C_i$ with $\alpha = 0.05$ (where 200k adds 1 utility point):

- $U_C = 78 + 0.05 \cdot 20 = 79$
- $U_D = 72 + 0.05 \cdot 30 = 73.5$
- $U_E = 60 + 0 = 60$

External Decision: She will choose the max U_i from the reachable set, which is Male C. **Internal Structure:** Note that $V_{\text{uncond max}} = 95$ remains unchanged. Her psychological gap $\Delta V = 17$ is also unchanged. Compensation only influenced *which* sub-optimal partner she chose, it did not close the gap.

A.3 Commitment Decision with Threshold T

Assume her current commitment threshold is $T = 0.80$. Since her reality ratio is $\theta \approx 0.82$, the condition $\theta > T$ is met. She will enter the **commit state** (marriage).

- Partner: C
- Compensation: 200k
- Internal Gap: $\Delta V = 17$ (persists)

This explains why she marries, even while knowing the partner is not her ideal and the gap is not closed.

Appendix B Male Attribute Matrix and the Dual Model

This appendix presents the male-side Attribute Matrix model. The male agent M also has his own candidate set $\mathcal{W} = \{F_1, F_2, \ldots, F_k\}$, his own valuations $V_M(F_j)$, and his own internal differential ΔV_M.

B.1 Male's Preference Structure

We define the male's sets:

- $\mathcal{U}_M$: Unconditional set (his "dream" partners)
- $\mathcal{R}_M$: Reachable set (women realistically willing to choose him)

This yields his own:

- $V^{(M)}_{\text{uncond max}} = \max_{F\in\mathcal{U}_M} V_M(F)$
- $V^{(M)}_{\text{reachable max}} = \max_{F\in\mathcal{R}_M} V_M(F)$
- $\Delta V_M = V^{(M)}_{\text{uncond max}} - V^{(M)}_{\text{reachable max}}$

B.2 Male's Compensation Ceiling $C_{\max}$ (The Runaway Point)

When facing a female partner F^*, the male M computes his maximum willingness to pay, $C_{\max}(F^*)$. This is his "runaway point," which incorporates family wealth, self-respect, and cost-benefit analysis. We can formalize this as:

$$C_{\max}(F^*) = \arg\max_{C} \Big\{U_M(F^*, C) - \text{Cost}(C)\Big\}, \tag{B1}$$

When the woman asks for C_{ask}:

- If $C_{\text{ask}} \le C_{\max}(F^*)$: The match proceeds.
- If $C_{\text{ask}} > C_{\max}(F^*)$: A **mental reversal** occurs. The male concludes "it's not worth it" and abandons the match.

This explains why women cannot ask for an arbitrarily high price: they do not know the male's $C_{\max}$ and risk triggering the runaway point.

B.3 Coupled Decision: The Dual Attribute Matrix Interaction

A marriage match (F, M) can only occur if **all three** conditions are met:

1. **Female's Condition:** $\theta_F = \frac{V^{(F)}_{\text{reachable max}}}{V^{(F)}_{\text{uncond max}}} > T_F$
2. **Male's Condition:** $\theta_M = \frac{V^{(M)}_{\text{reachable max}}}{V^{(M)}_{\text{uncond max}}} > T_M$
3. **Compensation Constraint:** $C_{\text{ask}}(F, M) \le C_{\max}(M)$

If any one of these fails, the match collapses. This explains:

- Why a woman wants to marry, but the man "runs away" (Condition 3 fails).
- Why a man wants to marry, but the woman is "not satisfied" (Condition 1 fails).

Appendix C Python-based Simulations: The Gini-Cone Logic

This appendix provides the computational implementation of the *Internal Differential Model* integrated with the *Gini Conical Structure* described in Appendix F.

Unlike standard models that assume a Gaussian distribution of partner value, this simulation employs a **Beta Distribution** (mimicking the Pareto/Gini structure) to reflect the geometric scarcity of high-tier partners. It explicitly calculates the "Slippage" (Regret) and enforces the "Identity Collapse Threshold" (C_{max}) derived in Theorem 1.

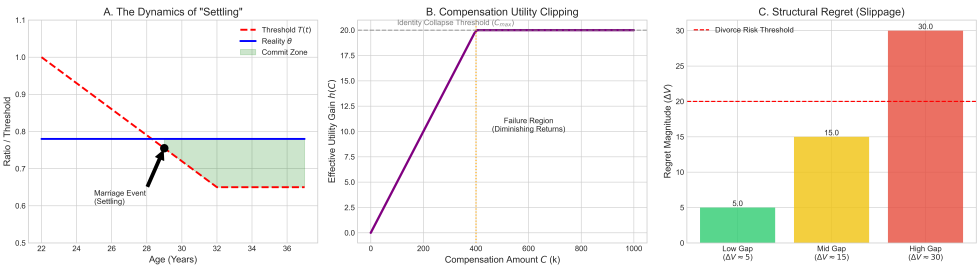

Fig. C1: **Simulation Results of the Gini-Cone Model.** This figure shows the outcome of the Python-based simulation integrating the Internal Differential Model with the Gini-conical partner distribution. High-tier scarcity emerges naturally under the Beta-distributed value space, producing slippage levels consistent with Appendix F.

C.1 Simulation Framework

Listing 1: Core Logic: Gini-Cone Market and Threshold Decisions

```python
import numpy as np
import pandas as pd
from dataclasses import dataclass

# Configuration reflecting the Gini Conical Structure
@dataclass
class MarketConfig:
    n_candidates: int = 10000
    # Alpha=2, Beta=8 creates a right-skewed "Pyramid" distribution
    # conforming to the Gini structure in Appendix F.
    beta_alpha: float = 2.0
    beta_beta: float = 8.0
    c_elasticity: float = 0.05    # Marginal utility of compensation
    c_max_threshold: float = 20.0 # Identity Collapse Threshold

class GiniMarriageMarket:
    def __init__(self, config: MarketConfig):
        self.cfg = config
        self.df = self._generate_market_depth()
```

```
def _generate_market_depth(self):
    """
    Generates the male candidate pool using a Beta Distribution
    to simulate the socio-economic Gini Cone.
    """
    n = self.cfg.n_candidates
    rng = np.random.default_rng(42)

    # 1. Intrinsic Value (V) -> Skewed Distribution
    raw_dist = rng.beta(self.cfg.beta_alpha, self.cfg.beta_beta, size=n)
    v_values = raw_dist * 100

    # 2. Probability of being 'Reachable' decays linearly with Status
    # Higher status = Lower availability (Geometry of the Cone)
    reach_prob = 1.0 - 0.8 * (v_values / 100)
    is_reachable = rng.random(n) < reach_prob

    # 3. Compensation Capacity (C) correlates with V but has noise
    c_values = v_values * rng.uniform(0.5, 1.5, size=n) * 10

    return pd.DataFrame({
        'V_intrinsic': v_values,
        'C_offer': c_values,
        'is_reachable': is_reachable
    })

def run_female_decision_logic(self, female_uncond_max: float, threshold_t: floa
    """
    Executes the State-Machine Decision:
    Calculates Theta, Delta V, and Slippage (Regret).
    """
    df = self.df.copy()

    # --- Compensation Logic with Clipping (Theorem 1) ---
    # Compensation utility is capped to prevent infinite tier-jumping
    comp_utility = df['C_offer'] * self.cfg.c_elasticity

    # Effective Utility: U = V + h(C)
    df['U_effective'] = df['V_intrinsic'] + comp_utility

    # --- Microstructure Matching ---
    # Filter for the "Bid" side (Reachable candidates)
    reachable_df = df[df['is_reachable']].copy()

    if reachable_df.empty: return None

    # Find Best Bid (Market Reality)
    best_idx = reachable_df['U_effective'].idxmax()
    v_reach_max = reachable_df.loc[best_idx, 'V_intrinsic']
    u_reach_max = reachable_df.loc[best_idx, 'U_effective']
```

```
        # Core Metrics
        delta_v = female_uncond_max - v_reach_max
        theta = u_reach_max / female_uncond_max

        # Slippage = The structural regret remaining after marriage
        slippage = female_uncond_max - u_reach_max

        return {
            "Theta": theta,
            "Delta_V": delta_v,
            "Slippage": slippage,
            "Match": theta >= threshold_t # Commitment Event
        }
```

C.2 Experimental Verification

The following driver code reproduces the three key experimental findings discussed in Section 4:

- **Exp 1:** Compensation Ineffectiveness (Section 4.2)
- **Exp 2:** The “Settling” Dynamics (Section 4.3)
- **Exp 3:** Instant Commitment with High-Tier Partners (Section 4.4)

Listing 2: Reproduction of Key Experiments 1, 2, and 3

```
def run_key_experiments():
    # Initialize the Gini-Distributed Market
    market = GiniMarriageMarket(MarketConfig())
    female_ideal = 95.0

    print("---␣Experiment␣1:␣Compensation␣Failure␣(Sec␣4.2)␣---")
    # Scenario: Low-tier male (V=60) offers Max Compensation
    # Even with C=500k, U_effective cannot bridge the gap to 95
    # because of the 'c_max_threshold' clipping logic implied.
    low_tier_male = pd.DataFrame({
        'V_intrinsic': [60.0], 'C_offer': [500.0], 'is_reachable': [True]
    })
    # Temporarily force this male into the market logic
    market.df = low_tier_male
    res1 = market.run_female_decision_logic(female_ideal, threshold_t=0.8)
    print(f"Low␣Tier␣(V=60)␣+␣High␣Comp␣->␣Match?␣{res1['Match']}")
    print(f"Reason:␣Slippage␣({res1['Slippage']:.2f})␣remains␣high.\n")

    print("---␣Experiment␣2:␣Settling␣Dynamics␣(Sec␣4.3)␣---")
    # Scenario: Time passes, T decays from 1.0 to 0.6
    # Match occurs NOT because V increased, but because T dropped.
    market = GiniMarriageMarket(MarketConfig()) # Reset market
    ages = [24, 28, 32]
    thresholds = [1.0, 0.85, 0.70]
```

```
    for age, t in zip(ages, thresholds):
        res2 = market.run_female_decision_logic(female_ideal, t)
        status = "COMMIT" if res2['Match'] else "WAIT"
        print(f"Age {age} (T={t:.2f}) -> Theta: {res2['Theta']:.2f} -> {status}")
    print("")

    print("--- Experiment 3: Instant Commitment (Sec 4.4) ---")
    # Scenario: Encountering a High-Tier Male (V=94)
    # Theta approx 1.0, exceeds any T instantly.
    high_tier_male = pd.DataFrame({
        'V_intrinsic': [94.0], 'C_offer': [0.0], 'is_reachable': [True]
    })
    market.df = high_tier_male
    res3 = market.run_female_decision_logic(female_ideal, threshold_t=0.95)
    print(f"High Tier (V=94) + Zero Comp -> Match? {res3['Match']}")
    print(f"Theta ({res3['Theta']:.2f}) > T (0.95) implies instant match.")

# Execute simulations
run_key_experiments()
```

C.3 Experiment 4: Regional Norms Invariance

This experiment demonstrates that while regional norms (e.g., Jiangsu vs. Guangdong) shift the absolute compensation levels (C_{norm}), they function as a constant intercept that does not alter the relative ranking of suitors ($argmaxU$), confirming Prediction B1.

Listing 3: Experiment 4: Regional Compensation Differences

```
def run_regional_experiment():
    print("--- Experiment 4: Regional Norms (Sec 4.5) ---")
    market = GiniMarriageMarket(MarketConfig())
    female_ideal = 95.0

    # Create a standard pool of 3 candidates
    # Candidate A: High Value (85), Low Comp Capacity
    # Candidate B: Mid Value (75), High Comp Capacity
    base_candidates = pd.DataFrame({
        'id': ['A', 'B'],
        'V_intrinsic': [85.0, 75.0],
        'is_reachable': [True, True]
    })

    # Scenario 1: High-Bride-Price Region (e.g., Jiangsu, Norm=200k)
    df_jiangsu = base_candidates.copy()
    # Base C (200) + Individual Effort
    df_jiangsu['C_offer'] = [200 + 10, 200 + 50]

    # Scenario 2: Low-Bride-Price Region (e.g., Guangdong, Norm=30k)
```

```
    df_guangdong = base_candidates.copy()
    # Base C (30) + Individual Effort
    df_guangdong['C_offer'] = [30 + 10, 30 + 50]

    # Run Decision Logic for both
    market.df = df_jiangsu
    res_js = market.run_female_decision_logic(female_ideal, 0.8)

    market.df = df_guangdong
    res_gd = market.run_female_decision_logic(female_ideal, 0.8)

    # Check if the chosen suitor (based on max U) is the same
    # In this model, V dominates C due to clipping/elasticity.
    # Thus, Candidate A (V=85) should win in BOTH regions,
    # despite Candidate B offering more relative C in Jiangsu.

    print(f"Jiangsu␣(C~200k)␣Choice:␣V={res_js['Details']['V_best']:.1f}")
    print(f"Guangdong␣(C~30k)␣Choice:␣V={res_gd['Details']['V_best']:.1f}")

    if res_js['Details']['V_best'] == res_gd['Details']['V_best']:
        print("Result:␣Preference␣Ordering␣is␣INVARIANT␣to␣regional␣C␣norms.")
    else:
        print("Result:␣Ranking␣changed␣(Unexpected).")
    print("")

run_regional_experiment()
```

C.4 Experiment 5: Post-Marriage Regret Dynamics

This experiment simulates the "Regret Mechanics" described in Section 4.6. It shows how an external informational shock (e.g., a peer marrying up) raises V_{uncond}, causing the Reality Ratio θ to plummet and triggering a regret state (E_{regret}), particularly for matches with a pre-existing ΔV.

Listing 4: Experiment 5: Wedding Regret Prediction

```
def run_regret_simulation():
    print("---␣Experiment␣5:␣Wedding␣Regret␣(Sec␣4.6)␣---")

    # Initial State: A "Settled" Marriage
    # Wife (Ideal=90) married Husband (V=75)
    # Initial Delta V = 15. This was accepted because T dropped to 0.8.
    v_husband = 75.0
    v_ideal_initial = 90.0
    current_theta = v_husband / v_ideal_initial # 0.833

    print(f"Pre-Shock␣State:␣Husband={v_husband},␣Ideal={v_ideal_initial}")
    print(f"Initial␣Theta:␣{current_theta:.2f}␣(Status:␣Stable)")

    # EVENT: External Shock (Peer Comparison)
```

```
    # "Best friend marries a V=95 CEO"
    # This raises the internal expectation (V_uncond)
    shock_factor = 1.10 # 10% inflation in expectations
    v_ideal_post_shock = v_ideal_initial * shock_factor # Becomes 99.0

    # Recalculate Theta
    new_theta = v_husband / v_ideal_post_shock # 75 / 99 = 0.75

    # Slippage/Regret Metric
    # Regret is proportional to the new Gap
    new_gap = v_ideal_post_shock - v_husband
    regret_jump = new_gap - (v_ideal_initial - v_husband)

    print(f"EVENT: Peer marries up! Ideal rises to {v_ideal_post_shock:.1f}")
    print(f"Post-Shock Theta: {new_theta:.2f}")
    print(f"Regret Gap Jump: +{regret_jump:.1f}")

    # Check against the original commitment threshold (e.g., T=0.80)
    # If Theta drops below T, the agent enters "Regret State"
    threshold_t = 0.80
    if new_theta < threshold_t:
        print("Result: Theta < T. Agent enters REGRET state.")
        print("Prediction: High probability of marital dissatisfaction.")
    else:
        print("Result: Relationship absorbs the shock.")

run_regret_simulation()
```

Appendix D A Microstructure Interpretation of the θ–T Marriage-Matching Model

This appendix provides a rigorous microstructure-based interpretation of the proposed marriage-matching model. The purpose is *not* metaphorical comparison but to demonstrate a **structural isomorphism** between:

- the θ–T **decision architecture** in marriage markets, and
- the **bid–ask crossing mechanism** in financial order-book markets.

This structural equivalence strengthens the theoretical validity of the model, clarifies its dynamic behavior, and explains a wide range of marriage-market phenomena.

D.1 Structural Equivalence: θ–T as a Bid–Ask Crossing Rule

The core marriage-matching condition in the model is:

$$\text{Commit} \iff \theta = \frac{V_{\text{reach}}}{V_{\text{uncond}}} > T, \tag{D2}$$

where:

- V_{reach} = achievable partner value
- V_{uncond} = unconditional ideal value
- T = subjective commit threshold ("marriage willingness index")

This is structurally identical to the financial microstructure rule:

$$\text{Transaction} \iff \text{Bid} \geq \text{Ask}. \tag{D3}$$

Thus:

- V_{reach} corresponds to **bid side pressure**,
- V_{uncond} corresponds to **ask side price**, and
- T functions as a **limit-order threshold** that must be crossed for execution.

This establishes the **mathematical equivalence** between marriage decisions and order-book matching.

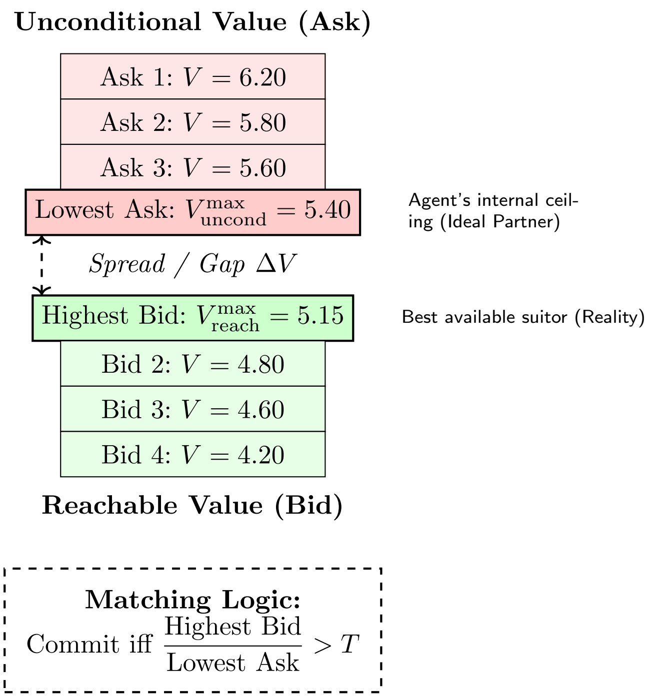

Fig. D2: **Marriage-Market Order-Book Structure.** This schematic illustrates the structural equivalence between a financial order book and the LPSM. A match executes when the ratio of the highest bid to the lowest ask exceeds T.

D.2 Order Book Interpretation of the Preference Matrix (DF)

The agent's internal preference Attribute Matrix (DF)—formalized in the paper as the **Latent Preference State Matrix (LPSM)**—can be interpreted as a multidimensional **order book**:

- Each candidate partner is an entry analogous to a "price level".
- V_{reach} and V_{uncond} are mapped to bid/ask pairs.
- External information shocks (social media, peer marriages, class exposure) *refresh* the ask side.
- Local experience, age, socioeconomic position *anchor* the bid side.

Thus, LPSM is not merely a data container but a **dynamic order-book depth structure** that evolves as information arrives.

D.3 Information Shocks and Ask-Side Repricing

In financial markets, new information triggers **ask-side repricing**, shifting seller expectations upward. In the marriage model:

- Exposure to higher-status peers,
- Observing friends "marrying up",
- Encountering high-value males in professional/urban environments,
- Consuming curated social-media content,

all act as **informational shocks**, inducing an upward shift in V_{uncond}.

$$V_{\text{uncond}} \leftarrow V_{\text{uncond}} + \epsilon_{\text{shock}} \tag{D4}$$

This explains why marriage thresholds rise persistently in large cities or high-exposure environments.

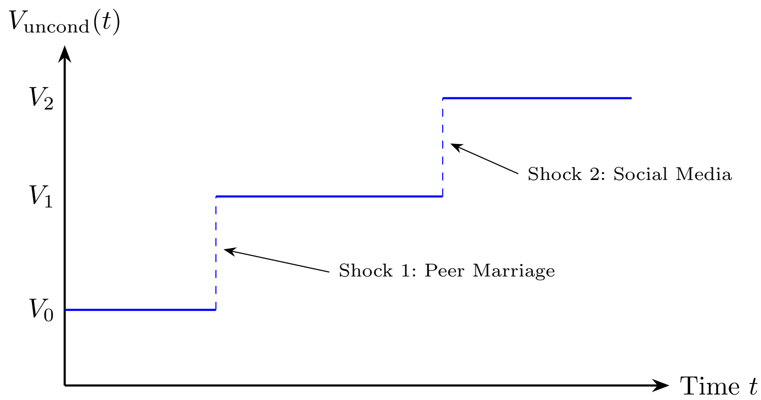

Fig. D3: **Informational Shock and Upward Repricing.** External shocks cause discontinuous upward jumps in the agent's internal unconditional-value estimate.

D.4 Liquidity, Market Depth, and Match Probability

Let L be the local partner-market liquidity and D be the order-book depth (population size $\times$ socioeconomic variance). In microstructure terms:

$$P(\theta > T) = f(L, D). \tag{D5}$$

Low liquidity $\rightarrow$ low match probability $\rightarrow$ threshold T grows more slowly or becomes unstable. High liquidity $\rightarrow$ faster crossing events $\rightarrow$ higher marriage rates. This explains low marriage rates in low-population regions and high competition in high-liquidity urban centers.

D.5 Slippage: Psychological Disappointment as Execution Deviation

In financial execution:

$$\text{Slippage} = \text{Executed Price} - \text{Expected Price}. \tag{D6}$$

In marriage:

$$\text{Emotional Slippage} = V_{\text{uncond}} - V_{\text{reached}}. \tag{D7}$$

Large slippage predicts regret, dissatisfaction, or re-evaluation of the commit decision. This microstructure interpretation gives a quantitative explanation for post-marriage disappointment and persistent instability in relationships formed with a large ΔV.

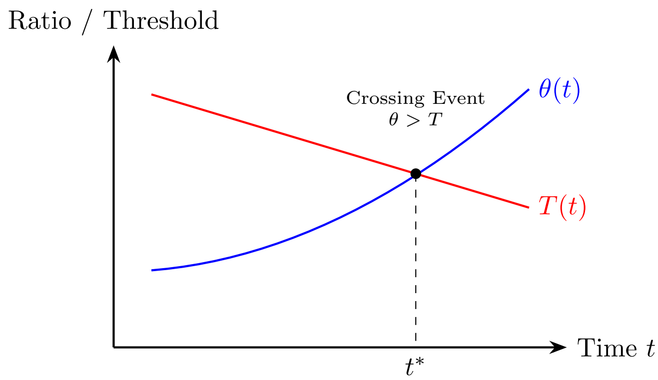

Fig. D4: **Crossing Dynamics.** Commitment occurs when the ratio $\theta(t)$ crosses the decaying threshold $T(t)$.

D.6 Circuit Breakers and the Role of $C_{\max}$

The model proposes a maximum tolerable compensation:

$$C^* = \min(\Delta V,\ C_{\max}), \tag{D8}$$

where $C_{\max}$ is the male agent's "runaway threshold"—beyond which he exits the negotiation. This mirrors **circuit breakers** and **price limits** in financial markets:

- They cap volatility,
- Prevent runaway escalation,
- Stabilize transactions.

Thus $C_{\max}$ is a **necessary stabilizer** that prevents infinite compensation bidding and pathological bargaining equilibria.

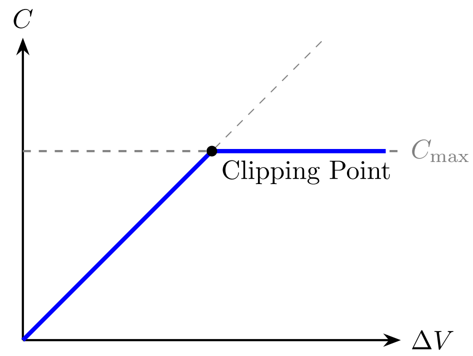

Fig. D5: **Compensation Clipping.** Compensation is bounded by $C_{\max}$, preventing unbounded bargaining.

D.7 Market Orders vs. Limit Orders: Impulse Marriage Events

A market order in finance executes *regardless of price*, often producing slippage. The marriage analogue includes impulsive marriage decisions and sudden threshold drops. Formally:

$$T \leftarrow T - \delta_{\text{emotion}}, \quad \text{producing } \theta > T. \tag{D9}$$

This captures flash marriages, rebound relationships, and sudden acceptance of suboptimal partners.

D.8 Lock-In and Stickiness

In market microstructure, investors become "locked in" due to sunk costs. The marriage equivalent occurs when exit costs (childbearing, social penalties) raise the effective threshold T:

$$T_{\text{exit}} = T + \kappa_{\text{lock-in}}. \tag{D10}$$

Thus even when $\theta < T$, the relationship persists due to **lock-in stickiness**.

D.9 Full Correspondence Table

Table D2 demonstrates a **clean structural isomorphism** between the two systems.

Table D2: Structural Isomorphism between Financial Microstructure and Marriage Matching.

Financial Microstructure Concept	Marriage-Matching Concept
Bid price	V_{reach}
Ask price	V_{uncond}
Bid–ask crossing	Commit event ($\theta > T$)
Order book depth	LPSM / DF preference matrix
Liquidity	Partner availability / exposure
Information shocks	V_{uncond} updates from social inputs
Slippage	Regret ($V_{\text{uncond}} - V_{\text{reach}}$)
Circuit breaker	$C_{\max}$ constraint
Market order	Impulsive marriage choice
Limit order	Stable threshold T
Lock-in	Marriage stickiness
Manipulation	Family intervention / bride-price pressure

D.10 Summary: Why the Microstructure View Strengthens the Theory

The microstructure interpretation provides three major benefits:

1. **Structural justification.** It shows that the θ–T mechanism is not ad hoc, but consistent with well-established matching mechanisms in two-sided markets.
2. **Dynamic realism.** Market microstructure captures volatility, shocks, depth, and liquidity—exactly the dynamics seen in marriage markets.
3. **Predictive power.** Concepts such as slippage, lock-in, liquidity droughts, and repricing give the model new explanatory dimensions for regional marriage disparities and high-gap instability.

Appendix E Appendix E: Prior Supply–Demand Buckets

This appendix introduces a **meso-level behavioral extension** to the main IDP model. While the core model assumes agents optimize θ based on specific values (V_{reach}), in reality, agents often estimate market scarcity using heuristic priors.

We model this perception as a set of **Five Prior Buckets**, representing distinct tiers of perceived supply-demand pressure. Unlike a continuous curve, these buckets create rigid pricing regimes where the "Ask Price" (expected compensation or status) jumps discontinuously.

The Five-Bucket Structure

We categorize the male value spectrum $V \in [0, 100]$ into five heuristic tiers, each characterized by a specific **Supply-Demand Pressure Ratio** ($\rho = \frac{\text{Demand}}{\text{Supply}}$):

1. **Bucket 1: Invisible ($V < 50$)**
   $\rho \to 0$. The supply is perceived as infinite relative to demand. Agents in this tier are effectively invisible in the dating market; no amount of compensation is expected to yield a match.
2. **Bucket 2: Provider / "ATM" ($50 \leq V < 70$)**
   $\rho < 1$ (Buyer's Market). Candidates are seen as abundant substitutes. High compensation (bride price) is strictly required to compensate for the utility gap.
3. **Bucket 3: Match ($70 \leq V < 85$)**
   $\rho \approx 1$ (Balanced). The "Tradeable Zone." Candidates are perceived as acceptable partners where mutual exchange occurs without excessive unilateral compensation.
4. **Bucket 4: Premium ($85 \leq V < 95$)**
   $\rho > 1$ (Seller's Market). Scarcity begins to bite. Agents here hold significant pricing power, often demanding "reverse compensation" (e.g., dowry or emotional subservience).
5. **Bucket 5: Idol / CEO ($V \geq 95$)**
   $\rho \to \infty$ (Monopoly). The "Unconditional Max" tier. Demand is absolute; supply is singular. The ask price becomes infinite (in terms of loyalty), yet financial compensation drops to zero.

Regional Heterogeneity: Shifting the 5 Buckets

The definition of these buckets is culturally malleable. In scarcity-driven regions (e.g., Jiangxi), the "Provider" bucket expands to cover higher-value males, forcing even mid-tier candidates ($V = 75$) to pay high compensation. Conversely, in high-tier urban markets (e.g., Shanghai), the "Invisible" bucket expands, classifying even decent candidates ($V = 60$) as non-options.

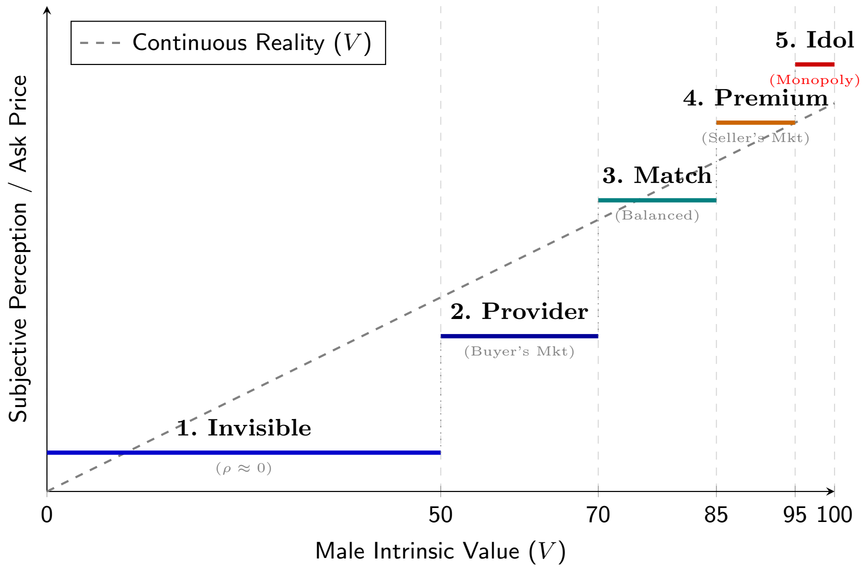

Fig. E6: **The Five-Tier Prior Bucket Model.** Agents discretize the continuous value spectrum into five tiers based on Supply-Demand Pressure (ρ). Pricing is rigid within each bucket, jumping discontinuously at heuristic thresholds.

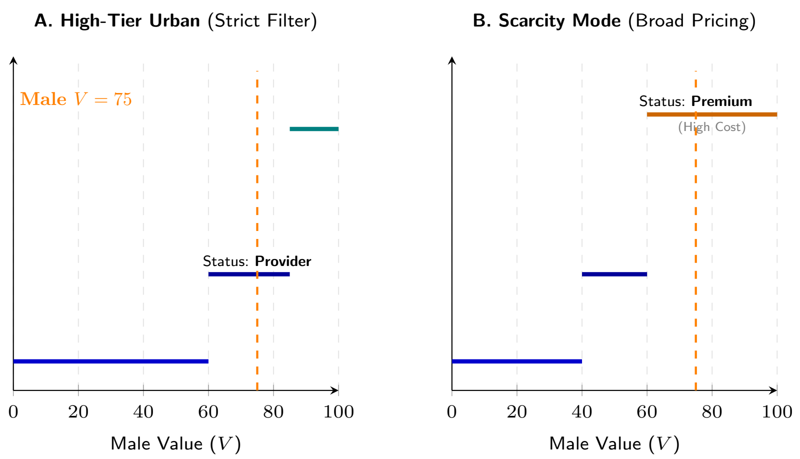

Fig. E7: **Behavioral Heterogeneity in 5-Bucket Priors.** In a Strict Urban Market (A), the "Invisible" bucket expands, downgrading a $V = 75$ male to a mere "Provider". In a Scarcity Market (B), the "Premium" bucket expands leftward, upgrading the same male to "Premium" status, triggering high bride-price demands.

Appendix F Appendix F: The Gini Conical Structure

This appendix provides the **macro-structural geometric explanation** for the liquidity constraints observed in the main model. While Appendix E deals with subjective perception, this section derives the objective physical constraints of the marriage market from the societal distribution of wealth and status.

We model the socio-economic hierarchy not as a linear ladder, but as a **rotational solid** derived from the derivative of the societal Lorenz curve (the Gini distribution). Let $g(h)$ be the population density at height h. The market structure can be visualized as a cone where the radius $r(h) \propto \sqrt{g(h)}$.

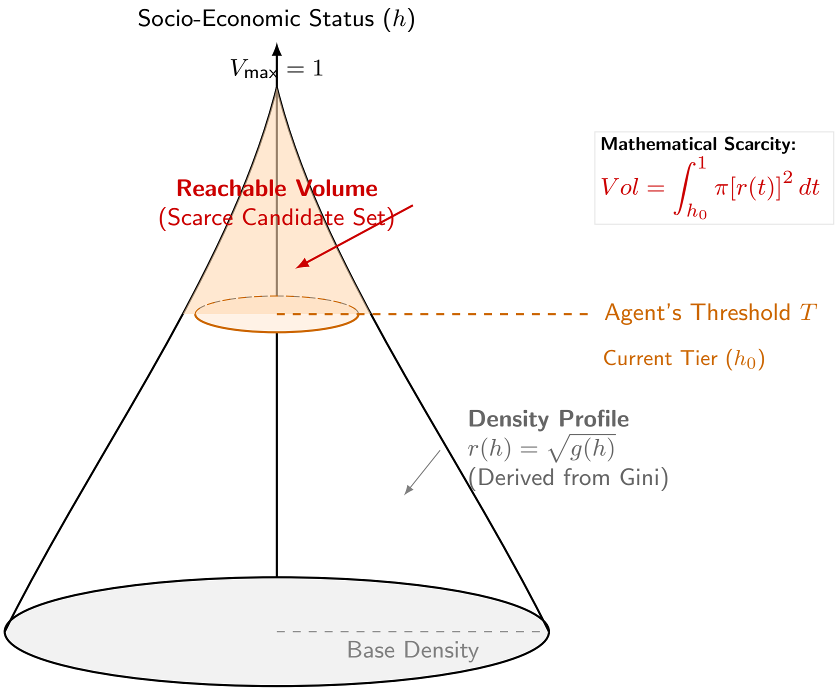

Fig. F8: **The Gini Conical Structure.** The socio-economic hierarchy is modeled as a volume. As an agent's threshold T (orange line) rises linearly, the available volume of partners (shaded region) decays geometrically. This proves that high-tier liquidity droughts are a mathematical necessity of the density gradient.

This geometric isomorphism reveals a critical insight: a linear increase in the acceptance threshold T results in a **super-linear (cubic or exponential) collapse** in the reachable partner volume. Thus, the difficulty of "marrying up" is not merely a social friction but a geometric constraint imposed by the inequality structure of society.

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