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Invited Review

Agency models in online platforms: A review of recent developments and future prospects

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ABSTRACT

Over the past decade, the ascendancy of the platform economy has led to a significant shift by numerous online merchants, transitioning from the conventional wholesale model to the agency model. Within the agency model, suppliers control pricing decisions, and in exchange for leveraging the online marketplace to access consumers, they apportion a segment of the revenue to the retailers. Reports indicate that third-party sellers are the primary source of Amazon's income via the agency model. This model has emerged as a prevalent distribution agreement for many physical goods within the digital marketplace. Furthermore, its influence extends to the realm of digital content distribution, as evidenced by its adoption by both Apple and Google in their respective application stores. Notwithstanding the widespread adoption of the agency model in practice, there has been a notable deficiency in the scholarly examination of contemporary advancements in this area. Consequently, this study conducts a systematic review of the agency model. Specifically, we identify and focus on three critical issues regarding the agency model in the literature: the impact of the agency model on channel distribution, how to effectively manage the operations and information management strategy when employing the agency model. Our investigation furnishes an exhaustive synopsis of the latest advances concerning the agency framework and encapsulates pertinent insights for management. We conclude this article by proposing directions for future research.

1. Introduction

For decades, retailers have utilized the traditional wholesale model, wherein they acquire products from suppliers at a wholesale price and retail them to the final consumers while charging a markup. Although this wholesale model persists as a prevalent practice in brick-and-mortar settings, the agency model (also known as agency selling) has begun to challenge the wholesale model in the digital commerce domain, propelled by the swift expansion of the platform economy. Within the agency model, retailers act as an online intermediary and permit suppliers to engage directly with consumers by determining the retail pricing. In exchange, retailers retain a specified percentage of the revenue. Prominent retailers, such as Amazon, Walmart, eBay, JD.com, and Alibaba, have adopted this alternative distribution agreement.

It has been estimated that in 2022, approximately 60% of Amazon's gross sales come from third-party sellers, equating to a revenue figure of $118 billion (Statista, 2023). The transactions of third-party sellers on Amazon are regulated under the agency model, with Amazon's commission fees varying between 8% (e.g., for computers and video game consoles) to 45% (e.g., for Amazon Device Accessories) (Amazon, 2023). Similarly, Walmart imposes a commission fee on third-party sellers that fluctuates from 8% to 15% for transactions conducted within its Walmart Marketplace (Walmart Marketplace, 2023). The agency model extends its influence beyond physical goods transactions to encompass digital content distribution. Tech giants, such as Apple and Google, facilitate third-party developer engagement with consumers by permitting the distribution of applications via the Apple App Store and Google Play Store, respectively. Under this arrangement, developers pay 15% of the revenue for the first $1 million and 30% for the revenue beyond $1 million (Manish Singh, 2021). The agency model has become the predominant contractual framework in the platform economy.

To better understand the agency model, it is beneficial to examine its evolution. The term "agency model" is derived from the notable antitrust litigation United States v. Apple Inc. in 2011, wherein the U.S. Department of Justice alleged that Apple conspired with leading publishers to inflate the prices of e-books (Rosenblatt, 2011). The agency

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model denotes that an online platform serves as an intermediary, orchestrating transactions in exchange for a commission. While the initial application of the agency model was confined to the sale of e-books, it swiftly expanded to encompass a broader range of products and services, gradually supplanting the traditional wholesale model. This shift can be attributed predominantly to the burgeoning platform economy.

The agency model resembles the revenue-sharing contract in offline settings, yet it exhibits distinct differences (Tan & Carrillo, 2016). Within the revenue-sharing contract, the retailers pay the supplier a reduced wholesale price for each unit purchased, in addition to a fraction of the revenue generated by the retailer (Cachon & Lariviere, 2005) (see Table 1). While this contract achieved a measure of success within the video rental industry (e.g., Blockbuster), its prevalence in other industries is limited. A primary constraint is the incremental administrative expense associated with the revenue-sharing contract. Under such a contract, retailers must reveal their financial performance to the upstream suppliers, who, in turn, must monitor and authenticate the retailer's revenue information. These tasks are resource-intensive, particularly in traditional retail settings. Moreover, the negotiation process between supplier and retailer encompasses not only the determination of the revenue-sharing ratio but also establishing the reduced wholesale price, rendering the process exceedingly intricate. In stark contrast to the revenue-sharing agreement's high costs and complexity, the agency model is characterized by greater efficiency and ease of implementation. Under the agency model, the supplier and the platform engage solely through a predetermined revenue-sharing ratio; this streamlined approach has catalyzed the widespread acceptance of the agency model against the backdrop of the burgeoning platform economy.

Despite the practical significance of the agency model, the previous literature lacked a systematic and comprehensive review of the academic research; a strong need existed to survey the current studies of agency models in online platforms to fill this research gap. Academic research on the agency model has mainly focused on three critical questions: 1) *What is the impact of the agency model on channel distribution?* 2) *What is the optimal operations management strategy when employing the agency model? and 3) What is the optimal information management strategy when employing the agency model?* In this study, we conduct a structured and comprehensive review of recent academic contributions to address these three critical issues concerning the agency model. Specifically, we pay close attention to the research regarding Operational Research applications of the agency model. The findings of this study not only provide the status quo and possible avenues for scholars interested in the agency model but also offer actionable insights to managers in relevant industries.

The remainder of this paper is organized as follows. Section 2 describes the model formulation and common structure of the agency model. This is followed by the literature selection criteria and conceptual framework in this study. In Section 3, we systematically introduce the impact of the agency model on channel distribution. Sections 4 and 5 discuss how to manage operations and information effectively when employing the agency model. We conclude this paper with directions for future research in Section 6.

Table 1
Differences between the wholesale, agency, and revenue-sharing models.

	Wholesale model	Agency model	Revenue-sharing contract
Who shares revenue	-	The supplier	The retailer
Who sets the wholesale price	The supplier	-	The supplier
Who sets the retail Price	The retailer	The supplier	The retailer

2. Model formulation and framework development

Investigations into the agency model are often propelled by real-world practices observed between online platforms and their upstream counterparts. Within the agency model, retailers serve as intermediaries in return for commission fees, while suppliers directly decide the retail price. The past decade has witnessed a marked surge in the adoption of the agency model. Notable e-commerce giants, including the Apple App Store, JD.com, Target, and Walmart, have embraced this distribution strategy (Hagiu et al., 2022). Despite the burgeoning platform economy catalyzing the ascendancy of the agency model, the conventional selling format – the wholesale model (also widely referred to as wholesaling or reselling) – maintains its preeminence as the primary distribution method across numerous industries. Under the wholesale model, retailers acquire goods from upstream suppliers at wholesale prices and subsequently offer these goods to the end market at a retail price.

The following highlights the critical distinction between the wholesale and agency models. To better understand the different preferences of upstream suppliers and downstream retailers for both distribution contracts, we employ analytical models to demonstrate 1) how the wholesale and agency models differ and 2) how they affect pricing decisions between the upstream and downstream layers. Then, we also emphasize the distinctions between common distribution contracts in the supply chain.

2.1. Model formulation

To elucidate the fundamental distinctions between the wholesale and agency models, we expound upon our framework by examining a single supplier who distributes products via a retailer under one of the two aforementioned models (see Fig. 1). Note that this simple structure, on the one hand, facilitates an intuitive comprehension of the primary differences between the two contractual arrangements, but on the other hand, it also represents the most basic structure in the literature, with all subsequent models expanding upon this foundation.

In this model, subscript 'W' denotes the Wholesale model, and subscript 'A' denotes the Agency model. The supplier incurs a marginal production cost c. We use π_N^S to denote the supplier's profit in scenario N, while π_N^R denotes the retailer's profit in scenario N, where.

$N \in \{\mathrm{W}, \mathrm{A}\}$. In the traditional wholesale model (Fig. 1(a)), the retailer (generically, 'she') purchases products from the supplier (generically, 'he') at wholesale price w in the first stage, and then the retailer sets the retail price p_W. Hence given the wholesale price, the retailer maximizes the profits accordingly[1]:

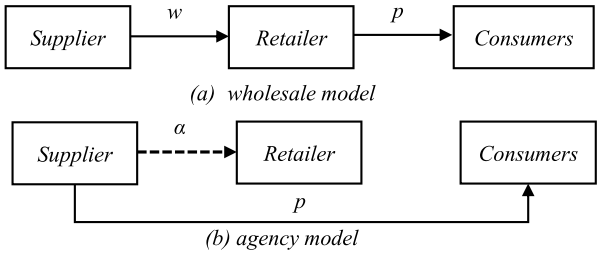


Fig. 1. Selling format choices for a simple supply chain.

[1] We utilize a general demand function rather than explicitly specifying a particular form. This deliberate decision stems from the recognition (Hao & Tan, 2019; Hu et al., 2022; Wei et al., 2020) that the conclusions derived from a nonlinear demand function can markedly differ, or even contradict, those derived with a linear demand function.

$$\max_{p_W} \pi_W^R(p_W) = (p_W - w) * q(p_W)$$

In the first stage, anticipating the above retail price $p_W(w)$, the manufacturer's profit maximization problem is as follows:

$$\max_{w} \pi_W^S(p_W) = (w - c) * q(p_W(w))$$

After obtaining the optimal w^*, we can derive the equilibrium wholesale price, retail price, and both firms' profits.

In the agency model (Fig. 1(b)), the supplier uses the retailer's platform and reaches the consumers directly by charging the retail price p_A, and the retailer keeps a proportion α of the revenue.[2] The supplier gets the remaining $1 - \alpha$ proportion of the revenue. Hence, given the pre-determined commission fee, the supplier maximizes his profits accordingly:

$$\max_{p_A} \pi_A^S(p_A) = [(1 - \alpha)p_A - c] * q(p_A)$$

Note that the commission rate (α) may either be exogenous or endogenous under the agency model, prompting an exploration of the rationales for each type. Exogenous commission rates are primarily justified for two key reasons: firstly, even amid substantial market changes, commission rates tend to remain relatively stable in current industry practices, and secondly, from a modeling perspective, an exogenous rate can simplify calculations and analyses. The main reason for the endogenous rate is that the rate is a key decision variable for the retailer, and the retailer's strategic decision on the commission forms a significant part of the game. Moreover, Hu et al. (2022) contribute a noteworthy insight, highlighting that exogenous commissions are typically grounded in the assumption of zero production costs, a scenario in which the retailer's profit monotonically increases with the commission rate.

2.2. Remarks

Now, we conceptualize the differences between the agency and traditional wholesale models. The wholesale and agency models differ in two fundamental ways. First, the agency model incorporates a revenue-sharing mechanism that enables the downstream to receive a portion of the commission from the upstream sales revenue. Second, in the wholesale model, the retailer obtains the pricing power of the product after paying the wholesale price to the supplier. In contrast, the upstream parties control the retail price in the agency model.

In addition to the wholesale model, it is imperative to differentiate the agency model from other common contract agreements (see Table. 2). In the conventional revenue-sharing contract (Cachon & Lariviere, 2005; Pan et al., 2010; Bart et al., 2021), the retailer apportions part of her revenue in exchange for a lower wholesale price, whereas in the agency model, the corresponding payment flows from suppliers to retailers, and the supplier gains the retail pricing power. Additionally, among the other contractual instruments, two-part tariff (Raju & Zhang, 2005; Moorthy, 1987; Kolay and Shaffer, 2013) is based on the wholesale model for an additional fixed fee. Further, the franchise contract (Lafontaine & Slade, 2001; Shane et al., 2006) amalgamates revenue-sharing with a two-part tariff structure: the supplier charges the retailer a fixed fee, a wholesale price for each unit sold, and a commission fee from sales revenue. Less common is the consignment model (Johnson, 2017), in which the retailer sets the wholesale price paid to the supplier while the supplier determines the retail price.

Table 2
Comparison of common contract agreements.

	Revenue sharing contract	Franchise contract	Two-part tariff contract	Consignment model
Prepaid fixed fee	No	Yes	Yes	No
Revenue sharing agreement	From the retailer to the supplier	From the retailer to the supplier	-	-
Who sets the wholesale price	The supplier	The supplier	The supplier	The retailer
Who sets the retail Price	The retailer	The retailer	The retailer	The supplier

In sum, neither revenue sharing nor franchise contracts allow upstream suppliers to control pricing decisions. Moreover, other proposed contractual instruments, such as two-part tariff and the consignment model, are essentially built on top of the conventional wholesale model, and none involve revenue sharing or transfer of pricing power.

2.3. Literature analysis and framework

We conducted a literature search based on the Web of Science (WoS) Core Collection database, focusing on the following keywords: selling formats, agency selling, marketplace selling, platform selling, agency pricing, marketplace pricing, third-party marketplace, and agency model.[3] The initial search yielded overwhelming results, so to ensure the relevance and accuracy of our findings, we consequently applied several filters to narrow down the search results. First, the timeframe was limited to studies published from 2011 onwards. Second, we excluded conference articles and working papers due to their incompleteness. Third, given the interdisciplinary nature of the keywords, we limited our research to studies in the field of business economics. Lastly, the agency problem is considered out of our scope.[4] Note that we have only included a representative selection of works due to relevance and space constraints. The following subsection discusses the literature sample and categorizes the selected works.

2.3.1. Literature analysis

In Fig. 2, we present the number of selected papers addressing the agency model published each year. The number of published articles

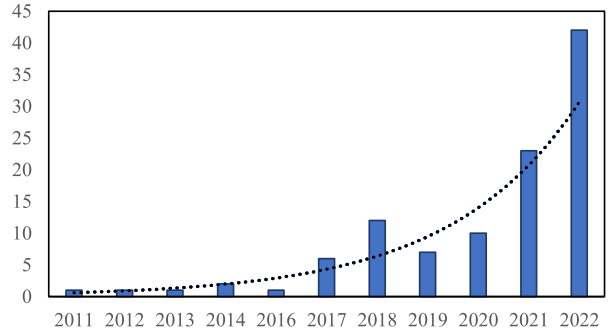


Fig. 2. Number of sampled papers published per year.

[2] There are two distinct ways to model commission fees under the agency model (Teh, 2022): a fixed commission fee and a revenue sharing commission fee. The latter form is widely used in practice and the academic literature, thus we have chosen it as the primary model in our main text. However, if we model commission fees in the first way, then the supplier's profit becomes $(p - c - \alpha) * q(p)$.

[3] The sample includes all works published before September 2023.

[4] An agency problem occurs when one party in a business relationship fails to act in the best interest of the other party, creating a conflict of interest. This problem has nothing to do with the issues studied in this review, so we excluded such papers from the search results.

increased over time. Fig. 3 displays the peer-reviewed academic journals where the sampled documents were published. Out of the 41 journals in our sample, eight journals account for more than 50% of the sample's papers, including the European Journal of Operational Research (16), Production and Operations Management (11), International Transactions in Operational Research (8), Transportation Research Part E: Logistics and Transportation Review (7), Electronic Commerce Research (6), International Journal of Production Research (5), Computers & Industrial Engineering (4), and International Journal of Electronic Commerce (4). We grouped the remaining 28 journals that published only one to three sample papers into the category 'Others' for improved readability. This category includes, for example, Econometrica and The Review of Economic Studies.

2.3.2. Literature framework

The agency model emerged during the growth of online retailing, yet early studies on the topic (Simchi-Levi et al., 2004; Tsay & Agrawal, 2009) often overlook the revenue-sharing mechanism inherent in this model. In contrast, this study provides a comprehensive analysis of previous literature on channel distribution and operations and information management within the framework of the agency model. Our study first shows how channel participants incorporate the agency model into their consideration sets and reexamine the original channel configuration (Fig. 4(a)). Next, we focus on how the agency model affects the channel's operations (Fig. 4(b)) and information management strategies (Fig. 4(c)).

3. Multichannel distribution

Multichannel distribution is a structure in which products flow to consumers through one or more sales channels. This multichannel distribution configuration includes direct selling[5] through a physical or online store, reselling through an online or offline retailer, the introduction of store brand products, and agency selling through an online marketplace. In this section, by reviewing the studies that focus on the agency model coexisting with the other three traditional selling models (Fig. 4 (a)), we first examine the case where a monopolistic supply chain mainly includes a supplier and a retailer platform. The retailer offers the supplier either one pricing contract (Fig. 5 (I)) or both (Fig. 5 (II-III)). In addition, we further consider asymmetric channel distribution structure in monopoly situations, that is, the retailer introduces store brand products (Fig. 5 (IV)). Moreover, we summarise a series of papers that analyze the competition conditions where multiple retailers and suppliers coexist in a supply chain (Fig. 6 (I-V)).

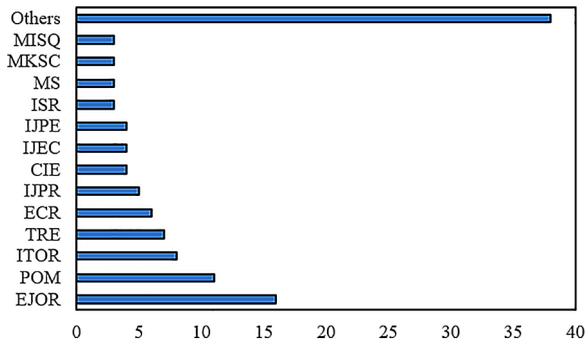


Fig. 3. Journals that published the highest number of sampled papers.
Notes: IJPR- International Journal of Production Research, ECR- Electronic Commerce Research, EJOR- European Journal of Operational Research, IJPE- International Journal of Production Economics, ITOR- International Transactions in Operational Research, MS- Management Science, MISQ- MIS Quarterly, MKSC- Marketing Science, ISR- Information Systems Research, IJEC- International Journal of Electronic Commerce, CIE- Computers & Industrial Engineering, TRE- Transportation Research Part E: Logistics and Transportation Review, POM- Production and Operations Management.

[5] Direct selling refers to suppliers selling products directly to consumers through their channel (Chiang et al., 2003; Arya et al., 2007). Although this is similar to the agency model in terms of pricing, the agency model emphasizes that products reach consumers through intermediaries' channels with commission fees.

3.1. Channel expansion in a monopoly setting

3.1.1. The wholesale model or the agency model

In a bilateral monopoly scenario (Fig. 5 (I)), Johnson (2017) utilizes a general demand form to identify the incentives for retailer deviation from the wholesale model to the agency model. Both layers bear a marginal cost, and comparing the profits under the two selling formats, he reveals that when demand exhibits log-concave, log-linear, or constant-elasticity properties, the retailer can achieve higher profits under the agency model than the wholesale model. This happens because she can benefit from the increase in overall demand stemming from the retail price reduction under the agency model. Xu et al. (2022b) further analyze the selling format choice under the cap-and-trade regulation. The supplier pays the order-fulfillment cost under the agency model, while he does not incur this cost but suffers a negative double marginalization effect under the wholesale model. Therefore, when the cost is low, the negative effect dominates the cost-saving effect, so the agency model gains more profit for the supplier.

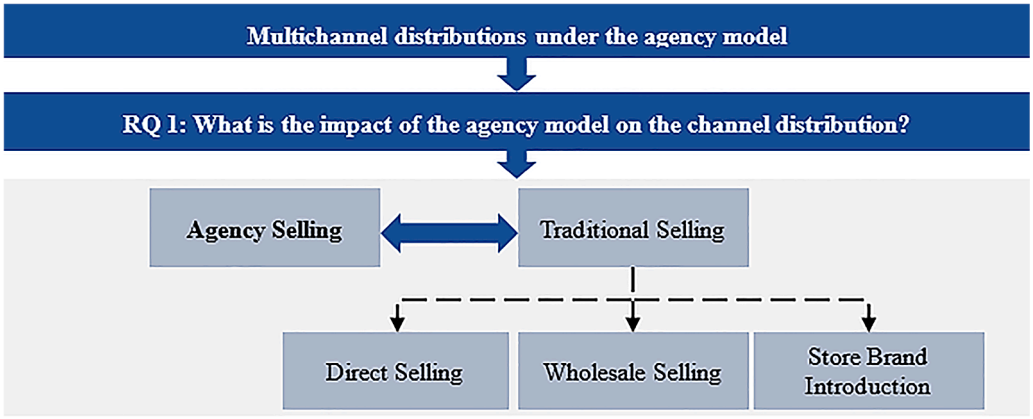
Different from the aforementioned papers, Yu et al. (2020) consider a scenario wherein a monopoly supplier sells products through the direct or indirect channel (wholesale or agency). The demand for both channels depends on service differences and consumers' heterogenous preferences across channels. Then, the equilibrium channel distribution strategies are direct channel only, indirect channel only, and dual channel (a combination of direct selling and the wholesale or agency model). They find that the supplier prefers dual-channel distribution when consumers have a significant preference for either the direct or indirect channel.

In addition, Ye et al. (2018) and Liao et al. (2019) examine how the limited capacity impacts the supplier's choice of selling format. As shown in Liao et al. (2019), the supplier cooperates with the online retailer to enlarge market demand with either a wholesale or an agency model. The demand in the online channel demand is realized before the supplier's direct channel. Their finding suggests that when the supplier's capacity is relatively small, the online retailer prefers the agency model over the wholesale model due to the higher commission rate contributing to increased expected revenue.

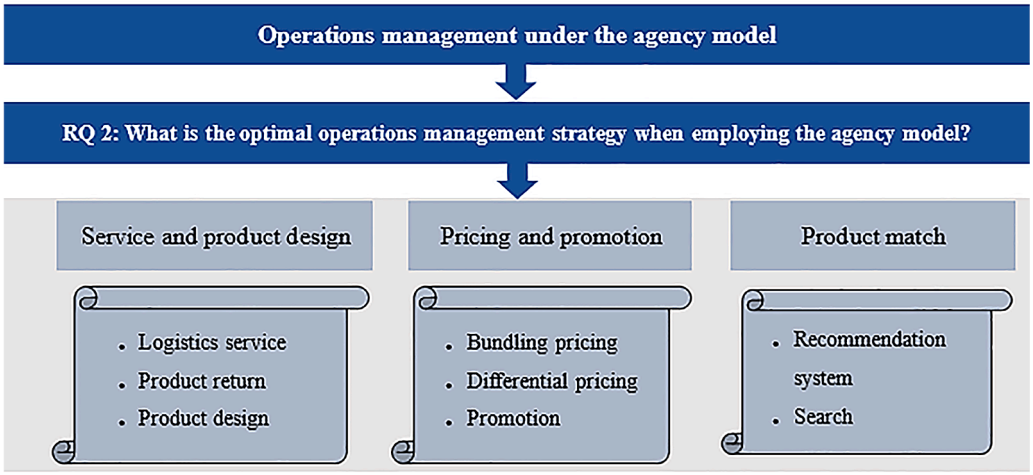
3.1.2. The wholesale model and the agency model

An increasing number of e-commerce retailers, such as Amazon and JD.com, operate dually as both agents and wholesalers; they utilize both the wholesale and agency model (Fig. 5 (II)). To elucidate the efficacy of this hybrid model, Yan et al. (2018) focus on spillovers from the online reselling and agency channels to the offline direct channel. According to their findings, the supplier's willingness to embrace the hybrid model increases, while the retailer's inclination to do so diminishes the level of spillovers.

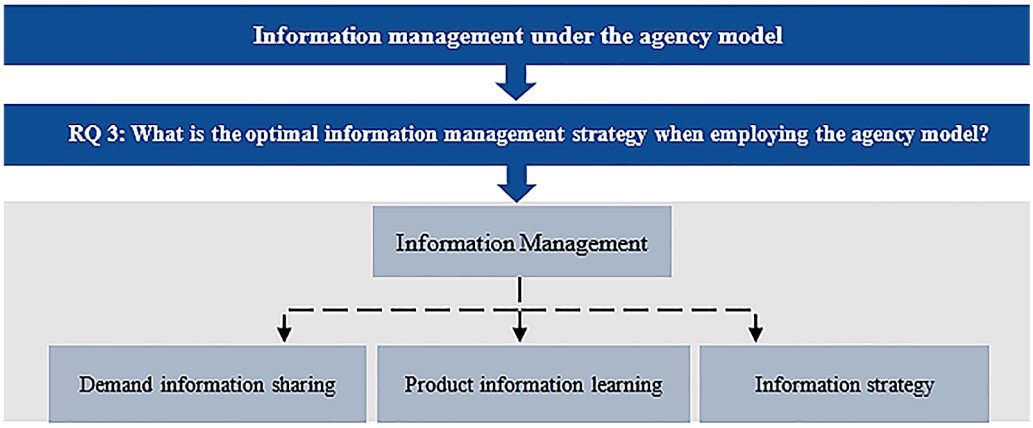
Xie et al. (2021) analyze the impact of limited capacity on the supplier's selection of selling formats, specifically choosing among the pure wholesale, pure agency, and hybrid models. In the scenario with limited capacity, the supplier prioritizes fulfilling the retailer's orders first, allocating the rest to the agency channel. Their findings demonstrate that the supplier profits more from the hybrid model than the pure agency model. However, tight or high capacity makes the pure wholesale model more favorable. In addition, Chen et al. (2022) delve into the supplier's optimal selling formats under the minimum quantity contract,



(a) Multichannel distributions



(b) Operations management



(c) Information management

Fig. 4. Literature classification.

wherein the supplier is obliged to sell a specified minimum quantity. Their research indicates that the supplier's optimal choice of selling format depends on the proportion of consumers loyal to each distribution model. As the number of loyal consumers increases, the supplier initially tends to choose only one selling format (wholesale or agency) to avoid channel competition and subsequently prefers to employ the hybrid model.

Ha et al. (2022a) investigate the same distribution channel choice of an online retailer that exerts service effort to enhance the demand. They show that the hybrid model achieves a win-win outcome, as the introduction of the agency model compels the supplier to reduce the wholesale price in the reselling channel, mitigating the negative effect of double marginalization inherent in the wholesale model. Further, the hybrid model coordinates sales under both selling formats, prompting the retailer to exert more effort to increase market demand. Additionally, Tao et al. (2022) reveal that the hybrid model effectively coordinates both the supplier and the retailer.

3.1.3. Digital product distribution

The pricing of digital and physical goods varies significantly due to

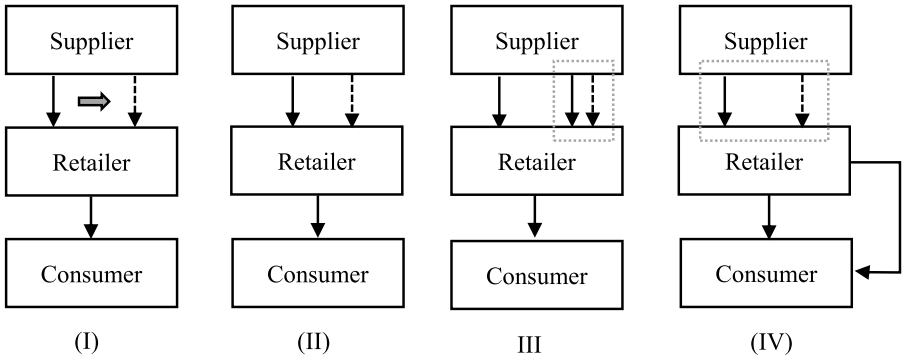


Fig. 5. Channel configurations in the monopoly and store-brand setting.
Notes: Solid lines refer to the wholesale model; dotted lines refer to the agency model. The part inside the dotted box denotes that channel members are free to choose the wholesale or agency model.

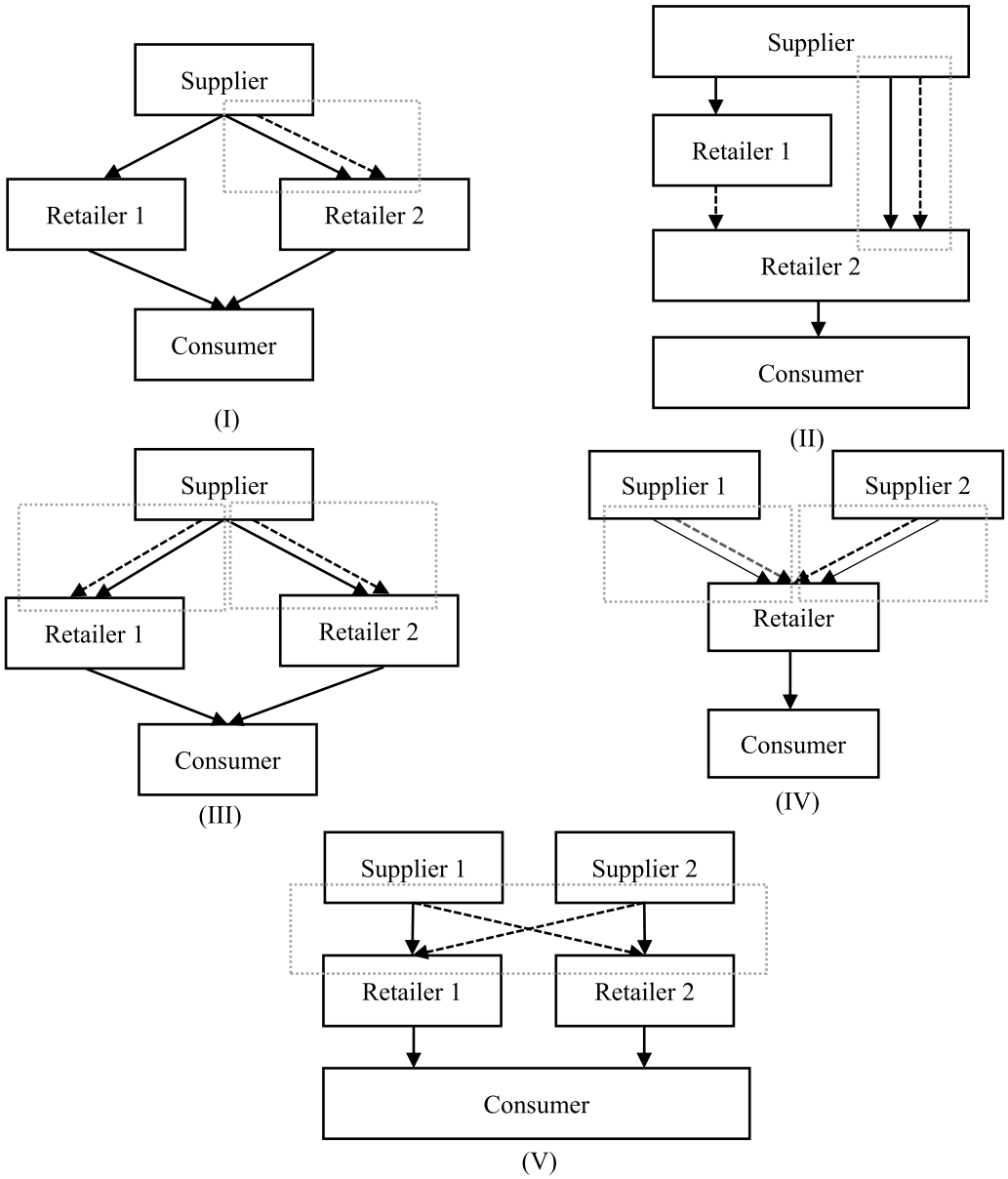


Fig. 6. Channel configurations in a competitive scenario.
Notes: Solid lines refer to the wholesale model; dotted lines refer to the agency model. The part inside the dotted box denotes that channel members are free to choose the wholesale and agency models.

distinctions in their production, delivery, and distribution. Typically, the supplier distributes digital products with either the wholesale or agency model, while physical products are conventionally sold with the traditional wholesale model (Fig. 5 (III)).

Hao and Fan (2014) conduct a comparison of prices for e-books and e-readers under the wholesale and agency models. In their model, e-books are assumed to be paired with an e-book reader. The copyright fee, selling cost of physical books, and production cost of the e-reader all play roles. They point out that under the agency model, e-book prices tend to be higher, whereas e-reader prices are lower than under the wholesale model. Kim (2018) explores a scenario wherein e-books are sold through the agency model, and printed books are distributed through the wholesale model. They show that the retailer might lose when attempting to increase commission fees to extract more from each e-book sold. Tan and Carrillo (2017) scrutinize the supplier's strategic choice regarding selling formats for digital goods. They assume that the supplier opt to sell digital products with either the wholesale or agency model. Their findings suggest that the agency model for digital goods outperforms the wholesale models in most cases.

However, in a scenario analogous to Tan and Carrillo (2017), Lyu et al. (2022) additionally discover that the retailer's offline investment strategy significantly influences the selling format choice of digital products. Ke et al. (2022) integrate the cannibalization effect of a delayed launch strategy and prove that such a strategy can raise prices for both physical and digital products, benefiting both the supplier and retailer.

3.2. Introduction of store brand product

Motivated by the phenomenon that retailers leverage store brands to compete with national brand suppliers (Fig. 5 (IV)). Ryan et al. (2012) examines the question of whether the supplier should sell through the retailer with the agency model when the retailer introduces store brand products. The retailer first determines whether to open her agency channel to the supplier and then decides whether to introduce the store brand products. Subsequently, the supplier decides whether to sell through the retailer. They suppose that customers prefer to purchase products from the agency channel rather than the supplier's direct channel. Their findings indicate that direct sales, store brand sales, and agency channel sales do not coexist in market equilibrium.

Zhang and Hou (2022) investigate the impact of store brand introduction on suppliers' choice between wholesale and agency models. Assuming a brand advantage for national brand products over store brands, they demonstrate that under the agency model, the supplier and retailer can align their incentives, even when their preferences for the wholesale and agency models are opposite in most cases. Further, Hagiu et al. (2022) extend the setting from one seller to multiple sellers, each with a direct channel. They target the impact of a regulatory ban on store brand introduction and assume that a superior seller benefits from making product innovations among multiple fringe sellers. As a Stackelberg leader, the platform chooses among the three possible models: pure agency model without introducing store brands, pure seller model (only selling own products in competition with outside sellers), or dual model (operating in both models). Comparing the above three models, the authors indicate that a regulatory ban on the dual mode would likely have more negative consequences than positive ones.

Liu et al. (2022) and Li et al. (2023) contribute to this stream of studies by examining two sources for the retailer's store brand products: a new external third-party supplier or the original national brand supplier. The results imply that the supplier should take into account the retailers' outsourcing strategy when he decides on selling formats.

3.3. Channel expansion in a competitive scenario

3.3.1. Downstream competition

Intense competition often frequently exposes retailers to a vulnerable and disadvantageous scenario. However, as demonstrated in this section, retailers can effectively mitigate channel conflicts by strategically adopting the wholesale or agency model within a common supplier channel structure (Fig. 6 (I, II, III)).

3.3.1.1. Asymmetric retailers. With the emergence and development of platform retailers, competition among downstream retailers has become more subtle, as the supplier has the flexibility to opt for either the wholesale or agency model within the retail channel (Fig. 6 (I)). To delve into the selling format distinctions under downstream competition, Lu et al. (2018), for example, examine a situation with two asymmetrical retailers – one a traditional wholesaler and the other offering either a wholesale model or an agency model. Their analysis illustrates that both the supplier and retailer can benefit from the agency model as the supplier sets a lower retail price under this model, resulting in a larger total demand. Further works investigating a related issue regarding selling format choice include Wang et al. (2022) and Pu et al. (2021).

Assuming that the two downstream retailers are a pure wholesaler and a pure agent, Hao and Kumar (2023) investigate the repercussions of consumer showrooming on offline wholesaler welfare. Contrary to conventional wisdom, their findings indicate that consumer showrooming can benefit the offline wholesaler because showrooming blurs the boundary between the online agency channel and offline wholesale channel, consequently limiting the supplier's capacity to adjust the volume of online shoppers in response to a decrease in the supplier's marginal cost of handling online returns. Liu et al. (2022) explore the incentives for the wholesaler to sell through the agent. Their findings imply that the wholesaler's entry into the agency channel reduces the pricing power of the supplier and raises downstream retail prices.

Shen et al. (2019) compare three potential channel expansion strategies for the supplier: selling through a wholesale retailer, selling through a platform retailer with the agency model, or selling through both. Slightly differently, the platform retailer is powerful enough to charge the supplier a slotting fee on top of the commission fees. The authors discern that the supplier prefers to distribute through both retailers when the slotting fee is endogenous. Pu et al. (2020) and Li et al. (2022) further consider an alternative expansion strategy for the supplier through his direct channel. Their findings suggest that direct selling can emerge as a dominant strategy in comparison to the agency model, contingent on the efficiency of the direct selling. Further, Zhen et al. (2022) examine a similar issue, although, in their model, the supplier has both online and offline channels at the initial stage. They subsequently leverage the spillover effect of sales between online and offline channels (Abhishek et al., 2016; Xu et al., 2022a) to measure the demand for newly introduced indirect channels. They discover that the direction of the spillover effect significantly influences the supplier's preference for selling formats in the new channel.

Owing to the formidable market influence and extensive user bases of giant retailers, smaller retailers, and suppliers often rely on the dominant retailers' channels for sales (Fig. 6 (II)). Shi et al. (2022) consider a scenario where the supplier sells through a giant retailer through a wholesale or an agency model, while the small retailer is restricted to selling her wholesale goods to the giant retailer through an agency model. Their finding suggests that when the selling cost of the supplier within the agency model is not at the two extremes, the giant retailer and supplier typically prefer to collaborate with the wholesale model. In a comparable context, Wang et al. (2022a) further identify regions for suppliers to choose among the direct selling, wholesale, and agency models.

In addition, in the scenario where two downstream retailers wholesale products from a monopoly supplier, Wang et al. (2022b) analyze the small retailer's selling choices under various competition forms. Four scenarios are constructed based on two selling modes (i.e., agency and direct selling) and two competition forms (i.e., Bertrand and Cournot). The results reveal that the small retailer's optimal choice of selling mode

is primarily influenced by the direct selling cost under Bertrand competition. However, in the case of Cournot competition, it is jointly affected by the direct selling cost, competition intensity, and commission rate.

Considering other cases of asymmetrical market power (such as Dai et al., 2022), Chen and Guo (2022) investigate the motivations behind a leading retailer's decision to open her platform to a smaller third-party retailer. The leading retailer has both valuation and awareness advantage over the third-party seller. The comparative advantage of leading retailers is twofold: firstly, consumers exhibit a preference for purchasing products from the leading retailer under equivalent circumstances; secondly, a portion of uninformed consumers is exclusively aware of the leading retailer. The third-party retailer faces the choice of either targeting these uninformed consumers through high-cost advertising or opting to sell through the established platform, incurring a proportional sales commission for heightened awareness and value enhancement. The authors find that the introduction of the agency model relies on advertising costs falling within an intermediate range. This strategic decision is grounded in the alignment of interests between the two retailers in this particular region.

3.3.1.2. Symmetric retailers. In the symmetric case, downstream retailers have the freedom to function as either a wholesaler or an agent (Fig. 6 (III)). While this flexibility may appear to complicate the selection of selling formats, it also introduces additional possibilities for channel coordination.

Tan et al. (2016) conduct a study to analyze the economic effect of two rival retailers' transition from the wholesale model to the agency model. Both retailers distribute goods with either a wholesale or an agency model. The authors find that the agency model can be superior to the traditional wholesale model for all participants in the digital supply chain. In a similar setting, Zhu and Yao (2018) further explore the scenario of two competing retailers selling both e-books and e-readers. The retailer's e-books and the e-reader are not entirely complementary, and consumers weigh the mismatch cost between the two e-readers and choose one of them. The study also demonstrates that retailers prefer the agency model over the wholesale model.

Given that the monopoly supplier already possesses a direct selling channel, Abhishek et al. (2016) investigate the selling format choice problem in the context of two symmetric retailers. Both retailers act as market leaders and independently decide to distribute products with either a wholesale or an agency model. The study analyzes and compares three possible configurations based on the retailers' decisions: both as wholesalers, one as a wholesaler and the other as an agent, or both as agents. To simplify the multichannel demand analysis, the authors utilize the cross-channel spillover effect between the retail and direct channels to measure sales of the direct channel. They reveal that if the retail channel has a negative cross-effect on demand in the direct channel, it is optimal for retailers to adopt the agency model. Conversely, in the presence of a strong positive cross-effect, retailers prefer to employ the wholesale model. Further relevant works are those of Liu et al. (2021) and Wei et al. (2021).

3.3.2. Upstream competition

In a common retailer channel, suppliers sell products through a monopoly retailer (Fig. 6 (IV)). Tian et al. (2018) examine how upstream duopoly competition influences the retailer's choices between agency and wholesale models. They evaluate three alternative scenarios: the retailer as a pure wholesaler, the retailer as a wholesaler for one supplier and as an agent for the other supplier, and the retailer as a pure agent. It is noteworthy that if the retailer functions as a wholesaler, she will incur a fixed cost to fulfill the order, while if the retailer acts as an agent, the supplier bears such order-fulfillment costs. Their findings indicate that order-fulfillment costs and upstream competition intensity jointly affect the retailer's choice of selling format.

Zennyo (2020) explores the strategic selection of selling formats by two suppliers with asymmetric market potential (low or high). In contrast to Tian et al. (2018), four scenarios are compared, as situations where the two asymmetric suppliers choose distinct selling formats are not equivalent. The study reveals that when the commission fee is determined endogenously by the retailer, she strategically adjusts it to guide suppliers toward her desired selling formats. Specifically, when the degree of substitution is intermediate, the low-volume supplier embraces the agency model, while the other opts for the wholesale model. Wei et al. (2020) further examine the leader-follower relationship between two suppliers and its impact on the choice of selling formats. Their findings suggest that the optimal strategy for the retailer is consistently encouraging both suppliers to utilize the wholesale model. Irrespective of the selling formats adopted by the leading supplier, the following supplier consistently favors the agency model.

In a common retailer channel with multiple competing suppliers, Hu et al. (2022) delineate the general conditions under which the retailer functions as a pure wholesaler or a pure agent. The authors characterize a demand function with general properties rather than specifying a specific linear demand function as done previously. Through systematic comparisons of retailer's payoffs under both the linear and nonlinear channel structure, they discover that the retailer's choice regarding selling formats is critically moderated by retail pass-through behavior, i.e., how the retail price of another brand adjusts to changes in a given brand's wholesale price. Specifically, with negative retail pass-through, the wholesale model intensifies supplier competition and thus could appeal more to the retailer than the agency model.

To scrutinize the motivations behind a retailer's transition from distributing the initial supplier's products with the wholesale model to establishing an additional agency channel for third-party suppliers, Mantin et al. (2014) elucidate that by opening the agency channel to a third-party sales commission, the retailer acquires enhanced outside options. This augmentation strengthens their negotiating position with the primary supplier, a circumstance advantageous to the retailer but disadvantageous to the suppliers. Nevertheless, in a similar model setup but with positive production costs, Zheng et al. (2022) demonstrate that the original supplier can derive benefits from alleviating double marginalization despite the heightened competition resulting from the inclusion of third-party suppliers on the retailer's platform.

3.3.3. Other competition scenarios

Given that the agency model effectively alleviates the issue of double marginalization, it remains effective within this intricate structure, even when the market transitions from the preceding monopoly to an oligopoly (Fig. 6 (V)). In a bilateral duopoly market, Foros et al. (2017) investigate the circumstances under which retailers opt for the agency model. The author compares three scenarios: both retailers act as wholesalers, one retailer functions as a wholesaler while the other operates as an agent, and both retailers act as agents. The findings indicate that the agency model results in a higher retail price if and only if the substitution between suppliers surpasses the substitution between retailers. Moreover, adopting the agency model may give rise to a prisoner's dilemma, wherein the equilibrium involves neither retailer utilizing the agency model, even when such adoption would result in higher retail prices and increased profits. In a variant context where retailers can enhance demand through costly efforts, Wirl (2018) demonstrates the existence of an asymmetric equilibrium, wherein one retailer chooses the agency model while the other opts for the wholesale model. Li and Ai (2021) further characterize another symmetric scenario where retailers operate as an agent for one supplier and as a wholesaler for the other supplier. They find that this new case with a hybrid model is less likely to arise in equilibrium.

Lu (2017) compares the relative profitability of the wholesale and agency models for suppliers and retailers, where both retailers operate either as wholesalers or agents. The results show that suppliers consistently achieve higher profits under the wholesale model and have no

incentive to switch from it, whereas retailers experience greater profits under the agency model, particularly when suppliers' products are highly differentiated.

4. Operations management

The primary objective of operations management is to orchestrate the design, planning, and control of the production of products and service provision. As the transition from the traditional wholesale model to the agency model occurs, retailers must re-evaluate their strategies and identify the most effective operational solutions for the new selling formats. In the subsequent section, we will synthesize and structure the relevant literature based on the categorization presented in Fig. 4(b).

4.1. Service and product design

Service and product design are integral to a business's success by influencing customer satisfaction, providing a competitive edge, and improving efficiency. While prior literature (e.g., Li et al., 2016; Zhang et al., 2019) has predominantly concentrated on service and product design under a wholesale model, this section sheds light on articles that examine the strategic interplay between selling formats and service and product design (see Table 3).

4.1.1. Logistics service

Qin et al. (2021) examine the question of who provides logistics services under different selling formats. Both the supplier and retailer provide logistics services with equal efficiency. Under the wholesale model, the supplier sets the wholesale price, and then the service provider (supplier or retailer) decides the service level. In contrast, the supplier and service provider simultaneously determine the retail price and service level under the agency model. Through a comparison of the four possible scenarios, the authors demonstrate that when the logistics service cost is medium, the equilibrium result is that the retailer operates as an agent and the supplier offers logistics service. Otherwise, the case where the retailer acts as a wholesaler and provides the logistics service becomes the equilibrium scenario.

Lai et al. (2022) investigate the strategic decision of whether a retailer should share logistics services with the supplier in the context of store brand introduction (Fig. 5 (IV)). In their model, the supplier sells through the retailer with the agency model and utilizes a third-party logistics service. The demand for each type of product is influenced by both price and service levels. The critical decision for the retailer revolves around whether to participate in the shared logistics services with the supplier to generate additional business revenue. The findings reveal that both the supplier and the retailer can benefit from sharing logistics services, as the positive effect, where logistics sharing effectively mitigates price competition, dominates the negative effect of intensified service competition between the supplier and retailer. Similar issues are addressed by Li et al. (2021) and Qin et al. (2020).

Zhang and Ma (2022) delve into the interplay between the introduction of an agency channel and logistics services sharing choice. Their findings demonstrate that the supplier is always inclined to introduce an agency channel alongside the existing wholesale channel. Optimal logistics service sharing involves the supplier providing logistics within the agency channel, while the retailer undertakes logistics business in the wholesale channel.

4.1.2. Product return

Cao et al. (2020) explore the ramifications of a supplier's return policy in the direct channel on the propensity to launch an additional agency channel. The supplier invariably offers return services in the agency channel, yet harbours ambivalence regarding providing such services in the direct channel. The authors examine four possible scenarios based on the supplier's channel selection and return policy. Their findings indicate a tendency for the supplier to extend return services in the direct channel, especially when the salvage value of the returned products is substantial. Importantly, the decision to introduce the agency channel remains unaffected by the return strategy, while the return strategy itself does influence the introduction of the agency channel. Alaei et al. (2022) delve into the influence of the return policy in the direct channel on the selling format decisions of two rival suppliers on a retailer's platform. Contrary to expectations, their results reveal that offering return services in direct channels does not impinge upon the selection between wholesale and agency models.

Chen et al. (2021) explore the selection of return-freight insurance (RI) under the wholesale and agency models. In the presence of RI, the retailer bears the cost of purchasing RI for consumers in the wholesale model, while the supplier carries the RI cost in the agency model. Note that the compensation through RI does not fully cover the cost of the return, resulting in a per-unit return loss for each returned product. The authors find that when the per-unit return loss is low or high, the retailer consistently benefits from providing RI in the wholesale model, while whether to offer RI in the agency model depends on specific conditions.

Wang et al. (2021) examine whether to offer money-back guarantee (MBG) returns in various distribution channels. In the initial stage, the supplier decides to distribute products with either a wholesale or an agency model alongside his direct channel. Then, he decides whether to implement MBG returns within the direct channel. Notably, the supplier consistently provides an MBG for products sold through the retailer channel. In the presence of an MBG, customers incur a hassle cost to return misfit products for a full refund, while in the absence of an MBG, they are compelled to keep the unsatisfactory product. The study reveals that the retailer's choice of selling formats is contingent on the sales efficiency in each channel, whereas the supplier's decision regarding the returns policy is solely influenced by the salvage value of a returned product.

Table 3
Service and product design.

Articles	SCC	SBI	NP	SF	Remarks
Qin et al. (2021)	1 S, 1 R	No	1	W or A	Who offers logistics service
Lai et al. (2022)	1 S, 1 R	Yes	2	A	Whether the R shares logistics service with the S
Zhang and Ma (2022)	1 S, 1 R	No	1	W & A	Whether to offer an agency channel and who to offer logistics service
Cao et al. (2020)	1 S, 1 R	No	2	D & A	Whether the S introduces the agency channel and offers an offline return
Alaei et al. (2022)	2 Ss, 1 R	No	2	W & A & D	Whether Ss offer product returns in the direct channel
Chen et al. (2021)	1 S, 1 R	No	1	W or A	Whether the R offers return insurance
Wang et al. (2021)	1 S, 1 R	No	1	W & A & D	Whether the supplier offers a money-back guarantee return
Zhang et al. (2019)	1 S, 1 R	No	1	A	Endogenous quality and commission fee structure
Luo et al. (2022)	1 S, 1 R	No	1	W & A	Endogenous quality and SF choice
Wei and Dong (2022)	1 S, 1 R	No	2	W & A	SF choice of differentiated quality products
Yenipazarli (2021)	2 Ss, 1 R	No	2	W & A	SF choice of differentiated products under upstream competition
Sun and Ji (2022)	1 S, 1 R	No	1	W or A	Quality enhancement and SF choice

Notes: SCC represents the supply chain structure, SBI denotes the store brand introduction, and SF signifies selling formats. W, A, and D correspond to the wholesale model, agency model, and direct selling, respectively. S and R represent supplier and retailer, respectively. '&' denotes the coexistence of multiple selling formats. NP signifies the number of product types.

4.1.3. Product design

Zhang et al. (2019) examine the dynamics between a retailer's choice of commission contract and a supplier's determination of product quality. Initially, the retailer decides to implement either a fixed commission fee or a revenue-based commission fee on the supplier for each transaction (see Section 2.1). Then, the supplier sets the product quality and prices. The research indicates that pronounced (insignificant) consumer diversity in quality preferences leads the retailer to favor a revenue-based (fixed-fee) contract. This preference is attributed to the fact that a revenue-based commission contract, in contrast to a fixed fee, results in a reduced retail price, whereas the fixed-fee contract encourages the enhancement of product quality beyond what is attainable through revenue sharing.

In the case of Luo et al. (2022), the supplier partakes in commerce through the retailer, utilizing either a wholesale model, an agency model, or a combination of both. Their findings show that when the commission rate is minimal, the supplier chooses a lower quality level and prefers a hybrid model. Conversely, with a higher commission rate, the supplier selects a superior quality level and exclusively engages in a wholesale model. Wei and Dong (2022) study the product design issues of a supplier in different sales channels. In their model, the supplier primarily distributes products through a wholesale model, and then he deliberates on introducing a new agency channel alongside the original retailer. Ultimately, he decides to place the high-end and low-end products between the wholesale and agency channels, respectively. Their results show that when the product differentiation level is high, the supplier favors exclusive distribution of the low-end product through the wholesale channel. This strategic choice prompts the retailer to establish a higher retail price for the low-end product. Consequently, the high-end product experiences a corresponding price increase, allowing the supplier to maximize revenue through the exclusive sale of high-end products with the agency model. However, in situations with low product differentiation leading to intense product competition and cannibalization, the supplier intentionally sells the high-end product exclusively through the wholesale channel to increase the competitiveness of the low-end product in the agency channel. Further works that examine a similar problem are Dai et al. (2023), Zhang et al. (2022), and Zhang et al. (2023).

Numerous researchers, such as Chen et al. (2018), Yenipazarli (2021), and Pu et al. (2022), examine product design strategies aimed at alleviating conflicts between two rival suppliers in the wholesale and agency channels. Yenipazarli (2021) examines how two suppliers with vertical quality differences choose between the wholesale and agency models. Based on the selling format choices of two asymmetric suppliers, he compares and analyzes four possible combinations of selling formats for suppliers, unveiling that the degree of product differentiation between two suppliers significantly influences selling format choice.

Sun and Ji (2022) investigate the interaction between the supplier's investment decision in product functionality and the retailer's selection of selling formats. The retailer initially determines whether to function as a wholesaler or an agent. Subsequently, based on the original quality, the supplier decides whether to leverage customer usage information and incur costs to enhance product functionality. Finally, the retailer establishes a transfer payment to either charge a license fee or subsidize the supplier for each sale. Notably, customers are segmented into privacy-sensitive and privacy-indifferent groups, depending on their willingness to share usage information. This study reveals that the supplier is more inclined to invest and to invest more, in product functionality under the wholesale model compared to the agency model.

4.2. Pricing and promotion

This subsection focuses on price and promotion schemes under the agency model, including bundling pricing, differential pricing, and promotion (see Table 4).

Table 4
Pricing and promotion.

Articles	SSC	SF	Periods	Remarks
Geng et al. (2018)	1 S, 1 R	W or A	1	SF choice under product bundling
Guo et al. (2021)	2 Ss, 1 R	A	1	The S's pricing under the R's bundling decision
Xu et al. (2021)	1 S, 1 R	W or A	1	SF choice under product and service bundling
Zhen and Xu (2022)	1 S, 2 Rs	W & A	1	Agency channel introduction in a new retailer and differential pricing for channels
Xi and Zhang (2023)	1 S, 2 Rs	W & A	1	Agency channel introduction in the original retailer and Differential pricing for channels
Hao and Yang (2022)	1 S, 1 R	W or A	1	Differential pricing for different channels
Chen et al. (2022)	1 S, 1 R	W or A	1	Differential pricing for different types of consumers and SF choice
Chen et al. (2020)	1 S, 1 R	D & W or A	2	SF choice and promotional pricing timing
Chen et al. (2021)	1 S, 1 R	D & W or A	2	SF choice and promotional pricing
Yu et al. (2022)	1 S, 2 Rs	D or W or A	2	SF choice and strategic consumers and promotional pricing

Notes: SCC, S, R, SF, W, A, D, and '&' carry the meanings stated in Table 3.

4.2.1. Bundling pricing

Geng et al. (2018) examine the interaction between a supplier's add-on strategy and a retailer's selling format choice. The supplier's pricing strategy includes bundling the core product and the add-on or selling them separately. In the case of bundling, the supplier sells the bundle through the retailer with either the wholesale or agency model. Alternatively, with add-on pricing, the retailer sells the core product, and the supplier sells the add-on directly. Note that only a subset of consumers find utility in the add-on product, while others do not derive any utility from it. The authors find that the supplier prefers to bundle both products under the wholesale model but chooses to retail the add-on separately under the agency model.

In the scenario studied by Guo et al. (2021), the retailer decides whether to bundle products from two independent suppliers. Both suppliers sell through the retailer with the agency model and set their product prices, while the retailer determines whether to offer the bundled product and establishes its price accordingly. High-valued and low-valued consumers have symmetric valuations for the two products. In comparing models with and without bundling, the authors demonstrate that the retailer adopts the bundling strategy only when the commission rate and the product prices are sufficiently high.

Xu et al. (2021) and Zheng et al. (2022) examine the bundled strategy for products and services under the wholesale and agency models. In the scenario studied by Xu et al. (2021), the supplier presents the product with a fixed production cost, while the service operator delivers the service at no charge. The study postulates a consumer mass uniformly distributed across a square and depicts network externality as a linear function of the anticipated market demand. The findings indicate that bundling under the agency model outperforms that under the wholesale model, particularly when the production cost is relatively small.

4.2.2. Differential pricing

Zhen and Xu (2022) explore the collective decision to introduce an agency channel via a new retailer and employ a differentiated pricing strategy. In the initial channel involving a supplier and a traditional retailer, three alternative scenarios are considered: solely by the supplier, solely by the traditional retailer, and jointly by both the supplier

and retailer. Under the uniform pricing strategy, the supplier commits to matching the retailer's selling price. However, under the differentiated pricing strategy, both the supplier and retailer maximize their profits independently. They find that the supplier prefers both sides to introduce the agency channel, whereas the retailer prefers to introduce the agency channel alone under the differentiated pricing strategy. In a similar vein, Xi and Zhang (2023) analyze the dynamics between a differentiated pricing strategy and the introduction of an agency channel via the initial platform retailer. Their results indicate that, with a differentiated pricing strategy, the platform retailer consistently anticipates the other retailer to introduce the agency channel through her, while the supplier prefers to introduce such a channel alone. In contrast, under the uniform pricing strategy, the platform retailer and the supplier concur to permit the supplier to introduce the agency channel exclusively.

Hao and Yang (2022) explore the impact of the supplier's differentiated pricing strategy on the retailer's choice of selling formats. The retailer assumes roles as either a wholesaler or an agent, while the supplier engages in sales on the retailer platform through both regular and live-streaming channels. Depending on the supplier's price position and price control mechanisms, three pricing strategies are employed by either the supplier or the retailer: targeting high-valued consumers to set a high price in both channels, setting a high price in the regular channel while establishing a lower price in the live channel, and setting a low price to attract all consumers in both channels. Notably, unlike the regular channel, live-streaming selling incurs an effort cost to serve consumers, and this cost is borne by the party establishing the price. Interestingly, their results show that the wholesale model can be superior to the agency model under the differentiated pricing strategy. Chen et al. (2022) examine a similar issue in the single-channel setting, and they demonstrate that differentiated pricing is more likely to be implemented under the wholesale (agency) model when the valuation of the two segments is (not) close.

4.2.3. Promotion

Chen et al. (2020) examine the optimal pricing strategy during a two-period promotion under the wholesale and agency models. In the first period, the supplier utilizes his direct channel to distribute products to customers directly. Subsequently, in the second period, the remaining products are sold at a discounted price via a retailer channel. Ultimately, all superfluous products will be cleared by the retailer or supplier (depending on the selling format) at a loss. The supplier has the flexibility to choose between selling through the retailer with either the wholesale or agency model. Contrary to conventional wisdom brought about by the double marginalization effect, the authors demonstrate that the agency model might result in a higher retail price compared to the wholesale model. In a similar context, Chen et al. (2021) analyze the optimal timing for promotional pricing in an uncertain market under the wholesale and agency models. The supplier first determines the selling format in the retailer channel and subsequently decides on the promotional pricing timing for the dual channel. The promotional pricing timing of the direct channel can be prior to, simultaneous with, or after the retailer channel. Considering the choice of selling format, the authors examine six possible scenarios, and find that when the supplier sets promotional price on the direct channel before the retailer channel, the retail price under the wholesale model is lower than that under the agency model.

Yu et al. (2022) and Zhang et al. (2022) consider how promotional prices evolve under the wholesale and agency models in the presence of strategic consumers. In the scenario studied by Yu et al. (2022), the supplier decides to introduce either a direct selling channel, a wholesale channel, or an agency channel in addition to a pre-existing wholesale channel. Consumers are segmented into myopic and strategic consumers, with myopic consumers purchasing in period one, while strategic consumers base their purchase decisions on the utility gained from buying at a promotional price in period two and the utility acquired from purchasing in period one. Comparing the equilibrium results under three possible dual-channel structures, the authors show that, in contrast to the other two scenarios, introducing the retailer channel with the wholesale model results in the highest retail prices.

4.3. Product match

In the agency model, the retailer, serving as an intermediary connecting consumers and suppliers, plays a crucial role in facilitating matching for both parties. This involves two fundamental aspects: the design of the retailer's recommendation system and the guidance provided by the retailer for consumer search (see Table 5).

4.3.1. Recommendation system

Li et al. (2018) investigate how the recommendation system affects channel members. Two competing suppliers sell products through a common retailer, and the retailer makes recommendations based on their recommendation scores, which is a weighted sum of the expected retailer profits and expected consumer net utility. Loyal consumers buy only from the manufacturer that has their loyalty, while the others are shoppers who only buy products that offer them the highest surplus. Shoppers may be aware of both products, partially aware of one product, or aware of neither product with recommendation. The retailer recommends a corresponding product to a consumer according to the preceding rule after she observes a signal regarding the consumer's location. The finding shows that such a recommendation system may not benefit the retailer; its efficacy depends on the interaction between the signal accuracy, price competition effect, and demand-enhancing effect of the recommender system. In a similar setting, Zhou and Zou (2023) examine the welfare impact of the price-neutral and profit-based recommendation systems. There are two types of consumers: uninformed consumers have no knowledge about products and only buy the recommended item, while informed consumers choose the product that offers them maximum utility. The retailer infers the consumers' preferences based on a noisy signal. She recommends a product to

Table 5
Recommendation system and search.

Articles	SSC	SF	PRS	Remarks
Li et al. (2018)	2 Ss, 1 R	A	The R's profit and the consumer's net utility	How does the recommendation system affect the Ss' competition
Zhou and Zou (2023)	2 Ss, 1 R	A	Consumer preference/ price	When to choose a price-neutral/ profit-based recommendation system
Zhang et al. (2021)	1 S, 2 Rs	A	-	Whether the R recommends the competing R
Zhou et al. (2023)	2 Ss, 1 R	A	-	Who the R recommends
Teh and Wright (2022)	n Ss, 1 R	A	Expected commission, price, and consumers' match component	How Ss' competition in prices and commissions affect R's recommendation
Johnson et al. (2023)	n Ss, 1 R	A	The current and previous prices	When to choose (dynamic) price-directed prominence when suppliers use Q-learning pricing algorithm
Jiang and Zou (2020)	n Ss, 1 R	A	-	How consumer search cost and filtering affect members' welfare
Song (2021)	1 S, 1 R	A	-	Whether the R makes store-brand products prominent
Zennyo (2022)	n Ss, 1 R	A	-	Whether the R makes store-brand products prominent

Notes: SCC, S, R, SF, and A retain the meanings specified in Table 3. PRS refers to the principle of the recommender system.

consumers solely based on her perceived product fit information under the price-neutral recommendation system. In contrast, she further incorporates suppliers' price information to recommend the product with the highest expected profit under the profit-based recommendation system. They show that although the profit-based recommendation system seems advantageous, the price-neutral recommendation system can dominate because it alleviates suppliers' recommendation competition when the consumer profiling accuracy is sufficiently high.

Zhang et al. (2021) explore the propensity of a retailer to make recommendations steering consumers to her competitor. They find that two rival retailers may recommend each other when the supplier employs a uniform pricing scheme. This counterintuitive phenomenon is due to the alignment of interests between both retailers. Zhou et al. (2023) study whether the retailer makes exclusive or nonexclusive recommendations about suppliers. They reveal that the retailer prefers to make a selective recommendation in either low- or high-competition markets.

The work of Teh and Wright (2022) examines a scenario where multiple suppliers engage in price and commission competition to obtain a recommendation from a common retailer. The retailer ranks products based on three components: price, commission, and perceived consumer match values. Compared to the unbiased case where the retailer recommends products of maximum utility for consumers (no steering), steering consumers through recommendation engenders a prisoner's dilemma for competing suppliers. Under steering, each supplier endeavors to gain an advantageous edge through commissions, but they end up paying the same commission. Consequently, the higher commissions result in a higher equilibrium price and a smaller market size, which leaves them in a less favorable position. Johnson et al. (2023) explore the implication of the dominant retailer's steering rules when suppliers use pricing algorithms. The retailer balances commission fees and consumer surplus and employs the following two policies to steer consumers to purchase from certain suppliers: price-directed prominence (PDP), and dynamic price-directed prominence (Dynamic PDP). The former simply guides consumers toward these suppliers with lower prices; the latter additionally takes into account past prices. In response to the steering rules, suppliers use a Q-learning algorithm to set prices. The authors show that compared to PDP, Dynamic PDP leads to a substantial increase in consumer surplus and a moderate increase in platform commissions.

4.3.2. Search

Jiang and Zou (2020) focus on how reduced consumer search cost on a retail platform impacts suppliers, a retailer, and consumers. In their setting, consumers either incur search costs to learn the match value and price of each product in turn, or they exit to choose an outside option. The equilibrium search strategy follows Wolinsky (1986): consumers stop searching and buy the last searched-for product if and only if the incremental utility of making another search is less than the search cost. Their findings indicate that while a lower search cost intensifies competition among suppliers, potentially reducing profits, these reduced search costs can, paradoxically, result in higher profits. This occurs because reduced search costs make consumers more inclined to purchase from the retailer rather than choose the outside option.

Song (2021) employs a search model to investigate whether the retailer should rank her store-brand products first. Specifically, consumers first visit the prominent product list arranged by the retailer; then, they decide whether to search for other products inside the retail platform or the outside option product before making a purchase. Note that although consumers have heterogeneous search costs for different products, and they can free recall. The author reveals that when an outside market exists, the retailer will make the store-brand products prominent because the negative effect of price reduction is outweighed by the positive effect of increased demand. Unlike the prior model, Zennyo (2022) assumes that there are multiple consumers and suppliers first determining whether to participate in the retail platform before consumers decide how many product searches to conduct. Notably, consumers are heterogeneous regarding their outside options. His results indicate that the retailer's preference for store brand products is not necessarily anti-competitive because this self-preference behavior benefits consumers, so the retailer can attract more consumers. However, to counter the negative effect of this behavior, the retailer will reduce the commission fee to incentivize greater supplier participation.

5. Information management

Effective information management constitutes a pivotal facet of supply chain management, with far-reaching impacts on channel efficiency, consumer decision-making, and the dynamics between channel members. In the subsequent sections, we organize the pertinent literature (see Table 6) according to three perspectives: demand information learning from retailers, product information learning from retailers, suppliers or consumers, and information strategy in response to information asymmetry among supply chain members.

5.1. Demand information sharing

Ha et al. (2022b) investigate how the retailer's decision to share information impacts the supplier's choice to expand the channel by encroaching on the retailer platform with an agency model. They employ a random variable to depict demand uncertainty and assume the information structure follows a linear relationship. The original and new

Table 6
Information management.

Articles	SCC	SF	CF	AI	DF	Remarks
Ha et al. (2022b)	1 S, 1 R	W & A	B	Demand	N	DI sharing and whether to introduce the agency channel
Zhang and Zhang (2020)	1 S, 1 R	D & W or A	B	Demand	U	DI sharing and S encroachment
Wang et al. (2021)	1 S, 2 Rs	W & A	B	Demand	N	Share DI to whom
Zha et al. (2022)	1 S, 2 Rs	W & A	B	Demand	N	Share DI to whom and SF choice
Chen et al. (2021)	1 S, 1 R	W or A	-	Demand	N	Whether to share DI and recommend and SF choice
Wu and Yu (2022)	2 Ss, 1 R	W & A	B	Demand	U	Costly share DI to whom
Kwark et al. (2017)	2 Ss, 1 R	W or A	C	Quality	-	Quality information learning and SF choice
Li et al. (2019)	1 S, 2 Rs	W or A	C	Fit	-	Fit information learning and SF choice
Hao and Tan (2019)	1 S, 1 R	W or A	C	Valuation	-	Who should facilitate consumers' valuation learning and SF choice
Jiang et al. (2011)	1 S, 1 R	A	-	Demand	High or low	R's demand learning and store-brand introduction
Yan et al. (2019)	1 S, 1 R	W & A	C	Demand & Cost	High or low	Whether to introduce the agency channel
Li et al. (2021)	1 S, 2 Rs	W & A	B	Demand	High or low	Sharing DI to which R

Notes: The meanings of SCC, S, R, SF, W, A, D, and '&' are as in Table 3. CF denotes the competition forms, and B and C refer to the Bertrand and Cournot competition, respectively. AI stands for asymmetric information. DF signifies the distribution forms, and N and U represent the normal and uniform distribution. H and L mean the high and low demand states, respectively. DI refers to demand information.

agency channels adopt the wholesale and agency models, respectively. By comparing information-sharing strategies with and without channel expansion, the authors demonstrate that the retailer prefers to withhold demand information without encroachment, while she tends to share information only when the commission rate is at an intermediate level in the presence of encroachment. In a similar context, Zhang and Zhang (2020) analyze the effect of the retailer's demand information-sharing decision on the supplier's offline channel expansion. At the beginning of the game, the retailer determines to utilize either a wholesale or an agency model. Subsequently, the retailer decides whether to share the market potential information and finally, the supplier determines whether to set up an offline direct channel. The results highlight that retailers have opposite information sharing strategies under the wholesale and agency model. Further works that consider similar motives are those of Zheng et al. (2021) and Zhang and Ma (2023).

To further examine the retailers' incentive to share demand information in asymmetric channel structures (Zhong et al., 2023) (see Section 3.3.1.1 and Fig. 6 (II)), Zha et al. (2022) examine four possible information sharing strategy for the giant retailer. This study considers no information sharing, only sharing with the supplier, only sharing with the small retailer, and full information sharing. Combining these strategies with the giant retailer's choice of selling formats, the authors analyze eight potential scenarios. The findings indicate that regardless of the supplier's selling formats, the giant retailer always has incentives to share demand information with the supplier. Moreover, the dominant retailer has more substantial incentives to share information with the supplier under the agency model. In a similar vein, Wang et al. (2021) assume that the supplier distributes products through both small and giant retailers with a wholesale model, while the small retailer sells via the dominant retailer with an agency model. They conclude that with low channel competition, the dominant retailer prefers to share information with the small retailer. When the competition intensity is moderate and the proportional fee is low, the full information-sharing strategy is optimal; otherwise, the giant retailer is inclined to share information with the supplier.

Additionally, several studies extend the above works to examine the effects of the wholesale and agency model on retailers' motivation for information sharing in the context of other market conduct, such as online recommendations (Chen et al., 2021), cause marketing (Xu & Li, 2022), and blockchain usage (Wu & Yu, 2022). In the scenario studied by Chen et al. (2021), the online recommendation level positively affects the demand and is independent of demand uncertainty. Analyzing the equilibrium solutions, the authors show that the platform retailer tends to withhold demand information under the wholesale model but prefers to share demand information under the agency model in both the recommendation and non-recommendation scenarios. Wu and Yu (2022) consider the retailer's information-sharing strategies with two suppliers with wholesale and agency distribution models. The retailer uses blockchain to eliminate information asymmetry and transaction costs. The results show that when the commission rate is low, the retailer has an incentive to share information with the wholesaler via blockchain; when the rate is moderate, she prefers the agency seller to join the blockchain; otherwise, she withholds the demand information.

5.2. Product information learning

Apart from the asymmetry of demand information, consumers could learn product information from disclosed product quality information (Hong et al., 2023) and online reviews. This information significantly impacts consumers' expected utility and, in turn, affects the upstream decisions regarding selling formats. Kwark et al. (2017) examine a case where two suppliers distribute their products through a common retailer. The retailer with third-party information strategically chooses the wholesale or agency model. Third-party information is common knowledge to all members and helps consumers identify quality and fit attribute information better. Based on Bayesian updating, the authors derive the expected utility difference between two products with a perceived quality difference and a misfit signal. The results demonstrate that sharing information on quality attributes decreases the perceived utility differences among competing products, resulting in intensified competition between suppliers. This benefits the retailer utilizing the wholesale model but hurts the retailer using the agency model. Conversely, sharing information on the fit dimension increases differences in consumers' perceived fit with products, leading to softened competition between suppliers. This harms the retailer under the wholesale model but positively impacts the retailer under the agency model.

Li et al. (2019) explore the interplay between the online consumer review (OCR) integration strategy for the offline retailer and the online retailer's selling format choice. The offline retailer moves first to decide whether to integrate consumer reviews from the online retailer. It is crucial to note that the authors conceptualize offline services and OCR as signals perceptible to consumers. Ultimately, they find that integrating OCR can benefit the offline retailer when the OCR is more informative than the offline services, particularly under the wholesale model. Moreover, the offline retailer may also prefer to integrate the OCR even when it is less informative than the offline services under the agency model.

Hao and Tan (2019) investigate incentives for the retailer and supplier to facilitate information disclosure under the wholesale and agency models. In their setting, consumers are uncertain about their true valuation but can receive a private signal equal to their true valuation. The facilitating of information disclosure improves the accuracy of the signal. The findings indicate that when consumers' valuation distribution has a relatively high dispersion, and the accuracy of information is moderate, the supplier benefits, but the retailer suffers from more information disclosure in the agency model. Nevertheless, double marginalization eradicates the potential benefits associated with more information disclosure in the wholesale model.

5.3. Information strategy

Asymmetric information between retailers and suppliers occurs when one party possesses more information than the other party, which motivates either party to deploy information strategies (Belhadj et al., 2020; Wang et al., 2022; Yan et al., 2019) to mitigate information asymmetries and reach a consensus on uncertain information. However, when alternative selling formats are available to them, the corresponding information design must be more deliberate. For instance, Jiang et al. (2011) analyze a platform retailer's strategic introduction of store brand products in response to uncertain ex-ante demand. In a two-period model, the retailer updates her belief after observing the supplier's first-period sales and decides whether to introduce store brands. If the supplier sells store brands, participants simultaneously choose their service level and price. If the supplier decides not to introduce store brands, he picks his second-period service level and price. Anticipating the supplier's incentives to withhold high-demand information by lowering his sales with a reduced service level, the authors employ intuitive criteria and additional logical reasoning to refine the equilibrium results. Their results indicate that the retailer might suffer from introducing store brands, and the supplier may benefit from the retailer's threat of entry.

Yan et al. (2019) address the supplier's channel choice strategy under demand information asymmetry. The downstream firms privately observe the exact demand state and initially decide on the order quantities under the wholesale model. Then, the supplier acquires demand information through two strategies and tailors his sales under the agency model: one strategy is to pool at first and infer from the signal; the other is to screen the type of retailer by adjusting the wholesale price. By comparing the profits in these cases, the supplier considers the following trade-off. Although screening allows the supplier to benefit from inferring demand information early, it takes the retailer out of the

wholesaling market when the demand state is low, which hurts the supplier when considering the sales inefficiency cost and commission fee.

Li et al. (2021) investigate a dominant retailer's strategic information sharing in an asymmetric market (see Fig. 6 (II)). The giant retailer chooses between four alternative information-sharing strategies: no information sharing, full information sharing, information sharing only with the supplier, and information sharing only with the small retailer. When information is shared, the authors characterize the lexicographically maximum sequential equilibrium in the signaling game. Their findings reveal that when the channel competition between the supplier and the small retailer is relatively low and the demand variability is moderate, the giant retailer prefers full information sharing; otherwise, she prefers to share information only with the supplier.

6. Conclusion and future research

The growth of e-commerce and the platform economy have spurred the adoption of the agency model. Over the last decade, since the inception of Amazon Marketplace, the agency model has gained popularity among online retailers. Motivated by the overwhelming phenomenon, academia has turned its attention to three key questions: 1) *What is the impact of the agency model on channel distribution?* 2) *What is the optimal operations management strategy when employing the agency model? and 3) What is the optimal information management strategy when employing the agency model?* Through academic research, scholars have gained a deeper understanding of these cutting-edge practices, including the role of the agency model in coordinating channel conflicts and managing the marketing mix and information disclosure. Despite significant attention already given to this topic, there is still room for further research, which we discuss below.

(1) *Extension of empirical research*

Most of the sampled works employ game-theoretic or operations research approaches to formulate stylized theoretical models. Only a few papers (Santos & Wildenbeest, 2017; He et al., 2020; Li et al., 2019; Maier & Wieringa, 2021; Zhu & Liu, 2018) have empirically investigated the effect of the introduction of the agency model due to the lack of the data. Table 7 summarises the research questions and data sources used in the above empirical studies. These empirical analyses shed light on the effects of the agency model on supplier prices and volumes, but they fail to explain the dissimilarity in the optimal marketing strategy under the wholesale and agency models. Future empirical research, therefore, holds the potential for studying the distinct operational strategies employed by suppliers and retailers under the agency model. In addition, empirical research is subject to platform restrictions on information scraping (Amazon, 2022). Hence, platforms should balance their data use and disclosure policies. We believe that more data availability will encourage scholars worldwide to analyze data and publish their research to better bridge the gap between theoretical and empirical research.

Table 7
Research questions and data sources for empirical studies.

Article	Research question	Data source
Santos and Wildenbeest (2017)	The price difference under the wholesale and agency model	Daily prices of e-books on Amazon and other major e-book retailers
Zhu and Liu (2018)	Amazon's entry pattern into third-party sellers' product spaces	Product category data for Amazon third-party sellers and Amazon private label
Li et al. (2019)	The effect of the agency model on the wholesale model	Weekly online sales date from an online retail platform in China
He et al. (2020)	The effect of the platform entry on the demand of third-party sellers	Transaction data from an e-commerce platform in China
Maier and Wieringa (2021)	Whether the introduction agency channel grows or cannibalizes a retailer's sales	Daily sales data of an international retailer of refurbished electronics

(2) *Realistic modeling principles*

Most of the reviewed papers make restrictive assumptions, such as a linear and deterministic demand function and a single-period equilibrium. The findings of Hu et al. (2022) state that the general consensus in the literature regarding supplier preferences for the agency model is only applicable under linear demand, meaning that contradictory results may hold under multiplicative or exponential demands. In addition, Johnson et al. (2023) and Zennyo (2022) employ the standard logit function to characterize an oligopoly equilibrium. Mai et al. (2021) develop a dynamic repeated game model based on a long-term gradient adjustment mechanism to characterize the price adjustment for a supplier with bounded rationality. These provide a guideline for examining the strategic choice of the agency model in a more realistic situation. Hence, future research could also try to solve complex stochastic demands and multi-period equilibria, but this part of the research may rely on the development of simulation models and numerical computing methods.

(3) *Platform's self-preferencing behavior*

On the one hand, the platform typically holds substantial power in online markets, which gives it a dominant advantage in competition with third-party sellers. This power allows the platform to dictate contract types and engage in self-preferencing behavior. In particular, the platform has a solid motivation to imitate and produce popular products based on analysis of sales data. What is more, she can manipulate algorithms and recommendation systems to gain a more competitive advantage, and therefore, such a platform's self-preferencing behavior creates regulatory issues and concerns. Sellers, on the other hand, will not sit still about an unfair advantage, and they may use weapons to fight against such behavior. For one thing, they may coerce the platform to guarantee them exclusive selling using the threat that they will exit this marketplace. For another thing, they may utilize high investments (or upgrades) to make their products difficult for platforms to imitate; other options also exist. Nevertheless, limited research has been conducted on such platform behavior, with Jiang et al. (2011), Hagiu et al. (2022), and Zhu and Liu (2018) being exceptions. Given this, a series of questions arise: Under what circumstances do platforms enter consumer markets? How do third-party sellers counter platform entry? Do regulators need to impose restrictions on such behavior of platforms?

(4) *New business practices*

In the ever-changing business landscape, the marketing tactics employed by platforms are not set in stone. Fluctuations in regulatory regulations or market trends can prompt strategic adaptation by channel participants. Antitrust scrutiny, for instance, has driven platforms to lower their commission rates, attracting academic interest in examining these business model modifications (such as Bhargava et al., 2022). Ongoing changes in platform rules will continue to fuel the growth of this area of research. Future studies could focus on tracking changes in platform rules as a means of supporting and guiding the advancement of business practices.

(5) *Retailers with multiple revenue structures*

Contrary to the conventional wisdom that sales revenue constitutes the principal source of income for retailers, commission fees have emerged as a substantial revenue stream as the use of the agency model grows. Additionally, in their dual capacity as wholesalers and agents, retailers engage in a variety of commercial activities, including advertising and the provision of other marketing services. For instance, retailers design their

marketplaces with additional considerations for advertising revenue streams (Hao et al., 2017). In their study, an advertising revenue contract enables the retailer to predetermine the advertising price and the revenue-sharing rate with the developer, thereby considering both advertising income and agency sales revenue in this context. Future studies could investigate complex dynamics among advertisers, suppliers, and retailers. This encompasses determining who manages the advertising bids, the methodologies employed, and the manner in which retailers balance advertising income against agency sales revenue post-bid. Another notable research gap relates to platform retailers, such as JD.com and Amazon, that also operate as logistics service providers, thus generating business income beyond traditional sales revenue and commissions. Acknowledging these additional sources of revenue is a critical consideration for platform retailers when selecting their sales formats. Consequently, future research could probe into how platforms with multifaceted roles adapt and organize their operations across various sales formats.

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