Online Privacy and Information Disclosure by Consumers

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Bank of Canada

FTC Microeconomics Conference

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Question

What are the welfare & price implications of consumers' privacy in online marketplaces?

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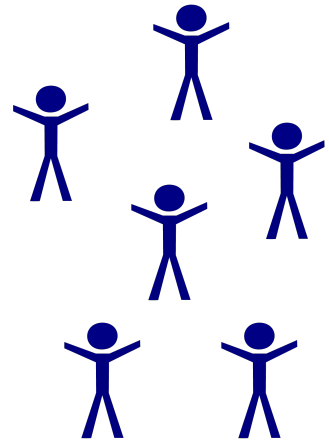

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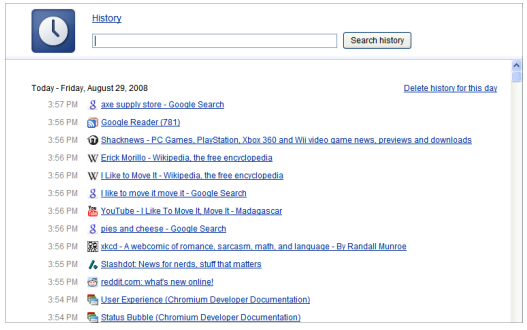

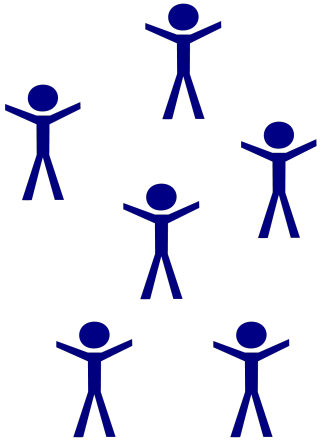

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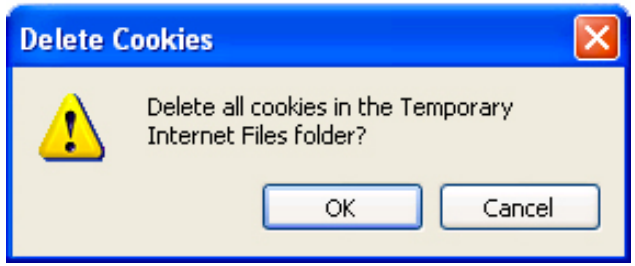

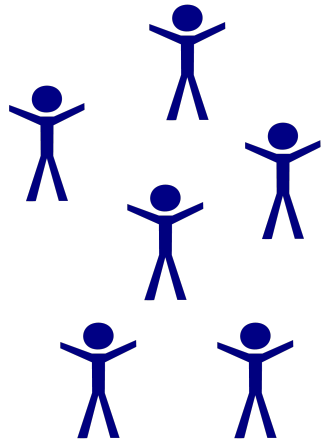

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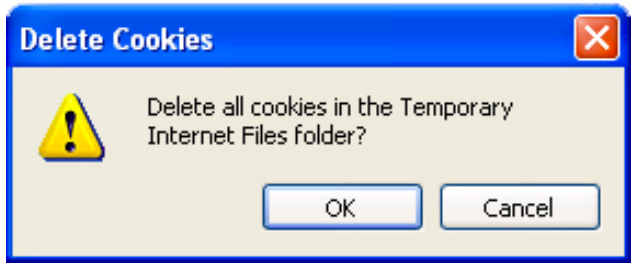

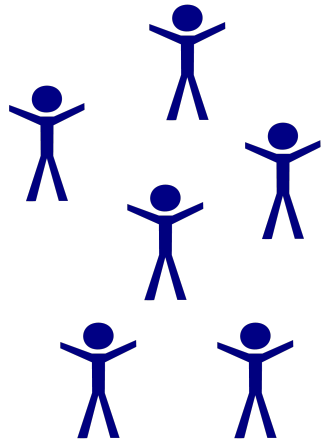

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  - Seller makes a product recommendation
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  - Benefit: Recommend/advertise appropriate products
  - Cost: (Potential) price discrimination

Related Literature

Consumers' Personal Data

- Calzorari and Pavan (2006)
- Bergemann and Bonatti (2011, 2015)

Behavioral Price Discrimination

- Villas-Boas (1999, 2004)
- Fudenberg and Tirole (2000)
- Taylor (2004)
- Acquisti and Varian (2005)

Endogenous Privacy Choice

- Conitzer, Taylor, and Wagman (2012)
- Montes, Sand-Zantman, Valletti (2017)
- Braghieri (2017)

Information Design

- Bergemann, Brooks, and Morris (2015)
- Condorelli and Szentes (2017)
- Roesler and Szentes (2017)

Roadmap

1. Model
2. Results
3. Extension

Model: Primitives

Players:

- Seller sells products 1 and 2
- Consumer with unit demand
- (u_1, u_2): value of each product, IID

Preferences:

- Consumer: value (u_k) $-$ price, or zero
- Seller: revenue

Two Pricing Regimes

Nondiscriminatory & discriminatory pricing

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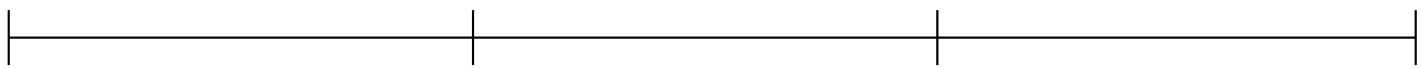
Nondiscriminatory & discriminatory pricing



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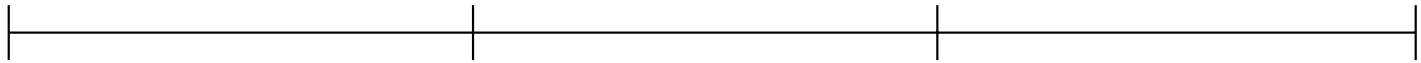

Pricing

(Nondisc.)

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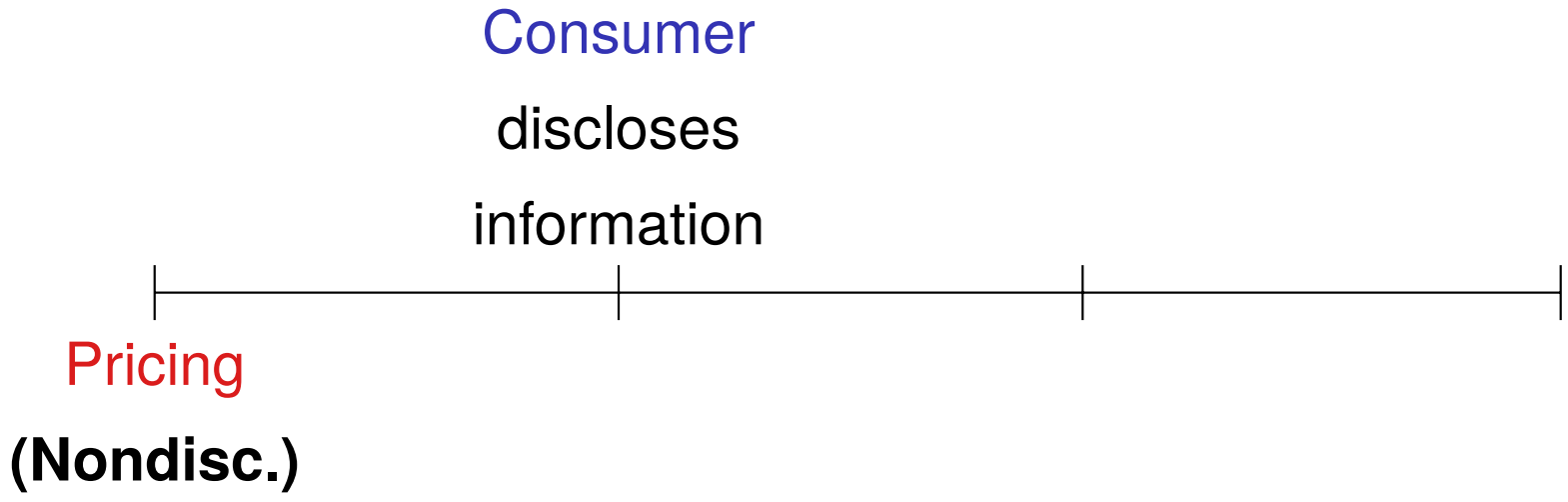

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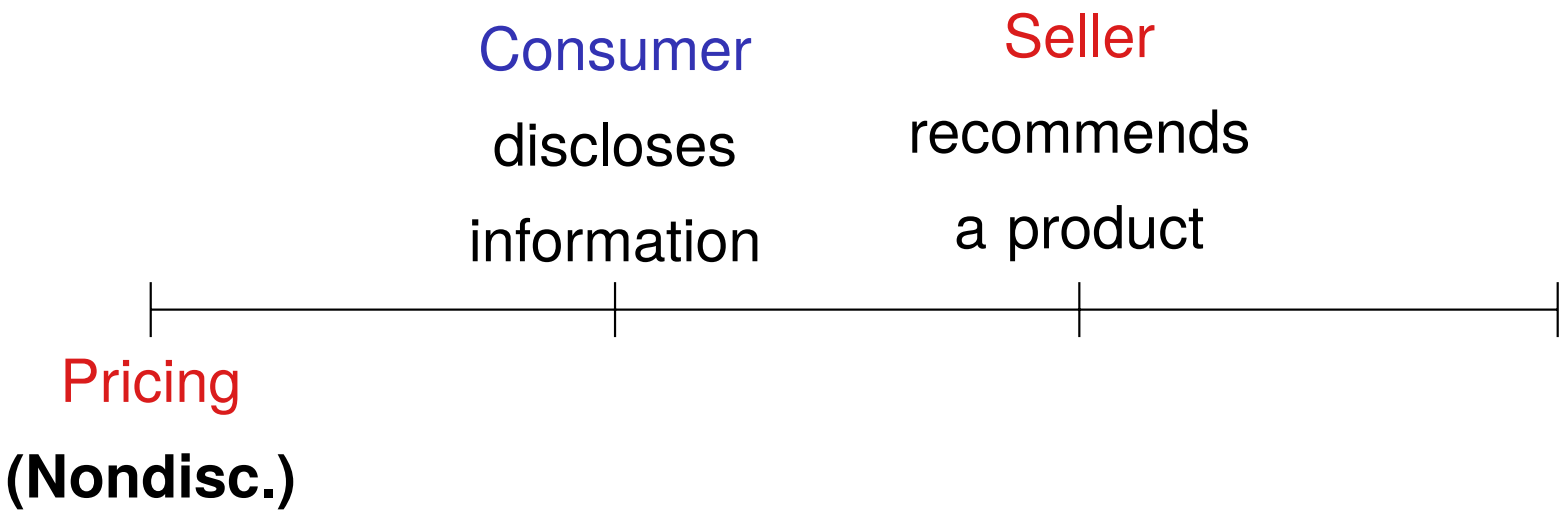

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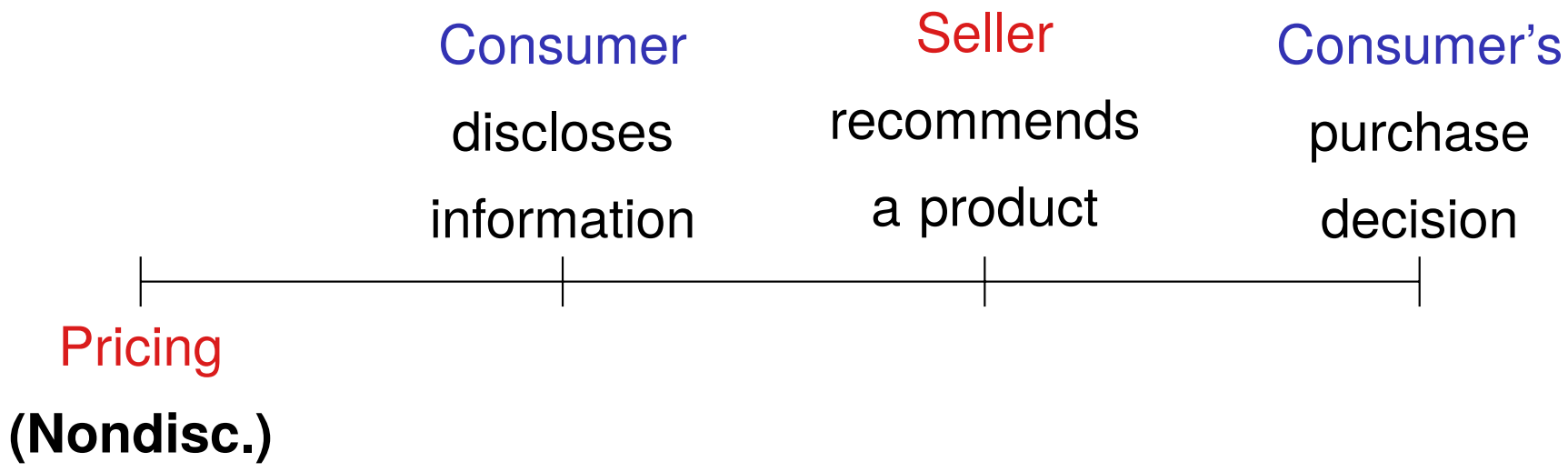

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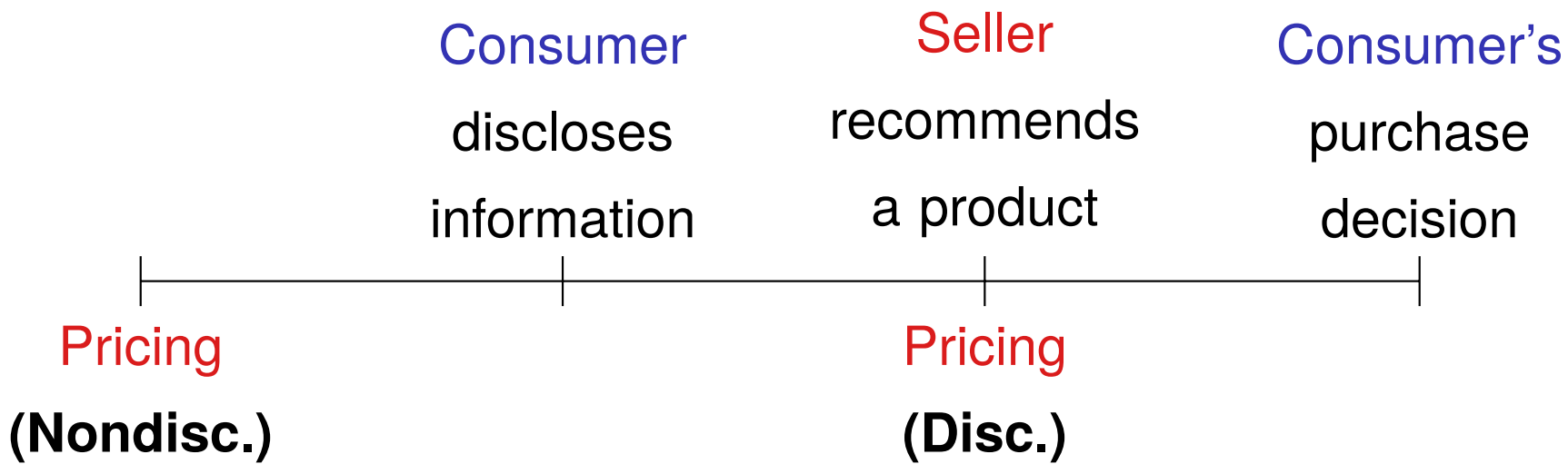

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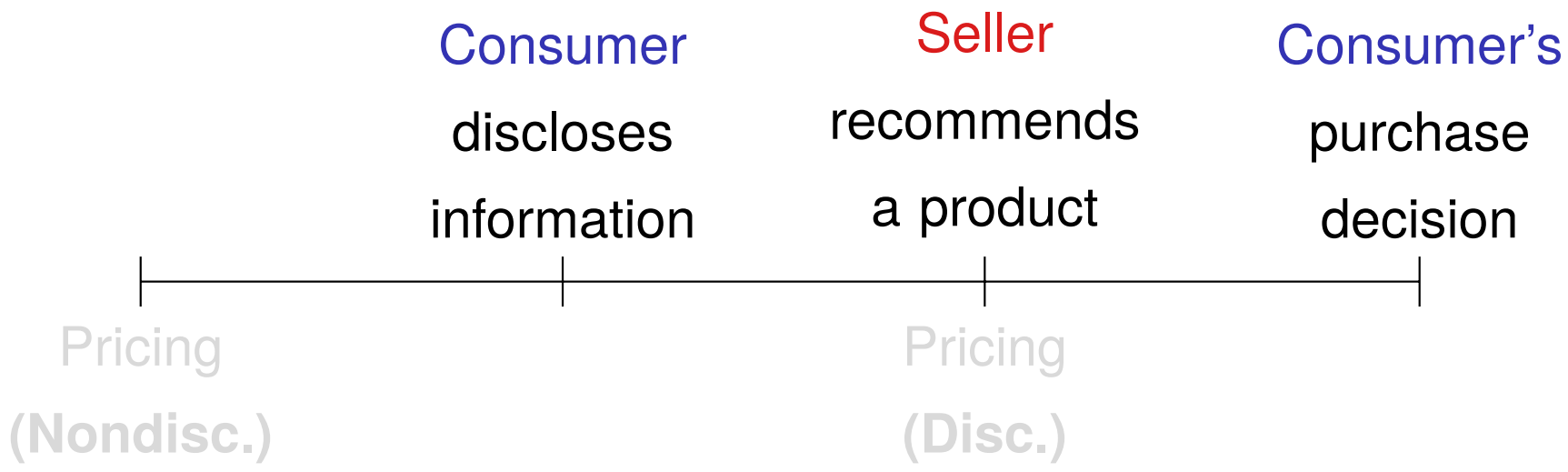
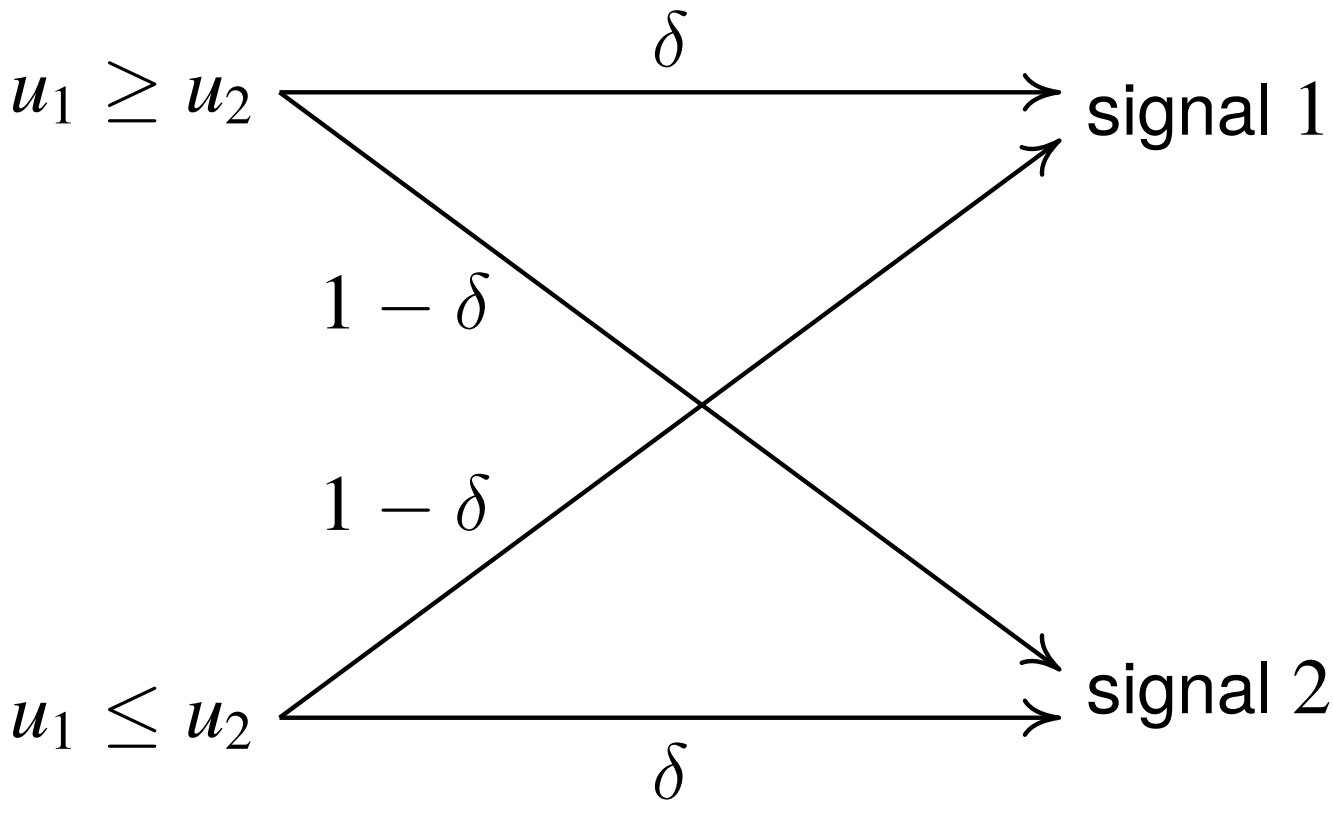


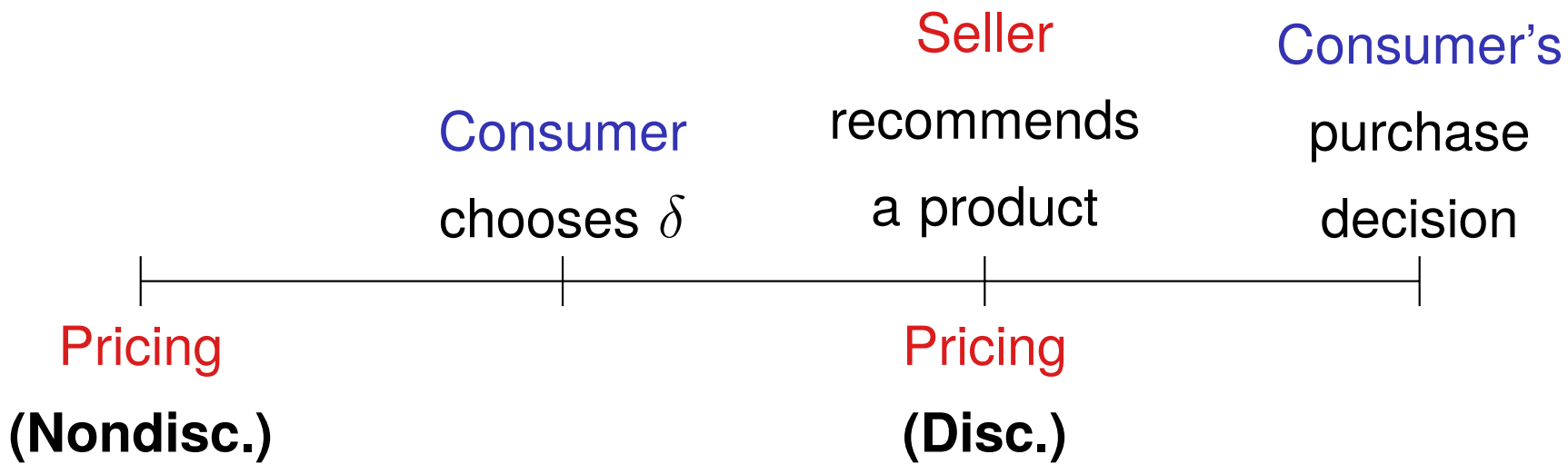
Information Disclosure

- **Before observing** (u_1, u_2), Consumer chooses a disclosure level $\delta \in \left[\frac{1}{2}, 1\right]$
- Seller observes δ and a signal realization



Timing of the Game

Nondiscriminatory & discriminatory pricing



Recommendation & Purchase

After Seller updates its belief:

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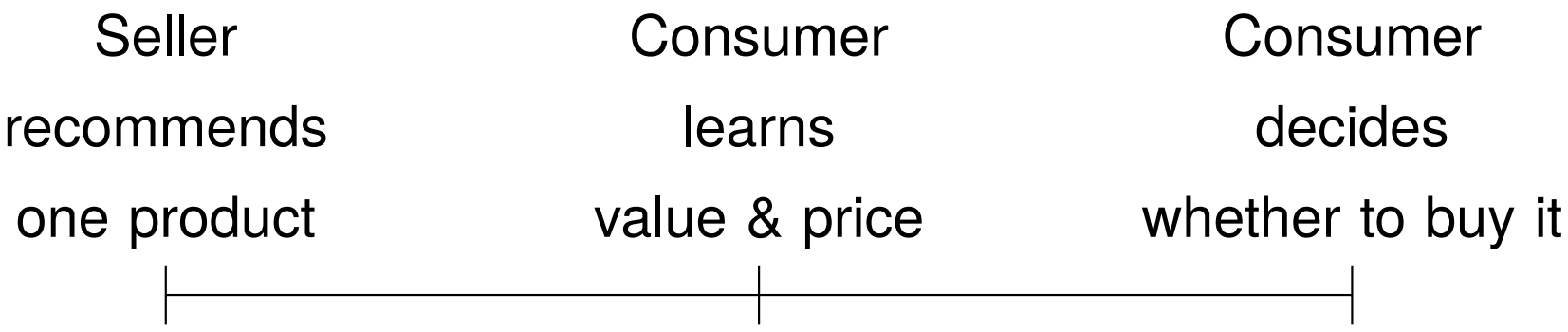

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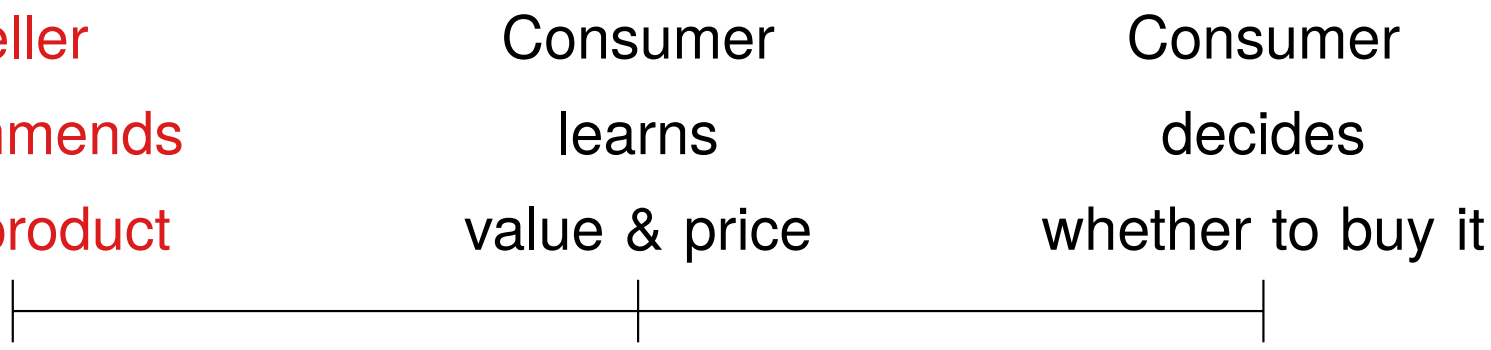

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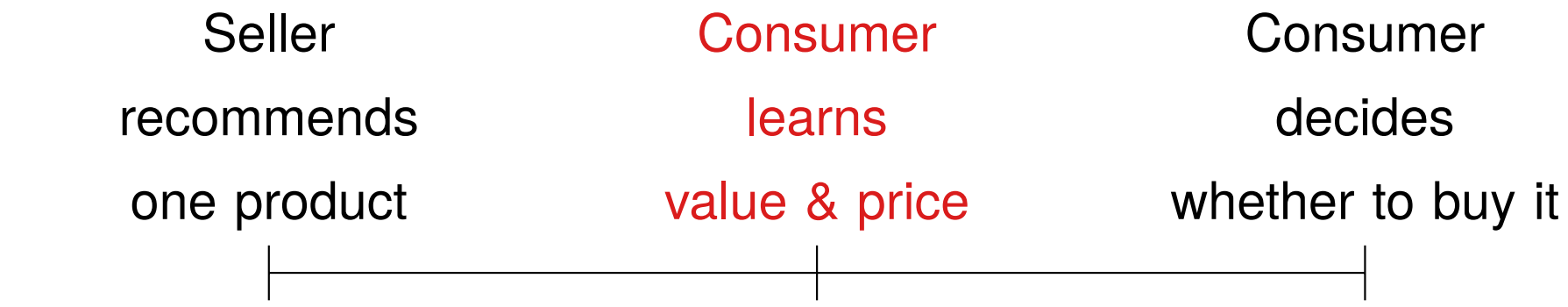


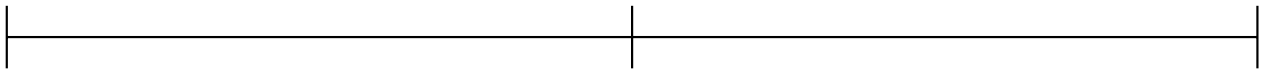
Recommendation & Purchase

After Seller updates its belief:

Seller recommends one product

Consumer learns value & price

Consumer decides whether to buy it



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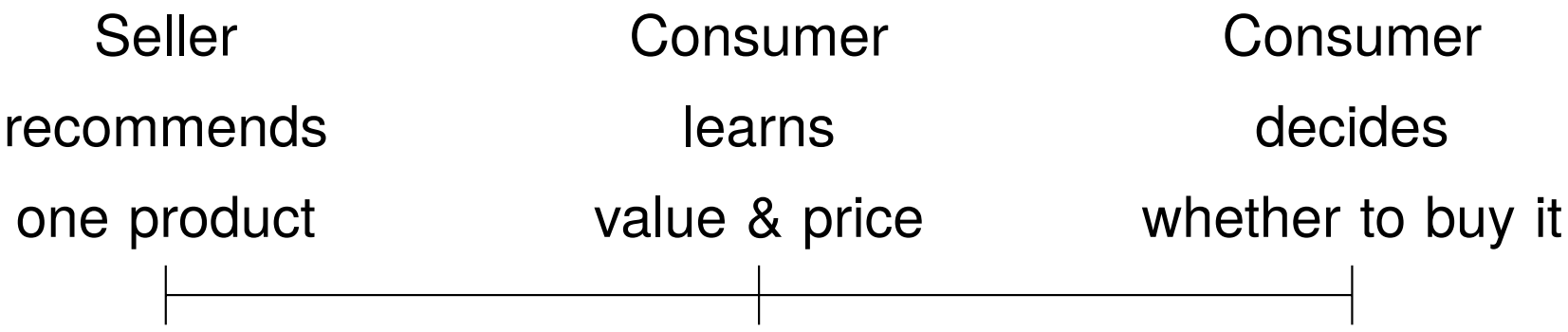

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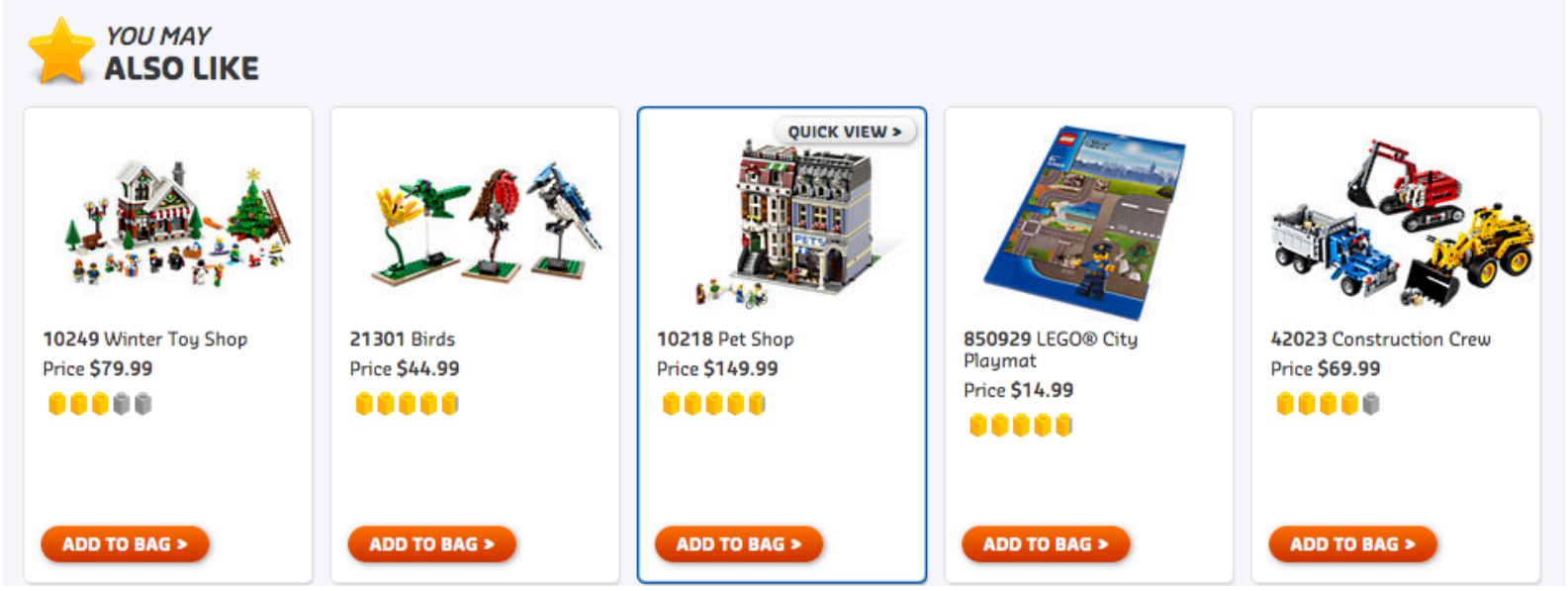

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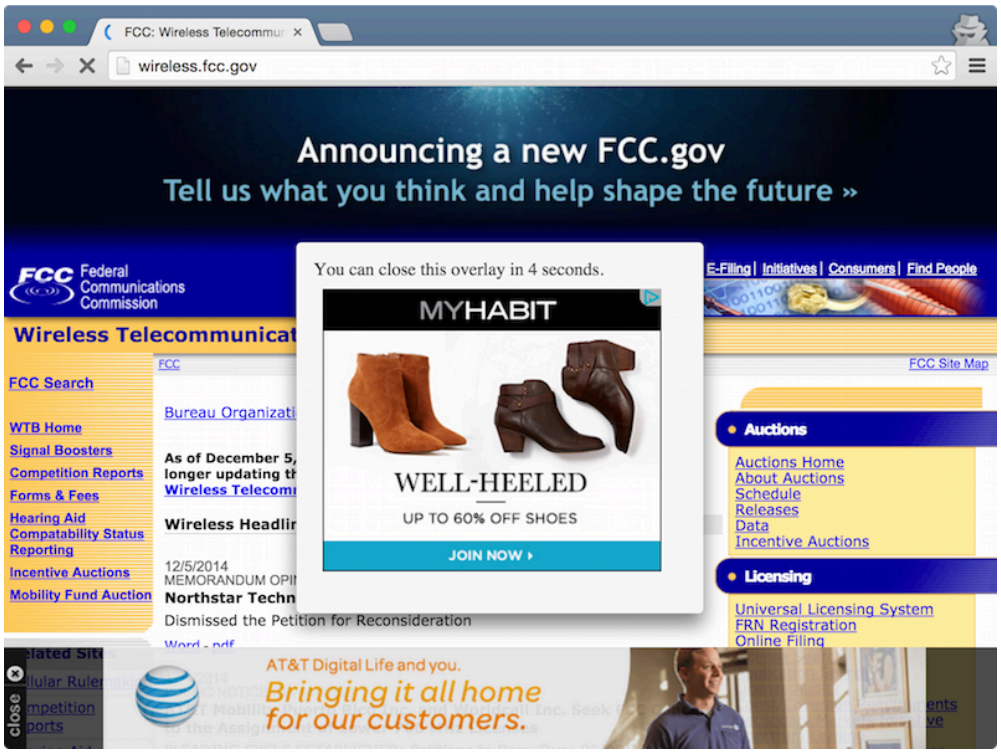

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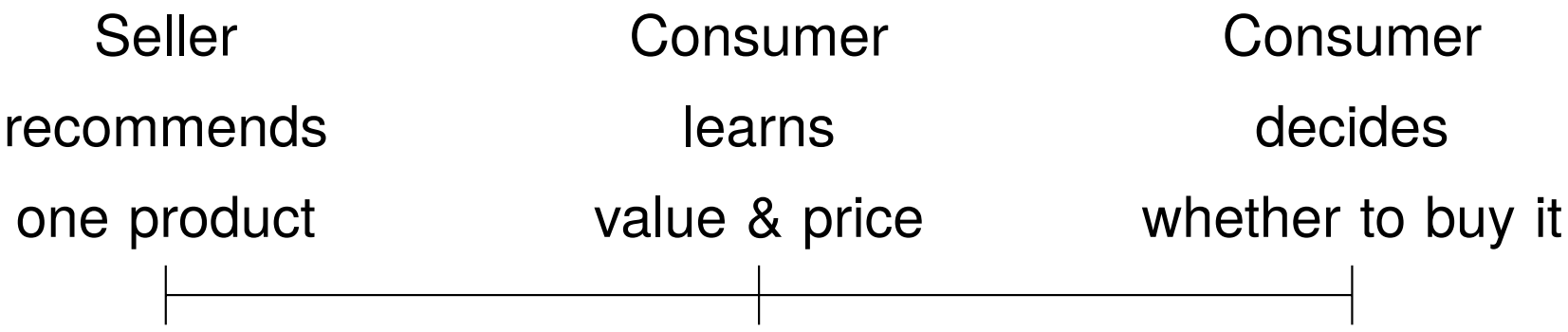

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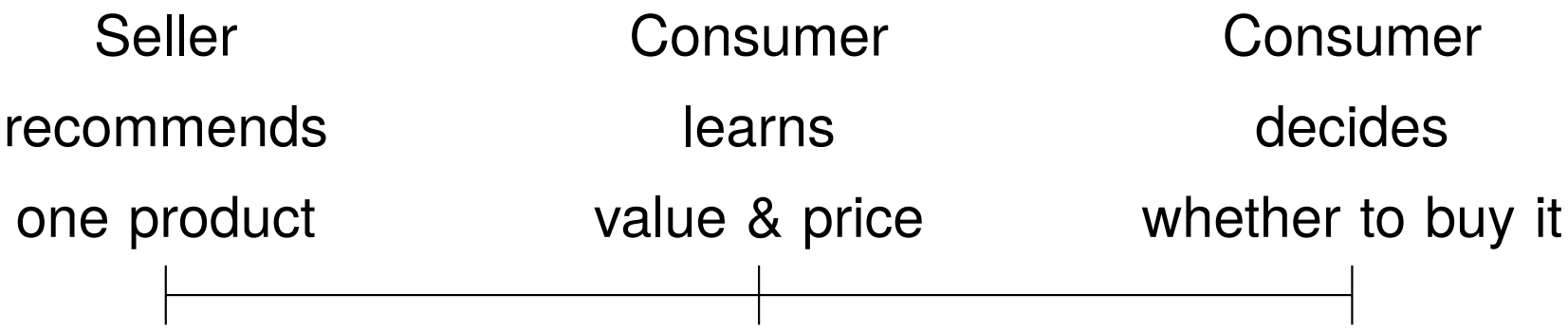

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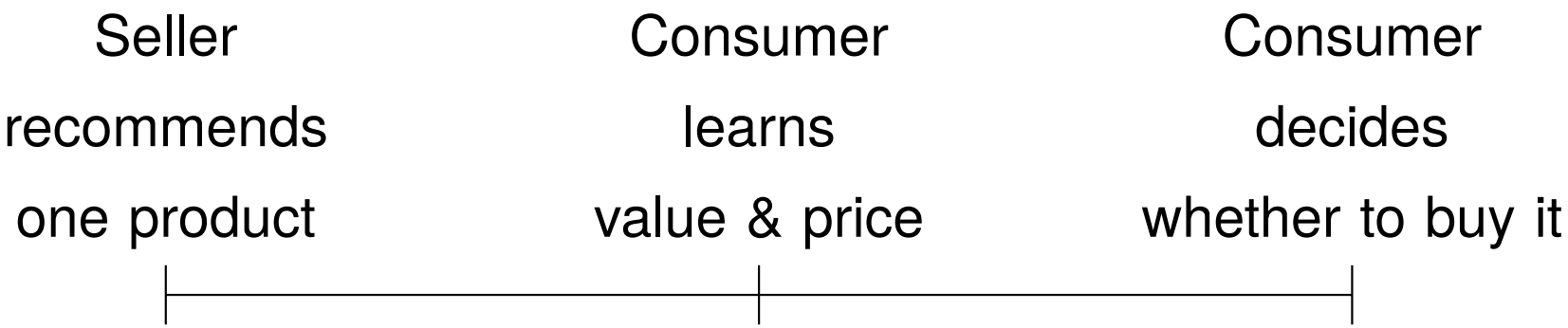

- Assumption: Consumer *cannot* buy non-recommended product
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  (Salant and Rubinstein [2008], Eliaz and Spiegler [2011], etc)

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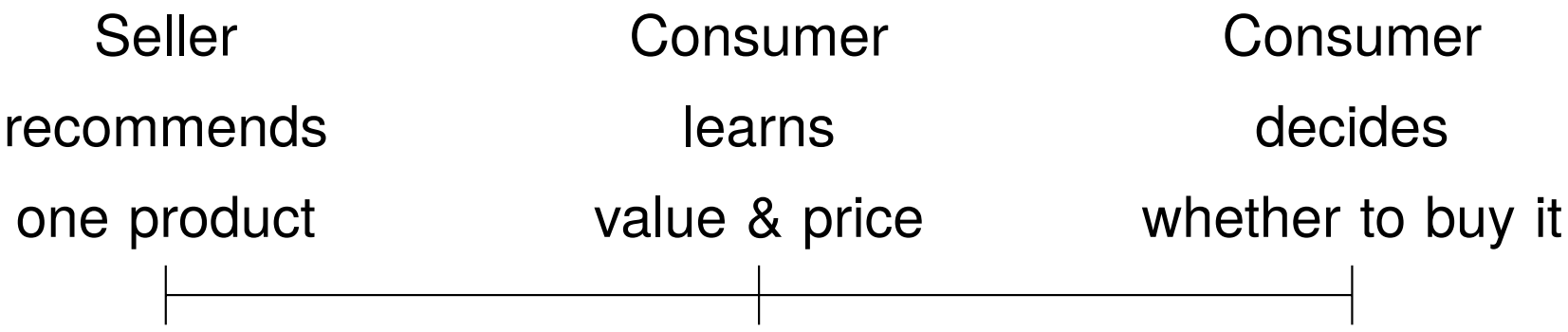

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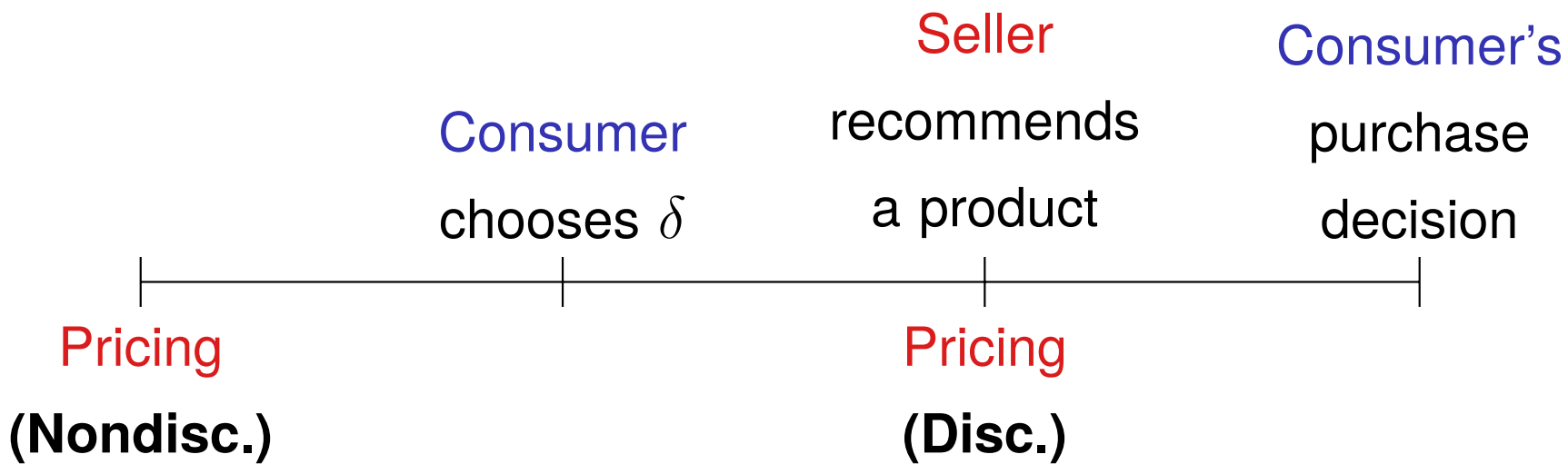
  (Salant and Rubinstein [2008], Eliaz and Spiegler [2011], etc)
- Seller can influence what consumers pay attention to

Timing of Game & Solution Concept

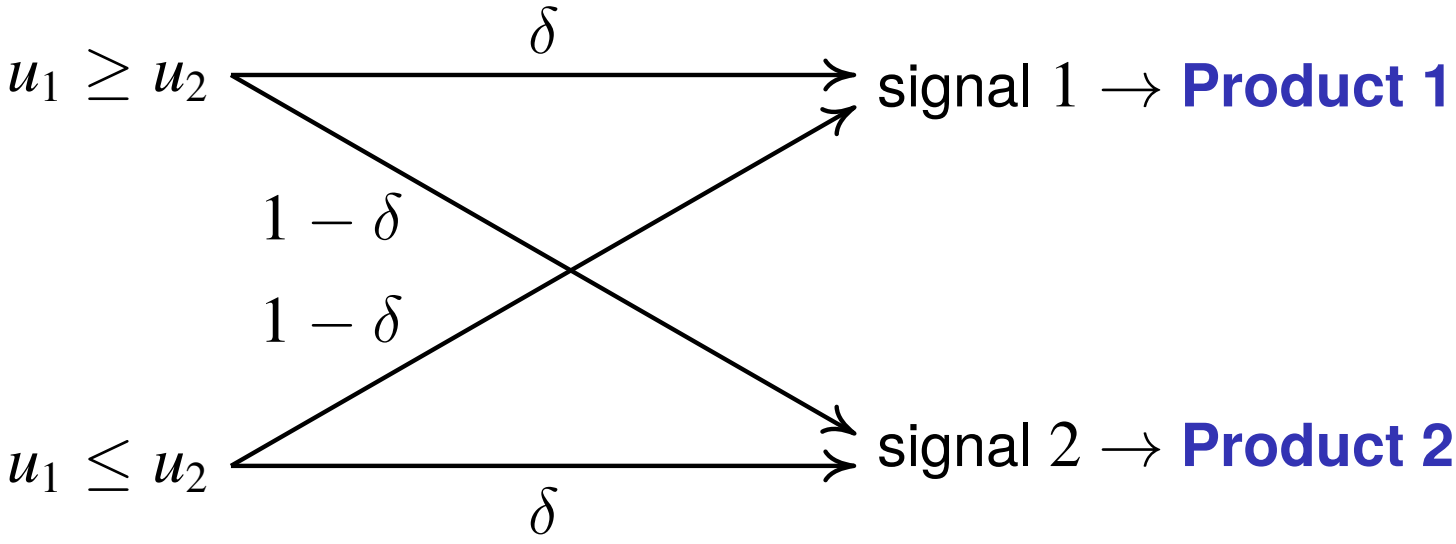


Solution: SPE with Seller and Consumer's tie-breaking

Roadmap

1. Model
2. Results
3. Extension

Equilibrium Recommendation



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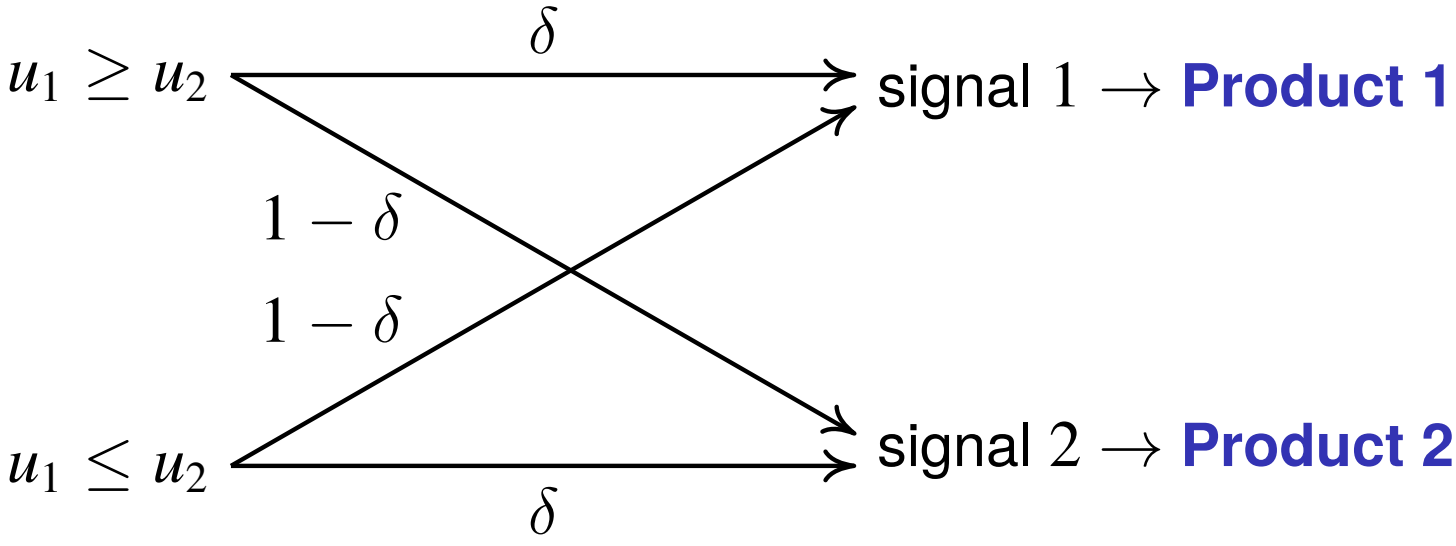

- More disclosure $\rightarrow$ better product match

Equilibrium Pricing

As Consumer increases δ under discriminatory pricing,

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  $\rightarrow$ Lower hazard rate (stronger than FOSD)

  $\rightarrow$ "less elastic" demand
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  $\rightarrow$ Lower hazard rate (stronger than FOSD)
  $\rightarrow$ "less elastic" demand
- Pricing $\rightarrow$ Monopolist sets a higher price

Main Result

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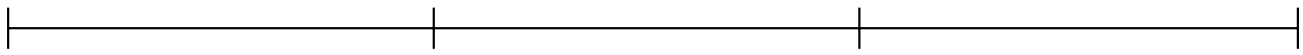
Theorem

In the unique equilibrium, Seller is better off and Consumer is worse off under nondiscriminatory pricing.

Intuition



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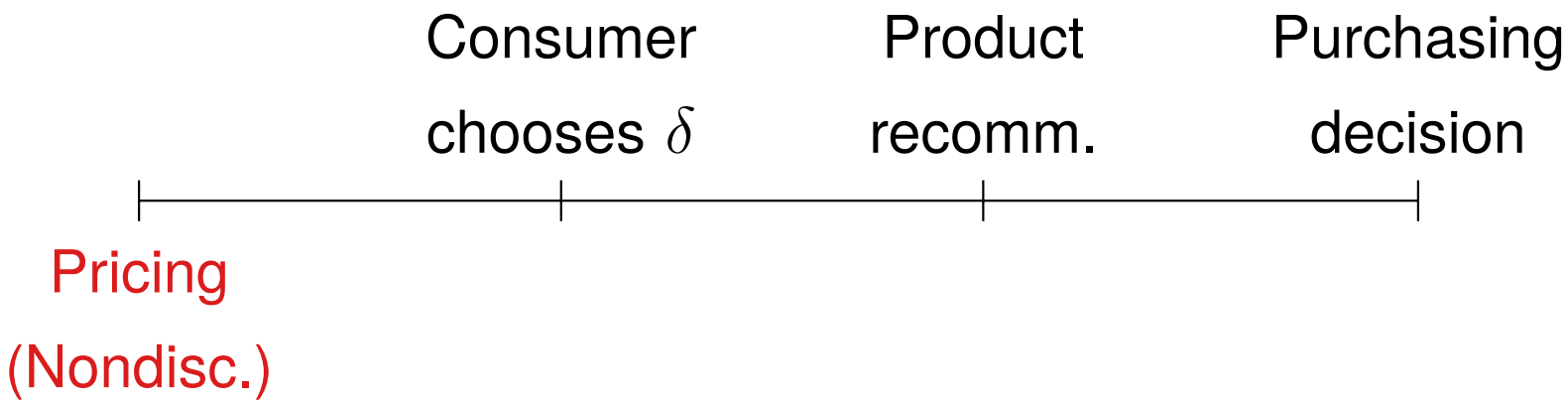
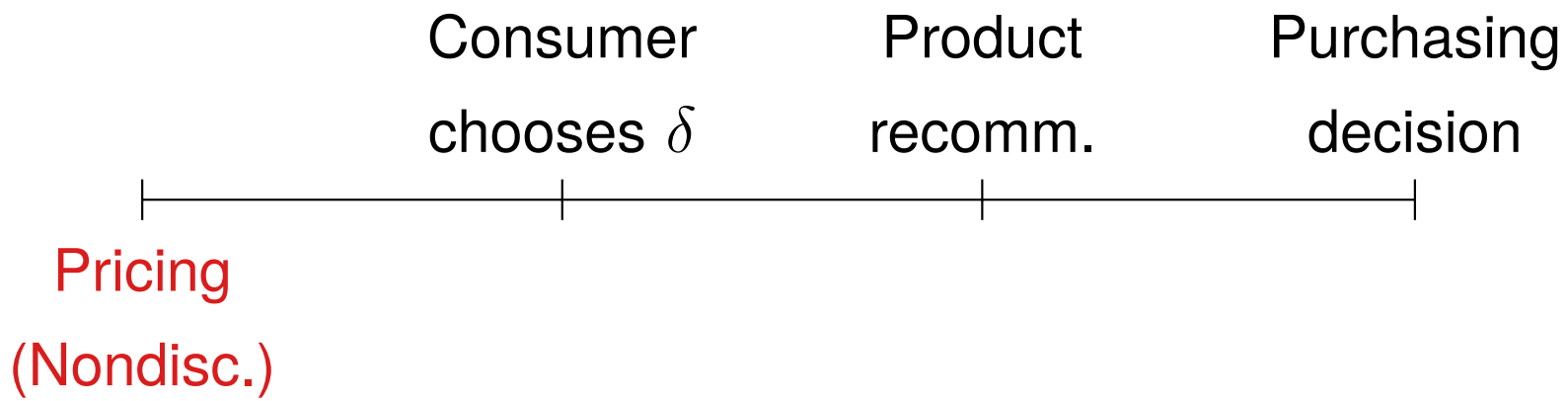

Consumer
chooses δ
Product
recomm.
Purchasing
decision
Pricing
(Nondisc.)

Intuition



Nondiscriminatory:

- Highest disclosure level ($\delta = 1$) to get best recomm.

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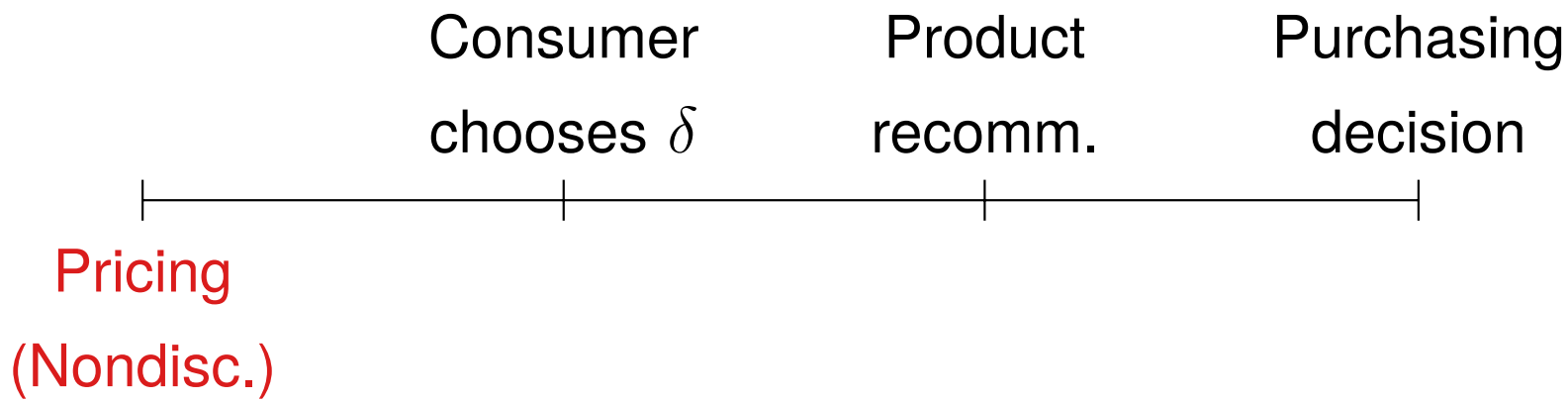

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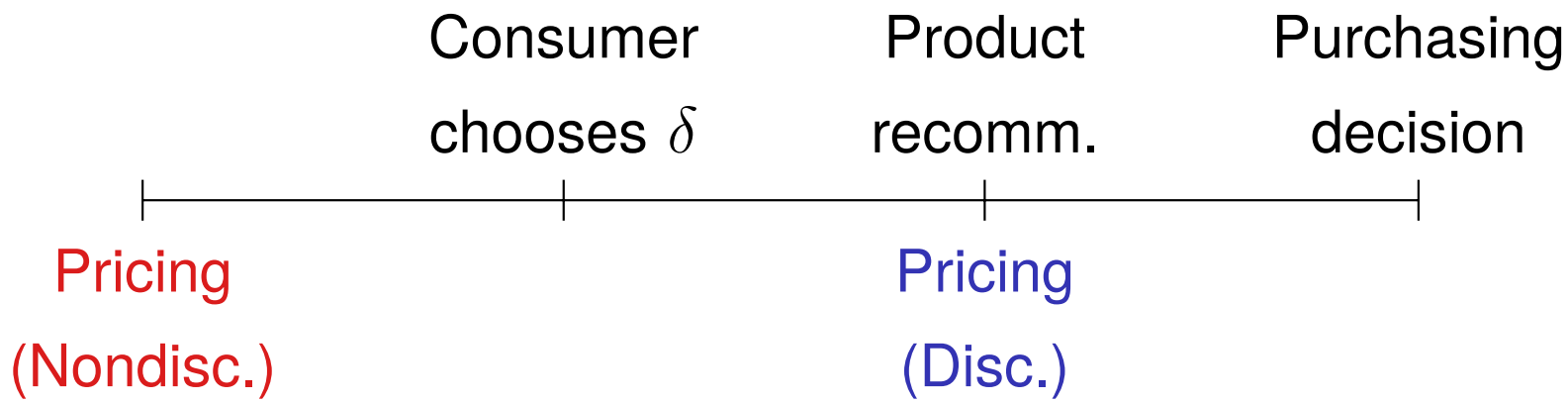

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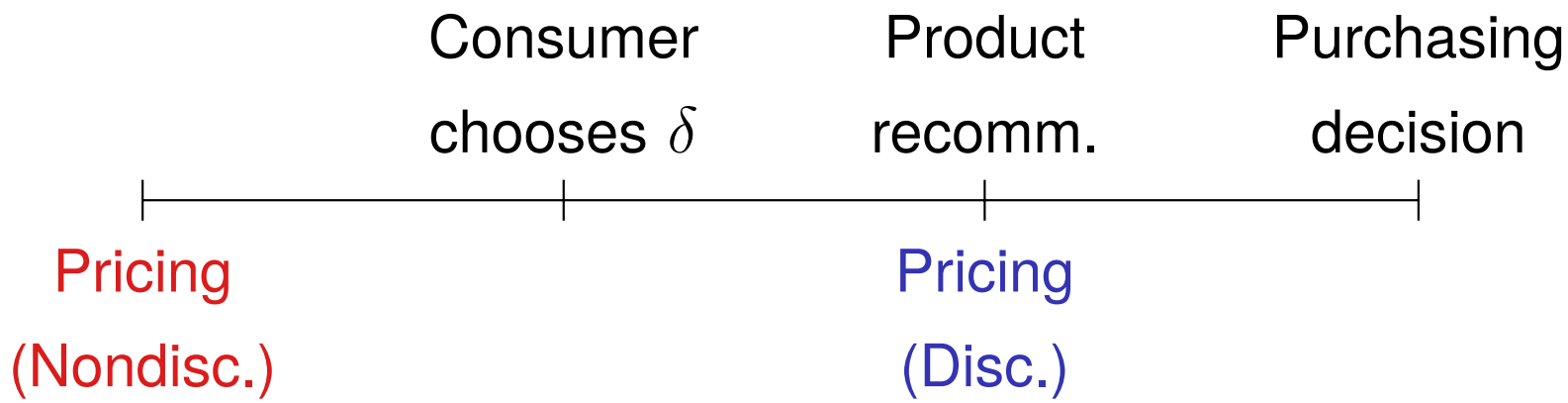

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Discriminatory:

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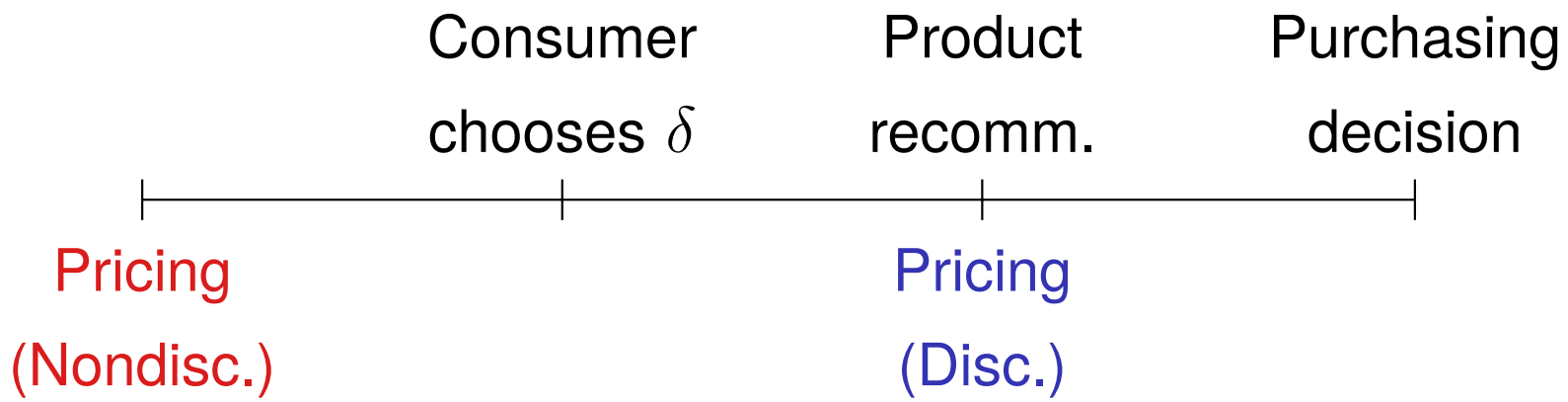

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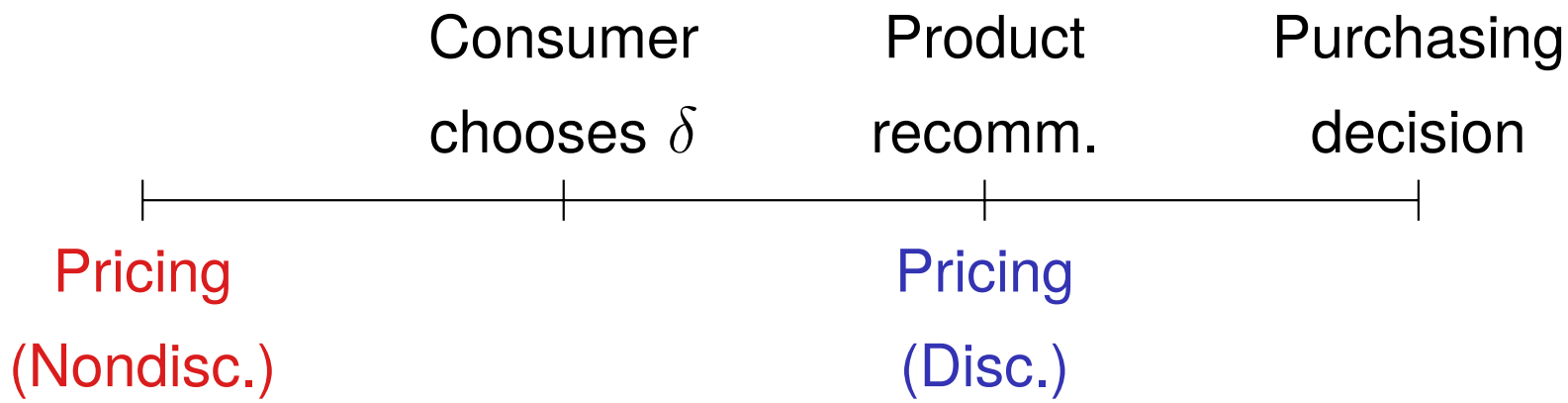

Nondiscriminatory:

- Highest disclosure level ($\delta = 1$) to get best recomm.
- Seller sets a high price ($p(1)$)

Discriminatory:

- Consumer is the Stackelberg leader
- Disclose less info, lower price ($p(\delta^*)$), higher payoff

Aside: Second Intuition

Alternative interpretation of the model:

- A *continuum* of consumers
- Seller sets prices after disclosure
  - Discriminatory: Different prices to different consumers
  - Nondiscriminatory: A single price for each product

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Equilibrium:

- Consumers are worse off under NDP
- Negative externality under NDP: Disclosure hurts other consumers through higher prices

Main Result

Theorem

In the unique equilibrium, Seller is better off and Consumer is worse off under nondiscriminatory pricing.

Implications

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1. A rationale for nondiscriminatory pricing

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   - Discriminatory pricing

     $\rightarrow$ less disclosure

     $\rightarrow$ product mismatch

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1. A rationale for nondiscriminatory pricing
   - Discriminatory pricing

     $\rightarrow$ less disclosure

     $\rightarrow$ product mismatch
   - Key: multiple products
2. Consumers disclose “too much” under NDP
   - Better off by precommitting to withhold information
   - Regulation to limit disclosure?

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“Unrestricted” Model

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- Seller sells K products, IID values

  (Technical assumption: Prior has finite support)

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  - Robustness of the main finding
  - Information design
  - If $K = 1$, Bergemann, Brooks, and Morris (2015)

Result

Unrestricted model with $K \geq 2$

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Unrestricted model with $K \geq 2$

Theorem

Seller is better off and Consumer is worse off under NDP.

Result

Unrestricted model with $K \geq 2$

Theorem

Seller is better off and Consumer is worse off under NDP.

- Benefit of accurate rec. $>$ Loss from no price disc.
- Characterize the efficient disclosure policy
- In contrast to $K = 1$ (BBM, 2015)

Total Surplus

- Does NDP enhance total welfare?

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Proposition

For a sufficiently large K, NDP achieves greater total surplus.

(Both in the restricted and unrestricted models)

Summary

Welfare & price implications of consumers' privacy?

Model:

- Multi-product Seller
- Consumer with limited attention
- Information affects pricing & recommendation

Results: Committing NOT to price discriminate

1. benefits Seller,
2. hurts Consumer, and
3. may improve total welfare

Extension: Selling data

Market for Data

- Seller can offer financial incentives for collecting info.

  Offer: What Consumer discloses + how much Seller pays

- Consumer accepts $\rightarrow$ Seller obtains info and makes payment
- Consumer rejects $\rightarrow$ play the original game
- Again, consider two pricing regimes

Market for Data

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- For *some* parameters, not only Consumer but Seller prefer discriminatory pricing

Appendix

Concrete example of disclosure level δ

- With probability 0.5, Consumer is of type $k \in \{1, 2\}$
- Type k values product k more, and visits Website k with prob. 0.6 everyday (non-strategic)
- Seller understands this correlation
- Browsing history $(1221212112 \cdots)$
- Consumer decides the length of history to share (1 week? 1 year?) without realizing how his browsing history looks like
- If Seller can access a long history, it can more accurately predict Consumer's type
- Sharing longer history $=$ Greater δ