Endemic and Non-Endemic Retail Media: The Role of Brand Response

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Abstract

"Retail media," which refers to ads served to customers on retailers' websites, is rapidly becoming an important component of the business models of retail platforms (as well as of traditional retailers as they increasingly sell online). In this paper, we use a game theory model to investigate a retailer's offering of retail media and manufacturers' responses as manifested in their advertising and distribution strategies. The manufacturers who sell through the retailer use the retailer's first-party customer data and their own knowledge of which type of customers their products best match with to bid in auctions run by the retailer to place ads (called "endemic ads"). The retailer can also offer "non-endemic ads," which allow off-site manufacturers to place ads on the retail platform. These ads increase the efficiency of matching customers and products, and the retailer relies on advertising as a significant source of profit in comparison to revenue share. In determining its optimal retail media mix strategy, the retailer faces a commission-ad revenue trade-off arising from the manufacturers' strategic distribution choices. We find that the ad types the retailer offers depend crucially on its market strength and organic match accuracy. A retailer with small customer traffic should forego retail media to prevent manufacturers from competing away their profits through ad auctions on the retail platform. In contrast, a retailer with large customer traffic and high organic match accuracy should offer both endemic and non-endemic ads to capture the off-site manufacturers' high ad valuation at the expense of sales commission.

Keywords: retail media, first-party data, distribution channel, endemic advertising, non-endemic advertising.

1 Introduction

When customers visit a retailer's website, the retailer can capture valuable data about their characteristics and behavior on the website. These customers, essentially captive at the retailer and in "buying mode," are ideal prospects for personalized advertising. "Retail media" refers to digital advertising that is shown on a retailer's website powered by the retailer's first-party data.[1] Retail media has become increasingly popular as retailers look for new ways to monetize their customer traffic and data. As a case in point, in 2022, Amazon's ad business had a revenue of $37.7 billion,[2] which accounted for approximately 16% of its revenues from online and physical stores. More broadly, in recent years, ad spend in the US on retail media has grown at an annual rate of over 25% and is projected to reach $100 billion by 2026.[3] From the perspective of brands, retail media provides new ways to reach and engage with customers in a contextually relevant environment using reliable first-party data (e.g., search and transaction histories), along with high trackability of outcomes, and has seen rapid adoption by brands.

Retail media has been both praised and criticized by industry experts. On the one hand, targeted advertising on retail media can benefit all parties involved (i.e., brands, retailers and consumers). Brands can leverage their proprietary data to target consumers and mitigate inefficiencies in retailers' organic ranking (e.g., Long et al., 2022; Yang et al., 2023). Enhanced ranking improves consumers' shopping experiences and boosts sales on the retailer's website. Moreover, retail media generates additional revenue streams for retailers that may allow them to lower commission rates for brands and improve services for consumers (e.g., faster and cheaper shipping). On the other hand, retail media has been criticized as a tool used by dominant retailers to squeeze surplus from brands as they have to bear additional advertising costs, on top of commission, for selling on the retailer's website.

The objective of this paper is to develop a theoretical framework to help advance our understanding of this novel and burgeoning market. We seek to address the following inter-related

[1] A broader definition is that retail media refers to digital advertising that appears on a retailer's owned and operated assets or on third-party publishers' properties and other media content powered by the retailer's first-party shopper data (eMarketer, 2023).

[2] www.statista.com/statistics/1290259/advertising-revenue-retailers/

[3] https://www.bcg.com/publications/2022/how-media-is-shaping-retail

research questions: What types of ads should retailers sell, if at all? How does the retailer's optimal mix of ad offerings vary by market conditions? What are the implications of retail media for consumers' search and likelihood of finding product matches? How does retail media impact ad pricing and how is revenue from product sales shared between brands and retailers? Finally, should brands sell through the retailer or take up alternate options such as direct sales on their own websites?

To shed light on these questions, we develop a game-theoretic model with two competing brands, a retail platform on which the brands can sell and can place ads (if the retailer allows) by competing in ad auctions, and a unit mass of consumers. The brands decide whether to sell through the retailer, who charges a commission on sales (as per the general practice of retail platforms), or to sell directly through their own websites.[4] Consumers search for products before making their purchase decisions. We focus on two exogenous parameters in the market: relative improvement in the ranking of products at the retail platform due to ads (that reflect the information that manufacturers have), and the retailer's market strength (the stronger the retailer, the more consumers start search on the retail platform).

Our analysis generates several interesting findings. If the retailer allows retail media, eligible manufacturers can show ads to customers at the retailer's website. Specifically, if the retailer sells "endemic" ads, then manufacturers that sell on-site can bid for ads, and if it sells "non-endemic" ads, then manufacturers that sell off-site can bid for ads. Manufacturers have private knowledge about which customers their products match best with; they leverage this knowledge to bid for ads to be shown to customers based on their characteristics and behavior reflected in the retailer's first-party data. This enhances product-consumer matching efficiency by improving the set of results presented to customers at the retailer, which increases sales. Interestingly, because the retailer owns the customer data, it can appropriate, through ad auction payments, (a part of) the surplus that is generated due to the manufacturers' private information on customer match.

Overall, manufacturers that sell through the retailer not only pay the retailer a sales commission on higher sales, but also pay, through ad auctions, for placing ads that lead to the higher sales.

[4]Note that direct selling can also be interpreted as selling through a different retailer, who is passive in our model. The main idea is that the manufacturer can utilize a reasonably attractive outside option for selling.

Conditional on manufacturers' selling through the retailer, retail media enables the retailer to appropriate larger surplus from manufacturers than when the retailer does not sell ads.

Considering manufacturers' endogenous distribution strategies (i.e., whether to sell through retailers or through their direct channels), we find that retail media is profitable for dominant retailers with large customer traffic, but may backfire for mid-size retailers (who have a significant fraction of consumers not visiting them when not all manufacturers sell through them). The intuition is that retail media creates competition for prominence that entraps manufacturers in an advertising Prisoner's dilemma. Therefore, if the retailer implements retail media but does not attract sufficiently large customer traffic, some manufacturers sell directly instead to avoid the Prisoner's dilemma that squeezes their profit. Mid-sized retailers may be better off committing *not* to offer retail media to attract more manufacturers to sell through their platform.

We find that the retailer can sell "non-endemic advertising" to offset the negative effect of retail media driving manufacturers away from the retail platform. Non-endemic ads allow manufacturers that do not sell on the retail platform to bid for ads to be placed on the retail platform. Even though non-endemic ads may re-direct sales away from the retailer — hence lowering the retailer's revenues from commission payments — they boost ad revenue through ad payments from off-site manufacturers and, more interestingly, by promoting bidding competition for ads on the retail platform, which increases ad prices for endemic ads as well. This insight matches with industry commentary regarding non-endemic ads.[5] The combination of endemic and non-endemic ads is especially profitable for dominant retailers with large customer traffic and high organic match accuracy. Intuitively, a large baseline traffic mitigates the retailer's commission loss from re-directing sales to the non-endemic manufacturer's off-site channel. Simultaneously, high organic match accuracy lowers retail-selling manufacturers' valuation for advertising, increasing the relative appeal of selling non-endemic advertising for retailers. Our insights provide a rational explanation for the seemingly puzzling move by Amazon of offering tools that encourage brands to sell outside of their platform.[6]

[5] See https://skai.io/blog/non-endemic-amazon-ads/, which is an article on non-endemic ads sold by Amazon and states that non-endemic ads "ultimately help drive Amazon Ads inflation by driving up costs for Amazon DSP and Display ads."

[6] For example, see https://supplychain.amazon.com/.

In sum, our work sheds light on the retailer's commission-ad revenue trade-off in the context of new taxonomy of ads (i.e., endemic vs. non-endemic) and manufacturers' strategic reactions as manifested in their distribution strategies.

Related Literature

Our work contributes to the literature on advertising in the context of distribution channels. Dukes and Liu (2010) study in-store advertising under channel coordination considerations, and show that retailers may discourage in-store advertising. The underlying mechanisms, however, are qualitatively distinct from our paper — rather than to enhance channel coordination as in Dukes and Liu (2010), the retailer in our paper refrains from selling ads to attract more manufacturers to the platform. Kuksov and Pazgal (2007) show that manufacturers do not offer slotting allowances to a monopoly retailer. However, we find that manufacturers pay for advertising on a monopolist retail platform to attain search prominence, which reflects certain ideas in Armstrong and Zhou (2011). Kuksov et al. (2017) demonstrate that hosting a competitor's ad could alleviate price competition by incentivizing the hosting retailer to raise product prices. We explore a similar setup where the retailer sells non-endemic ads to extract surplus from manufacturers who do not sell through the retailer. In contrast to Kuksov et al. (2017), who abstract from manufacturers' distribution strategies, we find that the retailer may not sell non-endemic ads to retain manufacturers on its platform.

Shaffer and Zettelmeyer (2004) investigate whether channel members are better or worse off with persuasive ads that increase the manufacturers' perceived differentiation. Based on a similar model of horizontal differentiation, Shaffer and Zettelmeyer (2009) provide a channel-based rationale for why manufacturers show (non-)comparative ads. Lal and Narasimhan (1996) show that ads can intensify competition between retailers and reduce their margins. We consider a qualitatively distinct setup where ads serve an informative role and can be targeted. Manufacturers in our paper benefit from awareness-building ads, but react negatively to the fact that the retailer squeezes their surplus through ads. The profit-eroding effect of ads does not stem from shifts in consumer preferences or price competition (Chen et al., 2009), but from manufacturers' bids for prominence that entraps them in a Prisoner's dilemma in which manufacturers pay high ad costs.

In the context of online retailers, Abhishek et al. (2016) show that retailers mitigate competition by adopting agency selling over reselling. Building on Abhishek et al. (2016), Long (2023) finds that retail media can backfire if implemented under a marketplace (vs. reselling) format because retail media disproportionately hurts high-quality sellers, undermining allocation efficiency. Long et al. (2022) show that bids for ads by sellers reveal the sellers' private information that platforms can leverage to improve their organic listings. While our paper shares certain features, it is different in that our primary focus is on the strategic reactions of symmetric manufacturers to the retailer's selling ads. In Choi and Mela (2019), platforms trade off reduced search efficiency due to distorted product listings with higher ad revenue. Our paper shows that even if ads improve consumer-product matching, retail platforms still forego selling ads because the retailer's commitment to sell ads elicits a switch in manufactures' channel strategies.

More broadly, our paper contributes to the growing literature on digital advertising, including sponsored search and display advertising (Amaldoss et al., 2015, 2016; Berman, 2018; Berman and Katona, 2013; Choi et al., 2023; Choi and Sayedi, 2019, 2023; Desai et al., 2014; Despotakis et al., 2021a,b; Despotakis and Yu, 2023; Dukes et al., 2022; Gritckevich et al., 2022; Jerath et al., 2011; Katona and Sarvary, 2010; Kuksov et al., 2017; Lu et al., 2015; Ning et al., 2022; Sayedi, 2018; Sayedi et al., 2018, 2014; Shin and Shin, 2022; Shin and Yu, 2021; Shin, 2015; Wilbur and Zhu, 2009; Zeithammer, 2019; Zia and Rao, 2019). Within this literature, Cao and Ke (2019) and Jerath et al. (2021) study manufacturer-retailer cooperation in search advertising and its competitive implications. Our paper contributes to this research stream by incorporating manufacturers' strategic responses to the retailers' endogenous decision of whether to sell ads on their platforms.

The remainder of this paper is structured as follows. In Section 2, we describe the main model. In Section 3, we present the key findings pertaining to the manufacturers' advertising and distribution strategies, and the retailer's utilization of retail media. In Section 4, we conclude and discuss avenues for future research. We provide all proofs of main results in Appendix A1.

2 Model

We develop a stylized model with two manufacturers, labeled A and B, one retailer, and a unit mass of consumers. Below we describe each player's strategies and payoff.

Manufacturers: Each manufacturer $j \in \{A, B\}$ produces a good and prices it at p_j. The manufacturer can sell the good through the retailer or through its direct channel. We denote the former strategy choice by R and refer to it as an R-manufacturer; we denote the latter strategy choice by D and refer to it as a D-manufacturer. We normalize the marginal cost of producing the product to 0. If a manufacturer sells through the retailer, it pays α fraction of sales to the retailer as commission. Thus, a manufacturer that sells a product at price p_j through the retailer earns profit $(1-\alpha)p_j$. To highlight the key economic forces clearly, we make the simplifying assumption that the retailer's commission, α, is exogenous.

If the manufacturer sells its product at price p_j through its direct channel, its net profit is p_j. The main idea behind allowing the manufacturer to sell through its direct channel is to give the manufacturer an alternative to selling through the retailer; we could also model this as selling through an outside passive retailer. We normalize any fixed and marginal costs of selling through the direct channel to 0 as this does not impact our insights qualitatively.

Consumers: A consumer's preference may or may not match with a manufacturer's offering. For consumer i and Manufacturer $j \in \{A, B\}$, we define m_{ij} as the match value:

$$m_{ij} = \begin{cases} 1 & \text{if consumer } i \text{ and Manufacturer } j \text{ match,} \\ 0 & \text{otherwise.} \end{cases} \tag{1}$$

We assume that each consumer i independently matches with Manufacturer $j \in \{A, B\}$ with probability $\mu \in (0, 1)$; i.e., $\mathbb{P}\{m_{ij} = 1\} = \mu = 1 - \mathbb{P}\{m_{ij} = 0\}$. The parameter μ can be interpreted as the baseline attractiveness of the product category; i.e., it measures how mainstream (vs. niche) the product category is. If a consumer purchases Manufacturer j's product at price p_j, her net utility is $m_j - p_j$, where m_j is the binary match value in (1). Consumers' outside option yields a normalized utility of 0.

Consumers *ex ante* know the existence of both manufacturers as well as their distribution channels.[7] However, consumers need to search to learn the match values and prices of the manufacturers' offerings. Following Kuksov (2004) and Bostanci et al. (2022), we assume that processing the match and price information for the first search is free, whereas subsequent information processing costs $s > 0$. We make the following assumptions regarding the consumers' channel search behavior. When both manufacturers sell through the retailer, all consumers start search at the retailer. When both manufacturers sell directly through their own channels, consumers randomly start search at either manufacturer's direct channel with equal probability. When one manufacturer sells through the retailer and the other through its direct channel, β fraction of consumers start search at the retailer, and $1-\beta$ fraction at the D-manufacturer's channel. Thus, β measures the retailer's market strength; large β would make it more difficult for a manufacturer to sell through its direct channel because it would have fewer customers there.[8]

Retailer: For every consumer who arrives on the retailer's platform, the retailer receives an imperfect, private signal about consumer-manufacturer match. Specifically, if consumer i visits and searches on the retail platform, then for each R-manufacturer j, the retailer independently receives a match signal $s_{ij} \in \{0, 1\}$. The accuracy of the match signal is

$$\rho = \mathbb{P}\{s_{ij} = m_{ij} | m_{ij}\} \in [1/2, 1]. \tag{2}$$

Because consumers are *ex ante* symmetric from the retailer's perspective, we hereafter suppress the consumer subscript i to simplify notation.

A key decision variable in our model is the type of retail media ads that the retailer offers, if at all. The retailer can sell only endemic ads to on-site manufacturers, only non-endemic ads to off-site manufacturers, both, or neither.[9] We denote the retailer's strategy choice of not allowing ads as $\emptyset$, selling only endemic ads as E, selling only non-endemic ads as N, and selling both endemic and

[7] Bar-Isaac and Shelegia (2022) make a similar assumption that consumers, prior to search, know "which good is stocked" in different retailers.

[8] According to Djuraskovic (2023), "[a]bout 50% of [shoppers] prefer searching for new products on Google or Instagram. However, Amazon is still the go-to marketplace for initial product searches. Approximately 63% of consumers start their product search on the platform, and about 63% also compare the pricing on Walmart.".

[9] We assume that if the retailer is indifferent between two or more strategies, it opts for the "simpler" one; e.g., if it is indifferent between selling non-endemic ads and not offering any ads, it chooses the latter. This corresponds to the asymptotic case when the retailer incurs an infinitesimal fixed cost for implementing the "more complex" strategy.

(a) Organic Ranking *(b) Organic Ranking Below Sponsored Ad (Gray) With $b_A < b_B$*

Figure 1: Organic and Sponsored Ranking With $s_A > s_B$

non-endemic ads as $E + N$.

If advertising is not allowed ($\emptyset$), the retailer uses its imperfect, private signals about consumer-manufacturer match to display an organic listing of R-manufacturers; the retailer ranks manufacturers in the organic listing in descending order of match signals.[10] The retailer breaks ties randomly with equal probability. For example, if $s_A = 1$ and $s_B = 0$, such that the retailer perceives the consumer to match only with A, the retailer shows A on top and B below it (see Figure 1a). If $s_A = s_B$, such that the retailer evaluates manufacturers to be of equal match quality, then the retailer ranks them randomly.

If advertising is allowed, the retailer enables the manufacturers to place an ad by bidding in a second-price auction. Specifically, if the retailer sells endemic ads (E), then R-manufacturers that sell through the retailer can participate in the ad auction; if the retailer allows non-endemic ads (N), then D-manufacturers that do *not* sell through the retailer can participate. The winning manufacturer's ad is displayed at the top of the search results page, and the retailer's organic listing is presented below the ad (see Figure 1b). We assume that the manufacturers are equipped with some private information about match values for their own products that the retailer does not possess (e.g., Abhishek et al., 2023; Long et al., 2022; Yang et al., 2023). Combined with the retailer's first-party data, manufacturers can infer match values for their own products more accurately than the retailer.[11]

[10] It can be shown that this ranking strategy maximizes the retailer's expected profit. In our model, the retailer does not benefit from displaying low-signal manufacturer more prominently than a high-signal counterpart. Long et al. (2022) and Long and Liu (2023) explore settings where organic rankings may be adjusted due to interaction effects with sponsored listings.

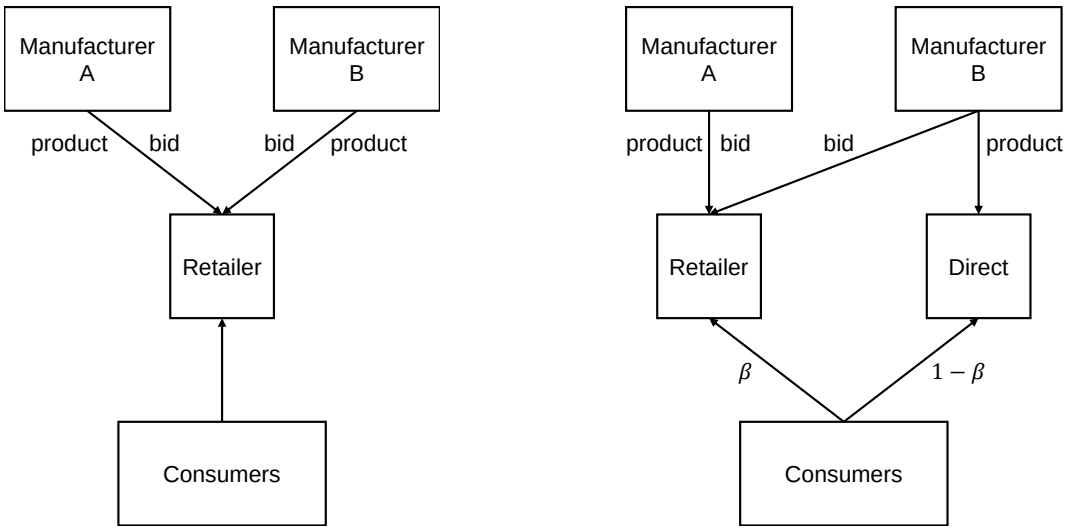
[11] That the retailer shares all of its data with manufacturers can be shown to be equilibrium outcome. Despite conventional wisdom that large retailers (e.g., Amazon) who collect vast troves of customer data are better informed than manufacturers, our conversation with high-ranking executives at a major online retailer suggests that this is not the case. For example, retailers struggle with even basic customer identity resolution because many consumers hide their identity (by not logging in) until the moment of purchase.

In other words, the accuracy with which a manufacturer infers whether a consumer matches with its offering is higher than that of the retailer. To simplify the analysis, we normalize manufacturers' inference accuracy to 1. However, a manufacturer cannot infer beyond its prior whether the consumer matches with the other competing manufacturer. Whereas the retailer has information on the characteristics of the consumer who arrives at its website and obtains imperfect signals of match for this consumer for both manufacturers, a manufacturer, with knowledge of the consumer's characteristics and its own product, perfectly knows whether there is a match with this consumer. This idea is the same as in de Cornière and de Nijs (2016) and, as described in that paper and typically implemented in reality, can be implemented through "conditional bids" wherein a bidder (in this case, a manufacturer) submits to the auctioneer (in this case, the retailer) a bid and the criteria that a consumer must satisfy for the manufacturer to enter the ad auction. Note that the assumption that the manufacturer can perfectly infer its match with a consumer appears to favor manufacturers' joining and advertising on the retailer over selling directly. Interestingly, we later show that this is not necessarily the case. Under certain conditions, manufacturers avoid selling through the retailer when the retailer offers retail media, even though ads improve the product-ranking efficiency.

The retailer's payoff consists of product sales commission (if there are manufacturers selling through it) and ad revenue (if the retailer offers ads). If a manufacturer sells its product through the retailer at price p and advertises its product on the retail platform at price q, the retailer's total profit from this manufacturer is $\alpha p + q$.

Timeline: The timing of the game is as follows.

1. Retailer decides which types of ads to offer, if at all, and sets reserve prices.
2. Manufacturers A and B simultaneously decide whether to sell through retailer and pay commission rate α, or through their direct channels.
3. Manufacturers set product prices. Consumers visit websites, after which the retailer observes match value signals.
4. If the retailer offers retail media, eligible manufacturers submit bids.
5. Consumers form beliefs about prices and conduct product search.
6. Consumers make purchase decisions and payoffs are realized.



(a) Retailer sells endemic ads, and manufacturers sell through retailer

(b) Retailer sells endemic and non-endemic ads, and manufacturers sell through different channels

Figure 2: Examples of Subgame Structures

We denote the retailer's choice of ad offerings and the manufacturers' channel strategies by X_{YZ} where $\mathrm{X} \in \{\emptyset, E, N, E+N\}$ is the retailer's choice, $\mathrm{Y} \in \{\mathrm{R},\mathrm{D}\}$ is Manufacturer A's choice and $\mathrm{Z} \in \{\mathrm{R},\mathrm{D}\}$ is Manufacturer B's choice. For example, $\emptyset_{\mathrm{RD}}$ refers to the regime where the retailer does not sell ads, Manufacturer A sells through the retailer, and Manufacturer B sells directly. Similarly, E_{RR} refers to the regime where the retailer sells endemic ads and both manufacturers sell through the retailer (see Figure 2).

3 Analysis

We begin the analysis with consumers' search and manufacturers' product pricing strategies. Due to positive search cost s, the only possible equilibrium is one in which consumers hold price beliefs $\tilde{p}_A = \tilde{p}_B = 1$ and do not search beyond the first product shown on top of the search results page (e.g., Diamond, 1971; Kuksov, 2004). This setup allows us to focus on the interaction between retail media and manufacturer's distribution strategies by simplifying the price and search dynamics. Without loss of generality, we hereafter restrict our analysis to the case where $p_A = p_B = 1$ and consumers make purchase decisions after learning (at no cost) only the first shown product's match value and price. We state this preliminary result in the following lemma.

Lemma 1. *Consumers hold product price beliefs $\tilde{p}_A = \tilde{p}_B = 1$, which are fulfilled in equilibrium. As a result, consumers do not search beyond the first product displayed.*

3.1 Manufacturers' Strategies

Manufacturers decide their distribution channels (i.e., retail or direct). If the retailer allows advertising, eligible manufacturers can submit bids for ad impressions. Specifically, if the retailer allows endemic advertising, R-manufacturers can bid for ad impressions, and if the retailer allows non-endemic advertising, D-manufacturers can bid as well.

We denote the regime in which the retailer does not sell ads with a subscript $\emptyset$. The regimes in which the retailer sells only endemic ads, only non-endemic ads, and both types of ads, are denoted, respectively, with subscripts E, N, and $E + N$. Furthermore, we denote the two manufacturers' channel choices as a tuple in $\{\mathrm{R}, \mathrm{D}\} \times \{\mathrm{R}, \mathrm{D}\}$, where R denotes retail-selling and D direct-selling.

In analyzing the manufacturers' strategies, there are four subgames to consider: the subgames in which the retailer (i) does not sell any ads ($\emptyset$), (ii) sells only endemic ads (E), (iii) sells only non-endemic ads (N), and (iv) sells both endemic and non-endemic ads ($E+N$). For ease of exposition, we present only the analyses for the three representative regimes – $\emptyset$, E and $E + N$ – that involve the primary forces of the model. The analysis for the N-regime, which is shown to be dominated in equilibrium, is provided in the appendix.

3.1.1 Retailer Does Not Sell Ads

Consider the subgame in which the retailer does not sell ads ($\emptyset$). In $\emptyset_{\mathrm{RR}}$, where both manufacturers sell through the retailer, the retailer ranks manufacturers organically based on its private signals. For instance, if the retailer deems the consumer to only match with A (i.e., $s_A = 1$ and $s_B = 0$), then the retailer shows A on top and B below. The retailer breaks ties (i.e., $s_A = s_B$) randomly. Thus, the retailer ranks manufacturers in (weakly) descending order of their signals. For $j \in \{A, B\}$, Manufacturer j's profit under this regime is positive if and only if its product is shown on top by the retailer's organic rank, and the consumer matches with Manufacturer j. Therefore, its expected

profit is

$$\pi_j^{\emptyset_{\text{RR}}} = \sum_{(s_j,s_{-j})\in\{0,1\}^2} \mathbb{P}\{s_j, s_{-j}\}\mathbb{P}\{\text{Manufacturer } j \text{ shown on top}|s_j, s_{-j}\}\mathbb{P}\{m_j = 1|s_j\}(1-\alpha). \quad (3)$$

By independence of signals, we have $\mathbb{P}\{s_j, s_{-j}\} = \mathbb{P}\{s_j\}\mathbb{P}\{s_{-j}\}$, where $\mathbb{P}\{s_j = 1\} = \rho\mu + (1-\rho)(1-\mu)$ and $\mathbb{P}\{s_j = 0\} = (1-\rho)\mu + \rho(1-\mu)$. Moreover,

$$\mathbb{P}\{\text{Manufacturer } j \text{ shown on top}|s_j, s_{-j}\} = \begin{cases} 1 & \text{if } s_j = 1, s_{-j} = 0, \\ 1/2 & \text{if } s_j = s_{-j}, \\ 0 & \text{if } s_j = 0, s_{-j} = 1, \end{cases}$$

and by Bayes' rule, the posterior match probabilities are

$$\mathbb{P}\{m_j = 1|s_j\} = \frac{\mathbb{P}\{s_j|m_j = 1\}\mathbb{P}\{m_j = 1\}}{\mathbb{P}\{s_j|m_j = 0\}\mathbb{P}\{m_j = 0\} + \mathbb{P}\{s_j|m_j = 1\}\mathbb{P}\{m_j = 1\}} = \begin{cases} \frac{\rho\mu}{\rho\mu+(1-\rho)(1-\mu)} & \text{if } s_j = 1, \\ \frac{(1-\rho)\mu}{(1-\rho)\mu+\rho(1-\mu)} & \text{if } s_j = 0. \end{cases}$$

Putting the above together, Manufacturer j's expected profit in (3) simplifies to

$$\pi_j^{\emptyset_{\text{RR}}} = \frac{1}{2}\mu(\mu + 2\rho(1-\mu))(1-\alpha). \quad (4)$$

That the manufacturer's expected profit increases in the retailer's organic ranking accuracy, ρ, reflects the matching effect. As consumers are more likely to be shown manufacturers that match their preferences, more products are sold in expectation.

3.1.2 Retailer Sells Only Endemic Ads

Consider the E subgame in which the retailer offers only endemic advertising. Consider the regimes E_{DD} and E_{RD}, in which, no manufacturers sell through the retailer, and only one manufacturer sells through the retailer, respectively. Both of these regimes are degenerate in that no ads are sold. In E_{DD}, no manufacturer sells through the retailer, and consequently, no ads are bought. In RD_E, the product of the R-manufacturer, being the sole manufacturer selling through the retailer,

is shown organically even without advertising; therefore, no ads are sold.

In the E_{RR}-regime, where both manufacturers sell through the retailer, both R-manufacturers may bid for their matching consumers. (Recall that manufacturers can perfectly infer match, and bid for ads accordingly through conditional bids.) To compute the manufacturer's bid for its matching consumer, we compare each manufacturer's profit when its ad is shown to its matching consumer versus when it is not shown.

Suppose Manufacturer A's ad is shown to a consumer who matches with A (i.e., $m_A = 1$). The consumer would learn (at no cost) about A's product and realize that the product matches her preference. At this point, the consumer chooses between buying A's product at price $p_A = 1$, and searching for B's product at cost s. However, she rationally anticipates $p_B = 1$, such that her expected utility from searching product B is $\mu(1-1) + (1-\mu)0 - s < 0$. Therefore, the consumer foregoes search and buys A's product (see Lemma 1). Overall, A's expected profit from showing the ad (after paying α commission to the retailer) is

$$\pi_A(\text{ad shown}) = 1 - \alpha. \tag{5}$$

Now suppose A's ad is *not* shown to A's matching consumer. In this case, A's payoff depends on whether the consumer also matches with B (i.e., $m_A = m_B = 1$) or she only matches with A (i.e., $m_A = 1, m_B = 0$). If she also matches with B, then B shows its ad to her. The consumer then purchases B's product by virtue of B's prominence attained through its ad. If the consumer does not match with B, then B does not bid for this consumer, and neither manufacturer's ad is shown to the consumer. The consumer only sees the retailer's organic ranking, which could show either A or B on top. The organic ranking "correctly" shows A's product on top with probability

$$\mathbb{P}\{s_A = s_B | m_A = 1, m_B = 0\}\frac{1}{2} + \mathbb{P}\{s_A = 1, s_B = 0 | m_A = 1, m_B = 0\}. \tag{6}$$

Exploiting the independence of signals, we can expand each terms in (6) as follows and simplify:

$$\begin{aligned}\mathbb{P}\{s_A = s_B | m_A = 1, m_B = 0\} &= \mathbb{P}\{s_A = 1 | m_A = 1\}\mathbb{P}\{s_B = 1 | m_B = 0\} \\ &\quad + \mathbb{P}\{s_A = 0 | m_A = 1\}\mathbb{P}\{s_B = 0 | m_B = 0\} \\ &= 2\rho(1-\rho)\end{aligned}$$

and

$$\begin{aligned}\mathbb{P}\{s_A = 1, s_B = 0 | m_A = 1, m_B = 0\} &= \mathbb{P}\{s_A = 1 | m_A = 1\}\mathbb{P}\{s_B = 0 | m_B = 0\} \\ &= \rho^2,\end{aligned}$$

so that (6) $= \rho$. In this case, the consumer buys from A, and A's profit is $1-\alpha$. The organic ranking "erroneously" shows B's product on top (even though $m_A = 1$ and $m_B = 0$) with probability $1-\rho$. In this case, A's product is not sold and A's profit is 0. Overall, A's expected profit when A's ad is *not* shown to the matching consumer is

$$\pi_A(\text{ad not shown}) = \mathbb{P}\{m_B = 0\}\rho(1-\alpha) = (1-\mu)\rho(1-\alpha). \tag{7}$$

Therefore, for $j \in \{A, B\}$, Manufacturer j's valuation, and hence bid, for its matching consumer is

$$b_j^{E_{\text{RR}}} = \pi_j(\text{ad shown}) - \pi_j(\text{ad not shown}) = \left(1 - (1-\mu)\rho\right)(1-\alpha). \tag{8}$$

It is evident from the expression in (8) that manufacturers' ad valuations decrease in the retailer's organic match accuracy ρ. The diminishing valuation reflects the substitution effect highlighted in Ke et al. (2023). Intuitively, the more accurate the organic ranking, the less manufacturers are incentivized to invest in advertising to improve the ranking efficiency. This insight is instrumental in understanding the retailer's equilibrium strategy of *which ad types to offer*, as it provides the basis for the relative profitability of non-endemic ads vs. endemic ads under different market conditions. We state this result in the following lemma.

Lemma 2. *In the E_{RR} regime, where both manufacturers sell through the retailer that allows*

endemic advertising, the manufacturers' ad valuations decrease in the retailer's organic match accuracy ρ.

In the E_{RR} regime where the retailer allows endemic advertising with reserve price r_E each manufacturer's expected profit is

$$\begin{aligned}\pi_j^{E_{\text{RR}}}(r_E) &= \mathbb{P}\{m_j = m_{-j} = 1\}\frac{1}{2}\left(1-\alpha-\max\left\{r_E, b_j^{E_{\text{RR}}}\right\}\right) + \mathbb{P}\{m_j = 1, m_{-j} = 0\}(1-\alpha-r_E) \\ &= \frac{1}{2}\mu^2\left(1-\alpha-\max\left\{r_E, b_j^{E_{\text{RR}}}\right\}\right) + \mu(1-\mu)(1-\alpha-r_E), \end{aligned} \tag{9}$$

where $b_j^{E_{\text{RR}}}$ is the manufacturers' ad valuations in (8).

That the manufacturers' profit decreases in the reserve price r_E creates an important trade-off for the retailer. All else equal, the retailer's profit increases in the reserve price (provided it does not exceed valuation) as the retailer extracts more surplus from the manufacturers. However, excessive surplus extraction may elicit manufacturers to sell directly instead. Manufacturer churn not only reduces product sales commission for the retailer, but also lowers ad revenue as thinner auction participation softens bidding competition.

Interestingly, we find that the manufacturers' profits under the $\emptyset_{\text{RR}}$ regime, where the retailer does not sell any ads, may be higher than that under E_{RR}, *even if* the reserve price is 0. From (4), we have

$$\pi_j^{\emptyset_{\text{RR}}} = \frac{1}{2}\mu(\mu + 2\rho(1-\mu))(1-\alpha), \tag{10}$$

which is greater than

$$\pi_j^{E_{\text{RR}}}(0) = \frac{1}{2}\mu^2\left(1-\alpha-b_j^{E_{\text{RR}}}\right) + \mu(1-\mu)(1-\alpha) = \frac{1}{2}(1-\mu)\mu(2+\mu\rho)(1-\alpha)$$

if and only if $\rho > \frac{(2-3\mu)^+}{(2-\mu)(1-\mu)}$. This implies that to retain manufacturers on its platform, the retailer may need to do more than lower the reserve price; it may need to commit to not sell ads altogether, especially if the its organic match accuracy is high. By not selling ads, the retailer spares the manufacturers from competing away their profits through ad auctions, and thereby prevents manufacturer churn. Indeed, we later show that under certain conditions (including large ρ), the retailer withholds selling ads altogether (i.e., choose $\emptyset$ over E and $E+N$), even though selling ads

is costless.

3.1.3 Retailer Sells Endemic and Non-endemic Ads

Consider the $E + N$ subgame in which the retailer offers both types of ads so that both R- and D-manufacturers can both advertise on the retailer's platform. This subgame is only meaningful to the extent that there exist R- and D-manufacturers. For instance, if all manufactures sell through the retailer, then there would be no demand for non-endemic advertising, rendering the subgame degenerate. Therefore, we restrict attention to the *RD*-regime.

We compute, in turn, the valuations of D- and R-manufacturers for advertising to their respective matching consumers. If the D-manufacturer shows an ad to its matching consumer on the retailer, then the consumer buys from the D-manufacturer, yielding profit 1 from the retail platform. Note that the D-manufacturer does not pay commission to the retailer because it does not sell through the retailer *per se*; it simply diverts retailer traffic to the direct channel. Also, the D-manufacturer may earn profit from some of its direct traffic (of size $1-\beta$) but this is independent of its advertising activity on the retail platform and so does not affect the D-manufacturer's ad valuation. If the D-manufacturer does not show an ad, then the consumer will not buy from the D-manufacturer and its profit would be 0 from the retail platform. Therefore, the D-manufacturer's ad valuation is

$$b_D^{E+N_{\mathrm{RD}}} = 1 - 0 = 1. \tag{11}$$

Next, consider the R-manufacturer, who can also advertise because the retailer offers both ad types in this subgame. If it advertises, its profit would be $1 - \alpha$ net of commission. If it does not advertise, the R-manufacturer could still earn profit through organic listing; this happens if the consumer does not match with the D-manufacturer. Thus, the R-manufacturer's profit would be $(1 - \mu)(1 - \alpha)$, yielding ad valuation of

$$b_R^{E+N_{\mathrm{RD}}} = 1 - \alpha - (1 - \mu)(1 - \alpha) = \mu(1 - \alpha). \tag{12}$$

Comparing the two manufacturers' ad valuations in (11) and (12) and the total expected sales

under the regimes $E + N_{\text{RD}}$ and E_{RR}, we obtain the following proposition.

Proposition 1. *The D-manufacturer under $E + N_{RD}$ has higher ad valuation than does the R-manufacturers under E_{RR}. However, the total expected sales on the retail platform under $E + N_{RD}$ is lower than that under E_{RR}.*

The intuition behind the first part of Proposition 1 revolves around the asymmetric outside options of R- and D-manufacturers. The R-manufacturers have a positive outside option in that they earn positive expected profit through organic listing even if their ads are not shown. In contrast, the D-manufacturers can capture the retail consumer *only if* they show an ad to the consumer; the D-manufacturers' products cannot appear in the retailer's organic list, which only displays R-manufacturers' products. Therefore, the D-manufacturers have a higher valuation for advertising than R-manufacturers.

The second part of Proposition 1 claims that fewer products are sold in expectation when only one sells through the retailer than when both manufacturers sell through it. Even if the retailer attracts the entire consumer population ($\beta = 1$), the very fact that the retailer has fewer product variety under RD than under RR implies that fewer products are sold in the former case.

Taken together, Proposition 1 highlights one of the central trade-offs faced by the retailer in determining what types of ads to offer on its platform. On the one hand, the D-manufacturer's high ad valuation represents a profitable opportunity for boosting its ad revenue – the retailer could set a high reserve price for non-endemic ads and monetize the D-manufacturer's high ad valuation. On the other hand, this approach requires that a manufacturer sells off-site, which, all else equal, reduces total sales, and hence, the total commission the retailer receives.

In summary, the retailer's decision of what types of ads to offer, if at all, (which subsumes the problem of what manufacturer channel choices to induce) is a complex problem involving nuanced trade-offs. The retailer's principal trade-off is between product sales commission and ad revenue. By selling ads at high reserve price, the retailer may obtain high ad revenue, but doing so may prompt manufacturers to sell off-site, lowering commission. Similarly, selling non-endemic ads to off-site manufacturers to extract their higher valuation for advertising than on-site manufacturers may increase the retailer's ad revenue but this requires sustaining the RD-regime in which one

manufacturer sells off-site, again lowering commission.

In the next section, we analyze how the retailer resolves these key trade-offs and characterize its equilibrium strategy (i.e., what types of ads to offer) under different market conditions.

3.2 Equilibrium

We turn to the central question of the paper: what types of ads should the retailer sell, if at all? The previous subgame analyses revealed three main forces: selling ads incentivize the manufacturers to sell direct, valuations for endemic ads decrease in ρ, and non-endemic manufacturers have higher valuation for advertising than do endemic manufacturers.

We find that the retailer chooses to either sell no ads ($\emptyset$), only endemic ads (E), or both endemic and non-endemic ads ($E+N$). The following proposition summarizes the conditions under which the retailer implements each.

Proposition 2. *The retailer*

- *does not sell ads to induce* $DD_\emptyset$ *if* $\beta \leq \tilde{\beta}$ *and* $\rho \leq \tilde{\rho}$*;*
- *does not sell ads to induce* $\emptyset_{RR}$ *if* $\beta \leq \tilde{\beta}$ *and* $\rho > \tilde{\rho}$*;*
- *sells both endemic and non-endemic ads to induce* RD_{E+N} *if* $\beta > \hat{\beta}$ *and* $\rho > \hat{\rho}$*;*
- *sells only endemic ads to induce* E_{RR} *otherwise.*

Proposition 2, illustrated in Figure 3, offers valuable insight into the implementation of retail media by retailers. First, if the retailer attracts little customer traffic and has low organic match accuracy (below the solid line and left of dotted line in Figure 3), then there is little value for the manufacturers to sell through the retailer. In this case, the retailer cannot induce manufacturers to sell through it, even if it commits not to sell ads, and the retailer's advertising decision is degenerate.

Second, if a weak retailer has sufficiently accurate organic match (below the solid line and right of dotted line in Figure 3), then manufacturers expect to generate considerable sales through the retailer's organic listing such that manufacturers sell through the retailer. However, the retailer needs to "compensate" manufacturers for the low traffic by committing not to sell ads, because selling ads would entrap retail-selling manufacturers in a Prisoners' Dilemma wherein manufacturers

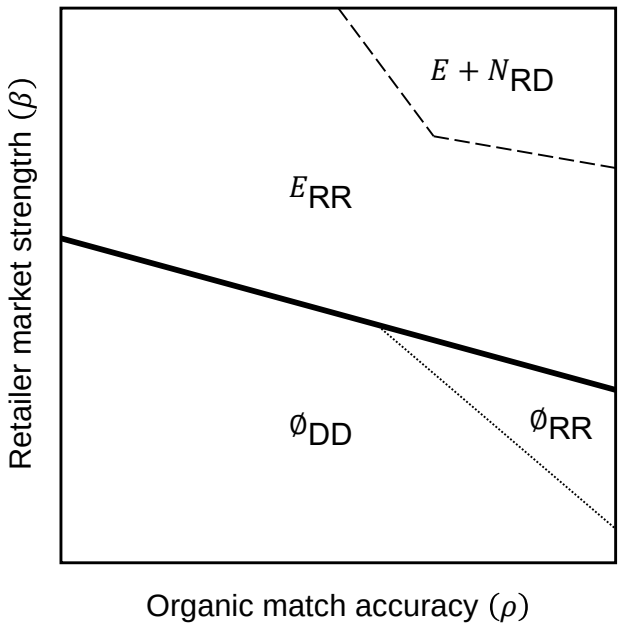


Figure 3: Retail Media Implementation and Manufacturers' Distribution Strategies (not to scale)

compete away their profits.

Third, in contrast to the above cases, if the customer traffic on the retailer's platform is high (above the solid line in Figure 3), then manufacturers have strong incentives to sell through the retailer and be found by consumers. Thus, the retailer can sell ads and extract additional surplus, which in fact is arising from the manufacturers' better match determination abilities, without worrying about driving manufacturers away. Interestingly, the *types of ads* a retailer should sell depends further on the size of customer traffic and the accuracy of its organic match. If the retailer is dominant in both dimensions (above and to the right of dashed line in Figure 3), then the retailer sells both endemic and non-endemic ads to induce asymmetric selling modes.

In this parameter region, the retailer balances the trade-off between commission and ad revenue in an interesting way. We decompose the intuition in terms of β and ρ. By inducing one manufacturer to sell off-site, the retailer loses commission. This commission loss, however, is not significant because the retailer commands a large β. Moreover, the retailer more than compensates for this small commission loss by capitalizing on the non-endemic manufacturer's high ad valuation (see Proposition 1). The retailer not only extracts greater ad revenue from the non-endemic manufacturer, but also from the endemic manufacturer who bids more competitively due to non-endemic

participation relative to the RD-regime without non-endemic advertising.

The inclusion of non-endemic ads in the retailer's ad mix is particularly profitable when its organic match accuracy (ρ) is large. The reason is that accurate organic ranking substitutes for advertising such that manufacturers' ad valuation under E_{RR} decreases in ρ (see Equation (8)). Therefore, the retailer switches from generating revenue from endemic ads, whose valuations are low, to extracting non-endemic manufacturer's high ad valuation at the expense of commission.

Finally, in other conditions where either the retailer's market strength or its organic match accuracy is intermediate (between solid line and dashed line in Figure 3), the retailer sells only endemic ads. The intuition is the converse of the $E + N$ case above. If β is not large enough, then the retailer would incur a significant decline in customer traffic from inducing manufacturer churn. Furthermore, a low enough ρ implies that manufacturers have moderately high valuation for endemic as. Taken together, the retailer earns higher profit from inducing both manufacturers to sell through the retailer and selling endemic ads to them than prompting manufacturer churn and selling both endemic and non-endemic ads.

Proposition 2 offers practical insights for managers. The result suggests that retailers should be mindful of their market size and organic ranking efficiency before deciding on what ad types of offer, if at all. We find that a dominant retailer that attracts large customer traffic and ranks organic results accurately should offer a wider variety of ads than a less dominant retailer. Counter-intuitively, a dominant retailer can earn higher profits from inducing manufacturer churn, and then capitalizing on the off-site manufacturer's strong incentive to advertise, on top of collecting commission and ad revenue from the on-site manufacturer.

Another important implication of this result is related to the future growth of retail media. Retail media has already been implemented by the larger retailers and, while the spend on larger retailers can be expected to continue growing, a significant portion of future growth is expected to come from "second-tier" retailers adopting retail media. However, our result shows that retailers that have intermediate market strength may not have as strong incentives to implement retail media as retailers that have high market strength because it is easier for brands to switch away from selling through these retailers. The future growth potential of retail media should be evaluated with this

caveat in mind.

To summarize the insights from the main model, we find that the introduction of retail media increases the cost for manufacturers to sell through the retailer. When the market power of the retailer is intermediate, this induces the manufacturers to sell through their direct channels instead. In these cases, the retailer may abandon retail media, and the lack of advertising on the retailer reduces the overall search ranking accuracy, ultimately decreasing total sales in the market. Furthermore, if the retailer can set its organic match accuracy, it has the incentive to set it at an intermediate value.

4 Conclusion

One of the most important developments in the advertising and retailing industries has been the rapid rise of retail media, which refers to, as per eMarketer (2023): digital advertising that appears on a retailer's owned and operated assets or on third-party publishers' properties and other media content powered by the retailer's first-party shopper data. In this paper, we investigate a retailer's offering of ads to consumers who are on its website by manufacturers who sell through the retailer (endemic ads) and also by manufacturers who do not sell through the retailer (non-endemic ads). The ads are sold through auctions in which manufacturers bid for their ads to be placed in front of individual consumers. The manufacturers' bids are based on their knowledge of match with a consumer, determination of which is facilitated by the retailer's first-party data.

The main finding is that what types of ads a retailer should sell depends crucially on its market strength and its organic ranking accuracy. A strong retailer that attracts large customer traffic that can rank organic results with high accuracy can maximize its profit by offering both endemic and non-endemic ads. The reserve prices are set such that they induce one manufacturer to sell on-site and the other off-site. While encouraging one of the manufacturers to sell off-site decreases the total sales made on the retail platform, the retailer re-captures the surplus by capitalizing on the off-site manufacturer's high valuation for advertising on the retail platform.

Furthermore, we find that while retail media can help to improve matching between consumers and products leading to higher sales, this may benefit the retailer at the expense of the manu-

facturers because the latter have to pay high prices for the ads that enable this match. Stated differently, the retailer is able to extract (a large part of) the surplus that is generated by the accurate targeting of ads to consumers which is enabled by the retailer's first-party data on consumers. This is in addition to the revenue on sales that the manufacturers have to share with the retailers. Consequently, when the manufacturers have reasonable alternative options for selling, such as their direct channels, one or both of them may take these options, thus hurting the retailer's profits. To prevent this, the retailer may lower the reserve price or choose not to offer retail media altogether — specifically, this may happen for mid-sized retailers who have a significant fraction of consumers not visiting them when all manufacturers do not sell through them.

We acknowledge several limitations of our model which provide avenues for future research. First, by focusing on binary match values, the main model abstracts away from pricing nuances at the retail level. Future research could consider continuous match values and investigate the impact of retail media on product prices. To the extent that advertising is necessary for purchase, the escalation of advertising intensity due to Prisoners' dilemma as highlighted in the main model will act as a higher marginal production cost, thereby raising product prices (Dellarocas, 2012).

Second, future research could consider multiple manufacturers, such that the cost for the retailer of losing one manufacturer at the margin may be smaller; this in turn could result in asymmetric equilibria where manufacturers sell through different channels. Furthermore, the result that advertising has no value for the R-manufacturer in the RD regime would also change with more manufacturers. While considering multiple manufacturers would not qualitatively affect the main insights, it would be interesting to examine what new outcomes emerge under such circumstances. In a similar vein, future work could consider multiple retailers. Then, if a retailer adopts retail media, manufacturers would have the option to sell through other retailers who may not have adopted it. This may lead to equilibria in which ex ante identical retailers have different retail media strategies and ex ante identical manufacturers join different retailers, with the potential outcome that the price of retail media ads is controlled.

Third, a number of developments are rapidly happening in retail media which offer interesting research opportunities. For instance, an interesting phenomenon is off-site advertising, whereby manufacturers selling through a retailer (and even those not selling through the retailer) can leverage

the retailer's data and advertise to consumers on third-party publishers (eMarketer, 2023). In this case, the retailer is acting primarily as a data provider. It would be interesting to analyze how this practice influences adoption and use of retail media.

Declarations

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Appendix

A1 Proofs

A1.1 Proof of Lemma 1

That price beliefs $\tilde{p}_A = \tilde{p}_B = 1$ is a fulfilling equilibrium is trivial and its proof is omitted. We show uniqueness by showing profitable deviations for other equilibrium candidates.

1. $\tilde{p}_A < \tilde{p}_B$. Under these beliefs, Manufacturer A raises its price to $p_A = \tilde{p}_B$. To see this, compare Manufacturer A's profit in the following scenarios. Since a consumer who does not match with Manufacturer A does not buy regardless of p_A, Manufacturer A only considers the demand from consumers who match with it.
   (a) A is shown first. Consumer compares her utility from purchasing A, which is $1-\tilde{p}_B$ with her expected utility from searching B, which is $\mu(1-\tilde{p}_B)-s$. Therefore, she purchases A at a higher price $\tilde{p}_B$ than $\tilde{p}_A$.
   (b) B is shown first. Suppose consumer matches with Manufacturer B. If $\mu(1-\tilde{p}_A)-s \leq 1-\tilde{p}_B$, changing p_A does not induce consumer to search, so Manufacturer A is indifferent. If $\mu(1-\tilde{p}_A)-s > 1-\tilde{p}_B$, consumer searches. If she matches, she will search A and buy it (assume p_A is set infinitesimally smaller than $\tilde{p}_B$). Suppose the consumer does not match with Manufacturer B. In a similar vein, if $\mu(1-\tilde{p}_A)-s \leq 0$, changing p_A does not induce consumer to search, so Manufacturer A is indifferent. If $\mu(1-\tilde{p}_A)-s > 0$, consumer searches. If she matches, she will search A and buy it.
2. $\tilde{p}_A = \tilde{p}_B < 1$. Suppose a consumer matches with Manufacturer A.
   (a) First see Manufacturer B's product. (i) If she matches with B, then because $1-\tilde{p}_B > \mu(1-\tilde{p}_A)-s$, she does not search regardless of p_A. (ii) If she does not match with B, then if $\mu(1-\tilde{p}_A)-s < 0$, she does not search regardless of p_A. Otherwise, she searches. Therefore, A can raise price to $p_A = 1$.
   (b) First see Manufacturer A's product. Consumer compares $1-p_A$ vs. $\mu(1-\tilde{p}_B)-s$. So A can raise price to $p_A = \min[1, 1-\mu(1-\tilde{p}_B)+s] = \min[1, 1-\mu+\mu\tilde{p}_B+s]$.

A1.2 Proof of Lemma 2

The result follows immediately from (8).

A1.3 Proof of Proposition 1

The first part follows from

$$b_{\mathrm{D}}^{E+N_{\mathrm{RD}}} = 1 > (1-(1-\mu)\rho)(1-\alpha) = b_j^{E_{\mathrm{RR}}}.$$

For the second part, observe that under $E + N_{\mathrm{RD}}$, a sales occurs if and only if the R-manufacturer's product is shown at the top of the search results page. Given that the D-manufacturer has a higher bid for its matching consumer than the R-manufacturer, this happens if and only if the consumer matches only with the R-manufacturer. Therefore,

$$\mathbb{E}\left[\text{total sales}^{E+N_{\mathrm{RD}}}\right] = \beta\mu(1-\mu), \tag{A1}$$

where β measures the total traffic on the retail platform.

Under E_{RR}, a sales occurs on the retail platform if and only if at least one manufacturer matches with the consumer; therefore,

$$\mathbb{E}\left[\text{total sales}^{E_{\mathrm{RR}}}\right] = 1-(1-\mu)^2,$$

which is greater than (A1).

A1.4 (Sketch) Proof of Proposition 2

1. $\emptyset_{\mathrm{DD}}$:
   - With advertising, even if $r_E = 0$, retailer cannot induce RR nor RD if $\beta \leq \tilde{\beta}$.
   - If $\beta < \tilde{\beta}$, then retailer can induce $\emptyset_{\mathrm{RR}}$ if and only if $\rho > \tilde{\rho}$.
2. $E + N_{\mathrm{RD}}$: if $\beta > \tilde{\beta}$, then retailer can induce E_{RR} with $r_E \geq 0$. This regime yields higher profit than $\emptyset_{\mathrm{DD}}$ and $\emptyset_{\mathrm{RR}}$.

- Due to Claim 1, there exist $\hat{\beta}$ and $\hat{\rho}$ such that for $\beta > \tilde{\beta}$, the retailer's profit is higher under $E + N_{\text{RD}}$ than under E_{RR} if and only if $\beta > \hat{\beta}$ and $\rho > \hat{\rho}$.
- Due to Claim 2, N_{RD} is dominated by E_{RR}.

3. E_{RR}: it follows from above that E_{RR} occurs for all other parameter ranges.

A1.5 Statement and Proof of Claim 1

Claim 1. *There exist $\hat{\beta}$ and $\hat{\rho}$ such that the retailer's profit is higher under $E + N_{RD}$ than under E_{RR} if and only if $\beta > \hat{\beta}$ and $\rho > \hat{\rho}$*

Proof. The retailer's expected profit under $E + N_{\text{RD}}$, provided it can be sustained, is

$$\pi_{\text{Retailer}}^{E+N_{\text{RD}}}(r_E, r_N) = \beta\left(\mu^2 \max\{r_N, \mu(1-\alpha)\} + \mu(1-\mu)r_N + (1-\mu)\mu(r_E+\alpha)\right). \tag{A2}$$

To induce the regime, the retailer's reserve prices r_N and r_E, for non-endemic and endemic ads, respectively, must satisfy the manufacturers' incentive compatibility constraints. That is,

$$\pi_R^{E+N_{\text{RD}}} \geq \pi_D^{E+N_{\text{DD}}} \text{ and } \pi_D^{E+N_{\text{RD}}} \geq \pi_R^{E+N_{\text{RR}}}.$$

Note that the incentive compatibility constraint on r_E implies a necessary condition for sustaining the $E + N_{\text{RD}}$ regime, which is

$$0 < 1 - \alpha - \frac{1}{2\beta(1-\mu)}. \tag{A3}$$

These constraints, in turn, simplify to

$$\pi_R^{E+N_{\text{RD}}} \geq \pi_D^{E+N_{\text{DD}}} \Leftrightarrow \beta\mu(1-\mu)(1-\alpha-r_E) \geq \frac{1}{2}\mu \Leftrightarrow r_E \leq 1 - \alpha - \frac{1}{2\beta(1-\mu)},$$

and

$$\pi_D^{E+N_{\mathrm{RD}}} \geq \pi_R^{E+N_{\mathrm{RR}}} \Leftrightarrow \beta\left(\mu^2\left(1-\max\left\{r_N, \mu(1-\alpha)\right\}\right)+\mu(1-\mu)\left(1-r_N\right)\right)+(1-\beta)\mu \geq (9)$$

$$\Leftrightarrow \begin{cases} r_N \leq \frac{-\pi_R^{E_{\mathrm{RR}}}(r_E)-\left(\mu^3(\beta-\alpha\beta)\right)+\mu}{\beta(1-\mu)\mu} & \text{if } r_N \leq \mu(1-\alpha), \\ r_N \leq \frac{-\pi_R^{E_{\mathrm{RR}}}(r_E)+\mu}{\beta\mu} & \text{if } \mu(1-\alpha) < r_N \end{cases}$$

Since $-\pi_R^{E_{\mathrm{RR}}}(r_E)$ increases in r_E, the constraints become more relaxed as r_E increases. Moreover, the retailer's profit increases in r_E; therefore, the retailer will set r_E as high as possible:

$$r_E^* = \min\left\{\mu(1-\alpha), 1-\alpha-\frac{1}{2\beta(1-\mu)}\right\},$$

where the cap of $\mu(1-\alpha)$ ensures the reserve price is less than the endemic manufacturers' ad valuation (12). Applying the feasibility constraints, we obtain the following optimal reserve price for the non-endemic ads:

$$r_N^* = \begin{cases} \min\left\{1, \frac{-\pi_R^{E_{\mathrm{RR}}}\left(r_E^*\right)+\mu}{\beta\mu}\right\} & \text{if } \mu(1-\alpha) \leq \frac{-\pi_R^{E_{\mathrm{RR}}}\left(r_E^*\right)+\mu}{\beta\mu} \text{ and (A3)}, \\ \min\left\{\mu(1-\alpha), \frac{-\pi_R^{E_{\mathrm{RR}}}\left(r_E^*\right)-\left(\mu^3(\beta-\alpha\beta)\right)+\mu}{\beta(1-\mu)\mu}\right\} & \text{if } \mu(1-\alpha) > \frac{-\pi_R^{E_{\mathrm{RR}}}\left(r_E^*\right)+\mu}{\beta\mu} \text{ and (A3)}. \end{cases}$$

In other cases, the regime cannot be sustained by any pair of reserve prices. In sum, the retailer's optimal expected profit under the $E+N_{\mathrm{RD}}$ regime simplifies to

$$\pi_{\mathrm{Retailer}}^{E+N_{\mathrm{RD}}} = \begin{cases} \frac{1}{2}\mu\left(2\alpha(\beta+1)(1-\mu)^2-(1-\alpha)\mu(1-\mu)\rho+2\mu(2-(\beta+1)\mu+\beta)\right) & \text{if } \beta > \frac{1}{2(1-\alpha)(1-\mu)^2}, \\ \frac{\mu(\beta(1-\mu)(2\beta-(1-\alpha)\mu\rho)+\beta-1)}{2\beta} & \text{otherwise,} \end{cases}$$

under the feasibility constraint (A3).

Next, we turn to the endemic-only regime. The retailer's expected profit under E_{RR}, provided it can be sustained, with reserve price r_E capped at valuation $(1-(1-\mu)\rho)(1-\alpha)$ is

$$\pi_{\mathrm{Retailer}}^{E_{\mathrm{RR}}}(r_E) = \mu^2\left(\alpha+(1-(1-\mu)\rho)(1-\alpha)\right)+2\mu(1-\mu)(\alpha+r_E). \tag{A4}$$

To determine the optimal reserve price, we partition the parameter space into three. For large β,

the manufacturers do not deviate from RR even if the reserve price is set as high as their valuation. For intermediate β, the manufacturers do not deviate from RR for small r_E but deviate for large r_E. Finally, for small β, manufacturers deviate from RR even if the reserve price is set to 0.

If a manufacturer deviates to direct-selling from RR, then its expected profit is

$$\pi_D^{E_{\text{RD}}} = (1-\beta)\mu.$$

Therefore, the bounds for the partitions are determined by $\pi_{\text{Retailer}}^{E_{\text{RR}}}((1-(1-\mu)\rho)(1-\alpha)) > (1-\beta)\mu$ and $\pi_{\text{Retailer}}^{E_{\text{RR}}}(0) < (1-\beta)\mu$. In the top partition, the retailer has nothing to lose from setting the maximum reserve price, so $r_E^* = (1-(1-\mu)\rho)(1-\alpha)$, whereas in the bottom partition, no manufacturer sells through the retailer and reserve price is degenerate. In the intermediate partition, the reserve price is set to make the manufacturers indifferent between RR and the switching regime (either RD or DD).

To compare the profitability of $E + N_{\text{RD}}$ and E_{RR}, it suffices to compare their profits under the former strategy's feasibility constraint (A3). But under this constraint, the retailer's profit under E_{RR} simplifies to

$$\pi_{\text{Retailer}}^{E_{\text{RR}}}(r_E^*) = \begin{cases} (2\beta-\mu)\mu & \text{if } \beta \leq 1-(1-\alpha)(2-\mu)(1-\mu)\rho/2, \\ (2-\mu)\mu(1-(1-\alpha)(1-\mu)\rho) & \text{otherwise.} \end{cases} \tag{A5}$$

It can be shown that $\pi_{\text{Retailer}}^{E+N_{\text{RD}}}(r_E^*, r_N^*) > \pi_{\text{Retailer}}^{E_{\text{RR}}}(r_E^*)$ only if $\beta > 1-(1-\alpha)(2-\mu)(1-\mu)\rho/2$. Next, consider the two parameter regions:

- $\frac{1}{2(1-\alpha)(1-\mu)^2} < \beta$. In this case,

$$\frac{d}{d\rho}\left(\pi_{\text{Retailer}}^{E+N_{\text{RD}}}(r_E^*, r_N^*) - \pi_{\text{Retailer}}^{E_{\text{RR}}}(r_E^*)\right) = \frac{1}{2}(1-\alpha)(1-\mu)\mu(4-3\mu) > 0,$$

  such that

$$\pi_{\text{Retailer}}^{E+N_{\text{RD}}}(r_E^*, r_N^*) > \pi_{\text{Retailer}}^{E_{\text{RR}}}(r_E^*) \Leftrightarrow \rho > \hat{\rho},$$

where $\hat{\rho}$ solves $\pi^{E+N_{\text{RD}}}_{\text{Retailer}}(r^*_E, r^*_N) = \pi^{E_{\text{RR}}}_{\text{Retailer}}(r^*_E)$.

- $1-(1-\alpha)(2-\mu)(1-\mu)\rho/2 < \beta \leq \frac{1}{2(1-\alpha)(1-\mu)^2}$. In this case,

$$\frac{d}{d\beta}\left(\pi^{E+N_{\text{RD}}}_{\text{Retailer}}(r^*_E, r^*_N) - \pi^{E_{\text{RR}}}_{\text{Retailer}}(r^*_E)\right) = \mu\left(1-\mu+\frac{1}{2\beta^2}\right) > 0,$$

such that

$$\pi^{E+N_{\text{RD}}}_{\text{Retailer}}(r^*_E, r^*_N) > \pi^{E_{\text{RR}}}_{\text{Retailer}}(r^*_E) \Leftrightarrow \rho > \hat{\beta},$$

where $\hat{\beta}$ solves $\pi^{E+N_{\text{RD}}}_{\text{Retailer}}(r^*_E, r^*_N) = \pi^{E_{\text{RR}}}_{\text{Retailer}}(r^*_E)$.

Taken together, we obtain

$$\pi^{E+N_{\text{RD}}}_{\text{Retailer}}(r^*_E, r^*_N) > \pi^{E_{\text{RR}}}_{\text{Retailer}}(r^*_E) \Leftrightarrow$$
$$rho > \hat{\rho} \text{ and } \beta > \hat{\beta}.$$

■

A1.6 Statement and Proof of Claim 2

Claim 2. *The retailer's strategy of selling only non-endemic ads is dominated by selling only endemic ads.*

Proof. We show dominance in two partitions of the parameter space.

1. $\beta \leq 1-(1-\alpha)(2-\mu)(1-\mu)\rho/2$: in this region, the retailer's expected profit under E_{RR} simplifies to

$$\pi^{E_{\text{RR}}}_{\text{Retailer}} = (2\beta-\mu)\mu.$$

Note that the positivity of $\pi^{E_{\text{RR}}}_{\text{Retailer}}$ is guaranteed by the necessary condition for sustaining N_{RD}, which is

$$\pi^{N_{\text{RD}}}_{R} > \pi^{N_{\text{DD}}}_{D} \Leftrightarrow \beta > \frac{1}{2(1-\mu)(1-\alpha)}. \tag{A6}$$

In this case, even if the retailer could hypothetically charge the highest reserve price $r_N = 1$ for the non-endemic manufacturers, its expected profit under N_{RD} would be

$$\pi^{N_{\text{RD}}}_{\text{Retailer}} = \beta\mu(1 + (1-\mu)\alpha),$$

but this is still less than $\pi^{E_{\text{RR}}}_{\text{Retailer}}$ because

$$\begin{aligned}(2\beta - \mu)\mu > \beta\mu(1 + (1-\mu)\alpha) &\Leftrightarrow 2\beta - \mu > \beta + \beta(1-\mu)\alpha \\ &\Leftrightarrow \beta > \frac{\mu}{1 - (1-\mu)\alpha},\end{aligned}$$

which is implied by $\beta > \frac{1}{2(1-\mu)(1-\alpha)}$, because

$$\begin{aligned}\frac{1}{2(1-\mu)(1-\alpha)} > \frac{\mu}{1-(1-\mu)\alpha} &\Leftrightarrow 1 - (1-\mu)\alpha > 2\mu(1-\mu)(1-\alpha) \\ &\Leftrightarrow 1 - 2\mu(1-\mu) + \alpha(1-\mu)(2\mu - 1) > 0,\end{aligned}$$

which holds for $\alpha \in \{0, 1\}$, and hence for all $\alpha \in [0, 1]$ by linearity.

2. $1 - (1-\alpha)(2-\mu)(1-\mu)\rho/2 < \beta$: in this region, the retailer's expected profit under E_{RR} simplifies to

$$\pi^{E_{\text{RR}}}_{\text{Retailer}} = (2-\mu)\mu(1 - (1-\alpha)(1-\mu)\rho). \tag{A7}$$

To characterize the retailer's expected profit under N_{RD}, consider the incentive compatibility constraint

$$\begin{aligned}\pi^{N_{\text{RD}}}_{D} > \pi^{N_{\text{RR}}}_{R} &\Leftrightarrow \beta\mu(1 - r_N) + (1-\beta)\mu > \pi^{N_{\text{RR}}}_{R} \\ &\Leftrightarrow r_N \leq \frac{\mu - \pi^{N_{\text{RR}}}_{R}}{\beta\mu} \\ &\Leftrightarrow r_N \leq \frac{2 - 2(1-\alpha)(1-\mu)\rho + \alpha\mu - \mu}{2\beta},\end{aligned}$$

where the last line follows from substituting (10) into the previous inequality. Note that the

necessary condition (A6) implies

$$\frac{2-2(1-\alpha)(1-\mu)\rho+\alpha\mu-\mu}{2\beta}<1,$$

so that the reserve price is capped by the D-manufacturer's ad valuation. It follows that

$$r_N^*=\frac{2-2(1-\alpha)(1-\mu)\rho+\alpha\mu-\mu}{2\beta}.$$

Taken together, we obtain

$$\begin{aligned}\pi_{\text{Retailer}}^{N_{\text{RD}}}&=\beta\mu(r_N^*+(1-\mu)\alpha)\\&=\frac{1}{2}\mu(2-2\alpha\beta\mu+2\alpha\beta-2(1-\alpha)(1-\mu)\rho+\alpha\mu-\mu),\end{aligned}$$

which can be shown to be less than (A7) under the necessary condition (A6).

■