

Product Choice and Price Discrimination in Markets with Search Costs

Natalia Fabra and Juan Pablo Montero

May 2017

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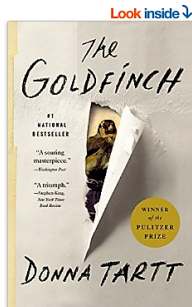
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Motivation: online books



The Goldfinch: A Novel (Pulitzer Prize for Fiction) Paperback – April 7,

2015

by Donna Tartt (Author)

★★★★☆ 25,083 customer reviews

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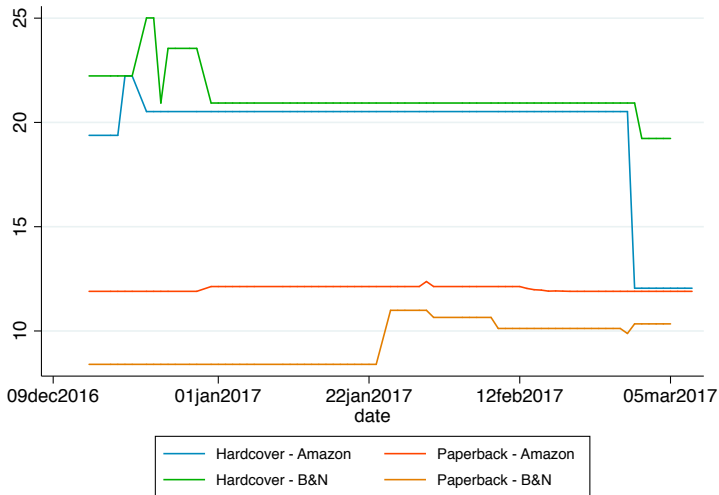
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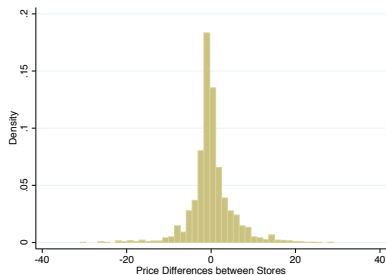
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Motivation: The Goldfinch at both stores

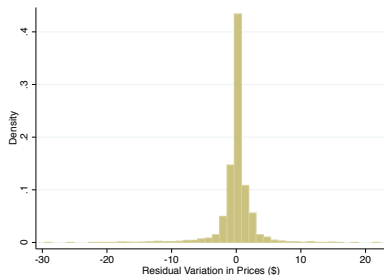


Evolution of prices of *The Goldfinch* (both stores)

Motivation: Price dispersion for online books



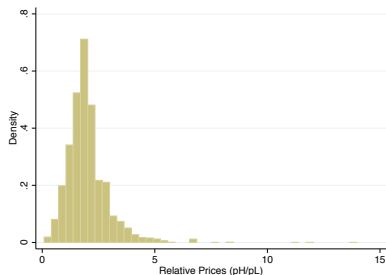
(a) Price dispersion across stores



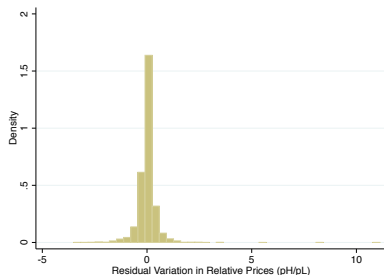
(b) Price dispersion across time

Notes: Data on book prices from Amazon and Barnes and Noble; Focus on prices by main seller (not used & new from others); Fiction and non-fiction #1 NYT best-sellers from 2012 to 2016.

Motivation: Relative prices for online books



(a) Relative prices



(b) Price dispersion in relative prices

Notes: Data on book prices from Amazon and Barnes and Noble; Focus on prices by main seller (not used & new from others); Fiction and non-fiction #1 NYT best-sellers from 2012 to 2016.

Summing up...

In the context of online bookstores:

- ▶ 2nd degree price discrimination: goods of **various qualities**
- ▶ Several **competing** firms
- ▶ **Overlapping product lines**
- ▶ **Price dispersion**: across firms, within firms, and across time
- ▶ Evidence of search costs

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This applies beyond the online books example:

- ▶ **Gasoline** (Shepard, 1991)
- ▶ **Cable TV** (Crawford and Shum, 2003)
- ▶ **Cellular phone plans** (Miravete and Röller, 2003)
- ▶ **Advertising** (Busse and Rysman, 2005)
- ▶ **Intertemporal price discrimination** (Hendel and Nevo, 2013)

Objectives of this Paper

Main objective:

Understand the strategic incentives that shape product lines and pricing incentives in markets with search costs

1. Product lines:

Why do firms choose overlapping product lines?

2. Price discrimination:

How do price discrimination and competition interact?

3. Search costs:

How do search costs affect product lines and pricing incentives?

Roadmap

- ▶ Overview of the model
- ▶ Related literature
- ▶ Model
 - ▶ Description
 - ▶ No search costs
 - ▶ Arbitrarily small amount of search costs
- ▶ General model
 - ▶ Pricing
 - ▶ Product lines
- ▶ Conclusions

Overview of the Model

- ▶ Two goods: high and low quality
- ▶ Consumers have to visit the stores to learn product lines and prices
- ▶ Four types of consumers:
 - ▶ *high or low* preference for quality
 - ▶ *shoppers or non-shoppers*
- ▶ Two-stage game: product choices followed by price decisions

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Champsaur & Rochet (Ecta, 1989): *Multiproduct Duopolists*

- ▶ Product choice; no search costs

Varian (AER, 1980): *A Model of Sales*

- ▶ Single-product and no price discrimination; search costs

Champsaur & Rochet (1989)

- ▶ Quality commitment prior to price choices; no search costs
- ▶ **Non-overlapping product lines** soften competition

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In our model:

- ▶ If no search costs: similar result as C&R
- ▶ An infinitesimal amount of **search costs** destroy C&R's prediction
 - ▶ **Overlapping product lines**
 - ▶ Back to Bertrand: prices (almost) equal to marginal costs
- ▶ For all search costs: equilibrium with overlapping product lines
- ▶ For high search costs: it is the unique equilibrium

Varian (1980)

- ▶ Search costs; single product firms (no price discrimination)
- ▶ Search costs destroy pure-strategy equilibria
- ▶ **Mixed strategy** pricing implies price dispersion:
 - ▶ Across firms and over time (periods of *sales*)

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In our model:

- ▶ **Price discrimination within firms:** high/low types
- ▶ **Incentive compatibility** constrains pricing within the firm
- ▶ Predictions on price dispersion and relative prices depend on product lines

Other Related Literature

Search: single product firms, no scope for price discrimination

- ▶ Varian (AER, 1980); Burdett & Judd (Ecta, 1983)...
- ▶ Anderson & Renault (RJE, 1999); Wildenbeest (RJE, 2011)...

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Multi-product search: preference for one-stop shopping

- ▶ Rhodes and Zhou (2016), Zhou (AER, 2013), Rhodes (RES, 2014)

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Multi-product search: preference for one-stop shopping

- ▶ Rhodes and Zhou (2016), Zhou (AER, 2013), Rhodes (RES, 2014)

Price discrimination and imperfect competition

- ▶ Gal-Or (RJE, 1983), Stole (JEMS, 1995): no search costs
- ▶ Garret et al. (2016): no quality pre-commitment

The Model

- ▶ Two **products** $\{L, H\}$, with qualities $q^L < q^H$

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- ▶ Two **firms** must choose:
 - ▶ 1st stage: **product lines** in $\{\emptyset, L, H, LH\}$
 - ▶ Product choices observed by firms
 - ▶ 2nd stage: **prices** p^L and p^H

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 - ▶ 2nd stage: **prices** p^L and p^H
- ▶ **Cost** of production: $\Delta c \equiv c^H - c^L > 0$
- ▶ **Convex costs of quality**: $c^H/q^H > c^L/q^L$
- ▶ Fixed cost $\epsilon \rightarrow 0$ of carrying a product

The Model

- ▶ Goods are substitutes: each consumer buys **only one good**
- ▶ Consumers differ in their preference for quality:
 - ▶ utility of consumer $i \in \{L, H\}$ who buys product $j \in \{L, H\}$:

$$u^i = \theta^i q^j - p^j$$

- ▶ quality preferences: $\Delta\theta \equiv \theta^H - \theta^L > 0$
- ▶ $\lambda \in (0, 1)$ fraction of consumers are L -type

Preliminaries

- ▶ Prices must be **incentive compatible**: for $i, j = L, H$

$$\theta^i q^i - p^i \geq \theta^i q^j - p^j \quad (IC^i)$$

- ▶ or expressed as a function of **information rents**,

$$p^i \leq \theta^i q^i - (\theta^i q^j - p^j)$$

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- ▶ (IC-constrained) **monopoly prices** are:

$$p^L = \theta^L q^L$$

$$p^H = \theta^H q^H - \Delta\theta q^L$$

where $\Delta\theta q^L$ are the **information rents** of the H -types

Assumptions

The **monopolist** always finds it profitable to carry the full product line

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The **monopolist** always finds it profitable to carry the full product line

- ▶ (A1): $\lambda\pi^L > (1 - \lambda)\Delta\theta q^L$

The **competitive solution** is incentive compatible

- ▶ (A2): $\theta^L\Delta q < \Delta c < \theta^H\Delta q$

Escaping the Bertrand Paradox (no search costs)

Proposition

All (pure) SPE involve **non-overlapping** product choices:

- ▶ “monopolization” (LH, \emptyset) and “specialization” (L, H)
- ▶ Equilibrium prices are strictly above marginal costs

	\emptyset	L	H	LH
\emptyset	(\emptyset, \emptyset)	(\emptyset, L)	(\emptyset, H)	(\emptyset, LH)
L	(L, \emptyset)	(L, L)	(L, H)	(L, LH)
H	(H, \emptyset)	(H, L)	(H, H)	(H, LH)
LH	(LH, \emptyset)	(LH, L)	(LH, H)	(LH, LH)

Table 1: SPE in the game with no search costs

Escaping the Bertrand Paradox (no search costs)

Intuition:

- ▶ Non-overlapping: zero profits on overlapping products

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 - ▶ Equilibrium cannot have prices equal to **marginal costs**
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 - ▶ **Mixed strategies**: increase prices to make *IC* **binding**, or undercut

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 - ▶ **Mixed strategies**: increase prices to make *IC binding*, or undercut
- ▶ Deviation to (L, LH) : no profits on L , lower profits on H
 - ▶ Competition for L increases information rents of H -types
- ▶ Deviation to (LH, H) : no profits on H , (weakly) lower profits on L
 - ▶ Competition for H increases information rents of L -types

Back to the Bertrand Paradox (search costs)

Search costs à la Varian:

- ▶ μ fraction of consumers are *shoppers*: visit both stores
- ▶ $1 - \mu$ are *non-shoppers*: only visit one store at random
 - ▶ Main results robust to allowing for sophisticated non-shoppers
- ▶ Benchmarks: $\mu = 0$ (monopoly) and $\mu = 1$ (Bertrand)
- ▶ Search costs (μ) and quality preferences (λ) uncorrelated
 - ▶ Main results robust to allowing for correlation

Back to the Bertrand Paradox (search costs)

Proposition

Assume $\mu \rightarrow 1$.

There exists a SPE with **overlapping** product choices:

- ▶ If high c^H , (LH, LH) is the unique SPE.
- ▶ Otherwise, both (LH, LH) and (L, H) are SPE.

	\emptyset	L	H	LH
\emptyset	(\emptyset, \emptyset)	(\emptyset, L)	(\emptyset, H)	(\emptyset, LH)
L	(L, \emptyset)	(L, L)	(L, H)	(L, LH)
H	(H, \emptyset)	(H, L)	(H, H)	(H, LH)
LH	(LH, \emptyset)	(LH, L)	(LH, H)	(LH, LH)

Table 2: SPE product choices with search costs and low c^H

Back to the Bertrand Paradox

Intuition:

- ▶ “monopolization” not an equilibrium:
 - ▶ search costs create rents: entry is profitable

Back to the Bertrand Paradox

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 - ▶ firms are monopolists over the non-shoppers
 - ▶ competition vs discrimination trade-off not present
 - ▶ dropping a good would not allow for discrimination...
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 - ▶ and would not lead to higher profits on remaining good
- ▶ “specialization” not an equilibrium for c^H high:
 - ▶ firm L can add good H w/o affecting profits on L

Summing up so far...

Monopoly case, $\mu = 0$:

- ▶ Full product line; monopoly profits
- ▶ Driver: profits from **price discrimination** only

No search costs, $\mu = 1$:

- ▶ Non-overlapping products; prices $>$ marginal costs
- ▶ Driver: **softening competition** only

Arbitrarily small search costs, $\mu \rightarrow 1$:

- ▶ Equilibria with overlapping and non-overlapping products

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Arbitrarily small search costs, $\mu \rightarrow 1$:

- ▶ Equilibria with overlapping and non-overlapping products

What if search costs are neither very high nor very low?

Analysis of the General Model

Solve the game by backwards induction:

1. **Equilibrium pricing** at every possible subgame. For the presentation, focus on:
 - ▶ Full overlap: (LH, LH)
 - ▶ Partial overlap: (H, LH)
2. **Equilibrium product choices**
3. **Comparative statics**

Pricing Equilibrium: a general property

Lemma

In equilibrium, multi-product firms choose IC prices, i.e.,

$$\Delta p \in [\theta^L \Delta q, \theta^H \Delta q]$$

Pricing Equilibrium: a general property

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Intuition: discrimination is profitable

- ▶ If IC^H not satisfied: all consumers buy at p^L
- ▶ It's profitable to reduce p^H to satisfy IC^H , so as to sell it to the H types at a higher profit margin
- ▶ Similar if IC^L not satisfied
- ▶ Important departure from Varian (1980):
 - ▶ **Goods within a store cannot be priced independently**

Pricing under Full Overlap (LH,LH)

Proposition

Given (LH, LH), there does not exist a PSE.

Pricing under Full Overlap (LH,LH)

Proposition

Given (LH, LH), there does not exist a PSE. In any MSE,

- ▶ *Firms obtain a share of monopoly profits:*

$$\Pi(LH, LH) = \frac{1-\mu}{2} \left[\lambda\pi^L + (1-\lambda)(\pi^H - \Delta\theta q^L) \right]$$

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- ▶ At lower bound, good H is discounted relatively more

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Implications:

- ▶ Lower profits than when goods sold independently
- ▶ At lower bound, good H is discounted relatively more
- ▶ Potential equilibrium multiplicity, but **all payoff-equivalent:**

$$\Pi(LH, LH) = \frac{1+\mu}{2} \left[\lambda(\underline{p}^L - c^L) + (1-\lambda)(\underline{p}^H - c^H) \right]$$

Pricing under Full Overlap (LH,LH)

Proposition

Given product choices (LH, LH), there exists a MSE in which firms choose p^i in $[\underline{p}^i, \bar{p}^i]$, for $i = L, H$, according to

$$F^i(p^i) = \frac{1 + \mu}{2\mu} - \frac{1 - \mu}{2\mu} \frac{(\bar{p}^i - c^i)}{(p^i - c^i)}$$

where the upper bound prices \bar{p}^i are **(constrained) monopoly prices**, and

$$\underline{p}^i = c^i + \frac{1 - \mu}{1 + \mu} (\bar{p}^i - c^i) > c^i.$$

Relative markups are kept **constant** along the support,

$$\frac{p^H - c^H}{p^L - c^L} = \frac{\bar{p}^H - c^H}{\bar{p}^L - c^L}.$$

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where $\alpha = \frac{p^L - c^L}{\bar{p}^L - c^L}$ is larger for prices higher up in the support.

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- ▶ At the lower bound: $\alpha = (1 - \mu) / (1 + \mu)$. Hence:
- ▶ $\Delta p \rightarrow \Delta c$ as $\mu \rightarrow 1$ (no search costs)
- ▶ $\Delta p \rightarrow \theta^H \Delta q$ as $\mu \rightarrow 0$ (monopoly)

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Proposition

Given (H, LH) , (i) if μ **small**, there exists a unique PSE:

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- ▶ H firm sets the (unconstrained) monopoly price

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Intuition:

- ▶ Firm *LH*'s prices are IC-constrained; firm *H*'s are not
- ▶ Information rents create a wedge btw. the two firms' prices
- ▶ Firm *H* only serves the non-shopper *H*-types. Competing for the shoppers would require leaving information rents
- ▶ This is unprofitable if the mass of shoppers μ is small enough

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Implication:

- ▶ no price dispersion if high search costs and asymmetric firms

Partial product overlap (H,LH)

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Given (H, LH) , if μ large, unique MSE:

- ▶ Firm LH mixes $p^H \in [\underline{p}^H, \theta^H q^H - \Delta\theta q^L]$
- ▶ ...and chooses p^L so as to satisfy IC and participation constraints
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Given (H, LH), if μ large, unique MSE:

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- ▶ Competition for the shoppers destroys PSE
- ▶ Upper bound: monopoly prices (constrained or unconstrained)
- ▶ Firm H obtains a fraction of monopoly profits:

$$\Pi(H, LH) = \frac{1-\mu}{2}(1-\lambda)\pi^H$$

Equilibrium Product choices

Proposition

- ▶ (LH, LH) is a SPE for all $\mu < 1$.

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such that (L, H) is a SPE iff $\mu \geq \mu^*$.

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- ▶ Hence, (LH, LH) is the unique SPE iff $\mu < \mu^*$.
- ▶ c^H high is sufficient condition for uniqueness

Search Costs, Prices and Consumer Surplus

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- ▶ *There exists $\mu' \in (0, 1)$ such that expected prices are higher and CS lower w/o search costs than at $\mu \in (\mu', 1)$ if firms play (LH, LH).*

Implications:

- ▶ Reducing search costs is in general pro-competitive unless it induces firms to choose non-overlapping product lines.
- ▶ Greater concern when high quality provision is not too costly.

Search Costs and Consumer Surplus

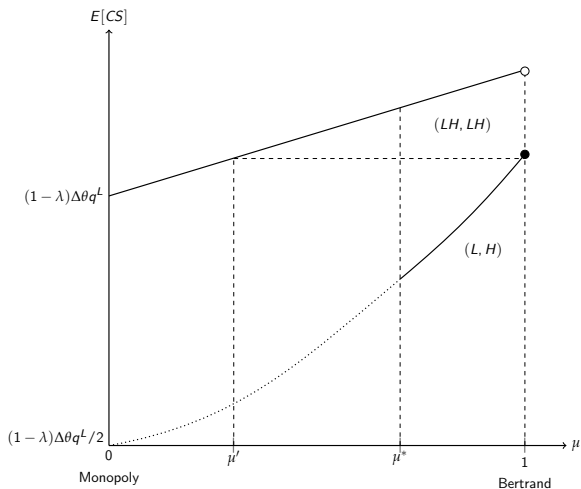


Figure 3: Equilibrium Product Choices under $c^H < \theta^L q^H$

Robustness

- ▶ N products; N consumer types; N firms
- ▶ Product choices known by consumers prior to search
- ▶ Correlation between search costs and quality types

Conclusions

Search costs impact market outcomes through **product choice**:

- ▶ They can give rise to overlapping product choices
- ▶ Small search costs can lead to head-to-head competition
- ▶ Not endogenizing product choice might lead to overestimating pro-competitive effects of reducing search costs

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Search costs impact market outcomes through **product choice**:

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Search costs interact with the ability to **price discriminate**:

- ▶ multi-product firms tend to charge lower prices
- ▶ markets with high search costs need not generate price dispersion

Thank You!

questions? comments?