Peer-to-Peer Markets with Bilateral Ratings

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Bilateral Ratings at Airbnb

Our community is built on a great deal of trust—trust that makes hosts feel comfortable allowing travelers to stay in their home, and trust that helps travelers feel like they belong anywhere. The foundation of that trust is our review system.

For each guest review, a host is asked to give a star rating for the guest's cleanliness and communication. Airbnb allows hosts to pick and choose these strangers by publishing guest profiles and reviews.

Research Questions

By implementing bilateral ratings and reviews, a peer-to-peer platform (e.g., Airbnb, RVShare, Upwork) discloses information on both sides of the market.

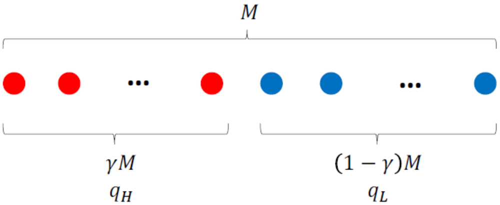
- How does the availability of information on consumers affect the competitive landscape?
- How do prices change when such ratings are available?
- How does the bilateral rating system compare to unilateral ratings?

Literature Review

- Competitive search in labor market
  - e.g., Montgomery (1991), Peters (1991), Burdett, Shi and Wright (2001), Shi (2002)
  - Models the matching of heterogeneous agents on two sides of the market; often involve assortment effects and discrete consumer types
- Behavior-based discrimination
  - e.g., Fudenberg and Villas-Boas (2006), Pazgal and Soberman (2008), Shin and Sudhir (2010), Zhang (2011), Shin, Sudhir and Yoon (2012) Providers here cannot price discriminate but can refuse service
- P2P platform
  - e.g., Romanyuk and Smolin (2019) study cream skimming and information design in markets with exogenous prices

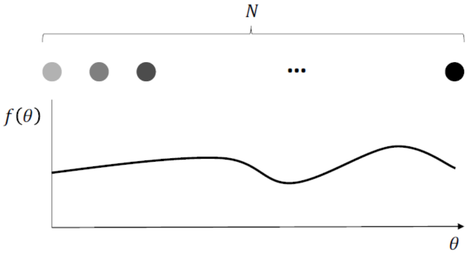
MODEL

Service Providers



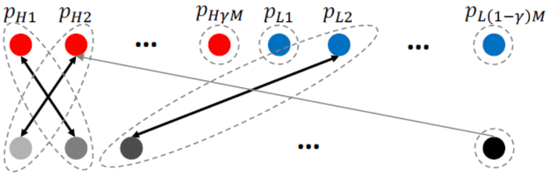
- M service providers are distinguished by service quality, with $\gamma \in (0, 1)$ in high quality q_H, and $1 - \gamma$ in low quality $q_L \leq q_H$.
- Each service provider can serve at most one consumer: capacity constraint.
- Marginal cost of service provision is normalized as zero.

Consumers



- N consumers distinguished by serving cost. Cost type θ has positive and finite PDF $f(\theta)$ for $\theta \in [0, \bar{\theta}]$.
- To serve a consumer of cost type θ, a service provider of quality q incurs cost $\theta g(q)$, where $g(\cdot) > 0$ and $g^{t}(\cdot) \geq 0$.
  - e.g., $g(q) = 1$. $g(q) = q$.
- Consumption utility of quality q and price p is $u(p, q) = q - p$.

Matching Game



1. Service providers post prices.
   - Service providers can commit to their posted prices.
   - Prices do not depend on θ—no rating-based price discrimination.
2. Each consumer submits at most one application.
3. Each service providers accepts at most one application.
4. Trade and payoffs realize. Platform charges δ fraction of commission from provider.

Market Frictions

Without search costs, where do frictions come from in this model?

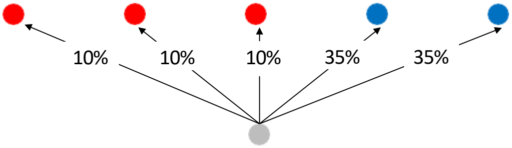
- **Coordination frictions**—multiple consumers apply for the same service provider; meanwhile, some service providers receive no applications.
- Allow unmatched agents play the same matching game again → some more will get matched → lower coordination frictions and mismatches.
- We only consider one-shot game.
  - P2P market is often time sensitive and hence has capacity constraints

Large Market and Symmetric Equilibrium

- $M, N \to \infty$, and $0 < n \equiv N/M < \infty$.
- We only consider symmetric equilibrium strategy:
  - Service providers of the same type post the same price.

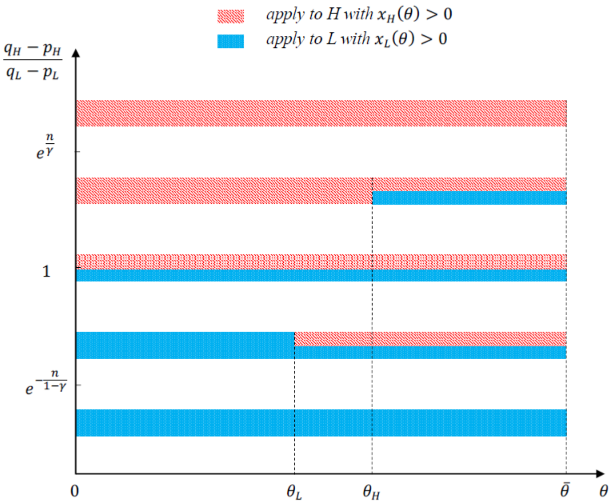
$$p_{H1} = \cdots = p_{H\gamma M} = p_H,$$
$$p_{L1} = \cdots = p_{L(1-\gamma)M} = p_L.$$

  - Consumers of the same type use the same application strategy. $a_j(\theta)$ is the probability a consumer applies to one particular service provider of type $j \in \{H, L\}$. Example:



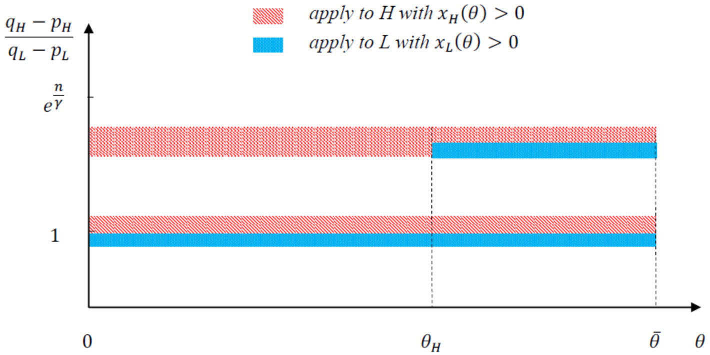
$$a_H(\theta) = 10\%$$
$$a_L(\theta) = 35\%$$

Characterization of Consumers' Application Strategy



EQUILIBRIUM IMPLICATIONS

Equilibrium Market Segmentations



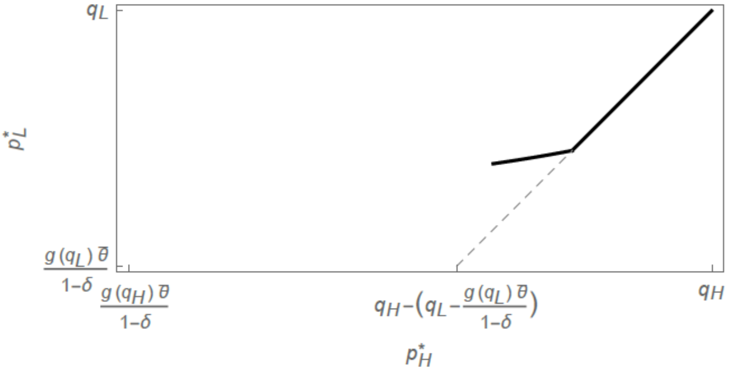


Figure: Equilibrium prices under the parameter setting that $n = 1$, $\gamma = 0.5$, $q_H = 2q_L$, $\delta = 0.1$, $\theta = 0.2q_L$, and $g(q) = 1$.

Equilibrium Acceptance Rates and Expected Utilities

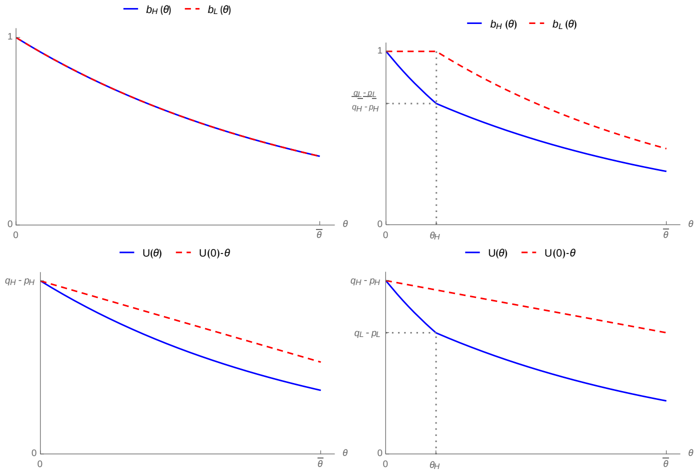


Figure: In the left panels, $(p_H^*, p_L^*) = (0.787q_H, 0.573q_L)$ with $q_H - p_H^* = q_L - p_L^*$; in the right panels, $(p_H^*, p_L^*) = (0.666q_H, 0.533q_L)$ with $q_H - p_H^* > q_L - p_L^*$.

Comparative Statics

General monotone comparative statics for supermodular games:

- The equilibrium prices p_H^* and p_L^* increase with n, as more consumers make the market less competitive
- They decrease with γ, as high-quality providers compete more
- They also decrease with $\overline{\theta}$ and δ for n sufficiently large, as it becomes more critical to attract the lowest-cost consumers

Platform Strategy

Raising commission rate has two effects:

- Platform gets larger share of profit
- Providers reduce prices to attract better customers

- Numeral examples suggests that the direct effect dominates

INCOMPLETE MARKET COVERAGE

Incomplete Market Coverage

- Some consumers are so costly that it is not profitable for some service providers to serve them.
- Consider the most interesting case that the market coverage is complete for low-quality service providers but incomplete for high-quality service providers.

$$(1-\delta)p_H - \overline{\theta}g(q_H) < 0,$$

$$(1-\delta)p_L - \overline{\theta}g(q_L) \geq 0.$$

Consumer Applications

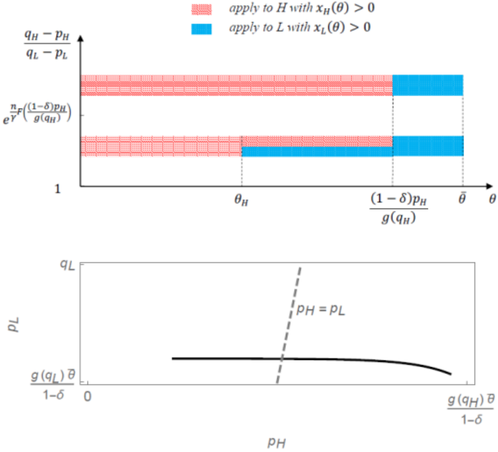


Figure 8: Equilibrium Prices under Incomplete Market Coverage under $n = 1$, $\gamma = 0.9$, $q_H = 2q_L$, $\delta = 0.1$, $\overline{\theta} = 0.8$ and $g(q) = q$.

Pricing "Anomaly"

How could $p_H^* < p_L^*$ be an equilibrium?

- By charging a lower price, a high-quality service provider attracts more applications and cherrypicks a low-cost consumer;
- a low-quality service provider faces the remaining pool of consumers and charges a higher price to make up for the high serving cost.

UNILATERAL RATINGS

Unilateral Ratings

Under unilateral ratings, service providers cannot discern low-cost consumers from those with high costs, so they will randomly choose a consumer given multiple consumers' applications.

Comparison of Equilibrium Prices

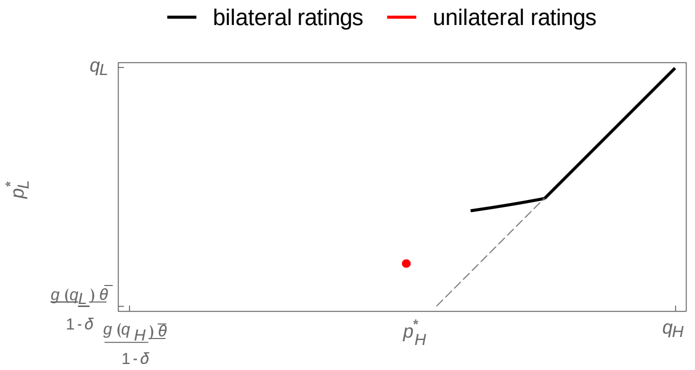
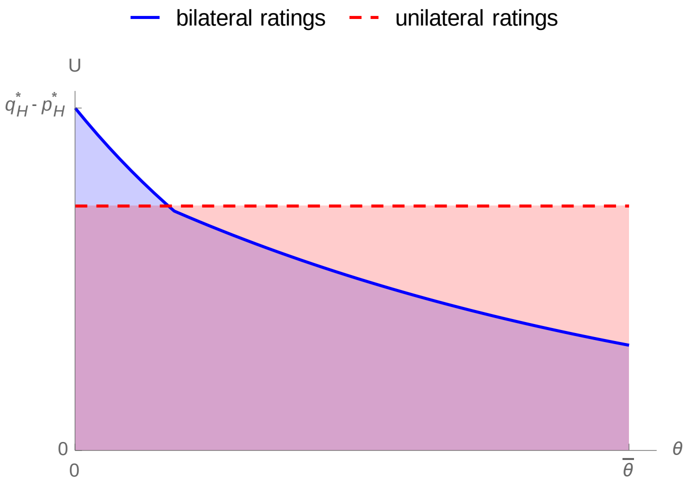


Figure 9: Equilibrium Prices with Bilateral and Unilateral Ratings under $n = 1$, $\gamma = 0.5$, $q_H = 2q_L$, $\delta = 0.1$, $\bar{\theta} = 0.2$ and $g(q) = 1$.

- Why may equilibrium prices get lower under unilateral ratings?
  Cost-based market segmentation under bilateral ratings softens price competition.

Comparison of Consumer Surplus



Alternative Model Assumptions

- A small market place: two providers and two customers
  - No pure strategy equilibrium; price anomaly may still occur
- Multiple applications: a customer can submit two applications
  - No pure strategy equilibrium; endogenous composition effect holds
- General distribution of customer types
  - Numerical result: prices decrease when service cost increases
- High-quality providers has lower service cost
  - If market is covered for low-quality providers but not covered for high-quality providers, the latter charges lower price; if equilibrium exists

CONCLUSION

Conclusion

In a peer-to-peer matching market with coordination frictions, bilateral ratings could lead to cost-based market segmentation

- Market prices can decrease with: provider/consumer ratio, higher fraction of high-quality providers, consumer cost range and platform commission rate.
- Higher-quality providers may charge a lower price.
- Compared with unilateral ratings, bilateral ratings may lead to higher equilibrium prices.

Thank You!

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