Online Markets

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Einav, Kuchler, Levin, Sundaresan, "Learning from Seller Experiments in Online Markets" (*AEJ: Micro* 2015):

EKLS propose that an alternative to field experiments is opportunistic experimentation: eBay is so big that there must be some seller who has run the experiment you would like to do.

Few eBay items are really unique. For about one-half one can find a nearly identical item sold by the same seller. Defining "experiment" to mean an exact match on seller, category, title, and subtitle, they find 55 million experiments involving a total of 350 million listings.

For many of their analyses they restrict attention to experiments with at least two auctioned items and at least one successful posted price sale. This still leaves 244,419 experiments with 7,691,273 listings.

The paper contains multiple subpapers including (1) how do buy-it-now prices affect outcomes; (2) how do shipping fees affect outcomes; and (3) how and why do reserve prices affect revenues? I'll just talk about reserve prices.

EKLS "Learning from Seller Experiments in Online Markets

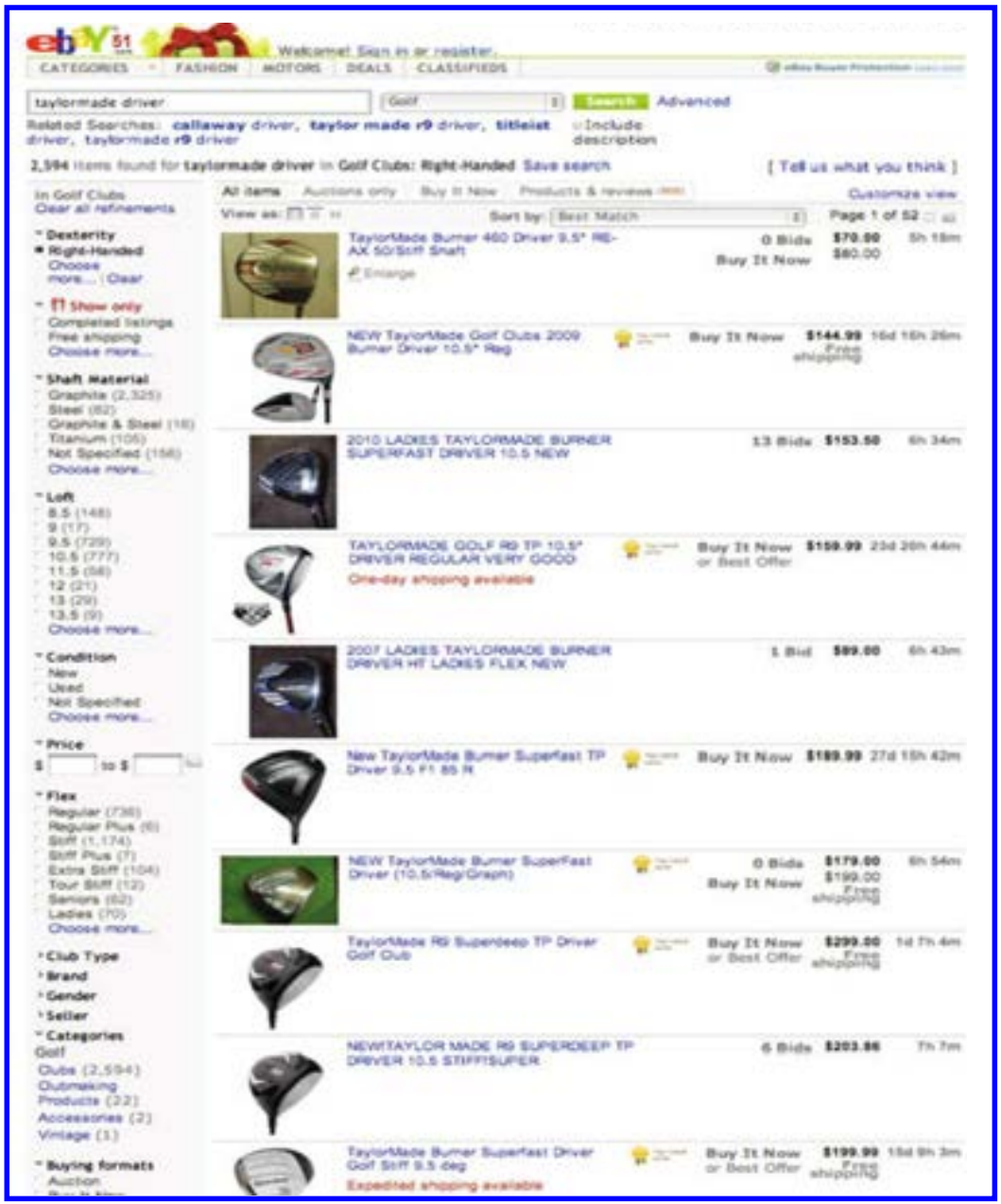


FIGURE 1A. A STANDARD SEARCH RESULTS PAGE ON EBAY

EKLS "Learning from Seller Experiments in Online Markets

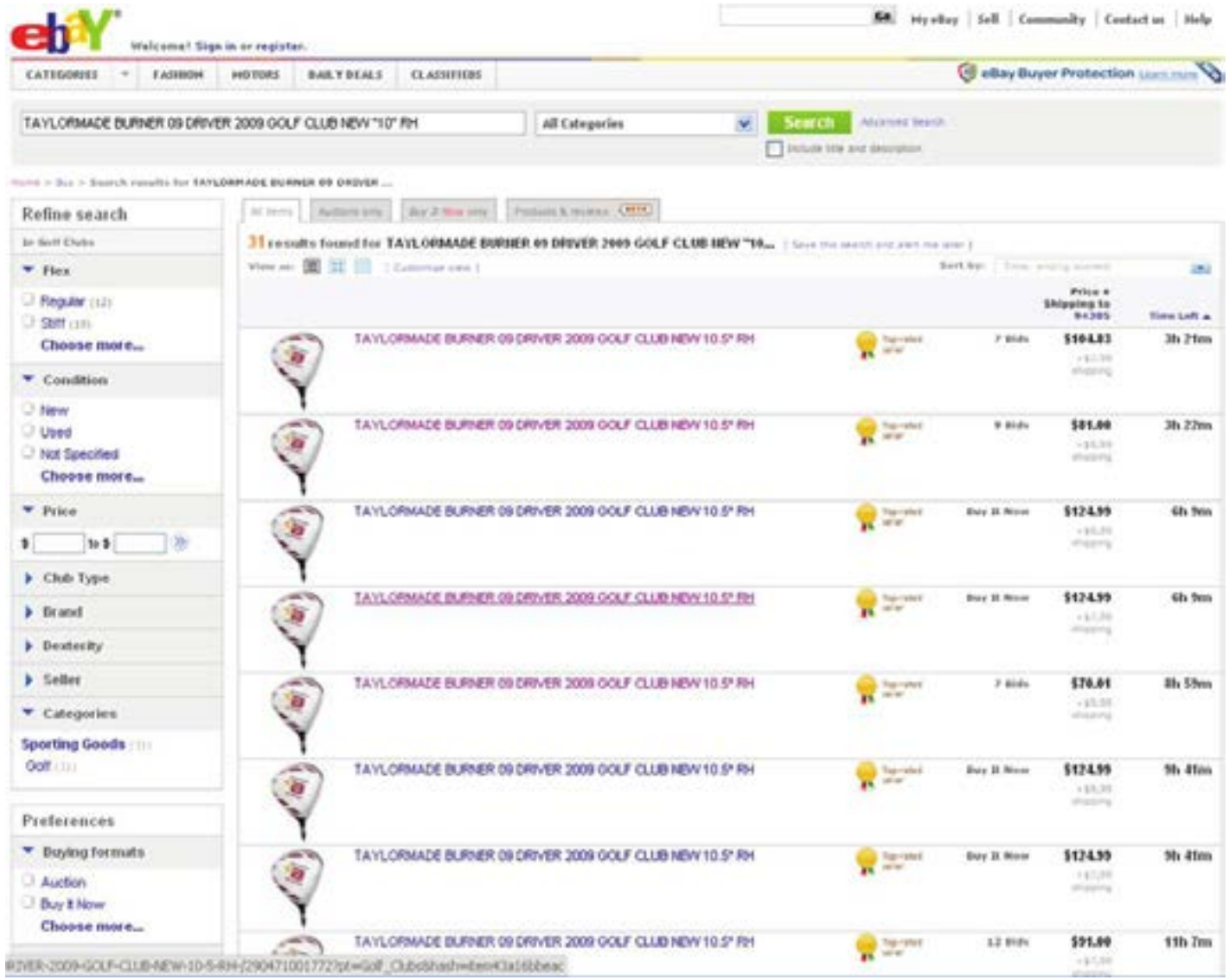


FIGURE 1B. AN EXAMPLE OF A MATCHED SET

Notes: The figure illustrates a matched set. It shows the first 8 out of 31 listings for the same golf driver by the same seller. All the listings were active on 9/12/2010. Of the 8 listings in the figure, 4 are offered at a fixed price (Buy It Now) of $124.99. The other four listings are auctions. The listings also have different shipping fees (either $7.99 or $9.99).

Reserve Prices

The optimal reserve price in an IPV English auction is the monopoly price.

1. A reserve price of r truncates the distribution of prices paid at r. It creates a mass point at r, but does not affect the density of p for $p > r$.
2. Given any r we can compute the probability of sale $q(r)$ and the expected price $Ep(r)$ conditional on a sale occurring. Varying r we are tracing out a curve $(q(r), Ep(r))$ which can be thought of as an inverse demand curve. The optimal reserve price is the monopoly price on this curve.

Previous authors have noted several reasons why this simple theory may not work in practice including (1) entry costs; (2) common values; and (3) behavioral preferences such as loss aversion.

EKLS's analysis of reserve prices is restricted to 19,777 experiments which have several desired features: start price variation, free shipping, no secret reserve price, and no buy-it-now option. These experiments have a total of 494,170 listings, about 25 per experiment

Table 5 shows that there is a lot of variation in start values.

Reserve Prices in the Experiments

TABLE 5—VARIATION IN AUCTION START PRICE WITHIN AND ACROSS MATCHED SETS

		Item reference value				
	Number of listings	< $10 92,925	$10–30 184,652	$30–100 125,326	$100–1,000 91,269	All listings 494,170
Ratio of auction start price to reference value	< 0.05	6.5%	7.3%	20.3%	25.3%	13.8%
	0.05 to 0.15	6.7%	3.6%	0.5%	0.8%	2.9%
	0.15 to 0.30	5.3%	0.7%	1.5%	0.2%	1.7%
	0.30 to 0.45	2.1%	1.8%	2.2%	0.7%	1.7%
	0.45 to 0.60	5.5%	2.9%	3.5%	1.3%	3.2%
	0.60 to 0.85	12.9%	21.7%	17.4%	8.4%	16.5%
	0.85 to 1.00	42.1%	44.7%	37.0%	44.4%	42.2%
	1.00 to 1.20	11.5%	12.5%	13.8%	16.1%	13.3%
	> 1.20	7.3%	4.8%	3.8%	3.0%	4.7%

		Maximum (within matched set) ratio of auction start price to reference value						
		< 0.05	0.05 to 0.45	0.45 to 0.85	0.85 to 1.00	1.00 to 1.20	> 1.20	Total
Minimum (within matched set) ratio of auction start price to reference value	< 0.05	489	627	745	908	343	150	3,262
	0.05 to 0.45		473	1,077	545	119	126	2,340
	0.45 to 0.85			2,027	3,121	728	357	6,233
	0.85 to 1.00				2,627	2,436	1,068	6,131
	1.00 to 1.20					550	667	1,217
	> 1.20						594	594
	Total	489	1,100	3,849	7,201	4,176	2,962	19,777

Note: The table presents the distribution of (normalized) start prices, and the amount of variation within matched sets, for the sets we use to analyze the effect of auction start price.

Reserve Price Results

One departure from the theory is that the auction demand curve turns up at very low reserve prices (very high probability of sale). This suggests that low reserve prices increase entry into the auction.

A consequence of the first result is that the marginal revenue curve starts to slope up at a high probability of sale. The monopoly price is either on the downward sloping portion of the marginal revenue curve or at the right boundary.

Consistent with this incentive, the top panel of Table 5 shows that most firms use a very low reserve or a very high reserve.

The paper tests other predictions, e.g. Figure 4(d) looks at whether the upper tail of the price distribution is unaffected by increases in the reserve price. This one only works so well.

Results

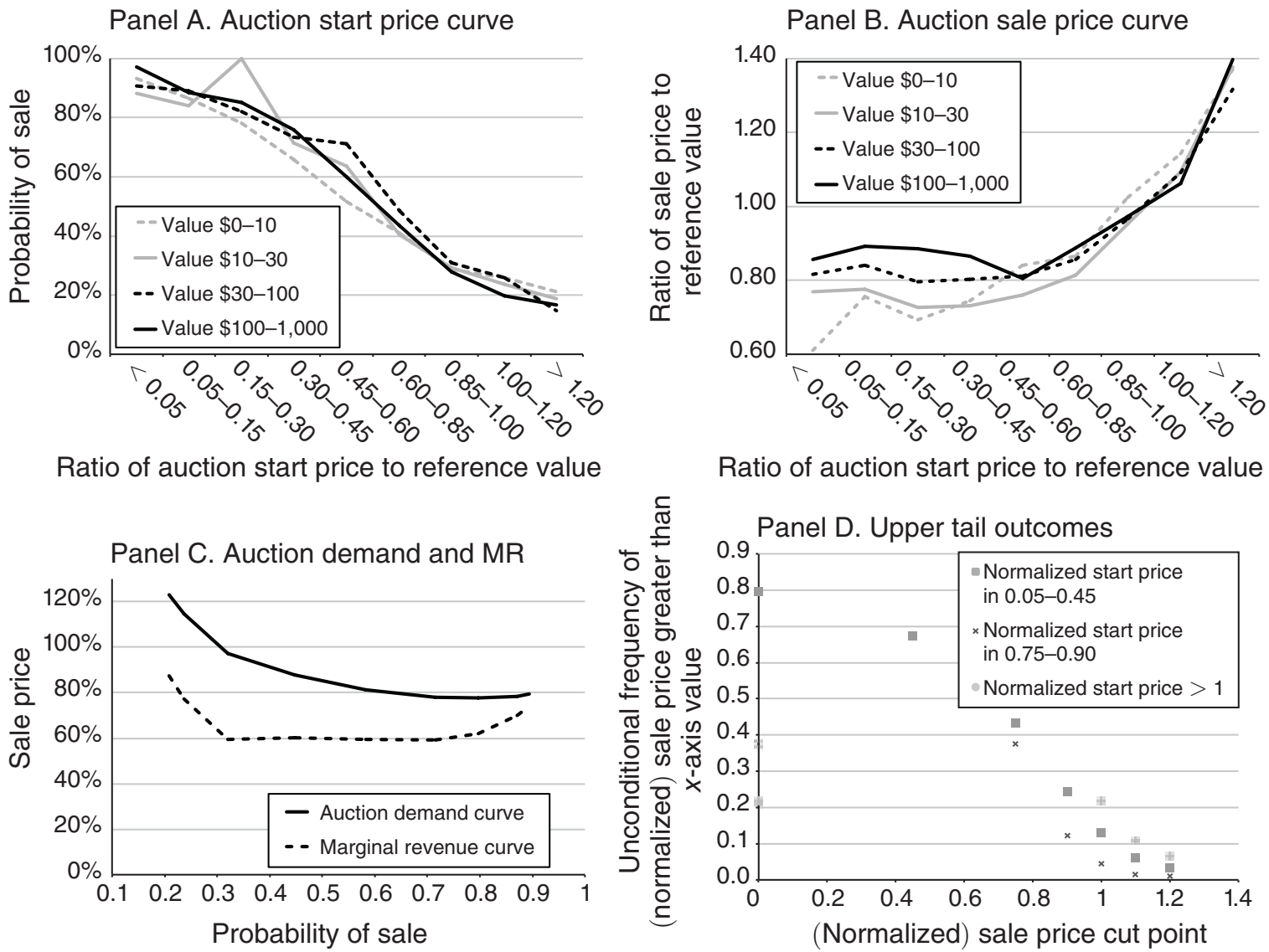


FIGURE 4. THE EFFECT OF AUCTION START PRICE

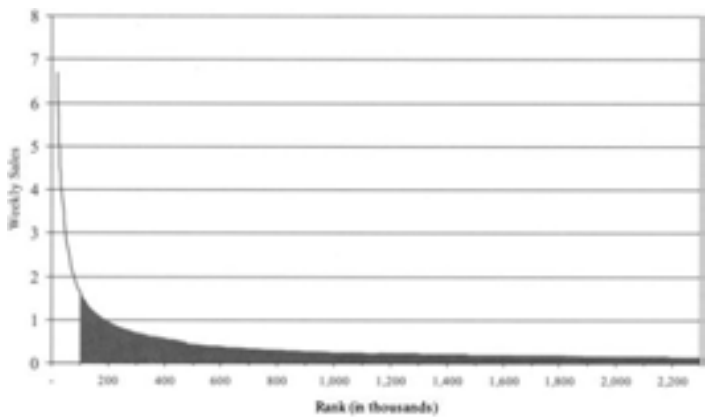
Brynjolfsson, Hu, and Smith, "Consumer Surplus in the Digital Economy: ... ," *Management Science*, 2003

In the early 2000s there was skepticism about how large online retail could be. Shipping goods by truckload to retail stores is much cheaper than shipping individual packages. Amazon initially undercut physical stores by selling at low markups, but could it ever sell at a profit?

One factor that could offset a cost disadvantage is gains from product variety.

Amazon launched in 1995 wtih 1 million titles where large bookstores had 100,000. BHS estimate the surplus gain by estimating the fraction of Amazon sales to books outside the top 100,000 and multiplying by an estmated CS.

They estimate that the increased product variety enhanced consumer surplus by \$700 million to \$1 billion in 2000. This is about ten times the estimated surplus that consumers received from paying lower prices online.

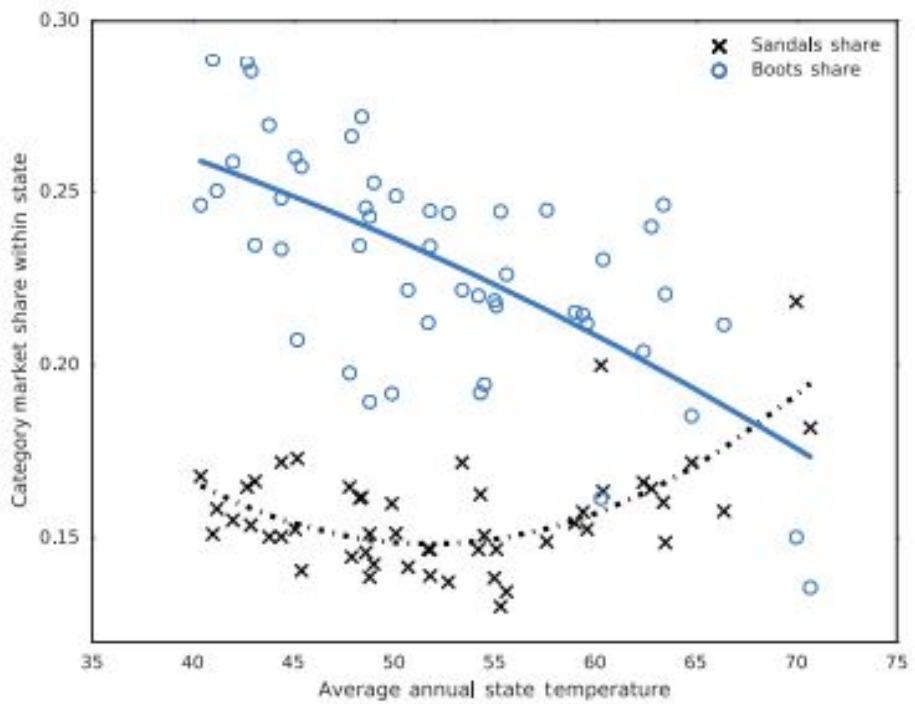


Quan and Williams, "Product Variety, Across Market Heterogenetiy, and the Value of Online Retail," *RAND*, 2018

The calculation in BHS may overestimate the gains from product variety because different physical bookstores carry different books.

Quan and Williams investigate this idea using a transaction-level dataset containing the 2012-2013 sales by a large online shoe store.

One simple illustration of the likelihood that physical stores will carry different selections is a graph of online boot and sandal sales as as a function of a state's average annual temperature.



Quan and Williams, "Product Variety and the Value of Online Retail"

Quan and Williams use a nested logit demand model in which there are location-specific shocks to the mean utility provided by each product and category-specific and product-specific individual taste shocks:

$$\begin{aligned} u_{i\ell j} &= \delta_{\ell j} + \zeta_{ic(j)} + (1-\lambda)\epsilon_{i\ell j} \\ \delta_{\ell j} &= x_j\beta - \alpha p_j + \xi_{\ell j} \end{aligned}$$

One challenge in estimation is that the standard logit market share inversion method for obtaining IV estimates is inappropriate given that many products have few (or zero) units sold in many geographic areas. They discuss a GMM approach that is feasible in their application.

Dealing appropriately with zeros is also very important for estimating welfare. Almost all models have zero sales in a CSA-month, so if local stores carried the actually most-purchased products, onlline sales would provide zero benefit.

The estimation aggregates sales to the location-month level using 213 locations. It uses BLP-style instruments to identify the price coefficient and nesting parameters. Prices, reviews, and the product set are time varying.

The estimates indicate that there is substantial cross-market heterogeneity in the $\delta_{\ell j}$.

Quan and Williams, "Product Variety and the Value of Online Retail"

They estimate the gains from online product variety by comparing estimated welfare with estimated welfare in a counterfactual world where consumers can only choose among simulated stores in their local area.

- The counterfactual uses data on the number of products available at local Macy's and Payless shoe stores to estimate the number of products N_ℓ available in each market as a function of population.
- It then assumes that offline consumers can choose among the N_ℓ products with the highest $\delta_{\ell j}$.

The estimates suggest that the benefits of online product variety are smaller than had been reported previously in two senses:

- Local stores tailored to local demand would provide about half of the product variety benefit of online shopping relative to a standard store.
- Product variety benefits are smaller than those reported elsewhere. Gains are roughly equivalent to a 5% drop in prices, where BHS estimated the variety benefit of Amazon books to be ten times the price benefit.

Macy's and Payless do carry different shoes in different stores and Macy's has highlighted its efforts. The revenue gain from customizing stores is estimated to be about 6%.

Ellison and Ellison, "Match Quality, Search, and the Internet Market for Used Books," 2020

We return to the question of why the Intenet has not done more to make prices low and nondispersed. It offers an alternate explanation with very different welfare implications: prices could be higher because lower search costs lead to better consumer-product matching; and dispersion could reflect inherent asymmetries in online search.

The paper

1. Develops some simple models to illustrate the ideas
2. Tests some model predictions using data on offline and online used book sales
3. Develops structural estimates of the welfare changes

Ellison and Ellison, "Match Quality and Market for Used Books"

Consider first a simple model of dynamic monopoly pricing of a unique item.

Suppose consumers with values $v_j \sim F$ arrive at Poisson rate γ and must be served immediately or not at all.

Let $D(p) = 1 - F(p)$. Expected profit is

$$\begin{aligned} \pi(p) &= E(pe^{-r\tilde{t}}) = \int_0^\infty pe^{-rt}\gamma D(p)e^{-\gamma D(p)t}dt \\ &= \frac{\gamma D(p)}{r + \gamma D(p)}p \end{aligned}$$

We can think of monopoly pricing in two ways:

$$p^m = \text{argmax}_p \frac{\gamma p D(p)}{r + \gamma D(p)}.$$

$$p^m = \text{argmax}_p (p - \pi^*)D(p).$$

Ellison and Ellison, "Match Quality and Market for Used Books"

Observations:

1. The monopoly price is increasing in the customer arrival rate γ/r.
   - Increases in the arrival rate will lead to higher prices.
   - Arrival rate heterogeneity leads to price dispersion.
2. The sensitivity of prices to arrival rates depends on the thickness of the upper tail of F.
   - For $D(p) = \text{Min}(1, hp^{-\eta})$ the monopoly price is proportional to $(\gamma/r)^{\frac{1}{\eta}}$.
3. With constant elasticity demand we have an interesting welfare property.

Proposition

Suppose that the distribution of consumer valuations is such that demand has the truncated constant elasticity form and that the monopolist's price is not at the kink in the demand curve. Then,
(i) The monopoly price maximizes social welfare.
(ii) Expected social welfare is $E(W) = p^m$.

Ellison and Ellison, "Match Quality and Market for Used Books"

Consider now a similar $N+1$ population model oligopoly model.

- Shoppers arrive at Poisson rate γ_0 and buy from i with probability $D(p_i, p_{-i})$.
- Nonshoppers arrive at firm i at rate γ_i and purchase with probability $D^m(p_i)$.

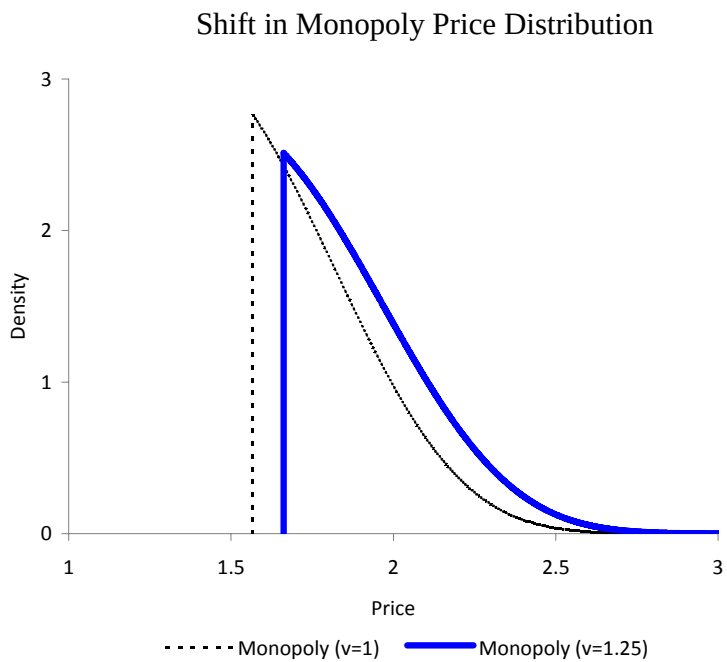
This model can have pure-strategy dispersed price equilibria where firms with higher arrival rates set higher prices.

Online prices would be expected to differ from offline prices for two reasons:

- "Match Quality": Higher arrival rates shift the distribution of monopoly prices.
- "Competition": Desire to attract shoppers pulls down low-priced firms' prices.

Ellison and Ellison, "Match Quality and Market for Used Books"

The figure on the left gives the distribution of monopoly prices at two demand levels. The right panel adds prices the higher demand level in a nine-firm oligopoly with a shopper arrival rate $\gamma_0 = 2$.



The effects are felt differently at the high and low ends of the distribution. Two predictions should be robust.

1. The online price distribution will have a thicker upper tail.
2. The online price distribution will be more dispersed.

Ellison and Ellison, "Match Quality and Market for Used Books"

We gathered data on 335 books representative of traditional used book stores' inventories.

- 100 Standard books
- 158 Local Interest books
- 77 Popular books

We have price/condition information from four data collections:

- 2009 offline prices for books randomly selected from offline stores
- 2009 online prices for the same books via AbeBooks.com
- Nov. 2012 online prices for the same books (Amazon incorporated AbeBooks listings in 2010).
- Jan. 2013 online prices.

Listings that disappear between the final two collections provide a proxy for sales.

Ellison and Ellison, "Match Quality and Market for Used Books"

Predictions:

1. Online prices should be more dispersed than offline prices with a thicker upper tail.

2. Local interest books may already be well-matched by offline stores so the online-offline gap should be smaller.

The Mt. Vernon Street Warrens: A Boston Story 1860-1910

> *The fortune of the Warren family, derived from a Maine papermill, enabled five siblings to grow up in the elite society of Boston's Beacon Hill in the early 1900s. In telling the stories of those children who became notable for eccentricity and philanthropy, Green (Children of the Sun) focuses on Ned Warren, a homosexual and mover in the international movement of aestheticism, who was determined to lead a "grand but blighted life." ... This somewhat jumbled tale of a family's sundering through greed and suicide ...*

Ellison and Ellison, "Match Quality and Market for Used Books"

Predictions:

1. Online prices should be more dispersed than offline prices with a thicker upper tail.

2. Local interest books may already be well-matched by offline stores so the online-offline gap should be smaller.

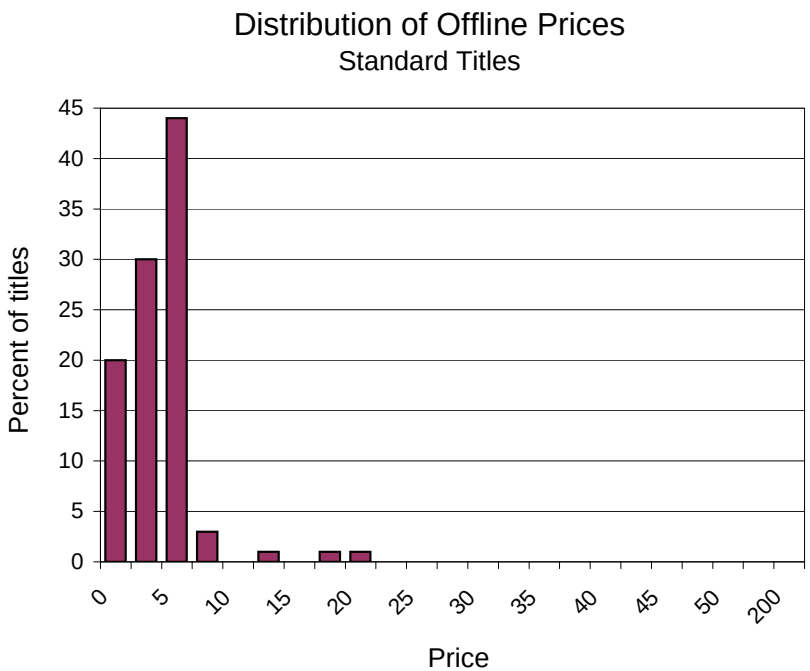
3. The online-offline gap should be smaller for popular titles because the value distribution may have a thinner upper tail.

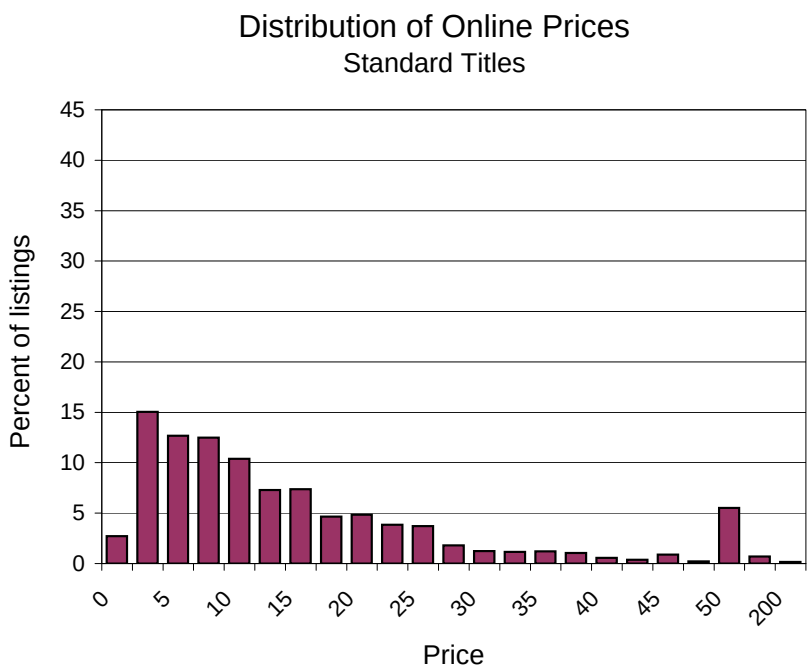
4. Amazon's "buy used" feature should lead to more low prices in 2012, but the upper tails of the 2009 and 2012 distributions should be similar.

Ellison and Ellison, "Match Quality and Market for Used Books"

Tests of Model Predictions:

1. Online prices for standard titles are much more dispersed that offline prices for the same titles.

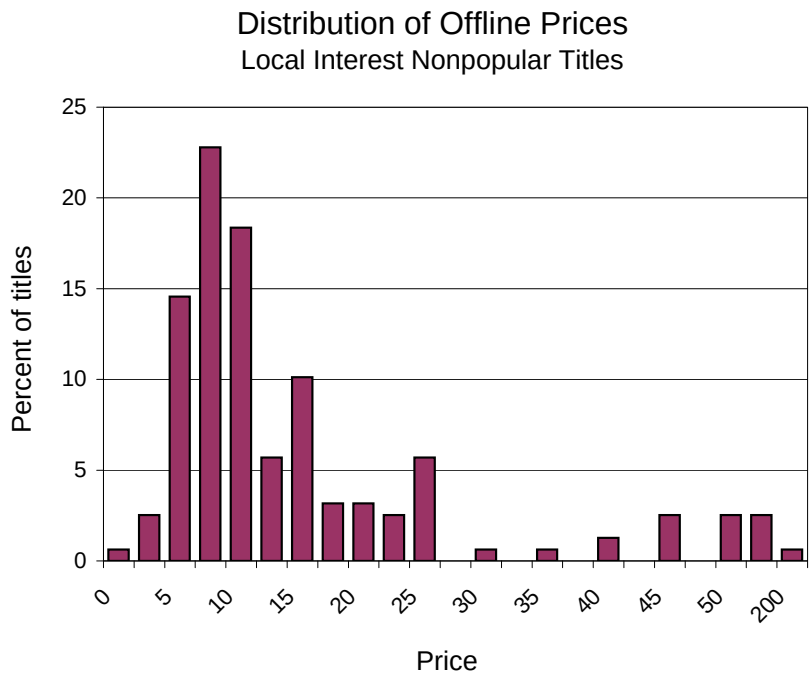


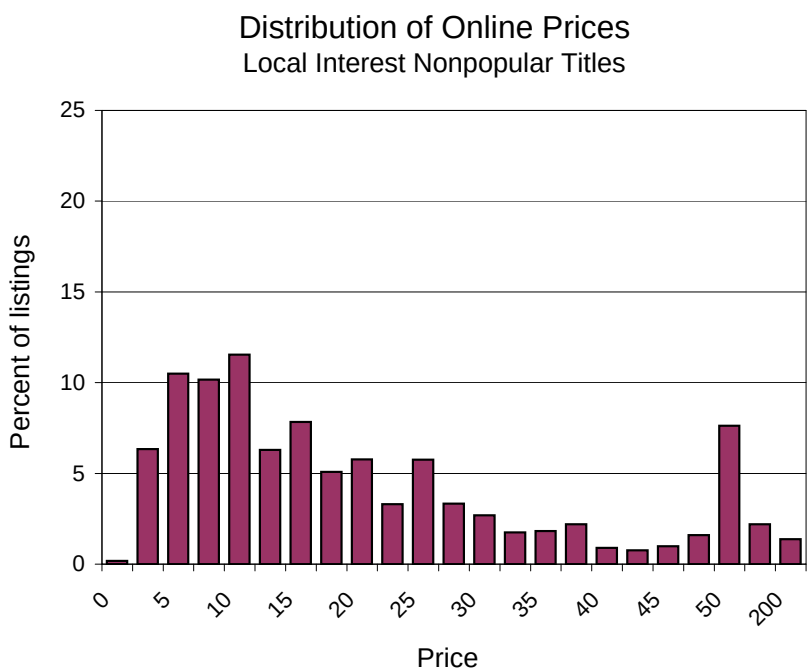


Ellison and Ellison, "Match Quality and Market for Used Books"

Tests of Model Predictions:

2. Offline prices for local interest titles were more dispersed and the online-offline gap is smaller.

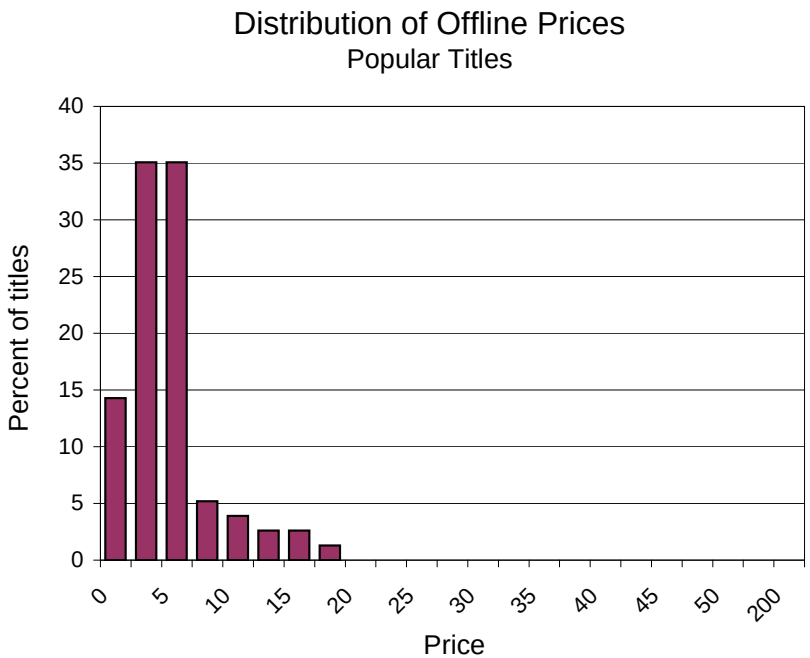


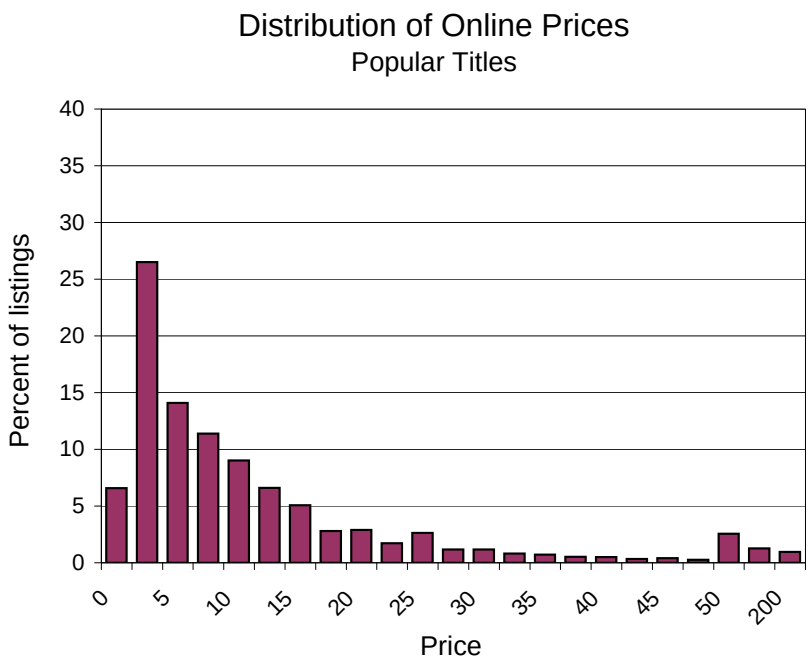


Ellison and Ellison, "Match Quality and Market for Used Books"

Tests of Model Predictions:

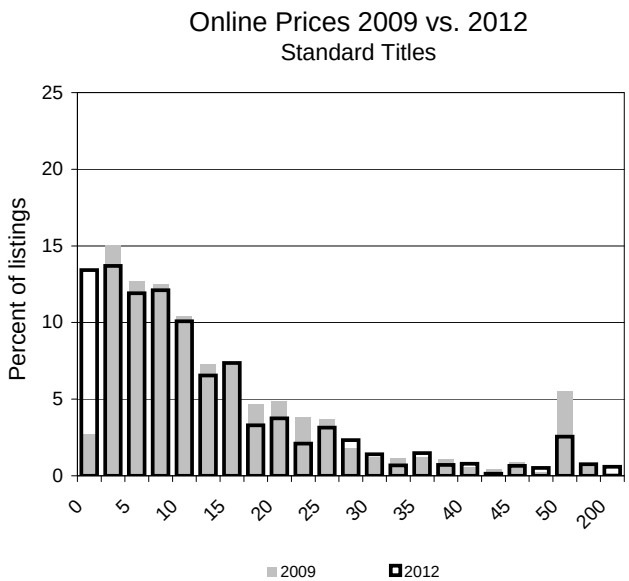
3. The online-offline gap is also smaller for popular books.

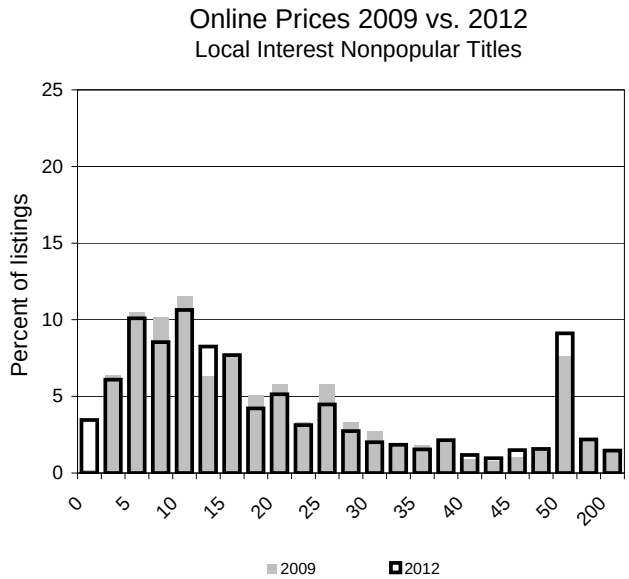


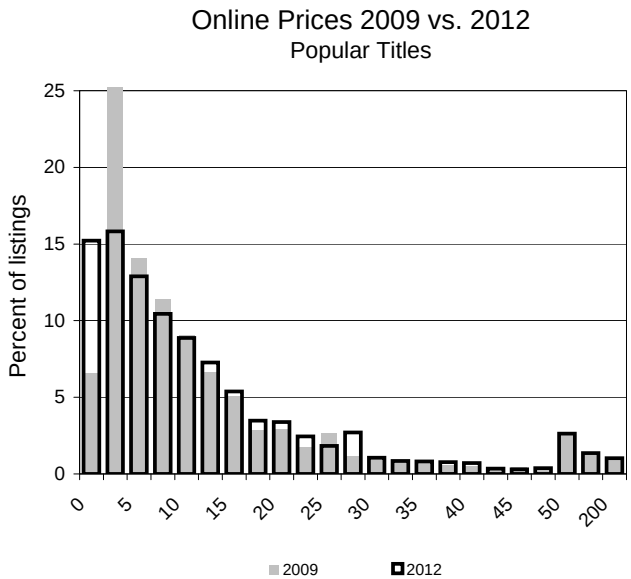


Ellison and Ellison, "Match Quality and Market for Used Books"

4. Between 2009 and 2012 the lower-tail of price distributions thickened, while there was little change in the upper tail.







Ellison and Ellison, "Match Quality and Market for Used Books"

The paper also develops a structural model of the used book markets. It notes that a combination of two assumptions improves tractability:

1. Firms maximize profits as if the world was stationary.
2. Heterogeneity consists solely of differences in arrival rates.

Given these assumptions (and any set of parameters) we can back out the unobserved arrival rate that must have been present to make each observed price optimal. We can evaluate the likelihood of the data given these parameters as the likelihood of the implied arrival rates.

Ellison and Ellison, "Match Quality and Market for Used Books"

We estimate that the shift to online sales led to substantial increases in both profit and consumer surplus.

Average value per listing	2009 offline listings	2009 online listings	2012 online listings
Gross profit	**$3.62**	**$7.86**	**$6.84**
Price ×	(0.27)	(0.37)	(0.41)
Discounting	$11.95 × 0.30	$16.42 × 0.48	$14.87 × 0.46
Consumer surplus	**$4.15**	**$9.01**	**$7.84**
Nonshoppers +	(0.35)	(0.75)	(0.70)
Shoppers	$4.15 + ——	$7.74 + $1.27	$6.50 + $1.34
Welfare	**$7.76**	**$16.87**	**$14.68**
	(0.53)	(0.94)	(0.95)

On Wednesday I'll discuss cryptocurrencies. Papers will include

- *Makarov and Schoar*
- *Budish*
- *Huberman, Leshno, and Moallemi*
- *Cong, He, and Li*

See you then!

14.271 Industrial Organization I

Fall 2022