Price Dispersion and Loss- Leader Pricing: Evidence from the Online Book Industry

박미소 / 김종원

1. Introduction

Price Dispersion

Different retailers price differently on a same price

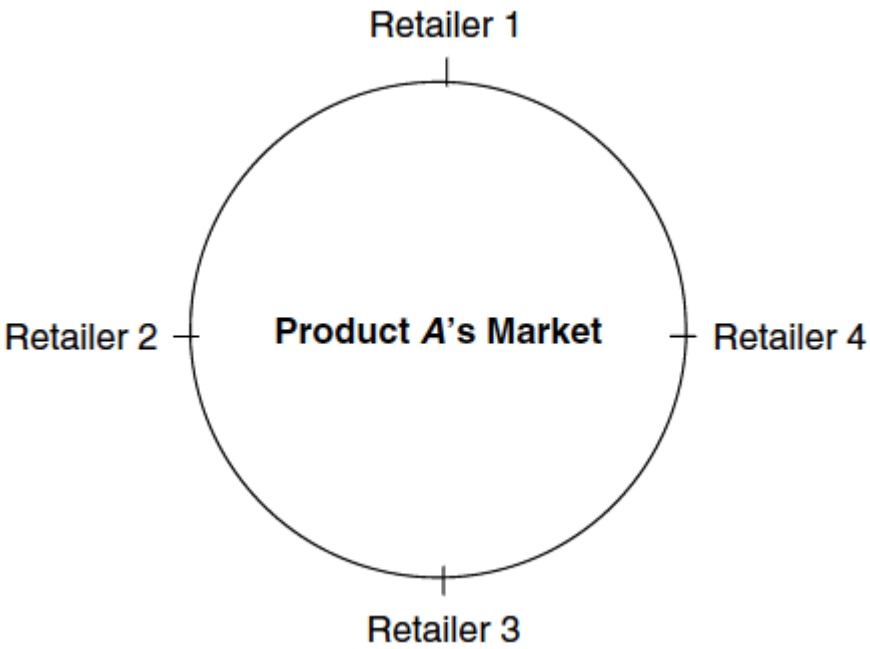
Loss-Leader Pricing

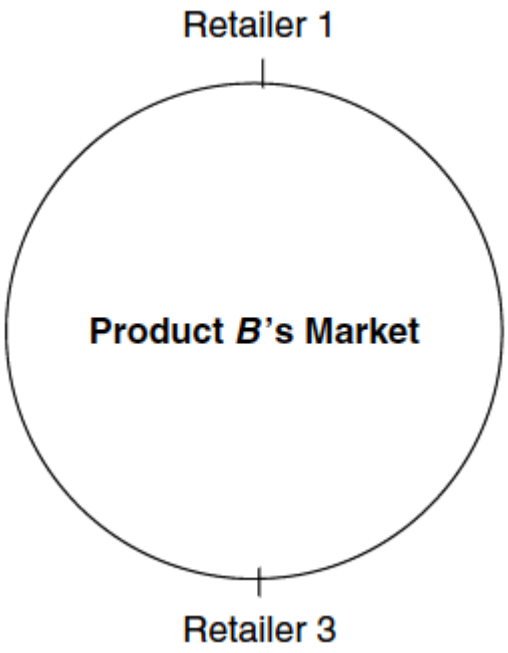
Retailers price below the cost in order to get more customers and take profit from other products

3. Analytical Model

3.1. A Model of Loss-Leader Pricing

Utility : $v - p_{jk} - t|x - x_j|$





(reference : Monopolistic competition with outside goods, Salop, 1979)

3. Analytical Model

3.1. A Model of Loss-Leader Pricing

Not considering cross-selling

$$\pi_1^D(p_{1A}, p_{1B}) = p_{1A}\left(\frac{t/4 - p_{1A} + p_{2A}}{2t} + \frac{t/4 - p_{1A} + p_{4A}}{2t}\right)d + p_{1B}\left(\frac{t/2 - p_{1B} + p_{3B}}{t}\right), \quad (1)$$

$$\pi_2^D(p_{2A}) = p_{2A}\left(\frac{t/4 - p_{2A} + p_{1A}}{2t} + \frac{t/4 - p_{2A} + p_{3A}}{2t}\right)d, \quad (2)$$

$$\pi_3^D(p_{3A}, p_{3B}) = p_{3A}\left(\frac{t/4 - p_{3A} + p_{2A}}{2t} + \frac{t/4 - p_{3A} + p_{4A}}{2t}\right)d + p_{3B}\left(\frac{t/2 - p_{3B} + p_{1B}}{t}\right), \quad (3)$$

$$\pi_4^D(p_{4A}) = p_{4A}\left(\frac{t/4 - p_{4A} + p_{3A}}{2t} + \frac{t/4 - p_{4A} + p_{1A}}{2t}\right)d, \quad (4)$$

3. Analytical Model

3.1. A Model of Loss-Leader Pricing

Considering cross-selling

$$\pi_1(p_{1A}, p_{1B}) = (p_{1A} + bp_{1B})\left(\frac{t/4 - p_{1A} + p_{2A}}{2t} + \frac{t/4 - p_{1A} + p_{4A}}{2t}\right)d + \left(p_{1B} + \frac{1}{2}bp_{1A}\right)\left(\frac{t/2 - p_{1B} + p_{3B}}{t}\right) + \frac{1}{2}bp_{1A}\left(\frac{t/4 - p_{1A} + p_{2A}}{2t} + \frac{t/4 - p_{1A} + p_{4A}}{2t}\right), \quad (5)$$

$$\pi_2(p_{2A}) = p_{2A}\left(\frac{t/4 - p_{2A} + p_{1A}}{2t} + \frac{t/4 - p_{2A} + p_{3A}}{2t}\right)d + \frac{1}{2}bp_{2A}\left(\frac{t/4 - p_{2A} + p_{1A}}{2t} + \frac{t/4 - p_{2A} + p_{3A}}{2t}\right), \quad (6)$$

$$\pi_3(p_{3A}, p_{3B}) = (p_{3A} + bp_{3B})\left(\frac{t/4 - p_{3A} + p_{2A}}{2t} + \frac{t/4 - p_{3A} + p_{4A}}{2t}\right)d + \left(p_{3B} + \frac{1}{2}bp_{3A}\right)\left(\frac{t/2 - p_{3B} + p_{1B}}{t}\right) + \frac{1}{2}bp_{3A}\left(\frac{t/4 - p_{3A} + p_{2A}}{2t} + \frac{t/4 - p_{3A} + p_{4A}}{2t}\right), \quad (7)$$

$$\pi_4(p_{4A}) = p_{4A}\left(\frac{t/4 - p_{4A} + p_{3A}}{2t} + \frac{t/4 - p_{4A} + p_{1A}}{2t}\right)d + \frac{1}{2}bp_{4A}\left(\frac{t/4 - p_{4A} + p_{3A}}{2t} + \frac{t/4 - p_{4A} + p_{1A}}{2t}\right), \quad (8)$$

3. Analytical Model

3.2. Model Predictions and Hypotheses

By partially differentiating the profit functions by each p_{jk}'s, we can obtain these optimal values.

$$p_{1A}^{*} = p_{3A}^{*} = \frac{(6d - b(6bd^2 + 8d - 7))t}{4(6d - b(2bd(1+d) - 3))}, \tag{9}$$

$$p_{1B}^{*} = p_{3B}^{*} = \frac{(24d + b(12 - 7b + 2(-3+b)d + 12d^2))t}{8(6d - b(2bd(1+d) - 3))}, \tag{10}$$

$$p_{2A}^{*} = p_{4A}^{*} = \frac{(6d - b(d(4 + b + 4bd) - 5))t}{4(6d - b(2bd(1+d) - 3))}. \tag{11}$$

3. Analytical Model

3.2. Model Predictions and Hypotheses

Result 1. A's demand ↑ => 1 and 3 reduce prices

$$\partial p_{1A}^*/\partial d = \partial p_{3A}^*/\partial d < \partial p_{2A}^*/\partial d = \partial p_{4A}^*/\partial d < 0$$

Result 2. A's demand ↑ => A's dispersion increases when A's demand is not too low.

$$(\partial \text{Variance}(p_{1A}^*, p_{2A}^*, p_{3A}^*, p_{4A}^*))/\partial d > 0 \text{ if } d > 1/2.$$

Result 3. 1 and 3 set lower prices than 2 and 3 when A's demand is not too low.

$$p_{1A}^* = p_{3A}^* < p_{2A}^* = p_{4A}^* \text{ if } d > 1/2$$

1 and 3 charge a price below cost but 2 and 4 don't when A's demand is sufficiently high

$$p_{1A}^* = p_{3A}^* < 0 \text{ if } d > (3 - 4b + \sqrt{9 + 2b(-12 + b(8 + 21b))})/(6b^2) \qquad p_{2A}^* = p_{4A}^* \geq 0.$$

3. Analytical Model

3.2. Model Predictions and Hypotheses

Hypothesis 1 (H1)

Retailers with high cross-selling capabilities are likely to lower prices more than retailers with low cross-selling capabilities when the demand for a product increases.

Hypothesis 2A (H2A)

Demand increases lead to higher observed price dispersion across all retailers.

Hypothesis 2B (H2B)

The increase in overall observed price dispersion when product demand increases is mainly driven by the price difference between retailers with high across-selling capabilities and those with low cross-selling capabilities.

4. Empirical Analysis

4.1. Data Description

Hard cover books in *Books in Print* :

(i) Active status

(ii) Written in English

(iii) Published Jan. 2000 – Feb. 2004

Best sellers : at least 1 review by *Books in Print* or *Publishers Weekly* best-seller list (Jan. 1, 2000 – Feb. 9, 2004)

→ Sample books : 2,651 books

4. Empirical Analysis

4.1. Data Description

Price data

each week between Mar. 5, 2004 – Oct. 25, 2004

pricescan.com → 22 online bookstores

(book prices, shipping costs,

availability from 22 bookstores)

Price may not be actively monitored

→ Final sample : 1,614 books

(i) "ships within 24 hours" both on Amazon and Barnes & Noble

(ii) Book appears on pricescan.com during the period

Table 1 Summary Statistics across Bookstores

Bookstore	(1) Average price ($)	(2) Average shipping cost ($)	(3) Average price as a percentage of list price (%)	(4) Multicategory retailer	(5) Book coverage (%)
A1Books	12.99	2.99	52.40	No	99.92
AllDirect	15.42	3.45	62.29	No	96.87
Amazon	17.19	4.48	69.72	Yes	100.00
Barnes & Noble	20.39	3.54	82.43	No	99.51
BCY	16.52	4.00	66.67	No	91.21
BiggerBooks	18.15	3.97	73.36	No	100.00
Blackwell	24.70	0.00	99.78	No	99.06
BookCloseouts	6.68	4.00	27.83	No	69.37
Books-A-Million	18.36	3.95	74.18	No	100.00
Buy	16.43	2.40	66.48	Yes	96.94
eCampus	18.52	3.97	74.88	No	99.81
HamiltonBook	10.92	3.90	41.63	No	55.60
Overstock	14.45	1.40	59.57	Yes	94.42
Page 1	17.89	3.95	72.74	No	97.10
Powell's	20.08	3.50	81.36	No	98.57
Reiter's	27.74	5.00	100.10	No	21.46
San Diego Technical	20.81	5.00	84.85	No	91.85
Textbookx	16.53	3.58	66.72	No	97.70
TotalCampus	16.25	3.49	66.79	No	65.30
VarsityBooks	24.74	4.95	100.03	No	99.81
Walmart	15.67	2.48	63.57	Yes	98.00
WordsWorth	22.56	4.95	91.88	No	97.66
All bookstores	17.86	3.59	71.79	N/A	89.55

4. Empirical Analysis

4.1. Data Description

Dummy Variable

-to assess the cross-selling capability :
multi category / book coverage

-to consider the best-seller for a given week :
BestSellerDummy (*Publishers Weekly ?*)

-to consider the competition from paperback edition for a given week :
PaperBackDummy

Age : # of days passed since the release

4. Empirical Analysis

4.2. Empirical Models

Hypothesis 1 (H1)

$$\log(Price_{ijt}) = \beta_1 BestSellerDummy_{it} + \beta_2(BestSellerDummy_{it} \times Multicategory_j) + \beta_3(BestSellerDummy_{it} \times BookCoverage_j) + \beta_4 logAge_{it} + \beta_5 PaperbackDummy_{it} + \theta_i + \delta_j + \tau_t + \varepsilon_{ijt}$$

Higher cross-selling capability → reduce price more

$\therefore\ \beta_2 < 0\ ,\ \beta_3 < 0$?

Table 2 Summary Correlation Matrix for Major Independent Variables

Variables	(1)	(2)	(3)	(4)	(5)
(1) *BestSellerDummy*	1				
(2) log *Age*	–0.00	1			
(3) *PaperbackDummy*	–0.02	0.61	1		
(4) *Multicategory*	0.00	0.00	0.00	1	
(5) *BookCoverage*	0.00	0.00	0.00	0.23	1

4. Empirical Analysis

4.2. Empirical Models

Hypothesis 2A (H2A)

$$\log(PriceVariance_{it}) = \beta_1 BestSellerDummy_{it} + \beta_2 logAge_{it} + \beta_3 PaperbackDummy_{it} + \theta_i + \tau_t + \varepsilon_{it}$$

Higher demand → increase price dispersion

$\therefore\ \beta_1 > 0$?

4. Empirical Analysis

4.2. Empirical Models

Hypothesis 2B (H2B)

$$PriceVariance_{it} = aPriceVariance\_HIGH_{it} + bPriceVariance\_LOW_{it} + ab(AvgPrice\_HIGH_{it} - AvgPrice\_LOW_{it})^2$$

$$a = \frac{NumStores\_HIGH}{NumStores\_HIGH + NumStores\_LOW}$$

$$b = \frac{NumStores\_LOW}{NumStores\_HIGH + NumStores\_LOW}$$

4. Empirical Analysis

4.2. Empirical Models

$$\log(PriceVariance\_HIGH_{it}) = \beta_1^H BestSellerDummy_{it} + \beta_2^H logAge_{it} + \beta_3^H PaperbackDummy_{it} + \theta_i^H + \tau_t^H + \varepsilon_{it}^H$$

$$\log(PriceVariance\_LOW_{it}) = \beta_1^L BestSellerDummy_{it} + \beta_2^L logAge_{it} + \beta_3^L PaperbackDummy_{it} + \theta_i^L + \tau_t^L + \varepsilon_{it}^L$$

$$\log[(AvgPrice\_HIGH_{it} - AvgPrice\_LOW_{it})^2] = \beta_1^P BestSellerDummy_{it} + \beta_2^P logAge_{it} + \beta_3^P PaperbackDummy_{it} + \theta_i^P + \tau_t^P + \varepsilon_{it}^P$$

price dispersion → mainly by the price difference between two groups

$\therefore\ \beta_1^P \gg \beta_1^H, \beta_1^L$?

4. Empirical Analysis

4.3. Regression Results

H1 : $\beta_2 < 0$, $\beta_3 < 0$

→ statistically significant (α=0.01)

∴ Retailers with high cross-selling capability decrease price more !

Table 3 Regression Analysis of Pricing Strategy

	OLS	WLS
BestSellerDummy	0.320***	0.326***
	(0.075)	(0.076)
BestSellerDummy × *Multicategory*	−0.073***	−0.074***
	(0.011)	(0.011)
BestSellerDummy × *BookCoverage*	−0.335***	−0.342***
	(0.078)	(0.079)
PaperbackDummy	−0.004	−0.004
	(0.003)	(0.003)
log *Age*	0.023***	0.024***
	(0.003)	(0.003)
R^2	73.14%	73.22%
Number of observations	904,307	904,307

Notes. Coefficients for product fixed effects, time fixed effects, and store fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

***$p < 0.01$.

4. Empirical Analysis

4.3. Regression Results

H2A : $\beta_1 > 0 \rightarrow$ statistically significant ($\alpha = 0.01$)

$\therefore$ Higher demand increases price dispersion!

Table 4 Regression Analysis of Price Dispersion

	Overall price dispersion	Price dispersion among retailers with high cross-selling capability	Price dispersion among retailers with low cross-selling capability	Price difference between the two retailer groups
BestSellerDummy	0.055***	0.048	−0.015	0.503**
	(0.018)	(0.045)	(0.033)	(0.207)
PaperbackDummy	0.042***	−0.032	0.103***	−0.153
	(0.012)	(0.023)	(0.017)	(0.096)
log *Age*	0.078***	−0.166***	0.182***	1.333***
	(0.015)	(0.025)	(0.023)	(0.102)
R^2 [a]	87.75%		72.95%	
Number of observations[b]	54,876		54,876	

Notes. Coefficients for product fixed effects and time fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]For seemingly unrelated regressions, the system weighted R^2 provided by SAS is reported.

[b]We have fewer observations than Table 3 because the regressions for prices are conducted at the retailer level, whereas the regressions for price dispersion are conducted at the market level.

**$p < 0.05$; ***$p < 0.01$.

4. Empirical Analysis

4.3. Regression Results

H2B : $\beta_1^P \gg \beta_1^H, \beta_1^L \rightarrow$ statistically significant ($\alpha = 0.05$)

$\therefore$ Price difference between two groups is the main factor of increased price dispersion of best-sellers

Table 4 Regression Analysis of Price Dispersion

	Overall price dispersion	Price dispersion among retailers with high cross-selling capability	Price dispersion among retailers with low cross-selling capability	Price difference between the two retailer groups
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PaperbackDummy	0.042***	−0.032	0.103***	−0.153
	(0.012)	(0.023)	(0.017)	(0.096)
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**$p < 0.05$; ***$p < 0.01$.

4. Empirical Analysis

4.4. Robustness Analysis

Robustness

the ability to perform well even if its assumptions are somewhat violated from original models

4. Empirical Analysis

4.4. Robustness Analysis

(1) Takes time to adjust prices after demand shock
→ lagged *BestSellerDummy*

(2) Demand before getting into the 'best-seller list' could also influence retailers' pricing strategy
→ lagged *AmazonSalesRank*

(3) Corresponding paperback could make it to the best-seller list
→ *PaperbackBestSellerDummy*

4. Empirical Analysis

4.4. Robustness Analysis

(4) The way to group 22 bookstores can be different
→ not split into equal size

(5) Price dispersion can be measured by other criteria
→ coefficient of variation (CV)

4. Empirical Analysis

4.4. Robustness Analysis

(6) Proxy of cross-selling capability could differ reputation / scale / physical store presence

→ *Reach* : % of Internet users visiting a retailer
→ *Popularity* : relative # of searches on a retailer
→ *DualChannel* : both online and offline (dummy)

Table 5 Robustness Analysis of Pricing Strategy

	Use lagged *BestSellerDummy*	Control for lagged *AmazonSalesRank*	Control for *Paperback BestSellerDummy*	Control for reputation and dual channel presence
BestSellerDummy	0.319***	0.314***	0.320***	0.203***
	(0.074)	(0.079)	(0.075)	(0.067)
BestSellerDummy × *Multicategory*	−0.072***	−0.071***	−0.073***	−0.045***
	(0.012)	(0.014)	(0.011)	(0.014)
BestSellerDummy × *BookCoverage*	−0.337***	−0.336***	−0.335***	−0.326***
	(0.078)	(0.082)	(0.078)	(0.079)
BestSellerDummy × log *Reach*				0.026***
				(0.009)
BestSellerDummy × log *Popularity*				−0.041***
				(0.010)
BestSellerDummy × *DualChannel*				−0.020*
				(0.011)
PaperbackDummy	−0.003	−0.004	−0.004	−0.003
	(0.003)	(0.003)	(0.003)	(0.004)
PaperbackBestSellerDummy			−0.005	
			(0.010)	
log *Age*	0.026***	0.029***	0.023***	0.027***
	(0.004)	(0.004)	(0.003)	(0.004)
log *AmazonSalesRank* (lagged)		0.001*		
		(0.001)		
R^2	73.05%	73.15%	73.14%	71.53%
Number of observations[a]	874,064	820,934	904,307	660,943

Notes. Coefficients for product fixed effects, time fixed effects, and store fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]We have fewer observations than in Table 3 because the observations that do not have lagged *BestSellerDummy*, lagged *AmazonSalesRank*, *Reach*, or *Popularity* data are excluded from analysis. In addition, Amazon prices data are excluded from analysis in the second column, where the lagged *AmazonSalesRank* is added to control for the prior period demand.

*$p < 0.1$; ***$p < 0.01$.

Table 6 Robustness Analysis of Price Dispersion Using Prior Period Best-Seller Status

	Overall price dispersion	Price dispersion among retailers with high cross-selling capability	Price dispersion among retailers with low cross-selling capability	Price difference between the two retailer groups
BestSellerDummy	0.042**	0.045	−0.038	0.468**
	(0.018)	(0.043)	(0.037)	(0.233)
PaperbackDummy	0.037***	−0.034	0.093***	−0.143
	(0.012)	(0.024)	(0.017)	(0.100)
log *Age*	0.108***	−0.208***	0.225***	1.898***
	(0.017)	(0.029)	(0.026)	(0.124)
R^2 [a]	87.98%		73.39%	
Number of observations [b]	53,262		53,262	

Notes. Coefficients for product fixed effects time fixed effects, and store fixed effects, are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]For seemingly unrelated regressions, the systems weighted R^2 provided by SAS is reported.

[b]We have fewer observations than in Table 4 because the observations that do not have lagged data are excluded from analysis.

$^{**}p < 0.05$; $^{***}p < 0.01$.

Table 7 Robustness Analysis of Price Dispersion Controlled for Prior Period Demand

	Overall price dispersion	Price dispersion among retailers with high cross-selling capability	Price dispersion among retailers with low cross-selling capability	Price difference between the two retailer groups
BestSellerDummy	0.047**	0.029	−0.001	0.382*
	(0.019)	(0.049)	(0.030)	(0.228)
PaperbackDummy	0.037***	−0.027	0.089***	−0.157
	(0.012)	(0.023)	(0.017)	(0.100)
log *Age*	0.107***	−0.151***	0.192***	1.766***
	(0.017)	(0.029)	(0.026)	(0.129)
log *AmazonSalesRank* (lagged)	0.001	−0.041***	0.024***	0.093***
	(0.003)	(0.005)	(0.004)	(0.023)
R^2 [a]	87.98%		73.43%	
Number of observations [b]	53,262		53,262	

Notes. Coefficients for product fixed effects and time fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]For seemingly unrelated regressions, the system weighted R^2 provided by SAS is reported.

[b]We have fewer observations than in Table 4 because the observations that do not have lagged *AmazonSalesRank* data are excluded from analysis.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 8 Robustness Analysis of Price Dispersion Under Alternative Grouping of Retailers

	Overall price dispersion	Price dispersion among retailers with high cross-selling capability	Price dispersion among retailers with low cross-selling capability	Price difference between the two retailer groups
BestSellerDummy	0.055***	0.081***	−0.050	0.461***
	(0.018)	(0.031)	(0.042)	(0.151)
PaperbackDummy	0.042***	−0.033*	0.133***	−0.089
	(0.012)	(0.019)	(0.018)	(0.096)
log *Age*	0.078***	−0.020	0.175***	1.415***
	(0.015)	(0.021)	(0.025)	(0.103)
R^2	87.75%		73.35%	
Number of observations	54,876		54,876	

Notes. Coefficients for product fixed effects and time fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]For seemingly unrelated regressions, the system weighted R^2 provided by SAS is reported.

$^{*}p < 0.1$; $^{***}p < 0.01$.

Table 9 Robustness Analysis of Price Dispersion Using Coefficient of Variation as the Dependent Variable

	Overall price dispersion	Price dispersion among retailers with high cross-selling capability	Price dispersion among retailers with low cross-selling capability	Price difference between the two retailer groups
BestSellerDummy	0.007***	0.006	0.002	0.018***
	(0.002)	(0.004)	(0.003)	(0.005)
PaperbackDummy	0.005***	−0.003	0.014***	−0.005*
	(0.002)	(0.003)	(0.002)	(0.003)
log *Age*	−0.000	−0.018***	0.007**	0.043***
	(0.002)	(0.003)	(0.003)	(0.003)
R^{2a}	79.21%		66.94%	
Number of observations	54,876		54,876	

Notes. Coefficients for product fixed effects and time fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]For seemingly unrelated regressions, the system weighted R^2 provided by SAS is reported.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

4. Empirical Analysis

4.4. Robustness Analysis

(7) Whether results can be explained by cost differences between retailers

(i) Publishers offer secret deals to large retailers (cost advantage)
(ii) Larger wholesale discounts / efficient SCM
(iii) Efficient inventory management system
(iv) Scale effect on costs (*Reach*, *Popularity*)
(v) Other measure of cross-selling capability controlling the scale effect on costs

Table 10 Robustness Analysis Using New Cross-Selling Measure for Large Retailers

	New cross-selling measure for large retailers
BestSellerDummy	0.101**
	(0.042)
BestSellerDummy × *Multi-Item*	−0.161***
	(0.061)
BestSellerDummy × log *Reach*	0.005
	(0.007)
BestSellerDummy × log *Popularity*	−0.024***
	(0.006)
BestSellerDummy × *DualChannel*	−0.005
	(0.005)
PaperbackDummy	0.004**
	(0.002)
log *Age*	−0.006***
	(0.002)
R^2	87.35%
Number of observations[2]	350,564

Notes. Coefficients for product fixed effects, time fixed effects, and store fixed effects are omitted from the table. Huber–White robust clustered standard errors are in parentheses.

[a]We have fewer observations than in Table 3 because the observations that do not have *Multi-Item*, *Reach*, or *Popularity* data are excluded from analysis.

**$p < 0.05$; ***$p < 0.01$.

4. Empirical Analysis

4.4. Robustness Analysis

Results of robustness analysis

(1) cross-selling capability moderates pricing strategies on best sellers

(2-1) overall price variation increases when a book makes it to the best-seller list

(2-2) it is mainly driven by the price difference between two groups

∴ our main results hold qualitatively

Summary

Higher price dispersion when books make the *Publishers Weekly* best-seller list

Retailers with high cross-selling capabilities reduce prices when a book makes it to the best-seller list significantly more than retailers with low cross-selling capabilities

Increased price dispersion for best sellers is mainly driven by the price difference between the two groups of retailers divided based on their cross-selling capabilities

Incentive given retailers' asymmetric cross-selling capabilities and uses changes in product demand condition to identify retailers' pricing strategies

Summary

Higher price dispersion when books make the *Publishers Weekly* best-seller list

Retailers with high cross-selling capabilities reduce prices when a book makes it to the best-seller list significantly more than retailers with low cross-selling capabilities

Increased price dispersion for best sellers is mainly driven by the price difference between the two groups of retailers divided based on their cross-selling capabilities