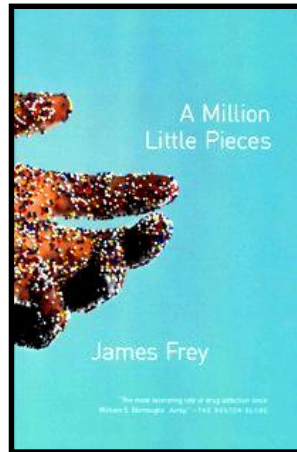


How Does Variance of Product Ratings Matter?

Monic Sun
Stanford University

Amazon's New Look



amazon.com

BARNES & NOBLE
www.bn.com

Customer Rating:



Average customer rating based on 6 comments:



Customer Reviews

1,792 Reviews

5 star:		(792)
4 star:		(254)
3 star:		(161)
2 star:		(130)
1 star:		(455)

Average Customer Review

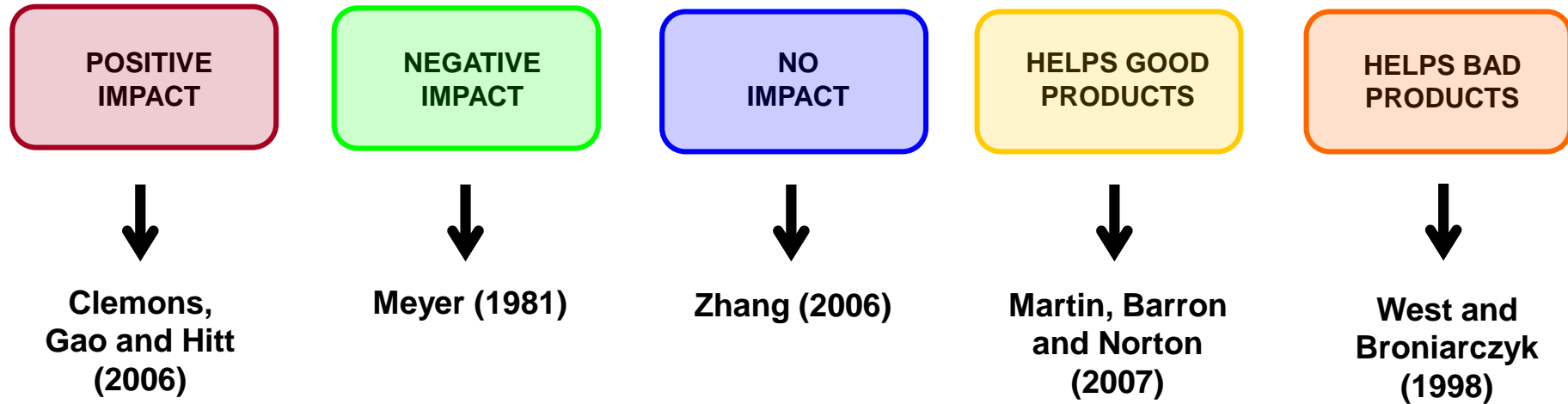
★★★★☆ (1,792 customer reviews)

new chart !

Research Questions

- ① How does price change with the variance?
- ② How does demand change with the variance?
- ③ How does profit change with the variance?

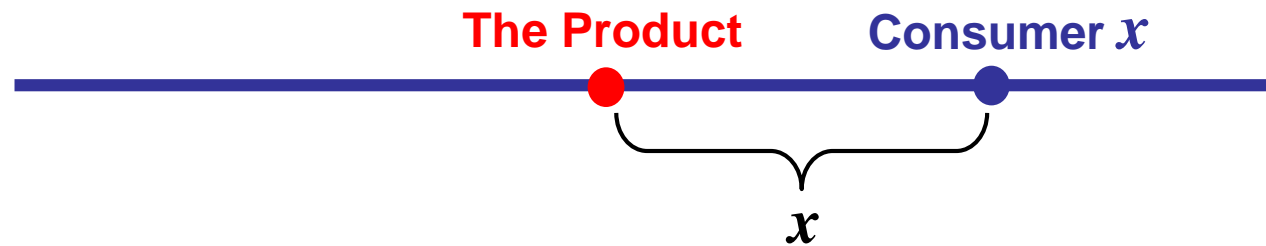
Literature Review



no consensus, little modeling, focus on demand

Baseline Model

- A seller and many risk-neutral consumers
- Consumers have different tastes



- each consumer knows his own taste x
- common knowledge: x is uniformly distributed on $[0,1]$

Consumer Utility

$$U(x) = v - t \cdot x - P$$

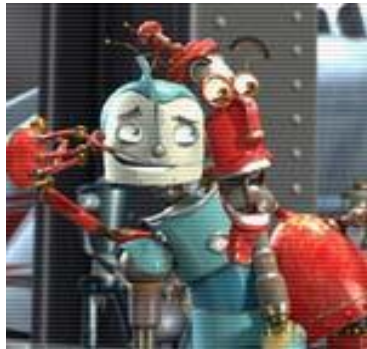
Product Attributes
Vertical Quality Mismatch Cost

Consumer Taste

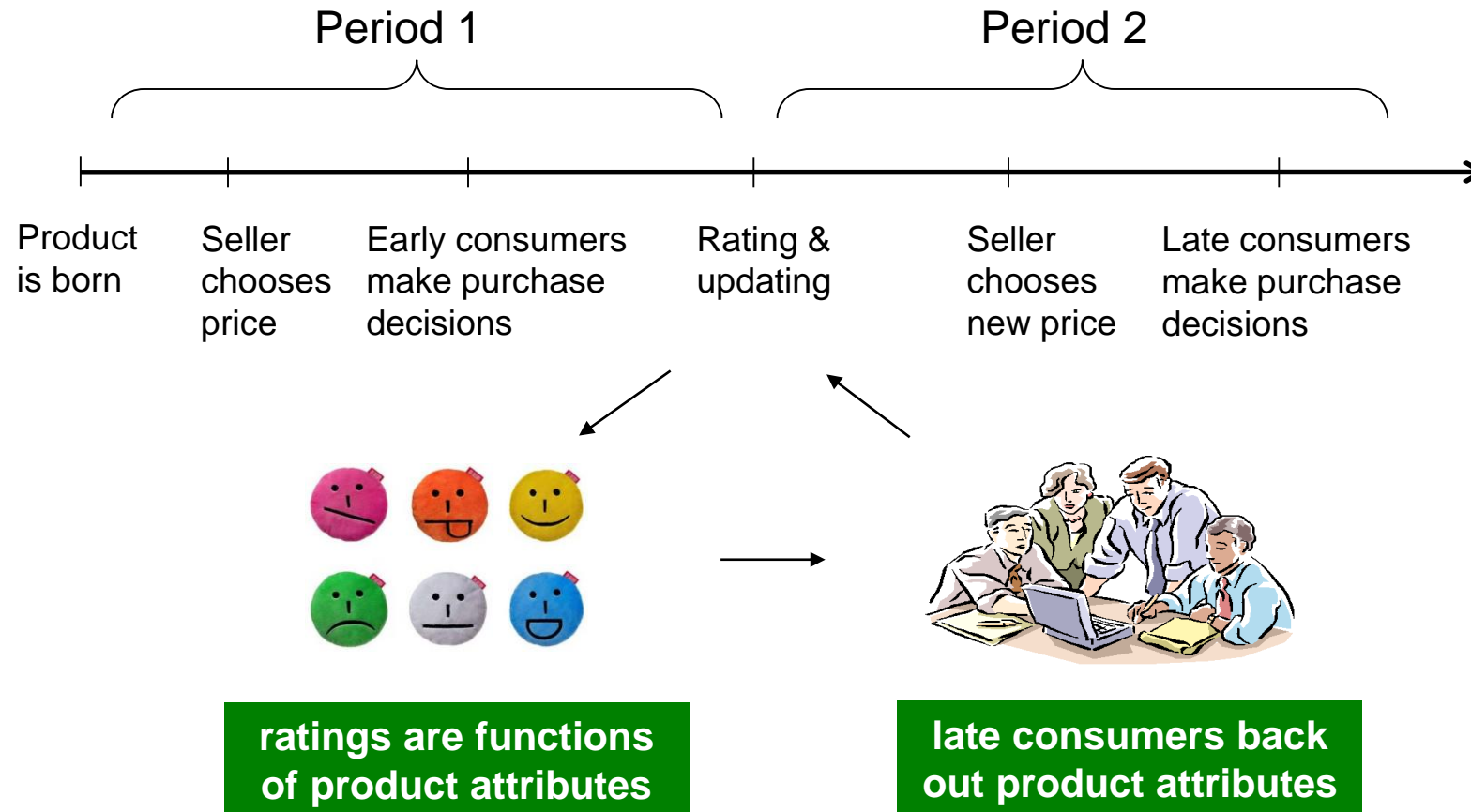
Price

- v and t are random variables

Example: Cartoon Films



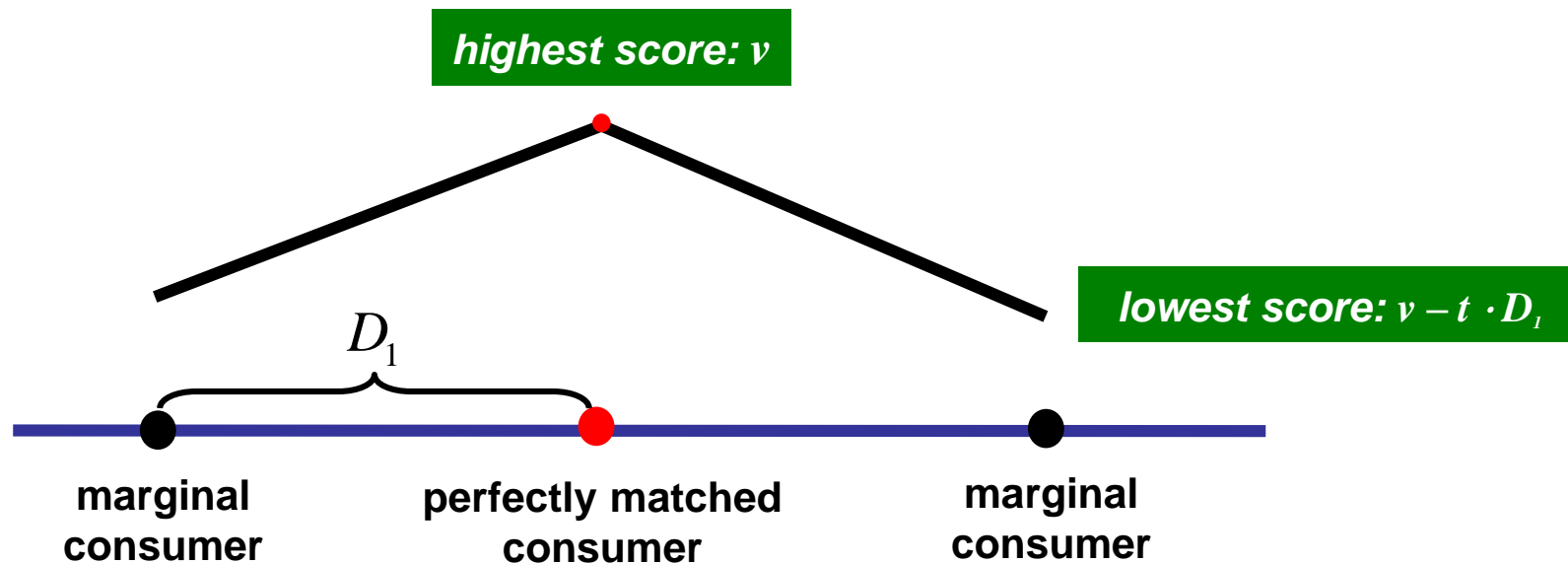
Product Life Cycle



Product Ratings

Rating formula:

$$S(x) = v - t \cdot x$$



Equilibrium Outcomes

consumer
updating

$$\begin{aligned} M &= v - \frac{1}{2}t \cdot D_1; \\ V &= \frac{1}{12}(t \cdot D_1)^2 \end{aligned} \quad \rightarrow \quad v = M + \sqrt{3V}; \quad t = \frac{2\sqrt{3V}}{D_1}$$

period 2
solution

$$\begin{aligned} \text{Max}_{P_2} \quad & P_2 \cdot D_2 \\ \text{s.t.} \quad & v - t \cdot D_2 - P_2 = 0 \end{aligned} \quad \rightarrow \quad P_2^* = \frac{v}{2}; \quad D_2^* = \frac{v}{2t}; \quad \Pi_2^* = \frac{v^2}{4t}$$

period 1
solution

$$\begin{aligned} \text{Max}_{P_1} \quad & P_1 \cdot D_1 \\ \text{s.t.} \quad & E(v) - E(t) \cdot D_1 - P_1 = 0 \end{aligned} \quad \rightarrow \quad P_1^* = \frac{E(v)}{2}; \quad D_1^* = \frac{E(v)}{2E(t)}; \quad \Pi_1^* = \frac{E(v)^2}{4E(t)}$$

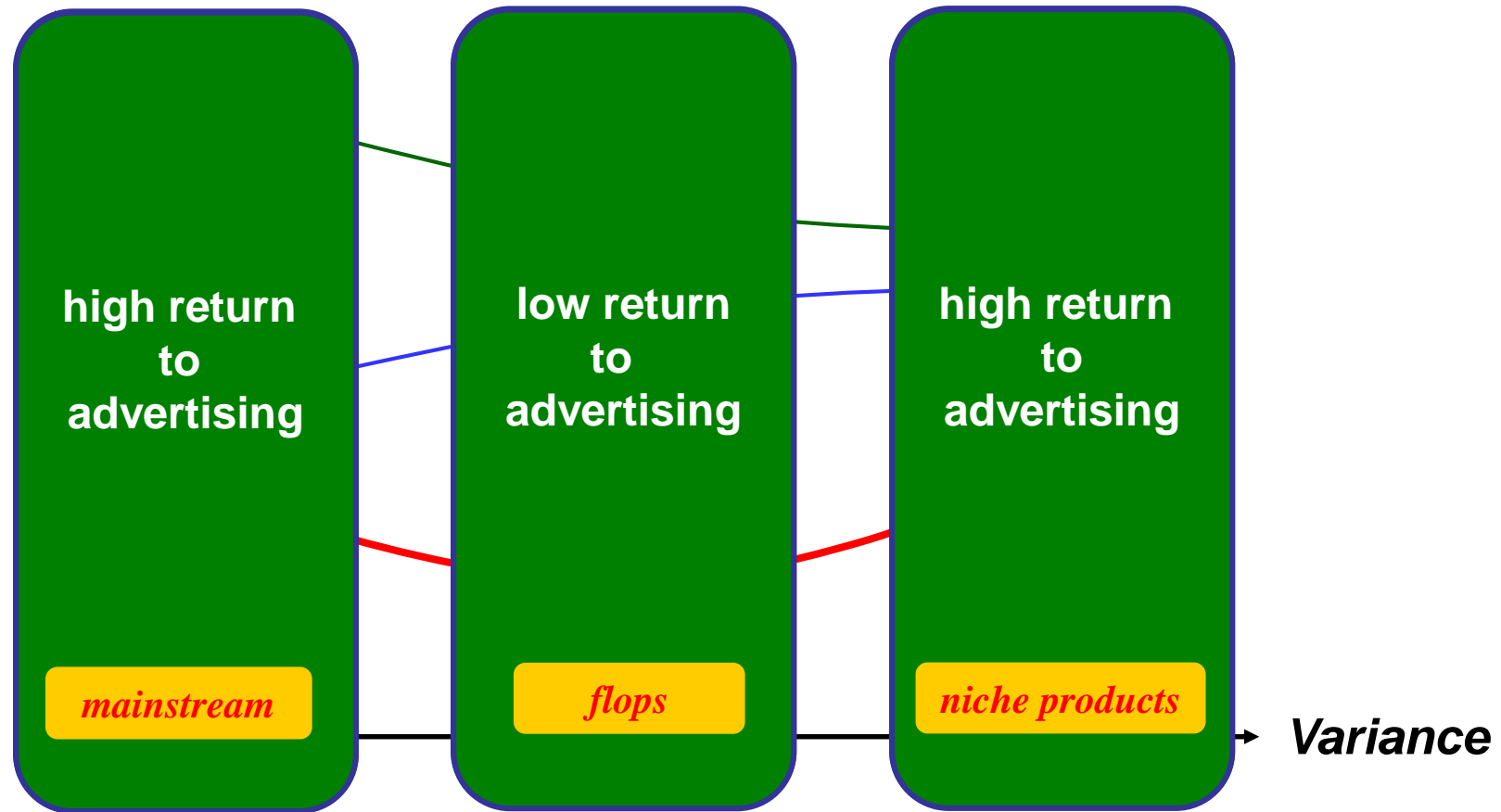
Ratings' Impact: what we already know

$$P_2^* = \frac{M + \sqrt{3V}}{2}; \quad D_2^* = \frac{D_1}{4} \left(\frac{M}{\sqrt{3V}} + 1 \right); \quad \Pi_2^* = \frac{D_1}{4} \left(\frac{M^2}{\sqrt{3V}} + \sqrt{3V} + 2M \right).$$

- 1 Price increases over time for high-variance products (Bergemann & Välimäki 2006)
- 2 Higher average rating increases price, demand, and profit (Elberse & Eliashberg 2003; Chevalier & Mayzlin 2006; Cao & Gruca 2004; Bruce, Haruvy & Rao 2004)

Ratings' Impact: what we did not know

FOR A GIVEN, HIGH, AVERAGE RATING



Test I: Motion Pictures

Test how first day box office responds to variance of pre-release critic ratings

Why movies?

- billion dollar industry
- differentiated consumer tastes
- fixed price
- disagreement often a salient cue

Motion Pictures Data

403 wide-release movies in 2002-2006

- sources: boxofficemojo.com & metacritic.com
- # of ratings **21.3**; average score 55.1 points
- SD **15.1** points; SD of SD **3.7** points
- first day BO \$7.9m

Incorporating Fixed Price

$$D_2 = C_1 \cdot \left(\frac{M - P}{2\sqrt{3V}} + \frac{1}{2} \right)$$

first day demand

ticket price

of pre-release critic ratings

- P1** First day BO increases with average rating
- P2** First day BO increases with variance iff $M < P$

Impact of Critic Ratings

Dependent Variable: Log (first day BO)		
Average Rating	0.007**	0.025***
SD of Ratings	-0.006	0.057*
AR * SD		-0.001**
No. of Ratings	0.016	0.017*

Observations: 403

- BO \nearrow with SD iff AR < 57, true for 57% movies
- BO \nearrow with AR iff SD < 25, true for 99% movies

Test II: Books

Test how book sales respond to variance of consumer ratings

Why books?

- ratings and reviews are proven to be considered
- DID approach: Chevalier & Mayzlin 06
- public data source

Book Data: Jan 2009

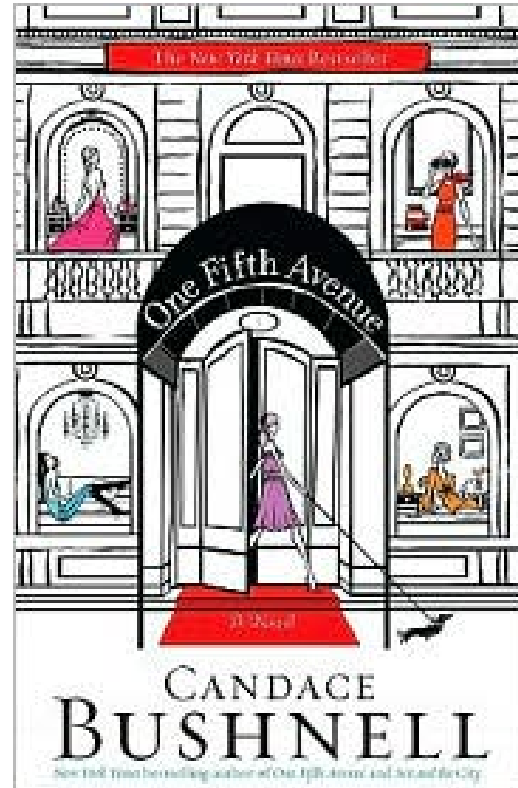
892 random books from the bestseller section of Global Books in Print

	Amazon	BN
Sales Rank	228,804	127,183
Price	12.59	15.53
# Reviews	125.97	32.94
Average Rating	3.61	4.47
SD of Ratings	1.39	0.66

Dependent Variable: Ln(A rank) - Ln(B rank)			
Amazon ln(Price)	2.153***	2.152***	2.192***
BN ln(price)	-2.207***	-2.206***	-2.238***
Amazon ln(No. of Ratings)	-0.109**	-0.106**	-0.096**
BN ln(No. of Ratings)	0.066**	0.069**	0.070*
Amazon Average Rating	-0.124*	-0.183	-0.681**
BN Average Rating	0.097*	0.095	0.102
Amazon SD of Ratings		-0.112	-1.496*
BN SD of Ratings		-0.016	-0.079
Amazon AR*SD			0.371*
BN AR*SD			0.012

Observations: 892

Difference-in-Differences



One Fifth Avenue

by [Candace Bushnell](#)

(Paperback - Reprint)

Reader Rating: ★★★★★ (54 ratings)

Detailed Rating:

"Book Cover" See All ▾

> [Read customer reviews](#) [Write a Review](#)

- Pub. Date: June 2009
- 464pp
- Sales Rank: 4,301


• Available in **DIGITAL** eBook **\$15.16**

More Formats	Online Price
Hardcover	\$20.76
Paperback - Bargain	\$4.98
Compact Disc - Abridged, 7 CDs, 8 hrs.	\$14.99
MP3 Book - Abridged	\$7.46

DID: Books with <30 reviews

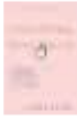
Sort by: **Newest** | Highest Rating | Most Helpful

Showing 1 - 5 of 23 | [Next](#)



penname96

I Also Recommend:




pleasantly surprised

★★★★☆ Reader Rating [See Detailed Ratings](#)

Posted August 28, 2009, 6:52 PM EST: This book has been in my book pile for awhile. It was like a movie that you really don't want to go see, but are dragged to, then you are pleasantly surprised. No, this is not a "Sex In the City" book. This is a fresh story about people who live at One Fifth Ave and how their everyday lives are entangled. I enjoyed and recommend.

Was this review helpful? [Permalink](#) [Flag this Review](#)

0 out of 0 people found this review helpful.



Fun Read

★★★★★ Reader Rating [See Detailed Ratings](#)

Posted July 11, 2009, 9:34 AM EST: Full of interesting and very real characters. I thought the plot was focused and even though I have never lived in New York I was able to appreciate the setting and life style of the characters. I understood and could relate to each character as an individual. I also appreciate that the story line came back around. There were several characters introduced throughout the story and it was clear how each character was related to the story and had significance to each other. I loved the book and was happy I took the time to read it!

Summary Stats of 87 books

	<u>January 09</u>		<u>May 09</u>	
	Amazon	BN	Amazon	BN
Sales Rank	297,815	154,935	407,117	200,417
Price	11.59	15.53	11.78	14.13
# Reviews	20.8	4.8	15.9	5.1
Average Rating	3.38	4.37	4.08	4.35
SD of Ratings	1.47	0.75	1.13	0.77

Dependent Variable: $\Delta\{\text{Ln}(\text{A rank}) - \text{Ln}(\text{B rank})\}$			
Amazon $\Delta\ln(\text{Price})$	1.347***	1.377***	1.599***
BN $\Delta\ln(\text{price})$	-2.551***	-2.784***	-2.926***
Amazon $\Delta\ln(\text{No. of Ratings})$	-0.130	-0.062	-0.246
BN $\Delta\ln(\text{No. of Ratings})$	0.578	0.456	-0.049
Amazon $\Delta\text{Average Rating}$	0.268	0.655	-1.191*
BN $\Delta\text{Average Rating}$	-0.584	-1.501	-5.424**
Amazon $\Delta\text{SD of Ratings}$		0.610	-4.472**
BN $\Delta\text{SD of Ratings}$		-0.744	-12.964
Amazon $\Delta\text{AR}*\text{SD}$			1.068**
BN $\Delta\text{AR}*\text{SD}$			2.449
R square	0.29	0.31	0.39

Sales ↗ with SD if AR < 4.19, true for 56% books

Test III: Computer Products

Goals

- how does price change when chart appears?
- when does seller show the chart?



- Newegg pioneered the chart
- both are leading sellers of computer products

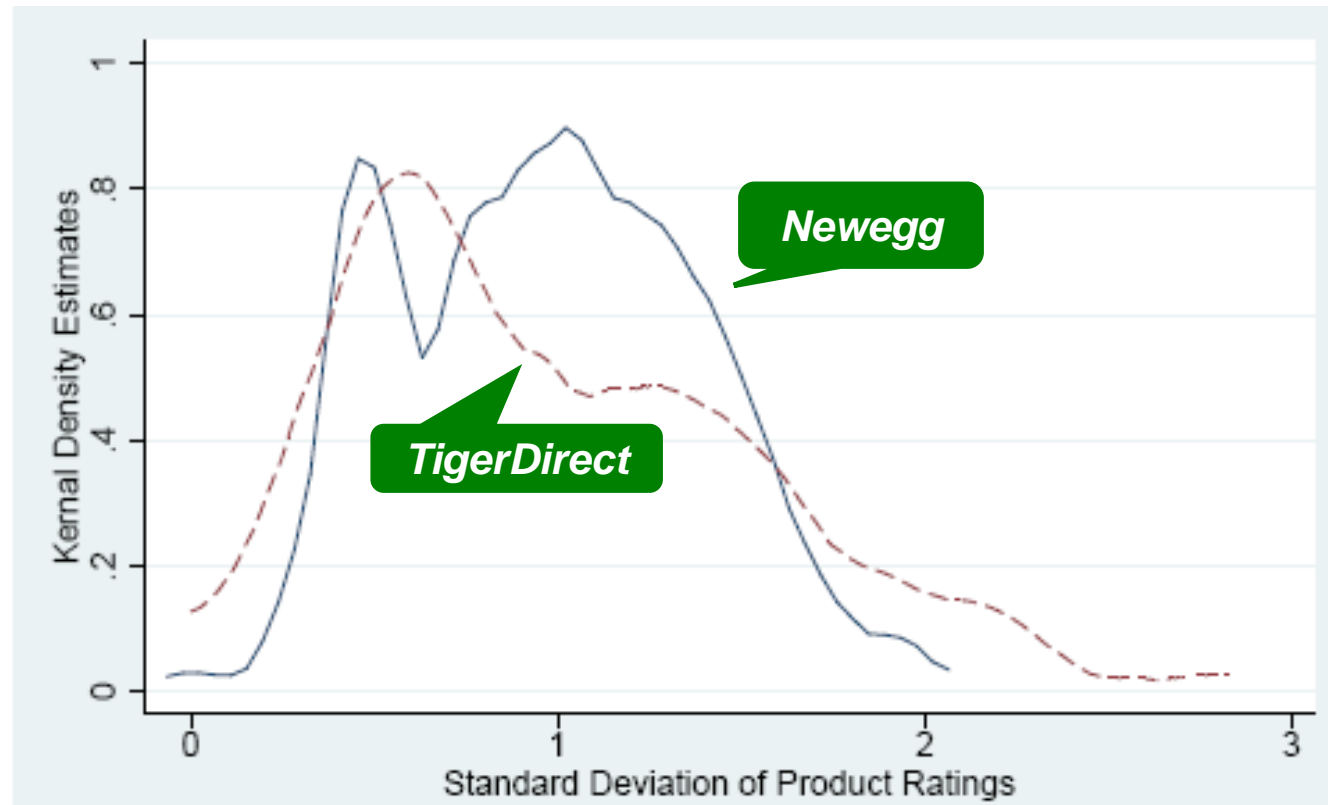
Price Comparison

P3 Price difference increases with SD of ratings

Dependent Variable: Newegg Price – TigerDirect Price	
Newegg SD of Ratings	3.916***
Average Rating	2.047**
Average No. of Ratings	0.005
Observations	1002

Product Pool Comparison

- P4 Newegg sells higher fractions of mainstream & niche products



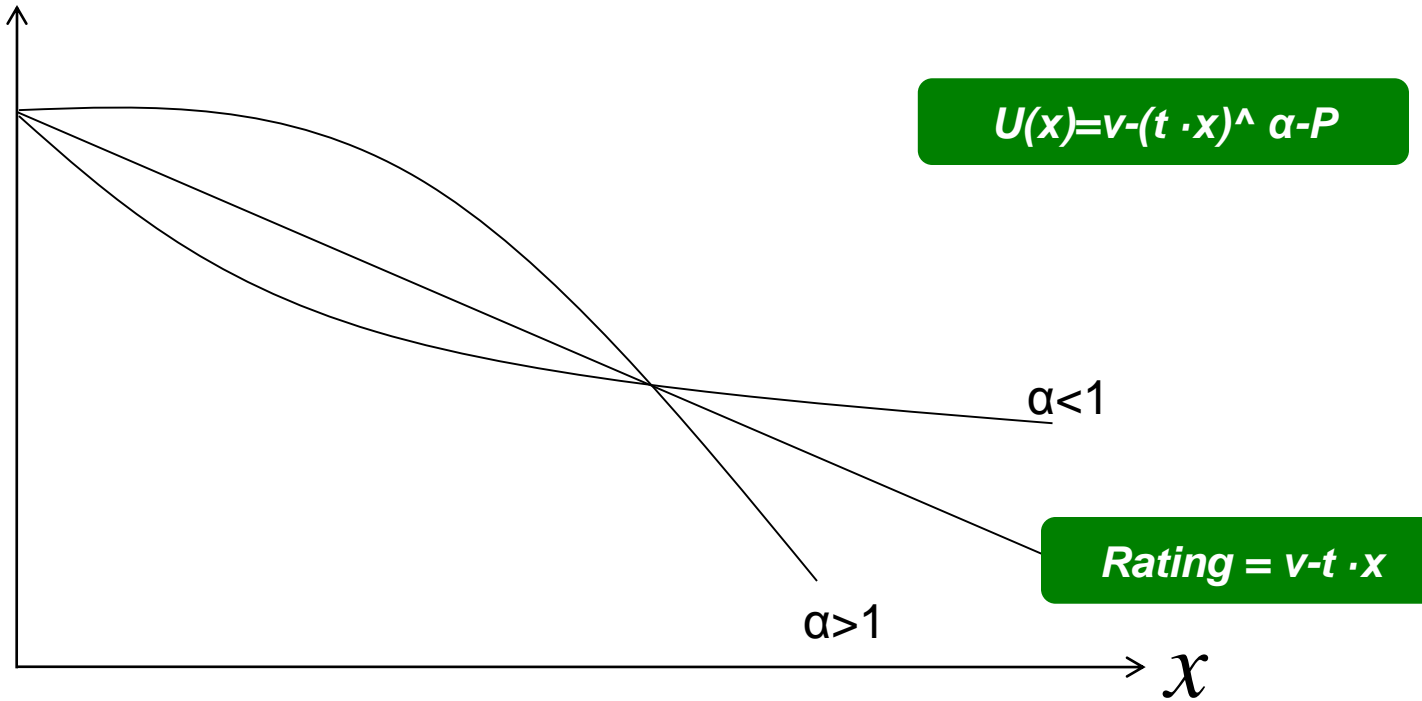
Contributions

- 1** First model on consumer disagreement
(U shape helps unify mixed evidence)
- 2** First empirical analysis on rating distribution
(interaction term is crucial)
- 3** New rules of thumb for managers
(pricing, advertising, chart)

Thank You!

monic@stanford.edu

Boundary Conditions



- demand always increases with variance if $\alpha < \frac{1}{4} \frac{E(v)}{\bar{v}} \frac{t}{E(t)}$
- demand always decreases with variance if $\alpha < \frac{1}{4} \frac{E(v)}{\bar{v}} \frac{t}{E(t)}$

Consumer Waiting

- 71% online shoppers seek out product reviews
- Model change: d , n
- Higher variance leads to higher price iff $n > 1$
- Lower first-period price (even lower with high d)

Duopolistic Competition

- Competition may overturn effect of ratings
- Model change: Firms A & B located at each end
- **When does high variance help?**
 - low average rating
 - competitor has high average rating and low SD

Variance & Reliability

Contradict Empirical Results

- v with probability p , rating is v
- 0 with probability $1-p$, rating is 0 , inconvenience cost is c
- expected utility $p \cdot v - (1-p) \cdot c$ **decreases** in variance

Comments with One-Star Reviews

- I gave it one not because the board cannot perform. Mainly want to warn others if you are going to install win2k avoid this board...
- Panda 2007 is a good product, IF.. you never need tech support.

User Ratings

235 wide-release movies in Jan 2002-Sept. 2004

- source: Yahoo! Movies
- # of ratings 4,097; SD of 6,048
- average score 9.1/13 points
- SD 3.7 points; SD of SD 0.7 points

Impact of User Ratings

Dependent Variable: Log (first day BO)		
Average Critic Rating	0.018*	0.019*
SD of Critic Ratings	0.084***	0.083***
AR * SD Critic Ratings	-0.002***	-0.002***
No. of Critic Ratings	0.069***	0.069***
Average User Rating	0.072	0.578***
SD of User Ratings	-0.039	1.231**
AR * SD User Ratings		-0.124***
No. of User Ratings	0.000	0.000

Observations: 235