ECON 8854: Search II—Salz (2022)

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- Slides are based on the working paper Salz (2017).
- The paper is now published as Salz (2022).

Intermediation and Competition in Search Markets

An Empirical Case Study

TOBIAS SALZ

November 30th, 2017, FTC

RESEARCH QUESTION

How do intermediaries affect buyers and sellers?

- Buyers who delegate directly benefit from better “search technology” (*direct effect*).
- Selection creates search-externality, Salop and Stiglitz (1977), (*indirect effect*).

What is the welfare effect? No quantity distortion, but:

- Demand side: Reduction in search cost.
- Supply side: More efficient production (reallocation).

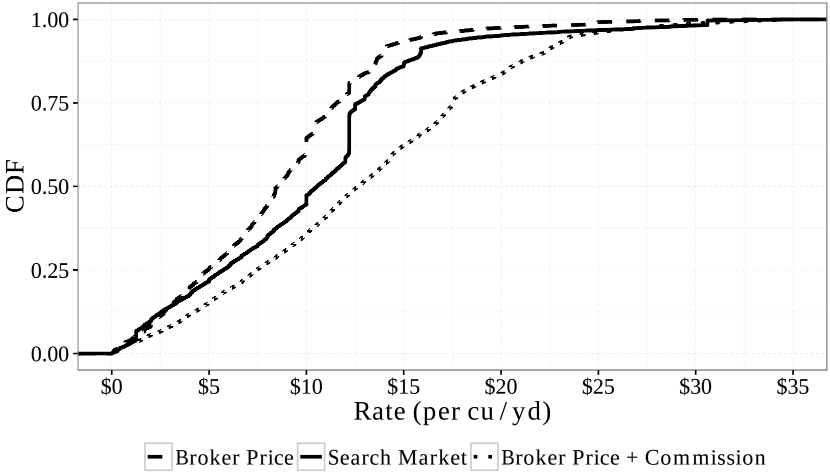
Importance?

- Intermediaries are important in search markets, but little studied
- Advances empirical search models to allow for heterogeneous costs
  - Note: Allen, Clark, and Houde (2019) do this too (via a somewhat similar auction approach)
  - Applicability limited by data requirements

WHAT BROKERS DO

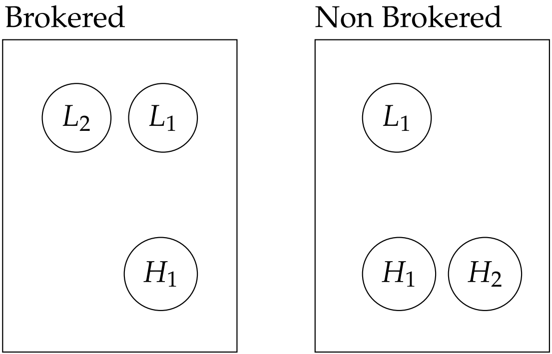
[...] Rubicon, based in Atlanta, isn't in the business of hauling waste. It doesn't own a single truck or landfill. [...] It begins by holding an online bidding process for its clients' waste contracts, fostering competition among waste management businesses and bringing down their prices. [...] Through a combination of big data and online auctions for hauling contracts, Rubicon says it reduces clients' waste bills by 20 percent to 30 percent.[...] — **New York Times (10/26/2014)**

Brokered vs. Non Brokered Contracts



$$\bar{P}_{broker} + Commission > \bar{P}_{search} > \bar{P}_{broker}$$

ILLUSTRATION SELECTION



Model

MODEL SETUP

Primitives:

- Search expenses: $\kappa \sim \mathcal{H}(.|\mathbf{x})$
- Carter cost: $\mathcal{C}(\mathbf{z}, c)$ with $c \sim \mathcal{G}_k(.|\mathbf{z}), k \in \{L, H\}$

Timing:

- Customer draws κ, carters c (both *private*, *iid*)
- Customer chooses:

  Delegate: Broker *RFP* amongst N_b carters, fee $\Phi(\mathbf{x}, \mathbf{z})$

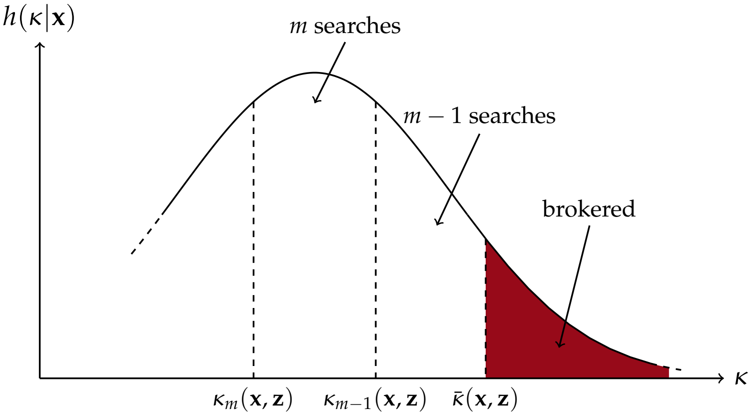
  Not Delegate: $\min_{m \in \{2,\ldots,M\}} \left(q \cdot \mathbb{E}[p|\mathbf{z}, m] + m \cdot \kappa \right)$

- Carters bid:

  If delegated: Knowing their N_b competitors.

  If not delegated: Under stochastic $m \in \{2, \ldots, M\}$

SORTING OF CUSTOMERS



CARTER PRICING, DEFINITIONS

Fraction of customers that make m searches

- $w_m, m \in \{2, \ldots, M\}$.
- $w_m(\mathbf{x}, \mathbf{z}) = \mathcal{H}(\kappa_{m-1}|\mathbf{x}) - \mathcal{H}(\kappa_m|\mathbf{x})$.

Optimal strategies of carters $k \in \{L, H\}$

- Broker market: $\beta_{b,k}(.)$ for broker b with N_b bidders.
- Search market: $\beta_{S,k}(.)$.

Cost Distribution

- $\widetilde{\mathcal{G}}_k(.|\mathbf{z}) = 1 - \mathcal{G}_k(.|\mathbf{z}), k \in \{L, H\}$.

CARTER PRICING

Carter H's objective in the broker market:

$$\max_p (p-c) \cdot \underbrace{\widetilde{\mathcal{G}}_L(\beta_{b,L}^{-1}(p)|\mathbf{z})^{N_{b,L}} \cdot \widetilde{\mathcal{G}}_H(\beta_{b,H}^{-1}(p)|\mathbf{z})^{N_{b,H}-1}}_{\substack{\text{Probability that } p \text{ is lower than} \\ \text{prices offered by } N_{b,L} \text{ and } N_{b,H}-1 \text{ rivals}}}$$

Carter H's objective in the search market:

$$\max_p (p-c) \cdot \left[\sum_{m=1}^{M-1} \underbrace{w_m(\mathbf{x},\mathbf{z})}_{\substack{\text{Customer} \\ \text{calls } m \text{ carters}}} \cdot \sum_{k=0}^{m} \underbrace{\frac{\binom{N_L}{k} \cdot \binom{N_H-1}{m-k}}{\binom{N_H+N_L-1}{m}}}_{\substack{\text{Probability that } k \\ \text{rivals are type } L}} \cdot \underbrace{\widetilde{\mathcal{G}}_L(\beta_{S,L}^{-1}(p)|\mathbf{z})^k \cdot \widetilde{\mathcal{G}}_H(\beta_{S,H}^{-1}(p)|\mathbf{z})^{m-k}}_{\substack{k \text{ firms of type } L \text{ and } m-k \\ \text{firms of type } H \text{ bid above } p}} \right]$$

Equilibrium Definition

An **equilibrium** is a set of:

- Bidding strategies $\beta_{S,k}(.)$ and $\beta_{b,k}(.)$ for each broker b and types $k \in \{L, H\}$.
- Customer cut-off types $\kappa_1, \ldots, \kappa_M$ and $\hat{\kappa}$.

Such that:

- $\kappa_1, \ldots, \kappa_M$ and $\hat{\kappa}$ result from optimal search under $\beta_{b,k}(.)$ and $\beta_{S,k}(.)$.
- $\beta_{b,k}(.)$ is optimal given N_b and $\beta_{S,k}(.)$ is optimal given $\kappa_1, \ldots, \kappa_M$ and $\hat{\kappa}$.

Identification

Identification

1. Carter type: price residuals in price regression
2. Cost distribution: Given (1), get this from Athey and Haile (2002) identification of costs in asymmetric FPA.
3. Weights ω on each search strategy *m* from search market transaction price distribution given costs adjusted for selection from (1) and (2).
4. Weights on *m* let us back out unobserved offer price distribution, and hence κ from equation (1). this gives the search cost distribution.

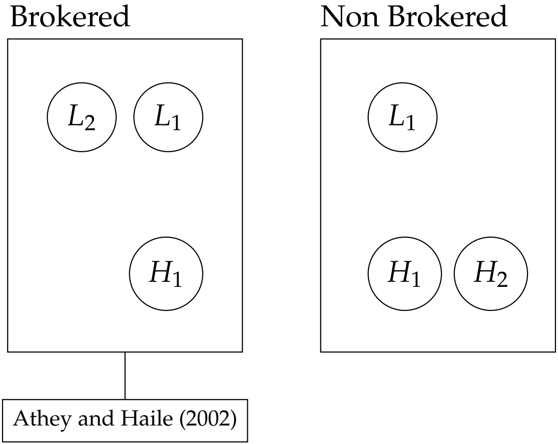
$$q \cdot \mathbb{E}[p^B|\mathbf{x},\mathbf{z}] \cdot \phi(\mathbf{x},\mathbf{z}) = q \cdot \mathbb{E}[p|\mathbf{x},\mathbf{z},m(\bar{\kappa})] + m(\bar{\kappa}(\mathbf{x},\mathbf{z})) \cdot \bar{\kappa}(\mathbf{x},\mathbf{z}) \tag{1}$$

IDENTIFICATION

Observed objects:

- Prices + contract covariates in both market.
- Number of bidders on a contract (= carters serving borough through broker).
- Type of carter (L/H), average residual price (fixed effects).
- Broker fees on a contract.

BROKERED MARKET: GET CARTERS COST



BACKING OUT w

Observed price distribution in search-market:

$$\mathcal{F}^O(p) = \sum_{m=1}^{M} w_m \cdot \sum_{k=0}^{m} \frac{\binom{N_L}{k} \cdot \binom{N_H}{m-k}}{\binom{N_H+N_L}{m}} \cdot \left(1 - \widetilde{\mathcal{G}}_L(\beta_{S,L}^{-1}(p,w))^k \cdot \widetilde{\mathcal{G}}_H(\beta_{S,H}^{-1}(p,w))^{m-k}\right)$$

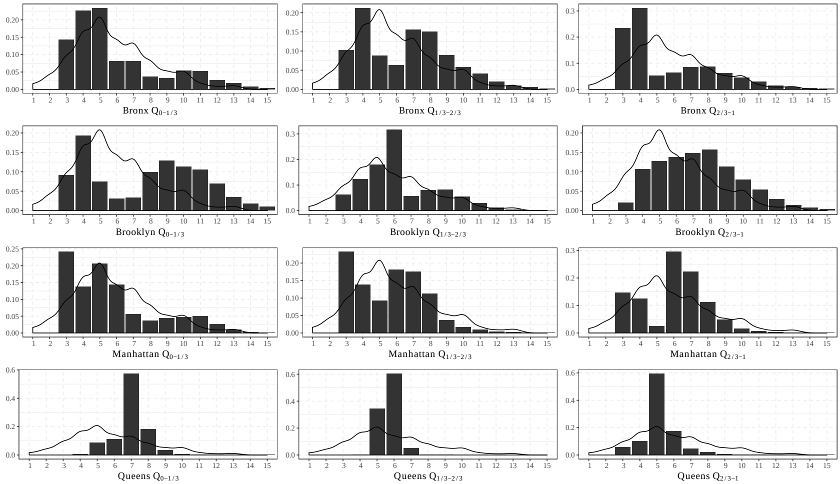
- LHS observed.
- RHS known up to w, finite.
- Has to hold for all p, continuous.

▸ Monte Carlo Results

Robustness: Number of Bidders

- N_b = No. bidders in broker b auctions.
- Main specification: Bidders = all carters serving borough through that broker.
- Suppose only a (z-specific) subset participate in each auction?
- Naive intuition:
  - Overestimate $N \to$ overestimate c
  - overestimate $c \to$ underestimate markups
  - underestimate markups $\to$ underestimate s
- But... counterfactual reports s moves in the same directions as c!
- Why?
  - Reducing N lowers c
    - Need a higher markup to fit prices
    - Need m to fall
  - Reducing N lowers $var(c)$
    - Reduces m
    - perhaps so much that need s to *rise*

SEARCH INQUIRIES

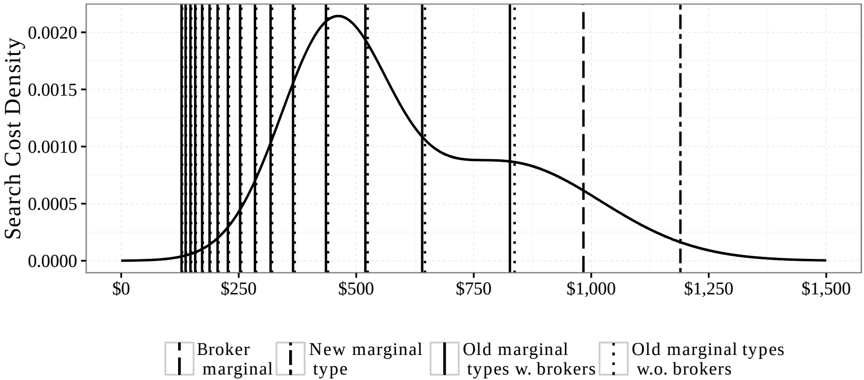


Search Expenses

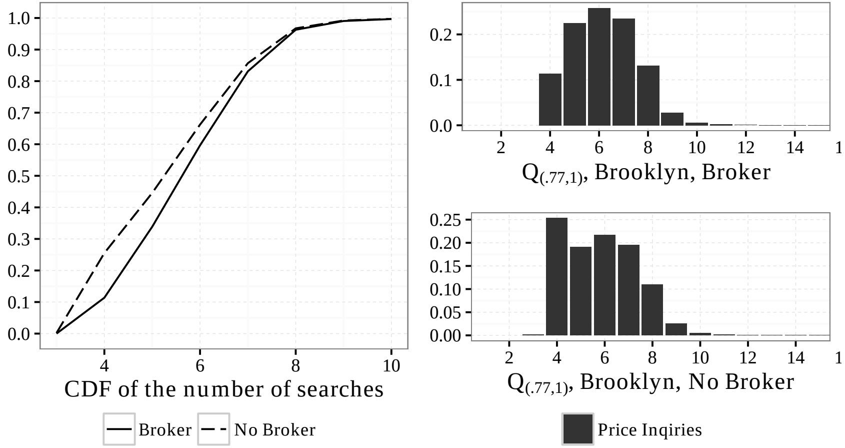
Subset	Search Cost Per Inquiry ($) $\kappa < \Delta_B$	$\kappa > \bar{\kappa}$	Number of Searches $\kappa < \bar{\kappa}$	Total Search Cost ($), (Fraction of Total) $\kappa < \bar{\kappa}$
Bronx				
$Q_{0,33}$	48.8	143.3	6.6	214.6 (0.2)
$Q_{33,77}$	125.2	418.1	7.3	652.6 (0.3)
$Q_{77,100}$	655.8	1575.3	7.3	2137.7 (0.3)
Brooklyn				
$Q_{0,33}$	39.3	111.7	9.1	240.2 (0.3)
$Q_{33,77}$	138.3	309.4	7.1	568.5 (0.3)
$Q_{77,100}$	534.3	1706.4	8.3	2832.8 (0.3)
Manhattan				
$Q_{0,33}$	56.5	111.3	6.8	187.5 (0.2)
$Q_{33,77}$	169.6	409.2	6.7	706.9 (0.3)
$Q_{77,100}$	745.4	1454.2	6.9	3160.2 (0.3)
Queens				
$Q_{0,33}$	39.4	65.0	7.3	149.5 (0.2)
$Q_{33,77}$	132.0	169.1	5.9	224.1 (0.1)
$Q_{77,100}$	774.4	1721.9	5.8	2841.7 (0.3)

Counterfactual No Broker

COUNTERFACTUAL



No Broker Counterfactual, Example



CONSUMER WELFARE AND PROFITS

Table: Counter-factual Overview

	Change in Buyer Expenses			
	Not Brokered	Brokered	All	Carter Profits
Δ Absolute	$130.34	$237.48	$138.9	$40.36
Δ Percent	4.8%	6.7%	5.0%	1.84%

Reallocation of rents due to:

- Indirect effect: $11.0 Million
- Direct effect: $2.6 Million

Total Welfare

Components

- $+\Delta$ Service cost (reallocation)
- $+\Delta$ Search cost (search market)
- $+\Delta$ Search cost (broker market)
- $-\Delta$ Broker fixed cost.

Increase in Cost (decrease in welfare):

- Between and \$13.1 and \$22.6 Million.
- Between 4.8% and 9.1% of market volume.
- 17.8% of welfare change due to search cost (counting broker cost as search cost).

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