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Abstract

This paper explores the economic roles of resale price maintenance (RPM) in supply chains for a specific product, when consumers have taste heterogeneity and the manufacturer faces demand uncertainty. Two transaction schemes within supply chains are compared: (1) RPM, and (2) decentralized pricing in a competitive market environment. With decentralized pricing, a manufacturer loses the incentive to produce a product in categories where the probability that the manufacturer fails to design the product as suitable to public tastes of consumers is high. However, RPM resolves the problem and induces the manufacturer to supply the good, bringing positive surplus to consumers.

Keywords: Reseal price maintenance; Supply chains; Product uncertainty; Economics

1. Introduction

The economic effects of resale price maintenance (RPM) in supply chains are a subject of controversy from a regulatory economics viewpoint in many advanced economies. Recently, for example, while the Swiss Competition Commission has prohibited an RPM arrangement for Swiss book sales, it is remarkable that the German government has decided that RPM is mandatory for book sales by law (Schulz, 2007). An important reason for permitting RPM for publications in several advanced countries is to provide sufficient service from retailers so as to prevent mismatch between the product and consumer needs (Telser, 1960). An example of such a presale service is book-browsing services provided by bookstores. Consumers visiting a large bookstore, which incurs the costs of the service, are able to browse through books that they are considering purchasing. Prior confirmation of the book's content relieves consumers of the risk that the book does not satisfy their needs. Furthermore, the information transmitted by bookstores cannot be provided efficiently by manufacturers through alternative methods such as advertising. Under free market transactions in competitive environments without RPM, web-based booksellers who do not incur the costs of a physical book-browsing service to customers may survive through discounted prices. As a result, a highly specialized book, which only experts or "bibliomaniacs" have a particularly strong willingness to buy, might be driven out of the retail market because booksellers cannot afford to pay the service cost, leading to a reduction of consumer surplus in the long run.

While RPM is currently allowed by law for the distribution of books in France, Germany and Japan, the jurisdictions that permit RPM for publications and copyrighted works differentiate among types of items (OECD, 1997). For example, RPM is permitted to apply to books but not to magazines in France, while RPM on both magazines and newspapers is allowed in Germany. Furthermore, in Japan, RPM is permitted for other copyrighted works such as music records, tapes and CDs in addition to books. One reason

why RPM may be applied to music tapes and CDs in Japan is that retail CD stores should provide preview services for music CDs to prevent mismatch between music and consumers' taste, which is also regarded as a special presale service under RPM.[1]

Motivated by such differences regarding the implementation of RPM mainly, on publications across countries, and continuing policy debate, this paper explores the economic role of RPM in information service provision by retailers, focusing on the special presale service argument in the existing literature (e.g., Telser, 1960). In the presence of taste heterogeneity of consumers for a specific good, economic models of the following two transaction schemes within supply chains are compared in terms of consumer welfare and profits for firms: (1) RPM and (2) decentralized pricing in a competitive market environment. Specifically, the manufacturer faces uncertainty as to which of two possible states will be realized subsequent to production: one is that the manufacturer successfully designs a good that is "suitable" to the tastes of consumers, and the other is that the good proves to be "unsuitable". In this respect, we incorporate uncertainty of the product into existing RPM models that consider consumer heterogeneity (e.g., Winter, 1993; Schulz, 2007). In the previous models, taste heterogeneity is introduced as an asymmetry of the "average" utility of consumers. However, this paper further considers the "variance" of the heterogeneity of utility between the two states, implying that the risk of purchasing the uncertain good varies across consumers. In this setting, we assume that the consumers range from those who have particularly strong tastes for the good to those who have no particular tastes, meaning that the degree of tastes differs across consumers. If the "suitable" state is realized, consumers who have stronger tastes may obtain higher utility from consuming the good. In contrast, the utility of such consumers from consumption falls considerably if the "unsuitable" state is realized. Therefore, the utility of consumers who have stronger relative tastes varies more according to the realized state, indicating that they are exposed to a sort of risk from purchasing the product. Such uncertainty surrounding the product has not been considered in

the literature examining the special service role of RPM in supply chains. By incorporating heterogeneity into the RPM model, we aim to derive new economic implications under uncertainty that have not been previously revealed in the literature.

With the settings of the model, the primary finding is summarized as follows. With decentralized pricing in a competitive environment, a manufacturer loses the incentive to produce and market a product in categories where there is a high probability that the manufacturer fails to design a product suitable to the general tastes of potential consumers, meaning that the manufacturer bears high risk in developing the product. However, RPM with an information service for consumers provided by retailers resolves the problem and induces the manufacturer to supply the good, leading to positive consumer welfare. The economic intuition behind this result is as follows. Consumers learn which state has been realized by receiving an information service from retailers under RPM, whereas they do not know the state under competitive market environments. By letting consumers know the realized state regarding product suitability through the retailer service, the manufacturer is able to set an appropriate price, leading to positive expected profit for the manufacturer before production. As a consequence, the manufacturer decides to produce and market the good, and positive consumer surplus for the marketed good is generated. In contrast, the product is not marketed under a decentralized pricing regime in competitive market transactions, because the manufacturer cannot set the appropriate price based on the probability that the suitable state will be realized and thus has a negative expected profit. As a result, consumers obtain no surplus from the good. Additionally, we show that the introduction of RPM is more likely to enhance consumer welfare when consumers have stronger tastes for the product or the taste heterogeneity across consumers is more substantial. Our results suggest that RPM is effective in that it induces the manufacturer to supply the good by removing the risk of developing the product, bringing substantial benefits to consumers.

The most important practical contribution of this study in the economics of production context is that we provide useful policy implications for regulators. Our findings above imply that regulators should allow RPM by law only for products for which manufacturers face a low probability of successfully configuring a product that satisfies the tastes of general consumers and that achieves popularity among them. Moreover, implementation of RPM should be permitted if taste heterogeneity across consumers is substantial. Conversely, the results indicate that RPM would not be adopted for minimally differentiated goods for daily use, which are frequently purchased. This is because consumers are likely to have similar tastes for such products, and the risk of purchasing them is expected to be minimal.

In the context of the presale book-browsing service referred to earlier, our results indicate that the selling price should be fixed across retailers so as to provide book-browsing services through the protection of a sufficient retailer margin if it is difficult for a publisher to publish successfully a book that gains popularity among consumers, e.g., highly specialized books such as artistic books. Apart from publications, Winter (1993) discusses fitting service provision in the jeans market under RPM, arguing that the situation in which consumers pay for services only when they need them is socially efficient. Moreover, Brannon (2003) empirically investigates the effect of Wisconsin's Unfair Sales Act, which requires gasoline stations to mark up their prices by at least 6% over the wholesale price. He concludes that the average markup of retail petrol significantly increased in the state of Wisconsin more than in other states when the penalties for violation of the Act were strengthened.

Comanor and Rey (1997) argue that European policy standards toward RPM and other vertical restraints are relatively stringent and particular attention has been paid to them to ensure free trade across EU countries, while similar US policy has shifted over time. They attribute such differences across advanced countries to the lack of a general consensus regarding the long-run economic consequences of RPM. In the United States, RPM was per se illegal between Dr. Miles Medical Co. v. John D. Park and Sons Co., 220 US 373 (1911)

and Leegin Creative Leather Products, Inc. v. PSKS, Inc., 551 US ____ (2007). Subsequently, an important exception to RPM was established in the 1919 Colgate decision (United States v. Colgate & Co., 250 US 300, 1919). A manufacturer can unilaterally establish suggested resale prices in advance and lawfully refuse to deal with retailers who fail to adhere to those prices. Until recently, the doctrine was considered too narrow to be useful, because the normal business relationship between a manufacturer and a retailer includes communication that precludes the doctrine. In SprayRite Service Co. v. Monsanto Co., 465 US 752 (1984), however, the Supreme Court expanded the Colgate exception. While finding that RPM had been adopted illegally by Monsanto, the Court expressed that "a conscious commitment to a common scheme" to invoke the illegal practice could not be inferred "merely from the existence of complaints, or even from the fact that termination of contracts came about 'in response to' complaints from other dealers". More recently, the Supreme Court overruled Dr. Miles' holding that vertical price restraints such as minimum advertised pricing are not per se unlawful but, rather, must be judged under the rule of reason (Leegin Creative Leather Products, Inc. v. PSKS, Inc., 551 US ____, 2007).

In EU countries, on the other hand, the European Commission issued a Green Paper launching a debate on possible reforms of its policy pertaining to vertical agreements. In December 1999, it adopted the new Regulation 2790/1999 and the Guidelines on vertical restraints, which lists five hardcore restraints; one of them is RPM. After the publication of the regulation in October 2000, the European Commission found in 2001 that letters and circulars sent by Volkswagen (VW) to its German distributors, asking them to offer limited or no discounts on sales of the VW Passat, amounted to resale price maintenance in violation of Article 81(1). The European Commission imposed a 30.96 million euro fine on VW. Subsequently, however, the Court of First Instance (CFI) annulled the ruling as there was no evidence that distributors had accepted VW's call to limit their discounts—a mere intention to influence a dealer's pricing is not in itself caught by Article 81(1). The CFI accepted VW's

argument that the letters constituted unilateral action, concluding that the Commission had failed to prove that there was concurrence of wills between VW and the German dealers. The above overview on several legal cases of RPM in the United States and EU countries suggests that the policy on RPM has recently shifted in advanced economies from per se illegal with the exceptional situation of the Colgate doctrine to the rule of reason.

In the economics literature, the economic outcomes of RPM and other various vertical restraints within supply chains have been widely discussed. Among a large number of law and economic studies that shed light on the special service role of RPM, the seminal work by Telser (1960) suggests that manufacturers wish to protect dealer margins through RPM to induce dealers to compete by providing special presale services and selling to customers who benefit from the service provision of the full-service dealers. His informational free-riding argument is a plausible explanation for the use of RPM when tangible services provided by dealers serve to increase the demand for a manufacturer's product but where the services would not be provided in the absence of margin protection.

Vast subsequent research has provided various explanations for the justification of RPM. This specific form of vertical restraint is to enhance the service level provided by retailers (e.g., Winter, 1993; Perry and Porter, 1990; Schulz, 2007), to overcome the double marginalization problem (e.g., Tirole, 1988), to provide incentives to retailers to hold sufficient inventories (e.g., Deneckere, Marvel, and Peck, 1996; Flath and Nariu, 2000; Krishnan and Winter, 2007), to purchase quality or certification from reputable retailers (e.g., Marvel and McCafferty, 1984), and to prevent price discrimination by retailers (Chen, 1999)[2]. Furthermore, Marvel and McCafferty (1985) provide a selective survey of the uses of RPM together with an analysis of some of the welfare consequences of the practice in the context of several specific examples. As noted, this study specifically concentrates on the special service argument of RPM. In this research strand, Mathewson and Winter (1998) review the economics of RPM and critique selected Canadian cases, comparing jurisprudence in Canada

with that in the US and other jurisdictions. Based on the actual cases, they argue that the imposition of a resale price floor is an effective instrument for eliciting the appropriate balance between price and service levels by retailers as long as no cartel behavior occurs. They conclude that the service aspect is more general and important in justifying the implementation of RPM, because social welfare might be harmed by abolishing RPM if the service by retailers is valuable to consumers.

Given the above overview of the literature, this study could be described as the latest in a long line of research attempting to formalize Telser's argument. In particular, this research contributes to the literature by considering the situation where consumers not only have taste heterogeneity, but also face the risk that the product in question may not suit their tastes before purchasing it. Based on the special services argument advanced in the literature, this paper provides a theoretical rationale for the legal authorization of RPM in the presence of such uncertainty in supply chains. The remainder of this paper is structured as follows. Section 2 describes the model structure and provides the assumptions that underpin the model. Sections 3 and 4 construct economic models of RPM and of competitive market transactions within supply chains respectively, calculating firm profit and consumer welfare under each distribution scheme. Section 5 compares them and summarizes the major implications derived from the analysis. In Section 6, we explore further possible extension and generalization of the constructed model. Section 7 concludes the paper.

2. Model structure

This section provides assumptions and settings for our analytical model. Table 1 summarizes the nomenclature of the variables, which are used in the model. Fig. 1 illustrates the timeline of a series of events. Consider a supply chain where a monopolistic manufacturer sells a good to retailers, and retailers subsequently market the good to consumers. Initially,

8

the manufacturer chooses RPM or decentralized pricing as the transaction scheme within the supply chain for the product at stage 1 if implementation of RPM is allowed by the regulator. If RPM is not allowed, it automatically adopts decentralized pricing. Next, the manufacturer develops and produces an amount Q of the good at stage 2 if the expected profit is nonnegative. At stage 3, the manufacturer sets the wholesale price, r, under decentralized pricing, while it sets both the wholesale price, r, and the retail price, p, under RPM. At stage 4, each retailer decides whether to provide the information service ($e=\bar{e}$) or not ($e=0$). Additionally, retailers set the retail price, p, only under a decentralized pricing scheme. Only if consumers receive the information service is it revealed at stage 5 whether the good is "suitable" or "unsuitable" to consumers' tastes. Consumers decide to buy a unit of the good if their expected net utility from the consumption is nonnegative at stage 6. Finally, if consumers did not receive the information service at stage 5, whether the good is "suitable" or "unsuitable" is revealed at stage 7.

An important assumption associated with uncertainty in the above timeline is that either of the following two states is realized at stage 5 or 7: the manufacturer successfully configures the good as "suitable" to the public tastes of consumers, or the product is not popular, and it proves to be "unsuitable" to public tastes. In this respect, the manufacturer faces uncertainty before developing the good. The probability of suiting consumers' tastes and that of not suiting them are λ_1 and λ_2, respectively. For model tractability, let λ denote $\lambda_1 - \lambda_2$. By definition, $\lambda_1 + \lambda_2 = 1$ and $-1 \leq \lambda \leq 1$ hold, indicating that $(\lambda_1, \lambda_2) = ((1+\lambda)/2, (1-\lambda)/2)$.

On the other hand, consumers discover whether the product meets their tastes or not, that is, whether the product is "suitable" or "unsuitable", either after consuming the good or after receiving information regarding the content of the product from a retailer. Without the information, consumers do not know in advance whether the good is configured to meet their potential tastes. The assumption signifies that not only firms but also consumers are exposed to the risk that the product does not meet their tastes in the absence of information service.

[Table 1]

[Fig. 1]

The setting involves consumers uniformly distributed over the interval [0,1] with unit density, following Winter (1993). Each consumer is assumed to know his own location, x. The utility that consumers obtain from the good, $u(x)$, varies across consumers, indicating that they have taste heterogeneity for the product. A consumer located at x ($0 \leq x \leq 1$) obtains utility of $\alpha + t \cdot x - p$ when the good is proved to be configured to suit his or her tastes. By contrast, the consumer gains utility of $\alpha - t \cdot x - p$ when the good is found to be unsuitable and does not satisfy his or her needs. p represents the retail price of a unit of the good, and t and α are nonnegative constants. Because utility varies according to the location, x, there is taste heterogeneity across consumers. The utility function form indicates that a consumer closer to 0 has a weaker taste for the product and that one nearer to 1 has a stronger taste. The variance of the utility of a consumer located at x who does not know the realized state is:

$$\mathrm{var}\big(u(x)\big) = \big(1 - \lambda^2\big) t^2 x^2 . \tag{1}$$

Equation (1) signifies that a consumer with a stronger particular taste (i.e., with x nearer to 1) must bear higher risk. Moreover, consumers face higher risk when t is large, or when the probability for the two states is equal, i.e., $\lambda = 0$, meaning that uncertainty is high. Hence, we may regard t as representing the strength of tastes of consumers for the product, because consumers are exposed to a higher risk from purchasing the good as t increases. As reviewed earlier, previous studies define taste heterogeneity as the "average" utility from consumption varying across consumers. Therefore, it is worth noting that the asymmetry of the "variance" of the utility arising from taste heterogeneity across consumers indicated by

10

Equation (1) is a unique viewpoint, which is an original contribution of the present model. Because we refer to books in the model, we can regard "suitable" as the state in which the book is interesting and suits the tastes of general readers, and "unsuitable" as the converse state. Furthermore, note that the expected utility for every consumer becomes constant, $\alpha-p$, either when the probability for each of the two states is the same and the uncertainty is thus the highest ($\lambda=0$) or when consumers' tastes are perfectly homogeneous ($t=0$).

To let customers know whether the good suits their tastes or not prior to the purchase, a retailer has to provide an information service to them by incurring positive service cost, $\bar{e}$. Assume that consumers have lexicographic preferences in order of lower price first and information service provision second. Namely, consumers decide to purchase the good from a retailer who offers the lowest price among n ($n \geq 2$) retailers carrying the good, no matter whether the retailer provides the information service or not, because the information service spills over horizontally. If several retailers post the same lowest retail price, they purchase from a retailer who provides information service, e.[3] We presume that the level of the information service, e, takes on binary values, 0 or $\bar{e}$. When both p and e are the same among the n retailers, each of the retailers faces equal consumer demand, Q/n, where Q is total demand from consumers. Such consumer behavior assumed here is most likely for the retail book market. When buying a certain book, for example, after visiting a bookstore with a browsing service for books and confirming that the contents of a book suit his or her tastes, the consumer may buy from a discounter or web-based online bookstore with no service provision. In this respect, such special presale service spills over across retailers and engenders a horizontal externality.

Given the above settings, notice that the presale service is more valuable to consumers who have stronger tastes. Equation (1) implies that a consumer whose x is close to one incurs higher risk, and the service that informs him of the suitability of the product removes this higher risk. In this respect, our settings are consistent with Telser's premise in that each

customer values special services differently. Telser (1960) presumes that consumers differ in their valuations of the special services, which are difficult to measure, and thus argues that it is difficult to price the services and charge separately for them. The problem does not arise if consumers are identical to one another, because then they all value the services identically and it is possible to set a separate price on the services.

The manufacturer is assumed to incur marginal cost c, which is less than α, and fixed cost F to produce the good. The manufacturer's profit is given as:

$$\pi_M = (r - c)Q - F , \tag{2}$$

where r represents the wholesale price. There are n potential retailers who deal in the good. The profit function of retailer i is given as:

$$\pi_{Ri} = (p_i - r)q_i - e_i , \tag{3}$$

where subscript i indexes retailers, p_i represents the retail price, q_i the quantity sold, and e_i the fixed cost of the information service. We posit that the manufacturer cannot discriminate among the wholesale price across retailers.

Furthermore, assume that Bertrand price competition among retailers occurs under decentralized pricing in competitive market transactions, reducing the retail price, p, to the level where the zero profit condition for retailers holds. Based on the assumptions above, we proceed to formulate an RPM model and a decentralized pricing model.

3. RPM: Resale price maintenance

With the imposition of RPM, a monopolistic manufacturer forces retailers to resell the

good at the retail price that the manufacturer dictates. This in turn implies that price-mediated competition across retailers does not occur. Alternatively, they compete at the level of information services because of the assumption of lexicographic preferences among consumers. Suppose that retailers cannot collude with each other. Note first that every retailer provides information services by paying the service cost, $\bar{e}$, in the equilibrium of this competition. For example, suppose that retailer i deviates from the state where all other retailers provide services ($e_j = \bar{e}$ for $j \neq i$) by ceasing to provide the service ($e_i = 0$). Then, the retailer will face zero demand and consequently will receive zero profit because the retail price is fixed by the manufacturer. Therefore, in the equilibrium, every retailer provides special presale service by setting $e = \bar{e}$.[4] Accordingly, we henceforth develop the RPM model when all the retailers provide information services by incurring the positive cost, $\bar{e}$.

We next specify consumers' demand schedules in the retail market. First, suppose the situation where consumers know that the good is configured to suit their tastes at stage 5, because RPM induces all the retailers to transmit information about the characteristics of the product to customers. This state arises with the probability of λ_1 ($= (1+\lambda)/2$). The net utility from consuming a unit of the good for a consumer located at x, $u(x)$, is described as:

$$u(x) = \alpha + t \cdot x - p. \tag{4}$$

Panel A of Fig. 2 depicts the consumer evaluation of the good, $\alpha + t \cdot x$, as the line "RPM". Each consumer who has nonnegative net utility and thus satisfies the following inequality buys a unit of the good:

$$\begin{aligned} &u(x) \geq 0 \\ &\Leftrightarrow (p - \alpha)/t \leq x \leq 1 \end{aligned}. \tag{5}$$

Equation (5) suggests that the manufacturer will target consumers with stronger tastes as primary clientele if the probability that the manufacturer successfully produces a suitable good is relatively high. This gives the aggregated demand function under RPM, Q^{RPM}, as follows.

$$Q^{RPM}=1- (p-\alpha)/t \qquad (6)$$

[Fig. 2]

We next formulate another case of RPM, where the produced good proves to be unsuitable with the probability of λ_2 $(=(1-\lambda)/2)$ at stage 5. Utility of the consumer located at x is described as:

$$u(x)=\alpha-t{\cdot}x-p. \qquad (7)$$

Panel B of Fig. 2 draws consumer evaluation, $\alpha-t{\cdot}x$, as "RPM". Consumers whose net utility is non-negative as follows buy the good:

$$\begin{aligned} u(x) &\geq 0 \\ &\Leftrightarrow 0 \leq x \leq (\alpha - p)/t \end{aligned} \qquad (8)$$

Equation (8) suggests that the manufacturer sells the good mainly to consumers with weaker tastes by trimming the retail price if the probability of the unsuitable state is high. Hence, the demand function is:

$$Q^{RPM}=(\alpha-p)/t . \qquad (9)$$

14

With the above settings, we next solve decision-making problems for the manufacturer and retailers. First, we should note that the manufacturer have the following four choices regarding the resale price setting at stage 3. They are (1) $\alpha < p < \alpha + t$, (2) $p = \alpha$, (3) $\alpha - t < p < \alpha$, and (4) $p = \alpha - t$. If the manufacturer charges a price, p, that is greater than $\alpha + t$, the demand will fall to zero irrespective of the realized state. On the other hand, if p is less than $\alpha - t$, the manufacturer can raise the price and earn a higher margin per unit with the maximum demand amount of one being maintained. Therefore, both $p < \alpha - t$ and $p \geq \alpha + t$ are obviously unreasonable choices for the manufacturer. In the following subsections, we respectively calculate expected profits and consumer surplus in each of the above four cases.

3.1. Case 1: $\alpha < p < \alpha + t$

When the firm sets a retail price higher than α, a positive demand from consumers who have relatively strong taste and consequent positive profit are achievable only if the suitable state is realized. Conversely, no consumer will buy the good if the unsuitable state occurs. Given Equation (6), a retailer faces the following expected profit function because the total demand is equally divided across the n retailers:

$$
\begin{aligned}
E\pi_{Ri}^{RPM} &= (p-r)q_i - e_i \\
&= \lambda_1(p-r)(1-(p-\alpha)/t)/n - \bar{e}
\end{aligned}
\tag{10}
$$

Using backward induction, the manufacturer rationally produces $1-(p-\alpha)/t$ units of the good, which consumers will buy under the suitable state, at stage 2. Recall that the monopolistic manufacturer rather than retailers decides the resale price, p, under RPM. Therefore, the optimal level of the resale price, p^{RPM*}, for this problem is equivalent to that for another situation where the manufacturer vertically integrates all retailers. Hence, we

15

alternatively maximize the following expected profit, $E\pi_M^{VI}$, which represents the expected profit function under vertical integration with respect to p.

$$
\begin{aligned}
E\pi_M^{VI} &= \lambda_1 p\big(1-(p-\alpha)/t\big)-c\big(1-(p-\alpha)/t\big)-F-n\overline{e} \\
&= (t+\alpha-p)\big((1+\lambda)p-2c\big)/(2t)-F-n\overline{e}
\end{aligned}
\tag{11}
$$

The first order condition of Equation (11) derives the optimal retail price as follows.

$$
p^{RPM*}=p^{VI*}=\big((1+\lambda)(t+\alpha)+2c\big)/\big(2(1+\lambda)\big)
\tag{12}
$$

As written above, p^{VI*} is equal to the optimal resale price under RPM, p^{RPM*}. Because the manufacturer induces retailers to resell the product at the optimal retail price, p^{RPM*}, it sets the wholesale price so that the profit of a retailer in Equation (10) is equal to 0.[5]

$$
r^{RPM*}=p^{RPM*}-\frac{n\overline{e}}{\lambda_1\big(1+(\alpha-p^{RPM*})/t\big)}
\tag{13}
$$

Equation (13) indicates that the manufacturer reimburses each retailer the dollar margin that is required to provide the information service by controlling the wholesale price, r, in addition to the retail price based on expected sales quantity. Note that such manufacturer behavior is identical in the other three cases as well as the present case of $p>\alpha$. Therefore, in the RPM case, we henceforth focus on the optimal resale price, p, rather than the wholesale price, r. From Equations (6) and (12), the amount of production at stage 2 is:

$$
Q^{RPM*}=\big((1+\lambda)(t+\alpha)-2c\big)/\big(2(1+\lambda)t\big).
\tag{14}
$$

Hence, the amount of sales at stage 6 is Q^{RPM*} in the suitable state and 0 in the unsuitable state. Imposing the prerequisite condition that $\alpha<p<\alpha+t$ for this case on Equation (12) yields the following two inequalities:

$$\lambda(t-\alpha)>-(t-\alpha+2c) \text{ and } \lambda(t+\alpha)>-(t+\alpha-2c), \tag{15}$$

which are prerequisites for this case. Reevaluating Equation (11) at the optimal retail price, p^{RPM*}, yields the following optimal expected profit for the manufacturer:

$$E\pi_M^{RPM*} = ((1+\lambda)(t+\alpha)-2c)^2/(8(1+\lambda)t)-F-n\bar{e}. \tag{16}$$

We may compute expected consumer welfare in this case as follows:

$$ECW^{RPM*} = \lambda_1 \int_{\frac{p^{RPM*}-\alpha}{t}}^{1} (\alpha+tx-p^{RPM*})dx = ((1+\lambda)(t+\alpha)-2c)^2/(16(1+\lambda)t). \tag{17}$$

3.2. Case 2: p=α

Next, we investigate the case where the manufacturer sets the resale price equal to α, which is the utility for a consumer with no particular tastes. Positive demand arises only in the suitable state when $t>0$, whereas demand is equal to 1 when $t=0$. Therefore, the manufacturer's expected profit is:

$$\begin{aligned}
E\pi_M^{RPM*} &= (1+\lambda)\alpha/2-c-F-n\bar{e} \qquad &(\text{when } t>0) \\
&= \alpha-c-F-n\bar{e} \qquad &(\text{when } t=0)
\end{aligned}. \tag{18}$$

The manufacturer will set p equal to α when the optimal price represented by Equation (12) is

17

equal or less than α. This gives the following prerequisite conditions for this case.

$$\lambda(t-\alpha) \leq -(t-\alpha+2c) \text{ and } \lambda(t+\alpha) > -(t+\alpha-2c). \tag{19}$$

Expected consumer surplus is:

$$ECW^{RPM*} = \lambda_1 \int_0^1 (\alpha+tx-p)dx = (1+\lambda)t/4. \tag{20}$$

3.3. Case 3: α–t<p<α

   We should note that the analysis is rather complicated only when the manufacturer sets the retail price between α–t and α mainly because a positive demand arises even if the unsuitable state occurs. Accordingly, the manufacturer has the following three choices regarding the production amount at stage 2 in this case.

Choice (i): The manufacturer produces one unit of the good, which is the maximum demand from consumers, at stage 2. Subsequently, it sells one unit in the suitable state or $(\alpha-p)/t$ in the unsuitable state at stage 6.

Choice (ii): The manufacturer produces $(\alpha-p)/t$, which is less than 1, at stage 2. It sells $(\alpha-p)/t$ in either the suitable or the unsuitable state at stage 6.

Choice (iii): The firm produces $\hat{q}$ ($(\alpha-p)/t < \hat{q} < 1$) at stage 2, selling $\hat{q}$ in the suitable state and $(\alpha-p)/t$ in the unsuitable state at stage 6.

   Because the major purpose of this paper is to prove that RPM generates social welfare by giving the manufacturer the incentive to develop a risky product under uncertainty regarding the product characteristics, we here restrict our attention to the case where choice

(i) is taken. As will be shown later, we can prove the existence of the situation where RPM dominates decentralized pricing even if we analyze this case only under choice (i). For example, in an extreme situation where c is so small that we may regard the variable production cost as negligible, the choice of (i) obviously dominates the choice of (ii) and (iii) because the good left unsold places little burden on the manufacturer.

If choice (i) is taken, expected profit is calculated as:

$$E\pi_M^{RPM} = \lambda_1 p + \lambda_2 p((\alpha - p)/t) - c - F - n\overline{e}. \tag{21}$$

Maximizing Equation (21) on p gives the optimal retail price as:

$$p^{RPM*} = (t + \alpha + \lambda(t - \alpha))/(2(1 - \lambda)). \tag{22}$$

Substituting Equation (22) into $\alpha - t < p < \alpha$ gives the following prerequisite conditions for this case:

$$\lambda(t - \alpha) > (3t - \alpha) \text{ and } \lambda(t + \alpha) < -(t - \alpha). \tag{23}$$

As noted, the production amount is equal to one, while the sales amount is one in the suitable state and is $(t - \alpha + \lambda(t + \alpha))/(2t(\lambda - 1))$ in the unsuitable state. From Equation (21), the expected optimal profit for the manufacturer is:

$$E\pi_M^{RPM*} = ((t + \alpha + \lambda(t - \alpha))^2 - 8(1 - \lambda)ct)/(8(1 - \lambda)t) - F - n\overline{e}. \tag{24}$$

Expected consumer welfare in the equilibrium is calculated as:

$$ECW^{RPM*} = \lambda_1 \int_0^1 (\alpha + tx - p^{RPM*})dx + \lambda_2 \int_0^{(\alpha - p^{RPM*})/t} (\alpha - tx - p^{RPM*})dx$$
$$= ((1-\lambda)^2 \alpha^2 + 2(1-\lambda^2)t\alpha + (1+\lambda)(1-7\lambda)t^2)/(16(1-\lambda)t)$$

(25)

3.4. Case 4: p=α–t

Finally, if the manufacturer sets p equal to α–t, demand quantity is one irrespective of the realized state. Hence, the manufacturer produces one unit at stage 2. The expected profit is:

$$E\pi_M^{RPM*} = \alpha - t - c - F - n\bar{e} \ .$$

(26)

Expected consumer surplus is:

$$ECW^{RPM*} = \lambda_1 \int_0^1 (\alpha + tx - (\alpha - t))dx + \lambda_2 \int_0^1 (\alpha - tx - (\alpha - t))dx$$
$$= (2+\lambda)t/2$$

(27)

4. Decentralized pricing in competitive market environments

We now turn to the analysis of a decentralized pricing scheme in competitive market environments. Similarly to the case of RPM, this section derives wholesale and retail prices in equilibrium under competitive transactions, calculating consequent profit and consumer welfare. Under a decentralized pricing scheme, the profit function for a retailer i is:

$$\pi_{Ri}^{DP} = (p_i - r)q_i - e_i \ .$$

(28)

Initially, we should note that no retailer is willing to provide information services and

thus $e_j=0$ for all j under the decentralized pricing. If a specific retailer transmits information to consumers by setting $e_i=\bar{e}$, the retailer will face the demand function after information asymmetry between firms and consumers is removed, Q^{RPM}. Bertrand-type price competition forces retailer i to set the retail price, p_i, at the wholesale price, r, to capture a fraction of demand. However, the retailer experiences negative profit if $p_i=r$ because of the fixed service costs, $\bar{e}$, and thus will cease to handle the good. If $p_i>r$, lexicographic preferences induce all consumers to buy from other retailers, and the profit of retailer i becomes negative. Conversely, if $p_i<r$, negative profits for the retailer will accumulate by selling more of the goods because the cost price, r, exceeds the selling price. Therefore, no retailer has an incentive to deviate from the state where $e_i=0$. Of course, the situation where all retailers provide the service is never an equilibrium because each retailer's profit will be negative because of the fixed service cost. In summary, the optimal level of the service, e^*, is zero under decentralized pricing with competitive market transactions.

Because information asymmetry persists in this decentralized pricing system, the expected net utility from consuming a unit of the good for a consumer at x, $Eu(x)$, is given by:

$$Eu(x)=\lambda_1(\alpha+t\cdot x)+\lambda_2(\alpha-t\cdot x)-p=\alpha+(\lambda_1-\lambda_2)t\cdot x-p=\alpha+\lambda\cdot t\cdot x-p. \tag{29}$$

We derive the optimal price and social welfare when λ takes a nonnegative value and when it takes a negative value, respectively.

4.1. Case 1: $0\leq\lambda\leq1$

Consider the first case when $0\leq\lambda\leq1$, meaning that the probability that the product in question meets the taste of consumers is higher than otherwise. From Equation (29), consumers who satisfy the following inequality buy the good.

$$Eu(x) \geq 0$$
$$\Leftrightarrow (p-\alpha)/(\lambda t) \leq x \leq 1 \qquad (30)$$

Inequality (30) gives the aggregated demand:

$$Q^{DP}=1-(p-\alpha)/(\lambda\ t)\ . \qquad (31)$$

The line "DP" in Panel A of Fig. 2 depicts the expected evaluation of the good, $\alpha+\lambda\ t{\cdot}x$, in this case. The profit function for a retailer i is:

$$\pi_{Ri}^{DP}=(p_i-r)Q^{DP}/n-e_i\ . \qquad (32)$$

As proved, no retailer is willing to convey product information by expending its resource, meaning that $e_i=0$. Furthermore, the lexicographic preferences of consumers preclude all retailers from driving up the resale price above the purchase price, leading to $p_i=p=r$. Thus, given Equation (31), the manufacturer's profit is:

$$\pi_M^{DP} = (r-c)Q^{DP} - F = (p-c)(1-(p-\alpha)/(\lambda t))- F\ . \qquad (33)$$

Because the minimum net utility for a consumer located at the origin is $\alpha-p$, the manufacturer never undercuts the wholesale price below α in this case. Maximization of Equation (33) with respect to the retail (or wholesale) price gives:

$$p^{DP*}=r^{DP*}=(\alpha+c+\lambda t)/2 \qquad \text{(when } (\alpha-c)/t < \lambda \leq 1 \text{)}$$
$$=\alpha \qquad \text{(when } 0 \leq \lambda \leq (\alpha-c)/t \text{).}$$
$$(34)$$

Substituting these into Equation (33) yields the optimal profit.

$$\pi_M^{DP*} = (\alpha - c + \lambda t)^2 /(4\lambda t) - F \qquad \text{(when} \quad (\alpha - c)/t < \lambda \leq 1)$$
$$= \alpha - c - F \qquad \qquad \text{(when} \quad 0 \leq \lambda \leq (\alpha - c)/t) \tag{35}$$

Now we can compute expected consumer welfare, ECW^{DP*}, by integrating the surplus of each consumer. The reason why we compute the "expected" surplus is that we compare consumer welfare under decentralized pricing with that under RPM in a subsequent section.

$$ECW^{DP*} = \int_{\frac{p^{DP*}-\alpha}{\lambda t}}^{1}(\alpha + \lambda tx - p^{DP*})dx = (\alpha - c + \lambda t)^2 /(8\lambda t) \text{ (when} (\alpha - c)/t < \lambda \leq 1)$$
$$= \int_{0}^{1}(\alpha + \lambda tx - p^{DP*})dx = \lambda t/2 \qquad \qquad \text{(when} \quad 0 \leq \lambda \leq (\alpha - c)/t) \tag{36}$$

4.2. Case 2: –1≤λ<0

We derive welfare in another case, where the probability that the manufacturer successfully develops a suitable good is lower than otherwise, i.e., –1≤λ<0. Consumers satisfying the following inequality will purchase the good.

$$Eu(x) \geq 0$$
$$\Leftrightarrow 0 \leq x \leq (\alpha - p)/(-\lambda t) \tag{37}$$

This inequality gives the demand as:

$$Q^{DP} = (\alpha - p)/(-\lambda t). \tag{38}$$

23

Panel B of Fig. 2 presents the expected evaluation of the good as the "DP" line. Profit for a retailer is written as:

$$\pi_{Ri}{}^{DP}=(p_i-r)Q^{DP}/n-e_i\,. \tag{39}$$

Similar to the previous case, Bertrand price competition undercuts the retail price until $p_i=p=r$ holds, and no information service is provided, i.e., $e_i=0$. Equation (38) gives the manufacturer's profit as:

$$\pi_M^{DP} = (r-c)Q^{DP} - F = (p-c)(\alpha - p)/(-\lambda t) - F\,. \tag{40}$$

The manufacturer will not cut the price below $\alpha+\lambda t$ in this case, because the minimum expected net utility from a consumer who has the strongest taste is $\alpha+\lambda t-p$. The first order condition of the profit function yields the optimal price:

$$\begin{aligned} p^{DP*}=r^{DP*}&=(\alpha+c)/2 &&(\text{when} \quad -1\le \lambda \le -(\alpha-c)/(2t)) \\ &=\alpha+\lambda t &&(\text{when} \quad -(\alpha-c)/(2t)< \lambda <0). \end{aligned} \tag{41}$$

Substituting Equation (41) into Equation (40) yields the optimal profit for the manufacturer:

$$\begin{aligned} \pi_M^{DP*} &= -(\alpha-c)^2/(4\lambda t)-F &&(\text{when} \quad -1\le \lambda \le -(\alpha-c)/(2t)) \\ &= \alpha-c+\lambda t-F &&(\text{when} \quad -(\alpha-c)/(2t)< \lambda <0). \end{aligned} \tag{42}$$

The expected consumer welfare is:

$$\begin{aligned} ECW^{DP*} &= \int_0^{\frac{\alpha-p^{DP*}}{-\lambda t}}(\alpha+\lambda tx-p^{DP*})dx = -(\alpha-c)^2/(8\lambda t)(\text{when}-1\le \lambda \le -(\alpha-c)/(2t)) \\ &= \int_0^1(\alpha+\lambda tx-p^{DP*})dx = -\lambda t/2 &&(\text{when} \quad -(\alpha-c)/(2t)<\lambda <0). \end{aligned} \tag{43}$$

5. Implications

This section compares the economic outcomes of the two transaction schemes and draws implications centering on social welfare. To get a clear picture of the outcomes, Table 2 summarizes profit and consumer welfare in equilibrium derived in previous sections. Moreover, Fig. 3 provides an illustration of the profits and consumer welfare under each distribution system ($E\pi_M^{RPM*}$, π_M^{DP*}, ECW^{RPM*} and ECW^{DP*}) when $t>\alpha$ holds. Notice that $E\pi_M^{RPM*}$ in the figure is drawn based on Equation (16), where the manufacturer sets a retail price, p, greater than α. Because one may easily confirm that $-(t+\alpha-2c)/(t+\alpha)>-(t-\alpha-2c)/(t-\alpha)$ holds if $t>\alpha$, $\lambda>-(t+\alpha-2c)/(t+\alpha)$ is necessary for $p^{RPM*}>\alpha$ according to Inequality (15). Hence, graphs in Fig. 3 are drawn within the interval between $-(t+\alpha-2c)/(t+\alpha)\le\lambda\le1$. Moreover, because the manufacturer has alternative choices to set a price less than or equal to α, the graph indicates that expected profit of at least $E\pi_M^{RPM*}$ is guaranteed to the manufacturer for each λ by adopting RPM. As the benchmark, the following two propositions hold when either taste heterogeneity or uncertainty is absent.

[Table 2]

[Fig. 3]

Proposition 1. When there is no uncertainty on the characteristics of a good, meaning that the good is deterministically suitable ($\lambda=1$) or deterministically unsuitable ($\lambda=-1$), adoption of RPM reduces firm profit. Thus, the manufacturer is unwilling to impose RPM on retailers.

Proof. See Appendix A.

Proposition 2. If the tastes of consumers for the good are perfectly homogeneous, meaning that t=0, the imposition of RPM reduces firm profit. Hence, the manufacturer has no incentive to introduce RPM.

Proof. See Appendix A.

Propositions 1 and 2 suggest that regulators need not allow manufacturers to implement RPM when there is no uncertainty associated with the product ($|\lambda| = 1$) or consumers have the same tastes ($t = 0$), because the profit under RPM is always less than that under decentralized pricing in competitive environments. Namely, if there is no uncertainty or if consumers' tastes are perfectly homogeneous, resources spent on the information services become wasteful, consistent with intuition. Hence, the manufacturer is not willing to adopt RPM even if it is permitted by regulators. In contrast, the following propositions hold in the presence of uncertainty or heterogeneity.

Proposition 3. Consider the situation where $F > \alpha - c$ and $t > 4F - \alpha + 2c + 2\sqrt{2F(2F - \alpha + 2c)} > 0$ hold and the service cost is so small that we may approximate $n\bar{e}$ as 0. When the uncertainty associated with production of the good is the highest, i.e., λ=0, $E\pi_M^{RPM*} > 0 > \pi_M^{DP*}$ holds. Therefore, the manufacturer does not provide the good under decentralized pricing in competitive market transactions, leading to no consumer surplus. However, permission of RPM enables the manufacturer to produce and market such a risky good, generating consumer surplus for the good.

Proof. See Appendix A.

Proposition 4. Consider the situation where $F > \alpha - c$ and $t > \alpha - c$ hold and the service cost is so small that we may approximate $n\bar{e}$ as 0. Assume either of the two cases: (i) $(\lambda t + \alpha - c)^2 / (4\lambda t) < F < ((1 + \lambda)(t + \alpha) - 2c)^2 / (8(1 + \lambda)t)$ when $\lambda > 0$ or (ii)

$-(\alpha-c)^2/(4\lambda t) < F < ((1+\lambda)(t+\alpha)-2c)^2/(8(1+\lambda)t)$ when $\lambda < 0$, meaning that the degree of consumer tastes, t, is moderately high so that there exists a certain degree of taste heterogeneity across consumers. In either situation, permission for the adoption of RPM enables the manufacturer to produce the good and generates positive consumer surplus, whereas the manufacturer does not market the good under competitive transactions.

Proof. See Appendix A.

These two propositions deserve attention from a regulatory economics viewpoint. Proposition 3 suggests that if consumers' taste heterogeneity is substantial and the uncertainty associated with production of the good is the highest, RPM contributes to enhance social welfare by giving the manufacturer the incentive to develop "risky" products, because it will not develop such a product under decentralized pricing in a free market transaction system. Furthermore, Proposition 4 indicates that permission of RPM generates positive social surplus if consumers' taste heterogeneity is moderately high.

Overall, the basic logic behind the propositions is summarized as follows. If consumers' taste heterogeneity is substantial or uncertainty is large, consumers do not buy the good in the absence of the information service because they hate to bear risk. When we take books as an example, no bookstore provides the information service because they fear the informational free-riding possibility by other stores under a competitive transaction system. Consequently, risky books that require sufficient information services for consumers may not be offered in the market. RPM guaranteeing sufficient margin to retailers enables consumers to buy the book without risk by conveying the product information, leading to positive profit for the manufacturer. In summary, the reason why no consumer surplus arises under decentralized pricing is that the good is simply not produced because positive profit is unattainable for the manufacturer even though some consumers may be willing to buy the good.

Recall that Fig. 3 indicates that expected profit of at least $E\pi_M^{RPM*}$ is guaranteed to the manufacturer for each λ under RPM. Hence, when $\lambda=0$, the manufacturer may earn at least positive expected profit under RPM, while its profit falls to a negative value under decentralized pricing. In Fig. 3, the interval of "BOTH" signifies that the manufacturer provides the good to the market because it gains positive profit under either transaction system. On the contrary, the manufacturer never markets the good under not only decentralized pricing but also RPM if the probability that the manufacturer fails to develop a suitable product is very high. This case is illustrated as the region of "NEITHER" in the figure. The most important interval that we should highlight in the figure is "RPM". When λ takes a value in the interval "RPM", although the manufacturer has no incentive to market the product under competitive transactions, adoption of RPM induces the manufacturer to develop and supply the product. The fundamental reason for this is that the manufacturer may drive up the retail price so as to target consumers with strong tastes as its primary clientele if the probability that the suitable state occurs is relatively high. By contrast, when the product is less likely to be suitable, it keeps the price below α to sell the goods mainly to consumers with weaker tastes.

In summary, RPM with a retailer information service enables the manufacturer to post the appropriate retail price and to obtain positive expected profit, leading to positive consumer welfare for the product. In this sense, RPM contributes to enhance social welfare particularly when a manufacturer bears high risk in developing a new product with demand uncertainty. For example, publishers of highly specialized or artistic books often face the difficulty of editing them to suit the tastes of general readers and thus are exposed to risk. Our result indicates that regulators should allow such publishers to implement RPM so as to remove the risk through a retailer information service. By contrast, regulators need not permit publishers who produce fast-selling books such as magazines or paperbacks to use RPM, because it is much easier for the firms to determine popularity in those categories, and readers

are less likely to have particular tastes for such books.

6. Extension

In this section, we examine the possibility for further extension and generalization of the present model to describe the actual retail market better. While this paper has consistently presumed the retail book market as an empirical example, our model shows that every retailer provides an information service under RPM in the equilibrium. In reality, however, retailers can also differentiate themselves by either providing the service or not in the book market. For example, bookstores in department stores provide almost no service, whereas large bookstores such as Barnes & Noble, Inc., provide sufficient browsing services. The above results imply that there exist no "book browsing" facilities in countries where RPM is not allowed. In this respect, our model admits further generalization.

To incorporate the differentiation of service provision, we can extend the model by adding the following two assumptions to the established model. (1) Two types of retailers exist: specialty stores, which incur only variable costs for the provision of the information service because the fixed cost for the service facilities has already been "sunk", and discounters, which must bear both variable and fixed costs to provide the service. (2) There are two kinds of consumers: price-searching consumers, who have lexicographic preferences as in the present model and thus visit multiple stores to find the lowest price after receiving the information service, and nonsearching consumers, who randomly choose only a single store from all the stores to visit and determine whether to purchase the good at the store if the expected utility is nonnegative.

With these additional assumptions, under decentralized pricing in competitive transactions, specialty stores raise the retail price to the monopolistic level through service provision and sell the good exclusively to non-searching consumers, generating monopolistic

29

profit. Consequently, all price-searching consumers come to the discounters. Bertrand price competition between discounters induces them to sell the good to both types of consumers at the cost price, because they cannot discriminate the retail price by the type of consumers. Therefore, in the equilibrium of decentralized pricing, specialty stores provide the information service so as to avoid Bertrand competition with discounters, whereas discounters provide no service.

On the other hand, with RPM, the manufacturer forces both types of retailers to adhere to the resale price determined by the manufacturer and to provide the information service. To make such a contract feasible, the manufacturer guarantees both the fixed and the variable costs that are required to provide the service to the discounters. Because the manufacturer cannot discriminate the wholesale price by the type of retailer, it guarantees the same dollar amount to specialty stores as well as to discounters, leading to positive profits for specialty stores. To support this situation as the equilibrium, the condition that precludes discounters from stopping providing the service is required. As long as this condition holds, both types of retailers provide the information service in the equilibrium under RPM.

Solving the problems under RPM and decentralized pricing in the presence of two types of retail formats and consumers, respectively, we seek to find the situations where the expected profit under RPM is positive and that under decentralized pricing is negative in equilibrium, as we derived in Propositions 3 and 4 in the current paper.

To reiterate, our major purpose of this research is to prove that RPM has the possibility of contributing to social welfare by removing the manufacturers' risk of developing a product with uncertainty, which has not been documented in previous research. While our model made a new contribution to the literature in this way, generalization of the RPM model along with the above framework to describe the actual market environments better is identified as a practical topic that should be addressed in further research.

7. Concluding remarks

This paper explored the economic roles of resale price maintenance (RPM) in the presence of consumer taste heterogeneity for a product with uncertainty regarding suitability to public tastes. The established model indicates that RPM in supply chains contributes to the emergence of consumer welfare by transmitting product information to consumers, either when the uncertainty is substantial or when consumers have large heterogeneity in tastes. From an economics viewpoint, the model suggests that the government should allow firms offering such products for sale to adopt RPM. Mathewson and Winter (1998) argued that the service aspect is more general to justify the implementation of RPM. If the service by retailers is valuable to consumers, social welfare might be reduced by abolishing RPM. In this context, the current study has provided new insights into supply chains facing uncertainty by showing that RPM contributes to removing the risk not only for consumers but also for the manufacturer.

In our model, a manufacturer could act monopolistically under both transaction schemes of RPM and decentralized pricing in competitive market environments. In practice, however, there is a fear that RPM will yield above-competitive returns to dealers: in other words, that the practice is anticompetitive. We expect that such anticompetitive behavior of firms will occur especially when manufacturers and retailers are competitive and cannot act as a monopolist as in the established model. Assessment of the effects of RPM on consumer welfare incorporating competition among multiple manufacturers is also an appealing topic, as is the generalization of the model suggested earlier.

Footnotes

1. Flath (1989) gives a detailed perspective on the antimonopoly laws of Japan. Although

RPM agreements are in principle a violation of Japan's antimonopoly law, RPM is authorized as an exception for copyrighted works. However, amendments to the antimonopoly law that would remove the special authorization of RPM for copyrighted works are also under serious discussion in Japan (Ariga et al., 1991; Ariga, 1995). Flath and Nariu (2000) prove that the adoption of RPM enhances profits for a marketing channel when consumer demand is uncertain. Moreover, Matsui (2009) empirically investigates the influence of supplier concentration on transaction prices between suppliers and retailers at the level of product in Japan.

2. Other relevant studies include Mathewson and Winter (1984), Perry and Groff (1985), Rey and Tirole (1986), Bolton and Bonanno (1988), Klein and Murphy (1988), Marvel (1994), and Chen and Chen (2007). Furthermore, empirical studies that discuss the relationship between RPM and oligopoly or price discrimination also appear in the literature (Borenstein, 1991; Shepard, 1993).

3. Because all the consumers in our model have lexicographic preferences, they are regarded as "searching" consumers across multiple retail stores. In reality, however, "nonsearching" consumers who attach more importance to service than price are also present in the market. In response to the coexistence of "searchers" and "nonsearchers", booksellers are expected to differentiate themselves; some stores provide the browsing service and others do not. See Section 6 for possible extensions of this model structure.

4. Moreover, one may prove that the state where all retailers provide no presale service ($e_j=0$ for all j) is not an equilibrium by taking the following steps. Assume the state where no retailers provide the service, and compare the profit for a retailer between remaining in a state of no service provision and deviating from the state by supplying the service for each of the four cases: (i) $\lambda \geq 0$, $t \geq \alpha - c$, (ii) $\lambda \geq 0$, $t < \alpha - c$, (iii) $\lambda < 0$, $t \geq \alpha - c$, and (iv) $\lambda < 0$, $t < \alpha - c$. One may show that the profit for the retailer when it deviates from the state where no retailers provide the service always exceeds that when it remains in the state. Although the author

has proved this outcome, the proof is not presented in the current paper because of space limitation. The proof is available from the author on request.

5. In practice, the manufacturer will set resale retail price, p, marginally higher than the wholesale price, r, so that retailers gain marginal profit and therefore have an incentive to carry the product under RPM.

Appendix A

A.1. Proof of Proposition 1

Because $\lambda=1$ signifies that a suitable state deterministically arises, the manufacturer obviously sets the retail price, p, above α to glean monopolistic profit. Substituting $\lambda=1$ into Equations (16) and (35), we immediately have $E\pi_M^{RPM*}<\pi_M^{DP*}$ (see Fig. 3 for an illustration). Secondly, we calculate the manufacturer's profit under each transaction system when $\lambda=-1$. Because the product is deterministically unsuitable, the manufacturer sets the retail price, p, below α given the consumer demand schedule. The manufacturer produces the demand quantity of the good, $(\alpha-p)/t$ at stage 2 and sells it at stage 6. The profit under RPM is:

$$
\begin{aligned}
\pi_M^{RPM} &= (p-c)q - F - n\bar{e} \\
&= (p-c)(\alpha-p)/t - F - n\bar{e}
\end{aligned}
\tag{A1}
$$

Maximization of Equation (A1) on p yields:

$$
p^{RPM*} = (\alpha+c)/2 .
\tag{A2}
$$

Replacing p in Equation (A1) with Equation (A2) gives the optimal profit as:

$$
\pi_M^{RPM*} = (\alpha-c)^2/(4t) - F - n\bar{e} .
\tag{A3}
$$

On the other hand, optimal profit under decentralized pricing is calculated by evaluating Equation (42) at $\lambda=-1$. The profit is:

$$
\pi_M^{DP*} = (\alpha-c)^2/(4t) - F .
\tag{A4}
$$

One may confirm that profit under decentralized pricing is greater than that under RPM by

comparing Equations (A3) and (A4).　　　　　*Q.E.D.*

A.2. Proof of Proposition 2

The manufacturer obviously sets the retail price as $p=\alpha$ under RPM when the utility from consumption is equal to α for all consumers. Equation (18) indicates that the profit is:

$$\pi_M^{RPM*} = \alpha - c - F - n\overline{e} \, . \tag{A5}$$

On the other hand, when the manufacturer chooses decentralized pricing, its profit is as follows from Equation (35):

$$\pi_M^{DP*} = \alpha - c - F \, . \tag{A6}$$

Hence, $E\pi_M^{RPM*} < \pi_M^{DP*}$.　　　　　*Q.E.D.*

A.3. Proof of Proposition 3

We compare the manufacturer's expected profit when it sets a price above α under RPM represented by Equation (16) and the profit under decentralized pricing represented by Equation (35). Evaluating Equation (16) at $\lambda=0$ yields the following expected profit under RPM:

$$E\pi_M^{RPM*} = (t + \alpha - 2c)^2 / (8t) - F - n\overline{e} \, . \tag{A7}$$

On the other hand, Equation (35) represents the profit under decentralized pricing without uncertainty, i.e., $\lambda=0$ as follows:

$$\pi_M^{DP*} = \alpha - c - F \, . \tag{A8}$$

Because $F > \alpha - c$, $\pi_M^{DP*} < 0$.

Notice that $t > 4F - \alpha + 2c + 2\sqrt{2F(2F - \alpha + 2c)}$ automatically satisfies $t > \alpha$ because $F > \alpha - c$. The derivative of $E\pi_M^{RPM*}$ in Equation (A7) on t is given as:

$$\frac{\partial E\pi_M^{RPM*}}{\partial t} = \frac{(t + \alpha - 2c)(t - \alpha + 2c)}{8t^2} > 0 \, . \quad (\text{if } t > \alpha) \tag{A9}$$

Inequality (A9) signifies that $E\pi_M^{RPM*}$ is monotonically increasing in t if $t > \alpha$. Because

$E\pi_M{}^{RPM*} = 0$ when $t = 4F - \alpha + 2c + 2\sqrt{2F(2F - \alpha + 2c)}$, $E\pi_M{}^{RPM*} > 0 > \pi_M{}^{DP*}$ holds if $F > \alpha - c$ and $t > 4F - \alpha + 2c + 2\sqrt{2F(2F - \alpha + 2c)}$. Therefore, the manufacturer decides to produce the good because of positive expected profit only under RPM. Furthermore, see the graphs for $E\pi_M{}^{RPM*}$, $\pi_M{}^{DP*}$, ECW^{RPM*} and ECW^{DP*} in Fig. 3, which illustrates an example of such a situation.

Lastly, remember that the manufacturer has four choices in the case of RPM: (i) $\alpha < p < \alpha + t$, (ii) $p = \alpha$, (iii) $\alpha - t < p < \alpha$, and (iv) $p = \alpha - t$, as investigated in Section 3. Although we examine only the choice of (i), the above proof indicates that at least a positive profit is guaranteed to the manufacturer by choosing RPM, meaning that this proposition holds. *Q.E.D.*

A.4. Proof of Proposition 4

We compare the expected profit under RPM when $p > \alpha$ (Equation (16)) and that under decentralized pricing when $\lambda > 0$ (Equation (35)) or $\lambda < 0$ (Equation (42)). For case (i), imposing $(\lambda t + \alpha - c)^2 / (4\lambda t) < F < ((1 + \lambda)(t + \alpha) - 2c)^2 / (8(1 + \lambda)t)$ on Equations (16) and (35) immediately shows that $\pi_M{}^{DP*} < 0 < E\pi_M{}^{RPM*}$ holds because $n\bar{e}$ may be regarded as zero. Likewise, in case (ii), imposition of $-(\alpha - c)^2 / (4\lambda t) < F < ((1 + \lambda)(t + \alpha) - 2c)^2 / (8(1 + \lambda)t)$ on Equations (16) and (42) immediately proves that $E\pi_M{}^{RPM*} > 0 > \pi_M{}^{DP*}$.   *Q.E.D.*

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Fig. 1.   Timeline of events

Stage 1: The manufacturer chooses RPM or decentralized pricing in a competitive market environment as the transaction scheme within the supply chain for the product if implementation of RPM is allowed by the regulator. If RPM is not allowed, it automatically adopts decentralized pricing.

$\downarrow$

Stage 2: The manufacturer develops and produces Q units of the good if the expected profit is nonnegative.

$\downarrow$

Stage 3: The manufacturer sets the wholesale price, r, under decentralized pricing, while it sets both the wholesale price, r, and the retail price, p, under RPM.

$\downarrow$

Stage 4: Each retailer decides whether to provide the information service ($e=\bar{e}$) or not ($e=0$). Additionally, retailers set the retail price, p, only under a decentralized pricing scheme.

$\downarrow$

Stage 5: Only if consumers receive the information service, whether the good is "suitable" or "unsuitable" is revealed.

$\downarrow$

Stage 6: Consumers decide to buy a unit of the good if the expected net utility from the consumption is nonnegative.
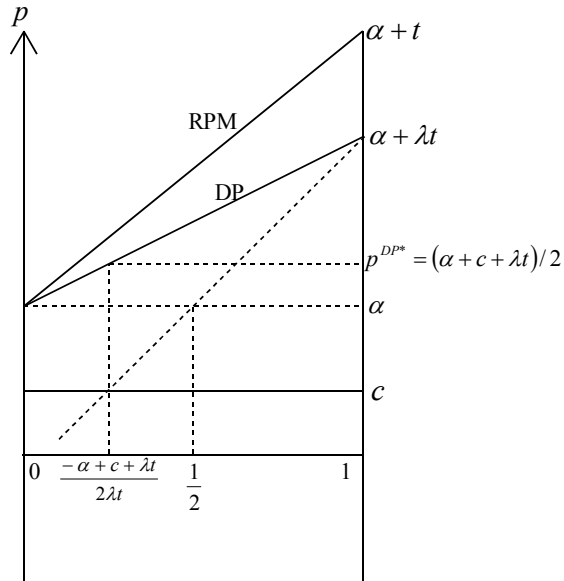
$\downarrow$

Stage 7: If consumers did not receive the information service at stage 5, whether the good is "suitable" or "unsuitable" is revealed.

Fig. 2.   Consumer evaluation of the good under resale price maintenance and decentralized pricing
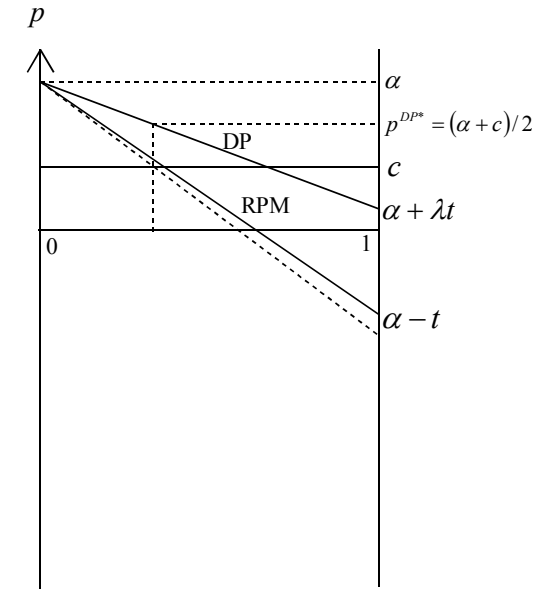
Panel A: RPM...evaluation in the "suitable" state under RPM

DP...expected evaluation under decentralized pricing when

$\lambda \geq 0$

Panel B: RPM...evaluation in the "unsuitable" state under RPM

DP...expected evaluation under decentralized pricing when

$\lambda < 0$

Note: "RPM" represents the evaluation of the good for consumers distributed in the segment between [0,1] when firms apply resale price maintenance and thereby remove the uncertainty of the product. "DP" is the expected evaluation when a manufacturer sells the product through competitive retailers and consumers face risk in purchasing the good.

Fig. 3. Manufacturer's expected profits and consumer welfare for resale price maintenance and decentralized pricing
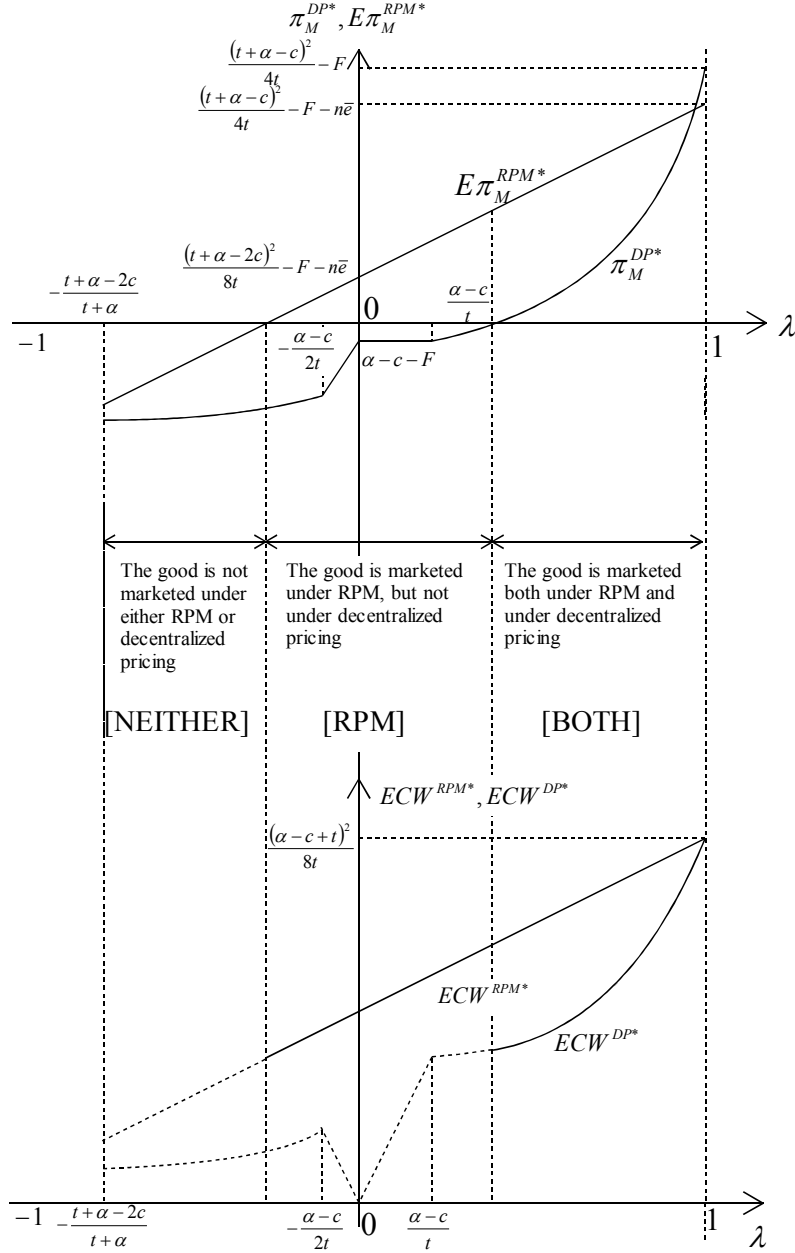
Note: See Table 1 for the definition of variables and functions. The figure illustrates graphs of profits and consumer welfare under each distribution system when $t > \alpha - c$ holds. $E\pi_M^{RPM*}$ corresponds to Equation (16), where the manufacturer sets a retail price greater than α. Because the manufacturer may set the price at less than α, the graph indicates that expected profit of at least $E\pi_M^{RPM*}$ is guaranteed to the manufacturer for each λ under RPM. Note that the good is marketed only when resale price maintenance is permitted by regulators in the interval of "RPM". Because the manufacturer will not market the good if λ is small under market transactions, expected consumer surplus falls to zero in this situation. Thus, ECW^{DP*} in the intervals of "NEITHER" and "RPM" is depicted by a dotted line. Likewise, ECW^{RPM*} in the interval of "NEITHER" is also drawn as a dotted line.

Table 1   Nomenclature

p	retail (resale) price
r	manufacturer wholesale price
c	marginal cost to the manufacturer of producing a unit of the good
F	fixed cost to the manufacturer of producing the good
q	retailer demand
Q	aggregated demand
t	strength of tastes of consumers for the good
α	evaluation of the good for a consumer with no taste heterogeneity
x	consumer location
λ_1	probability that the good is configured to suit the public tastes of consumers
λ_2	probability that the good is not configured to suit the public tastes of consumers
λ	$\lambda_1 - \lambda_2$
$u(x)$	net utility from consuming a unit of the good for a consumer located at x
e	information service level provided by retailers
e^*	retailer optimal service level
$\bar{e}$	service cost for a retailer to provide information to consumers
i	subscript that indexes retailers
n	number of retailers dealing in the good
Q^{RPM}	aggregated demand under RPM
Q^{DP}	aggregated demand under decentralized pricing
p^{VT*}	optimal retail (resale) price when the manufacturer vertically integrates all retailers
p^{RPM*}	optimal retail (resale) price under RPM
p^{DP*}	optimal retail price under decentralized pricing
r^{RPM*}	optimal wholesale price under RPM
r^{DP*}	optimal wholesale price under decentralized pricing
π_R^{RPM}	profit for a retailer under RPM
π_M^{VI}	profit for the manufacturer when it vertically integrates all retailers
π_R^{DP}	profit for a retailer under decentralized pricing
π_M^{DP}	profit for the manufacturer under decentralized pricing
π_M^{RPM*}	optimal profit for the manufacturer under RPM
$E\pi_M^{RPM*}$	expected optimal profit for the manufacturer under RPM
π_M^{DP*}	optimal profit for the manufacturer under decentralized pricing
CW^{RPM*}	consumer welfare under RPM in equilibrium
CW^{DP*}	consumer welfare under decentralized pricing in equilibrium
ECW^{RPM*}	expected consumer welfare under RPM in equilibrium
ECW^{DP*}	expected consumer welfare under decentralized pricing in equilibrium

Table 2　Profit and consumer welfare in equilibrium

	Resale price maintenance	Decentralized pricing $(0 \leq \lambda \leq 1)$	Decentralized pricing $(-1 \leq \lambda < 0)$
$E\pi_M^*$: expected profit for the manufacturer	$((1+\lambda)(t+\alpha)-2c)^2/(8(1+\lambda)t)-F-n\bar{e}$ $\left(\text{when } \alpha < p^{*RPM} < \alpha + t\right)$ $(1+\lambda)\alpha/2 - c - F - n\bar{e}$ $\left(\text{when } t > 0 \text{ and } p^{RPM*} = \alpha\right)$ $\alpha - c - F - n\bar{e}$ $\left(\text{when } t = 0 \text{ and } p^{RPM*} = \alpha\right)$ $((t+\alpha+\lambda(t-\alpha))^2 - 8(1-\lambda)ct)/(8(1-\lambda)t)-F-n\bar{e}$ $\left(\text{when } \alpha - t < p^{RPM*} < \alpha\right)$ $\alpha - \bar{q} - c - F - n\bar{e}$ $\left(\text{when } p^{RPM*} = \alpha - t\right)$	$(\alpha - c + \lambda t)^2/(4\lambda t) - F$ (when $(\alpha - c)/t < \lambda \leq 1$) $\alpha - c - F$ (when $0 \leq \lambda \leq (\alpha - c)/t$)	$-(\alpha - c)^2/(4\lambda t)-F$ (when $-1 \leq \lambda \leq -(\alpha-c)/(2t)$) $\alpha - c + \lambda t - F$ (when $-(\alpha-c)/(2t) < \lambda \leq 0$)
ECW^*: expected consumer welfare	$((1+\lambda)(t+\alpha)-2c)^2/(16(1+\lambda)t)$ $\left(\text{when } \alpha < p^{RPM*} < \alpha + t\right)$ $(1+\lambda)t/4$ $\left(\text{when } p^{RPM*} = \alpha\right)$ $((1-\lambda)^2\alpha^2 + 2(1-\lambda^2)t\alpha + (1+\lambda)(1-7\lambda)t^2)/(16(1-\lambda)t)$ $\left(\text{when } \alpha - t < p^{RPM*} < \alpha\right)$ $(2+\lambda)t/2$ $\left(\text{when } p^{RPM*} = \alpha - t\right)$	$(\alpha - c + \lambda t)^2/(8\lambda t)$ (when $(\alpha - c)/t < \lambda \leq 1$) $\lambda t/2$ (when $0 \leq \lambda \leq (\alpha - c)/t$)	$-(\alpha - c)^2/(8\lambda t)$ (when $-1 \leq \lambda \leq -(\alpha - c)/(2t)$) $-\lambda t/2$ (when $-(\alpha - c)/(2t) < \lambda < 0$)