Information Intermediaries in Monopolistic Screening

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August 2024

Motivation

- Information affects matches of consumers and products
- Advisors/Intermediaries; Information Acquisition; Seller-to-Consumer
- Properties of optimal selling mechanisms
- Sellers' response to information frictions
  - Market Inefficiencies; Distortions
  - Division of Surplus; Efficiency

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- Consumer considers purchasing an iPhone
- iPhone SE vs iPhone 15 vs iPhone 15 pro
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  - Consumer Payoff—maintain audience
  - Bias toward high-quality product—maintain reputation for expertise

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- Consumer chooses product after observing information
- Conceptual Novelty: Study selling problem with info intermediary
- Methodological Novelty: Bayesian Persuasion problem as constraint

Preview of Results

- Characterization of profit-maximizing menu
- Seller's ideal outcome (if controls info) attainable if and only if sufficiently biased intermediary
- Expanded variety of product options
- Comparative Statics: Profit decreases, consumer payoff non-monotone with upward trend
- Comparative Statics: Efficiency/Total Surplus non-monotone with downward trend

(Most) Related Literature

- **Monopolistic Screening:** Mussa and Rosen (1978), Maskin and Riley (1984).
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- **Bayesian Persuasion:** Kamenica and Gentzkow (2011), Dworczak and Martini (2019), Arieli et al. (2013).
  - Sender's indirect utility function is endogenous.

Plan

- Model
- Main Results and Intuition
- Uniform Quadratic Framework
- Profits, Total Surplus, Consumer Payoff, Quality Distortions
- Conclusion and Open Questions

Model

Model–Monopolist and Consumer

- Monopolist offers a menu M
  - Quality: $q \in [0, \bar{q}]$
  - Transfer: $t \in \mathbb{R}_+$
- Buyer's valuation: $\theta \sim F_0([0,1])$, f_0 positive over $[0,1]$.
- Buyer's utility
$$U_B(\theta, q, t) = \theta q - t$$
- Monopolist's profit
$$\Pi(q, t) = t - c(q)$$
$c(q)$: strictly increasing; strictly convex

Model–The Intermediary

- θ unknown to both seller, consumer and intermediary
- After observing the menu, intermediary chooses information structure $s : [0,1] \to \Delta([0,1])$
- Consumer observes realization and obtains posterior value
- Intermediary's payoff if the buyer chooses the item (q, t) is

$$U_I(\theta, q, t) = \underbrace{bq}_{\text{bias towards higher quality}} + \underbrace{(\theta q - t)}_{\text{consumer payoff}}$$

  $b \geq 0$ captures the intermediary's bias

Discussion of Intermediary's Objective

- Intermediary cares about:
  - Consumer Payoff to maintain clientele—attaches weight of 1
  - High-quality to maintain reputation of expertise—attaches weight of b

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- Intermediary cares about:
  - Consumer Payoff to maintain clientele—attaches weight of 1
  - High-quality to maintain reputation of expertise—attaches weight of b
- Alternative Interpretation:
  - Steering the consumer towards high-quality products may yield future revenue from complementary products

Model–Posterior Types

- Given the realization s, buyer's expected value is

$$w := \mathbb{E}(\theta|s)$$

- Buyer's and Intermediary's expected payoffs depend only on w
- Trade outcomes depend only on marginal of posterior mean
- Work with CDF of this marginal, G with support $suppG$

Timing

1. Seller posts mechanism M
2. Intermediary picks distribution G of posterior means
3. Nature chooses θ and buyer observes posterior mean w
4. Buyer chooses item from menu and payoffs accrue

Direct Mechanisms

- Focus on direct mechanisms: $q : [0,1] \to \mathbb{R}_+$ and $t : [0,1] \to \mathbb{R}_+$

- Standard individual rationality and incentive compatibility constraints for the buyer:

$$wq(w) - t(w) \geq wq(w') - t(w') \text{ for all } w \in [0,1]$$

$$wq(w) - t(w) \geq 0 \text{ for all } w \in [0,1]$$

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- Additional constraint: Intermediary's obedience constraint

Feasible Posteriors

- G feasible $\Leftrightarrow$ mean-preserving contraction of prior F_0 $\Leftrightarrow$ F_0 is a mean-preserving spread of G.

- $\mathcal{F}$:set of CDFs over $[0,1]$

- $F \in \mathcal{F}$ mean-preserving spread of G if and only if

$$I_G(\theta) := \int_0^\theta (F - G)(s)ds \geq 0 \text{ for all } \theta \in [0,1] \text{ and } \; I_G(1) = 0$$

- Feasible posteriors

$$MPC(F_0) = \{G \in \mathcal{F} : I_G(\theta) \geq 0 \text{ for all } \theta \text{ and } I_G(1) = 0\}$$

Intermediary's Problem

- Intermediary's problem given (q, t)

$$\max_{G \in MPC(F_0)} \int_0^1 U_I(w) dG(w) \tag{IP}$$

where $U_I(w) = [bq(w) + (wq(w) - t(w))]$ is intermediary's indirect utility function.

- Linear Persuasion problem with U_I determined by menu, i.e. by monopolist

Monopolist's Problem

- Aware of the learning process after presenting product offerings
- Customize menu to
  - Effectively screen and attract consumers
  - Influence the learning process to their advantage

Monopolist's Problem

Monopolist's problem (MP) is given by

$$\max_{(q(w),t(w)),G\in MPC(F_0)} \int_0^1 [t(w) - c(q(w))]\, dG(w)$$

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$$G \in \underset{\hat{G}\in MPC(F_0)}{\arg\max} \int_0^1 [bq(w) + (wq(w) - t(w))]\, d\hat{G}(w) \qquad \text{(I-OB)}$$

Main Results and Intuition

Relaxed Problem: No Intermediary

- Bergmann, Heumann and Morris (2022): Direct seller-to-consumer info provision

- No intermediary–no obedience constraint

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Assumption 1: Marginal cost is strictly convex and the prior distribution F_0 has density f_0 that satisfies:

$$f_0'(\theta) < 0 \Rightarrow f_0''(\theta) \leq 0$$

Result: Under Assumption 1, profit-maximizing menu is single-item menu

Sufficiently Biased Intermediaries

Proposition

Under Assumption 1, a value b^* exists such that the intermediary is "redundant" if and only if $b \geq b^*$.

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- Solution to monopolist's problem exactly the same as if no intermediary and direct seller-to-consumer info provision

Small Bias–Main Results

Proposition (Characterization of Optimal Menu)

Suppose N-item menu $(q_i^*, p_i^*)_{i=1}^N$ *and distribution* G^* *solve (MP). Then,* G^* *pools types in the intervals*

$$[0, w_1^* - b], [w_1^* - b, w_2^* - b], ..., [w_N^* - b, 1]$$

and has support given by $G^* = \{w_0^*, w_1^*, w_2^*, \cdots w_N^*\}$ *where*

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$$\begin{aligned}
w_0^* =& \mathbb{E}(\theta | 0 \leq \theta \leq w_1^* - b) \\
w_1^* \equiv t_1^*/q_1^* =& \mathbb{E}(\theta | w_1^* - b \leq \theta \leq w_2^* - b) \\
w_i^* \equiv \frac{t_i^* - t_{i-1}^*}{q_i^* - q_{i-1}^*} =& \mathbb{E}(\theta | w_i^* - b \leq \theta \leq w_{i+1}^* - b) \quad \text{for} \quad i = 2, ..., N-1 \\
w_N^* \equiv \frac{t_N^* - t_{N-1}^*}{q_N^* - q_{N-1}^*} =& \mathbb{E}(\theta | w_N^* - b \leq \theta \leq 1)
\end{aligned}$$

Small Bias–Main Results

Proposition (Continued)

Moreover, the optimal qualities are given by

$$c'(q_N^*) = w_N^*$$

$$c'(q_i^*) = w_i^* - \frac{\sum_{j=i}^{N} \Big(F_0(w_{j+1}^* - b) - F_0(w_j^* - b) \Big)}{F_0(w_{i+1}^* - b) - F_0(w_i^* - b)} (w_{i+1}^* - w_i^*) \qquad (\mathrm{OPT} - \mathrm{Q_i})$$

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- This proposition characterizes the optimal menu given that it consists of N items
- What is the optimal N, and how does it change wrt the bias?

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The optimal number of items in the menu, N_b^*, increases as the intermediary's bias b decreases.

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Expanded variety of available options

Intuition

- Suppose Assumption 1 holds and initially $b > b^*$
- Optimal menu is a single high-quality product
- Some consumers purchase and receive 0 payoff; rest don't
- Suppose b decreases to $\hat{b} < b^*$
- Intermediary induces higher posterior means
- Fewer consumers purchase $\rightarrow$ lower profits

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- By same logic, as bias decreases, seller introduces succesively higher number of products in menu

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- Same menu as if consumer's value was private information

Intuition

- Intermediary provides info to ensure that buyer makes efficient ex-post trading decisions
- Only way to guarantee this by inducing learning of true value
- Thus, as if true values is consumer's private information

Uniform-Quadratic Framework

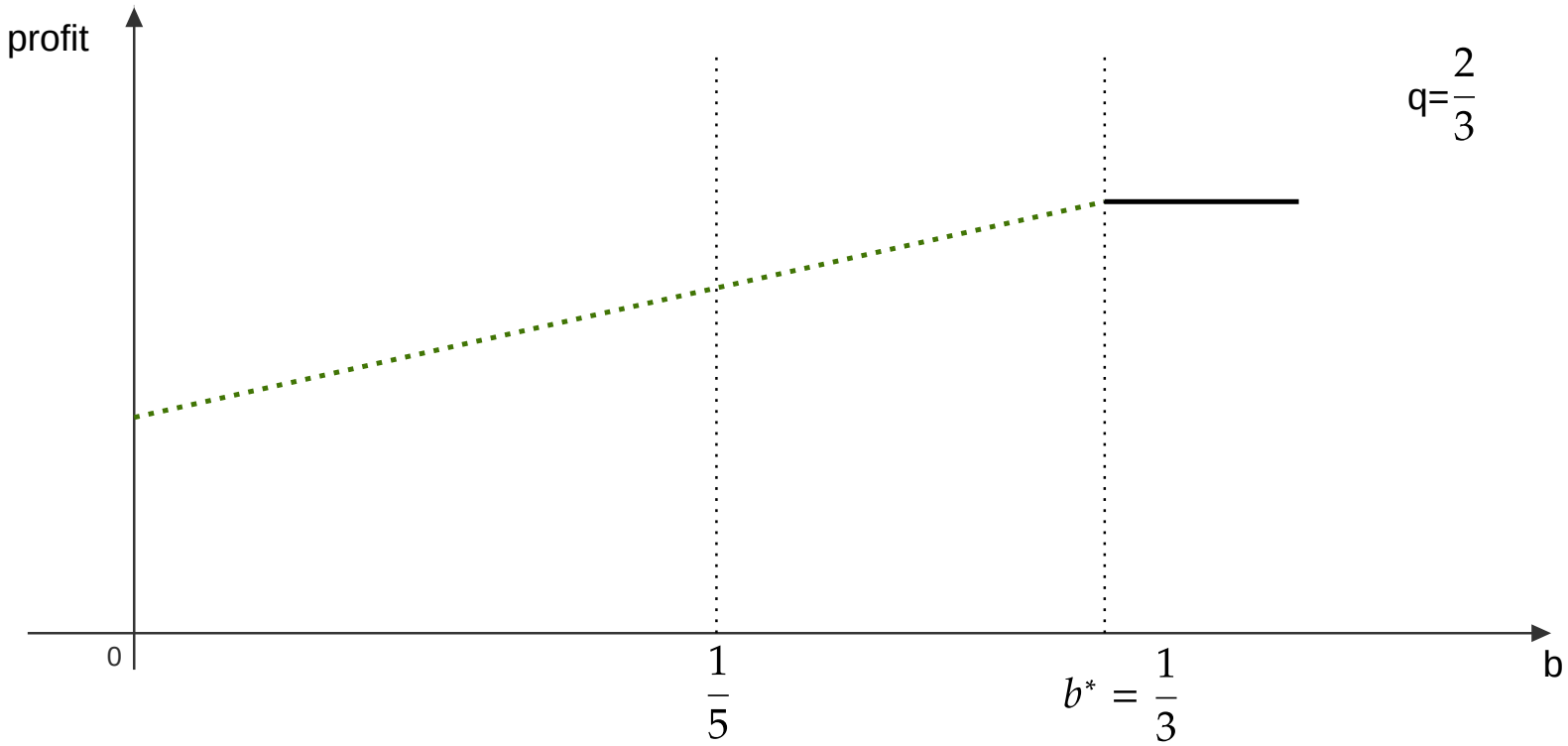
Uniform-Quadratic

- Suppose F_0 is standard Uniform and $c(q) = q^2/2$
- N_b-items optimal if

$$\frac{1}{4}(\frac{1}{b} - 1) \leq N_b < \frac{1}{4}(\frac{1}{b} + 3)$$

- Introduce new item when optimal quantity positive
  - $b = 0.1$: 3 items
  - $b = 0.01$: 25 items
  - $b = 0.001$: 250 items

Intuition



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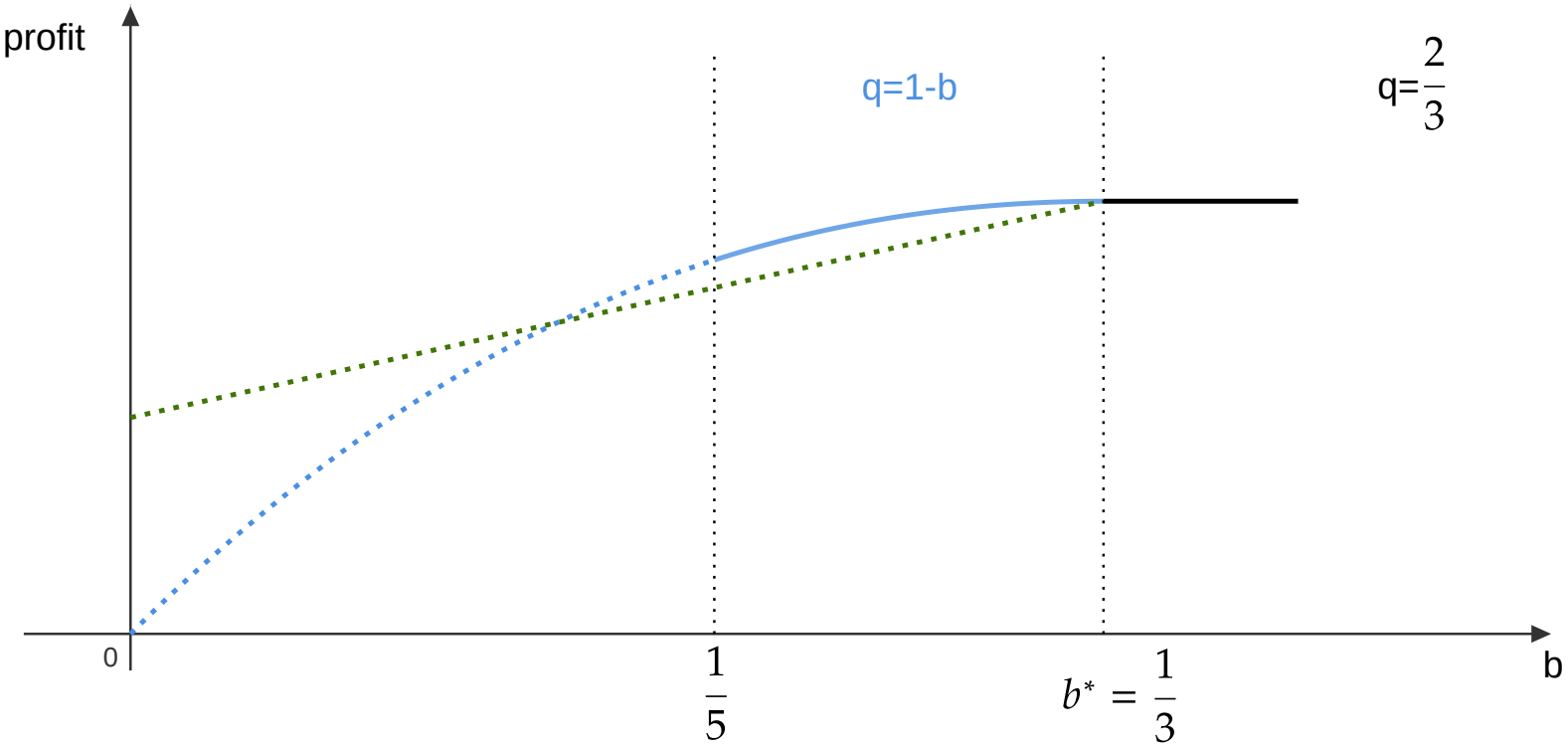

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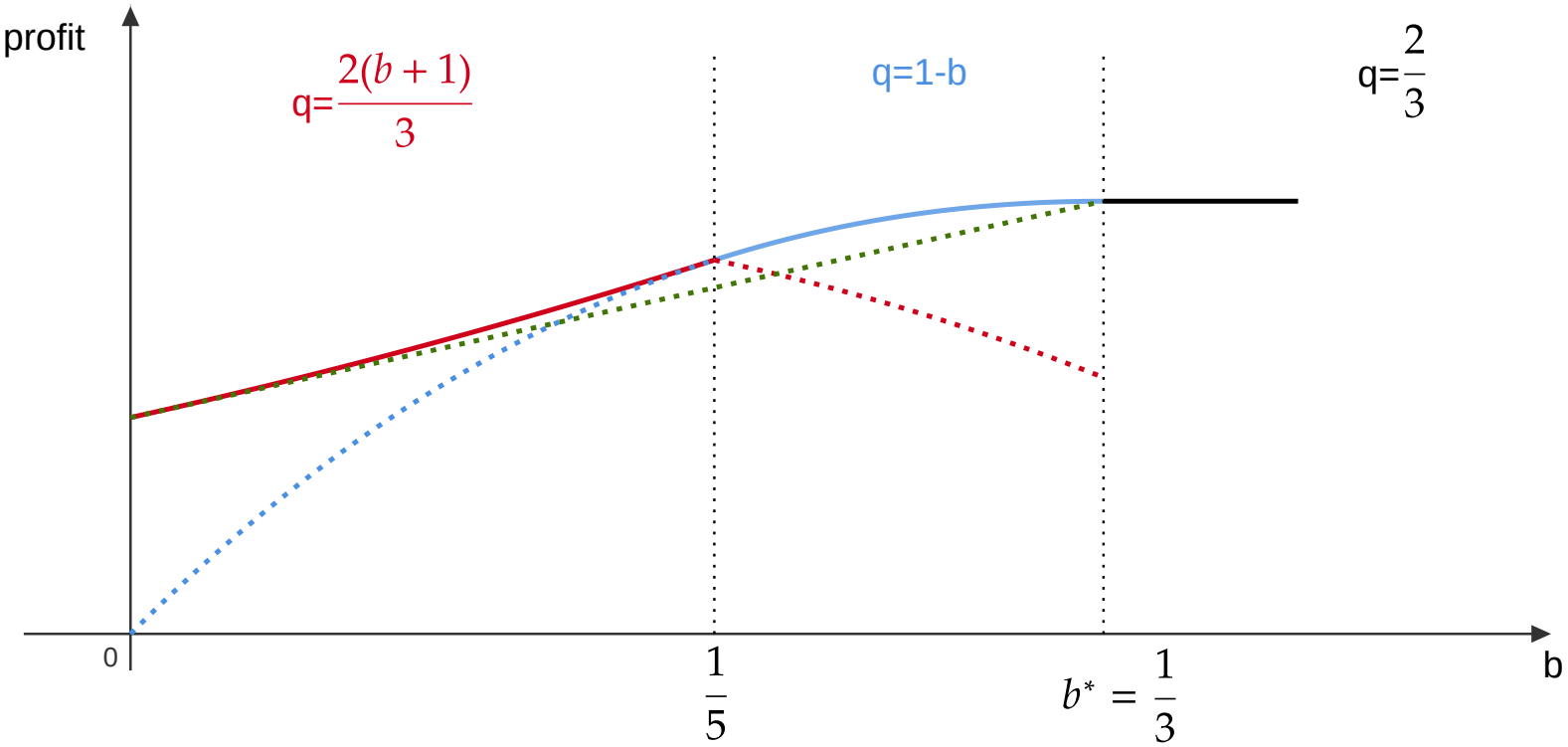

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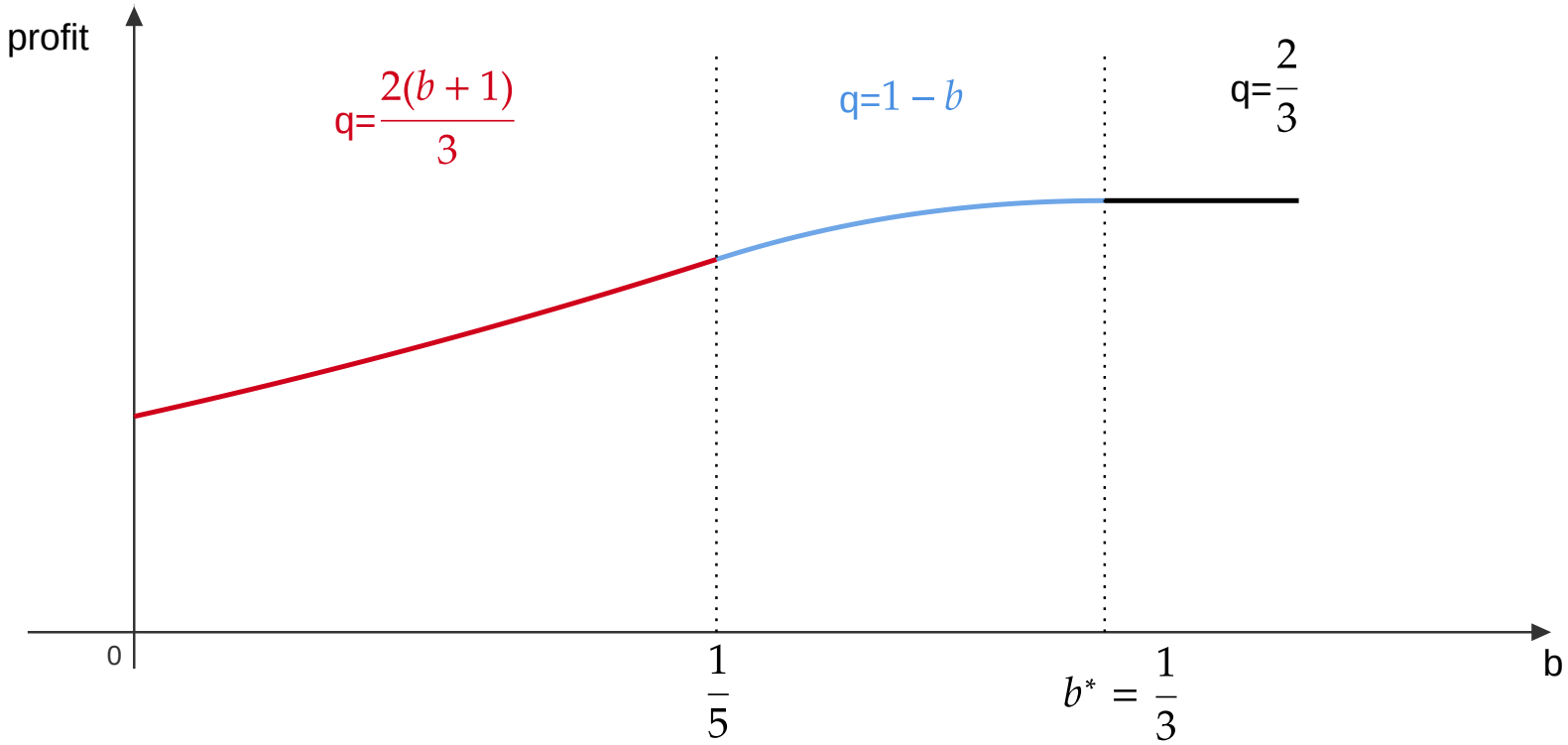
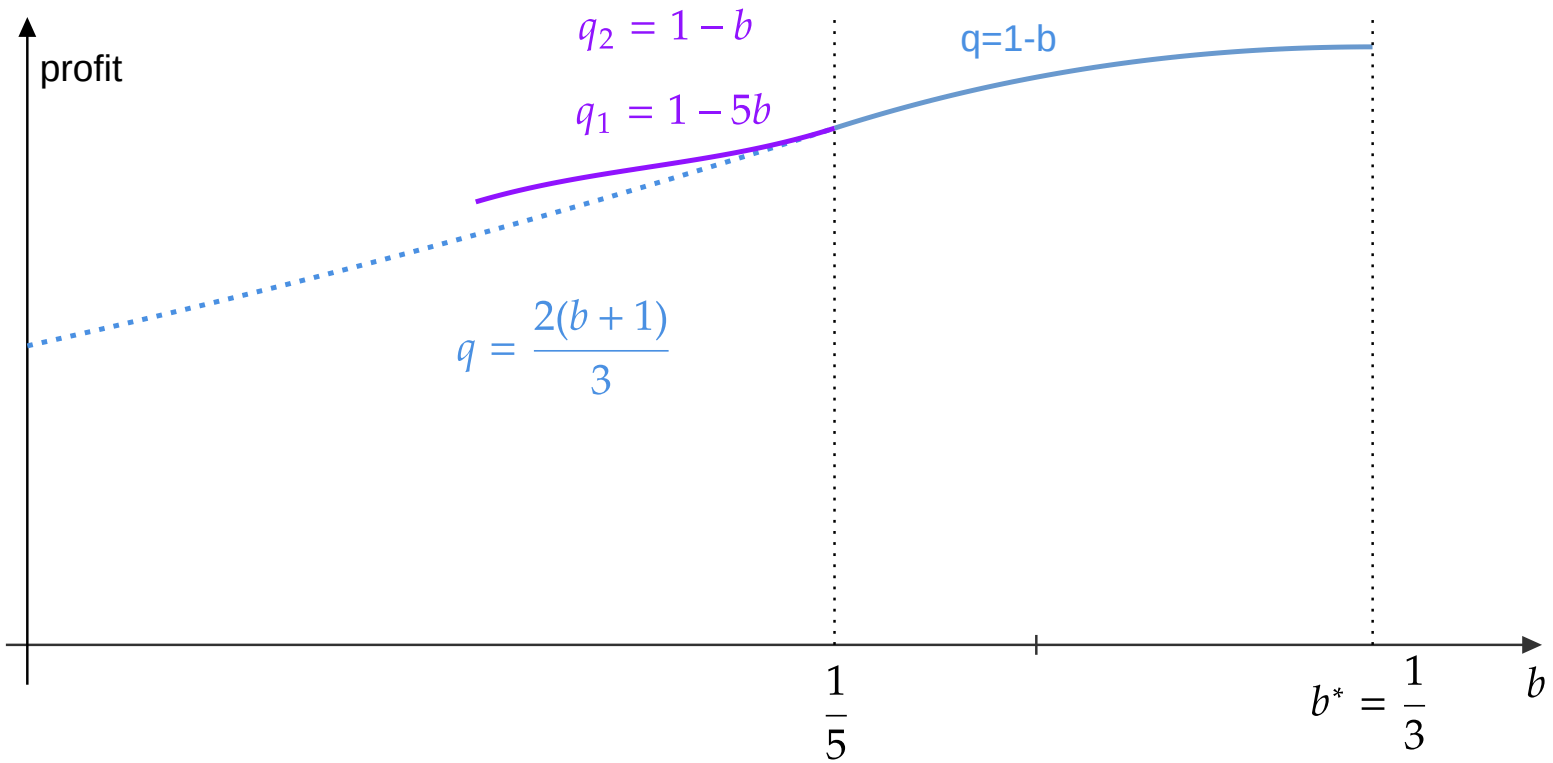


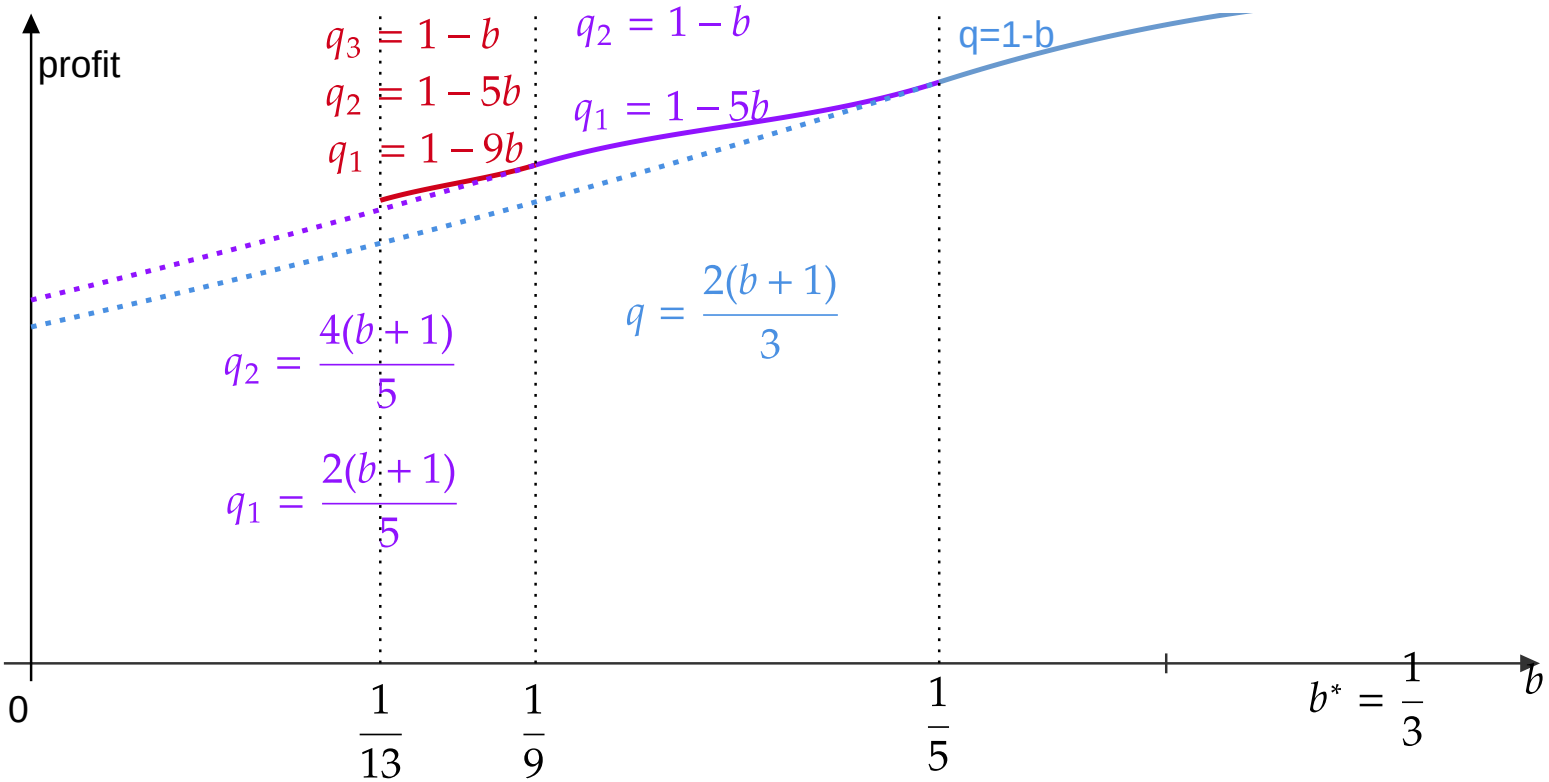
Intuition

- As b decreases, N_b^* increases:
  - Instead of offering a single quality and leave rents
  - Increase this quality and introduce a lower-quality option



Intuition

- As b decreases, N_b^* increases
  - Instead of offering two qualities and leave rents to high type
  - Increase both and introduce a lower-quality option



Profits, Consumer Payoff, Efficiency, Quality Distorions

Definitions

$$PR = \mathbb{E}_{G^*}[t(w) - c(q(w))] \quad \text{(Profits)}$$

$$CP = \mathbb{E}_{G^*}[wq(w) - t(w)] \quad \text{(Consumer Payoff)}$$

$$EF = \mathbb{E}_{G^*}[wq(w) - c(q(w))] \quad \text{(Efficiency/Total Surplus)}$$

$$QD = \mathbb{E}_{G^*}[q^{FB}(w) - q(w)] \quad \text{(Quality Distortions)}$$

where $q^{FB}(w)$ is the efficient quality that type w should receive

- Since $c'(q) = q$, it follows that $q^{FB}(w) = w$

Profits

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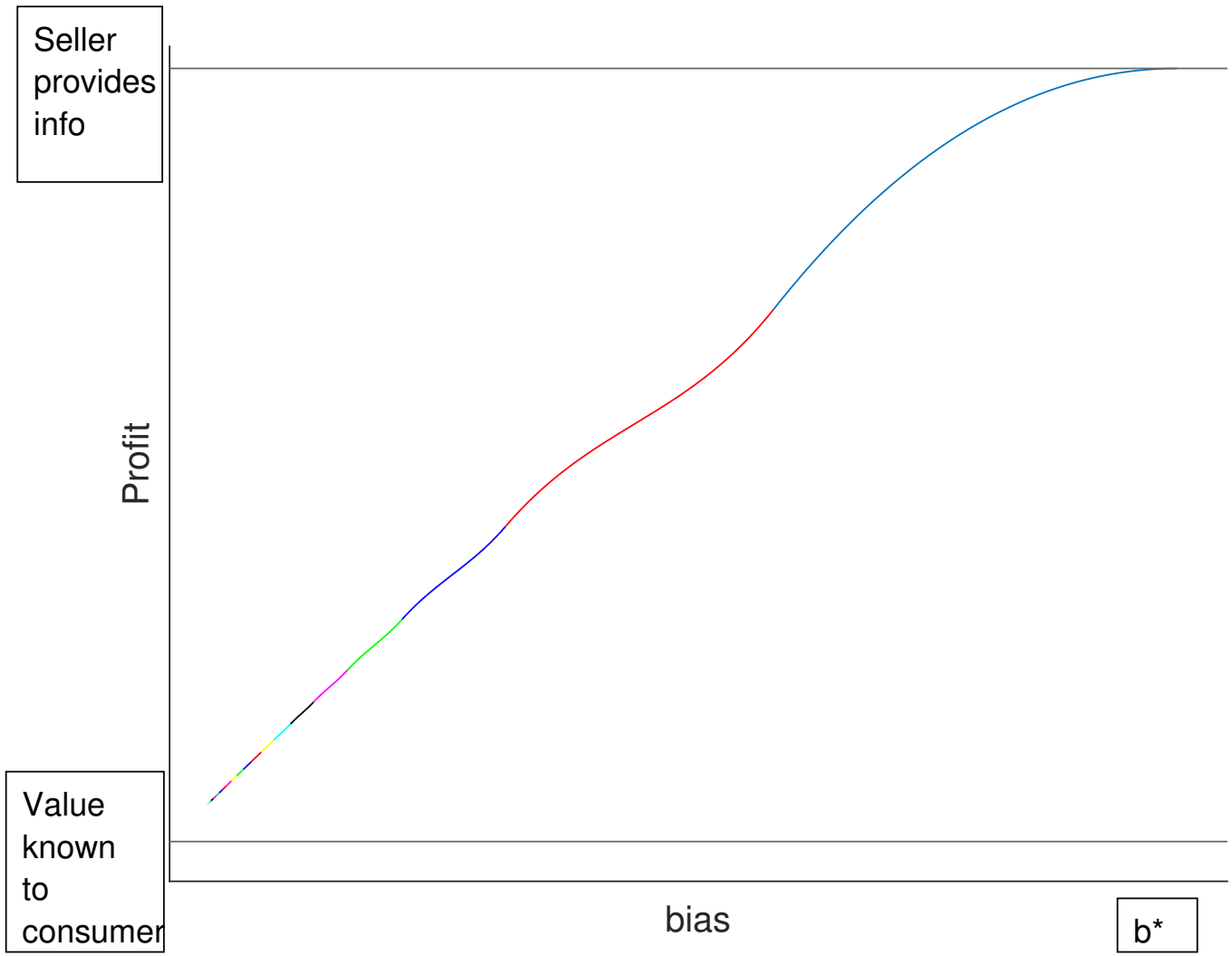

Consumer Payoff

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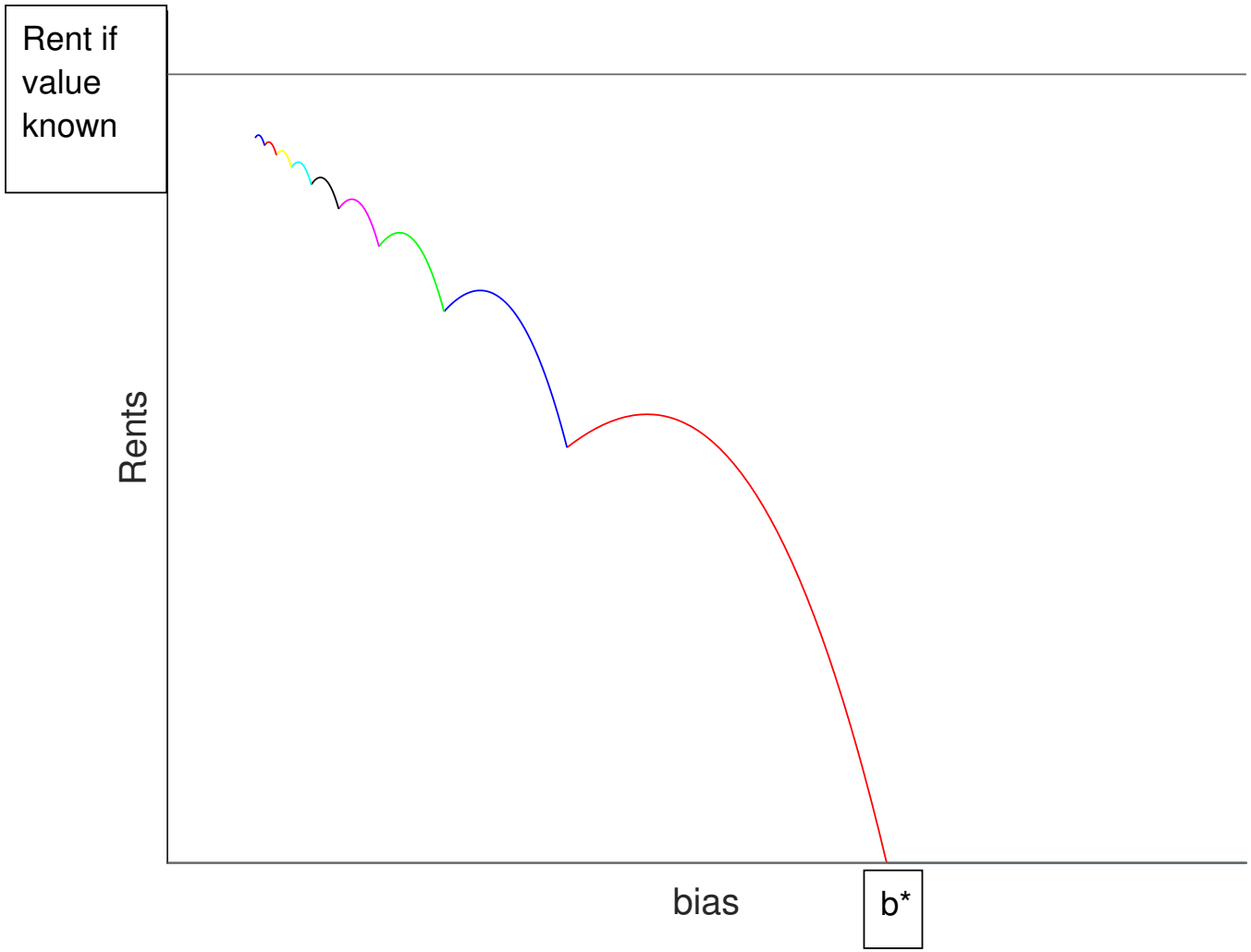

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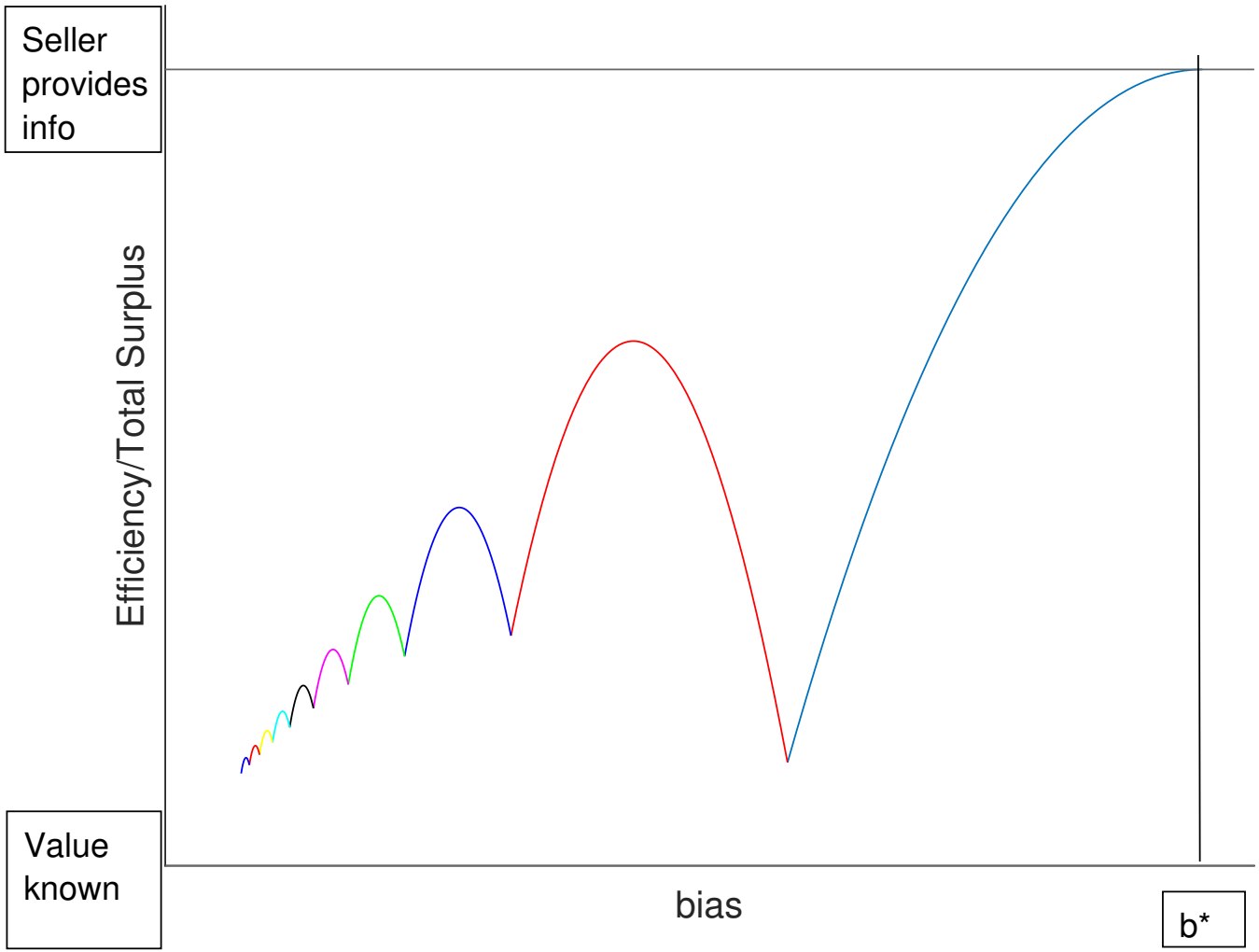

Quality Distortions

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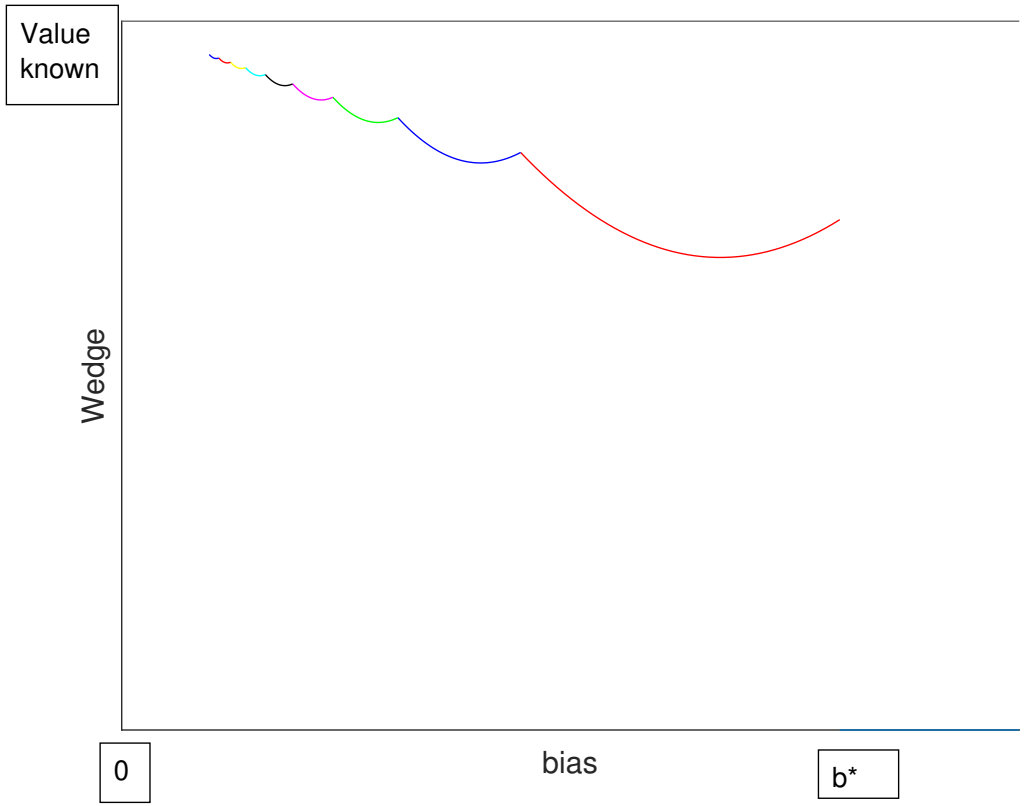

- Quality distortions overestimated by analyst if info intermediary ignored

Conclusions

- Monopolistic screening with information intermediary
- Main result: expanded variety of products offered
- Comparative Statics wrt intermediary's bias:
  - Lower profit
  - Non-monotone consumer payoff with upward trend
  - Non-monotone efficiency with downward trend

Open Questions

- Alternative objectives for the intermediary
- Introduction of contracts between seller and intermediary
- What if intermediary is Amazon/Apple Store and can offer product via private label?

Thank you!