DOUBLY-BOUND RELATIONSHIP BETWEEN PUBLISHER AND RETAILER: THE CURIOUS MIX OF WHOLESALE AND AGENCY MODELS

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Abstract

Since the time the industry for e-books transitioned from the wholesale to the agency model, several interesting observations have been made. For instance, despite its revenue-sharing approach that is supposed to be effective in addressing channel coordination issues present in wholesaling, the agency model has curiously led to higher prices and less demand in the e-book market. The main purpose of the current study is to provide insights into this curious market phenomenon by focusing on: (i) the substitutability between the printed- and e-book versions, and (ii) the interaction between the wholesale model (for printed books) and the agency model (for e-books). In this exploration, using a game-theoretic model, we discover that an increase in the agency fee that the retailer collects in the e-book market can depress the vitality of the market, which not only ends up hurting the publisher, but also the retailer. This is a telltale sign that retailers should perhaps be moderate in their effort to get a bigger cut in the agency arrangement. In addition, the complex interplay between the two parties across two retail channels is explained along with how it may lead to a counterintuitive equilibrium outcome. Some of the interesting observations from practice may, in fact, stem from a large agency fee in the e-book market. Reducing this fee can lead to a win-win outcome for both the publisher and the retailer.

Keywords: Agency, books, e-books, economic theory, retailing, revenue sharing, substitutes, wholesale.

Brief Bio of the Author

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Introduction

In what could be described as Amazon's "empire" today, the book market still remains a significant part of the company that was launched originally with a narrower focus of becoming the "Earth's biggest bookstore" [24]. Books were Amazon's largest product category up until 2008, and book sales still stretch well beyond US$7 billion mark [14]. As an online book retailer, Amazon demonstrates its unparalleled prowess, and some go so far as to say that "Amazon has basically no competition among online booksellers" [25]. The company is tightening its grip on the book market by also opening physical bookstores in its hometown of Seattle, with plans to open hundreds more in the near future [5].

In 2010, this retail giant ended up in a tug of war with some of the major publishers—often referred to as the "Big Five"—the power struggle essentially being about the e-books [11]. Traditionally, printed books have been sold through a wholesale arrangement, where a publisher first sells to a retailer at a wholesale price and then the retailer resells to consumers at a retail price. Amazon wanted to extend this model to the e-book market to control the retail price of e-books as well. The publishers, however, had something else in mind. The digital format of e-books afforded more flexible retail arrangements, and the publishers wanted the agency model where they—instead of the retailer—get to decide on the final retail price and pay a certain fraction of their revenue to the retailer as an agency fee. Unwilling to give up the control over the e-book retail price, Amazon did not agree to the agency model, and a long battle between Amazon and the publishers ensued, involving lawsuits with the US Department of Justice in 2012 as well as several back and forth between the wholesale and agency arrangements in the e-book market [11].

A few years later, in 2016, it seemed as though the publishers had gotten their way. The publishers made Amazon agree to the agency model in the e-book market [30, 34]. However, since the adoption of this agency model, something puzzling has happened. Despite an anticipation that it would flourish, the e-book market has actually shrunk, and in contrast, the printed-book market has grown. Moreover, the e-book prices have gone up whereas the printed-book prices have gone down, and the publishers' profits have decreased whereas Amazon's increased [7, 28, 29]. Mike Shatzkin—the founder and CEO of *The Idea*

Logical, a New York publishing consultancy—shares something that raises a suspicion that the publishers might not have fully comprehended the repercussions of moving to the agency model in the e-book market. He writes, "…four of the five big publishers think agency has been a big mistake. As one observer sees it, it has bled 25% out of digital sales that have been replaced by physical, resulting in an increased share for Amazon of the print portion of publishers' businesses" [29]. In stark contrast, according to Shatzkin [28], "Amazon is now happy with the fact that they have no control over the final retail price of e-books."

Such a market outcome is quite ironic considering how aggressively the publishers pushed to gain control over the e-book price. And, the outcome may appear even more puzzling when we consider what the conventional wisdom suggests. The lack of channel coordination in the wholesale model leads to double marginalization, which manifests itself in the market as an inefficiently high retail price and low market coverage [36, p. 175]. Often, revenue-sharing schemes such as the agency model are touted as a possible solution to this double-marginalization problem. Hence, with the injection of this revenue sharing into the old pure-wholesale model, one might have expected the retail prices to go down and the demands to go up in the e-book market. The dissonance between the reality and the conventional wisdom leads us to the following questions: Why could the publishers not benefit from having more control over their e-book price? What could the publishers have overlooked while forcing Amazon to agree to the agency arrangement? Why does the conventional wisdom that introducing the agency model would reduce price and increase demand not apply here? Further, given the publishers' remorse about moving to the agency model, should the publishers now try to move back to wholesaling? As mentioned above, there have already been several back and forth between wholesale and agency models in the e-book market. Is there a retail configuration that can be mutually beneficial to the parties involved? These are the questions we explore in this work.

Specifically, we focus on two defining market characteristics: (i) printed books and e-books are partially substitutable, and (ii) e-books are now sold through the agency model whereas printed books are still sold through the wholesale setup. Hereafter, this arrangement is referred to as agency-mix, which is in contrast to the pure-wholesale setup where both products were sold through the wholesale arrangement. So,

in this market, the coexistence of the wholesale and the agency models create complications that some compare to a “three-dimensional chess” [28]. Perhaps this analogy is apt. Chess is normally played between two players on a two-dimensional board, but now, the mixture of wholesale and agency channels gives rise to a third dimension, requiring the players to consider both channels together, not separately. The focus of this work is to delineate the dynamics between the publisher and the retailer in such a doubly-bound relationship and to provide possible explanations to the surprising real-world observations.

For this exploration, we put together a parsimonious model where the publisher sells its printed books through the wholesale model and sells the electronic version through the agency model. In essence, this setup captures a market where the retailer sets the final retail price for printed books, while the publisher sets the final retail price for e-books. From the analyses, we arrive at several interesting findings that are of managerial importance. First, unlike what the prior literature suggests, the retailer’s profit in the e-book market can actually decrease in the agency fee—as the retailer claims a bigger fraction of the e-book price, the publisher finds the e-book market less attractive and raises the e-book price with the intent of nudging consumers to the printed-book market. Such a reaction from the publisher may depress the e-book market to a degree that the retailer actually loses despite its ability to claim a higher agency fee. Moreover, this loss in the e-book market can end up hurting the retailer’s overall bottom line. This finding implies that Amazon should perhaps be careful while pushing for a larger cut of the pie in the e-book market.

Also, the game-theoretic interaction between the publisher and the retailer gives rise to an interesting equilibrium whereby the effect of the agency fee in the e-book market spills over to the printed-book market, and an increase in the demand for printed books can be accompanied by a higher printed-book price. Along the same lines, we also discover that a high agency fee alone can account for the realities of today’s book market. Finally, regarding the two potential remedies—(i) going back to pure-wholesale, or (ii) reducing the agency fee while keeping the agency-mix model—the findings of this paper suggest that the latter can lead to a win-win outcome for both the publisher and the retailer.

Literature Review

One of the key defining characteristics of digital goods is the high level of flexibility in how the products can be sold. For instance, firms can provide increased variety through consumer-driven bundling [2], can distribute time-locked samples to help consumers learn about the fit [13], can sell add-ons in the form of downloadable contents (DLC) after selling the base version of a product (e.g., game) [12], and can even offer their products across the globe despite the presence of cultural protection policies [10]. Alongside a traditional method of directly charging consumers, firms may consider revenue streams from advertisements as well [15, 23]. There is also a rich body of literature on various types of channel structures in markets for information goods, and the key reason behind this variety is that distribution channels for digital goods exhibit a higher level of flexibility. Firms could adopt many innovative ways of reaching their consumers across different digital channels [4]. For instance, Lang and Vragov [22] compare a more traditional client-server model with a newer peer-to-peer model. Putting the two types together, Feng et al. [16] consider the dual channel structure comprising a business-to-consumer (B2C) channel and an innovative consumer-to-consumer (C2C) channel.

The agency model—where the retailer provides a convenient platform to connect firms with their customers—is now among the very popular arrangements for selling all sorts of digital goods, including apps, games, music, movies, and e-books. The novel element of the agency model is that the manufacturer can directly control the retail price, and the retailer simply collects a fraction of the revenue without being involved in the pricing decision. This novelty has drawn much attention from the research community [e.g., 1, 18, 21, 35]. In this work, the main focus is on what happens when the agency model is applied to the e-book market along with the wholesale model in the printed-book market, creating complex dynamics between the publisher and the retailer as the two parties engage in both markets through two very different retail arrangements.

The wholesale model has been widely adopted. Under wholesaling, once a manufacturer sells its products to a retailer, it no longer needs to keep track of them. From the retailer's point of view, once it

purchases the products from the manufacturer, it has the freedom to set whatever retail price fits its overall market strategy. Such convenience and flexibility are among the main reasons for the popularity of the wholesale arrangement. However, such an arrangement is not without problems. One of the most well-known issues with wholesaling is double marginalization [33]—when a monopolistic manufacturer sells through a monopolistic retailer, the vertical externality manifests itself as a higher retail price, a lower demand, and hence, reduced profits. The related literature is so vast that it is impossible to provide a comprehensive coverage in the short literature review section of this work. (Interested readers should refer to the surveys by Cachon [8] and Höhn [19].) Among the ideas that have been proposed to address double marginalization is revenue sharing, which is at the heart of the agency model [8, 27]. However, prior work has also demonstrated that revenue sharing may not be a panacea for double marginalization. For instance, if costly advertising becomes critical to boosting sales, royalty payments based on a revenue-sharing formula may not fully coordinate the channel [9, 17]. Augmenting this stream, this work shows that the agency model may not automatically translate to lower margins and a lower retail price even when factors such as costly advertising are assumed away.

This research relates most closely to the growing body of literature that considers both the agency and the wholesale setup. Kwark et al. [21] explore a setting with upstream competition between manufacturers and identifies cases where the retailer benefits from external third-party information concerning the quality and the fit of the product. There, the authors consider both the wholesale and agency models, albeit in separate settings. Like us, Abhishek et al. [1] also consider a case where substitute products are sold through a mixture of wholesale and agency arrangements. However, their model captures the case where one retailer sells the printed book and the other, the e-book. They do not consider the case of one monopolistic retailer selling both products (printed book and e-book). Accordingly, the nature of the game there is quite different from the one studied here. This work is inspired by what has happened between publishers and Amazon, a monopolistic retailer selling both the formats. Therefore, the insights are different as well. For example, Abhishek et al. [1] find that, in the absence of network externalities, the e-book price is higher under

wholesaling. In contrast, in our paper, the e-book price may actually be higher under agency selling, in line with the realities of today's e-book market.

A similar setup is also found in [35] where the retailer sells traditional goods through wholesaling and digital goods through an agency arrangement. While the model details differ, the authors also find that the agency model may be preferred to the traditional wholesale setup by both the publisher and retailer. However, they find that the retailer can only do better with a higher agency fee, which is in contrast with one of the main findings of this work. In addition, the authors argue that utilizing a "partial revenue sharing" scheme alleviates double marginalization, leading to lower retail prices and an increase in the overall demand. On the contrary, this paper finds that the e-book price can actually be higher in the agency-mix setting than in the pure-wholesale model, leading to a shrinkage in the e-book market. The key reason for this difference in the results is the timing of the game—unlike our setup, where the retail prices are determined simultaneously, there, the retail price for e-book is determined before that of the printed version. Since the publisher has full control over the e-book's retail price though—and the retailer over the printed-book's retail price—it is more realistic to assume that the retail prices can be changed at will in response to each other.

In another related work, Hao and Fan [18] focus on the complementary relationship between e-books and e-readers. Unlike this paper, they assume an exogenous price for the printed book and find that selling an e-reader as a two-part tariff can address the issue of double marginalization. Nevertheless, thanks to virtualization technologies, content is becoming increasingly platform-independent—through the use of appropriate apps, people can now read e-books on any device, handheld or otherwise. Therefore, we do not consider platform aspects in this work.

Model

Following the realities of the book market today, we examine the case where e-books are sold through the agency model and printed books are sold through wholesaling. The timeline of events is as depicted in

Figure 1: First, at time $t = 0$, the publisher sets the wholesale price (w_b) of the printed-book version. Then, at $t = 1$, the retailer sets the retail price (p_b) of the printed book and the publisher, the retail price (p_e) of the e-book. This sequence captures the fact that (i) the wholesale price is typically determined before the retail prices are, and (ii) the retail prices are relatively more fluid compared to the wholesale price. Once the retail prices are set, at $t = 2$, the demand for each version is realized. Following backward induction, we first visit the demand specification, and subsequently, the profit maximization problems of the publisher and the retailer.

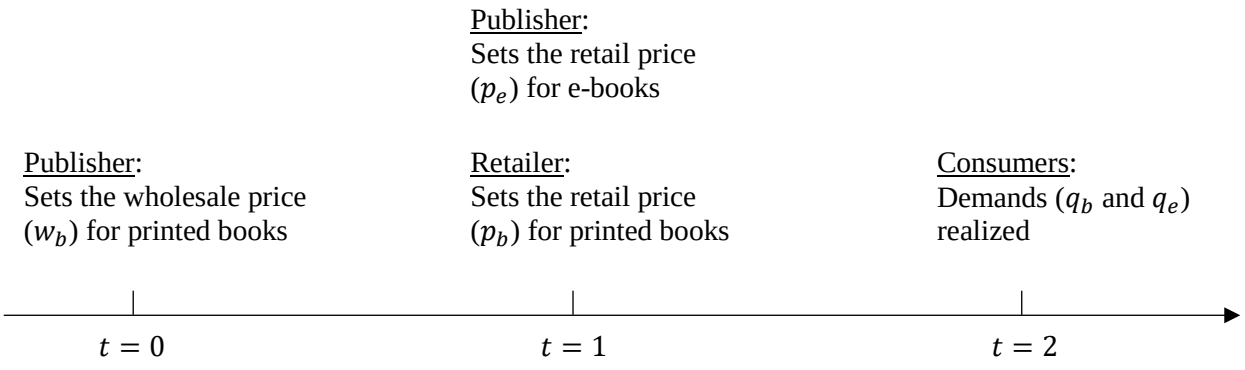

Figure 1: Timeline

Demand System

Here, we assume that the two versions (printed- and e-book) are symmetric and differentiated, and the consumers make a purchase decision based on: (i) the retail prices they see, and (ii) the substitutability between the two. We simply adopt a commonly used linear demand system [1, 20, 26, 31, 32] and denote printed- and e-books by subscripts b and e, respectively. The demands for printed- and e-books—$q_b \geq 0$ and $q_e \geq 0$—are:

$$q_b = \frac{1}{1+\sigma} - \frac{1}{1-\sigma^2} p_b + \frac{\sigma}{1-\sigma^2} p_e, \quad \text{and} \tag{1}$$

$$q_e = \frac{1}{1+\sigma} - \frac{1}{1-\sigma^2} p_e + \frac{\sigma}{1-\sigma^2} p_b, \tag{2}$$

where p_b and p_e are retail prices of printed- and e-book versions and $0 < \sigma < 1$ represents the substitutability between the two versions.[1] The level of substitutability, σ, is closely related to the cross-elasticity of demand which, in practice, can be estimated through field experiments. For example, one can run a promotion on the e-book or send out coupons for the printed book and note the ensuing changes in their demands. One could also use secondary data to see how an external price shock for one version (e.g., a new tax) affects the demand for the other.

Let us now take a closer look at the behavior of this demand specification. First, as expected, we see from Equations (1) and (2) that the demand for a version decreases in its own price and increases in the price of the substitute. Second, as the substitutability increases, the price difference between the two become more important as a determinant of the demand. This behavior is perhaps better illustrated by rearranging the above expression as: $q_f = \frac{1}{1+\sigma}(1 - p_s - \frac{1}{1-\sigma}(p_f - p_s))$, where subscript $f \in \{b, e\}$ stands for the "focal" product and $s(\neq f) \in \{b, e\}$ stands for the substitute.

As can be inferred from the lack of any explicit incentive compatibility constraints, we allow consumers to purchase both versions. In fact, if the two products are substantially different—say, the content formats are significantly different between the two versions [6]—a consumer who purchases the printed version may also end up purchasing the electronic version. Nonetheless, the total demand, $q_b + q_e = \frac{2-p_b-p_e}{1+\sigma}$, shrinks as the two versions become more substitutable. This is intuitive since, when the two versions are highly substitutable, consumers who purchase one version would be reluctant to also purchase the other.

Publisher's and Retailer's Decisions

For e-books, the publisher and the retailer are in an agency arrangement: The publisher directly controls the retail price (p_e) and, as an agency fee, pays the retailer a fraction $\alpha \in (0, 1)$ of the retail price for each copy sold. For printed books, the firms engage in a wholesale agreement, where the publisher sets the wholesale price (w_b) and then the retailer, the retail price (p_b). This combination of agency and wholesale arrangements between the publisher and retailer is summarized in Figure 2.

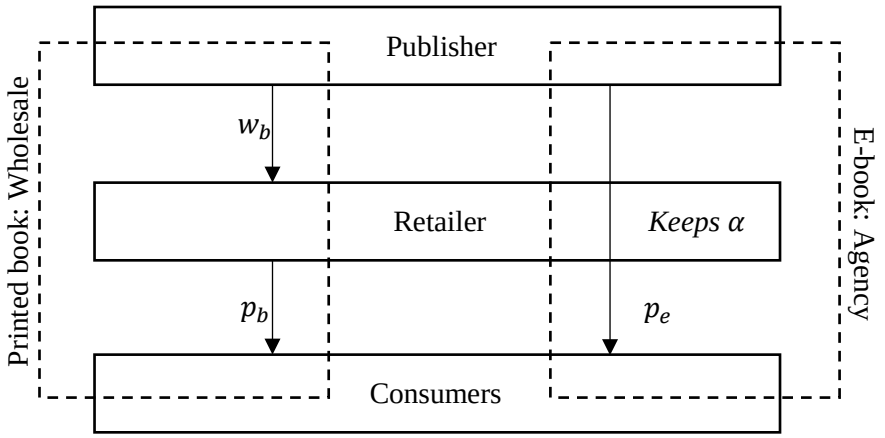

Figure 2: Publisher and Retailer Relationship

From the setting, the profits for the publisher and the retailer—Π_P and Π_R—can be written as:

$$\Pi_P = q_b w_b + (1-\alpha) q_e p_e, \quad \text{and} \tag{3}$$

$$\Pi_R = q_b (p_b - w_b) + \alpha q_e p_e. \tag{4}$$

The firms set the retail prices—the publisher sets p_e and the retailer, p_b—to maximize their own profits. Simultaneously solving the first-order conditions $\frac{d\Pi_P}{dp_e} = 0$ and $\frac{d\Pi_R}{dp_b} = 0$, we obtain the following equilibrium prices:[2]

$$p_e^* = \frac{(1-\alpha)(2-\sigma(1+\sigma)) + w_b \sigma (3-\alpha)}{(1-\alpha)\left(4-\sigma^2(1+\alpha)\right)}, \quad \text{and} \tag{5}$$

$$p_b^* = \frac{(1-\alpha)(1-\sigma)\left(2+\sigma(1+\alpha)\right) + w_b\left(2(1-\alpha)+\sigma^2(1+\alpha)\right)}{(1-\alpha)\left(4-\sigma^2(1+\alpha)\right)}. \tag{6}$$

The second-order conditions, $\frac{d^2\Pi_P}{dp_e^2} = -\frac{2(1-\alpha)}{1-\sigma^2} < 0$ and $\frac{d^2\Pi_R}{dp_b^2} = -\frac{2}{1-\sigma^2} < 0$, are also satisfied.

Substituting the retail prices in Equations (5) and (6) into Equations (3) and (4), we get the profits as functions of w_b. To find the equilibrium w_b, we examine the first-order condition $\frac{d\Pi_P}{dw_b} = 0$, which leads to:

$$w_b^* = \frac{(1-\alpha)\left(8(1-\alpha\sigma)+\sigma^3(1+\alpha)^2\right)}{16(1-\alpha)+2\sigma^2(1+\alpha)^2}. \quad (7)$$

Here as well, the second-order condition, $\frac{d^2\Pi_P}{dw_b^2} = -\frac{16(1-\alpha)+2\sigma^2(1+\alpha)^2}{(1-\alpha)\left(4-\sigma^2(1+\alpha)\right)^2} < 0$, is satisfied.

Equilibrium and Results

With the solutions above, we are now ready to analyze the equilibrium outcome. First, by solving $q_e = 0$ for α after substituting the equilibrium prices from Equations (5), (6), and (7), we can find an $\bar{\alpha}$, a threshold for α above which the market for e-book disappears:

- **Lemma 1** *The market for e-books collapses at a large* α*. Specifically, for all* $\alpha \geq \bar{\alpha} > 0$*, where*

$$\bar{\alpha} = \frac{4+\sigma\left(3-\sigma(1+\sigma)\right)-\sqrt{(4+\sigma(3-\sigma(1+\sigma)))^2-\sigma^2(1+\sigma)(2+\sigma)(4-\sigma(1-\sigma))}}{\sigma^2(1+\sigma)},$$

the market disappears.

Lemma 1 shows that, when the retailer tries to profit too much from e-book sales, the e-book market can actually collapse. Intuitively as well, when α becomes excessively high, leaving the publisher little from e-book sales, the publisher may respond strategically by shutting this channel down. Since we are primarily interested in the situation where the e-book market coexists with printed books, unless stated otherwise, we henceforth restrict our analyses to the case of $\alpha < \bar{\alpha}$.

Substituting the prices in Equations (5), (6), and (7) into Equations (3) and (4), we get the equilibrium profits for the publisher and retailer, denoted Π_P^* and Π_R^*, respectively:

$$\Pi_P^* = \frac{(1-\alpha)\left(4(3+\sigma)-(1+\sigma)\left(8\alpha-\sigma^2(1+\alpha)^2\right)\right)}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)}, \quad \text{and}$$

$$\Pi_R^* = \frac{X+\sigma^2(1+\alpha)(Y+Z)}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2},$$

where

$$X = 16(1-\alpha)^2((1-\sigma)(1+4\alpha)+8\alpha\sigma),$$

$$Y = 4((1-\sigma)(4-\alpha(1+\alpha+4\alpha^2)) + 8\alpha\sigma(1-\alpha^2)), \quad \text{and}$$

$$Z = \sigma^2(1+\alpha)^2(4(1-\sigma)+\alpha(1+\alpha)(1+\sigma)).$$

Of course, the above expressions are valid only for $\alpha < \bar{\alpha}$, and for $\alpha \geq \bar{\alpha}$, equivalent expressions can be obtained by replacing α with $\bar{\alpha}$.

Let us now reexamine the profit expressions—intuitively, the publisher ought to prefer a lower α while the retailer should desire exactly the opposite [35]. We first check whether this simple intuition still holds in our setup. As it turns out, the publisher always prefers to pay a lower agency fee because its overall profit (Π_P^*) decreases as it forks over a larger portion of the profit from e-book sales to the retailer. Interestingly, though, the retailer does not necessarily prefer a higher agency fee since Π_R^* may actually decrease in α beyond a certain point. We now state this formally:

- **Proposition 1 (Total Profit).** *The publisher's profit (Π_P^*) monotonically decreases in α whereas the retailer's profit (Π_R^*) may be non-monotonic in α. Specifically, when $\sigma \geq \hat{\sigma}$ where $\hat{\sigma} \approx 0.697$, Π_R^* strictly increases in α. However, when $\sigma < \hat{\sigma}$, Π_R^* increases in α only until a threshold $\hat{\alpha}$ and decreases beyond.*

Evidently, beyond a certain threshold, increasing α can be a losing proposition for both the publisher and the retailer. In negotiating the agency fee between the two parties, when the retailer's market power is strong, the retailer would try to push α towards its desirable direction (i.e., a higher agency fee). However, Proposition 1 cautions that even when the retailer's bargaining position is strong enough to command a large α, doing so may not be in its best interest. In fact, it may be a better strategic move for the retailer to concede a higher fraction of $(1-\alpha)$ to the publisher.

Let us now examine the e-book and printed-book markets separately by taking a closer look at the partial profits from each market. Using the equilibrium prices in Equations (5), (6), and (7), we can obtain the publisher's and retailer's profits from the printed market, respectively $\Pi_{Pb} = q_b w_b$ and $\Pi_{Rb} = q_b(p_b - w_b)$, and those from the e-book market, $\Pi_{Pe} = (1-\alpha)q_e p_e$ and $\Pi_{Re} = \alpha q_e p_e$. (See the Appendix

for details.) Once again, these expressions are valid only for $\alpha < \bar{\alpha}$. When $\alpha \geq \bar{\alpha}$, the profit expressions are obtained by substituting $\bar{\alpha}$ for α. Obviously, when $\alpha \geq \bar{\alpha}$, the e-book market collapses, so we end up with $\Pi_{Pe} = 0$ and $\Pi_{Re} = 0$.

The agency-fee percentage, α, within the e-book market is obviously an important indicator of the dynamics between the players in that market. Recall that, for a given α, the publisher collects the fraction $(1 - \alpha)$ of the revenue from e-book sales whereas the retailer collects the remaining fraction α. However, what is interesting is that the agency fee in the e-book market also has a spillover effect in the printed-book market. More specifically, the profit for the publisher from the printed-book market decreases with α, whereas that for the retailer strictly increases.

As is the case with the total profit, the publisher's partial profit from the e-book market falls with α as the publisher concedes a larger fraction of the revenue from e-book sales to the retailer. So, it seems that, as α increases, the publisher bleeds in both markets whereas the retailer always benefits in the printed-book market and may benefit even in the e-book market, provided that α is not excessively high. Once again, beyond a threshold, the retailer's profit from e-book sales may diminish. Therefore, even within just the e-book market, the conventional wisdom that a higher agency fee would always benefit the retailer may not actually hold:

- **Proposition 2 (Partial Profit).** *In the printed-book market, the publisher's profit* (Π_{Pb}) *strictly decreases in* α *whereas the retailer's profit* (Π_{Rb}) *strictly increases. However, in the e-book market, the publisher's profit* (Π_{Pe}) *strictly decreases in* α *whereas the retailer's profit* (Π_{Re}) *may be non-monotonic in* α*. Specifically, when* $\sigma \geq \breve{\sigma}$*, where* $\breve{\sigma} \approx 0.917$*,* Π_{Re} *strictly increases in* α*. However, when* $\sigma < \breve{\sigma}$*,* Π_{Re} *increases in* α *until a threshold* $\breve{\alpha}$ *and decreases beyond.*

Proposition 2 conveys a clear message for the retailer, together with Proposition 1. Though it may be tempting for the retailer to always push for a higher α, it may not be in the retailer's best interest to do so. Above a certain threshold, the profit from the e-book market may actually decrease in α, ultimately reducing

the total profit for the retailer. A retailer blindly following the conventional wisdom may end up always fighting for a higher α, a strategy that can easily turn out to be suboptimal for the retailer.

The proposition also carries a message for the publisher, though the message is a little subtler than the one for the retailer. As one may expect, the publisher loses as α increases. However, what is surprising is that this reduction may actually stem from the fact that the publisher ends up losing in both the markets, not just in the e-book market. As α increases, its primary effect on Π_{Pe} is easy to predict. However, the secondary effect on Π_{Pb} may not be as straightforward; an increase in α reduces not only Π_{Pe} but also Π_{Pb}. With this finding, the publisher has an added incentive to push for a lower α. Only focusing on the impact of the agency fee in the e-book market may lead to neglecting other possible negatives on the publisher's overall profit, leading to an underestimation of the impact of a rising α.

All of the profit-related results so far are direct consequences of the publisher's and retailer's pricing decisions. To better understand the driving forces behind these results, let us now take a closer look at the strategies of the players as represented by their equilibrium choices. By substituting the equilibrium wholesale price in Equation (7) into Equation (5) and (6), we obtain:

$$p_b^* = \frac{(1-\alpha)(12-4\sigma)+(1+\alpha)^2(\sigma^2(2-\sigma))}{16(1-\alpha)+2\sigma^2(1+\alpha)^2}, \quad \text{and} \tag{8}$$

$$p_e^* = \frac{8(1-\alpha)+\sigma(1+\alpha)(2-\sigma(1-\alpha))}{16(1-\alpha)+2\sigma^2(1+\alpha)^2}. \tag{9}$$

From these expressions, the nature of the strategic interaction between the two players starts to unfold. First, with an increase in α—which is generally perceived as an increase in the bargaining power of the retailer, or conversely, a diminishing position of the publisher—the e-book price rises, that is, $\frac{dp_e^*}{d\alpha} = \frac{\sigma(1-\sigma)\left(16-\sigma^2(1+\alpha)^2\right)}{(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$. Since it is the publisher that sets the e-book price, it may be tempting to think that an increase in the price reflects a stronger position of the publisher. After all, the whole reason why the "Big Five" fought for the agency model was to be able to control the e-book price directly. However, contrary to that belief, it is only when α is larger and the publisher is weaker in the e-book market that the

publisher will set a higher p_e^*. This finding demonstrates that, though the "Big Five" attempted to gain autonomy from Amazon's grip on the e-book market by being able to set the price themselves, their pricing decisions could be closely tied to their relative market positions in a way that may not have been obvious before.

As shown in Proposition 2, the effect of α is not confined to the profits in the e-book market and has a spillover effect on the printed-book profits as well. In fact, an increase in α raises not only the e-book price but also the printed-book price, that is, $\frac{dp_b^*}{d\alpha} = \frac{2\sigma^2(3-\alpha)(1+\alpha)(1-\sigma)}{(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$. To get to the underlying logic, recall that p_b^* is set by the retailer while p_e^* is set by the publisher. When the publisher needs to concede a bigger fraction of the e-book earnings to the retailer, it naturally finds the e-book market less desirable. Leveraging the substitutability between the two products, the publisher then raises the e-book price, in order to nudge the consumers to migrate from the less desirable e-book market to the printed-book one. However, when the publisher increases p_e^*, the retailer finds itself in a position where it can also raise p_b^*, since the price of the substitute has now increased and the competitive pressure has somewhat eased. As a result, with an increasing α, both the printed- and the e-book prices rise.

Let us now analyze the equilibrium demand. By substituting the equilibrium retail prices shown in Equations (8) and (9) into Equations (1) and (2), we obtain the following equilibrium demands:

$$q_b = \frac{2+\sigma^2-\alpha(2-\sigma^2)}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)}, \quad \text{and}$$

$$q_e = \frac{8(1-\alpha)+2\sigma(1-3\alpha)+\sigma^2(1+\sigma)(1+\alpha)^2}{2(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)}.$$

The above demand expressions reveal something interesting. Since the retail prices increase in α, all else equal, the equilibrium demands ought to decrease, but this intuition holds only in the e-book market where $\frac{dq_e}{d\alpha} = -\frac{16\sigma-\sigma^3(7-\alpha)(1+\alpha)}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} < 0$. In the printed-book market, however, $\frac{dq_b}{d\alpha} = \frac{2\sigma^2(5-\alpha(2-\alpha))-\sigma^4(1+\alpha)^2}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$, clearly indicating that the demand for the printed book increases even as its price goes up. Upon a closer observation, though, we can see that, as α increases, the publisher raises p_e^* a lot more aggressively

compared to how the retailer raises p_b^*, that is, $\frac{dp_e^*}{d\alpha} > \frac{dp_b^*}{d\alpha}$. Because of this difference in the rates with which p_b^* and p_e^* increase in α, many consumers find the printed version to be relatively more desirable than the electronic one. In the end, the migration from e-books to printed books outpaces the drop-off in the printed-book demand caused by the rising price. As a result, the demand for the printed version may increase along with its price. All these observations are summarized below:

- **Proposition 3 (Price and Demand).** *As α increases, both retail prices increase, but the e-book price increases faster than that of the printed book, from $\frac{dp_e^*}{d\alpha} > \frac{dp_b^*}{d\alpha} > 0$. Because of this difference in the rates, while both prices increase with α, only the e-book demand decreases whereas the printed-book demand increases, based on $\frac{dq_e}{d\alpha} < 0$ and $\frac{dq_b}{d\alpha} > 0$.*

One more piece is still needed to complete the picture: Why would the retailer increase p_b^* less aggressively compared to how the publisher increases p_e^*? It is understandable that the publisher may desire this to happen so that it can effectively move consumers from e-books to printed books. However, it is not immediately clear what incentive the retailer has to hold itself back from increasing the printed-book price more aggressively. Let us now try to examine the rationale behind it. Since the marginal cost is negligible, w_b is the publisher's margin on the printed book, and $m_b = p_b - w_b$ is the retailer's margin. Additionally, for e-books, we can calculate how much margin each player gains per copy sold. For the publisher, the margin on each e-book is $w_e = (1-\alpha)p_e$, and for the retailer, $m_e = \alpha p_e$. The following proposition summarizes the effect of α on all the margins.

- **Proposition 4 (Margin).** *For both printed- and e-books, the publisher's margins decrease with α while the retailer's increase, based on $\frac{dw_b^*}{d\alpha}, \frac{dw_e^*}{d\alpha} < 0$ and $\frac{dm_b^*}{d\alpha}, \frac{dm_e^*}{d\alpha} > 0$.*

What Proposition 4 shows us is that a higher α prompts the publisher to lower the wholesale price of the printed book. The insight that α—a parameter seemingly relevant only to the e-book market—can also

force the publisher to lower the wholesale price in the printed-book market happens to be both novel and interesting. As already mentioned, when α increases, the publisher increases p_e to nudge consumers away from the e-book and towards the printed one. This way, the publisher seeks to increase its revenue in the printed-book market in order to make up for the loss in the e-book market. Unfortunately for the publisher, however, in the printed-book market, it is not the publisher that sets the retail price, p_b; instead, it is actually the retailer. Yet worse, the retailer has more than one reason to increase p_b. First, because of the increased α, the e-book market is now more attractive to the retailer, and second, since the publisher increases p_e—the price of the substitute—the retailer can also afford to increase p_b. Anticipating this response from the retailer, the publisher sets w_b in the first stage of the game in a way that it becomes suboptimal for the retailer to increase p_b to a point where it would cancel out all the gains that the publisher expects from raising p_e. By decreasing w_b, the publisher is thus able to achieve exactly that—the publisher hands out an extra premium to the retailer, and this extra margin in the printed-book market takes away some of the increased appeal of the e-book market to the retailer. As a result, the retailer does not raise p_b as high as it would have otherwise.

Comparison with Pure-Wholesale Arrangement

As discussed in the introduction, the publishers had to coerce Amazon into signing the agency agreement. The rationale was straightforward. The emerging e-book market seemed promising, and the publishers wanted to set the retail price directly instead of letting Amazon control the price. Despite this original intent, though, the outcome seems to have gone in exactly the opposite direction of what the publishers had hoped for. The demand for e-books fell sharply, and the publishers' revenues dropped noticeably. On the contrary, the demand for printed books rose substantially, and Amazon who initially resisted the agency arrangement for the e-book market actually gained from the transition. In this section, we seek possible explanations behind this unforeseen outcome. As a quick reminder, we refer to the mixture of the wholesale and agency models as agency-mix to differentiate it from the pure-wholesale model.

To understand what might have happened following the transition from the pure-wholesale to the agency-mix arrangement, we use the former as our benchmark. To make a fair comparison, while analyzing the pure-wholesale model, we continue to use the same demand specification as in Equations (1) and (2). The profit expressions, however, change from Equations (3) and (4) to the following:

$$\Pi_{P\omega} = q_{b\omega} + q_{e\omega} w_{e\omega}, \quad \text{and}$$
$$\Pi_{R\omega} = q_{b\omega}(p_{b\omega} - w_{b\omega}) + q_{e\omega}(p_{e\omega} - w_{e\omega}),$$

where the subscript ω represents pure-wholesale. Unlike in the agency-mix model, here, the publisher determines both wholesale prices and then the retailer sets both retail prices. By backward induction, we can solve the retailer's pricing problem first and the publisher's, second. Hence, we first solve the first-order conditions $\frac{\partial \Pi_{R\omega}}{\partial p_{b\omega}} = 0$ and $\frac{\partial \Pi_{R\omega}}{\partial p_{e\omega}} = 0$ simultaneously, leading us to $p^*_{b\omega} = \frac{1+w_{b\omega}}{2}$ and $p^*_{e\omega} = \frac{1+w_{e\omega}}{2}$. The Hessian matrix of interest is:

$$H_R = \begin{bmatrix} \frac{\partial^2 \Pi_{R\omega}}{\partial p^2_{b\omega}} & \frac{\partial^2 \Pi_{R\omega}}{\partial p_{b\omega} \partial p_{e\omega}} \\ \frac{\partial^2 \Pi_{R\omega}}{\partial p_{e\omega} \partial p_{b\omega}} & \frac{\partial^2 \Pi_{R\omega}}{\partial p_{e\omega^2}} \end{bmatrix} = \begin{bmatrix} -\frac{2}{1-\sigma^2} & \frac{2\sigma}{1-\sigma^2} \\ \frac{2\sigma}{1-\sigma^2} & -\frac{2}{1-\sigma^2} \end{bmatrix},$$

and since H_R is negative definite, the second-order conditions are satisfied. Thus, $\Pi_{R\omega}$ is indeed maximized at $p^*_{b\omega}$ and $p^*_{e\omega}$.

Anticipating the above response from the retailer, the publisher sets the wholesale prices. By substituting $p^*_{b\omega}$ and $p^*_{e\omega}$ into $\Pi_{P\omega}$ expression above, we get the publisher's profit as a function of $w_{b\omega}$ and $w_{e\omega}$. Solving the first-order conditions $\frac{\partial \Pi_{P\omega}}{\partial w_{b\omega}} = 0$ and $\frac{\partial \Pi_{P\omega}}{\partial w_{e\omega}} = 0$, we obtain $w^*_{b\omega} = w^*_{e\omega} = \frac{1}{2}$. Now, the Hessian matrix of interest is:

$$H_P = \begin{bmatrix} \frac{\partial^2 \Pi_{P\omega}}{\partial w^2_{b\omega}} & \frac{\partial^2 \Pi_{P\omega}}{\partial w_{b\omega} \partial w_{e\omega}} \\ \frac{\partial^2 \Pi_{P\omega}}{\partial w_{e\omega} \partial w_{b\omega}} & \frac{\partial^2 \Pi_{P\omega}}{\partial w^2_{e\omega}} \end{bmatrix} = \begin{bmatrix} -\frac{1}{1-\sigma^2} & \frac{\sigma}{1-\sigma^2} \\ \frac{\sigma}{1-\sigma^2} & -\frac{1}{1-\sigma^2} \end{bmatrix}.$$

Once again, H_P is negative definite, so the second-order conditions are satisfied, implying that $\Pi_{P\omega}$ is maximized at $w_{b\omega}^*$ and $w_{e\omega}^*$. With these solutions, we can now describe the equilibrium:

$$w_{b\omega}^* = w_{e\omega}^* = \frac{1}{2}, p_{b\omega}^* = p_{e\omega}^* = \frac{3}{4}, q_{b\omega} = q_{e\omega} = \frac{1}{4(1+\sigma)},$$

$$\Pi_{Pb\omega} = \Pi_{Pe\omega} = \frac{1}{8(1+\sigma)}, \text{ and } \Pi_{Rb\omega} = \Pi_{Re\omega} = \frac{1}{16(1+\sigma)}.$$

The equilibrium total profits can be calculated by aggregating the partial profits above: $\Pi_{P\omega}^* = \Pi_{Pb\omega} + \Pi_{Pe\omega}$ and $\Pi_{R\omega}^* = \Pi_{Rb\omega} + \Pi_{Re\omega}$. In each market, the equilibrium price—wholesale or retail—is independent of its counterpart in the other. In other words, the level of substitutability, σ, has no impact on the equilibrium prices whatsoever, and the prices simply converge to what one may expect from any ordinary wholesale model.[3] This is because, in this pure-wholesale model, though the two products are substitutable, there is no longer any competition between the publisher and the retailer, as the retailer now sets both the retail prices.

Let us now see if we can explain the current state of affairs in the book industry. As mentioned earlier, after moving from pure-wholesale to agency-mix, (i) the publishers' profits have decreased whereas Amazon's profit has increased, (ii) the e-book price has gone up whereas the printed-book price has gone down, and (iii) the demand for e-book has decreased whereas that for the printed book has increased. In light of this reality, naturally, the main question is whether such an outcome can be corroborated by a comparison of our agency-mix and pure-wholesale setups. Reassuringly, we find that such an outcome is indeed possible: There always exists a region where $\Pi_P^* < \Pi_{P\omega}^*$, $\Pi_R^* > \Pi_{R\omega}^*$, $p_e^* > p_{e\omega}^*$, $p_b^* < p_{b\omega}^*$, $q_e < q_{e\omega}$, and $q_b > q_{b\omega}$, faithfully reflecting the realities of the market today.

It is commonly accepted that revenue sharing mitigates double marginalization, and our agency-mix model does employ revenue sharing in the e-book market, implying that the equilibrium price in this market should have been lower following the adoption of agency-mix. What is quite surprising, though, is that p_e^* can actually be higher than $p_{e\omega}^*$ in our model. In essence, when the agency fee is high, the e-book market becomes less attractive to the publisher, creating an incentive for the publisher to nudge consumers to the

printed book. This incentive in turn manifests itself in the form of a high e-book price, one that may even be higher than that fraught with double marginalization.

Notably, the anomaly above can occur for α values beyond α_R^*, where:

$$\alpha_R^* = \begin{cases} \hat{\alpha}, & \text{if } \sigma < \hat{\sigma}, \\ 1, & \text{otherwise,} \end{cases}$$

and $\hat{\alpha}$ and $\hat{\sigma}$ are as defined in Proposition 1; accordingly, α_R^* is the threshold for α below which the retailer's profit monotonically increases with α in the agency-mix setting. This hints at the possibility that, perhaps, the agency fee that Amazon is charging the "Big Five" is somewhat excessive and suboptimal for both parties. Moreover, even if Amazon were aware of the results in Proposition 1—and made sure to not bargain for an α beyond α_R^*—the publishers could still be worse off in the agency-mix setup. Not surprisingly, as described in the introduction, the publishers have had some second thoughts. The question then is: Is there a sweet spot in the agency-mix model that can make it more desirable vis-à-vis the pure-wholesale model to both the publisher and retailer alike? Specifically, is there a range of values of α where both parties can be better off in the agency-mix setting? Or, is there no such sweet spot and the two parties are simply better off reverting back to pure-wholesale? The proposition below seeks to answer these questions:

- **Proposition 5 (Profit Comparison).** *The publisher would prefer agency-mix to pure-wholesale if and only if $\alpha < \alpha_{P\omega}$, where $\alpha_{P\omega}$ is the unique real root for $\Pi_P^* = \Pi_{P\omega}^*$. On the other hand, the retailer prefers agency-mix if and only if $\alpha_{R\omega} < \alpha < \alpha_R^*$, where $\alpha_{R\omega}$ is the unique real root for $\Pi_R^* = \Pi_{R\omega}^*$. Finally, $\alpha_{R\omega} < \alpha_{P\omega} < \alpha_R^*$.*

From Proposition 5, we get several important insights. Since $\alpha_{P\omega} < \alpha_R^*$, if the retailer possesses substantial bargaining power to push α above $\alpha_{P\omega}$, the publisher would always be worse off in the agency-mix model. At the other end, when the publisher is powerful and α is too low (below $\alpha_{R\omega}$), the publisher would come out ahead with the agency-mix model, though the retailer would not. This is probably what the "Big Five" publishers were hoping for, and what Amazon was afraid of, when they were transitioning from

the pure-wholesale setup to the agency-mix model. This may also explain why the publishers were so eager to move to the new retail arrangement whereas Amazon was visibly reluctant.

As already seen from Proposition 1, generally, the retailer fares better with a higher α whereas the situation is just the opposite for the publisher. Hence, it should come as little surprise that the two players would generally disagree about the choice of α. Proposition 5 further shows that, not only do the players disagree about the ideal α, they also disagree in their preference for the agency-mix arrangement over pure-wholesale.

However, not all is lost. As shown in Proposition 5, there is indeed a region, $\alpha_{R\omega} < \alpha < \alpha_{P\omega}$, where the agency-mix setup can be "win-win" for both the publisher and the retailer, when compared to the pure-wholesale setup. In contrast, there is no region where pure-wholesale is a win-win proposition for both the parties. This finding has an obvious implication. Though the retailer and the publisher would always strive to pull α in their own desirable directions, it is clear that agency-mix is the only arrangement that they can perhaps agree on. Specifically, any α value between $\alpha_{R\omega}$ and $\alpha_{P\omega}$—an α not too high and not too low—is the one that can get both parties happily on board. If α becomes any higher than $\alpha_{P\omega}$, the publisher will want to defect to pure-wholesale, and if it becomes any lower than $\alpha_{R\omega}$, the retailer would do likewise.

To put this into a practical perspective, note that the publishers currently seem to have an urge to revert back to the pure-wholesale model. In fact, it appears that the publishers are already having some remorse about the agency-mix model [29]. However, if our findings are any indication, this may simply be a knee-jerk reaction that could make a bad situation even worse. The publishers could actually gain from the agency-mix setting if the revenue-sharing formula is properly drawn up. Though there is some divergence between the incentives of the publisher and retailer with respect to α, our findings seem to bring them back to the negotiating table in search for a win-win outcome.

Finally, note that the potential of a win-win outcome for agency-mix implies that this setup can reduce some of the channel inefficiencies associated with pure-wholesale. Naturally, one may be curious as to just how well this agency-mix setup performs when compared to a fully-coordinated channel. In particular, can

the agency-mix approach perfectly coordinate the channel? And, if so, under what circumstances? To answer, we consider a vertically-integrated channel making a profit of $\Pi_V = q_{bV}p_{bV} + q_{eV}p_{eV}$, where the subscript V stands for vertical integration. Here as well, we use the same demand specification as in Equations (1) and (2). Since we are dealing with only one firm here, the retail prices are determined by solving the first-order conditions $\frac{\partial \Pi_V}{\partial_{p_{bV}}} = 0$ and $\frac{\partial \Pi_V}{\partial_{p_{eV}}} = 0$ simultaneously, leading to $p_{bV}^* = p_{eV}^* = \frac{1}{2}$. The Hessian matrix of interest in this case is: $H_V = \begin{bmatrix} \frac{\partial^2 \Pi_V}{\partial p_{bV}^2} & \frac{\partial^2 \Pi_V}{\partial_{p_{bV}}\partial_{p_{eV}}} \\ \frac{\partial^2 \Pi_V}{\partial_{p_{eV}}\partial_{p_{bV}}} & \frac{\partial^2 \Pi_V}{\partial p_{eV}^2} \end{bmatrix} = \begin{bmatrix} -\frac{2}{1-\sigma^2} & \frac{2\sigma}{1-\sigma^2} \\ \frac{2\sigma}{1-\sigma^2} & -\frac{2}{1-\sigma^2} \end{bmatrix}$. Since H_V is negative definite, the second-order conditions are satisfied. Thus, Π_V is maximized at p_{bV}^* and p_{eV}^*, resulting in a total channel profit of $\Pi_V^* = \frac{1}{2(1+\sigma)}$.

As it turns out, regardless of α, Π_V^* is strictly greater than $\Pi_P^* + \Pi_R^*$ from the agency-mix model. This comparison tells us that, while agency-mix can address the issue of double marginalization to a degree—and can be a win-win solution for both the retailer and publisher when compared to pure-wholesale—there is still a room for further improvement. In other words, although the injection of agency arrangement into the e-book market may improve the channel efficiency, it is at best a partial solution and, perhaps, underlines the need for a better contractual arrangement.

Extensions

In this section, we examine whether the results from the main model are dependent on any of our assumptions. In particular, the focus is primarily on revisiting the strategic interaction between the publisher and the retailer highlighted in Propositions 1 through 4.

Fixed Market Size

In earlier sections, we assumed a demand system that made the total size of the market decreasing in σ. While this assumption about the influence of σ on the total market size is reasonable—and arguably

desirable—one may wonder whether the main results hinge on this particular assumption. Hence, in this extension, we revisit the main results assuming a fixed market size. In particular, we consider the following linear demand system:

$$q_b = 1 - p_b + \sigma(p_e - p_b), \quad \text{and}$$
$$q_e = 1 - p_e + \sigma(p_b - p_e).$$

This demand system still holds the essence of the original one, that is, the demand for a given version decreases in its own price and increases in that of the substitute. The key difference between this system and the one we had earlier is that, now, the overall size of the market does not change with σ, i.e., $q_b + q_e = 2 - p_b - p_e$.

The profit expressions remain the same as in Equations (3) and (4). Using backward induction, we first evaluate the equilibrium retail prices set by the retailer and publisher, and then solve for the equilibrium wholesale price set by the publisher. Simultaneously solving the first-order conditions, $\frac{d\Pi_P}{dp_e} = 0$ and $\frac{d\Pi_R}{dp_b} = 0$, results in the following equilibrium retail prices:

$$p_e^* = \frac{(1-\alpha)(2+3\sigma)+w_b\sigma(1+\sigma)(3-\alpha)}{(1-\alpha)\left(4+\sigma\left(8+\sigma(3-\alpha)\right)\right)}, \quad \text{and}$$
$$p_b^* = \frac{(1-\alpha)(2+\sigma(3+\alpha))+w_b(2+\sigma(4+3\sigma)-\alpha(2+\sigma(4+\sigma)))}{(1-\alpha)\left(4+\sigma\left(8+\sigma(3-\alpha)\right)\right)}.$$

It is easy to verify that the second-order conditions, $\frac{d^2\Pi_P}{dp_e^2} = -2(1-\alpha)(1+\sigma) < 0$ and $\frac{d^2\Pi_R}{dp_b^2} = -2(1+\sigma) < 0$, are also satisfied.

Substituting these equilibrium retail prices into the profits expressions, we get the profits as functions of w_b. To find the equilibrium w_b that the publisher would choose in the first stage, we once again examine the first-order condition, $\frac{d\Pi_P}{dw_b} = 0$. This leads to the following expression for the wholesale price of the

printed-book version: $w_b^* = \frac{(1-\alpha)(8(1-\sigma(\alpha(1+2\sigma)-3(1+\sigma)))+\sigma^3(3-\alpha)^2)}{2(1+\sigma)(8(1-\alpha)+16\sigma(1-\alpha)+\sigma^2(3-\alpha)^2)}$. Here as well, the second-order condition, $\frac{d^2\Pi_P}{dw_b^2} = -\frac{2(1+\sigma)(1+2\sigma)\left(8(1-\alpha)+16\sigma(1-\alpha)+\sigma^2(3-\alpha)^2\right)}{(1-\alpha)\left(4+\sigma\left(8+\sigma(3-\alpha)\right)\right)^2} < 0$, is satisfied.

At this point, all equilibrium metrics—prices, profits, and demands—can be obtained through a simple substitution process, much akin to the one described earlier; the detailed expressions are provided in the appendix. Also, by solving $q_e = 0$ for α, we can find the threshold ($\bar{\alpha}$) above which the market for e-book collapses, and, as before, we keep our focus on the range $\alpha < \bar{\alpha}$. By evaluating the equilibrium metrics, we observe the following:

- Total Profit: For the publisher, the total profit, Π_P^*, strictly decreases in α whereas, for the retailer, Π_R^* is non-monotonic in α.
- Partial Profit: For the publisher, the partial profits from the printed-book and e-book markets—Π_{Pb} and Π_{Pe}, respectively—decrease in α. For the retailer, Π_{Rb} increases in α whereas Π_{Re} is non-monotonic.
- Price and Demand: Both retail prices increase in α, but the price of e-books increases at a faster rate compared to the price of printed books: $\frac{dp_e^*}{d\alpha} > \frac{dp_b^*}{d\alpha} > 0$. As a result, the demand for e-books decreases in α whereas the demand for printed books increases: $\frac{dq_e}{d\alpha} < 0$ and $\frac{dq_b}{d\alpha} > 0$.
- Margin: The publisher's margins decrease in both markets as α increases whereas the retailer's margins increase: $\frac{dw_b^*}{d\alpha}$, $\frac{dw_e^*}{d\alpha} < 0$ and $\frac{dm_b^*}{d\alpha}$, $\frac{dm_e^*}{d\alpha} > 0$, where $m_b = p_b - w_b$, $w_e = (1-\alpha)p_e$, and $m_e = \alpha p_e$.

Clearly, the results in Propositions 1 through 4 remain intact, illustrating that the insights from our original model do not hinge on the assumption that the market size changes with σ.

Retailer Competition in the Printed-Book Market

Thus far, we have assumed that Amazon has monopolistic power in both the e-book and the printed-book markets. For e-books, this assumption is well aligned with reality. For instance, a recent report shows that Amazon accounts for more than 80% of all e-book sales in the United States [3]. This indicates that, although users are becoming less device dependent because of platform virtualization, they are still very much locked into Amazon's Kindle platform. Sticking with Kindle as a platform—as opposed to using various other platforms—gives users the ability to access and manage all purchased books through one interface.

However, the situation may be a little different in the printed-book market, especially for the bestseller books that can be found in multiple retail outlets. Consider, for example, the *New York Times* bestsellers that are available not only on Amazon but also at a local Costco store. For such items, retailers may actually face some competition, especially because the concept of a platform as well as that of a single touchpoint for managing all purchases are both moot for printed books. Of course, that is not to say that retailers have no pricing power whatsoever. In fact, the competition among the retailers is likely imperfect because of various reasons: for example, brand names, proximity of brick-and-mortar stores, recommender systems, and loyalty programs or lock-in mechanisms such as Amazon Prime, could all contribute to this imperfection. In summary, unlike the case of e-books, there may be different levels of competition as well as different number of retailers for printed books.

We now consider this competition aspect in the printed-book market and examine how it may affect the main insights of this research. For this exploration, we specify the demand for printed book, q_{bi}, that retailer $i \in \{1,2, \dots, n\}$ faces as follows:

$$q_{bi} = \underbrace{\left(\frac{1}{n}\right)\left(\frac{1}{1+\sigma} - \frac{1}{1-\sigma^2}p_{bi} + \frac{\sigma}{1-\sigma^2}p_e\right)}_{(a)} + \underbrace{\left(\frac{1}{n-1}\right)\sum_{1\le j(\neq i)\le n}\frac{p_{bj}-p_{bi}}{\delta}}_{(b)}, \tag{10}$$

where $n \geq 2$ is the number of retailers. Let us now take a closer look at Equation (10). Similar to what we had in Equation (1), in the term denoted (a), each retailer i competes with the e-book version. Additionally,

in term (b), each retailer competes with $n-1$ competitors in the printed-book market, and this competition depends on the price differences (i.e., $p_{bj}-p_{bi}$) as well as on the level of differentiation, δ. A lower δ essentially implies a fiercer competition among the printed-book retailers. Note that, if the printed-book prices set by the retailers are the same, then the overall demand for printed books, $\sum_{i=1}^{n} q_{bi}$, becomes identical to that specified in Equation (1). In other words, this demand system is a natural extension of our main model.

With the specification given in Equation (10), we can now write the aggregate demands for printed- and e-books—$q_b \geq 0$ and $q_e \geq 0$, respectively—as:

$$q_b = \sum_{i=1}^{n} q_{bi} = \left(\frac{1}{1+\sigma} - \frac{1}{1-\sigma^2}\left(\frac{1}{n}\sum_{i=1}^{n} p_{bi}\right) + \frac{\sigma}{1-\sigma^2}p_e\right), \quad \text{and}$$

$$q_e = \left(\frac{1}{1+\sigma} - \frac{1}{1-\sigma^2}p_e + \frac{\sigma}{1-\sigma^2}\left(\frac{1}{n}\sum_{i=1}^{n} p_{bi}\right)\right).$$

Note here that the price competition term—term (b) of (10)—drops out from the expression of q_b, as the competition simply moves consumers from one retailer to another. Put another way, it is assumed that each consumer buys at most one copy of the printed book.

With the demand system above, the publisher and the retailers decide on the prices. Similar to before, the publisher first sets the wholesale price w_b of the printed-book version. Subsequently, the retailers set the retail prices p_{bi} of the printed book, and the publisher sets the price p_e for the e-book. It is important to note that, in this model, only the first retailer $(i = 1)$—which we will refer to as Amazon for convenience—deals with both e-books and printed books, while all other retailers $(i \neq 1)$ sell only the printed version. This way, the retail competition is confined only to the printed-book market. Accordingly, the profit expression for Amazon (Π_{R1}) and that for other competing retailers $(\Pi_{Ri}, \forall i \neq 1)$ are as follows:

$$\Pi_{R1} = q_{b1}(p_{b1} - w_b) + \alpha q_e p_e, \quad \text{and}$$

$$\Pi_{Ri} = q_{bi}(p_{bi} - w_b), \forall i \neq 1.$$

The publisher's profit is still the same as in Equation (3): $\Pi_P = q_b w_b + (1-\alpha) q_e p_e$. Since all the retailers dealing only with the printed book (i.e., $i \neq 1$) are identical, in equilibrium, they all set the same retail price. Accordingly, we solve the first-order conditions $\frac{d\Pi_P}{dp_e} = 0$, $\frac{d\Pi_{R1}}{dp_{b1}} = 0$, and $\frac{d\Pi_{Ri}}{dp_{bi}} = 0$, $\forall i \neq 1$, which results in the equilibrium prices, p_e^*, p_{b1}^*, and p_{bi}^* ($\forall i \neq 1$). Though those expressions can be obtained in closed form, the precise formulas have been omitted from this manuscript to reduce clutter. Rather, what is worth noting is that p_{b1}^* for Amazon and p_{bi}^* for other retailers (i.e., $\forall i \neq 1$) turn out to be different. This is because Amazon maximizes its total profit from both printed- and e-book sales, whereas all the other retailers maximize their profits from the printed-book market alone.

Substituting these equilibrium retail prices into Π_P, we get the publisher's profit as a function of w_b. To find the equilibrium w_b^* the publisher chooses, we once again examine the first-order condition, $\frac{d\Pi_P}{dw_b} = 0$. Once again, the resulting equilibrium retail prices and profits can be found in closed form but are simply too large to include in the paper; that kind of size also makes it impossible to perform comparative statics analytically. However, since our interest here is only in studying the impact of competition in the printed-book market, that purpose is amply served through a numerical exercise. Let us carry out this exercise—holding σ fixed and by varying n and δ—to see the impact of the competition in the printed-book market on the equilibrium outcome. The first point that stands out is that n has little qualitative influence on the impact of α on the key economic metrics—profits, prices, demands, and margins—indicating that, generally, the insights from comparative statics should not depend on the number of competing retailers. Next, by changing δ, we are able to change the level of competition—while most of our earlier results continue to hold, some do change as competition intensifies. A summary of the observed patterns is provided below:

- Total Profit: Publisher's total profit, Π_P^*, still decreases in α, and Amazon's total profit, Π_{R1}^*, is still non-monotonic in α.

- Partial Profit: For the publisher, Π_{Pb} now increases in α but Π_{Pe} still decreases. For Amazon, Π_{Rb1} still increases in α and Π_{Re} is still non-monotonic.
- Price and Demand: The price p_e^* still increases in α, but p_{b1}^* is now non-monotonic. The e-book demand, q_e, is still decreasing in α, and the printed-book demand, q_b, is still increasing.
- Margin: The publisher's margin in the printed-book market, w_b^*, is now non-monotonic in α, whereas its margin in the e-book market, w_e^*, still decreases in α. For Amazon, its margin for printed book, m_b^*, and that for e-book, m_e^*, both are still increasing in α.

As before, when α increases, the e-book market becomes less attractive to the publisher, and the publisher again tries to nudge consumers to the printed market by increasing the e-book price. Of course, doing so also hurts the publisher's revenue from the e-book market, and as a result, the publisher loses as α increases, similar to what we saw in Proposition 1. Moreover, such a response from the publisher can depress the e-book market so much that it not only impairs Amazon's ability to profit from the e-book market but also hurts its combined profit from both the markets. One interesting observation not included above is that non-Amazon retailers (i.e., $i \neq 1$) gain as α increases because the publisher puts more effort into selling printed-books. Those retailers are not concerned with e-book sales, and they only reap the benefits of increased margins and revenues from printed-book sales.

Now, as the competition intensifies in the printed-book market, the publisher automatically gains a stronger influence over the retail prices of the printed version. This is because the retailers' margins get squeezed with competition and, accordingly, the retail prices start following the wholesale price (w_b^*) set by the publisher. This can be observed from how p_{b1}^* moves in lockstep with w_b^*. Unlike in Propositions 3 and 4—where w_b^* was strictly decreasing in α and p_b^*, strictly increasing—here, w_b^* and p_{b1}^* can both be non-monotonic in α. Essentially, to nudge consumers towards the printed market, the publisher adopts a two-pronged strategy. It increases p_e and, at the same time, lowers w_b, thereby encouraging retailers—whom competition now grants little margin—to reduce p_{bi}. At the extreme, when α becomes excessively high, the publisher decides to exit the e-book market by raising p_e drastically. When that happens, the

consumers are left with only one choice, the printed version. However, since competition no longer allows Amazon or any other printed-book retailers to take advantage of this situation, the publisher may actually see an opportunity to increase w_b. Hence, now, not only do the retailers gain from the increase in the printed-book demand, but so does the publisher as well. This is in stark contrast with Proposition 2 where the publisher loses in both markets. This demonstrates the extra leverage the publisher enjoys when downstream competition actually ties the retailers' hands.

Overall, when the retailer competition in the printed-book market is intense, the publisher gains a stronger hold over the final retail price of printed books. As a result, we may find that the publisher can actually do better in the printed-book market as α increases. However, our earlier insight that a high α can hurt the retailer's profit in the e-book market as well as its overall profit remains valid in this extension as well. This is intuitive because, facing competition in the printed-book market, Amazon is in a worse position now. If a retailer could lose with an increase in α in the absence of competition, it is only natural that it would continue to do so in the face of competition.

Discussion and Conclusion

With the advent of e-books arose an opportunity to experiment with the agency model, a novel retail arrangement in which the publisher sets the retail price and the retailer gets to keep a fraction of it. The agency model has a natural appeal to the publisher because it puts the publisher in charge of the final price. Contrast this with the traditional wholesale setup used for printed books, in which a retailer such as Amazon controls the retail price. In fact, as the expectation for the e-book market ballooned, the "Big-Five" publishers fought for and eventually forced Amazon to agree to the agency model. The sentiment then was that they had won the battle. It appears now, though, that they may have lost the war:

> "*Revenue is down in e-books because Amazon, using their mercantile might, has been aggressively selling printed-backs and hardbacks after publishers took away their power to control e-book pricing. Now e-book prices are way up and print prices are way down, a*

> *situation that eats into the publishers' physical distribution models and guts their e-book sales. Book pundits all over the web are blaming Amazon for its habit of aggressively pricing hardbacks and printed-backs after losing control of e-book pricing*" [7].

Intrigued by such an outcome, we took a closer look at the "three-dimensional chess" between a publisher and a retailer to better understand the mechanism behind the emerging realities in the book market [28]. To this end, we carefully examined how a change in the agency fee—the fraction of the e-book price kept by the retailer—influences the pricing strategies and the profits of the two players. Interestingly, we found that the retailer may actually lose when it attempts to extract more from each e-book sold. More specifically, as the agency fee increases beyond a threshold, the publisher nudges consumers towards printed books which are now more profitable to the publisher. As a result, the retailer may end up losing in the e-book market, so much so that the retailer's overall profit now starts to decline. Also, since the publisher nudges consumers to the printed-book market, the e-book demand monotonically decreases while that for the printed increases. In fact, if the agency fee is substantially high, it is even possible that a revenue-sharing mechanism such as the agency model would actually lead to a higher e-book price and a lower e-book demand when compared to pure-wholesale, which is infamous for its high price and under-consumption due to double marginalization. This way, our model was able to explain many of the apparent anomalies in today's e-book market. The lesson here is that what happens in the e-book market invariably spills over to the printed-book market, and only when this spillover effect is accounted for, can many of the puzzling realities be adequately explained.

There are other lessons as well. Despite the high e-book price and low demand, some remain optimistic and claim that "when e-book pricing returns to sanity, expect to see a lot more revenue from digital channels" [7]. However, according to the findings of this work, the "sanity" may never be restored automatically without an effort from both the publisher and retailer because the high e-book price may actually be a direct byproduct of the market structure. Still, not all is lost. As explained in the paper, there is a win-win region where the publisher and retailer can both be better off with the agency-mix setting. In

contrast, pure-wholesale can never be a win-win proposition, and anyone seeking to revert to it in haste is perhaps not taking full advantage of the economic potential of the agency-mix model. In summary, our insights may encourage the publisher and the retailer in their negotiations to converge to a more efficient channel configuration.

There are some limitations to this work. Although the agency-mix setup can offer benefits to both parties and can improve the channel efficiency, we found that it still does not fully coordinate the supply chain. This makes us wonder if there is at all a more efficient contracting arrangement for this context. Developing a better contract ought to be an important consideration, particularly because no such mechanism exists in practice today—the issue of channel coordination is indeed a difficult one to solve, especially when firms are linked with one another via multiple channels of partially substitutable products. However, a full exploration of alternative mechanisms is well beyond the scope of this work and warrants a separate study.

Despite such limitations, this study contributes by highlighting what happens when the publisher and retailer are doubly bound by a mix of wholesale and agency models at the same time. While we focused squarely on the book market, the findings actually have broader connotations, since similar relationships between channel partners are beginning to emerge in other industries as well. For example, the agency model has become increasingly popular as many online retailers are transforming into platforms that provide marketplaces. Though wholesale continues to be the dominant selling format in some mature digital industries such as music, indications are that these industries may also be going through a similar retail transformation. Apple has always used revenue sharing for digital music and, now, Amazon has adopted a similar model with its music offerings. Of course, as an online retail giant, Amazon also sells CDs and DVDs, products that are primarily sold through wholesaling. Thus, the music industry is already beginning to look similar to the book industry. It may just be a matter of time before other information goods—such as movies, games, and software—follow suit. As this transformation spreads more widely, players involved in these other industries may be compelled to pay closer attention to the potential risks and rewards of the doubly-bound relationship discussed in this work.

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Notes

[1] This demand specification comes from the following reservation price: $U(q_b, q_e) = q_b + q_e - \frac{({q_b}^2 + {q_e}^2 + 2\sigma q_b q_e)}{2}$, where $\sigma = -\frac{\partial^2 U}{\partial q_b q_e}$ represents the decline in the willingness-to-pay for one product arising from consumption of the other substitutable product [1].

[2] In reality, the printed version may involve a non-zero marginal cost. If we were to consider this printing cost, c, in the model, the profit function for the publisher would change to: $\Pi_P = q_b(w_b - c) + (1-\alpha)q_e p_e$. Following much of the same mechanics described in the paper, we can get the following equilibrium prices:

$$w_b^* = \frac{2c(4(1-\alpha)+\sigma^2(1+\alpha)^2)+(1-\alpha)(8(1-\alpha\sigma)+\sigma^3(1+\alpha)^2)}{16(1-\alpha)+2\sigma^2(1+\alpha)^2},$$

$$p_b^* = \frac{4(3+c)(1-\alpha)-4\sigma(1-\alpha)+2\sigma^2(1+\alpha)^2-\sigma^3(1+\alpha)^2}{16(1-\alpha)+2\sigma^2(1+\alpha)^2}, \quad \text{and} \quad p_e^* = \frac{8(1-\alpha)+2\sigma(1-c)(1+\alpha)-\sigma^2(1-\alpha^2)}{16(1-\alpha)+2\sigma^2(1+\alpha)^2}.$$

As a sanity check, it is easy to see that all expressions match their counterparts when $c = 0$. Once we repeat our analyses with these new expressions, we find that introducing c in the model does not change our results qualitatively, although analytical tractability becomes an issue in performing comparative statics. Numerically though, we could verify that all the results remain applicable.

[3] For an ordinary wholesale model with linear demand, the equilibrium wholesale price is $\frac{1}{2}$ and the corresponding retail price is $\frac{3}{4}$ [cf. 36, p. 175].

References

1. Abhishek, V.; Jerath, K.; and Zhang, Z.J. Agency selling or reselling? Channel structures in electronic retailing. *Management Science, 62*, 8 (2016), 2259–2280.

2. Adomavicius, G.; Bockstedt, J.; and Curley, S.P. Bundling effects on variety seeking for digital information goods. *Journal of Management Information Systems, 31*, 4 (Spring 2015), 182–212.

3. AuthorEarnings. Big, bad, wide & international report: Covering Amazon, Apple, B&N, and Kobo ebook sales in the US, UK, Canada, Australia, and New Zealand. (February 2017) (available at http://authorearnings.com/report/february-2017/).

4. Bang, Y.; Lee, D.J.; Han, K.; Hwang, M.; and Ahn, J.H. Channel capabilities, product characteristics, and the impacts of mobile channel introduction. *Journal of Management Information Systems, 30*, 2 (Fall 2013), 101-125.

5. Bensinger, G. Amazon plans hundreds of brick-and-mortar bookstores, mall CEO says. *Wall Street Journal* (February 2, 2016) (available at www.wsj.com/articles/amazon-plans-hundreds-of-brick-and-mortar-bookstores-mall-ceo-says-1454449475).

6. Berger, B.; Matt, C.; Steininger, D.M.; and Hess T. It is not just about competition with "free": differences between content formats in consumer preferences and willingness to pay. *Journal of Management Information Systems, 32*, 3 (Winter 2015-2016), 105-128.

7. Biggs, J. Print and ebook revenue down as Amazon slashes prices. *Techcrunch* (September 30, 2010) (available at www.techcrunch.com/2016/09/30/print-and-ebook-revenue-down-as-amazon-slashes-prices/).

8. Cachon, G.P. Supply chain coordination with contracts. In *Handbooks in Operations Research and Management Science*, 11, Amsterdam: Elsevier Science, 2003, pp. 227-339.

9. Cachon, G.P., and Lariviere, M.A. Supply chain coordination with revenue-sharing contracts: Strengths and limitations. *Management Science*, 51, 1 (January 2005), 30-44.

10. Cheng, H.K.; Feng, J., Koehler, G.J., and Marston S. Entertainment without borders: The impact of digital technologies on government cultural policy. *Journal of Management Information Systems, 27*, 3 (Winter 2010-2011), 269-302.

11. De los Santos, B., and Wildenbeest, M.R. E-book pricing and vertical restraints. *Quantitative Marketing and Economics, 15*, 2 (June 2017), 85-122.

12. Dey, D., and Lahiri, A. Versioning: go vertical in a horizontal market? *Journal of Management Information Systems, 33*, 2 (Fall 2016), 546-572.

13. Dey, D.; Lahiri, A.; and Liu, D. Consumer learning and time-locked trials of software products. *Journal of Management Information Systems, 30*, 2 (Fall 2013), 239-267.

14. Enright, A. Amazon sales climb 22% in Q4 and 20% in 2015. *Digital Commerce 360* (January 28, 2016) (available at www.internetretailer.com/2016/01/28/amazon-sales-climb-22-q4-and-20-2015).

15. Fan, M.; Jumar, S.; and Whinston, A.B. Selling or advertising: Strategies for providing digital media online. *Journal of Management Information Systems*, 24, 3 (Winter 2007-2008), 143-166.

16. Feng, Y.; Guo, Z.; and Chiang, W.K. Optimal digital content distribution strategy in the presence of the consumer-to-consumer channel. *Journal of Management Information Systems, 25*, 4 (Spring 2009), 241-270.

17. Gil, R., and Warzynski, F. Vertical integration, exclusivity, and game sales performance in the US video game industry. *Journal of Law, Economics, and Organization, 31*, 1 (April 25, 2014), 143-168.

18. Hao, L., and Fan, M. An analysis of pricing models in the electronic book market. *MIS Quarterly, 38*, 4 (December 2014), 1017-1032.

19. Höhn, M.I. Literature review on supply chain contracts. *Relational Supply Contracts*. Berlin, Heidelberg: Springer, 2010, pp. 19-34.

20. Jerath, K., and Zhang, Z.J. Store within a store. *Journal of Marketing Research, 47*, 4 (August 2010), 748-763.

21. Kwark, Y.; Chen, J.; and Raghunathan, S. Platform or wholesale? A strategic tool for online retailers to benefit from third-party information. *MIS Quarterly, 41*, 3 (September 2017), 763-785.

22. Lang, K.R., and Vragov, R. A pricing mechanism for digital content distribution over computer networks. *Journal of Management Information Systems, 22*, 2 (Fall 2005), 121-139.

23. Lin, M.; Ke, X.; and Whinston, A.B. Vertical differentiation and a comparison of online advertising models. *Journal of Management Information Systems, 29*, 1 (Summer 2012), 195-235.

24. Milliot, J. 20 years of amazon.com bookselling. *Publishers Weekly* (September 4, 2015) (available at www.publishersweekly.com/pw/by-topic/industry-news/bookselling/article/67986-20-years-of-amazon-com-bookselling.html).

25. Mosendz, P. Amazon has basically no competition among online booksellers. *The Atlantic* (May 30, 2014) (available at www.theatlantic.com/business/archive/2014/05/amazon-has-basically-no-competition-among-online-booksellers/371917/).

26. Raju, J.S.; Sethuraman, R.; and Dhar, S.K. The introduction and performance of store brands. *Management Science, 41*, 6 (June 1995), 957-978.

27. Rey, P., and Tirole, J. The logic of vertical restraints. *The American Economic Review, 76*, 5 (1986), 921-939.

28. Shatzkin, M. Ebook pricing resembles three dimensional chess. *The Idea Logical Company* (September 6, 2016) (available at www.idealog.com/blog/ebook-pricing-resembles-three-dimensional-chess/).

29. Shatzkin, M. A first at this blog: Walking back the assumptions that were the basis of the last post. *The Idea Logical Company* (February 29, 2016) (available at www.idealog.com/blog/a-first-at-this-blog-walking-back-the-assumptions-that-were-the-basis-of-the-last-post-here/).

30. Shatzkin, M. If Amazon pricing of ebooks is the problem, is agency actually the right solution? *The Idea Logical Company* (February 26, 2016) (available at www.idealog.com/blog/if-amazon-pricing-of-ebooks-is-the-problem-is-agency-actually-the-right-solution/).

31. Shubik, M., and Levitan, R. *Market Structure and Behavior*. Harvard University Press, Cambridge, MA, 1980.

32. Singh, N., and Vives, X. Price and quantity competition in a differentiated duopoly. *The RAND Journal of Economics, 15*, 4 (Winter 1984), 546-554.

33. Spengler, J.J. Vertical integration and antitrust policy. *Journal of Political Economy, 58*, 4 (August 1950), 347-352.

34. Tagholm, R. The aftermath of the agency model. *Publishing Perspectives* (February 12, 2013) (available at www.publishingperspectives.com/2013/02/the-aftermath-of-agency/).

35. Tan, Y.R., and Carrillo, J.E. Strategic analysis of the agency model for digital goods. *Production and Operations Management*, 26, 4 (2017), 724-741.

36. Tirole, J. *The Theory of Industrial Organization*. Cambridge, MA: The MIT Press, 1988.

Appendix

Notation Table

Notation	Definition	Comment
q_b	Demand for printed books	*, **
q_e	Demand for e-books	*, **
p_b	Retail price for printed books	*, **
p_e	Retail price for e-books	*, **
σ	Level of substitutability between printed- and e-book versions	
w_b	Wholesale price for printed books	*
$w_{e\omega}$	Wholesale price for e-books under pure-wholesale arrangement	
α	Agency fee that the retailer collects for each e-book sold	Fraction of the e-book retail price
$\bar{\alpha}$	Threshold for α above which the market for e-book disappears	
Π_P	Publisher's total profit	*
Π_R	Retailer's total profit	*
Π_{Pb}	Publisher's partial profit from printed-books	*
Π_{Pe}	Publisher's partial profit from e-books	*
Π_{Rb}	Retailer's partial profit from printed-books	*
Π_{Re}	Retailer's partial profit from e-books	*
Π_V	Total profit for the vertically-integrated firm	

Notes: * For pure-wholesale arrangement, ω is added as a subscript.
** For the case of vertically-integrated channel, V is added as a subscript.

Proof of Lemma 1

In equilibrium, $q_e = \frac{8(1-\alpha)+2\sigma(1-3\alpha)+\sigma^2(1+\sigma)(1+\alpha)^2}{2(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)}$, and $\frac{dq_e}{d\alpha} = -\frac{16\sigma-\sigma^3(7-\alpha)(1+\alpha)}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} < 0$, indicating that q_e decreases in α. By solving $q_e = 0$ for α, we can find that the demand for e-books disappears at $\alpha = \bar{\alpha} = \frac{4+\sigma(3-\sigma(1+\sigma))-\sqrt{(4+\sigma(3-\sigma(1+\sigma)))^2-\sigma^2(1+\sigma)(2+\sigma)(4-\sigma(1-\sigma))}}{\sigma^2(1+\sigma)}$. By grouping the terms, we can see that the expression can be reorganized as $\frac{A-\sqrt{A^2-B}}{\sigma^2(1+\sigma)}$ where:

$$A = 4 + \sigma(3 - \sigma(1 + \sigma)) \quad \text{and} \quad B = \sigma^2(1 + \sigma)(2 + \sigma)(4 - \sigma(1 - \sigma)).$$

Since $B > 0$, from the reorganized expression, it is clear that $\bar{\alpha} > 0$. This completes the proof. ■

Proof of Proposition 1

First, we examine how the publisher's total profit change with α. By taking the derivative of Π_P^* with respect to α, we get $\frac{d\Pi_P^*}{d\alpha} = \frac{64(1+\sigma)(1-\alpha)^2+\sigma^4(1+\sigma)(1+\alpha)^4-4\sigma^2(1+\alpha)\left(4\alpha^2(1+\sigma)+\alpha-\sigma(1+\alpha)-7\right)}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} < 0$, implying that the publisher's profit strictly decreases in α.

Next, we examine the retailer's total profit. $\frac{d\Pi_R^*}{d\alpha} = \frac{C}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^3}$, where:

$$\begin{aligned} C = {} & 512(1+\sigma)(1-\alpha)^3 + 64\sigma^2(5+3\alpha(\alpha^3-2(1+\alpha))) + 64\sigma^3(1+3\alpha(\alpha^3+2(1-\alpha))) \\ & +4\sigma^4(1+\alpha)^2(29+\alpha(6-\alpha(5+6\alpha))) - 4\sigma^5(1+\alpha)^2(17-\alpha(6-\alpha(7+6\alpha))) \\ & -\sigma^6(1-\alpha)(3+\alpha)(1+\alpha)^4 + \sigma^7(1+\alpha)^4(5+\alpha(2+\alpha)). \end{aligned}$$

First, $\frac{d\Pi_R^*}{d\alpha} > 0$ for $\sigma \geq \hat{\sigma}$, where this $\hat{\sigma}$ threshold is obtained from $\left.\frac{d\Pi_R^*}{d\alpha}\right|_{\alpha=1} = \frac{\sigma\left(2+\sigma\left(3(1-\sigma)+\sigma^3\right)\right)-2}{2\sigma^4(1+\sigma)} = 0$. Hence, Π_R^* is maximized at $\alpha = 1$ for $\sigma \geq \hat{\sigma}$.

Next, we examine the case where $\sigma < \hat{\sigma}$. Here, $\frac{d\Pi_R^*}{d\alpha} > 0$ for $0 < \alpha \leq \frac{1}{3}$, indicating that Π_R^* strictly increases with α for $0 < \alpha \leq \frac{1}{3}$. For $\frac{1}{3} < \alpha < 1$, $\frac{d^2\Pi_R}{d\alpha^2} = -\frac{2\sigma^2 D}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^4} < 0$, where

$$D = 768\alpha(1-\sigma) + 4\sigma^2(1+\alpha)^2(\alpha(\alpha-6)-79) + 4\sigma^3(1+\alpha)^2(\alpha(6-\alpha)+79) \\ +\sigma^4(1+\alpha)^3(\alpha(\alpha-5)+74) - \sigma^5(1+\alpha)^3(\alpha(\alpha-5)+74) - \sigma^6(1+\alpha)^5 + \sigma^7(1+\alpha)^5,$$

implying that Π_R^* is concave in α for $\frac{1}{3} < \alpha < 1$. And, since $\left.\frac{d\Pi_R^*}{d\alpha}\right|_{\alpha=1} < 0$, Π_R^* increases in α until $\hat{\alpha}$ and eventually decreases, where $\hat{\alpha}$ is the unique real root of $C = 0$ satisfying $\frac{1}{3} < \hat{\alpha} < 1$. To sum up, the uniqueness of $\hat{\alpha}$ can be shown from that fact that (i) Π_R^* is concave in α for $\frac{1}{3} < \alpha < 1$, (ii) $\left.\frac{d\Pi_R^*}{d\alpha}\right|_{\alpha=\frac{1}{3}} > 0$, and (iii) $\left.\frac{d\Pi_R^*}{d\alpha}\right|_{\alpha=1} < 0$. This completes the proof. ■

Proof of Proposition 2

From Equations (3) and (4), we can segment the total profit into two parts:

$$\Pi_{Pb} = q_b w_b, \qquad \Pi_{Pe} = (1-\alpha) q_e p_e,$$
$$\Pi_{Rb} = q_b(p_b - w_b), \quad \text{and} \quad \Pi_{Re} = \alpha q_e p_e.$$

Using the equilibrium prices in Equations (5), (6), and (7), we get:

$$\Pi_{Pb} = \frac{(1-\alpha)\left(8(1-\alpha\sigma)+\sigma^3(1+\alpha)^2\right)\left(2+\sigma^2-\alpha(2-\sigma^2)\right)}{2(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2}, \qquad \Pi_{Pe} = \frac{(1-\alpha)E}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2},$$
$$\Pi_{Rb} = \frac{(4(1-\alpha)(1-\sigma(1-2\alpha))+\sigma^2(1+\alpha)^2(2-\sigma(2-\alpha)))(2+\sigma^2-\alpha(2-\sigma^2))}{2(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2}, \quad \text{and} \quad \Pi_{Re} = \frac{\alpha E}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2},$$

where $E = (8(1-\alpha)+\sigma(1+\alpha)(2-\sigma(1-\alpha)))(8(1-\alpha)+\sigma(2-6\alpha+\sigma(1+\sigma)(1+\alpha)^2))$.

Now, let us check what happens in the printed-book market. In that market, the profits change with α in the following way: $\frac{d\Pi_{Pb}}{d\alpha} = -\frac{F}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^3}$, and $\frac{d\Pi_{Rb}}{d\alpha} = \frac{G}{2(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^3}$, where

$$F = 64\sigma(1-\alpha)^3 - 16\sigma^2(1-\alpha)^3 + 8\sigma^3(1-\alpha)^2\left(3+\alpha(8+\alpha)\right) + 8\sigma^4(2-\alpha)(1+\alpha)^2 \\ -8\sigma^5((1+\alpha)(1+\alpha^3)) + \sigma^7(1+\alpha)^4, \qquad \text{and}$$

$$G = 128\sigma(1-\alpha)^3 + 16\sigma^2(1-\alpha)(7+\alpha(2-\alpha)) - 16\sigma^3(1-\alpha)(1+\alpha(-5+\alpha(7+\alpha))) \\ +4\sigma^4(1+\alpha)^2(13-\alpha(4-\alpha)) - 2\sigma^5(1+\alpha)^2(17-\alpha(10-9\alpha)) - 2\sigma^6(1+\alpha)^4 + 3\sigma^7(1+\alpha)^4.$$

Since the denominators of both expressions are positive, the signs of the expressions are determined by those of F and G. Since $F > 0$ and $G > 0$, $\frac{d\Pi_{Pb}}{d\alpha} < 0$ whereas $\frac{d\Pi_{Rb}}{d\alpha} > 0$.

For the e-book market, we can conduct a similar analysis. Taking the derivative of the profit expressions with respect to α, we obtain: $\frac{d\Pi_{Pe}}{d\alpha} = -\frac{H}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^3}$, and $\frac{d\Pi_{Re}}{d\alpha} = \frac{I}{4(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^3}$, where

$$H = 512(1-\alpha)^3 + 256\sigma(1-\alpha)^3 + 32\sigma^2(1-\alpha)(11+\alpha(4-\alpha(5+6\alpha))) \\ -32\sigma^3\alpha(1-\alpha)\left(1-\alpha(2-5\alpha)\right) - 4\sigma^4(1+\alpha)^2(7-\alpha(16-\alpha(7+6\alpha))) \\ +4\sigma^5(1+\alpha)^2(11-\alpha(4-3\alpha(1-2\alpha))) + \sigma^6(1+\alpha)^6 - \sigma^7(1-\alpha)(3+\alpha)(1+\alpha)^4, \qquad \text{and}$$

$$I = 512(1-\alpha)^3 + 256\sigma(1-\alpha)^3 + 32\sigma^2(3-\alpha(7+\alpha(9+\alpha(1-6\alpha)))) \\ +32\sigma^3(3+6\alpha-\alpha^3(6-5\alpha)) - 4\sigma^4(1+\alpha)^2(-3+\alpha(-14+\alpha(7+6\alpha))) \\ -8\sigma^5\alpha(1+\alpha)^2(2-\alpha(1-3\alpha)) + \sigma^6(1+\alpha)^6 - \sigma^7(1+\alpha)^4(1-\alpha(2+\alpha)).$$

Since $H > 0$ for $\alpha < \bar{\alpha}$, $\frac{d\Pi_{Pe}}{d\alpha} < 0$.

Now, turning to Π_{Re}, there are two things to note. First, $\frac{d^2\Pi_{Re}}{d\alpha^2} = -\frac{\sigma^2 J}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^4} < 0$, where

$$J = 512(2+\alpha) - 128\sigma(3+\alpha(12-\alpha(6-\alpha(4-\alpha)))) - 32\sigma^2(1+\alpha)(1+\alpha(19-\alpha(5-\alpha))) \\ +16\sigma^3(1+\alpha)^2(8+\alpha(3-\alpha)(5+\alpha)) - 2\sigma^4(1+\alpha)^3(10-\alpha(13-\alpha)) \\ +2\sigma^5(1+\alpha)^3(7-\alpha(25-8\alpha)) - \sigma^7(1+\alpha)^5,$$

implying that Π_{Re} is concave in α. Second, $\left.\frac{d\Pi_{Re}}{d\alpha}\right|_{\alpha=1} = \frac{\sigma(8+\sigma(2+\sigma(\sigma(2+\sigma)-4)))-8}{8\sigma^4(1+\sigma)} \geq 0$ for $\sigma \geq \breve{\sigma}$ whereas $\left.\frac{d\Pi_{Re}}{d\alpha}\right|_{\alpha=1} < 0$ for $\sigma < \breve{\sigma}$; $\breve{\sigma}$ threshold is obtained by solving $\sigma(8+\sigma(2+\sigma(\sigma(2+\sigma)-4)))-8=0$. This shows that Π_{Re} is maximized at the corner (i.e., at $\alpha = 1$) for $\sigma \geq \breve{\sigma}$ whereas, for $\sigma < \breve{\sigma}$, the solution to $\frac{d\Pi_{Re}}{d\alpha} = 0$ becomes an interior one. Hence, for $\sigma < \breve{\sigma}$, Π_{Re} increases in α until $\breve{\alpha}$ and decreases beyond, where $\breve{\alpha}$ is the unique real root of $I = 0$ satisfying $0 < \breve{\alpha} < 1$. The uniqueness of $\breve{\alpha}$ follows from the fact that (i) Π_{Re} is concave in α, (ii) $\left.\frac{d\Pi_{Re}}{d\alpha}\right|_{\alpha=0} = \frac{(4-\sigma)(2+\sigma)^2(4-(1-\sigma)\sigma)}{4(1+\sigma)(8+\sigma^2)^2} > 0$, and (iii) $\left.\frac{d\Pi_{Re}}{d\alpha}\right|_{\alpha=1} < 0$ for $\sigma < \breve{\sigma}$. This completes the proof. ■

Proof of Proposition 3

By taking the derivative of the retail prices with respect to α, we can observe how they change with α: $\frac{dp_e^*}{d\alpha} = \frac{\sigma(1-\sigma)(16-\sigma^2(1+\alpha)^2)}{(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$ and $\frac{dp_b^*}{d\alpha} = \frac{2\sigma^2(3-\alpha)(1+\alpha)(1-\sigma)}{(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$. Though $\frac{dp_e^*}{d\alpha}$ and $\frac{dp_b^*}{d\alpha}$ are both positive, their magnitudes are not the same. Specifically, $\frac{dp_e^*}{d\alpha} - \frac{dp_b^*}{d\alpha} = \frac{\sigma(1-\sigma)(16-\sigma(1+\alpha)(6+\sigma-\alpha(2-\sigma)))}{(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$, indicating that p_e^* increases at a higher rate with α than does p_b^*. Also, $\frac{dq_e}{d\alpha} = -\frac{16\sigma-\sigma^3(7-\alpha)(1+\alpha)}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} < 0$ and $\frac{dq_b}{d\alpha} = \frac{2\sigma^2(5-\alpha(2-\alpha))-\sigma^4(1+\alpha)^2}{(1+\sigma)(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0$, showing that the demand for e-books decreases with α while that for printed-books increases. This completes the proof. ■

Proof of Proposition 4

The optimal wholesale price is as given in Equation (7), and the retailer's optimal margin on the printed books (m_b^*) can be obtained by subtracting the wholesale price from the retail price given in Equation (8). That is, $m_b^* = p_b^* - w_b^* = \frac{4(1-\alpha)(1-\sigma(1-2\alpha))+\sigma^2(1+\alpha)^2(2-\sigma(2-\alpha))}{16(1-\alpha)+2\sigma^2(1+\alpha)^2}$. By taking the derivatives w_b^* and m_b^* with respect to α, we find:

$$\frac{dw_b^*}{d\alpha} = -\frac{\sigma(64(1-\alpha)^2+8\sigma(3-\alpha)(1+\alpha)-8\sigma^2(1+(1+2\alpha)\alpha^2)+\sigma^4(1+\alpha)^4)}{2(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} < 0, \quad \text{and}$$
$$\frac{dm_b^*}{d\alpha} = \frac{\sigma(64(1-\alpha)^2+12\sigma(3-\alpha)(1+\alpha)-4\sigma^2(5+\alpha(2+\alpha(1+4\alpha)))+\sigma^4(1+\alpha)^4)}{2(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0.$$

In the e-book market, the margins for the publisher and the retailer—w_e^* and m_e^*, respectively—can be obtained from $w_e^* = (1-\alpha)p_e^*$, and $m_e^* = \alpha p_e^*$, where p_e^* is given in Equation (9). By taking their derivatives, we find:

$$\frac{dw_e^*}{d\alpha} = -\frac{16(1-\alpha)^2(4-\sigma)+16\sigma^2(2-\alpha(1+\alpha^2))+(1+\alpha)^2(4\sigma^3-\sigma^4(1-\alpha)(3+\alpha))}{2(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} < 0, \quad \text{and}$$
$$\frac{dm_e^*}{d\alpha} = \frac{64(1-\alpha)^2+16\sigma(1+\alpha(2-\alpha))-16\alpha\sigma^2(1+\alpha^2)+(1+\alpha)^2(2\sigma^3-\sigma^4(1-\alpha(2+\alpha)))}{2(8(1-\alpha)+\sigma^2(1+\alpha)^2)^2} > 0.$$

This completes the proof. ■

Proof of Proposition 5

We can obtain $\alpha_{P\omega}$ by a simple profit comparison: $\Pi_P^* = \Pi_{P\omega}^*$. There is only one real root for the equation in $0 < \alpha < 1$. Similarly, we can get $\alpha_{R\omega}$ from $\Pi_R^* = \Pi_{R\omega}^*$. For this case, there is only one real root in $0 < \alpha < \alpha_R^*$, where α_R^* is $\hat{\alpha}$ if $\sigma < \hat{\sigma}$ and 1, otherwise. These two roots—$\alpha_{P\omega}$ and $\alpha_{R\omega}$—define the indifference boundaries for the publisher and the retailer, and the uniqueness of these roots follows from Proposition 1. For all σ values between 0 and 1, $\alpha_{R\omega}$ can be verified to be less than $\alpha_{P\omega}$. This completes the proof. ■

Fixed Market Size: Summary of the Equilibrium

For this extension, in the equilibrium, we obtain:

$$w_b^* = \frac{(1-\alpha)(8(1-\sigma(\alpha(1+2\sigma)-3(1+\sigma)))+\sigma^3(3-\alpha)^2)}{2(1+\sigma)(8(1-\alpha)+16\sigma(1-\alpha)+\sigma^2(3-\alpha)^2)},$$
$$p_b^* = \frac{4(1-\alpha)(3+8\sigma)+\sigma^2(30+9\sigma+\alpha^2(2+\sigma)-6\alpha(4+\sigma))}{2(1+\sigma)(8(1-\alpha)+16\sigma(1-\alpha)+\sigma^2(3-\alpha)^2)}, \; p_e^* = \frac{(1+\sigma)(8(1-\alpha)+2\sigma(9-7\alpha)+\sigma^2(3-\alpha)^2)}{2(1+\sigma)(8(1-\alpha)+16\sigma(1-\alpha)+\sigma^2(3-\alpha)^2)},$$
$$q_b = \frac{2+\sigma(4+3\sigma)-\alpha(2+\sigma(4+\sigma))}{8(1-\alpha)+16(1-\alpha)\sigma+(3-\alpha)^2\sigma^2}, \quad \text{and} \quad q_e = \frac{8+26\sigma-2\alpha(4+15\sigma)+\sigma^2(29+12\sigma-\alpha(34-\alpha+2\sigma(5-\alpha)))}{2(1+\sigma)(8(1-\alpha)+16(1-\alpha)\sigma+(3-\alpha)^2\sigma^2)^2}.$$

Using these equilibrium prices and demands, we can obtain the publisher's and the retailer's profits from the printed market ($\Pi_{Pb} = q_b w_b$ and $\Pi_{Rb} = q_b(p_b - w_b)$, respectively), and those from the e-book market ($\Pi_{Pe} = (1-\alpha)q_e p_e$ and $\Pi_{Re} = \alpha q_e p_e$, respectively). Also, by solving $q_e = 0$ for α, we can find that the market for e-book collapses for $\alpha \geq \bar{\alpha}$, where $\bar{\alpha} = \frac{4+\sigma(15+\sigma(17+5\sigma))-\sqrt{(4+\sigma(15+\sigma(17+5\sigma)))^2-\sigma^2(1+2\sigma)(2+3\sigma)(4+\sigma(7+4\sigma))}}{\sigma^2(1+2\sigma)}$. ■