ECONOMIC ANALYSIS GROUP DISCUSSION PAPER

Competitive Effects of Resale Price Maintenance Through Inventory: Evidence from Publishing Industry

by

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EAG 22-5 December 2022

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November 29, 2022

Abstract

This paper examines the competitive effects of resale price maintenance (RPM) through inventory decisions under demand uncertainty. We focus on the Japanese publishing industry where RPM is allowed. We develop and estimate a model of RPM in which price and inventory are determined before demand is realized. Counterfactual simulations show that the RPM model would yield a higher consumer surplus than a wholesale model due to a sufficient inventory and a lower price of new titles. Moreover, we show that the price ceiling due to RPM plays a welfare-enhancing role, whereas the price floor is irrelevant in the industry.

*Keywords: Resale price maintenance; Return policy; Vertical relationship; Antitrust law; Demand uncertainty; Inventory; Product variety; Publishing industry; Book stores. JEL Codes: L11; L13; L42; L81; L82; M31; K21. The views expressed herein are entirely those of the authors and should not be purported to reflect those of the U.S. Department of Justice or the data provider.

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1 Introduction

Conservative inventory decisions by retail stores affect consumer welfare directly by reducing the variety of accessible goods at the stores and indirectly by increasing prices when inventory is insufficient. Under demand uncertainty, inventory of a brand at retail stores could be socially insufficient for various reasons. If retail stores are competitive, the concern for a price war in low-demand states could hinder inventory holding in the presence of demand uncertainty (Deneckere et al., 1996, 1997). If retail stores have market power, the double-marginalization could arise (Tirole, 1988; Klein, 1999; Blair and Lafontaine, 1999).

In both cases, resale price maintenance (hereafter RPM), a vertical contract between manufacturers and retailers that requires retailers to sell manufacturers' products at a price level below a price ceiling or above a price floor set by the manufacturers, could be a solution to restore the socially optimal level of inventory. The minimum RPM removes the concern for a price war (Deneckere et al., 1996, 1997) and the maximum RPM prevents a price increase (Tirole, 1988; Klein, 1999; Blair and Lafontaine, 1999), and so could encourage retail stores to hold inventory. Thus, RPM is potentially pro-competitive, but it is hardly openly practiced, because it is per se illegal in many jurisdictions including the European Union (EU) and Japan, and it could be challenged by the antitrust authorities in the United States (US) subject to the rule of reason. Therefore, it is important to develop an empirical framework to evaluate the competitive effects of RPM.

In this paper, we study the competitive effects of RPM through inventory decisions under demand uncertainty, by focusing on the Japanese publishing industry. The Japanese publishing industry is an ideal case for multiple reasons. First, the publishing industry is appropriate to assess the pro-competitive channels of RPM through inventory holding, because the demand for new book titles is highly uncertain.[1] The focus on inventory at bookstores has important implications in the publishing industry because it is related to the diversity of accessible titles, which is often the cultural object of the policy on the book market. Second, RPM is permitted for copyrighted goods, and all publishers and bookstores openly and strictly enforce it. Third, the vertical transfer mechanism is also well documented: revenue is shared among a publisher, a distributor, and bookstores,[2] and the prevailing revenue share division is known. Finally, rich data on prices, sales, and inventory of books are available at the bookstore level. We focus our analysis on physical books because

[1] Other pro-competitive justifications of RPM include the ability to incentivize bookstores to invest in services. Due to data limitations, this paper does not address this effect.

[2] Therefore, we can refer to this institution as the agency model (Johnson, 2017). However, we do not explicitly model how the revenue share is determined, because we use the prevailing revenue share as given in the estimation.

e-book sales in Japan is small. Moreover, many pro-competitive justifications of RPM do not apply to e-books.

After studying the implications of RPM through inventory decisions using a simple analytical model, we develop and estimate a model of a publisher and bookstores with RPM, in which the prices and inventories are determined before the realization of demand. In the model, the minimum and maximum RPM can be pro-competitive through different channels. For instance, the minimum RPM could prevent a price war among competitive bookstores in low-demand states, which could incentivize bookstores to hold more inventories than they otherwise would before the realization of demand. The maximum RPM, one the other hand, could mitigate double marginalization.

To assess the competitive effects of RPM, we incorporate the key features of the Japanese publishing industry into the model. For each book, the publisher and distributor set the price and inventory for each bookstore, and bookstores can return the books for free. The revenue is shared at fixed rates among a publisher, a distributor, and bookstores. The demand for new book titles is uncertain and publishers must decide the price and inventory before the demand realization. Book prices cannot be changed and are uniform across bookstores. Bookstores can reorder books when there is excess demand by paying additional adjustment costs. In the model, RPM can be either pro-competitive or anti-competitive depending on the degree of demand uncertainty and substitution patterns among bookstores. The pro-competitive effects can be realized either due to the maximum or minimum RPM depending on the local market structure of the retail stores.

We focus on the sales of new titles of the top 1000 literature authors in the first six months after publication. We focus on new titles because the demand is less uncertain for old or used books. We choose a six-months window because the prevailing contract allows bookstores to return books for free during this window, and most of the sales take place during the first six-months. We assume that there is no substitution across book titles because the top literature titles are unique products. In other words, we assume that the publisher of a title is a monopolist and there is no further concern for collusion. This modeling choice is made for computation tractability. It does, however, limit our ability to study the potential anti-competitive effects of RPM on price coordination.

Our empirical model consists of a consumer demand model and a supply-side model, and the estimation consists of two steps. In the first step, we estimate a multinomial logit demand model of new book titles (hardcovers) at the title-store-county level for the first six months after publication, during which bookstores can return the book for free. In the demand model, consumers may value inventory, because holding inventory allows bookstores to sell books without delay and display them on their shelves. The price elasticity of demand estimates ranged from -1.74 to -2.57, suggesting a moderately high market power of bookstores in the local book market.

In the second step, we take the estimated demand parameters as given and estimate a supply-side model. On the supply side, we relax the assumption that publishers have perfect foresight on the title-specific demand shocks. We assume that they have an unbiased signal of the demand shock when deciding the price and inventory, and we estimate the precision of the signals (or the variance).[3] The estimates of the precision parameter of the signals reject the perfect foresight assumption, demonstrating that the publishers are uncertain about the demand shocks. The publishers are assumed to pay quadratic adjustment costs if the realized demand exceeds the initial inventory. The estimated marginal adjustment costs are small.

Using the estimated model, we first conduct a counterfactual simulation with a wholesale model in which bookstores, instead of publishers and distributors, can set prices and inventories. The inventory decisions must be made before the demand is realized, but the price can be adjusted after the demand realization and can be different across bookstores. The shift to the wholesale model decreases the consumer surplus by1.26 million JPY (-27.71% of the baseline sales value) for the target books and regions. The sum of publisher and bookstore surpluses also decreases by 1.07 million JPY (-23.57% of the baseline sales value). This is caused by a significant reduction in the inventory holding in the wholesale model. The results imply that our baseline RPM model, which captures key features of the Japanese publishing industry, may result in higher total welfare as compared to a wholesale model.

To uncover the underlying economic forces that generate our results, we sequentially alter the baseline RPM model. First, we examine whether the low supply-side surplus in the baseline RPM model relative to the wholesale model is due to uniform pricing by allowing publishers to set prices and maintain RPM at the county level. We show that relaxing uniform pricing but maintaining RPM rather increases the consumer surplus by 0.69 million JPY (15.17% of the baseline sales value), and increases the supply surplus by 1.73 million JPY (38.21% of the baseline sales value) relative to the baseline model.

Second, we test whether the minimum RPM plays any role by considering a counterfactual in which bookstores can set price and inventory as in the wholesale model but the publisher is allowed to set a minimum RPM before the demand realization. We find that the equilibrium with the minimum RPM is almost the same as the wholesale model, meaning that the minimum RPM does not bind the price at the equilibrium. In the model of Deneckere et al. (1996) and Deneckere et al. (1997), the realization of low demand triggers a price war among retailers because they assume perfect competition of retailers. In our estimated

[3] We can elicit the precision parameter of the signals in addition to the marginal cost shocks of books because we observe two control variables of the supply-side, the price, and inventory.

model, bookstores have non-negligible market power and the decentralized retail price is higher than the optimal price for the publishers. On the contrary, a counterfactual model, in which bookstores can set price and inventory as in the wholesale model but the publisher is allowed to set a maximum RPM before demand realized, increases the consumer surplus by 3.16 million JPY (69.72% of the baseline sales value), increases the publisher surplus by 6.41 million JPY (141.44% of the baseline sales value), but decreases the store surplus by 2.09 million JPY (-46.06% of the baseline sales value) from the counterfacutual I. Thus, the pro-competitive effect in the baseline model mainly works through the maximum RPM.

Finally, we evaluate the pro-competitive effects of the maximum RPM by considering a vertically integrated industry, where prices are determined after the demand is realized as in the wholesale model, but they are determined by the publisher. We find that, compared to the wholesale model, this increases the consumer surplus by 12.61 million JPY (250.59% of the baseline sales value), and increases the supply surplus by 8.86 million JPY (172.04% of the baseline sales value). This result implies that bookstores have a large enough market power to suppress demand when the realized demand is high. Therefore, they do not hold sufficient inventory, reducing the consumer and publisher's surpluses.

The findings imply that the inventory decision under uncertainty is an important welfare-enhancing channel of RPM and the market power of the retailers determines which of the minimum and maximum RPM affects the outcome. The existing literature such as Daljord (2021) tends to find that RPM increases the retail price. However, we show that the retail price could be lower under the RPM because the bookstores have non-negligible market power in the local market. Our framework can be applied to other industries in which the inventory decision under demand uncertainty is important, such as consumer electronics. Our model, however, ignores the channel in which RPM can facilitate price coordination.

For the Japanese publishing industry, it is advised to maintain part of the current exemption of the RPM, namely, the maximum RPM, for protecting the consumer surplus. From the bookstores' viewpoint, the wholesale model might be better, at least in a static sense. However, the long-run consequence is unclear: limiting the access of consumers to new titles may undermine the potential demand for books and damage bookstore sales in the future. Although the minimum RPM did not restrict the equilibrium price in the sample period, the intensified competition with online bookstores may create a situation where the theory of Deneckere et al. (1996, 1997) theory is relevant. If a few online bookstores become dominant, then the role of the maximum RPM can be more significant. Since there are no inventory problems for the e-book market, the justification of RPM from this perspective would be invalid in the e-book market.

1.1 Novelty and Contribution

There is a long list of theoretical works on the effects of RPM. For minimum RPM, Telser (1960) and Jullien and Rey (2007) argue that minimum RPM facilities upstream collusion by making deviations from an upstream cartel less profitable and more easily detected, which therefore decreases social welfare. RPM can also deter upstream entrance by making retailers less willing to accommodate (Asker and Bar-Isaac, 2014). On the other hand, minimum RPM can prevent the "free-riding problem", where a discount retailer can free ride on the pre-sale investments (sales promotions, quality certifications, etc.) of full-investment retailers and steal consumers through low prices, which increases retailers' incentives to do pre-sale investments (Telser, 1960; Marvel and McCafferty, 1984). When demand is uncertain, and inventory has to be decided by retailers before demand realization, RPM can be used to prevent price wars among retailers in low-demand states and guarantee sufficient inventory holdings (Deneckere et al., 1996, 1997). For maximum RPM, many studies have argued that it can serve to eliminate the double-marginalization problem (Tirole, 1988; Klein, 1999; Blair and Lafontaine, 1999). When the demand of retailers is positively correlated, it can also force retailers to internalize the positive externality and reduce prices (Blair and Lafontaine, 1999).

However, the effects of minimum RPM, at least, are still ambiguous. This present paper contributes to the literature of empirical studies of RPM by evaluating the welfare implication of RPM in an environment where the RPM can have a pro-competitive effect through the inventory decision before the realization of demand. Despite the importance of empirical analyses of RPM, there are only a few empirical papers that study the effects of RPM (MacKay and Smith, 2017). A strand of the literature has attempted to establish the anti- or pro-competitive effects of RPM by using variations in RPM practice or policy (Gilligan, 1986; Ornstein and Hanssens, 1987; Bailey and Leonard, 2010) or by studying court cases (Ippolito and Overstreet, 1996). Another strand of the literature develops a structural model of manufacturer-retailer relations and evaluates the effects of RPM compared to alternative contracts. The closest to ours is Bonnet and Dubois (2010), which estimates a structural model of the bottled water market under different assumptions of the vertical contract: linear pricing, two-part tariff, and two-part tariff with RPM. They find that the two-part tariff with RPM best fits the data and disallowing RPM will improve consumer welfare. They do not directly observe the vertical contract, whereas we know that RPM and revenue sharing prevail. RPM does not have any pro-competitive effects in its model. In contrast, in our model RPM can have both pro and anti-competitive effects through the inventory decision, market structure, and model parameters.[4]

This paper's setting is related to the agency model literature. Johnson (2017) defines the agency model as the bilateral relationship in which the revenue is shared and its rate is determined by the downstream firm and the retail price is determined by the upstream firm. The wholesale model is defined as the setting where the upstream firm decides the wholesale price and the downstream firm decides the retail price. Foros et al. (2017) use the same definition. De Los Santos and Wildenbeest (2017) generalize the definition by considering the setting where the revenue sharing rate and the wholesale price are determined by bargaining. Because the revenue is shared and the retail price is determined by publishers, this paper's setting resembles the agency model. Because the retail price set by the publishers is uniform across bookstores, it resembles the agency model with the most favored nation (MFN) clause. Although Johnson (2017) and Foros et al. (2017) consider the adoption decision of the agency model, we consider the actual institution as given. De Los Santos and Wildenbeest (2017) estimate the bargaining parameter between e-book platforms and large publishers, but we do not, because we know the prevailing revenue sharing rate and take it as given in the estimation, and consider the wholesale model in which the publishers decide the wholesale price in the counterfactual setting. Moreover, we consider an industry with demand uncertainty and where the inventory can be an important pro-competitive channel of the RPM.

This paper complements the study of RPM in the publishing industry by showcasing the analysis of RPM in the Japanese publishing industry. Tosdal (1915) describes the history of RPM in German and the US book market. Bittlingmayer (1988) claims that RPM in the German book market is a form of bookseller cartel. Fishwick (2008) and Ball et al. (2008) study the effect of the abolition of RPM in the UK in 1995. Beck (2004) and Beck (2008) study the German book market around the abolition of RPM in 2008. Because RPM in the publishing industry is still legal in Japan, we do not use a variation before and after the abolition of RPM. Instead, we exploit the detailed institutional information and rich data to uncover the key model parameters to evaluate the welfare implication of RPM in the Japanese publishing industry.

This paper is also related to the literature on structural analysis of publishing industry. Li (2021) estimates the consumer's preference over book genres and reading formats, including e-books, print books from online retailers, and from offline bookstores, to investigate the optimal multi-channel price strategy. Li (2019) estimates consumers' preferences in a dynamic discrete choice model of e-reader adoption and e-book purchases to study the optimal joint intertemporal price discrimination strategy. Daljord (2021) exploits the abolition of fixed

[4]In our institutional setting, the upstream manufacturer is assumed to be a monopolist.

price policy in the Norwegian book market to estimate consumers' preferences for books and the discount factor in a dynamic discrete choice model of books to study the implications for the optimal durable goods pricing. Our paper differs from them by highlighting a different aspect of publishers' pricing strategy, RPM and its competitive effects.

2 Institutional Background

2.1 Legal Status of RPM

There are different legal treatments to RPM (Minimum RPM and Maximum RPM) across jurisdictions and over time. In the United States, for example, the legal treatment of RPM has gone through several changes since the early 19th century. RPM was ruled per se illegal in Dr. Miles Medical Co. v. John D. Park & Sons Co. in 1911, saying that "these agreements restrain trade is obvious" and hence violate Section 1 of Sherman Act.[5] Miller-Tydings Act (1937) and the McGuire Act (1952) removed RPM contracts from the reach of the Sherman Act if the contracts were valid under state laws, citing the intention to prevent aggressive price cutting from large chain stores. These acts were repealed, however, and the legal status of RPM reverted back to pre-1937 per se rule in the Continental T.V. v. GTE Sylvania Inc case.[6] The per se rule changed in the ruling of State Oil v. Khan in 1997 as the court found maximum RPM difficult to reconcile with the potential anti-competitiveness of minimum RPM, and the per se rule no longer applies to agreements with maximum RPM, and these agreements should be judged under the rule of reason. In the Leegin Creative Leather Products v. PSKS, Inc case in 2007, the U.S. Supreme Court ruled that RPM is no longer per se illegal, and agreements with minimum RPM should also be judged under the rule of reason. Some states in the U.S., however, have their own antitrust laws. California and Maryland still maintain the per se rule over RPM.

In Europe, RPM is illegal in general, but it is mixed for the publishing industry. A recent conference of the OCED was held to discuss the future of the publishing industry, and the treatment of RPM is one of the major topics.[7] The UK, for example, abandoned RPM in 1997, but prices have risen more than inflation Francis (2008). Germany, on the

[5]United States v. Colgagte & Co, manufacturers have the option to announce a suggested resale price. If retailers undercut the price, they will refuse to do business. But there is no agreement under the antitrust laws.

[6]Continental T.V. v. GTE Sylvania Inc. 1977 Court cited: the Court widen the scope of the rule of reason, stating that the exclusionary practice enhanced non-price dimension improvement which off-sets the free-rider problem. Vertical nonprice agreements are subject to the rule of reason. Vertical price agreements were in the per se rule.

[7]www.oecd.org/daf/competition/competition-issues-in-books-and-e-books.htm

other hand, allows RPM for its publishing industry, citing that, although Germany supports the prohibition of fixed prices in antitrust law, RPM could protect books as cultural assets.[8]

In Japan, the guideline of the Japan Fair Trade Commission (JFTC) writes that "any RPM imposed by an enterprise on distributors without *justifiable grounds* is illegal as unfair trade practices" and the "*justifiable grounds* might be granted only within a reasonable scope and only for a reasonable period, in the case where RPM by an enterprise with respect to its product results in actual pro-competitive effects, promotes inter-brand competition and increases demand for the product thus benefiting consumers" (Japan Fair Trade Commission, 2017).

However, an exemption has been granted for copyrighted works in physical media such as books, magazines, newspapers, and music that serve to promote culture. In a 2001 notice, the JFTC recommended the elimination of the exception in the long term but confirmed the continuation of the exception with the requirement that the practice is monitored and reviewed on a regular basis (Japan Fair Trade Commission, 2001). Consequently, with a few exceptions, RPM is common in the Japanese publishing industry.

2.2 Publishing Industry in Japan

The total book sales in Japan amounted to 742 billion yen[9], and a person spent 5,838 yen on books on average in 2015 (Japan Book Publishers Association, 2017). Although online bookstores are becoming more prolific, traditional brick-and-mortar bookstores still account for a large share of the total sales in Japan. In particular, sales of books and magazines at brick-and-mortar bookstores account for 64.6% of the market in 2015. The secondary channel for book and magazine sales is convenience stores, which share 10.6%, and the Internet accounts for only 9.6% of total sales in 2015.[10] E-book sales in 2015 are estimated to be 150.2 billion yen, 76.5% of which are e-comics.[11] This paper focuses only on physical books, and by "books" we mean physical books henceforth.

The Japanese book market has at least two distinctive features that are worth highlighting. First, publishers set the retail prices of new copies according to RPM. This practice applies to virtually all new copies. Accordingly, consumers face the same price for the same title regardless of whether they buy a copy from local neighborhood bookstores, large chain stores, or online stores. The observed resale price maintenance is a product of two price

[8]More examples include Norway, which allows for RPM in its publishing industry, whereas Denmark abandoned RPM in 2011.

[9]Roughly 7 billion US Dollars.

[10]Other channels include miscellaneous direct sales to libraries and the sales at station stands.

[11]In the United States, on the other hand, e-book sales account for x% of the total book sales, which is a much larger percentage than that of Japan.

Table 1: Distribution of Number of Stores in a County

	Number of stores in the county			
	1	2 to 4	5 to 7	Larger than 7
County	360 (43%)	369 (44%)	84 (10%)	27 (3%)

Table 2: Uncertainty of Book Sales

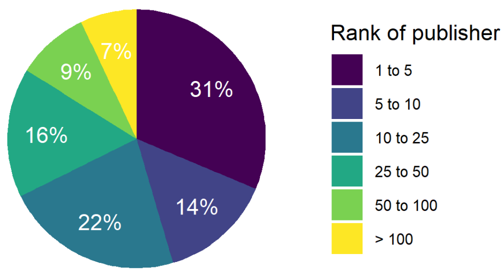
	Dummy included					
	Pub month	Publisher	County	Store	Author	All above
Store-title Level: R^2 (%)	0.03	0.87	1.39	2.65	9.16	20.11
Region-title Level: R^2 (%)	0.02	0.79	2.65	-	9.64	19.85
Title Level: R^2 (%)	0.06	2.91	-	-	47.35	55.81

maintenance agreements between a publisher and distributor and between a distributor and a bookstore. However, the exemption for using RPM does not apply to e-books and used books.

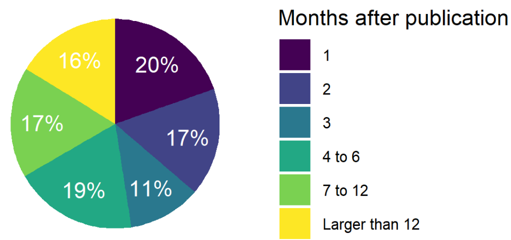
Second, bookstores have little control over their assortments and inventories. Under this system, book distributors decide the allocation of new titles to the bookstores with which they have exclusive supply contracts. The delivery costs from the publisher to wholesalers are borne by wholesalers, as are the delivery and warehouse costs from wholesalers to bookstores. Bookstores make profits by selling the assigned books to consumers. Usually, their margins are 22% of the (fixed) retail price. Distributors take 8% of the retail price and 70% goes to publishers and authors. Bookstores are allowed to return allocated books to their exclusive wholesalers within a certain duration, typically six months. In other words, bookstores carry virtually no inventory risk. Although several large bookstores have attempted to change this practice by bypassing distributors, the majority of bookstores still rely on this system.

2.3 Sector Description

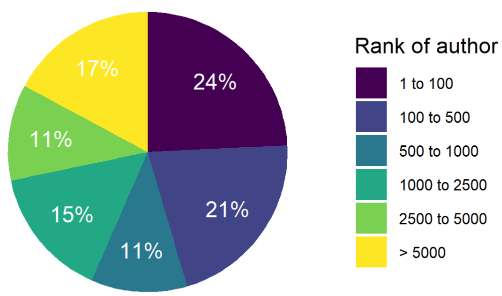
The wholesale sector is a duopoly in the Japanese publishing industry. The top two wholesalers have more than 70% of sales (Japan Book Publishers Association, 2017). The Japanese publishing sector, however, is not concentrated. Figure 1a plots the shares of top Japanese publishers, showing the top 5 and top 10 publishers account for only 31% and 45% of the



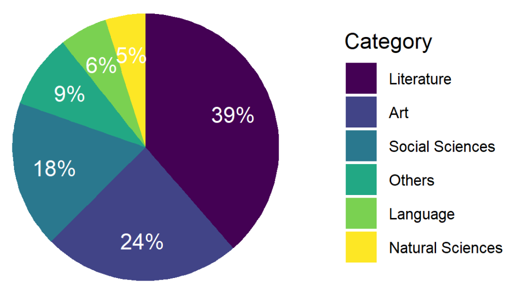
(a) By publisher sales ranking



(b) By month after publication



(c) By author sales ranking



(d) By category

Figure 1: Share of Sales

Table 3: Uncertainty of Book Sales of New Authors

	Dummy included				
	Pub month	Publisher	County	Store	All above
Store-title Level: R^2 (%)	0.02	1.04	1.42	2.63	3.97
Region-title Level: R^2 (%)	0.02	1.03	2.99	-	4.47
Title Level: R^2 (%)	0.1	4.77	-	-	4.91

sales.[12][13]

The structure of the brick-and-mortar bookstore market varies by geography. Table 1 shows the distribution of the number of bookstores in a county, the smallest administrative division in Japan. 43% of the counties have only one bookstore, 44% of the counties have two to four bookstores, only 10% of the counties have five to seven bookstores, and 3% of the counties have more than 7 bookstores.

Newly published books account for most of the sales. Figure 1b shows the sales share of books by the month after the publication. Books published within one month account for 20% of the sales, and the sales of the first six months of the book account for 67%. Books that have been published more than one year ago account for only 16% of the sales.

The sales are moderately concentrated among top authors. Figure 1c shows the share of sales according to the author's total sales ranking. Among the 35,000 authors in the data, the top 100 authors account for 24% of the sales and the top 1000 authors account for 57%. Authors with sales ranking lower than 5,000 accounts for only 17% of the sales.

Sales are unevenly spread across book categories. Figure 1d shows the share of sales by category. The largest category is literature, which accounts for 39% of sales, followed by art and social science books, accounting for 24% and 18% of total sales, respectively. Language and natural sciences are a less popular category, and they account for 6% and 5% of sales, respectively. Other book categories account for 8% of sales.

The demand for books is uncertain. This is important to consider when analyzing the effects of RPM. To assess the demand uncertainty, we regress the bookstore-title-level six-month sales, county-title-level six-month sales, and title-level six-month sales on the observed book characteristics and examine how much variation can be explained by the observable characteristics. We sequentially include the month of publication, store, publisher, and author dummies.

Table 2 shows the R^2 of these regressions. At the store-title level, the month of publication, store, and publisher fixed effects account for less than 5% of the variation of sales. The author fixed effect is the strongest predictor of sales, but it explains only 9.16% of the total variation. Including all variables explains only 20.11% of the total variation. The predictive power of these observable characteristics for sales at the county-title level is similar to that for sales at the store-title level. At the title level, the author fixed effect has a higher predictive power of 47.35%. Including all variables can account for 55.81% of the sales variation. Still, nearly half of the sales variation cannot be explained by the observed characteristics.

[12]In contrast, the big-5 publishers in the U.S. account for 80% of U.S. sales.

[13]The sector description hereafter is based on our data obtained from one of the largest wholesalers, which has an average market share of 41%. Therefore, although only bookstores and publishers that cooperate with our wholesalers are included, they should be representative.

Publishers and distributors may have more information for predicting book sales, but they will not be more informative than author-specific fixed effects. Moreover, books by new authors, the sales of which are harder to predict, are dropped from this analysis. Thus, it is difficult to predict book sales only from the observed characteristics.

To include the author fixed effect, new authors will be excluded from the sample. Therefore, we also show the same table, focusing only on new authors, except that we exclude the author fixed effect from the table. Table 3 shows the results. [TBA: more analysis]

For online bookstores, we take Amazon as the representative online bookstore. In Amazon, books directly sold by Amazon are under the restriction of RPM. However, there are books sold by other booksellers which are not strictly restricted by RPM, so booksellers can freely adjust the price of the books even for new books. This provides us with a chance to compare prices for the same books with and without RPM in the market.

Using data from a web service[14] that collects information on Amazon.co.jp, we check the distribution of the price of technically new books sold in the Amazon marketplace. Unfortunately, the web service only records the lowest price in the Amazon marketplace for each condition. According to this data, 4.6% of technically new books are sold above the maintained retail price in the first month, 82.7% are at the same price, and 12.7% are below the retail price. Thus, the price of a book can be either lower or higher than the retail price. Moreover, the fact that the lowest price in the Amazon marketplace could be higher than the RPM price for a non-negligible portion of books indicates that the average price could be higher than the RPM price for a larger portion of book titles and the book stores could exercise some market power.

2.4 Features of the Pricing Scheme

In the Japanese publishing industry, one retail price is set for each book by the publisher and is fixed across geographical areas and over different sales channels. This pricing scheme is exerting both the minimum resale price maintenance (minimum RPM) and maximum resale price maintenance (maximum RPM). Furthermore, the fixed price implies that the price floor set by the minimum RPM and the price ceiling set by the maximum RPM is identical. In this section, we discuss the implication of these features under demand uncertainty.

Minimum RPM As commonly believed, minimum RPM can be anti-competitive, because it is akin to horizontal price fixing, lessening competition in price. There are, however, pro-competitive justifications in the current context (Deneckere et al., 1997).

[14] See https://mnrate.com/, accessed on July 28, 2022.

Under demand uncertainty, if bookstores can freely set retail prices and inventory, they will be unwilling to stockpile much inventory, because they are afraid that if the demand turns out to be low, where they will have much more inventory than demand, they will be dragged into fierce competition to sell at least some copies to cover their prepaid cost in inventory. This negative externality of competition makes the inventory less than what is optimal from the publisher's perspective in the equilibrium and makes the inventory insufficient in the high-demand state. Then, to gain profits at the low inventory level, the publisher will increase the wholesale price (and thus the retail price) to suppress demand, which further hurts consumers.

With minimum RPM, however, the price war under a low-demand state is prevented and the return of inventory is recovered. The inventory in equilibrium increases and therefore both the supply surplus and consumer welfare could increase.[15]

In Appendix A, we formalize this argument using a simple linear demand model with two demand states and prove the above statement. This argument is relevant only when the retailers are competitive enough. If the retailers have strong market power, the equilibrium retail prices can be higher than the price floor the publisher would like to set. Then, the price floor does not have any impact. Thus, the effect of minimum RPM is critically dependent on the market power of retailers.

Maximum RPM The maximum RPM sets a price ceiling for bookstores. Under a wholesale model, if both the publisher and the bookstores have high market power, the market may suffer from double marginalization, which increases prices and suppresses inventory, making the supply side and consumers worse off than in a vertically-integrated model.

When the demand is uncertain and when the bookstores have to order inventory before the demand is realized, double marginalization may have a further negative effect on inventory across demand states. Suppose there are two demand states: one is a high demand state and the other is a low demand state. Under demand uncertainty, in a vertically-integrated model, the optimal inventory level for the integrated entity to hold is the one such that the optimal monopoly quantity is constrained in neither of the two demand states. Changing to a wholesale model will reduce the inventory compared to the vertically-integrated model due to double marginalization. Moreover, if demands in the two demand states are close enough, the incentive for the successive monopolists to suppress demand in the low demand state will lead the retailer to further decrease inventory holding before demand realization,

[15] Another pro-competitive justification for minimum RPM is to eliminate free-riding. The key idea is that in markets where firms compete in both prices and services, the minimum RPM provides an incentive for firms to invest in services. One can interpret that the decision to stock books is a type of competition for services.

making the supply side and consumers worse off in the high demand state.

With double marginalization under demand uncertainty, a price ceiling serves to restrict bookstores' market power and reduce the across-demand-state negative effect, increasing both the supply surplus and consumer welfare.

We formalize the intuition in Appendix B and prove the above statement. This argument, on the contrary, is relevant only when the retailers have enough market power. If the retailers are competitive enough, the double-marginalization problem is negligible. Thus, the effectiveness of the maximum RPM is also dependent on the retailers' market power.

Fixed price and geographically uniform pricing Setting an identical price floor and price ceiling allows no price adjustment after demand realization, which has ambiguous welfare effects. On the other hand, setting a uniform price across areas restricts geographical pricing flexibility, which decreases supply surplus and has an ambiguous effect on consumer welfare.

3 Model

3.1 Demand

We assume individual books are not substitutes, and consumers buy at most one copy of each title.[16] For each book title, consumers decide whether to buy the title, and if so, whether to buy it from one of the brick-and-mortar bookstores in county l, or an online bookstore. The indirect utility of consumer i buying book j from a brick-and-mortar bookstore m in county l is

$$\begin{aligned} u_{ijml} &:= x_j'\beta + \alpha p_j + \xi_j + x_{jml}'\gamma + \eta_{jml} + \epsilon_{ijml} \\ &:= \delta_j + \varphi_{jml} + \epsilon_{ijml}, \end{aligned} \tag{1}$$

where x_j and x_{jml} are vectors of observed exogenous characteristics of book j and the bookstore m in county l, respectively, and p_j is the price of the book. ξ_j and η_{jml} are unobserved characteristics (to the econometrician) of the book j and the bookstore m in county l, respectively, whose means are $\mathbb{E}\{\xi_j|x\} = 0$ and $\mathbb{E}\{\eta_{jml}|x, j\} = 0$, where x is a vector of x_j and x_{jml}. Lastly, ϵ_{ijml} is an i.i.d. type-I extreme value random variable. A publisher sets the price of book j based on the belief about ξ_j. Hence, p_j can be correlated with ξ_j. p_j

[16]Books are highly differentiated. There are, however, genres that are more substitutable, such as self-improvement books. In our analysis, we limit the set of books to genre, such as fiction and biography, to mitigate the concerns of book substitution.

is uncorrelated with η_{jml}, because the price is uniform across stores and counties. On the contrary, a wholesaler allocates inventory by anticipating ξ_j and η_{jml}. Therefore, inventory n_{jml} can be correlated with ξ_j and η_{jml}.

Similarly, the indirect utility of consumer i buying book j from the representative online bookstore A in county l is

$$\begin{aligned} u_{ijAl} &:= x_j'\beta + \alpha p_j + \xi_j + x_{jAl}'\gamma + \eta_{jAl} + \epsilon_{ijAl} \\ &:= \delta_j + \varphi_{jAl} + \epsilon_{ijAl}, \end{aligned} \tag{2}$$

We use index $b \in \{m, A\}$ to denote both the brick-and-mortar bookstores and the representative online bookstore. We denote the index $b = 0$ as the outside option of not buying the title. We normalize the mean indirect utility as $u_{ij0l} = \varepsilon_{ij0l}$. Then, the probability of choosing bookstore b for book j in county l is

$$q_{jbl}(p_j, n_j, \xi_j, \eta_j, \theta) := \frac{\exp(\delta_j + \varphi_{jbl})}{1 + \sum_{d \in \mathcal{B}_l} \exp(\delta_j + \varphi_{jdl})}, \tag{3}$$

where $n_j := [n_{j11}, \cdots, n_{jB_1 1}, \cdots, n_{j1L}, \cdots, n_{jB_L L}]'$ and $\eta_j := [\eta_{j11}, \cdots, \eta_{jB_1 1}, \cdots, \eta_{j1L}, \cdots, \eta_{jB_L L}]'$.

3.2 Supply

We treat a publisher and wholesaler as a single firm and refer to them as a publisher hereafter. Publisher f of book j sets the price p_j and decodes the allocation of book j across bookstores in each county. They make decisions based on the belief of the unobserved heterogeneity ξ_j. We assume that their belief about ξ_j is normally distributed around the true ξ_j with title-specific standard deviation $\sigma_{j\xi}$. The degree of uncertainty of the demand for book j from the publisher's perspective is captured by $\sigma_{j\xi}$. Moreover, we assume the degree of uncertainty depends on the popularity of the author. Specifically, we assume $\sigma_{j\xi}$ takes the following form

$$\sigma_{j\xi} = \exp(c_0 + c_1 * \mathbb{1}\{Past\_Pub_{a(j)j} \geq 1\}), \tag{4}$$

where $Past\_Pub_{a(j)j}$ is the number of books published by the author $a(j)$ of title j prior to the publication of title j. Let $F(\xi_j^*)$ be the distribution of ξ_j^* from the belief system. This subjective uncertainty influences the socially optimal level of inventory.[17]

Figure 2 shows the timing of the game. i) The publisher sets the price p_j and inventory allocation n_j to determine the number of initial prints. ii) The demand shocks ξ_j and η_j

[17] For tractability, we assume the perfect foresight for the title-bookstore-specific fixed effects η_{jbl} as the usual oligopolistic pricing model.

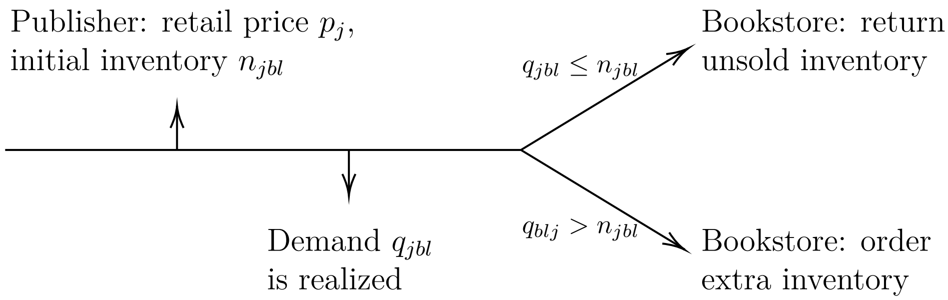


Figure 2: Timeline of Supply Decision

Note: When the unsold inventory is returned to the publisher, it is discarded with no extra cost. The cost of delivery and print is sunk for the publisher.

are realized, which determine the realized demand q_{jbl} at each store. iii a) If the realized demand is less than the initial inventory, the unsold inventory is returned to the publisher and discarded without extra cost. The publisher's printing and delivery costs are sunk. iii b) If the realized demand is above the initial inventory, the bookstore orders extra copies to meet the excess demand. In this case, the publisher pays additional adjustment costs in addition to the printing and delivery costs.

Denote ρ as the revenue share of a publisher and M_l as the market size of county l. For each book j, the publisher's profit maximization problem is

$$
\begin{aligned}
\max_{p_j, n_j} \quad & \underbrace{\rho p_j \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int min\{n_{jbl}, M_l q_{jbl}\} \; dF(\xi_j^*)}_{\text{Expected initial revenue}} - \underbrace{\sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} (\lambda_1' w_{jbl} + \varepsilon_{jbl}) n_{jbl}}_{\text{Initial printing and delivery cost}} . \\
& + \underbrace{\rho p_j \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} M_l \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; (M_l q_{jbl} - n_{jbl}) \; dF(\xi_j^*)}_{\text{Expected excess demand revenue}} \\
& - \underbrace{\sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; (\lambda_1' w_{jbl} + \varepsilon_{jbl})(M_l q_{jbl} - n_{jbl}) \; dF(\xi_j^*)}_{\text{Expected excess demand printing and delivery cost}} \\
& - \underbrace{\sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; \delta (M_l q_{jbl} - n_{jbl})^2 \; dF(\xi_j^*)}_{\text{Expected adjustment cost}},
\end{aligned}
\tag{5}
$$

where q_{jbl} is the optimal choice probability when the believed demand shocks at the title level is ξ_j^*, that is, $q_{jbl}(p_j, n_j, \xi_j^*, \theta)$.

The first term of (5) is the expected revenue from an initial allocation of the book, which is bounded by the inventory level n_{jbl}. The second term is the initial costs of printing and delivery, which is a linear function of the initial inventory allocation n_{jbl}. The marginal cost of printing and delivery depends on the characteristics of the book, bookstore, and county, w_{jbl}, which is a subset of x_{jbl}. The marginal cost shock is given by ε_{jbl}. The third and fourth terms capture the revenue and costs from excess demand, as the publisher will order more copies of the book to meet the excess demand. The fifth term is the quadratic adjustment costs to clear the excess demand, where δ measures the magnitude of adjustment costs.

The first-order condition with respect to p_j is

$$p_j = \frac{\mathbf{A}}{-\alpha\rho \sum_{l\in\mathcal{L}} \sum_{b\in\mathcal{B}_l} M_l \int q_{jbl}(1-\sum_{d\in\mathcal{B}_l} q_{jdl})\ dF(\xi_j^*)}, \tag{6}$$

where

$$\begin{aligned}\mathbf{A} = \sum_{l\in\mathcal{L}}\sum_{b\in\mathcal{B}_l} M_l \Bigg\{ &\rho \int q_{jbl}\ dF(\xi_j^*) \\ &- 2\alpha\delta \int \mathbb{1}_{\{M_l q_{jbl}\geq n_{jbl}\}}\ q_{jbl}(1-\sum_{d\in\mathcal{B}_l} q_{jdl})(M_l q_{jbl} - n_{jbl}) dF(\xi_j^*) \\ &- \alpha \int \mathbb{1}_{\{M_l q_{jbl}\geq n_{jbl}\}}\ q_{jbl}(1-\sum_{d\in\mathcal{B}_l} q_{jdl})(\lambda_1' w_{jbl} + \varepsilon_{jbl})\ dF(\xi_j^*)\Bigg\}.\end{aligned} \tag{7}$$

and the first-order condition with respect to n_{jdl} is

$$\begin{aligned}&\lambda_1' w_{jdl} + \varepsilon_{jdl} = \\ &2\delta \int \mathbb{1}_{\{M_l q_{jdl}\geq n_{jdl}\}}(M_l q_{jdl} - n_{jdl})\ dF(\xi_j^*) \\ &+ \int \mathbb{1}_{\{M_l q_{jdl}\geq n_{jdl}\}}(\lambda_1' w_{jdl} + \varepsilon_{jdl})\ dF(\xi_j^*).\end{aligned} \tag{8}$$

4 Estimation

4.1 Moments of Demand

The bookstore choice probability formulation (3) leads to the following equation

$$\ln q_{jbl} - \ln q_{j0l} = x_j'\beta + \alpha p_j + \xi_j + x_{jml}'\gamma + \eta_{jml}, \tag{9}$$

for bookstore b title j in county l, where $q_{j0l} = 1 - \sum_b q_{jbl}$.[18] We use Hausman-type instruments for price to estimate the parameters in (9). Specifically, for book j published in month

[18] The index b includes brick-and-mortar bookstores and representative online bookstores.

m, we use average prices of books published by the same publisher as book j at month $m-1$ as an instrument for p_j. This instrument captures the cost shock of the publisher one year before the pricing of the book j when it was published, varying at the book title level.

4.2 Moments of Supply

We use two sets of moment conditions to estimate the supply-side parameters. The first set of moments captures the distance between the predicted and observed prices. Specifically, for each parameter, we solve for the unobserved marginal costs ε_j for each book using the first-order condition with respect to inventory in Equation (8). Using the backed-out ε_j, we obtain the predicted price $p_j^{optimal}$ using the first order condition with respect to price as shown by Equation (7). The second set of moments is the orthogonality condition of the instrumental variables and the backed-out marginal costs ε_j. The detail of backing out unobserved marginal costs ε_j can be found in Appendix D.

Let $d_j = p_j - p_j^{optimal}$ be the difference between the observed and predicted price. The moment conditions for the supply parameter θ_s are expressed as

$$g_{s1}(\theta_s) \coloneqq \mathbb{E}\left\{d_j\right\} = 0, \tag{10}$$

$$g_{s2}(\theta_s) \coloneqq \mathbb{E}\left\{f_{jbl}\epsilon_{jbl}\right\} = 0, \tag{11}$$

where f_{jbl} is the set of excluded instrumental variables for the supply estimation. Let $g_s(\theta_s) = [g_{s1}(\theta_s)', g_{s1}(\theta_s)']'$

For the supply side estimation, we use the observed socioeconomic variables at the county level to be the instruments for the supply side prices, which serve as demand shifters excluded from the cost function. The socioeconomic variables include population, the number of colleges, the number of libraries, the number of employed workers, and the number of commercial centers in the county. We approximate the integration over the signals, ξ_j^*, with a Monte Carlo simulation.[19]

[19] Analytically, for a title j in bookstore b, $\int \mathbb{1}_{\{M_l q_{jdl} \geq n_{jdl}\}} dF(\xi_j^*)$ should never take a value of 1 if the inventory is positive, because the support of the uncertainty shocks is unbounded. However, because we evaluate it with finite draws, it can numerically take a value of 1, and $\mathbf{E}_j$ becomes singular. To avoid this, we set the upper bound of the numerical integration at 0.99.

When the observed initial inventory is 0, $\int \mathbb{1}_{\{M_l q_{jdl} \geq n_{jdl}\}} dF(\xi_j^*)$ analytically takes a value of 1 and ϵ_{jbl} is not point-identified. Because the marginal cost shock has to be greater than any epsilon to make some positive inventory optimal, we elicit the lower bound of such marginal cost shock by evaluating the moment with n being sufficiently close to 0. We use the lower bound of the marginal cost shock in the counterfactual simulations. If we use the lower bound of the marginal cost shock, the inventory is more likely to be positive when the institution changes than any greater value of the marginal cost shock. This does not affect the simulation results, because we only consider counterfactual settings where the incentive for the inventory decreases compared to the actual institution and the inventory is zero for any value of marginal cost shock

We define a generalized method of moments (GMM) estimator with a positive definite weighting matrix Φ_s by

$$\hat{\theta}_s \in \text{argmin}_{\theta_s} \hat{g}_s(\theta_s)' \Phi_s^{-1} \hat{g}_s(\theta_s). \tag{12}$$

5 Data

5.1 Source

We combine the brick-and-mortar bookstore transaction dataset and book price and ranking data from Amazon to construct the sales and inventory dataset at the bookstore level. The transaction data of brick-and-mortar bookstores are provided by one of the two largest book wholesalers. The data cover bookstores that transact with the data-providing wholesaler across the country from 2015 to 2017. We do not, however, have data from another large book wholesaler. Therefore, we focus on prefectures in which the data provider has a dominant share. Bookstores that transact with the large book wholesale we do not have data from are treated as part of the outside option and their behaviors are fixed throughout the counterfactual simulations.

The transaction data contain the number of deliveries and returns for every bookstore at the title, store, and month level. For bookstores that have a point-of-sale system (POS), the data also contains the sales volumes. Sales data are not available for bookstores that do not have a point of sales system. Because we need sales rather than delivery data, we focus on the POS stores. For any month from 2015 to 2017, if a bookstore has at least one record of sales for some book titles it is treated as a POS store. Otherwise, it is treated as a non-POS bookstore. For one title in one month, on average, the POS stores take up 90% of the total net deliveries (deliveries minus returns). The non-POS stores are also included in the outside option and their behaviors are fixed throughout the counterfactual simulations.

The Amazon book prices and ranking data are obtained from the web service that collects information on Amazon's website at the title-month level from 2015 to 2017. Among the 4,344 titles of the top 1000 literature authors, 2,131 titles are found in the ranking data. If they are not covered in the ranking data, their sales at Amazon were negligible. Therefore, we assumed purchasing these titles was unavailable on Amazon, to be consistent with the construction of the choice set of brick-and-mortar bookstores. [20] The Amazon price data include Amazon's prices that comply with the RPM and the prices in the Amazon marketplace that are not necessarily compliant with the RPM because books in the marketplace

greater than the lower bound if the inventory is zero in the actual institution.

[20]The ranking of a book is ranked by sales among all books sold on Amazon, and it is updated at the end of each month.

are technically used books even if they are not used.

For each book title, we observe information on its publisher, author, price, category, and publication date. Prices are set by publishers and uniform across bookstores for each book title due to RPM. To obtain the categories of books, we merge the categorical information from the openBD project provided by Calil.jp with our original transaction data.[21] It provides a free API to query bibliographic information. The openBD category code consists of 4 digits: The first digit indicates the classification of the target of the book, such as for general audience or students; The second digit indicates the classification of the publication form, such as the separate edition or series; The last two digits indicate the classification of the content of the book, such as literature, language, or history.[22] For example, a book with code 8091 indicates the book is a separate edition of Japanese literature for a general audience.

5.2 Data Construction

Constructing inventory data for brick-and-mortar bookstores. We construct the inventory data from the transaction data. Inventory at the beginning of month t is calculated as cumulative deliveries up to the month t less the sum of cumulative returns and cumulative sales up to the month $t-1$. We find that around 40% of the title-bookstore pairs have negative inventory in at least one of the months when the book title is first available in the bookstore. There are several reasons for this. First, there could be within-store transfers for chain stores. Second, the bookstores could transact with multiple wholesalers. Because the sales data are obtained directly from the bookstores, there could be some deliveries from other wholesalers which are missing in this dataset. Finally, for books published before 2015, there could be some initial inventories that are not observed because we only have data post-2015. To deal with the negative inventory problem, we adjust the original inventory for a title in a bookstore by adding a minimal initial inventory value such that the inventory of the book is non-negative at the end of every period. From the constructed inventory data, some bookstores have zero initial inventory for some book titles. On average, a consumer encounters zero initial inventory for one book in one bookstore with a probability of 82.5%.

Imputing zero sales data for brick-and-mortar bookstores. Another issue of our transaction data is that for any one month, we only have an observation of a book title at a bookstore when there was at least one unit of delivery, sales, or return of the book title at

[21]See https://openbd.jp/, accessed on November 19, 2021.

[22]The classification on the third digit includes: 1. General. 2. Philosophy. 3. History. 4. Social Science. 5. Natural Science. 6. Engineering. 7. Industry. 8. Arts. 9. Language. 10. Literature.

the bookstore in that month. Books with no delivery, order, sales, or return in one month at a bookstore are not observed for that month. Therefore, missing observation for a book title at a bookstore for one month could be due either to no activity or to unavailability. To distinguish no activity from unavailability, we attribute the missing observation of one book title at one bookstore for one month as due to no activity (zero delivery, zero sales, and zero return) if we observe at least one unit of delivery, order, sales, or return of the book title at the bookstore for at least one month within six months after the book title was published. We impute zero delivery, zero sales, and zero return for these missing observations due to no activity.

Imputing sales and inventory for the representative online bookstore. We transform the ranking data into sales data in copies by a method similar to (Chevalier and Goolsbee, 2003). We assume that the book sales follow a Pareto distribution. The cumulative distribution function is

$$F_S(s) = \begin{cases} 1 - \left(\frac{k}{s}\right)^{\theta} & \text{if} \quad s \geq k, \\ 1 & \text{if} \quad s < k, \end{cases} \tag{13}$$

where the parameter k is the (positive) lower bound of the sales, and the parameter θ indicates the relative frequency of large observations. The higher the θ, the smaller the relative frequency of large observations.

We use the expectation of distribution of order statistics $X_{(1)}, X_{(2)}, \dots, X_{(N)}$ to impute the sales of books that rank from 1 to N, with the book ranking 1 being the one with the lowest number of sales and the book ranking N being the one with the highest number of sales.[23] Given Pareto distribution of the book sales, for book ranking i, the expectation of the i^{th} order statistics $X_{(i)}$ is

$$\frac{\Gamma(N+1)\Gamma(N-i-\frac{1}{\theta}+1)}{\Gamma(N-i+1)\Gamma(N-\frac{1}{\theta}+1)} \cdot k, \quad for\ \theta > 1, \tag{14}$$

where $\Gamma(z) = \int_0^\infty x^{z-1} \exp^{-z} dx$.

Following (Chevalier and Goolsbee, 2003), we set $\theta = 1.2$. Parameter k is pinned down by matching the ratio of book sales on Amazon and book sales in brick-and-mortar bookstores in reality (i.e. 9.6% versus 64.6%)

After obtaining the sales at the title level for the representative online bookstore, we assume that the ratio between sales in a certain market and the overall sales are the same

[23] In the data, the book ranking 1 is the book with the highest number of sales. We transform the rank variable in the data to make the description less confusing

for brick-and-mortar bookstores and the representative online bookstores to impute its sales at the market level.

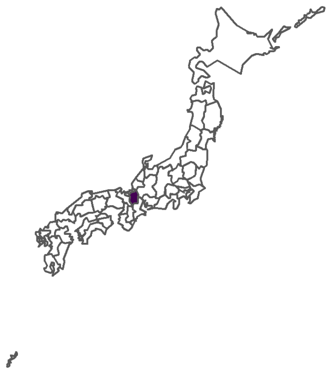
We do not observe inventory for the representative online bookstore. We impute the initial inventory for the online bookstore by assuming that the ratio between inventory and sales in a market is the same for the online bookstore and brick-and-mortar bookstores. This is a reasonable assumption because the inventories for the online bookstore and inventory for brick-and-mortar bookstores are both decided by the wholesalers under the consignment system. By doing this, we are able to obtain market-specific inventory for the online bookstore.

Sample selection We focus on the prefecture Shiga, where our wholesaler has one of the largest market shares, 65.9%. The prefectures with higher shares of the wholesaler than Shiga prefecture are small and not representative. Shiga is a prefecture of Japan located in the Kansai county of Honshu. Figure 3 shows the location of Shiga, which is divided into 24 counties. By 2015, Shiga had a population of 1,412,916 and a geographic area of 4,017 km^2. As discussed in Section 2.3, a large proportion of sales come from newly published books, top authors, and literature. Therefore, we restrict our sample to the sales of literature written by the top 1000 literature authors in the first six months after their publication. Because of our interest in demand uncertainty, we also exclude reprints of old titles. The demand for books can be uncertain shortly after its publication, but should gradually resolve over time as the demand is realized period by period. To obtain a balanced sample, we exclude books published in and after August 2018, for which we do not have observations for six months after their publication.

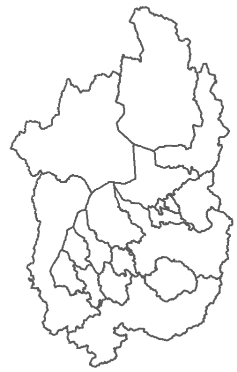
5.3 Summary Statistics

Table 4 shows summary statistics of key variables of Shiga's brick-and-mortar book market. The average county population in Shiga is 92,327.5, and the average number of bookstores per county is 3.7. The average store size, measured by the number of total book titles in stock, is 769.5 copies. The average price of a book is 1,296.3 JPY, and each bookstore holds 1.8 copies in inventory and sells 0.2 copies on average per month. At the title-store level, the average aggregate sales of a book in a bookstore over the first six months after the book's publication is 2.3 copies, with an average initial inventory of 3.2 copies.

Table 5 shows the summary statistics of the key variables for the representative online bookstore. At the title-month level, the imputed sales of the online bookstore are between 0 to 8883.3 copies, with a mean of 3 copies and a standard deviation of 116.5 copies. At the title-county level, the aggregate sales over the first six months since the book was published



(a) Location of Shiga



(b) Counties in Shiga

Figure 3: Map of Shiga

Table 4: Summary Statistics of the Shiga Book Market (Brick-and-Mortar)

	N	Min	Mean	Max	Sd
County Level					
Population	14	7,566.0	92,327.5	337,634.0	80,869.1
Num. store	14	1.0	3.7	14.0	3.5
Store Level					
Store size (copy)	52	9.3	769.5	1,763.5	479.2
Title Level					
Price (JPY)	4,344	500.0	1,296.3	7,200.0	351.5
Title-store level					
Aggre. sales (copy)	91,800	0.0	2.3	701.0	8.9
Initial inventory (copy)	91,800	0.0	3.2	413.0	7.0
Title-store-month level					
Sales (copy)	1,418,186	0.0	0.2	389.0	1.6
Inventory (copy)	1,418,186	0.0	1.8	216.0	3.2

Note: Store size is measured by the average number of book titles in the bookstore across month. Aggregate sales at the title-store level are aggregate sales of a title in a bookstore over the first 6 months since the title is published. Initial inventory is the initial delivery (adjusted by the negative inventory) of a title to a bookstore the first time the title was available in the bookstore.

Table 5: Summary statistics of the Shiga Book Market (Online)

	N	Min	Mean	Max	Sd
Title-month Level					
Sales (copy)	28,095	0	3.0	8,883.3	116.5
Title-county Level					
Aggre. sales (copy)	12,376	0	4.0	2,810.5	49.1
Initial inventory (copy)	12,376	0	27.2	10,924.1	360.6

Note: Sales are imputed from the rank data for the representative online bookstore. Aggregate sales at the title-county level are aggregate sales of a title in the representative online bookstore over the first 6 months since the title is published. Initial inventory is the imputed initial delivery of the title to the representative online bookstore the first time the title was available in the representative online bookstore.

are between 0 and 2810.5 copies, with a mean of 4 copies and a standard deviation of 49.1 copies. The imputed initial inventory for the representative online bookstore is between 0 to 10924.1 copies, with a mean of 27.2 copies and a standard deviation of 360.6 copies.

6 Estimation Results

6.1 Demand Estimation

Table 6 reports our demand estimation results. We deal with zero sales by adding a small constant to each. We estimated with 0.3, 0.5, 0.7, and by dropping zero sales observations. Because the estimates are similar, we use the result with 0.5 as the baseline model. We show the price elasticity of demand at the store level, which measures the percentage of bookstore demand change in response to one percent bookstore price change. In the baseline model, we control for the top-5-publisher, publication date, author, and store fixed effects, which is the finest specification. The result of the baseline model is reported in column (2) of Table 6. The price coefficient is -0.00193, with a price elasticity of -2.312 at the store level. In column (1), we try the demand estimation without controlling for any publisher-specific fixed effect. The price coefficient reports -0.00203, with a bit higher price elasticity of -2.43. In column (3), we control for county fixed effect instead of bookstore fixed effect. The price elasticity, in this case, is -0.00145, and the price elasticity is relatively lower at -1.74. From column (4) to column (6), we report the demand estimation results with different ways of dealing with zero sales. In column (4), we add a constant 0.3 to the zero sales instead of a constant 0.5. The price coefficient reports -0.00214 with a price elasticity of -2.565. Then, in column (5), we add a constant of 0.7. The price elasticity reports -0.00179 with a price elasticity of -2.146. And finally, in column (6), we drop zero sales observations instead of adding any

Table 6: Demand Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Price	-0.00203	-0.00193	-0.00145	-0.00214	-0.00179	-0.00163
	(0.00036)	(0.00033)	(0.00033)	(0.00037)	(0.00030)	(0.00060)
Num. books	3335	3335	3335	3335	3335	3335
Num. region	14	14	14	14	14	14
Num .stores	53	53	53	53	53	53
Elasticity						
median	-2.43	-2.312	-1.74	-2.565	-2.146	-1.952
Fixed effects						
top 5 publisher		Yes	Yes	Yes	Yes	Yes
publication date	Yes	Yes	Yes	Yes	Yes	Yes
author	Yes	Yes	Yes	Yes	Yes	Yes
county			Yes			
store	Yes	Yes		Yes	Yes	Yes
Zero sales	Add 0.5	Add 0.5	Add 0.5	Add 0.3	Add 0.7	Dropped
Num.Obs.	91640	91640	91640	91640	91640	55962
R2	0.555	0.559	0.549	0.518	0.582	0.610

Note: Column (2) is the baseline specification. Column(1) controls for no publisher fixed effect. Column (3) controls for county fixed effect. Column (4) adds 0.3 to zero sales observations. Column(5) adds 0.7 to zero sales observations. Column(6) drops zero sales observations.

constant. The price coefficient reports -0.00163 with a price elasticity of -1.952.

In general, our demand estimation is robust to different specifications and different ways of dealing with zero sales. The price elasticity falls between -2.565 to -1.952, implying relatively strong market power of the bookstores.

6.2 Supply Estimation

In our model, the standard deviation of the publisher's subjective belief of the book-level fixed effect (denoted as $\sigma_{j\xi}$) is a measure of demand uncertainty of a book title j. Our estimates show that, if the author for the book title is new (no publications before the book title), then the subjective belief uncertainty of the book demand is 3.69, relative to the standard deviation of the preference. However, if the author has at least one publication before, the subjective belief uncertainty is slightly lower at 3.41.

Our marginal cost estimates give the average marginal cost of delivery and print to be 46.02 JPY, which is 4% of the average price: 1261 JPY. The adjustment cost parameter is estimated to be $\delta = 0.14$. Table 7 shows how the adjustment cost varies over the difference between realized demand and initial inventory and its comparison with the average marginal

Table 7: Adjustment Cost

Difference (copy)	Marginal adjustment cost (JPY)	Ratio to marginal print&delivery cost
1	0.3	0.0
50	14.2	0.3
100	28.4	0.6
150	42.6	0.9
200	56.8	1.2

Table 8: Average Allocations over Resampled Marginal Cost Shock (Trimmed)

	N	Min	Mean	Median	Max	Sd
Price						
Observed price	90957	500	1259.89	1200.00	6000.00	299.41
Simulated price	90957	500	1336.69	1291.57	5150.41	286.74
Inventory						
Observed inventory	90957	0	3.75	2.00	430.36	11.87
Simulated inventory	90957	0	4.37	1.74	491.77	15.38
Sales						
Observed Sales	90957	0	2.22	1.00	232.00	5.85
Similated sales	90957	0	1.86	0.82	219.48	4.11

Note: Prices and inventory are at the bookstore-title level. Top 0.05% outliers in prices and inventory are excluded.

cost of delivery and print. The marginal adjustment cost is low compared to the average marginal cost of delivery and print. When the realized demand is one copy over the initial inventory, in addition to paying the delivery and print cost, ordering one extra book title costs the publisher only 0.3 JPY, which is less than 0.1 of the marginal delivery and print cost. When the realized demand increases and exceeds the initial inventory by 100 copies, the additional cost of ordering one extra copy goes to 28.4 JPY, but still only 0.6 of the marginal delivery and print cost. Only when the difference between the realized demand and the initial inventory is over 150 copies, the marginal adjustment cost increases to over 42.6 JPY, almost equal to the marginal cost of delivery and print.

6.3 Model Fit

To check how well our supply estimates fit, we resample the estimated marginal cost shocks 100 times and simulate the equilibria under the actual institution under the 100 resampled shocks and under the realized demand shocks. We take the average of the prices and inven-

Table 9: Equilibrium under Baseline

	N	Min	Mean	Max	Sd
Price	90,957	500.0	1,268.4	7,200.0	307.7
Marginal deliv&print cost	90,957	0.0	59.3	4,853.8	174.5
Ex-ante					
Initial revenue	90,957	0.0	2,238.5	377,902.2	7,370.1
Initial deliv&print cost	90,957	0.0	103.5	153,621.0	1,090.3
Initial profit	90,957	-8,896.4	2,134.9	365,441.7	6,824.6
Ex-post					
Excess demand revenue	90,957	0.0	519.0	803,998.0	5,647.1
Excess demand deliv&print cost	90,957	0.0	23.7	30,093.5	219.6
Adjustment cost	90,957	0.0	2.1	39,218.9	198.7
Excess demand profit	90,957	0.0	493.2	734,685.6	5,257.6

tories predicted under these equilibria. For both the price and inventory, although being extreme at the maximum, the model predicts equilibrium prices and inventory reasonably well. Table 8 shows the summary statistics of observed and simulated prices and inventories at the title-bookstore level, excluding the top 0.05% outliers. The simulated price and inventory fit the observed ones very well at each quantile. We also show the summary statistics without excluding outliers in Appendix C.

Table 9 shows the summary statistics of simulated prices, revenues, and costs of the baseline model at the bookstore level. The profit is decomposed according to Equation (5). The table includes the statistics before and after the realization of demand shocks (ex-ante and ex-post statistics). This is a key feature to determine the welfare effects of the baseline model because pricing and inventory decisions are determined before the realization of shocks, and adjustment costs are imposed upon the publisher if there is excess demand. The ex-ante statistics include the initial revenue, initial cost of delivery and print, and initial profit;[24] the ex-post statistics include excess demand revenue, excess demand cost of delivery and print, adjustment cost, and excess demand profit.[25] The simulation results show that the costs of delivery and printing from initial allocation are much higher than those of fulfilling excess demand. Thus, under the baseline model, the publisher tends to allocate a high level of inventory before the realization of demand shocks.

[24]These are sales revenue, cost of delivery and print, and the profit incurred by selling based on the initial inventory.

[25]These are the sales revenues, costs, and profits incurred by extra copies to meet the need of excess demand over the initial inventory.

Table 10: Comparison between Baseline and Counterfactual Models

	Baseline	I: Wholesale model	II: Market pricing	III: Min RPM	VI: Integration
Price decision	Publisher, Ex-ante	Bookstores, Ex-post	Publisher, Ex-post	Bookstores, Ex-post	Publisher, Ex-post
Inventory decision	Publisher, Ex-ante	Bookstores, Ex-ante	Publisher, Ex-ante	Bookstores, Ex-ante	Publisher, Ex-ante
Wholesale price	— —	Publisher, Ex-ante	— —	Publisher, Ex-ante	— —
RPM	Min and max	—	Min and max	Min	—
Price flexibility	Uniform	Store	Market	Store	Market
Adjustment cost	Publisher	Bookstores	Publisher	Bookstores	Publisher

Note: Price flexibility refers to the level at which the retail price is set.

7 Welfare Analysis of RPM

Our baseline model captures key features of the current practices of RPM in the Japanese publishing market. The welfare effects of the baseline model are complex. It depends on the importance of demand uncertainty on the prices and inventory decisions, the competitiveness of downstream bookstores, and the effects of uniform prices. In this section, we evaluate the welfare implications of the baseline model by comparing it to four counterfactual scenarios: (1) wholesale model, (2) market-pricing RPM, (3) wholesale model with minimum RPM, and (4) full vertical integration model. The first three counterfactual scenarios allow us to calculate the welfare implication of the pricing features of the baseline model, and the fourth model gives the constrained efficient result under demand uncertainty. [26] Table 10 summarizes the distinct features of the counterfactual scenarios we examine.[27]

[26]The formal modeling of the counterfactual experiments can be found in Appendix E.

[27]In the wholesale model, we relax the RPM assumption and also change the inventory decision-maker from the publisher-distributor to the bookstores. Theoretically, we can consider another counterfactual wholesale model where we only relax the RPM assumption and allow the bookstores to set the retail price, but still, allow the publisher-distributor to decide the inventory and the wholesale price. However, this setting

Due to computation limitations, we randomly sample 100 books to compute the welfare implications between the baseline model and the counterfactual models considered in this section.[28] After we obtain the welfare for the selected sample, we make back-of- envelope calculation to infer the welfare effect for all the top-1000 literature author's books at the nation level based on the ratio of the sales value. The ratio of sales value between the selected literature and all literature for POS stores in Shiga, between all literature for POS stores and Non-POS stores [29], between all literature for POS store in Shiga and in the whole nation is 0.05, 0.90, and 0.02, respectively. We simulate the equilibria of the models conditional on the estimated marginal cost shocks. The unobserved book and bookstore fixed effects are held fixed at the realized ones. In addition, we made the following assumptions about the representative online bookstore in the counterfactual simulations. An online bookstore like Amazon.com in general sets a uniform price across markets. Therefore, in counterfactuals I and III, they should be only allowed to set the uniform price, if we are to copy the reality. However, we find that we cannot obtain any reliable simulation results in such a setting. First, if we allow bookstores and the online bookstore to simultaneously set the prices, the best response price of the online bookstore can alternate, because their demand is the weighted sum of the markets. Second, if we make the online bookstore a first mover in the pricing and inventory decisions, we face convergence issues due to many stage games in the model.

Therefore, we consider two simplified settings: i) the representative online bookstore does not change the behavior, and ii) it sets the market-specific price and inventory like one of the brick-and-mortar bookstores. The first setting creates the least competitive pressure from the representative online bookstore, while the second setting creates the maximal competitive pressure. The reality should reside in between. In our counterfactual experiments, to simplify the illustration, we only report results where the representative online bookstore sets the market-specific price and inventory like one of the brick-and-mortar bookstores. The results where it sets fixed prices and inventory can be found in Appendix G. In the main text, we also report the results combining brick-and-mortar bookstores and the representative online bookstore. The separate results for brick-and-mortar bookstores and the representative online bookstore are reported in Appendix F.

is not realistic because if the publisher-distributor is able to decide both the inventory and the wholesale price, he will set both of them to high levels to drive the bookstores' profits to zero.

[28] We randomly sample 100 authors and sample one book per author.

[29] for POS stores and NON-POS stores, we infer based on the ratio of net delivery

7.1 Counterfactual I: Wholesale Model

The first counterfactual considers a wholesale model in which the publisher decides the wholesale price and bookstores decide the inventory before the realization of demand shocks. Moreover, bookstores choose profit-maximizing retail prices after the realization of demand shocks. This setup provides bookstores the ability to set prices based on the realized demand and local market conditions. Note, importantly, prices can differ across bookstores under this wholesale model.[30]

If the competition among bookstores is fierce, the wholesale model can lead to strong downward pressure on prices. Because bookstores anticipate a lower return for inventory, they have less incentive to stock inventory before the realization of demand shocks. With the degree of the negative externality of price competition, the initial inventory level becomes socially insufficient. Under the baseline model, however, the downward pricing pressure could be attenuated by the minimum RPM. On the contrary, if bookstores have enough market power, the downward pricing pressure under the wholesale model may not be relevant and the double-marginalization problem could be severe. The double-marginalization problem under the baseline model, however, could be mitigated by the maximum RPM feature. The double-marginalization problem of the wholesale model can also make the initial inventory level socially insufficient, because bookstores can suppress the demand by increasing retail prices, instead of having a larger amount of initial inventory. Therefore, the welfare effects of changing from the baseline model to the wholesale model depend on downstream bookstore market power, the incentive to hold inventory before the realization of a demand shock, and the degree of demand uncertainty.

Table 11 shows the welfare comparison between the baseline model and the wholesale model. The table shows that, for our selected sample, the counterfactual I decreases the consumer surplus by 1.26 million JPY (-27.71% of the baseline sales value), decreases the publisher surplus by 1.32 million JPY (-29.16% of the baseline sales value), but increases the store surplus by 0.25 million JPY (5.59% of the baseline value). By a back-of-envelope computation, the counterfactual I decreases the consumer surplus by 25.11 million JPY, decreases the publisher surplus by 26.42 million JPY, but increases the store surplus by 5.07 million JPY for all literature, all POS bookstores in Shiga. It decreases the consumer surplus by 27.90 million JPY, decreases the publisher surplus by 29.36 million JPY, but increases the store surplus by 5.63 million JPY for all literature, all bookstores in Shiga. And it decreases the consumer surplus by 164.10 million JPY, decreases the publisher surplus by

[30] Sequentially solving model is straightforward, because the ex-post pricing decisions given the inventory are a Bertrand competition, and the ex-ante inventory decisions given the wholesale price are a Cournot competition.

Table 11: Surplus under Baseline and Counterfactual I

	Consumer	Publisher	Store
Counterfactual I - Baseline: JPY			
Sample literature, Shiga, POS stores	-1.26	-1.32	0.25
All literature, Shiga, POS stores	-25.11	-26.42	5.07
All literature, Shiga, all stores	-27.90	-29.36	5.63
All literature, nation, all stores	-164.10	-172.71	33.11
Diff/Baseline sales: %			
	-27.71	-29.16	5.59

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. For all literature, we infer the welfare by a back-of-envolope calculation. The ratio of sales value between the selected literature and all literature for POS stores in Shiga, between all literature for POS stores and Non-POS stores, between all literature for POS store in Shiga and in the whole nation is 0.05, 0.90, and 0.02, respectively.

Table 12: Allocations under Baseline and Counterfactual I

	N	Min	Median	Mean	Max
Retail price					
Baseline	3,009	650.00	1,200.00	1,260.98	4,800.00
Counterfactual I	3,009	1,151.32	1,605.46	1,669.56	2,334.59
Inventory					
Baseline	3,009	0.00	2.00	5.08	545.24
Counterfactual I	3,009	0.00	0.00	0.01	10.81

Note: the price and inventory are at the title-bookstore level.

Table 13: Surplus under Counterfactual II

	Consumer	Publisher	Store
Counterfactual II - Baseline: JPY			
Sample literature, POS stores, Shiga	0.69	1.36	0.37
All literature, POS stores, Shiga	13.74	27.16	7.47
All literature, all stores, Shiga	15.27	30.18	8.30
All literature, all stores, Japan	89.82	177.50	48.80
Diff/Baseline sales: %			
	15.17	29.97	8.24

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual II refers to the institution featuring market-specific pricing. For all literature, we infer the welfare by a back-of-envolope calculation. The ratio of sales value between the selected literature and all literature for POS stores in Shiga, between all literature for POS stores and Non-POS stores, between all literature for POS store in Shiga and in the whole nation is 0.05, 0.90, and 0.02, respectively.

172.71 million JPY, but increases the store surplus by 33.11 million JPY for all literature, all bookstores in Japan.

Table 12 presents the comparison of prices and inventory between the baseline model and Counterfactual I. The average price per title per bookstore is 1260.98 JPY under the baseline model, which is 20% cheaper than that under Counterfactual I. Moreover, the average inventory per title and bookstore is 2 under the baseline model, but 0 under Counterfactual I. The higher consumer surplus of the baseline model is due to its lower prices.

There are two features of the baseline model that could lead to a lower price level and a higher inventory level in equilibrium. First, the minimum RPM increases the return to return to inventory in low demand states. Under demand uncertainty, the minimum RPM prevents bookstores from aggressive price cutting in low-demand states. Hence, bookstores have incentives to hold inventory before the realization of demand. Second, the maximum RPM leads bookstores to reorder books under high demand states and excess demand instead of raising prices as in the case in the wholesale model.

7.2 Counterfactual II: Market Pricing

The wholesale model allows prices to vary across bookstores, which could mechanically increase the producer surplus due to the deviation of uniform pricing rather than the effects of RPM. To separately identify the implications of minimum and maximum RPM, we consider a second counterfactual experiment in which we hold all characteristics of the baseline model fixed except that the publisher is allowed to set market-specific retail prices before demand realization. As a result, prices can vary across regions, and bookstores within a region face

Table 14: Allocations under Counterfactual II

	N	Min	Median	Mean	Max
Retail price					
Baseline	3,009	650.00	1,200.00	1.260980e+03	4.800000e+03
Counterfactual II	3,009	637.04	1,258.77	3.314881e+74	3.324825e+77
Inventory					
Baseline	3,009	0.00	2.00	5.080000e+00	5.452400e+02
Counterfactual II	3,009	0.00	1.59	9.860000e+00	1.463410e+03

Note: the price and inventory are at the title-bookstore level.

the same retail price and cannot adjust prices after the realization of demand shocks.

Table 13 shows the welfare comparison between the baseline model and counterfactual II. Allowing the publisher to set different RPM prices across different regions increases the consumer surplus by 0.69 million JPY (15.17% of the baseline sales value), the publisher surplus by 1.36 million JPY (29.97 of the baseline sales value), and the bookstore surplus by 0.37 million JPY (8.24 of the sales value). By a back-of-envelope calculation, the counterfactual II increases the consumer surplus by 13.74 million JPY, the publisher surplus by 27.16 million JPY, and the bookstore surplus by 7.47 million JPY for all literature, all POS bookstores in Shiga. It increases the consumer surplus by 15.27 million JPY, the publisher surplus by 30.18 million JPY, and the bookstore surplus by 8.30 million JPY for all literature, all bookstores in Shiga. And it increases the consumer surplus by 89.82 million JPY, the publisher surplus by 177.50 million JPY, and the bookstore surplus by 48.40 million JPY for all literature, all POS bookstores in Japan.

Table 14 shows the equilibrium prices and inventory under the baseline model and counterfactual II. Under counterfactual II, the prices and inventory are tailored to each market. For example, when a market receives a very large marginal cost shock for a certain book title, the retail price of the title in the market goes to an infinitely high level to prevent any sales of the title in the market (the maximal retail price per title per bookstore in the counterfactual II is $3.32 * 10^{77}$). However, if the retail price is set at the title level, it is still profitable for the publisher to set a reasonably high retail price and to have some sales.

7.3 Counterfactual III: Minimum Resale Price Maintenance

Both the minimum and maximum RPM could explain the higher consumer surplus of the baseline model than the wholesale model. In the third counterfactual, we consider a wholesale model in which the publisher can set a minimum RPM in addition to the wholesale price.

Table 15: Surplus under Counterfactual III

	Consumer	Publisher	Store
Couterfactual III - I: JPY			
	-0.04	-0.04	-0.04
Diff/Baseline sales: %			
	-0.83	-0.89	-0.87

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring the wholesale model. Counterfactual III refers to the institution featuring minimum RPM. For all literature, we infer the welfare by a back-of-envolope calculation. The ratio of sales value between the selected literature and all literature for POS stores in Shiga, between all literature for POS stores and Non-POS stores, between all literature for POS store in Shiga and in the whole nation is 0.05, 0.90, and 0.02, respectively.

Table 16: Allocations under Counterfactual III

	N	Min	Median	Mean	Max
Retail price					
Counterfactual I	3,009	1,151.32	1,605.46	1,669.56	2,334.59
Counterfactual III	3,009	1,158.97	1,619.79	1,669.06	2,324.96
Inventory					
Counterfactual I	3,009	0.00	0.00	0.01	10.81
Counterfactual III	3,009	0.00	0.00	0.01	9.70

Note: the price and inventory are at the title-bookstore level.

Table 17: Surplus under Counterfactual IV

	Consumer	Publisher	Store
Counterfactual IV - I: JPY			
Sample literature, Shiga, POS stores	3.16	6.41	-2.08
All literature, Shiga, POS stores	63.18	128.17	-41.69
All literature, Shiga, all stores	70.20	142.41	-46.32
All literature, nation, all stores	412.94	837.71	-272.46
Diff/Baseline sales: %			
	69.72	141.44	-46.00

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring the wholesale model. Counterfactual IV refers to the institution featuring maximum RPM. For all literature, we infer the welfare by a back-of-envolope calculation. The ratio of sales value between the selected literature and all literature for POS stores in Shiga, between all literature for POS stores and Non-POS stores, between all literature for POS store in Shiga and in the whole nation is 0.05, 0.90, and 0.02, respectively.

Bookstores, on the other hand, can raise prices if there is an excess demand but cannot cut prices below the minimum RPM when in low-demand states.

Table 15 shows the comparison of surpluses between counterfactuals I and III, and Table 16 presents the retail prices and inventory under counterfactuals I and III. The simulation results show that the surplus and allocations between counterfactuals I and III are almost the same except for very small numerical differences, implying that the equilibrium retail price under counterfactual I is higher than the optimal price floor set by the minimum RPM. The theory of Deneckere et al. (1997) assumed a perfect competition of retailers. If the bookstores could have market power, as in our model, the pro-competitive effects of the minimum RPM are not relevant.

7.4 Counterfactual IV: Maximum Resale Price Maintenance

We have shown in the previous subsection that the wholesale model with only minimum RPM yields the same welfare as that in the wholesale model. Therefore, the maximum RPM in the baseline model should contribute to the increase of the welfare from the wholesale model. To check this, in the fourth counterfactual, we consider a wholesale model in which the publisher can set a maximum RPM in addition to the wholesale price. Bookstores, on the other hand, can decrease prices if there is an excess demand but cannot increase prices above the minimum RPM when in low-demand states. We assume that the publisher will never set a wholesale price above the maximal retail price he sets.

Table 17 shows the comparison of surpluses between counterfactuals I and IV, and Table

Table 18: Allocations under Counterfactual IV

	N	Min	Median	Mean	Max
Retail price					
Counterfactual I	3,009	1,151.32	1,605.46	1,669.56	2,334.59
Counterfactual VI	3,009	675.06	912.85	1,156.11	2,085.13
Inventory					
Counterfactual I	3,009	0.00	0.00	0.01	10.81
Counterfactual VI	3,009	0.00	0.00	0.03	30.16

Note: the price and inventory are at the title-bookstore level.

18 presents the retail prices and inventory under counterfactuals I and IV. The simulation results show that the counterfactual IV increases the consumer surplus by 3.16 million JPY (69.72% of the baseline sales value), the publisher surplus by 6.41 million JPY (141.44% of the baseline sales value) from the counterfacutual I. But it decreases the store surplus by 2.08 million JPY (-46.00% of the baseline sales value). By a back-of-envelope calculation, compared with the counterfactual I, the counterfactual IV increases the consumer surplus by 63.18 million JPY, the publisher surplus by 128.17 million JPY, but decreases the bookstore surplus by 41.69 million JPY for all literature, all POS bookstores in Shiga. It increases the consumer surplus by 70.20 million JPY, the publisher surplus by 142.41 million JPY, but decreases the bookstore surplus by 46.32 million JPY for all literature, all bookstores in Shiga. And it increases the consumer surplus by 412.94 million JPY, the publisher surplus by 837.71 million JPY, but decreases the bookstore surplus by 272.46 million JPY for all literature, all POS bookstores in Japan.

The maximum RPM eliminates the double marginalization and thus decreases the retail price as shown in Table 18 .

7.5 Counterfactual V: Vertically Integrated Industry

To assess the pro-competitive effects of the maximum RPM, we consider a vertically integrated industry, where the prices are determined by the publisher after the realization of demand shocks as in the wholesale model. The publisher and bookstores are integrated as an entity, where inventory is decided at the bookstore level before demand realization, and prices are decided at the market level after demand is realized by the integrated supplier.

Table 19 shows the comparison of consumer and producer surplus between the baseline model, counterfactuals I and V. Compared to counterfactual I, the vertically integrated model increases consumer surplus by 12.61 million JPY (3.88% of the baseline sales value)

Table 19: Surplus under Counterfactual V

	Consumer	Supply
Counterfactual IV - Baseline		
Sample literature, POS stores, Shiga	11.35	7.80
All literature, POS stores, Shiga	227.09	155.91
All literature, all stores, Shiga	252.32	173.23
All literature, all stores Japan	1484.23	1018.99
Counterfactual IV - Counterfactual I		
Sample literature, POS stores, Shiga	12.61	8.86
All literature, POS stores, Shiga	252.19	177.26
All literature, all stores, Shiga	280.22	196.96
All literature, all stores Japan	1648.33	1158.59
IV - Baseline / Baseline sales		
	250.59	172.04
IV - I / Baseline sales		
	278.29	195.61

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring the wholesale model. Counterfactual VI refers to the vertically-integrated model. For all literature, we infer the welfare by a back-of-envelope calculation. The ratio of sales value between the selected literature and all literature for POS stores in Shiga, between all literature for POS stores and Non-POS stores, between all literature for POS store in Shiga and in the whole nation is 0.05, 0.90, and 0.02, respectively.

Table 20: Allocations under Counterfactual V

	N	Min	Median	Mean	Max
Retail price					
Counterfactual I	3,009	1,151.32	1,605.46	1,669.56	2,334.59
Vertically-integrated	3,009	519.16	550.71	592.99	1,959.07
Inventory					
Counterfactual I	3,009	0.00	0.00	0.01	10.81
Vertically-integrated	3,009	0.00	0.00	14.24	1,192.61

Note: the price and inventory are at the title-bookstore level.

and supply-side surplus by 8.86 (122.63% of the baseline sales value) million JPY. By a back-of-envelope calculation, the counterfactual IV increases the consumer surplus by 252.19 million JPY, and increases the supply surplus by 177.26 million JPY from the counterfactual I for all literature, all POS stores in Shiga. It increases the consumer surplus by 280.22 million JPY, and increases the supply surplus by 196.96 million JPY from the counterfactual I for all literature, all bookstores in Shiga. And it increases the consumer surplus by 1648.30 million JPY, and increases the supply surplus by 1158.59 million JPY from the counterfactual I for all literature, all bookstores in Japan. This is consistent with the elimination of double marginalization in the market. We further compare the bookstore-title level prices between counterfactuals I and IV as presented in Table 20. The average retail price per title per bookstore under counterfactual IV (550.71 JPY) is lower than that under counterfactual I (1605.46 JPY), which further supports welfare improvement by eliminating double-marginalization. The vertically integrated model also increases consumer surplus by 11.35 million JPY (250.59% of the baseline sales value) and supply surplus by 7.80 million JPY (172.04% of the baseline sales value) from the baseline model. The differences between the two models reflect the inefficiency of the revenue sharing rate and ex-ante price setting in the baseline model.

8 Conclusion

In this paper, we developed and estimated a model of publishers and bookstores with RPM, in which the inventory was determined before the demand realization. The model allowed us to evaluate the competitive effects of the key features of pricing in the Japanese publishing industry: the minimum and maximum RPM and the geographically uniform pricing. In the model, the minimum and maximum RPM could be pro-competitive by increasing inventories through different channels, depending on market structure: The minimum RPM could prevent a price war of competitive bookstores, while the maximum RPM could prevent the double-marginalization problem of monopolistic bookstores.

The demand estimates suggested that the bookstores had non-negligible market power in the local market. By counterfactual simulation, we found that the shift to the wholesale model decreases the consumer surplus by 1.26 million JPY, decreases the publisher surplus by 1.32 million JPY and increases the bookstore surplus by 0.25 million JPY million, respectively. The drop in the consumer surplus was due to the decreased inventory and the increased prices. Because the bookstores could suppress the excess demand by raising the retail price in the wholesale model, they reduced the inventory relative to the baseline model.

Part of the increase in the profit of the bookstores and publishers was due to the increased pricing flexibility. In another counterfactual simulation, we found that allowing the publishers to set the market-specific retail price increases the consumer surplus by 0.69 million JPY, increases the publisher surplus by 1.36 million JPY and increases the bookstore surplus by 0.37 million JPY.

We also found that the maximum RPM affected the equilibrium price but the minimum RPM does not. Thus, the pro-competitive effect of the RPM was through the suppression of the double marginalization by the maximum RPM.

There are several limitations in the analysis. First, the inter-brand competition across book titles was not considered. If we analyze other categories such as self-enhancement books, the substitution between book titles would be more important. Second, the bargaining powers of the bookstores and publishers were not explicitly estimated because the prevailing revenue sharing rate was observed. If we consider a counterfactual scenario where the wholesale price is determined by bargaining, the estimation of the bargaining power behind the observed revenue-sharing rate is necessary. However, we are skeptical whether the current revenue sharing rate could be regarded as a consequence of static bargaining because there seems to be a historical reason for these numbers. Third, another competitive channel of RPM, such as the enhancement of the in-store advertisement activity, was not considered. In addition, increasing inventory itself might have some advertisement effect, because it increases books on the shelves. We did not consider the former because we did not have data on in-store advertisements and did not consider the latter because the equilibrium becomes unstable if we consider this channel. By considering either channel, the results will become more in favor of the RPM, and hence our conclusion will not change. Fourth, the data is limited to the bookstores that transact with the data provider and has a point-of-sale system. Thus, the strategic responses of the other bookstores are not considered in the counterfactual simulations. Although the current coverage of the data is wide enough, the analysis based on a more comprehensive data set is desired. Fifth, the analysis does not utilize the variation in the regulatory regime. If similar data is available in countries that experienced a change in the resale price maintenance regime, such as the Norwegian book market, the model prediction could be validated.

References

Asker, John and Heski Bar-Isaac, "Raising Retailers' Profits: On Vertical Practices and the Exclusion of Rivals," *American Economic Review*, February 2014, *104* (2), 672–686.

Bailey, Elizabeth M. and Gregory K. Leonard, "Minimum Resale Price Maintenance: Some Empirical Evidence from Maryland," SSRN Scholarly Paper ID 1532998, Social Science Research Network, Rochester, NY January 2010.

Ball, C., S. Davies, M. Olczak, and Chris M. Wilson, "An evaluation of the impact upon productivity of ending resale price maintenance on books," *manuscript*, 2008.

Beck, Jonathan, "Fixed, Focal, Fair? Book Prices Under Optional Resale Price Maintenance," SSRN Scholarly Paper ID 645861, Social Science Research Network, Rochester, NY December 2004.

__ , *Resale price maintenance for books*, Norderstedt: Books On Demand, January 2008.

Bittlingmayer, George, "Resale Price Maintenance in the Book Trade with an Application to Germany," *Journal of Institutional and Theoretical Economics*, 1988, *144* (5), 789–812.

Blair, Roger D. and Francine Lafontaine, "Will Khan Foster or Hinder Franchising? An Economic Analysis of Maximum Resale Price Maintenance," *Journal of Public Policy & Marketing*, March 1999, *18* (1), 25–36.

Bonnet, Céline and Pierre Dubois, "Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance," *The RAND Journal of Economics*, 2010, *41* (1), 139–164.

Chevalier, Judith and Austan Goolsbee, "Measuring Prices and Price Competition Online: Amazon.com and BarnesandNoble.com," *Quantitative Marketing and Economics*, June 2003, *1* (2), 203–222.

Deneckere, Raymond, Howard P. Marvel, and James Peck, "Demand Uncertainty, Inventories, and Resale Price Maintenance," *The Quarterly Journal of Economics*, 1996, *111* (3), 885–913.

__ , __ , and __ , "Demand Uncertainty and Price Maintenance: Markdowns as Destructive Competition," *The American Economic Review*, 1997, *87* (4), 619–641.

Fishwick, Francis, "Book Prices in the UK Since the End of Resale Price Maintenance," *International Journal of the Economics of Business*, November 2008, *15*, 359–377.

Francis, Fishwick, "Book Prices in the UK Since the End of Resale Price Maintenance," *International Journal of the Economics of Busienss*, 2008, *15*, 359–377.

Gilligan, Thomas W., "The Competitive Effects of Resale Price Maintenance," *The RAND Journal of Economics*, 1986, *17* (4), 544–556.

Ippolito, Pauline M. and Thomas R. Overstreet, "Resale Price Maintenance: An Economic Assessment of the Federal Trade Commission's Case against the Corning Glass Works," *The Journal of Law and Economics*, April 1996, *39* (1), 285–328.

Japan Book Publishers Association, "Japan Book Publishers Association - 2017 - An Introduction to Publishing in Japan.pdf," 2017.

Japan Fair Trade Commission, "About Retail Price Maintenance of Copyrighted Works," March 2001.

__ , "Guidelines Concerning Distribution Systems and Business Practices," June 2017.

Johnson, Justin P., "The Agency Model and MFN Clauses," *The Review of Economic Studies*, July 2017, *84* (3), 1151–1185.

Jullien, Bruno and Patrick Rey, "Resale price maintenance and collusion," *The RAND Journal of Economics*, 2007, *38* (4), 983–1001.

Klein, Benjamin, "Distribution Restrictions Operate by Creating Dealer Profits: Explaining the Use of Maximum Resale Price Maintenance in State Oil v. Khan," *Supreme Court Economic Review*, January 1999, *7*, 1–58.

Li, Hui, "Intertemporal Price Discrimination with Complementary Products: E-Books and E-Readers," *Management Science*, March 2019, *65* (6), 2665–2694.

_ , "Are e-books a different channel? Multichannel management of digital products," *Quantitative Marketing and Economics*, June 2021, *19* (2), 179–225.

MacKay, Alexander and David A. Smith, "Challenges for Empirical Research on RPM," *Review of Industrial Organization*, March 2017, *50* (2), 209–220.

Marvel, Howard P. and Stephen McCafferty, "Resale Price Maintenance and Quality Certification," *The RAND Journal of Economics*, 1984, *15* (3), 346–359.

Ornstein, Stanley I. and Dominique M. Hanssens, "Resale Price Maintenance: Output Increasing or Restricting? The Case of Distilled Spirits in the United States," *The Journal of Industrial Economics*, 1987, *36* (1), 1–18.

Santos, Babur De Los and Matthijs R. Wildenbeest, "E-book pricing and vertical restraints," *Quantitative Marketing and Economics*, June 2017, *15* (2), 85–122.

Telser, Lester G., "Why Should Manufacturers Want Fair Trade?," *The Journal of Law & Economics*, 1960, *3*, 86–105.

Tirole, Jean, *The Theory of Industrial Organization*, Cambridge, MA, USA: MIT Press, August 1988.

Tosdal, H. R., "Price Maintenance in the Book Trade," *The Quarterly Journal of Economics*, November 1915, *30* (1), 86–109.

Øystein Daljord, "Durable Goods Adoption and the Consumer Discount Factor: A Case Study of the Norwegian Book Market," *Management Science*, December 2021.

Øystein Foros, Hans Jarle Kind, and Greg Shaffer, "Apple's agency model and the role of most-favored-nation clauses," *The RAND Journal of Economics*, 2017, *48* (3), 673–703.

Appendices

A Competition with Demand Uncertainty

We briefly introduce a simple model developed in Deneckere et al. (1997) to illustrate how competition exerts negative externality on inventory holding under demand uncertainty and how minimum RPM helps to recover the industrial optimal profit. Readers who are interested may refer to their paper for more details.

Suppose there are a risk-neutral manufacturer and a continuum of risk-neutral retailers, who sell the manufacturer's product to the consumers. The demand for the product is uncertain and is given by

$$D(p,\ \theta) = \begin{cases} 1-p, & \text{with probability } \frac{1}{2} \\ \theta(1-p), & \text{with probability } \frac{1}{2} \text{ , and } \theta > 1. \end{cases} \tag{15}$$

The cost of production is normalized to zero.

As a benchmark, we consider the market is vertically-integrated. The vertically-integrated manufacturer has to choose an inventory before demand realization but can set an optimal price for every state. The manufacture will choose a retail price $p = \frac{1}{2}$ for both states, and sell quantity $q^L = \frac{1}{2}$ in the low demand state and quantity $q^H = \frac{\theta}{2}$ in the high demand state. Given the zero product cost, the optimal inventory for the manufacture is $Q = \frac{\theta}{2}$. The expected producer surplus is $\frac{1+\theta}{8}$, and the expected consumer surplus is $\frac{1+\theta}{16}$.

If the retailers are not integrated with the manufacturer and compete in the market, the manufacturer no longer has control over the quantity of the product sold in the market in every state. The retailers have to commit to the amount of inventory from the manufacturer before the realization of the demand.

Proposition 1. *If the industry is not vertically integrated and the retailer has to commit to the amount of inventory before demand realization, the negative externality from competition decreases inventory holding from the industry optimal level (the optimal inventory level from a vertically-integrated entity's perspective).*

Proof. Consider the case where the industry is not vertically integrated. When the wholesale price is low, the retailers will order an inventory large enough to drive the retailer price in the low demand state to zero. Therefore, the manufacturer can only earn a profit from the high demand state with the profit function

$$\Pi_m = \frac{1}{2}(1 - \frac{Q}{\theta})Q, \tag{16}$$

where Q is the total inventory ordered by the retailers.

However, when the wholesale price increases, the retailers will find it not profitable to order too much inventory. The prices in both the high demand state and the low demand state will be positive. Therefore, given that retailers earn zero expected profit under perfect competition, we will have the profit function for the manufacturer to be

$$\Pi_m = [1 - \frac{(1+\theta)Q}{2\theta}]Q. \tag{17}$$

If $\theta \geq 3$, the manufacturer finds the first case more profitable, and it will set the wholesale price $p^w = \frac{1}{4}$. The retailers will order the total quantity $Q = \frac{\theta}{2}$ The resulting retail price in the high demand state is $p^H = \frac{1}{2}$, and the retail price in the low demand state is $p^L = 0$. This yields a manufacturer profit $\Pi_m = \frac{\theta}{8}$ and an expected consumer surplus $\frac{1}{4} + \frac{\theta}{16}$. Only the manufacturer profit drops from the benchmark.

If $\theta < 3$, the manufacturer finds the second case more profitable, and it will set the wholesale price $p^w = \frac{1}{2}$. The retailers order inventory $Q = \frac{\theta}{1+\theta}$. The retail price in the high demand state is $p^H = \frac{\theta}{1+\theta}$, and the retailer price in the low demand state is $p^L = \frac{1}{(1+\theta)}$. The equilibrium expected producer surplus and consumer surplus are equal to $\frac{1}{1+\theta}$ and $\frac{\theta}{4(1+\theta)}$, respectively. In this case, both the expected manufacturer profit and the consumer surplus drop from the benchmark □

Proposition 2. *With the minimum RPM, by setting a wholesaler price $p^w = \frac{1+\theta}{4\theta}$, and a lowest price floor $\bar{p} = \frac{1}{2}$, the industry-optimal inventory $Q = \frac{\theta}{2}$ and the industry-optimal manufacture profit $\frac{1+\theta}{8}$ can be recovered.*

Proof. Under RPM game, for a retailer t, the probability of selling one unit is $\frac{(1-\bar{p})}{Q}$ in the low demand state, and $\frac{\theta(1-\bar{p})}{Q}$ in the high demand state. Therefore, the expected profit for retailer t can be written as

$$\pi(t) = [\frac{\bar{p}(1-\bar{p})(1+\theta)}{2Q} - p^w)]q(t). \tag{18}$$

Under perfect competition, Q is not affected by individual $q(t)$ and the retailer earns zero expected profit. This gives us

$$\frac{\bar{p}(1-\bar{p})(1+\theta)}{2} = p^w Q, \tag{19}$$

which is satisfied by setting $p^w = \frac{1+\theta}{4\theta}$, $\bar{p} = \frac{1}{2}$ and $Q = \frac{\theta}{2}$. The retailers do not have profitable deviations.

For the manufacturer, the right-hand side of Equation (19) coincides with its profit, which is maximized by setting $\bar{p} = \frac{1}{2}$.

Therefore, setting $p^w = \frac{1+\theta}{4\theta}$, $\bar{p} = \frac{1}{2}$ and any $q(t)$ for retailer t satisfying $Q = \int_0^1 q(t)dt = \frac{\theta}{2}$ constitutes a subgame-perfect equilibrium. In the low demand state, The retail price is $p^L = \frac{1}{2}$ and the quantity sold is $q^L = \frac{1}{2}$. In the high demand state, the retail price is $p^H = \frac{1}{2}$ and the quantity sold is $q^H = \frac{\theta}{2}$. The manufacturer profit is $\frac{1+\theta}{8}$ and the consumer surplus is $\frac{1+\theta}{16}$ which are the same as that in the vertically-integrated model. □

In a wholesale model, the competition in the retail market creates a negative externality and reduces the incentive to accumulate inventory up to $\frac{\theta}{2}$. The manufacturer loses profit because the price deviates from its optimal level. The consumers may be severely harmed in the high-demand state as well if the reduction of inventory is high. With the minimum RPM, by setting a price floor for the retailers, the manufacturer can prevent the retailers from price competition if there is more inventory than demand. The retailers are restricted from pouring inventory into the market in the low-demand state.

B Double Marginalization with Demand Uncertainty

B.1 Baseline Model without Demand Uncertainty

We start with a vertical model without demand uncertainty. Consider the case where there are one manufacturer and one retailer facing a demand $Q = 1 - p$. We normalize the cost of production to zero. In a wholesale model, the manufacturer first chooses a wholesale price. Given the wholesale price, the retailer chooses the inventory level. Then it chooses a quantity to serve the market, where the quantity should be less than or equal to the inventory level it chose.

Proposition 3. *Under linear demand with no demand uncertainty, double marginalization in the wholesale model reduces the inventory holding by one-half compared to the vertically-integrated model.*

Proof. Without demand uncertainty, the demand can be perfectly foreseen. Therefore, the optimal inventory level will be equal to the quantity the retailer is going to serve the market. Choosing an inventory is equal to choosing an actual quantity to serve. Given a wholesale price p^w, the retailer chooses a retail price p to solve

$$\max_{p} p(1-p) - p^w(1-p). \tag{20}$$

We have $p = \frac{1+p^w}{2}$. Given the best response from the retailer, the manufacturer chooses p^w to solve

$$\max_{p^w} p^w(1 - \frac{1+p^w}{2}). \tag{21}$$

We get $p^w = \frac{1}{2}$, $p = \frac{3}{4}$, and $Q = \frac{1}{4}$.

Now consider the manufacturer and the retailer are integrated to be a single manufacturer. In this case, the manufacturer chooses p to solve

$$\max_{p} p(1-p). \tag{22}$$

The manufacturer will choose $p = \frac{1}{2}$ and $Q = \frac{1}{2}$.

□

Proposition 4. *In the wholesale model, with maximum RPM, the manufacturer is able to recover vertically-integrated inventory and profit.*

Proof. Let $\bar{p}$ denote the price ceiling set by the manufacturer in the wholesale model. The manufacturer will set $p^w = \bar{p} = \frac{1}{2}$, the optimal retail price in the vertically-integrated model. Then the retailer will be forced to set the retail price $p = \frac{1}{2}$ and sell quantity $Q = \frac{1}{2}$. The profit for the retailer is zero and the profit for the manufacturer is equal to the that under the vertically-integrated model. □

B.2 Model with Demand Uncertainty

In this subsection, we include demand uncertainty in the model. There are one manufacturer and one retailer, both of which are monopolists. Demand is uncertain and is assumed to be

$$D(p,\theta) = \begin{cases} 1-p & \text{with probability } \frac{1}{2}, \\ \theta(1-p) & \text{with probability } \frac{1}{2}, \text{and } \theta > 1. \end{cases} \tag{23}$$

The cost of production is normalized to 0.

In a wholesale model, the manufacturer first sets a wholesale price p^w. Then given p^w, before the demand is realized, the retailer chooses inventory k. After the demand is realized, the retailer chooses a retail price p (and hence a quantity Q) to serve the market. The actual quantity to serve in each state has to be less than or equal to the inventory set before demand realization.

In a vertically-integrated model, the integrated entity chooses inventory k before demand realization and chooses a retail price p (and hence a quantity Q) to serve the market after demand realization. Again, the actual quantity to serve in each state has to be less than or equal to the inventory set before demand realization.

Proposition 5. *Under linear demand with demand uncertainty, double marginalization reduces the inventory holding by at least one-half compared to the vertically-integrated model. When the difference between the high demand and low demand is moderate ($1 < \theta \leq 3$), double marginalization reduces the inventory holding by more than one-half.*

Proof. We start with solving the equilibrium for the wholesale model. In the last stage, the cost of inventory is sunk. Without any capacity constraint, the retailer will choose $p = \frac{1}{2}$ and $Q = \frac{1}{2}$ in the low demand state, and it will choose $p = \frac{1}{2}$ and $Q = \frac{\theta}{2}$ in the high demand state. If it is constrained by k, however, the retailer is forced to choose $Q = k$ and $p = 1 - k$ in the low demand state, and $Q = k$ and $p = 1 - \frac{1}{\theta}k$ in the high demand state.

In the second stage, where the retailer chooses its capacity, it can choose to be constrained in both states ($0 < k < \frac{1}{2}$), to be constrained in only the low demand state ($\frac{1}{2} \leq k \leq \frac{\theta}{2}$) or to constrained in neither of the two states ($k > \frac{\theta}{2}$). Therefore, the expected profit function for the retailer in the second stage can be expressed as

$$\Pi^r = \begin{cases} \frac{1}{8} + \frac{\theta}{8} - p^w k & \text{if } k > \frac{\theta}{2}, \\ \frac{1}{8} + \frac{1}{2}k(1 - \frac{1}{\theta}k) - p^w k & \text{if } \frac{1}{2} \leq k \leq \frac{\theta}{2}, \\ \frac{1}{2}k(1-k) + \frac{1}{2}k(1 - \frac{1}{\theta}k) - p^w k & \text{if } 0 \leq k < \frac{1}{2}. \end{cases} \tag{24}$$

Choosing $k > \frac{\theta}{2}$ is strictly dominated by choosing $k = \frac{\theta}{2}$, so the retailer never chooses $k > \frac{\theta}{2}$. If the retailer chooses $\frac{1}{2} \leq k \leq \frac{\theta}{2}$, an interior solution to maximize its profit will be choosing $k = \frac{(1-2p^w)\theta}{2}$, with the maximized profit $\frac{1}{8} + \frac{(1-2p^w)^2\theta}{8}$. However, if p^w increases to $\frac{\theta-1}{2\theta}$, the interior solution goes less than $\frac{1}{2}$ and the maximal profit can only be reached by choosing

$k = \frac{1}{2}$, with the maximized profit $\frac{1}{8} + \frac{1}{4}(1 - \frac{1}{2\theta}) - \frac{1}{2}p^w$. If the retailer chooses $0 \leq k < \frac{\theta}{2}$, the maximal profit can be reached by choosing $k = \frac{\theta(1-p^w)}{(1+\theta)}$ ($\frac{\theta(1-p^w)}{(1+\theta)} < \frac{1}{2}$, if $p^w > \frac{\theta-1}{2\theta}$), obtaining a profit of $\frac{\theta(1-p^w)^2}{2(1+\theta)}$. When $p^w \leq \frac{\theta-1}{2\theta}$, we always have $\frac{1}{8} + \frac{(1-2p^w)^2\theta}{8} > \frac{\theta(1-p^w)^2}{2(1+\theta)}$, so choosing $k = \frac{(1-2p^w)\theta}{2}$ is optimal for the retailer. And when $p^w < \frac{\theta-1}{2\theta}$, we always have $\frac{\theta(1-p^w)^2}{2(1+\theta)} > \frac{1}{8} + \frac{1}{4}(1 - \frac{1}{2\theta}) - \frac{1}{2}p^w$, so choosing $k = \frac{\theta(1-p^w)}{(1+\theta)}$ is optimal for the retailer. We can obtain the best response function of the retailer given p^w

$$k = \begin{cases} \frac{(1-2p^w)\theta}{2} & \text{if } 0 \leq p^w \leq \frac{\theta-1}{2\theta}, \\ \frac{\theta(1-p^w)}{(1+\theta)} & \text{if } p^w > \frac{\theta-1}{2\theta}, \end{cases} \tag{25}$$

In the first stage, given the best response function of the retailer in the second stage, we can obtain the profit function for the manufacturer

$$\Pi^m = \begin{cases} \frac{p^w(1-2p^w)\theta}{2} & \text{if } 0 \leq p^w \leq \frac{\theta-1}{2\theta}, \\ \frac{p^w\theta(1-p^w)}{(1+\theta)} & \text{if } p^w > \frac{\theta-1}{2\theta}. \end{cases} \tag{26}$$

If the manufacturer chooses $0 \leq p^w \leq \frac{\theta-1}{2\theta}$, then given $\theta \geq 2$, the interior maximum can be reached by choosing $p^w = \frac{1}{4}$, obtaining a profit of $\frac{\theta}{16}$. If $\theta < 2$, however, the maximum can only be reached by choosing $p^w = \frac{\theta-1}{2\theta}$, obtaining a profit of $\frac{\theta-1}{4\theta}$. If the manufacturer chooses $p^w > \frac{\theta-1}{2\theta}$, the maximal profit can be reached by choosing $p^w = \frac{1}{2}$, obtaining a profit of $\frac{\theta}{4(1+\theta)}$. When $\theta \leq 3$, we have $\frac{\theta}{4(1+\theta)} \geq \frac{\theta}{16}$, and choosing $p^w = \frac{1}{2}$ is optimal. When $\theta > 3$, we have $\frac{\theta}{4(1+\theta)} < \frac{\theta}{16}$, and choosing $p^w = \frac{1}{4}$ is optimal.

In conclusion, in the equilibrium, when $\theta > 3$, the wholesale price $p^w = \frac{1}{4}$, the inventory $k = \frac{\theta}{4}$, and the retail price $p = \frac{1}{2}$ in the low demand state and $p = \frac{3}{4}$ in the high demand state. The manufacturer profit $\Pi^m = \frac{\theta}{16}$, and the retailer profit $\Pi^r = \frac{(4+\theta)}{32}$. The retailer is constrained only in the high-demand state. The consumer surplus is equal to $\frac{\theta}{64} + \frac{1}{16}$. When $\theta \leq 3$, the wholesale price $p^w = \frac{1}{2}$, the inventory $k = \frac{\theta}{2(1+\theta)}$, and the retail price is $p = \frac{2+\theta}{2(1+\theta)}$ in the low demand state and $p = \frac{2\theta+1}{2(1+\theta)}$ in the high demand state. The manufacturer profit $\Pi^m = \frac{\theta}{4(1+\theta)}$ and the retailer profit $\Pi^r = \frac{\theta}{8(1+\theta)}$. The retailer is constrained in both the high-demand state and the low-demand state. The consumer surplus in this case is equal to $\frac{\theta}{16(1+\theta)}$.

Now we consider a model where the manufacturer and the retailer are vertically integrated, which simply becomes one manufacturer. Then the profit function for the manufacturer is

$$\Pi^m = \begin{cases} \frac{1}{8} + \frac{\theta}{8} & \text{if } k > \frac{\theta}{2}, \\ \frac{1}{8} + \frac{1}{2}k(1 - \frac{1}{\theta}k) & \text{if } \frac{1}{2} \leq k \leq \frac{\theta}{2}, \\ \frac{1}{2}k(1-k) + \frac{1}{2}k(1 - \frac{1}{\theta}k) & \text{if } 0 \leq k < \frac{1}{2}. \end{cases} \tag{27}$$

Again, choosing $k > \frac{\theta}{2}$ is strictly dominated by choosing $k = \frac{\theta}{2}$. If the manufacturer chooses $\frac{1}{2} \leq k \leq \frac{\theta}{2}$, the maximum is reached by choosing $k = \frac{\theta}{2}$, obtaining a profit of $\frac{1+\theta}{8}$. If the manufacturer chooses $0 \leq k < \frac{1}{2}$, the interior maximum can be reached by choosing $k = \frac{\theta}{1+\theta}$, which will be always larger than $\frac{1}{2}$, given $\theta > 1$. Therefore, the maximum for this case will be bounded above by choosing $k = \frac{1}{2}$, with a upper bound profit being $\frac{\theta}{2(1+\theta)}$, which is always smaller than $\frac{1+\theta}{8}$. Thus, the manufacturer chooses inventory $k = \frac{\theta}{2}$, and the retail price $p = \frac{1}{2}$ in both the high demand state and the low demand state. The manufacturer profit $\Pi^m = \frac{1+\theta}{8}$ and the consumer surplus is equal to $\frac{1+\theta}{16}$. Compared with the case with double marginalization, when $\theta \leq 3$, the invetory is reduced by more than one half. □

In a model with demand uncertainty, double marginalization in the wholesale model reduces the inventory by at least one-half compared to the vertically-integrated model. However, when the difference between the high-demand state and the low-demand state is moderate, the across-demand-state negative effect takes over. The profit gain from suppressing demand in the low demand state outweighs the loss from further suppressing demand in the high demand state. The incentive for the successive monopolists to suppress demand in both the high and low-demand state further reduces the inventory to $\frac{\theta}{2(1+\theta)}$, more than one-half compared to the vertically-integrated model. As a result, the capacity is constrained in both the high and low-demand states.

Proposition 6. *In the wholesale model under demand uncertainty, with maximum RPM, the manufacturer is able to increase both the supply surplus and consumer surplus.*

Proof. Let $\bar{p}$ denote the price ceiling set by the retailer. We assume that $p^w \leq \bar{p}$ and $\bar{p} \leq \frac{1}{2}$, the optimal retail price in the vertically-integrated model.

In the last stage, in the high demand state, if we have inventory $k \leq \theta(1-\bar{p})$, then the retailer cannot sell at the optimal price but can only set the price at $\bar{p}$ and sell k quantity. Similarly, in the low demand state, if we have inventory $k \leq 1-\bar{p}$, the retailer can only set price $p = \bar{p}$ and sell k quantity.

Therefore, in the second state, given the wholesale price p^w and the price ceiling $\bar{p}$, when deciding the inventory before demand realization, the profit function of the retailer is

$$\Pi^r = \begin{cases} \frac{1}{2}\bar{p}(1-\bar{p}) + \frac{1}{2}\bar{p}\theta(1-\bar{p}) - p^w k & \text{if } k > \theta(1-\bar{p}), \\ \frac{1}{2}\bar{p}(1-\bar{p}) + \frac{1}{2}\bar{p}k - p^w k & \text{if } 1-\bar{p} \leq k \leq \theta(1-\bar{p}), \\ (\bar{p} - p^w)k & \text{if } 0 \leq k < 1-\bar{p}. \end{cases} \tag{28}$$

Given the profit function, we can obtain the best response function of the retailer

$$k = \begin{cases} \theta(1-\bar{p}) & \text{if } \bar{p} \geq 2p^w, \\ 1-\bar{p} & \text{if } p^w \leq k < 2^w. \end{cases} \tag{29}$$

And the profit function of the manufacturer

$$\Pi^m = \begin{cases} p^w\theta(1-\bar{p}) & \text{if } \bar{p} \geq 2p^w, \\ p^w(1-\bar{p}) & \text{if } p^w \leq \bar{p} < 2^w. \end{cases} \tag{30}$$

In both case, the manufacturer will optimally set p^w at it maximal value. That is setting $p^w = \frac{1}{2}\bar{p}$ in the first case and setting $p^w = \bar{p}$ in the second case. So the profit function becomes

$$\Pi^m = \begin{cases} \frac{1}{2}\bar{p}\theta(1-\bar{p}) & \text{if } \bar{p} \geq 2p^w, \\ \bar{p}(1-\bar{p}) & \text{if } p^w \leq \bar{p} < 2^w. \end{cases} \tag{31}$$

In both case, the optimal $\bar{p} = \frac{1}{2}$. And the profit achieved $\frac{\theta}{8}$ in the first case and $\frac{1}{4}$ in the second case. When $\theta \geq 2$, the manufacturer will set $\bar{p} = \frac{1}{2}, p^w = \frac{1}{4}$. The retailer will order inventory $k = \frac{\theta}{2}$ and set the retail price at $\frac{1}{2}$. The retailer expected profit is $\frac{1}{8}$. And the manufacturer profit is $\frac{\theta}{8}$. The total supply surplus is $\frac{1+\theta}{8}$, and the consumer surplus is $\frac{1+\theta}{16}$, both of which are the same as those in the vertically-integrated model. If $\theta < 2$, the manufacturer will set $\bar{p} = \frac{1}{2}, p^w = \frac{1}{2}$. The retailer will order inventory $k = \frac{1}{2}$ and set the retail price at $k = \frac{1}{2}$. The retailer expected profit is 0. And the manufacturer profit (supply surplus) is $\frac{1}{4}$. The consumer surplus is $\frac{3\theta-1}{16\theta}$. Both the supply surplus and the consumer surplus are lower than those under the vertically-integrated model but are higher than those in the wholesale model without a price ceiling. □

C Model Fit

Table 21: Average Allocations over Resampled Marginal Cost Shock

	N	Min	Mean	Median	Max	Sd
Price						
Observed price	91047	500	1.260840e+03	1200.00	7.200000e+03	308.74
Simulated price	91047	500	5.807275e+198	1291.57	5.287350e+202	Inf
Inventory						
Observed inventory	91047	0	3.850000e+00	2.00	5.452400e+02	13.33
Simulated inventory	91047	0	5.210000e+00	1.74	1.966911e+04	89.04
Sales						
Observed Sales	91047	0	2.250000e+00	1.00	3.325800e+02	6.19
Similated sales	91047	0	1.890000e+00	0.82	3.910200e+02	4.72

Note: Prices and inventory are at the bookstore-title level.

D Elicitation of Unobserved Marginal Cost Shocks

We back out the marginal cost shock as follows. We can show that equation (8) is linear in ϵ_j:

$$\mathbf{E_j}\varepsilon_j = \mathbf{h_j}, \tag{32}$$

where $\mathbf{E_j}$ is a $(B_1 + B_2 + ... + B_L) \times (B_1 + B_2 + ... + B_L)$ matrix:

$$
\mathbf{E_j} = \begin{pmatrix} E_{j,B_1B_1} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & E_{j,B_2B_2} & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & E_{j,B_LB_L} \end{pmatrix}, \tag{33}
$$

where E_{j,B_lB_l} is a $B_l \times B_l$ matrix with its element

$$
e_{j,db} = \begin{cases} 1 - \int \mathbb{1}_{\{M_l q_{jdl} \geq n_{jdl}\}} \, dF(\xi_j^*, \eta_j^*) & \text{if} \quad b = d, \\ 0 & \text{if} \quad b \neq d \end{cases} \tag{34}
$$

for $b, d = 1, 2, ..., B_L$, and $\mathbf{h_j} = [h_{j11}, \cdots, h_{jB_11}, \cdots, h_{j1L}, \cdots, h_{jB_LL}]'$ is a $(B_1 + B_2 + ... + B_L) \times 1$ vector with its element h_{jB_ld} equal to

$$
\begin{aligned} 2\delta \int \mathbb{1}_{\{M_l q_{jdl} \geq c n_{jdl}\}} (M_l q_{jbl} - n_{jdl}) \, dF(\xi_j^*, \eta_j^*) - \\ \int \mathbb{1}_{\{M_l q_{jdl} \geq n_{jdl}\}} (\lambda_1' w_{jdl}) \, dF(\xi_j^*, \eta_j^*) - \lambda_1' w_{jdl}. \end{aligned} \tag{35}
$$

Then, we can elicit ϵ_j as

$$
\varepsilon_j = \mathbf{E_j}^{-1} \mathbf{h_j}. \tag{36}
$$

We then insert the backed-out ϵ_j into equation (6) to obtain the predicted price $p_j^{optimal}$.

E Model of Counterfactual Institutions

E.1 Counterfactual I: Wholesale Model

Price decision After the demand is realized, the bookstores choose retail price given the inventory level. In this period, the inventory cost is sunk. However, if the realised demand $M_l q_{jbl}$ is larger than the inventory constraint $c n_{jbl}$, there is adjustment cost equal to $\delta(M_l q_{jbl} - c n_{jbl})^2$, with $c \in [0, 1]$. Given ξ_j, η_{jbl} and n_{jbl}, bookstore b's pricing problem is given by:

$$
\begin{aligned} \max_{p_{jbl}} \quad & p_{jbl} M_l q_{jbl} - \mathbb{1}_{\{M_l q_{jbl} \geq c n_{jbl}\}} \, \delta(M_l q_{jbl} - c n_{jbl})^2 \\ & - p_j^w n_{jbl} - \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \, p_j^w (M_l q_{jbl} - n_{jbl}) \\ \text{s.t.} \quad & p_{jbl} \geq 0, \end{aligned} \tag{37}
$$

The first term is the revenue from book sales, the second term is the adjustment cost to meet the realized excess demand, the third term is sunk payments of the inventory to the publisher, and the last term is the payments of the additional prints to the publisher.

The first-order condition with respect to p_{jbl} is given by

$$p_{jbl} = \frac{1}{-\alpha(1-q_{jbl})} + \mathbb{1}_{\{M_l q_{jbl} \geq c n_{jbl}\}}\ 2\delta(M_l q_{jbl} - c n_{jbl}) + \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}}\ p_j^w. \tag{38}$$

Let $p_j^* = [p_{j11}^*, \cdots, p_{jB_1 1^*}, \cdots, p_{j1L}^*, \cdots, p_{jB_1 L}^*]'$ denote the price in the equilibrium, then it satisfies the following conditions:

$$p_{jbl}^* = \frac{1}{-\alpha[1-q_{jbl}(p_{jbl}^*)]} + \mathbb{1}_{\{M_l q_{jbl}(p_{jbl}^*) \geq c n_{jbl}\}} 2\delta\left[M_l q_{jbl}(p_{jbl}^*) - c n_{jbl}\right] + \mathbb{1}_{\{M_l q_{jbl}(p_{jbl}^*) \geq n_{jbl}\}} p_j^w, \tag{39}$$

for all $b \in \mathcal{B}_l,\ l \in \mathcal{L}$. The equilibrium conditions decide the equilibrium price p_j^* as a function of n_j

Inventory decision Before the demand is realized, given the wholesale price p_j^w, the bookstores anticipate the equilibrium pricing and resulting demand and decide on the inventory. We assume that their belief about ξ_j^* is normally distributed around true ξ_j with standard deviation σ_ξ, and their belief about η_{jbl}^* is normally distributed around true η_{jbl} with standard deviation σ_η. We assume that the bookstores and the publisher have the same belief about the uncertain demand because our focus is on the implication of vertical restraints and not the heterogeneity in the belief.

Given wholesale price p_j^W, the bookstore b's inventory problem is:

$$\begin{aligned} \max_{n_{jbl}} \quad & M_l \int [p_{jbl}^* q_{jbl}^* - \mathbb{1}_{\{M_l q_{jbl}^* \geq c n_{jbl}\}}\ \delta(M_l q_{jbl}^* - c n_{jbl})^2] dF(\xi_j^*, \eta_j^*) \\ & - p_j^w n_{jbl} - \int \mathbb{1}_{\{M_l q_{jbl}^* \geq n_{jbl}\}}\ p_j^w (M_l q_{jbl}^* - n_{jbl}) dF(\xi_j^*, \eta_j^*), \end{aligned} \tag{40}$$

where $q_{jbl}^* := q_{jbl}(p_j^*, n_j, \xi_j^*, \eta_j^*, \theta)$. The first term is the expected revenue from book sales, the second term is the expected adjustment cost, the third term is the immediate payments of the inventory to the publisher, and the last term is the expected payments of excess demand to the publisher.

The optimal choice of n_{jbl} depends on p_j^w and inventory of other bookstores n_{-jbl}. In the equilibrium, the conditions of optimal choice should be satisfied for all $b \in \mathcal{B}_l,\ l \in \mathcal{L}$.

Publisher decision Given the bookstores' best response, a publisher decides the wholesale price p_j^w before the demand is realized. The pricing problem for a publisher is:

$$\begin{aligned} \max_{p_j^w} \quad & \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \left[p_j^w - (\lambda_1' w_{jbl} + \varepsilon_{jbl})\right]\ n_{jbl}^* \\ & + \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl}^* \geq n_{jbl}^*\}} \left[p_j^w - (\lambda_1' w_{jbl} + \varepsilon_{jbl})\right]\ (M_l q_{jbl}^* - n_{jbl}^*)\ dF(\xi_j^*, \eta_j^*) \end{aligned} \tag{41}$$

where n_{jbl}^* is the inventory level in the equilibrium given the wholesale price p_j^w. The first term is the immediate revenue from the wholesales and the delivery and print cost and the second term is the expected revenue from wholesales for excess demand and associated delivery and print cost. Solving this model is straightforward because this is quantity competition followed by price competition. The best response mapping iterations of both stages converge quickly to equilibrium.

E.2 Counterfactual II: Market-specific Pricing

The publisher decides, for each book, a market-specific retail price and bookstore-level inventory to maximize the following objective function:

$$\begin{aligned}
\max_{p_{jl}, n_j} \quad & \rho \sum_{l \in \mathcal{L}} p_{jl} \sum_{b \in \mathcal{B}_l} \int min\{n_{jbl}, M_l q_{jbl}\} \ dF(\xi_j^*, \eta_j^*) - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} (\lambda_1' w_{jbl} + \varepsilon_{jbl}) n_{jbl}. \\
& + \rho \sum_{l \in \mathcal{L}} p_{jl} \sum_{b \in \mathcal{B}_l} M_l \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \ (M_l q_{jbl} - n_{jbl}) \ dF(\xi_j^*, \eta_j^*) \\
& - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \ (\lambda_1' w_{jbl} + \varepsilon_{jbl})(M_l q_{jbl} - n_{jbl}) \ dF(\xi_j^*, \eta_j^*) \\
& - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \ \delta(M_l q_{jbl} - n_{jbl})^2 \ dF(\xi_j^*, \eta_j^*).
\end{aligned} \tag{42}$$

E.3 Counterfactual III: Minimum Resale Price Maintenance

Price decision After demand is realized, given the inventory n_{jbl}, wholesale price p_j^w and price floor $\underline{p}_j$

$$\begin{aligned}
\max_{p_{jbl}} \quad & p_{jbl} M_l q_{jbl} - \mathbb{1}_{\{M_l q_{jbl} \geq c n_{jbl}\}} \ \delta(M_l q_{jbl} - c n_{jbl})^2 \\
& - p_j^w n_{jbl} - \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \ p_j^w (M_l q_{jbl} - n_{jbl}) \\
\text{s.t.} \quad & p_{jbl} \geq 0,
\end{aligned} \tag{43}$$

The retail price is decided by:

$$p_{jbl} = \begin{cases} \frac{1}{-\alpha(1-q_{jbl})} + \mathbb{1}_{\{M_l q_{jbl} \geq c n_{jbl}\}} \ 2\delta(M_l q_{jbl} - c n_{jbl}) + \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \ p_j^w, & \text{if} \quad p_{jbl}^o >= \underline{p}_j, \\ \underline{p}_j, otherwise, \end{cases} \tag{44}$$

Inventory decision Before realization of demand, wholesale price p_j^w and price floor $\underline{p}_j$, bookstores decide:

$$\begin{aligned}
\max_{n_{jbl}} \quad & M_l \int [p_{jbl}^* q_{jbl}^* - \mathbb{1}_{\{M_l q_{jbl}^* \geq c n_{jbl}\}} \ \delta(M_l q_{jbl}^* - c n_{jbl})^2] dF(\xi_j^*, \eta_j^*) \\
& - p_j^w n_{jbl} - \int \mathbb{1}_{\{M_l q_{jbl}^* \geq n_{jbl}\}} \ p_j^w (M_l q_{jbl}^* - n_{jbl}) dF(\xi_j^*, \eta_j^*),
\end{aligned} \tag{45}$$

where p^*_{jbl} is the equilibrium price in the retail price decision stage.

Wholesale price and price floor decision Before the realization of demand, for each book, the publisher distributor chooses the wholesale price p^w_j and price floor $\underline{p}_j$ to:

$$\begin{aligned} \max_{p^w_j, \underline{p}_j} \quad & \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \left[p^w_j - (\lambda_1' w_{jbl} + \varepsilon_{jbl})\right] \; n^*_{jbl} \\ & + \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q^*_{jbl} \geq n^*_{jbl}\}} \left[p^w_j - (\lambda_1' w_{jbl} + \varepsilon_{jbl})\right] (M_l q^*_{jbl} - n^*_{jbl}) \; dF(\xi^*_j, \eta^*_j), \end{aligned} \tag{46}$$

where n^*_{jbl} is the equilibrium inventory in the inventory decision stage.

E.4 Counterfactual IV: Vertically Integrated Model

Price decision After the demand is realized, the integrated supplier finds the optimal price given the inventory n_{jbl} by solving:

$$\begin{aligned} \max_{p_{jl}} \quad & \sum_{l \in \mathcal{L}} p_{jl} \sum_{b \in \mathcal{B}_l} min\{n_{jbl}, M_l q_{jbl}\} - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} (\lambda_1' w_{jbl} + \varepsilon_{jbl}) n_{jbl}. \\ & + \sum_{l \in \mathcal{L}} p_{jl} \sum_{b \in \mathcal{B}_l} M_l \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; (M_l q_{jbl} - n_{jbl}) \\ & - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; \lambda_1' w_{jbl} (M_l q_{jbl} - n_{jbl}) \\ & - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; \delta (M_l q_{jbl} - n_{jbl})^2 \end{aligned} \tag{47}$$

Inventory decision Before the demand is realized, the integrated supplier finds the optimal inventory by solving:

$$\begin{aligned} \max_{n_j} \quad & \sum_{l \in \mathcal{L}} p_{jl} \sum_{b \in \mathcal{B}_l} \int min\{n_{jbl}, M_l q_{jbl}\} \; dF(\xi^*_j, \eta^*_j) - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} (\lambda_1' w_{jbl} + \varepsilon_{jbl}) n_{jbl}. \\ & + \sum_{l \in \mathcal{L}} p_{jl} \sum_{b \in \mathcal{B}_l} M_l \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; (M_l q_{jbl} - n_{jbl}) \; dF(\xi^*_j, \eta^*_j) \\ & - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; (\lambda_1' w_{jbl} + \varepsilon_{jbl})(M_l q_{jbl} - n_{jbl}) \; dF(\xi^*_j, \eta^*_j) \\ & - \sum_{l \in \mathcal{L}} \sum_{b \in \mathcal{B}_l} \int \mathbb{1}_{\{M_l q_{jbl} \geq n_{jbl}\}} \; \delta (M_l q_{jbl} - n_{jbl})^2 \; dF(\xi^*_j, \eta^*_j). \end{aligned} \tag{48}$$

where p^*_{jl} is the equilibrium price in the price decision stage.

F Counterfactual Results for Online and Brick-and-Mortar Bookstores

F.1 Counterfactual I

Table 22: Surplus under Baseline and Counterfactual I for Brick-and-Mortar Bookstores

	Consumer	Publisher	Store	Supply	Social
Level (1M JPY)					
Baseline	324.66	4.44	1.35	5.79	330.45
Counterfactual I	323.40	3.24	1.56	4.80	328.20
Difference (1M JPY)					
Counterfactual I - Baseline	-1.26	-1.20	0.21	-0.99	-2.25
Ratio (%)					
Difference/Baseline	-0.39	-27.12	15.52	-17.17	-0.68

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model.

Table 23: Surplus under Baseline and Counterfactual I for the Representative Online Bookstore

	Consumer	Publisher	Store	Supply	Social
Level (1M JPY)					
Baseline	129.39	1.06	0.38	1.43	130.82
Counterfactual I	128.78	0.94	0.42	1.36	130.14
Difference (1M JPY)					
Counterfactual I - Baseline	-0.61	-0.12	0.04	-0.07	-0.69
Ratio (%)					
Difference/Baseline	-0.48	-11.05	11.45	-5.10	-0.53

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model.

F.2 Counterfactual II

Table 24: Surplus under Baseline and Counterfactual II for Brick-and-Mortar Bookstores

	Consumer	Publisher	Store	Supply	Social
Level (1M JPY)					
Baseline	324.66	4.44	1.35	5.79	330.45
Counterfactual II	325.35	5.48	1.65	7.13	332.48
Difference (1M JPY)					
Counterfactual II - Baseline	0.69	1.04	0.30	1.34	2.03
Ratio (%)					
Difference/Baseline	0.21	23.45	22.09	23.13	0.61

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual II refers to the institution featuring market-specific pricing.

Table 25: Surplus under Baseline and Counterfactual II for the Representative Online Bookstore

	Consumer	Publisher	Store	Supply	Social
Level (1M JPY)					
Baseline	129.39	1.06	0.38	1.43	130.82
Counterfactual II	130.03	1.37	0.45	1.82	131.85
Difference (1M JPY)					
Counterfactual II - Baseline	0.64	0.32	0.07	0.39	1.03
Ratio (%)					
Difference/Baseline	0.49	29.99	19.67	27.26	0.78

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual II refers to the institution featuring market-specific pricing.

F.3 Counterfactual III

Table 26: Surplus under Counterfactual III for Brick-and-Mortar Bookstores

	Consumer	Publisher	Store	Supply	Social
Level (1M JPY)					
Counterfactual I	323.40	3.24	1.56	4.80	328.20
Counterfactual III	323.37	3.22	1.54	4.76	328.12
Difference (1M JPY)					
Counterfactual III - I	-0.04	-0.02	-0.02	-0.04	-0.08
Ratio (%)					
Difference/Baseline	-0.01	-0.45	-1.63	-0.73	-0.02

Note: Consumer, publisher and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. Counterfactual III refers to the institution featuring minimum RPM.

Table 27: Surplus under Counterfactual III for the Representative Online Bookstore

	Consumer	Publisher	Store	Supply	Social
Level (1M JPY)					
Counterfactual I	128.78	0.94	0.42	1.36	130.14
Counterfactual III	128.74	0.92	0.40	1.32	130.06
Difference (1M JPY)					
Counterfactual III - I	-0.04	-0.02	-0.02	-0.04	-0.08
Ratio (%)					
Difference/Baseline	-0.03	-1.89	-4.58	-2.60	-0.06

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. Counterfactual III refers to the institution featuring minimum RPM.

G Counterfactual Results under the Fixed-amazon-action Assumption

G.1 Counterfactual I

Table 28: Surplus under Baseline and Counterfactual I for Brick-and-Mortar Bookstores

	Consumer	Publisher	Store
Counterfactual I - Baseline			
Sample literature, Shiga, POS stores	-0.55	-0.49	0.43
All literature, Shiga, POS stores	-11.07	-9.88	8.63
All literature, Shiga, all stores	-12.31	-10.98	9.59
All literature, nation, all stores	-72.38	-64.59	56.43
Diff/Baseline sales			
	-12.22	-10.90	9.53

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model.

Table 29: Surplus under Baseline and Counterfactual I for the Representative Online Bookstore

	Consumer	Publisher	Store
Counterfactual I - Baseline			
Sample literature, Shiga, POS stores	-0.09	5.00	-5.01
All literature, Shiga, POS stores	-1.70	100.06	-100.26
All literature, Shiga, all stores	-1.89	111.17	-111.40
All literature, nation, all stores	-11.12	653.97	-655.28
Diff/Baseline sales			
	-1.88	110.41	-110.63

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. The surplus for the representative online bookstore in counterfactual I is negative under the fixed-action assumption because the online bookstore is not optimizing its behaviors.

Table 30: Surplus under Baseline and Counterfactual I

	Consumer	Publisher	Store
Counterfactual I - Baseline			
Sample literature, Shiga, POS stores	-0.55	4.51	-4.58
All literature, Shiga, POS stores	-11.07	90.18	-91.62
All literature, Shiga, all stores	-12.31	100.19	-101.80
All literature, nation, all stores	-72.38	589.38	-598.84
Diff/Baseline sales			
	-12.22	99.51	-101.11

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. The negative surplus for stores in the counterfactual I under the fixed-action assumption is driven by the negative surplus for the representative online bookstore.

G.2 Counterfactual II

Table 31: Surplus under Baseline and Counterfactual II for Brick-and-Mortar Bookstores

	Consumer	Publisher	Store
Counterfactual II - Baseline			
Sample literature, POS stores, Shiga	0.69	1.04	0.30
All literature, POS stores, Shiga	13.74	20.83	5.98
All literature, all stores, Shiga	15.27	23.15	6.64
All literature, all stores, Japan	89.82	136.15	39.05
Diff/Baseline sales			
	15.17	22.99	6.59

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual II refers to the institution featuring market-specific pricing.

Table 32: Surplus under Baseline and Counterfactual II for the Representative Online Bookstore

	Consumer	Publisher	Store
Counterfactual II - Baseline			
Sample literature, POS stores, Shiga	0.64	0.32	0.07
All literature, POS stores, Shiga	12.72	6.33	1.49
All literature, all stores, Shiga	14.13	7.03	1.66
All literature, all stores, Japan	83.12	41.36	9.74
Diff/Baseline sales			
	14.03	6.98	1.64

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual II refers to the institution featuring market-specific pricing.

Table 33: Surplus under Baseline and Counterfactual II

	Consumer	Publisher	Store
Counterfactual II - Baseline			
Sample literature, POS stores, Shiga	0.69	1.36	0.37
All literature, POS stores, Shiga	13.74	27.16	7.47
All literature, all stores, Shiga	15.27	30.18	8.30
All literature, all stores, Japan	89.82	177.50	48.80
Diff/Baseline sales			
	15.17	29.97	8.24

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual II refers to the institution featuring market-specific pricing.

G.3 Counterfactual III

Table 34: Surplus under Counterfactual III for Brick-and-Mortar Bookstores

Consumer	Publisher	Store
Couterfactual III - I		
0.00	0.02	0.01
Diff/Baseline sales		
0.08	0.51	0.21

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. Counterfactual III refers to the institution featuring minimum RPM.

Table 35: Surplus under Counterfactual III for the Representative Online Bookstore

Consumer	Publisher	Store
Couterfactual III - I		
0.00	0.06	-0.06
Diff/Baseline sales		
0.08	1.30	-1.30

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. Counterfactual III refers to the institution featuring minimum RPM.

Table 36: Surplus under Counterfactual III

Consumer	Publisher	Store
Couterfactual III - I		
0.00	0.08	-0.05
Diff/Baseline sales		
0.08	1.81	-1.09

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. Counterfactual III refers to the institution featuring minimum RPM.

G.4 Counterfactual IV

Table 37: Surplus under Counterfactual IV

	Consumer	Supply
Counterfactual V - Baseline		
Sample literature, POS stores, Shiga	11.35	7.80
All literature, POS stores, Shiga	227.09	155.91
All literature, all stores, Shiga	252.32	173.23
All literature, all stores Japan	1484.23	1018.99
Counterfactual V - Counterfactual I		
Sample literature, POS stores, Shiga	11.91	7.87
All literature, POS stores, Shiga	238.16	157.35
All literature, all stores, Shiga	264.62	174.84
All literature, all stores Japan	1556.61	1028.45
IV - Baseline / Baseline sales		
	250.59	172.04
IV - I / Baseline sales		
	262.81	173.64

Note: Consumer, publisher, and store surplus are calculated as total surplus. Counterfactual I refers to the institution featuring a wholesale model. Counterfactual VI refers to the vertically-integrated model.