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Matsui, Kenji

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Should a retailer bargain over a wholesale price with a manufacturer using a dual-channel supply chain?

Kenji Matsui

Graduate School of Business Administration, Kobe University, 2-1, Rokkodaicho, Nada-ku, Kobe, Japan

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ABSTRACT

In this paper, we investigate the problem of whether a retailer should bargain over the wholesale price of a product with a manufacturer or accept the price unilaterally determined by the manufacturer. To investigate the problem, we develop a game-theoretic model describing a supply chain organized by one manufacturer and one retailer. Intuitively, if there is a bargaining opportunity, a retailer is better off bargaining over the wholesale price rather than simply accepting the price determined by the manufacturer. Consistent with this intuition, we first show the benchmark outcome that the retailer achieves a higher profit through bargaining over the price when the manufacturer uses only a single-channel supply chain, in which the manufacturer sells only through the retailer. Conversely, however, we demonstrate that this intuitive result can be completely reversed in a dual-channel supply chain environment, in which the manufacturer is able to sell products not only through the retailer but also directly to end-consumers. Specifically, we find that if a retailer's bargaining power is sufficiently strong and if consumers' substitutability between channels is substantially high, full acceptance of the wholesale price dictated by the manufacturer earns the retailer a higher profit than bargaining. This counterintuitive result is a warning to retailers in dual-channel environments because if a retailer does not accept the wholesale price dictated by a manufacturer, but heedlessly exploits its strong power and bargains with the manufacturer, it may ultimately harm itself and reduce its own profits.

1. Introduction

The recent accelerated growth of information and communication technologies (ICTs) has induced firms embedded in supply chains to restructure their distribution and sales channel strategies. In particular, a rapid expansion of online sales founded on the Internet prompts manufacturing firms to launch their own direct channels to distribute products to end-consumers. To reach a broader spectrum of consumers, prominent manufacturers employ the system called a *dual-channel supply chain*, which consolidates a direct channel and a traditional retail store channel. Such manufacturing companies appear in various industries, including fashion and apparel (e.g., Nike, Adidas, and Coach), electronics (e.g., Apple, Cisco Systems, and Dell), cosmetics (e.g., Estee Lauder), and toys (e.g., Mattel) (Tsay & Agrawal, 2004; Zhang, Li, Zhang & Dai, 2019).

Another significant influence of the development of the ICTs on supply chains is the power shift from upstream to downstream firms. In general, firms downstream of a supply chain tend to accumulate richer demand information because they are closer to end-consumers and have more opportunities to interact with them than do upstream firms. In particular, large-scale retailers tend to have greater power than upstream manufacturers because of their extensive information systems and greater knowledge of consumers' individual needs and preferences. Examples include huge retail chains such as Wal-Mart, Carrefour, and Tesco, which occupy a more predominant position in the market than do their suppliers (Ertek & Griffin, 2002).

Current power shifts along supply channels from upstream to downstream enable downstream retailers to influence their purchase prices. Increasingly, therefore, downstream retailers must determine the best strategy to negotiate effectively with other supply chain members. Often, for example, retailers have opportunities to negotiate wholesale prices with upstream manufacturers. The existing research suggests that a take-it-or-leave-it wholesale contract, in which either a manufacturer or a retailer exercises absolute bargaining power to decide transaction terms, is inconsistent with empirical evidence (e.g., Lovejoy, 2010). Often, a more realistic way of describing the determination process for a wholesale price is a bargaining framework, in which both upstream and downstream firms mutually exert influence in determining their

E-mail address: kmatsui@b.kobe-u.ac.jp

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transaction terms. Indeed, a number of wholesale price bargaining cases are observed in a variety of industries such as production, services, health care, and electricity (e.g., Nagarajan & Sošić, 2008).

Given the increasing importance of the issue of negotiations between upstream and downstream firms constituting supply chains, this paper addresses the question of whether bargaining to determine the wholesale price with a manufacturer really benefits a retailer operating in the environment of a dual-channel supply chain. More specifically, we investigate whether bargaining over the wholesale price with the manufacturer or purchasing at the price unilaterally set by the manufacturer is more profitable for the retailer. To investigate the problem, using game theory, we develop a model describing a supply chain organized by one manufacturer and one retailer. Intuitively, it seems that if there is a bargaining opportunity, a retailer would benefit from bargaining over the wholesale price rather than merely accepting the price determined by the manufacturer. Consistent with this intuition, we first show the benchmark outcome that the retailer achieves a higher profit through bargaining over the price when the manufacturer uses only a single-channel supply chain, in which the manufacturer sells only through the retailer. In contrast, we demonstrate that this intuition can be completely reversed in the environment of a dual-channel supply chain, in which the manufacturer is able to sell products not only via the retailer but also directly to end-consumers. Specifically, the central result of this paper is that if a retailer's bargaining power is very strong and consumers' substitutability between channels is substantially high, full acceptance of the wholesale price dictated by the manufacturer earns the retailer a higher profit than bargaining.

This central result is counterintuitive and notable because it indicates that in a dual-channel environment, a downstream retailer should not bargain but simply accept the wholesale price unilaterally dictated by the upstream manufacturer, regardless of how great the retailer's power is. Despite present power shifts from manufacturers to large-sized retailers in a variety of consumer goods categories, this finding is a warning to retailers that indiscriminately choosing to use their power to bargain over price, rather than accepting the wholesale price dictated by a manufacturer, may simply result in the loss of the opportunity to sell the manufacturer's product in the contemporary dual-channel environment enabled by e-commerce. Thus, the retailer would effectively "cut its own throat" in this environment by bargaining over price. Moreover, our result suggests that whereas the downstream retailer should always bargain over the wholesale price within a traditional single-channel supply chain, the retailer should not always bargain over the price in a dual-channel environment in which a manufacturer can sell directly to consumers. Therefore, a retailer must closely examine the supply chain environment and determine whether an upstream manufacturer can use only an indirect channel (a single channel) or both indirect and direct channels (a dual channel) when making its bargaining decision.

The logic behind the above result is laid out below. In essence, we note that there are generally both upsides and downsides for a manufacturer using a dual-channel system to sell products. Obviously, the upside is that the dual channel enables the manufacturer to reach different types of consumers, thereby opening up new market opportunities. However, the downside is *channel conflict*, whereby direct sales reduce the indirect sales volume through the retail channel. This occurs because some consumers, who would have otherwise purchased from the retail channel, shift to purchasing from the direct channel once it is established. This negative effect becomes more significant if consumers perceive that the two channels are more substitutable. In this situation, the demand increase in the direct channel significantly reduces the demand in the retail channel, which would have been higher in the absence of direct channel sales. Moreover, consumers are more sensitive to the price difference between the channels if the channel substitutability is higher. Accordingly, price competition between the channels is intensified, which places substantial downward pressure on retail prices. Furthermore, when the downstream retailer's bargaining power is strong, a larger portion of profit generated in the indirect retail channel is extracted by the retailer even if the manufacturer sells products in the retail channel. In such a case, the manufacturer is unable to achieve high profits by selling through both channels. If these negative effects of channel conflict become too significant, the manufacturer will cease selling products via the retailer, devoting itself solely to selling through the direct channel. Consequently, the retailer's sales and profits from reselling the manufacturer's product through the retail channel completely disappear. Hence, in this situation, the retailer is better off fully accepting the wholesale price set by the manufacturer rather than bargaining over the price. To put the implication in game-theoretic terms, the retailer is better off playing a Stackelberg game rather than a bargaining game.

The model constructed in this paper has the following unique features that significantly differentiate it from the models of existing studies. First, we investigate the most beneficial process of wholesale price formation not from the manufacturer's but from the retailer's perspective. As platform businesses as well as conventional retail companies are rapidly developing as retail intermediaries, retailers often confront decision-making problems associated with bargaining with manufacturers, given the change from a traditional single-channel environment to the current dual-channel environment. In this context, an issue of vital importance for retailers is how to counter the disintermediation of distributor firms by manufacturers, as a retailer earns no profits if a manufacturer removes it as an intermediary. Because large-scale retailers are increasingly influencing their purchase contracts in the current environment, the investigation of a desirable contract from the retailer's perspective is of increasing importance. Second, we focus on a dual-channel environment to examine the issue of the desirable form of wholesale price determination. As will be reviewed in the next section, most of existing studies analyze bargaining problems within a single- rather than a dual-channel supply chain. Therefore, the present paper is the first to deal with the issue of a desirable wholesale price determination from the perspective of a retailer embedded in a dual-channel supply chain.

Next, we overview real-life cases in which bargaining over wholesale terms seriously affected the retailer's profitability through changing the manufacturer's distribution channel policy. As many book publishers now distribute books in electronic and print forms through both online and offline channels, wholesale conditions are often negotiated between booksellers and publishers. The intense negotiations between Amazon and Hachette Book Group over the terms of a book deal, which lasted over seven months in 2014, are well known.[1] Hachette is one of the largest US publishers distributing books using a dual-channel supply chain. In April 2014, Amazon requested price controls on Hachette's books as a condition of a newly updated contract with Hachette. Hachette declined to accede to this demand, as meeting this condition would have allowed Amazon to drastically reduce the price of most e-books to the benchmark price of $9.99. When Hachette declined the request, Amazon resorted to bullying tactics, including lengthy delivery times, the inability to preorder upcoming titles, and the disappearance of several titles from search results, all of which had significant negative impacts on Hachette's sales. Subsequently, in July 2014, Amazon offered a compromise scheme,

[1] Media outlets such as the *Wall Street Journal* described extensively on this negotiation process throughout 2014; Sternad (2019) provides a complete summary of these negotiations.

whereby it would pay authors 100% of the profits from their e-books. However, the publisher declined this offer as well. Finally, in November 2014, Amazon and Hachette achieved a settlement that while Hachette would preserve control of e-book pricing, Amazon would provide financial incentives for price reductions. In this case, Amazon as the retailer influenced Hachette's channel policy by exerting its bargaining power, which in turn affected its own profitability because Amazon at least partially lost its opportunity to deal in Hachette titles during the seven months of the dispute. This case shows that a retailer can have an opportunity to bargain with its supplier in real life when the supplier is ready to encroach on the retail market.

Another brand-name manufacturer using a dual channel is Nike, which sells its sporting goods through the direct sales channel of Nike.com. Nike also commenced selling products via Amazon in the summer of 2017 and negotiated the wholesale conditions with Amazon, who plays the role of a retailer. However, because Nike-branded products sold by third-party resellers provided more profit to Amazon than those purchased directly from Nike, Amazon made little effort to resell products sold directly by Nike as the first-party seller (Safdar & Mattioli, 2019). As a consequence, after the sales on Amazon for two years, Nike announced that it would retreat from Amazon in November 2019. This actual case shows that even a leading manufacturer in dual-channel environments can be pressured by a retailer to withdraw from the retail channel after continual wholesale negotiation, resulting in Amazon losing the opportunity to carry authentic products directly warranted by Nike.

The abovementioned examples provide evidence that the process by which retailers negotiate wholesale prices with manufacturers who sell their products in dual-channel supply chains has become an important practical issue. The motivation for this paper is the increasing need for retailers to negotiate successfully with suppliers given the increasing prevalence of dual-channel environments. Considering that wholesale price negotiation in the context of dual-channel supply chain management has become a critical issue, this paper aims to provide useful insights into business practices as well as to contribute to the academic literature by addressing the issue.

The rest of this paper is structured as follows. In Section 2, we outline the literature concerning the game-theoretic research regarding management and bargaining in dual-channel supply chains. Section 3 describes the settings of the model. Then, we consider a preliminary single-channel supply chain model as a benchmark in Section 4. Section 5 constructs the main model describing a dual-channel supply chain, deriving the central results of this paper. Based on the results, we draw managerial implications. Subsequently, we extend the main model to prove that it captures general real business environments in Sections 6–8. More specifically, in Section 6, we examine the issue of supply chain coordination and derive the retailer's efficient level of bargaining power that achieves the maximum total supply chain profit when Nash bargaining is conducted over the wholesale price. Section 7 considers the existence of multiple supply chains. We investigate the alternative power structures of the retailer Stackelberg game and the vertical Nash game, then compare the results from the two games with the results from Nash bargaining in Section 8. Finally, Section 9 concludes the paper.

2. Literature review

Our research lies at the intersection of two research streams in the context of supply chain management: (i) dual distribution channels and (ii) bargaining. Below, we elaborate on how this paper relates to the existing studies in these research areas.

2.1. Dual-channel supply chain management

To date, considerable operational research (OR) and management science papers have studied various issues relating to dual-channel supply chain management based on game theory (e.g., Alawneh & Zhang, 2018; Batarfi, Jaber & Zanoni, 2016; Cai, 2010; Cai, Zhang & Zhang, 2009; Cattani, Gilland, Heese & Swaminathan, 2006; Chen, Zhang & Sun, 2012; Chen, Liang, Yao & Sun, 2017; Chen, Pun & Li, 2018; Chiang & Monahan, 2005; Chiang, Chhajed & Hess, 2003; Dumrongsiri, Fan, Jain & Moinzadeh, 2008; Groznik & Heese, 2010; Hamamura, 2021; He, Gan & Yuan, 2019; He, Huang & Li, 2020; Hua, Wang & Cheng, 2010; Huang & Swaminathan, 2009; Kurata, Yao & Liu, 2007; Lan, Li & Papier, 2018; Li, Zhang, Chiu, Liu & Sethi, 2019b; Li, Zhang & Liu, 2019c; Lin, Zhou & Hou, 2021; Matsui, 2016, 2017; Modak & Kelle, 2019; Qing, Deng & Wang, 2017; Rodríguez & Aydın, 2015; Song, Tang & Zhao, 2019; Sun, Jiao, Guo & Yu, 2022; Tang, Li & Cai, 2021; Wang & Huang, 2021; Xiao & Shi, 2016; Yan, Xiong, Chu, Li & Xiong, 2018a; Yan, Zhao & Liu, 2018b; Yan, Liu, Xu & He, 2020; Yang, Luo & Zhang, 2018; Yu, Cheong & Sun, 2017; Yue & Liu, 2006; Zhang & Hezarkhani, 2021; Zhang & Zhang, 2020; Zhang et al., 2019; Zhang, Yao & Xu, 2020; Zhang, Li, Liu & Sethi, 2021; Zhou, Zhao & Wang, 2019).

In this research stream, Chiang et al. (2003) is a seminal study that examines the benefits of a dual-channel supply chain system to members constituting the chain. Specifically, they formulate a game between a manufacturer and a retailer setting prices and find that a dual-channel supply chain helps the manufacturer enhance its profitability by alleviating inefficient price double marginalization in the retail channel. They also show that the dual-channel supply chain is not always detrimental to the retailer because it can reduce the wholesale price. Cai (2010) investigates the impact of a channel structure on the profitability of a supplier, a retailer, and an entire supply chain, in which the supplier and retailer use different supply chain structures. These structures include a traditional retail channel, a direct channel, and a dual channel that is a combination of both channels. By considering a revenue-sharing contract used in the supply chain, he reveals the impact of the different supply chain structures on the negotiating power of the supplier and the retailer under coordination. His model uses the concept of channel substitutability to measure the degree to which consumers perceive the direct and retail channels to be similar. Moreover, as we explain in a later section, his dual-channel supply chain model assumes a linear demand function. Because our model also uses these concepts and settings, Cai (2010) is relevant to this paper.

Following the earlier works, a number of game-theoretic studies on dual-channel management have recently emerged. Alawneh & Zhang (2018) study inventory management in dual-channel warehouses consisting of an area for online order fulfillment and an area for offline order fulfillment and stocking products. Specifically, they construct an inventory model of multiple items considering both lead time uncertainty and warehouse capacity constraints. They demonstrate that the inventory method proposed by the model enhances the flexibility of the management of dual-channel warehouses. Li et al. (2019b) examine the interaction of a national brand manufacturer and a store brand retailer by considering the online market entry by the manufacturer and the channel sharing strategy by the retailer. They analyze the following three scenarios: (i) the retailer sells both brands; (ii) the manufacturer enters the online market and the retailer sells both brands; and (iii) each firm sells only its own brand because the retailer ceases reselling the manufacturer's brand. They find that even if the retailer stops selling the manufacturer's brand, the retailer cannot prevent the manufacturer from encroaching when diseconomy of the direct selling is sufficiently low. Zhang et al. (2019) investigate the influence of encroachment by a manufacturer on product quality and supply chain members' profits under asymmetric demand information. Manufacturer encroachment causes a signaling game, in which a retailer diminishes the order quantity when encountering relatively small market size. They find that the retailer profits from the encroachment only when the direct selling cost of the manufacturer is at an intermediate level because the retailer can preclude the manufacturer from direct selling in this situation. Zhang, Yao & Xu (2020) focus on an environmental issue in the context of dual-channel management. They assume that a manufacturer first determines the channel structure to sell products through a direct channel and/or a retail channel. Subsequently, the manufacturer and the retailer sequentially make their decisions on selling a common or a low-carbon product. They find that the manufacturer should always set the sales quantity in the direct channel after observing the retailer's order quantity when using a dual-channel supply chain. Tang et al. (2021) investigate the problem of credit-term optimization in a dual-channel supply chain, in which, first, a manufacturer decides its wholesale price, the credit term for a retailer, and its direct retail price, and second, the retailer decides its retail price. They show that the manufacturer offers compensation either in terms of a negotiable lump sum fee or a profit-sharing mechanism for the purpose of supply chain coordination. The current paper aims to contribute to this line of research relating to dual-channel supply chain management.

2.2. Bargaining in supply chains

This paper is also relevant to a strand of research that applies the framework of bargaining devised in the field of game theory to issues relating to supply chain management (e.g., Balasubramanian & Bhardwaj, 2004; Baron, Berman & Wu, 2016; Draganska, Klapper & Villas-Boas, 2010; Dukes, Gal-Or & Srinivasan, 2006; Feng & Lu, 2013; Guan, Ye & Yin, 2020; Guo & Iyer, 2013; Gurnani & Shi, 2006; Iyer & Villas-Boas, 2003; Lovejoy, 2010; Matsui, 2020; Modak & Kelle, 2019; Nagarajan & Bassok, 2008; Nair, Narasimhan & Bendoly, 2011; Qing et al., 2017; Sheu & Gao, 2014; Sucky, 2006; Wu, Baron & Berman, 2009; Yang & Chen, 2020; Yang et al., 2018; Zhong, Zhou & Leng, 2021). Analytical research that formulates problems of bargaining in distribution channels originally emerged in the marketing literature. Iyer & Villas-Boas (2003) investigate bargaining between distribution channel members, demonstrating that the bargaining process influences the degree of coordination in a single channel consisting of one manufacturer and one retailer. They show that the institution of bargaining influences channel coordination when the complexity of nonspecifiability of product exchange exists. They demonstrate that greater retailer power enhances channel coordination, concluding that the existence of a powerful retailer can be beneficial to all the channel members. Balasubramanian & Bhardwaj (2004) consider a duopoly in which two firms compete on dimensions of both price and quality. The manufacturing and marketing managers hired in each firm are endowed with the conflicting incentives, aiming at cost minimization and revenue maximization, respectively. Accordingly, the managers negotiate with each other before reaching compromise decision on price and quality. They show that the firm's equilibrium profits in the presence of the conflict can be higher than those realized when the managers' decisions are perfectly coordinated.

Following the studies on bargaining issues from the viewpoint of marketing channel coordination that arose within the marketing literature, papers that apply the bargaining framework to supply chain management began to be published in the OR literature. Considering a single-channel supply chain consisting of a supplier and a buyer, Sucky (2006) proposes a joint economic lot size model that minimizes the joint total relevant costs. Specifically, he provides a bargaining model under information asymmetry concerning the cost structure of the buyer, assuming that the buyer's market power is strong enough to impose its individual optimal decision. He shows that the optimal level of supply quantity is realized if the supplier is able to estimate the buyer's cost structure sufficiently well, concluding that complete information sharing between the supplier and the buyer is not a necessary prerequisite for a bargaining solution. Wu et al. (2009) analyze optimal strategies adopted by two competing supply chains under demand uncertainty. Specifically, they consider joint pricing and quantity decisions under three possible strategies, which can be chosen by each supply chain: (i) vertical integration, (ii) adoption of a Stackelberg strategy by the manufacturer, and (iii) bargaining over the wholesale price. They find that while both chains choose vertical integration in the unique Nash equilibrium in a static game, the state in which both chains choose the Stackelberg strategy or bargaining can constitute the Nash equilibrium in a dynamic game consisting of an infinite number of periods. Feng & Lu (2013) investigate contracting behavior in a two-echelon supply chain organized by manufacturers and retailers under competition. Specifically, they compare the contracting outcomes of a manufacturer's take-it-or-leave-it game with that of a bargaining game. The former game is more advantageous for manufacturers because the retailers have no opportunity to make counter offers. Their analysis reveals that whether such an advantage benefits the manufacturers depends on the contractual form. Moreover, they show that the take-it-or-leave-it contract game corresponds to the extreme case of a bargaining game. Guo & Iyer (2013) investigate multilateral bargaining in a vertical supply chain in which an upstream manufacturer sells its products through two competing retailers. They consider both simultaneous and sequential bargaining by the two retailers with the manufacturer. Their results show that while simultaneous bargaining is optimal for the manufacturer when retail prices are similar, sequential bargaining is preferable when the dispersion in the retail prices is sufficiently large.

Most recently, in the present journal, Qing et al. (2017) deal with the issue of how a monopolistic supplier bargains and shares capacity with a manufacturer. They assume that the supplier allocates the capacity of main components to its internal channel, an external channel through a manufacturer, or a combination of the two channels. They show that whereas the supplier increases capacity share in response to its own bargaining power increase, the manufacturer decreases capacity share in response to its own bargaining power increase, meaning that the bargaining power change causes opposite impacts on the equilibrium capacities allocated in the dual channel. Differing from Qing et al. (2017), who focus on the bargaining over capacity, the present study deals with the bargaining over a wholesale price. Yang et al. (2018) investigate how nonlinear pricing schedules affect a supplier's decision concerning whether to open and use a direct channel in a supply chain consisting of the supplier and a single retailer. They assume that the two parties can share total sales revenue and engage in bilateral bargaining over the quantity and the wholesale price. Their results show that when the supplier is able to extract all sales revenue of the retailer, the nonlinear pricing in conjunction with revenue sharing can coordinate the supply chain. In the resulting equilibrium, the supplier subsidizes the procurement of products by the retailer with use of a negative wholesale price. Modak & Kelle (2019) investigate the optimal pricing and ordering policy in a dual-channel supply chain facing uncertain demand, depending on both delivery time and price. They consider the systems of centralized and decentralized decision-making under unforeknown distribution functions associated with the stochastic demand and examine how the delivery time and customers' channel preference influence a manufacturer's decision-making.

As discussed earlier, the process of determining transactional terms between manufacturers and retailers in the contemporary dual-channel environment is a critical issue not only from an aca-

Table 1
Notations.

w	wholesale price
p_R	price in the retail channel
p_D	price in the direct channel
q_R	quantity traded in the retail channel
q_D	quantity traded in the direct channel
c	marginal selling cost via the direct channel
a	intercept of the inverse demand function
b	slope of the inverse demand function
θ	channel substitutability between retail and direct channels ($0 < \theta < 1$)
t	channel substitutability between retailers within the retail channel ($0 < t < 1$)
γ	retailer's bargaining power ($0 < \gamma < 1$)
ϕ	profit-sharing rate for the retailer in the supply chain coordination contract ($0 < \phi < 1$)
R	subscript signifying the retail channel
D	subscript signifying the direct channel
MS	superscript denoting the equilibrium of the manufacturer Stackelberg game
RS	superscript denoting the equilibrium of the retailer Stackelberg game
VN	superscript denoting the equilibrium of the vertical Nash game
B	superscript denoting the equilibrium of the Nash bargaining game
C	superscript denoting the supply chain coordination (i.e., total profit maximization)
Π	retailer's profit
π	manufacturer's profit
$\bar{\Pi}$	retailer's disagreement point in the bargaining process
$\bar{\pi}$	manufacturer's disagreement point in the bargaining process
Ω	Nash product in the bargaining process

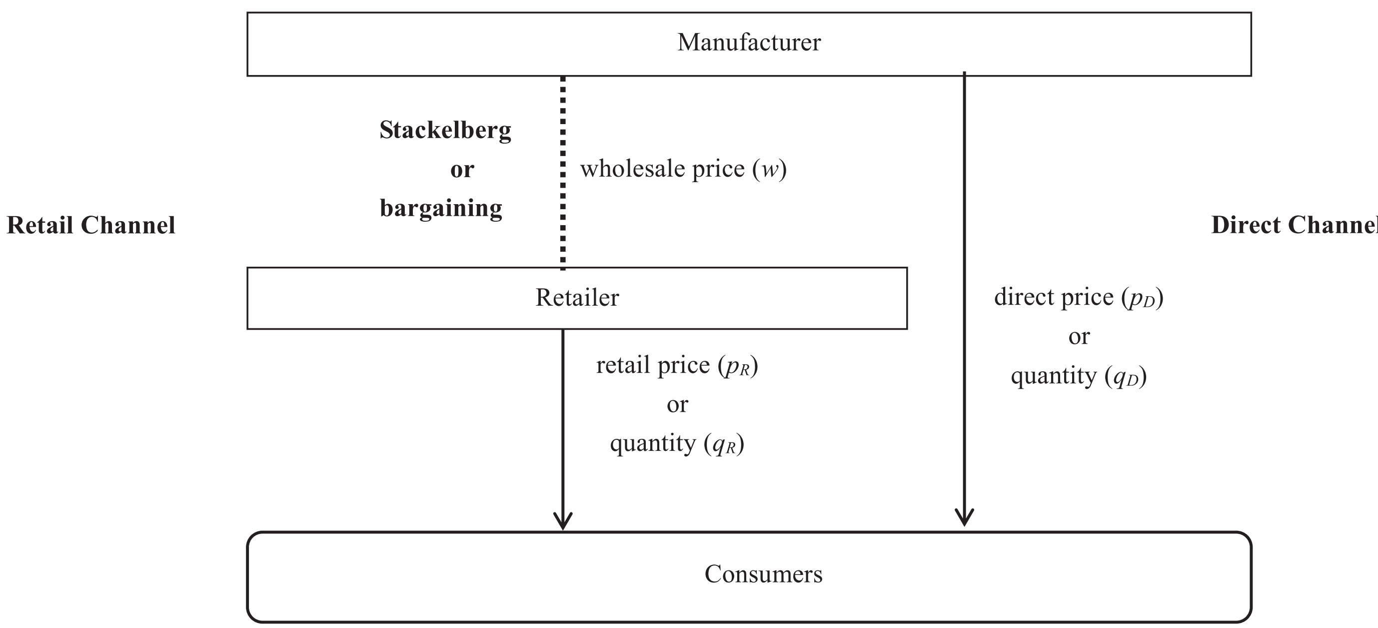

Fig. 1. Dual-channel supply chain structure.

demic but also from a practical perspective. Nevertheless, the literature overview above suggests that no previous research investigates this practically important problem of the desirable process for determining a wholesale price for a retailer in the context of a dual-channel supply chain management. Therefore, it is worthwhile to note that the present paper is the first to deal with this problem, thereby contributing to the literature on operational research.

3. Model

In this section, we delineate the assumptions that underpin our game-theoretic model. The variables used in the model are listed in Table 1. Fig. 1 describes the structure of a supply chain considered in the model. We initially assume that there is a manufacturer producing a product and selling the product to end-consumers directly and/or through a retailer. We call indirect sales through the retailer the retail channel and direct sales from the manufacturer the direct channel, as shown in Fig. 1. Compared with the manufacturer, the retailer typically enjoys an advantage in the sales process in real-world supply chain environments. To model this advantage, we normalize the selling cost for the retailer to zero, following the literature on manufacturers' encroachment on supply chains (e.g., Li, Gilbert & Lai, 2014; Yang et al., 2018). Meanwhile, because the manufacturer is often less efficient in retail operations than is the reseller, we assume that the manufacturer incurs a selling cost of c per unit of product sold in the direct channel. We also normalize the production cost for the manufacturer to zero, following the abovementioned literature.

We assume that the two distribution channels respectively face the following inverse demand functions.

$$p_R = a - b(q_R + \theta q_D)$$
$$p_D = a - b(q_D + \theta q_R) \tag{1}$$

q_R and q_D respectively represent the quantity supplied through the retail channel and through the direct channel. Moreover, p_R

and p_D respectively represent the retail price of a unit product sold from each channel. For convenience, we respectively refer to p_R and p_D as the retail price and the direct price throughout this paper. a represents the market size, which satisfies $a > c$.[2] b is the price sensitivity to the demand, which is a positive constant.[3] $\theta \in (0, 1)$ represents substitutability between the retail and direct channels. Hence, consumers perceive that the two channels become more differentiated as θ declines. In the literature, one of the earlier modeling studies on dual-channel supply chains by Cai (2010, p. 25) defines θ as *channel substitutability*. Accordingly, other dual-channel supply chain models also refer to the corresponding parameter between retail and direct channels as channel substitutability. To ensure the consistency of our model with such previous models in the literature, we define θ as channel substitutability, but not product substitutability, and use this definition throughout the paper.

We also assume that the parameters satisfy the next inequality:

$$a/c > \left(3-\theta^2\right)/((1-\theta)(3+\theta)). \tag{2}$$

Inequality (2) guarantees that the manufacturer sells its products via both channels in equilibrium.[4]

We employ the linear demand function expressed by Eq. (1) following existing operational research models on dual-channel management that adopt linear demand schedules (e.g., Cai, 2010; Li, Li & Sun, 2019a; Yang et al., 2018; Zhang et al., 2020). The specification of the demand function in Eq. (1) indicates that the two channels are differentiated not in terms of quality but in terms of variety. That is, the function means that consumers have different channel preferences and, thus, the value of the product sold in the retail channel is not necessarily higher than the value of that sold in the direct channel. In reality, some consumers may avoid online shopping because they prefer to examine the commodity in person, to experience services from store clerks, and to take purchased goods home quickly, rather than incurring shipping fees and waiting for delivery, whereas other consumers may avoid offline shopping in bricks-and-mortar stores owing to shopping costs and nuisances, including parking or queuing in stores. Consequently, channel preference can substantially vary across consumers, even if a manufacturer sells the same products in both retail and direct channels. Given this variety in the channel preferences of consumers, we adopt the demand functional form represented by Eq. (1).

The profits of the retailer and the manufacturer, denoted by Π and π are, respectively:

$$\Pi = (p_R - w)q_R, \tag{3}$$

$$\pi = wq_R + (p_D - c)q_D, \tag{4}$$

where w is the wholesale price.[5] Substituting Eq. (1) into Eqs. (3) and (4), we rewrite the profits as the functions of quantities:

$$\Pi = (a - b(q_R + \theta q_D) - w)q_R, \tag{5}$$

$$\pi = wq_R + (a - c - b(q_D + \theta q_R))q_D. \tag{6}$$

Meanwhile, we can solve the inverse demand functions of Eq. (1) for quantities to derive the following demand functions:

$$\begin{aligned} q_R &= ((1-\theta)a - p_R + \theta p_D)/\left(b\left(1-\theta^2\right)\right), \\ q_D &= ((1-\theta)a - p_D + \theta p_R)/\left(b\left(1-\theta^2\right)\right). \end{aligned} \tag{7}$$

Substituting Eq. (7) into Eqs. (3) and (4), we restate the profits of the retailer and manufacturer as the functions of prices instead of quantities:

$$\Pi = (p_R - w)((1-\theta)a - p_R + \theta p_D)/\left(b\left(1-\theta^2\right)\right), \tag{8}$$

$$\begin{aligned} \pi = &\, w((1-\theta)a - p_R + \theta p_D)/\left(b\left(1-\theta^2\right)\right) \\ &+ (p_D - c)((1-\theta)a - p_D + \theta p_R)/\left(b\left(1-\theta^2\right)\right). \end{aligned} \tag{9}$$

Using the system above, we consider the following two types of games classified by how the wholesale price, w, is determined. In the first game, which we henceforth call the *manufacturer Stackelberg game*, the manufacturer unilaterally determines the wholesale price and imposes this price on the retailer. In this game, we consider two scenarios classified by which control variable is determined at the retail market level, namely, a *price-setting scenario* and a *quantity-setting scenario*. In the price-setting scenario in the manufacturer Stackelberg game, the timeline of events is that first, the manufacturer makes a decision on its wholesale price (w) and direct price (p_D), and second, the retailer makes its decision on its retail price (p_R). Meanwhile, the manufacturer first sets w and the quantity sold in the direct channel (q_D) and the retailer second sets its quantity sold in the retail channel (q_R) in the quantity-setting scenario.

In the second game considered, which we refer to as the *bargaining game*, the retailer and the manufacturer bargain over the wholesale price. In this game, we formulate the negotiation process as Nash bargaining, following many of the previous studies on dual-channel supply chain management (e.g., Modak & Kelle, 2019; Qing et al., 2017; Yang et al., 2018).[6] In general, two possible negotiation results should be considered in Nash bargaining. The first result in our context is that an agreement is reached by the retailer and the manufacturer that the manufacturer distributes products through the retailer. In contrast, the second result is that

[2] The reason that the assumption of $a > c$ is necessary is explained as follows. Specifically, this assumption means that the intercept (a) in the vertical axis of the inverse demand function is higher than the marginal selling cost through the direct channel (c). In other words, a represents the highest price at which a consumer who most values the product is willing to buy it. Therefore, our dual-channel model would become meaningless if $a > c$ were not satisfied because the consumer's highest evaluation price of the product would be lower than the marginal cost, which means that no consumer would buy the product at a price higher than the marginal cost, and hence the manufacturer would be unable to earn a positive profit by selling the product via the direct channel. Indeed, reflecting this, the model of Yang et al. (2018) also assumes $c \in (0, a)$. We follow their model in employing the assumption that $0 < c < a$.

[3] We obtain the linear-form inverse demand function of Equation (1) by specifying the consumer's utility function as $U = a(q_R + q_D) - b({q_R}^2 + {q_D}^2 + 2\theta q_R q_D)/2$. Based on this utility function, consumer surplus signified by S is described as $S = U - (p_R q_R + p_D q_D) = a(q_R + q_D) - b({q_R}^2 + {q_D}^2 + 2\theta q_R q_D)/2 - (p_R q_R + p_D q_D)$. The consumer solves $\partial S/\partial q_R = \partial S/\partial q_D = 0$ to maximize S, yielding Equation (1). Refer to Ingene and Parry (2004, pp. 491–495) for more details on this demand system and its application to distribution management issues. Following their study, a number of dual-channel models assume similar linear-form demand functions (e.g., Cai, 2010; Wei et al., 2020; Zhang et al., 2020).

[4] If inequality (2) were not met, in equilibrium the manufacturer would sell its products through only the retail channel so as to achieve a larger profit even in the Stackelberg and vertical Nash games without bargaining, meaning that our model involving a dual-channel would become meaningless. Indeed, if $a/c > (3-\theta^2)/((1-\theta)(3+\theta))$ is met, then q_D as well as q_R are positive in equilibrium in all the Stackelberg and vertical Nash games mentioned below.

[5] While w represents the wholesale price, this variable is also interpreted as the purchase price from the retailer's perspective. Hence, the wholesale price and the purchase price have the same meaning throughout this paper.

[6] While the solution of Nash bargaining was originally devised in the field of cooperative game theory, this solution can be construed as subgame perfect Nash equilibrium resulting from sequential decision-making by players on how to distribute a constant payoff in a noncooperative game. Hence, we can translate the Nash bargaining solution regarding the wholesale price in the present study into the equilibrium arising in a noncooperative game, in which both retailer and manufacturer determine their optimal strategies concerning the wholesale price.

the agreement is not reached that the manufacturer sells through the retailer. Accordingly, we define $\bar{\Pi}$ and $\bar{\pi}$ respectively, as the retailer's and manufacturer's disagreement points, which are the profits in breakdown of the negotiation. The objective function denoted by Ω that is maximized in the bargaining is specified as:

$$\Omega = \left(\Pi - \bar{\Pi}\right)^{\gamma} (\pi - \bar{\pi})^{1-\gamma}. \tag{10}$$

Eq. (10) signifies the Nash product, which is used as the objective in Nash bargaining (e.g., Nash, 1950). γ represents a retailer's bargaining power, which satisfies $0 < \gamma < 1$. Because we may regard γ and $1 - \gamma$ as the retailer's and manufacturer's relative bargaining power, respectively, the retailer is more powerful, whereas the manufacturer is less powerful as γ rises, and vice versa. Note that $\bar{\Pi} = 0$ holds in all models below because the retailer has no alternative opportunity to sell products if the negotiation breaks down. The wholesale price, w, is determined at the level that maximizes Eq. (10) in the bargaining game.

In the bargaining game, we again consider the two scenarios of price- and quantity-setting that we considered for the manufacturer Stackelberg game. Similar to the manufacturer Stackelberg game, w and p_D are decided first and p_R is decided second in the price-setting scenario, whereas w and q_D are decided first and q_R is decided second in the quantity-setting scenario. Therefore, the retailer makes its decision on p_R or q_R and resells the product only after observing the wholesale price, w, in both games. That is, the manufacturer makes its decision first, followed by the retailer, which is a standard assumption in previous models describing dual-channel supply chains (e.g., Cai, 2010; Li et al., 2019a).

Next, we explain why we consider both quantity- and price-setting scenarios. In the literature, there exist two types of dual-channel supply chain models, in which the decision variable is either price or quantity. For example, dual-channel supply chain models developed in Cai (2010), Chiang et al. (2003), Matsui (2017), and Lee, Chang, Jean and Kuo (2021) assume that the decision variable is price. Meanwhile, dual-channel models in Li et al. (2014), Li et al. (2019b), Yang et al. (2018), and Hamamura & Zennyo (2021) assume that the decision variable is quantity. Moreover, from an empirical perspective, Cabral (2000, p. 113) states that the price-setting scenario is appropriate to describe competition in industries in which capacity and output can be easily adjusted, such as software and insurance. He also states that the quantity-setting scenario is more appropriate to describe competition in industries in which it is difficult to adjust capacity and output, such as automobiles and computers. Cabral's explanation suggests that a book publisher such as Hachette, mentioned in Section 1, is more likely to fit the price-setting scenario because e-books are less subject to capacity constraints and, hence, their output can be adjusted easily. Meanwhile, the quantity-setting scenario is more appropriate for Nike because, as an apparel product manufacturing company, it is more likely to be subject to capacity constraints and find it difficult to adjust its output. For these reasons, from both theoretical and empirical perspectives, we will demonstrate that the main results of this paper hold in both price- and quantity-setting scenarios, thus linking our paper to the literature and practical experience.

4. Preliminary result: single-channel supply chain

Before analyzing the main model of a dual-channel supply chain, we temporarily assume that the manufacturer has no direct channel and, thus, is able to sell products only via the retailer. This situation is considered as typical of the era in which only the traditional brick-and-mortal store channel existed, when e-commerce technology had not been developed and the Internet was not prevalent in general households. Fig. 1 can describe this situation if the direct channel is removed from the figure.

To investigate this situation as the benchmark, we substitute $q_D = 0$ into Eq. (1), obtaining:

$$p_R = a - bq_R. \tag{11}$$

Solving Eq. (11) for q_R derives the following demand function:

$$q_R = (a - p_R)/b. \tag{12}$$

Using Eqs. (11) and (12), we restate the profits of the retailer and the manufacturer in this single-channel model as the functions of quantities:

$$\Pi = (a - bq_R - w)q_R, \tag{13}$$

$$\pi = wq_R, \tag{14}$$

or the functions of prices:

$$\Pi = (p_R - w)(a - p_R)/b, \tag{15}$$

$$\pi = w(a - p_R)/b. \tag{16}$$

4.1. Manufacturer Stackelberg game

We first consider the manufacturer Stackelberg game in the single-channel supply chain model, in which first, the manufacturer determines w and second, the retailer determines p_R or q_R.[7] The following proposition summarizes the equilibrium results. (All proofs are in Appendix B uploaded as supplementary material on the web.)

Proposition 1. *The retailer's and manufacturer's equilibrium profits in the manufacturer Stackelberg game of the single-channel model (Π^{MS} and π^{MS}) are:*

$$\Pi^{MS} = \frac{a^2}{16b}, \qquad \pi^{MS} = \frac{a^2}{8b}.$$

4.2. Bargaining game

Next, we consider the bargaining game. Note that in the single-channel model, $\bar{\pi} = 0$ holds in Eq. (10) because the manufacturer has no alternative channel to sell products to consumers if the negotiation with the retailer breaks down. The equilibrium profits resulting from the bargaining game are summarized in the following proposition.

Proposition 2. *The retailer's and manufacturer's equilibrium profits in the bargaining game of the single-channel scenario (Π^{B} and π^{B}) are:*

$$\Pi^{B} = \frac{(1+\gamma)^2 a^2}{16b}, \qquad \pi^{B} = \frac{(1-\gamma)(1+\gamma)a^2}{8b}.$$

4.3. Implications

By comparing the equilibrium profits resulting from the two games, we obtain the following theorem showing which game is more advantageous for the retailer and the manufacturer in the preliminary single-channel model.

Theorem 1. *The following inequalities hold in the single-channel supply chain model:*

$$\Pi^{B} > \Pi^{MS}, \ \pi^{MS} > \pi^{B}.$$

[7] In the single-channel supply chain model established in this section, the analytical results derived are the same between the price- and quantity-setting scenarios, as shown in each proof in the Appendix. We distinguish between the two scenarios in the dual-channel supply chain model shown in the next section because they lead to different equilibrium profits.

Theorem 1 shows that the bargaining game always earns the retailer a higher profit than the manufacturer Stackelberg game in the single-channel model. This result is consistent with intuition because the Nash bargaining allows the retailer to influence the wholesale price to yield an advantageous price that improves its profits. Therefore, the managerial implication of the theorem is that the retailer should always bargain over the wholesale price in the traditional single-channel supply chain rather than simply accept the price unilaterally determined by the manufacturer.

Theorem 1 gives the following supplementary corollary.

Corollary 1. *$\partial(\Pi^{B} - \Pi^{MS})/\partial\gamma > 0$ and $\partial(\pi^{B} - \pi^{MS})/\partial\gamma < 0$ hold.*

Corollary 1 suggests that when the retailer's power is stronger, it will achieve a higher profit in the bargaining game than in the manufacturer Stackelberg game in the single-channel model. This result is intuitive because, in the bargaining game, stronger bargaining power enables the retailer to take a greater share of the profit realized in the retail channel. Hence, the greater the retailer's bargaining power, the stronger is its incentive to play the bargaining game rather than the manufacturer Stackelberg game.

However, this preliminary result, indicating the absolute advantage of the bargaining game relative to the manufacturer Stackelberg game for the retailer in a single-channel supply chain environment, is completely reversed in a dual-channel supply chain environment, as will be proven in the next section.

5. Main result: dual-channel supply chain

In this section, we proceed to consider the dual-channel supply chain environment, which is the main subject of this paper. To facilitate the interpretation of the results, we focus on analyzing the price-setting scenario in the main text. For the results derived from the quantity-setting scenario, see Appendix A, which proves that all central results shown in the price-setting scenario continue to hold.

5.1. Manufacturer Stackelberg game

The following proposition shows the equilibrium result in the manufacturer Stackelberg game.

Proposition 3. *The retailer's and manufacturer's equilibrium profits in the manufacturer Stackelberg game in the price-setting scenario of the dual-channel model (Π^{MS} and π^{MS}) are:*

$$\Pi^{MS} = \frac{((1-\theta)a+\theta c)^2}{16b(1-\theta^2)},\ \pi^{MS} = \frac{(a-c)^2}{4b} + \frac{((1-\theta)a+\theta c)^2}{8b(1-\theta^2)}.$$

5.2. Bargaining game

The equilibrium results from the bargaining game are summarized in the following proposition.

Proposition 4. *The retailer's and manufacturer's equilibrium profits in the bargaining game in the price-setting scenario of the dual-channel model (Π^{B} and π^{B}) are as follows.*

(i) When $\gamma < \sqrt{2(1-\theta^2)/(2-\theta^2)}$,

$$\Pi^{B} = \frac{(1+\gamma)^2((1-\theta)a+\theta c)^2}{16b(1-\theta^2)},$$

$$\pi^{B} = \frac{(a-c)^2}{4b} + \frac{\left((1-\gamma)(1+\gamma)\left(2-\theta^2\right)-\theta^2\right)((1-\theta)a+\theta c)^2}{16b\left(1-\theta^2\right)^2}.$$

(ii) When $\gamma \geq \sqrt{2(1-\theta^2)/(2-\theta^2)}$,

$$\Pi^{B} = 0,\ \pi^{B} = \frac{(a-c)^2}{4b}.$$

Proposition 4 shows that the equilibrium profits resulting from the bargaining game in the dual-channel model depend on two parameters: the retailer's bargaining power (γ) and the channel substitutability (θ). The reason for this result is that if the retailer becomes so strong that its bargaining power exceeds the threshold of $\sqrt{2(1-\theta^2)/(2-\theta^2)}$, then the manufacturer achieves a higher profit by selling only in the direct channel, rather than in both retail and direct channels. In this case, the manufacturer will completely withdraw its products from the retail channel and devote itself to direct sales only, and the retailer's profits become zero.

5.3. Implications

Comparing the equilibrium profits resulting from the two games, we obtain the following theorem that determines the game that earns the retailer a higher profit in the dual-channel environment.

Theorem 2. *The following relationship holds in the price-setting scenario of the dual-channel supply chain model under the following condition:*

$$\Pi^{MS} \gtrless \Pi^{B} \qquad \text{if and only if } \gamma \gtrless \sqrt{2\left(1-\theta^2\right)/\left(2-\theta^2\right)}.$$

Theorem 2 is the central result of the present study. It indicates that when the retailer's bargaining power is relatively weak, such that γ is smaller than $\sqrt{2(1-\theta^2)/(2-\theta^2)}$, the retailer generates a higher profit in the bargaining game than in the manufacturer Stackelberg game.[8] In contrast, when the retailer's bargaining power is relatively strong, such that γ is larger than the specified threshold, the retailer's profit is higher in the manufacturer Stackelberg game than in the bargaining game. The latter result is a highly counterintuitive finding.[9]

As we summarized in Section 4 using a preliminary model of a single-channel supply chain, it is intuitive to infer that the retailer will achieve a larger profit by bargaining over the wholesale price rather than merely accepting it if γ is higher and its bargaining power is stronger. Indeed, for the single-channel case, Corollary 1 and Theorem 1 together suggest that the higher the value of γ, the higher is the retailer's profit in the bargaining game. Conversely, Theorem 2 shows that this intuition is not necessarily correct in the case of the dual-channel supply chain. The condition of the inequality that classifies the equilibrium cases in the theorem indicates that a threshold of γ exists above which the retailer generates a higher profit in the manufacturer Stackelberg game than that in the bargaining game.

To examine the central result in more detail, we explore under which environment the counterintuitive result in Theorem 2 arises. The next observation summarizes these results as useful managerial implications for a retailer.

Observation 1. *In the case of the dual-channel supply chain, there is an increased possibility that the retailer will achieve a higher profit in the manufacturer Stackelberg game than in the bargaining game particularly when: (i) γ is high and the retailer's bargaining power is substantial; and (ii) θ is high and consumers perceive that the two different channels are relatively substitutable.*

[8] Note that in our model γ is defined in the range of $0 < \gamma < 1$. If γ were allowed to equal to 0, $\Pi^{MS} = \Pi^{B}$ and $\pi^{MS} = \pi^{B}$ would hold shown in Propositions 3 and 4. Indeed, substituting $\gamma = 0$ into Π^{B} and π^{B} in Proposition 4 coincides with Π^{MS} and π^{MS} shown in Proposition 3.

[9] This result means that the retailer achieves a higher profit by exerting no bargaining power at all and simply accepting the wholesale price unilaterally dictated by the manufacturer without resistance (i.e., the manufacturer Stackelberg game) compared with exerting its bargaining power over the manufacturer to demand that it lowers the wholesale price (i.e., the bargaining game). In this sense, this result is counterintuitive.

This observation enables us to conclude that when conditions (i) and (ii) hold, the retailer is better off not bargaining but simply accepting the wholesale price unilaterally set by the manufacturer. An especially striking managerial implication in the observation arises from point (i). In general, a retailer has more incentive to bargain over the wholesale price if its bargaining power is stronger. However, the observation suggests the contrary; the retailer should be aware that its profits will fall if it bargains over the wholesale price when its bargaining power is relatively strong.

Below, we lay out the logic behind this counterintuitive result. Overall, we note that there are both upsides and downsides for a manufacturer in a dual-channel supply chain when selling its products in the retail channel. Obviously, the upside is that the manufacturer expands its sales opportunities as a result of deriving demand in both channels, thereby enhancing its profitability. The downside is the problem of channel conflict; that is, direct sales reduce the volume sold through the retail channel because a portion of consumers who would have purchased from the retail channel in the absence of a direct channel, shift their demand and purchases to the direct channel.

Channel conflict becomes a more significant problem when consumers perceive that there is high substitutability between the direct and retail channels. If the two channels are more substitutable, there is a greater reduction in sales from the retail channel in response to consumers shifting to the direct channel. Moreover, consumers are more sensitive to price differences between the channels if the channel substitutability is higher and the intensification of price competition places substantial downward pressure on retail prices. Furthermore, when the downstream retailer's bargaining power is strong, a larger portion of the surplus generated in the indirect retail channel will be extracted by the retailer even if the manufacturer sells products through the retail channel. In this case, the manufacturer is unable to achieve high profits if it is using both channels. If the channel conflict becomes too significant, the manufacturer has an incentive to stop selling products in the retail channel, which deprives the retailer of the opportunity to sell the products. Therefore, the best strategy for the retailer, if its bargaining power is strong or if channel substitutability is high, is to accept the wholesale price set by the manufacturer. The retailer should not attempt to bargain over the price with the manufacturer if it intends to avoid the future scenario of the manufacturer removing its products from the retail sales channel.

In contrast, if consumers perceive that the two channels are more differentiated, the two markets are more independent and channel conflict is less likely to occur. In this situation, even if sales volume in the retail channel is high, this will barely reduce sales in the direct channel, and it remains advantageous to the manufacturer to preserve the sales opportunities in the retail channel. Accordingly, the retailer can safely bargain over the price with the manufacturer because there is a lower risk of the manufacturer ceasing retail channel sales. In summary, the managerial implication is that when the bargaining power of the retailer is excessively strong or when channel substitutability is very high, the retailer should be aware that it may disadvantage itself by bargaining over the wholesale price because of the risk that the manufacturer will stop selling products in the retail channel.

Finally, we provide the following additional implication that provides useful practical insights for managerial decision-making by a retailer. Theorem 2 indicates that the key factors affecting whether the bargaining game or the manufacturer Stackelberg game is more advantageous for the retailer are: (i) the retailer's bargaining power (γ); and (ii) the degree of channel substitutability (θ). Thus, other firm factors such as potential demand (a) and costs (c) have no influence on which game is more advantageous. Therefore, the retailer has only to pay attention to γ and θ and may ignore all other factors in determining whether to bargain with the manufacturer.

6. Supply chain coordination

In the next three sections, we extend the main model to demonstrate that it can describe more general real-life supply chain environments. An important previous study related to this paper by Baron et al. (2016) considers coordination of a supply chain involving Nash bargaining between a retailer and a manufacturer. Specifically, they use the term supply chain coordination to refer to the maximization of the total supply chain profit. Then, they define the bargaining power that maximizes the total profit in the entire chain as *efficient bargaining power*. In this section, following Baron et al. (2016), we derive the level of efficient bargaining power that achieves supply chain coordination, under which the total profit of the whole channel is maximized. The next proposition shows the level of efficient bargaining power and the resulting total profit.[10]

Proposition 5. *In the price-setting scenario of the Nash bargaining game, the efficient level of the retailer's bargaining power (γ^C) and the corresponding total supply chain profit ($(\Pi+\pi)^C$) maximized with γ^C are as follows:*

$$(\Pi+\pi)^C = \frac{(a-c)^2}{4b} + \frac{\left(4-\theta^2\right)((1-\theta)a+\theta c)^2}{16b\left(1-\theta^2\right)} \text{when } \gamma^C = 1-\theta^2$$

To achieve the supply chain coordination result shown in Proposition 5, both retailer and manufacturer must have an ex ante incentive to agree to adjusting the bargaining power (γ) to the efficient level of γ^C shown in the proposition because our main model considers γ to be an exogenous parameter, but not an endogenous decision variable. Accordingly, we consider the following profit-sharing contract as a real-life coordination mechanism that can provide the retailer and manufacturer with such an incentive.[11] Specifically, we assume that if the retailer and the manufacturer sign the profit-sharing contract ex ante, the portions ϕ and $1-\phi$ of the total supply chain profit finally attained will be distributed to the retailer and the manufacturer, respectively. At the same time, the contract stipulates that the two firms must mutually adjust the bargaining power to the efficient level of γ^C shown in Proposition 5. We investigate whether the retailer and manufacturer prefer this coordination contract, summarizing the result in the following theorem.

Theorem 3. *If the following conditions are met, both retailer and manufacturer earn higher profits by signing the coordination contract under which the bargaining power is ex ante adjusted to the efficient level (γ^C) and total profit is shared, than by playing the bargaining game in the price-setting scenario. Thus, both parties prefer the coordination contract to bargaining without the contract:*

$$\frac{(1+\gamma)^2((1-\theta)a+\theta c)^2}{(1-\theta)\left(8-\theta^2+\theta^3\right)a^2-2(1-\theta)\left(4+\theta^3\right)ac+\left(4-\theta^4\right)c^2} < \phi$$

$$< \frac{\left(2-\theta^2\right)\left(1+\gamma^2-\theta^2\right)((1-\theta)a+\theta c)^2}{\left(1-\theta^2\right)\left((1-\theta)\left(8-\theta^2+\theta^3\right)a^2-2(1-\theta)\left(4+\theta^3\right)ac+\left(4-\theta^4\right)c^2\right)}.$$

[10] Because we consider a feasible contract for coordination of the whole supply chain later in this section, we assume that the manufacturer always sells through the retail channel as well as the direct channel if signing the contract.

[11] We focus on the profit-sharing contract as a real-life means for coordination because it is sufficient to show the existence of only one contract that can coordinate the supply chain and enable the two firms to avoid pure bargaining over the wholesale price without coordination. Coordination may be also achieved with other types of contracts, such as a revenue-sharing contract.

The inequalities in Theorem 3 represent the conditions under which both retailer and manufacturer participate in this profit-sharing contract and coordinate the supply chain, which are also referred to as the individual rationality (IR) constraints in the context of the supply chain contract. Therefore, Theorem 3 is derived from the IR constraints. Specifically, the theorem suggests that if ϕ takes an intermediate value so that the inequality is satisfied, then both the retailer and the manufacturer have an incentive to sign the coordination contract because each of the two firms makes a larger profit by entering into the contract compared with bargaining without the contract. As ϕ increases within the range where the condition is satisfied, the retailer's share of the total profit becomes larger, and hence the contract is more advantageous to the retailer. Similarly, the smaller the value of ϕ, the larger the profit that the manufacturer can earn by entering into the coordination contract. Consequently, if the option of such a profit-sharing contract is available to the retailer, the retailer should conclude the contract in advance as long as the inequality in Theorem 3 is satisfied.

Whereas we propose a way of achieving supply chain coordination by adjusting bargaining power, in reality it may not be easy to adjust bargaining power because it is related to company size and market position. If the supply chain members fail to adjust their bargaining power, then vertical integration is an effective way to achieve coordination, particularly because our model simply assumes the existence of only one dual-channel supply chain and hence does not consider competition between two or more dual-channel supply chains. Vertical integration first eliminates the double marginalization arising in the retail channel and then enables the supply chain to choose desirable channel(s) to use for the purpose of total optimization in the whole chain. The resulting profit obtained after coordination through vertical integration is divided between the manufacturer and the retailer according to their bargaining power. Due to the assumption of only one dual-channel supply chain, vertical integration enables the supply chain members to coordinate the whole chain in this way.[12]

7. Multiple supply chains

In this section, we consider the existence of multiple supply chains because it is common for a real-world manufacturer to sell products to multiple retailers when using a retail channel. Following Guo & Iyer (2013), who construct a stylized model of multilateral bargaining between a manufacturer and two retailers, we assume that there are two retailers, retailer 1 and retailer 2, which bargain over their wholesale prices with a manufacturer, as illustrated in Fig. 2. Accordingly, we modify the inverse demand functions of Eq. (1) as follows to include the two retailers in the extended model:

$$\begin{aligned} p_{Ri} &= a - b\left(q_{Ri} + tq_{Rj} + \theta q_D\right), \qquad (i, j) = (1,2), (2,1) \\ p_D &= a - b(q_D + \theta q_{R1} + \theta q_{R2}), \end{aligned} \tag{17}$$

where p_{Ri} and q_{Ri} denote the retail price and demand quantity that retailer i faces ($i = 1, 2$).[13] t represents the channel substitutability between the two retailers within the retail channel. Because the channel substitutability between the two retailers belonging to the same channel is usually different from the channel substitutability between the two different channels, we introduce this new parameter t in the extended model involving the existence of two retailers.

The profit functions of retailer i and the manufacturer are restated as follows:

$$\Pi_i = (p_{Ri} - w_i)q_{Ri} \qquad (i = 1, 2) \tag{18}$$

$$\pi = w_1 q_{R1} + w_2 q_{R2} + (p_D - c)q_D \tag{19}$$

Additionally, the Nash product between retailer i and the manufacturer denoted by Ω_i is stated as:

$$\Omega_i = \left(\Pi_i - \bar{\Pi}_i\right)^{\gamma} (\pi - \bar{\pi})^{1-\gamma}. \tag{20}$$

The following proposition shows the results of the manufacturer Stackelberg game.

Proposition 6. *The retailer's and manufacturer's equilibrium profits in the manufacturer Stackelberg game of the price-setting scenario in the dual-channel model with two retailers (Π_i^{MS} and π^{MS}, i = 1, 2) are as follows:*

$$\Pi_i^{MS} = \frac{(1-t)\left(1-\theta^2\right)((1-\theta)a+\theta c)^2}{4b\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)^2},$$

$$\pi^{MS} = \frac{(a-c)^2}{4b} + \frac{\left(1-\theta^2\right)((1-\theta)a+\theta c)^2}{2b\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)}.$$

Next, the following proposition shows the equilibrium in the bargaining game involving two retailers.

Proposition 7. *The retailer's and manufacturer's equilibrium profits in the bargaining game of the price-setting scenario of the dual-channel model with two retailers (Π_i^B and π^B, i = 1, 2) are as follows:*

When

$$\begin{aligned} \gamma < \Big(&(1-t)\left(2+t-3\theta^2\right)\left(1+t-2\theta^2\right)^2\left(2-t-\theta^2\right)^2 \\ &+ 2\sqrt{\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)\left(2+t-t^2-\theta^2(3-t)\right)} \\ &\times \sqrt{\left((1-t)\left(2+t-3\theta^2\right)\left(2-t^2-\theta^2\left(4-2t-\theta^2\right)\right)\right)^2}\Big) \\ &/\big(24 - 3t^6 - 116\theta^2 + 178\theta^4 - 59\theta^6 - 70\theta^8 + 48\theta^{10} - 8\theta^{12} \\ &+ t^5\left(1+17\theta^2\right) + 3t^4\left(7-13\theta^2-9\theta^4\right) \\ &- t^3\left(5+69\theta^2-131\theta^4-3\theta^6\right) \\ &- t^2\left(42-151\theta^2+75\theta^4+97\theta^6-18\theta^8\right) \\ &+ t(4+64\theta^2-247\theta^4+233\theta^6-28\theta^8-8\theta^{10})\big), \end{aligned}$$

$$\begin{aligned} \Pi_i^B = &(1-t)\left(1-\theta^2\right)((1-\theta)a+\theta c)^2 \\ &\times \left((1-t)\left(2+t-3\theta^2\right) + \gamma\left(6+t-3t^2-13\theta^2+5t\theta^2+4\theta^4\right)\right)^2 \\ &/\Big(4b\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)^2 \\ &\times \left((1-t)\left(2+t-3\theta^2\right)+\gamma\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)\right)^2\Big) \end{aligned}$$

$$\begin{aligned} \pi^B = &(a-c)^2/(4b) + \left(1-\theta^2\right)((1-\theta)a+\theta c)^2 \\ &\times \left((1-t)^2\left(2+t-3\theta^2\right)^2\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)\right. \\ &+ \gamma^2\left(-24+3t^6+116\theta^2-178\theta^4+59\theta^6+70\theta^8-48\theta^{10}+8\theta^{12}\right. \\ &- t^5\left(1+17\theta^2\right) + 3t^4\left(-7+13\theta^2+9\theta^4\right) + t^3\left(5+69\theta^2-131\theta^4-3\theta^6\right) \\ &+ t^2\left(42-151\theta^2+75\theta^4+97\theta^6-18\theta^8\right) \end{aligned}$$

[12] This vertical integration solution for supply chain coordination was suggested by McGuire and Staelin's (1983) earlier supply chain competition model, to which Barron et al. (2016) also refer.

[13] We focus on the symmetric equilibrium between the two retailers in this section. Because the main purpose of this paper is to show the existence of environments in which the retailer earns a higher profit by simply accepting a wholesale price than by bargaining, showing the existence of only one equilibrium is sufficient to achieve this purpose.

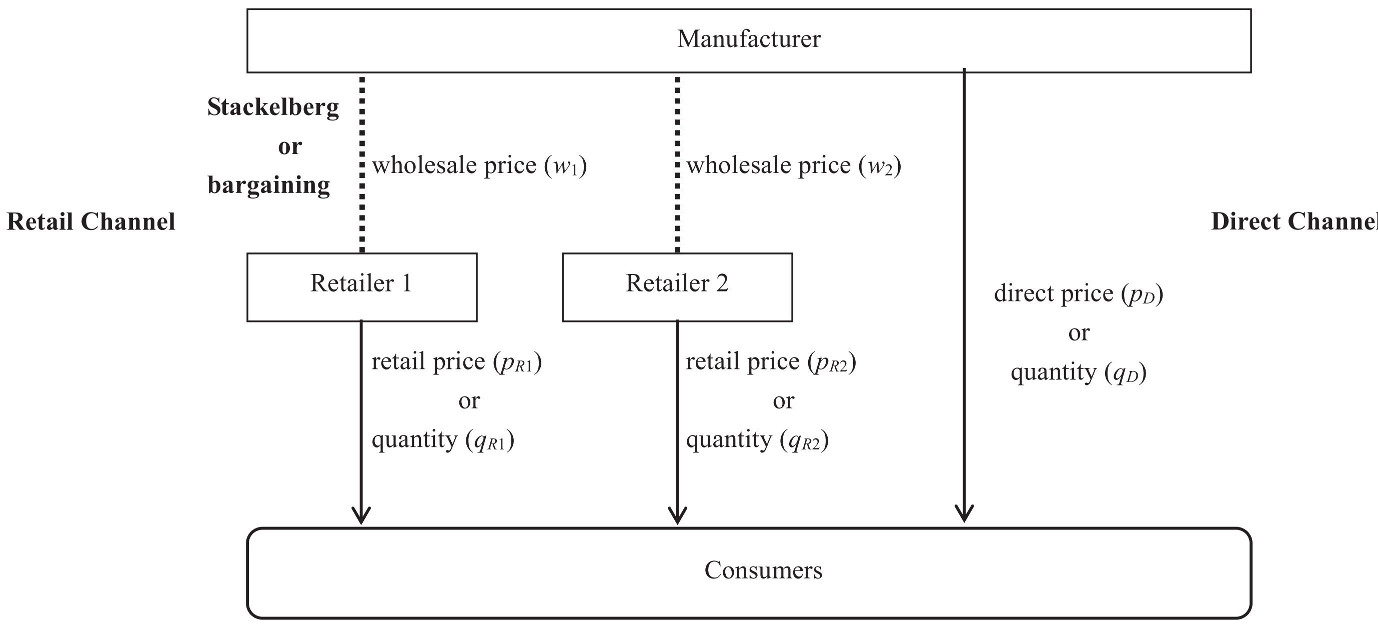

Fig. 2. Dual-channel supply chain structure with multiple retailers.

$$
\begin{aligned}
&+t\left(-4-64\theta^2+247\theta^4-233\theta^6+28\theta^8+8\theta^{10}\right)\big)\\
&+2\gamma(1-t)\left(2+t-3\theta^2\right)\left(1+t-2\theta^2\right)^2\left(2-t-\theta^2\right)^2\Big)\\
&/\Big(2b\left(1+t-2\theta^2\right)^2\left(2-t-\theta^2\right)^2\\
&\times\left((1-t)\left(2+t-3\theta^2\right)+\gamma\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)\right)^2\Big)
\end{aligned}
$$

When

$$
\begin{aligned}
\gamma \geq &\Big((1-t)\left(2+t-3\theta^2\right)\left(1+t-2\theta^2\right)^2\left(2-t-\theta^2\right)^2\\
&+2\sqrt{(1+t-2\theta^2)(2-t-\theta^2)(2+t-t^2-\theta^2(3-t))}\\
&\times\sqrt{((1-t)(2+t-3\theta^2)(2-t^2-\theta^2(4-2t-\theta^2)))^2}\Big)\\
&/\Big(24-3t^6-116\theta^2+178\theta^4-59\theta^6-70\theta^8+48\theta^{10}-8\theta^{12}\\
&+t^5\left(1+17\theta^2\right)+3t^4\left(7-13\theta^2-9\theta^4\right)\\
&-t^3\left(5+69\theta^2-131\theta^4-3\theta^6\right)\\
&-t^2\left(42-151\theta^2+75\theta^4+97\theta^6-18\theta^8\right)\\
&+t\left(4+64\theta^2-247\theta^4+233\theta^6-28\theta^8-8\theta^{10}\right)\Big),
\end{aligned}
$$

$$\Pi_i^{B}=0,\ \pi^{B}=\frac{(a-c)^2}{4b}.$$

Comparing the equilibrium profits in Propositions 6 and 7, we obtain the following theorem.

Theorem 4. *The following relationship holds in the price-setting scenario when there exist two retailers:*

$\Pi_i^{MS} \gtrless \Pi_i^{B}$ if and only if

$$
\begin{aligned}
\gamma \gtrless &\Big((1-t)\left(2+t-3\theta^2\right)\left(1+t-2\theta^2\right)^2\left(2-t-\theta^2\right)^2\\
&+2\sqrt{\left(1+t-2\theta^2\right)\left(2-t-\theta^2\right)\left(2+t-t^2-\theta^2(3-t)\right)}\\
&\times\sqrt{\left((1-t)\left(2+t-3\theta^2\right)\left(2-t^2-\theta^2\left(4-2t-\theta^2\right)\right)\right)^2}\Big)\\
&/\Big(24-3t^6-116\theta^2+178\theta^4-59\theta^6-70\theta^8+48\theta^{10}-8\theta^{12}\\
&+t^5\left(1+17\theta^2\right)+3t^4\left(7-13\theta^2-9\theta^4\right)\\
&-t^3\left(5+69\theta^2-131\theta^4-3\theta^6\right)\\
&-t^2\left(42-151\theta^2+75\theta^4+97\theta^6-18\theta^8\right)\\
&+t\left(4+64\theta^2-247\theta^4+233\theta^6-28\theta^8-8\theta^{10}\right)\Big).
\end{aligned}
$$

Theorem 4 proves that the central result of this paper holds even if multiple rather than single chains exist. That is, as long as γ exceeds a threshold, a retailer generates a higher profit by simply accepting the wholesale price than by bargaining over it, similar to the main model in Section 5.

To interpret the analytical results in Theorem 4, we investigate the impact of channel substitutability between retailers within the retail channel (t) and the impact of channel substitutability between retail and direct channels (θ) on the decisions of the manufacturer and the retailer. Specifically, we examine how the threshold of γ, shown on the left-hand side of the inequality in Theorem 4, depends on t and θ, included on the right-hand side. We do this because the inequality determines the threshold of γ that identifies whether the Stackelberg game or the bargaining game is more profitable and therefore affects the decisions of the manufacturer and the two retailers. Because this inequality is a complex polynomial with respect to t and θ, determining their impacts on the threshold of γ analytically is difficult. Fortunately, because there are only three parameters of t, θ, and γ included in the inequality, we can clearly see how t and θ affect the threshold of γ by drawing the inequality on a three-dimensional graph with t as the vertical axis, θ as the horizontal axis, and γ as the height axis. Fig. 3 illustrates this three-dimensional graph. Note that the lower the point on the surface is, the wider is the range of values of γ that make the Stackelberg game more profitable to the retailer than the bargaining game.

First, we examine how θ affects the threshold of γ. We find that the threshold of γ is always monotonically decreasing in θ under the fixed value of t, as shown in Fig. 3.[14] This result on the

[14] To check this monotonicity closely, we draw two-dimensional graphs in which θ and γ are shown on the horizontal and vertical axes, respectively, while setting

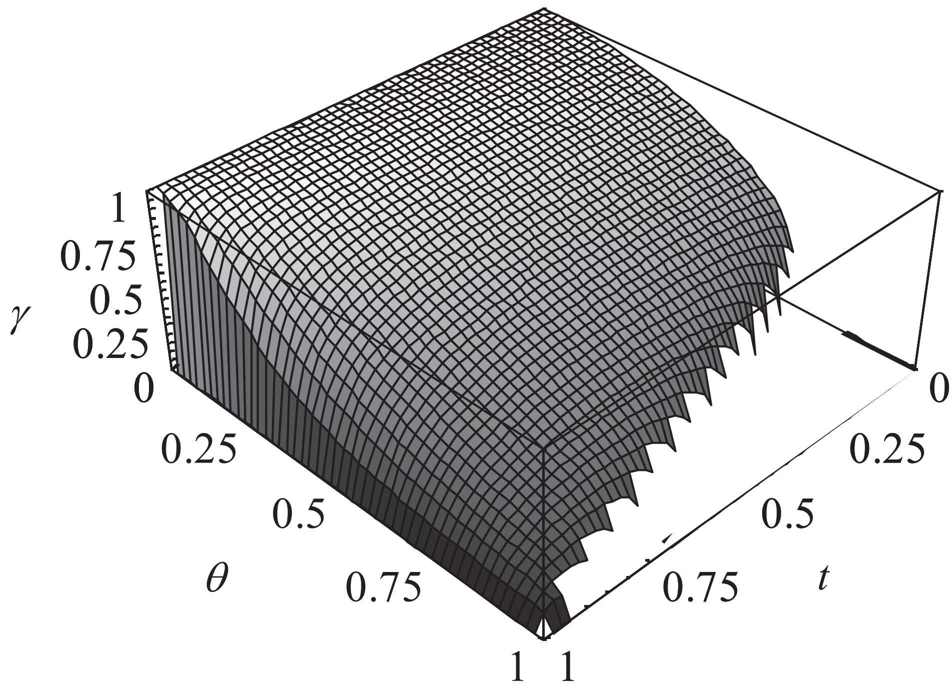

Fig. 3. Threshold of γ determining whether the bargaining game or the Stackelberg game is more profitable to the retailer given θ and t
Note: The curved surface is drawn based on the inequality of the relationship between t, θ, and γ as shown in Theorem 4. Given the values of t and θ, if the value of γ is above the surface, the retailer earns a higher profit by not bargaining and playing the Stackelberg game instead. In contrast, if the value of γ is below the surface, the retailer obtains a higher profit by bargaining.

effect of θ on γ is exactly the same as in the case of the basic model with only one retailer in Section 5. That is, as θ increases, the direct and retail channels become more competitive and the profit of the manufacturer using both channels decreases. Therefore, there is an increased incentive for the manufacturer to pull out from the retail channel in the bargaining game. As a result, the retailer obtains a higher profit in the Stackelberg game than in the bargaining game as θ becomes higher. Second, we examine how t affects the threshold of γ. We find that its influence is not always monotonic, as shown in Fig. 3. Specifically, given a fixed value of θ, the threshold of γ decreases in t when t is relatively large. However, when t is relatively small, the threshold of γ increases in t. This impact of t on the threshold of γ is explained by the following two trade-off effects arising from the increase in t. As t increases, first, competition between the two retailers intensifies, which reduces the margin extraction by the retailer and consequently reduces the manufacturer's incentive to pull out from the retail channel. Second, as t increases and competition in the retail channel becomes more intense, the efficiency in the retail channel relative to the direct channel improves, which increases the total retail channel profit earned by the two retailers in symmetric equilibrium relative to the manufacturer's profit in the direct channel. This increases the manufacturer's incentive to pull out from the retail channel. Because of the combination of these two opposing effects, the threshold of γ is neither monotonically increasing nor decreasing in t.

8. Alternative power structure

As a final extension of the main model, we consider a different decision sequence of the retailer and manufacturer because the structure of a game describing supply chain competition usually involves a decision sequence of supply chain members, often called a *power structure*. Specifically, while we consider the manufacturer Stackelberg game as our main model in Section 5, in this section, we consider two other power structures frequently considered in the literature, a *retailer Stackelberg game* and a *vertical Nash game* (e.g., see Cai et al., 2009; Liu & Ke, 2020). In practice, by using a so-called agency contract, the platform company Amazon can virtually determine its margin before upstream suppliers determine margins or prices (Chen, Zhao, Yan & Zhou, 2021; Yu, Sun & Guo, 2020). The issue of different power structures between a manufacturer and a retailer is particularly important today, as reflected in the discussion of real-life cases of Amazon's negotiations with Nike and Hachette in Section 1.

8.1. Retailer Stackelberg game

First, we consider the retailer Stackelberg game, summarizing the results in the next proposition.

Proposition 8. *The retailer's and manufacturer's equilibrium profits in the retailer Stackelberg game of the dual-channel model (Π^{RS} and π^{RS}) are:*

$$\Pi^{\mathrm{RS}} = \frac{((1-\theta)a+\theta c)^2}{8b\left(1-\theta^2\right)}, \pi^{\mathrm{RS}} = \frac{(a-c)^2}{4b} + \frac{((1-\theta)a+\theta c)^2}{16b\left(1-\theta^2\right)}.$$

Next, for the formulation of the Nash bargaining, we need to pay attention to the decision sequence. That is, because the retailer Stackelberg game is considered as the benchmark in this subsection, the retailer must first determine its margin before the other decision variables are determined in the bargaining game. Paying attention to this decision sequence, we derive the following proposition showing the bargaining result.

Proposition 9. *The retailer's and manufacturer's equilibrium profits in the bargaining game of the dual-channel model (Π^{B} and π^{B}) are as follows:*

fixed values of t, which varies from 0 to 1 in increments of 0.01. This confirms that the threshold of γ is monotonically decreasing with respect to θ in all the graphs.

(i) When $\gamma < 2(\sqrt{1-\theta^2}-1+\theta^2)/\theta^2$,

$$\Pi^{B} = \frac{((1-\theta)a+\theta c)^2}{4b(1-\theta^2)(2-\gamma)},\ \pi^{B} = \frac{(a-c)^2}{4b} + \frac{\left(4(1-\theta^2)(1-\gamma)-\theta^2\gamma^2\right)((1-\theta)a+\theta c)^2}{16b(1-\theta^2)^2(2-\gamma)^2}.$$

(ii) When $\gamma \geq 2(\sqrt{1-\theta^2}-1+\theta^2)/\theta^2$,

$$\Pi^{B} = 0,\ \pi^{B} = \frac{(a-c)^2}{4b}.$$

8.2. Vertical Nash game

In this section, we consider the vertical Nash game, in which all supply chain members determine their respective margins, which are their decision variables, completely simultaneously. More specifically, the manufacturer's margin in the retail channel (w) and the direct channel ($p_D - c$), as well as the retailer's margin ($p_R - w$), are all simultaneously determined in our model context. The results in the vertical Nash game are derived as follows.

Proposition 10. *The retailer's and manufacturer's equilibrium profits in the vertical Nash game of the dual-channel model (Π^{VN} and π^{VN}) are:*

$$\Pi^{VN} = \frac{((1-\theta)a+\theta c)^2}{9b(1-\theta^2)},\ \pi^{VN} = \frac{(a-c)^2}{4b} + \frac{((1-\theta)a+\theta c)^2}{9b(1-\theta^2)}.$$

Next, the following proposition shows the results from the Nash bargaining, in which the wholesale price and retailer's and manufacturer's margins are all simultaneously determined.

Proposition 11. *The retailer's and manufacturer's equilibrium profits in the bargaining game of the dual-channel model (Π^{B} and π^{B}) are as follows:*

(i) When $\gamma < 2(\sqrt{1-\theta^2}-1+\theta^2)/\theta^2$,

$$\Pi^{B} = \frac{((1-\theta)a+\theta c)^2}{b(1-\theta^2)(3-\gamma)^2},\ \pi^{B} = \frac{(a-c)^2}{4b} + \frac{\left(4(1-\theta^2)(1-\gamma)-\theta^2\gamma^2\right)((1-\theta)a+\theta c)^2}{4b(1+\theta)^2(1-\theta)^2(3-\gamma)^2}.$$

(ii) When $\gamma \geq 2(\sqrt{1-\theta^2}-1+\theta^2)/\theta^2$,

$$\Pi^{B} = 0, \pi^{B} = \frac{(a-c)^2}{4b}.$$

8.3. Implication

Comparing the results under the two power structures in this section, we arrive at the following theorem.

Theorem 5. *The following relationship holds in the dual-channel supply chain model under the two power structures of the retailer Stackelberg game and the vertical Nash game:*

$\Pi^{RS} \gtrless \Pi^{B}$ and $\Pi^{VN} \gtrless \Pi^{B}$ if and only if $\gamma \gtrless 2(\sqrt{1-\theta^2}-1+\theta^2)/\theta^2$.

Theorem 5 indicates that if the retailer's bargaining power exceeds the threshold of $2(\sqrt{1-\theta^2}-1+\theta^2)/\theta^2$, the retailer generates a higher profit by simply accepting the wholesale price rather than by bargaining over it. That is, the central result of this paper—the retailer should not bargain over the wholesale price in the dual-channel environment—continues to hold in the retailer Stackelberg and vertical Nash games, as well as in the manufacturer Stackelberg game.

Next, let us compare the thresholds of γ between different games shown in Theorems 2 and 5. We observe that the next inequality holds:[15]

$$2\left(\sqrt{1-\theta^2}-1+\theta^2\right)/\theta^2 - \sqrt{2\left(1-\theta^2\right)/\left(2-\theta^2\right)} > 0. \quad (21)$$

Inequality (21) suggests that the threshold for γ in the manufacturer Stackelberg game (Theorem 2) is lower than that in the retailer Stackelberg and vertical Nash games (Theorem 5). This threshold of γ represents the threshold above which the manufacturer withdraws products from the retail channel and devotes itself to direct sales only. Therefore, Inequality (21) indicates that the manufacturer stops selling products via the retail channel in a broader range of environments in the manufacturer Stackelberg game than in the retailer Stackelberg and vertical Nash games. Stated differently, in the manufacturer Stackelberg game only, the manufacturer is more likely to withdraw products from the retail channel.

The fundamental reason why the threshold in the manufacturer Stackelberg game only is lower is that the retailer is able to determine its margin after an agreement has been reached in the bargaining over the wholesale price, which deteriorates the manufacturer's disagreement point in the bargaining. Specifically, because the manufacturer determines the direct price (i.e., decision variable) before the retailer's decision on its margin in the manufacturer Stackelberg game, the manufacturer cannot adjust the direct price at the time when the retailer determines its margin and, thus, cannot avoid selling at the precommitted direct price. That is, the manufacturer needs to sell products to the retailer even if the retailer charges a high margin because, when the retailer determines its margin, the agreement under which the manufacturer sells through the retail channel has already been reached through bargaining in the manufacturer Stackelberg game. Therefore, this manufacturer's precommitment to the direct price deteriorates the manufacturer's disagreement point in the bargaining over the wholesale price, which in turn reduces the profit of the manufacturer selling through the retail channel. Based on this logic, the manufacturer Stackelberg game is more disadvantageous to the manufacturer and, hence, the manufacturer is more likely to remove its products from the retail channel.

In contrast, because the manufacturer need not determine its direct price before the retailer's decision on its margin in the vertical Nash or retailer Stackelberg games, the manufacturer has the option of selling products at its desired price through the direct channel only by breaking the negotiation if the retailer sets and demands a margin that is too high. This option works as a threat to the retailer and enhances the manufacturer's disagreement point in the bargaining, thereby enabling the manufacturer to gain a larger allocation of the profit from the bargaining. This option is equally advantageous to the manufacturer and, hence, the threshold of γ is the same in the retailer Stackelberg and vertical Nash games, as shown in Theorem 5, because the manufacturer need not commit to a specific direct price before the retailer's decision in both games. As a result, the manufacturer is less likely to withdraw from the retail channel in these two games.

Finally, let us examine whether the theoretical results derived in this section are consistent with the empirical insights gained in the previous research relating to power structures. Using actual price data to investigate power structures in supply chains, Cotterill & Putsis (2001) provide empirical evidence that manufacturers in consumer packaged foods categories make their price de-

[15] Solving the equation such that the left-hand side in Inequality (21) is equal to zero, we find that the solution is $\theta^2 = 0$ and 1. Substituting any value of θ within the range of its definition (i.e., $0 < \theta < 1$) into the left-hand side, we obtain a positive value. Consequently, Inequality (21) holds.

cisions earlier than or simultaneously with downstream retailers. Namely, their empirical results suggest that not only the manufacturer Stackelberg game but also the vertical Nash game is observed in real supply chain environments. Moreover, several empirical studies provide evidence that large-scale retailers often require margins for products from suppliers before suppliers determine their wholesale prices. Using price data on agricultural products, Kuiper & Meulenberg (2004) empirically show that downstream retailers exert price leadership, forcing upstream manufacturers to become price takers. Krishnan & Soni (1997) and Lee & Rhee (2008) report real-life cases in which large-scale retailers require guaranteed profit margins from their suppliers before the suppliers set their margins. These retailer price leaderships, which are interpreted as retailer Stackelberg games, are actually observed, as well as manufacturer Stackelberg and vertical Nash games. Therefore, our result—that simple acceptance of the wholesale price earns the retailer a higher profit than bargaining over the price, and this holds for the vertical Nash game and the retailer Stackelberg game (Theorem 5) as well as for the manufacturer Stackelberg game (Theorem 2)—has significant implications from the empirical perspective. Consequently, this section demonstrates that the theoretical results of this study are consistent with the empirical insights gained in preceding research, and confirms that the empirical validity of our central message is robust.

9. Conclusion

The development of ICTs has enabled retail companies to collect richer demand information than in the past, including information on consumers' individual needs and preferences. Moreover, because retailers are closer to and have more opportunities to interact with consumers than do upstream manufacturers, power within supply chains has tended to shift away from upstream manufacturers to downstream retailers. Given this recent trend, this paper investigates the problem of whether a retailer should bargain over the wholesale price of a product with a manufacturer or purchase at the price unilaterally set by the manufacturer. Now, we can answer this question, which is also the title of our paper, as follows. When a manufacturer sells products only through a retailer in a single-channel supply chain, a retailer should bargain over the wholesale price rather than simply accepting the price dictated by the manufacturer. Conversely, it is not necessarily advantageous for the retailer to bargain over a wholesale price in the environment of a dual-channel supply chain consisting of both retail and direct channels. The main result derived from our model is that if the retailer's bargaining power is very strong and there is high channel substitutability between the direct and retail channels, full acceptance of the wholesale price dictated by the manufacturer will earn the retailer a higher profit than bargaining. Furthermore, we confirm that the key finding is robust with respect to different power and chain structures, including manufacturer Stackelberg, retailer Stackelberg, and vertical Nash games.

As the summary indicates, our results are a warning to a retailer embedded in a dual-channel system that heedlessly using its strong power to bargain over price, rather than accepting the wholesale price dictated by a manufacturer, may ultimately harm the retailer. At the very least, the retailer must never assume that it can always utilize its power to bargain over the wholesale price with a manufacturer in a dual-channel environment because the manufacturer may disintermediate the retailer, dedicating itself solely to direct selling to consumers. For example, as mentioned in Section 1, Amazon, playing the role of a retailer, needed to make concessions to Hachette on price terms after intense negotiations. Moreover, Nike has pulled its products out from Amazon after successive negotiations. The implication of the model in this paper is that the retailer should let the manufacturer (or publisher) sell products at its asking price without negotiating—that is, playing a manufacturer Stackelberg game rather than playing a bargaining game may be more advantageous to real-life retailers encountering contemporary dual-channel supply chain environments.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ejor.2021.09.012.

Appendix A Results from the quantity-setting scenario

This appendix summarizes the results obtained in the quantity-setting scenario because we reported only the results in the price-setting scenario in the main text.

First, we consider the main model described in Section 5. The next proposition summarizes the equilibrium results of the manufacturer Stackelberg game in the quantity-setting scenario, which corresponds to Proposition 3 in the price-setting scenario.

Proposition 12. *The retailer's and manufacturer's equilibrium profits in the manufacturer Stackelberg game in the quantity-setting scenario of the dual-channel model (Π^{MS} and π^{MS}) are:*

$$\Pi^{MS} = \frac{((1-\theta)a+\theta c)^2}{4b\left(2-\theta^2\right)^2},\ \pi^{MS} = \frac{(a-c)^2}{4b} + \frac{((1-\theta)a+\theta c)^2}{4b\left(2-\theta^2\right)}.$$

The next proposition shows the equilibrium results of the bargaining game in the quantity-setting scenario, which corresponds to Proposition 4 in the price-setting scenario.

Proposition 13. *The retailer's and manufacturer's equilibrium profits in the bargaining game in the quantity-setting scenario of the dual-channel model (Π^{B} and π^{B}) are as follows:*

(i) When $\gamma < \sqrt{1-\theta^2/2}$,

$$\Pi^{B} = \frac{(1+\gamma)^2((1-\theta)a+\theta c)^2}{4b\left(2-\theta^2\right)^2},\ \pi^{B} = \frac{(a-c)^2}{4b} + \frac{\left(2\left(1-\gamma^2\right)-\theta^2\right)((1-\theta)a+\theta c)^2}{4b\left(2-\theta^2\right)^2}.$$

(ii) When $\gamma \geq \sqrt{1-\theta^2/2}$,

$$\Pi^{B} = 0,\ \pi^{B} = \frac{(a-c)^2}{4b}.$$

As in the price-setting scenario, Proposition 13 shows that the retailer's profits in the quantity-setting scenario become zero if the retailer's bargaining power is so strong that γ exceeds the threshold of $\sqrt{1-\theta^2/2}$. Comparing the equilibrium profits resulting from the two games, we obtain the following theorem determining the game that earns the retailer a higher profit, which corresponds to Theorem 2 in the price-setting scenario.

Theorem 6. *The following relationship holds in the quantity-setting scenario of the dual-channel supply chain model under the following condition:*

$\Pi^{MS} \gtrless \Pi^{B}$ if and only if $\gamma \gtrless \sqrt{1-\theta^2/2}$.

Here, note that the condition determining which game is more advantageous differs slightly between the price- and quantity-setting scenarios, as shown in Theorems 2 and 6. Specifically, because $(\sqrt{1-\theta^2/2})^2 - (\sqrt{2(1-\theta^2)/(2-\theta^2)})^2 = \theta^4/(2(2-\theta^2)) > 0$, the parameter region of θ and γ, in which the manufacturer Stackelberg game earns the retailer a higher profit than in the bargaining game, is more extensive in the price-setting scenario than in the quantity-setting scenario. Therefore, the Stackelberg game is more likely to be advantageous to the retailer in an environment of price competition than one involving quantity competition.

Next, we consider supply chain coordination through the adjustment of bargaining power addressed in Section 6. The following proposition and theorem show the results in the quantity-setting scenario, which correspond to Proposition 5 and Theorem 3, respectively, in the price-setting scenario.

Proposition 14. *In the quantity-setting scenario of the Nash bargaining game, the efficient level of the retailer's bargaining power (γ^C) and the corresponding total supply chain profit ($(\Pi+\pi)^C$) maximized with γ^C are as follows:*

$$(\Pi+\pi)^C \to \frac{(a-c)^2}{4b} + \frac{(4-\theta^2)((1-\theta)a+\theta c)^2}{4b(2-\theta^2)^2} \text{ when } \gamma^C \to 1$$

Theorem 7. *If the following conditions are met, both retailer and manufacturer earn higher profits by signing the coordination contract under which the bargaining power is ex ante adjusted to the efficient level (γ^C) and total profit is shared, than by playing the bargaining game in the quantity-setting scenario. Thus, both parties prefer the coordination contract to bargaining without the contract:*

$$\frac{(1+\gamma)^2((1-\theta)a+\theta c)^2}{(8-8\theta-\theta^2+2\theta^3)a^2-2(4-4\theta+\theta^3)ac+4c^2} < \phi$$
$$< \frac{2(1+\gamma^2)((1-\theta)a+\theta c)^2}{(8-8\theta-\theta^2+2\theta^3)a^2-2(4-4\theta+\theta^3)ac+4c^2}.$$

While Proposition 14 shows that the value of γ^C in the quantity-setting scenario is different from that in the price-setting scenario, Theorem 7 proves that the efficient level of the retailer's bargaining power can be achieved in the quantity-setting scenario.

Finally, we consider the existence of multiple retailers addressed in Section 7. The following propositions and theorem show the equilibrium result in the quantity-setting scenario, which correspond to Propositions 6 and 7 and Theorem 4, respectively, in the price-setting scenario.

Proposition 15. *The retailer's and manufacturer's equilibrium profits in the manufacturer Stackelberg game in the quantity-setting scenario in the dual-channel model with two retailers (Π_i^{MS} and π^{MS}, $i=1, 2$) are as follows:*

$$\Pi_i^{MS} = \frac{((1-\theta)a+\theta c)^2}{4b(2+t-2\theta^2)^2}, \pi^{MS} = \frac{(a-c)^2}{4b} + \frac{((1-\theta)a+\theta c)^2}{2b(2+t-2\theta^2)}.$$

Proposition 16. *The retailer's and manufacturer's equilibrium profits in the bargaining game of the quantity-setting scenario of the dual-channel model with two retailers (Π_i^B and π^B, $i=1, 2$) are as follows:*

When $\gamma < \frac{(2-t)((2+t)(2+t-2\theta^2)+4\sqrt{(2+t)(2+t-2\theta^2)})}{(2+t)(4(3+\theta^2)-2t(2-\theta^2)-t^2)}$,

$$\Pi_i^B = \frac{(2(1+3\gamma)-t(1-\gamma))^2((1-\theta)a+\theta c)^2}{4b(2+t-2\theta^2)^2(2(1+\gamma)-t(1-\gamma))^2}$$

$$\pi^B = \frac{(a-c)^2}{4b} + \frac{((1-\theta)a+\theta c)^2}{2b(2+t-2\theta^2)^2(2(1+\gamma)-t(1-\gamma))^2}$$
$$\times (t^3(1-\gamma)^2 - 2t^2(1-\gamma)(1+\theta^2+\gamma(3-\theta^2))$$
$$-8(\gamma^2(3+\theta^2)-(1+2\gamma)(1-\theta^2))$$
$$+4t(2(1-\gamma^2)\theta^2-(1-\gamma)^2))$$

When $\gamma \geq \frac{(2-t)((2+t)(2+t-2\theta^2)+4\sqrt{(2+t)(2+t-2\theta^2)})}{(2+t)(4(3+\theta^2)-2t(2-\theta^2)-t^2)}$,

$$\Pi_i^B = 0, \pi^B = \frac{(a-c)^2}{4b}.$$

Theorem 8. *The following relationships hold in the quantity-setting scenario when there are two retailers:*

$\Pi_i^{MS} \gtrless \Pi_i^B$ if and only if

$$\gamma \gtrless \frac{(2-t)\left((2+t)(2+t-2\theta^2)+4\sqrt{(2+t)(2+t-2\theta^2)}\right)}{(2+t)\left(4(3+\theta^2)-2t(2-\theta^2)-t^2\right)}.$$

Similarly to the price-setting scenario, Theorem 8 shows that there is a threshold of γ determining whether the bargaining game or the Stackelberg game is more profitable to the retailer.

To summarize, this Appendix proves that all the important results in the price-setting scenario remain valid in the quantity-setting scenario.

Appendix B Proofs of propositions, theorems, corollary, and observation

Appendix B is uploaded as supplementary material online.

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