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Content vs. Advertising: The Impact of Competition on Media Firm Strategy

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Media firms compete in two connected markets. They face rivalry for the sale of content to consumers, and at the same time, they compete for advertisers seeking access to the attention of these consumers. We explore the implications of such two-sided competition on the actions and source of profits of media firms. One main conclusion we reach is that media firms may charge higher content prices in a duopoly than in a monopoly. This happens because competition for advertisers can reduce the return per customer impression from the ad market, making each firm less willing to underprice content to increase demand. Greater competitive intensity may thus increase content profits and decrease ad profits. These findings are in sharp contrast to those in a regular one-sided product market, in which competition typically lowers product prices and profits. We extend the framework to examine competition across different media (e.g., between magazines and cable TV) and show that firms in a duopolistic medium may benefit from more intense competition from a monopolist in another medium. We characterize the conditions for each firm in the duopoly medium to bundle more ads and earn greater total profits than the rival firm in the monopoly medium.

Key words: media; advertising; two-sided markets; competitive strategy; game theory
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1. Introduction

In 1999, Conrad Black launched the *National Post* in Toronto, bringing the total number of daily newspapers in the market to four. Reports described the resulting context as "the most brutal newspaper war in North America" in which "losses are mounting and publishers are slashing newsstand prices. Some papers are even distributing special editions free" (Cherney 2001, p. B1). In the United States between 1990 and 2000, the number of movie screens increased by more than 50% (from 23,814 to 36,280), creating significantly more rivalry between theaters. The availability of more venues was accompanied by a marked drop in the number of patrons per theater and led theater owners to lower ticket prices slightly (by 18 cents on average when adjusting for inflation). Consequently, revenues from ticket sales per theater decreased by 31% (NATO 2005). Satellite radio represents a different example from those above. Operating as a de facto monopoly in the satellite radio market for its first few years of existence, XM Satellite Radio's initial strategy was to charge a monthly fee of $9.99 for its service. In April 2005, when its only competitor, Sirius, had finally garnered about 25% share of the market, XM *increased* the monthly subscription price to $12.95 (Murphy 2005, McBride 2005). Finally, it is interesting to observe that most websites started out in the mid-1990s by giving their content away for free and relying solely on advertising revenues. However, as more providers of online content emerged, we have witnessed the introduction of more pay-for-content models. For example, CNN.com now charges a subscription price of $2.95 a month for its *Pipeline* service, which offers online access to premium video content.

The preceding examples suggest very different predictions regarding the impact of competition on media firm content pricing. More intense competition seems to have been associated with lower content prices in both the newspaper and the movie theater businesses, but higher prices in the satellite radio and online content businesses. The former examples seem to conform to standard economic theory, while the latter, perhaps surprisingly, do not.

In this paper, we investigate the impact of competition on media firm decisions. It is our principal argument that to understand media firm behavior and explain deviations from standard theory—such as those witnessed in the satellite radio and online content markets—one needs to take into account the unique structure of media industries. Firms in these industries compete in two interrelated markets. On the one hand, they compete in the content market for consumers, and on the other hand, they face rivalry in the ad market to attract advertisers. Quite distinct from relatively simple multiproduct competition, this is a specific form of two-sided competition in which the customers in one market represent, in some sense, the *product* in the other market. That is, a magazine, for example, attracts the attention of customers in the content market and then sells that attention to advertisers in the ad market. We demonstrate that this interaction between the two markets can yield outcomes such as those noted above in which prices may increase with more competition.

It has long been suggested or intuitively believed that a media firm sets a lower price for its content relative to what a firm that does not bundle advertising would set. This is because the marginal benefit of one more customer is higher for a media firm that can earn more money by selling that customer's attention to advertisers. However, the literature has not addressed the extent to which this "underpricing effect" can be a function of the degree and source of competitive intensity the media firm faces. As we show, with competition, the returns to underpricing may decline because it becomes more difficult to capture the advertising value of additional content customers. Thus, competing media firms may find *underpricing* to be less attractive, yielding higher content prices.

We also investigate a closely related question: How much advertising should the firm bundle with its content and how does this change with competition? Our analysis yields the insight that the answer depends critically on the source and nature of the competition. In particular, although increased competition in the ad market from another outlet in the same medium has the expected effect of decreasing a media firm's optimal level of ad bundling, the same is not necessarily true with respect to increased competition at the content level. Nor do we obtain the standard results in an analysis of across-medium competition. In fact, with respect to the latter, we find that more intense competition from other media industries may result in *more* ad bundling, and in some cases, *higher* firm profits. While the interaction between separate media has always been a relevant topic of inquiry, one might argue that it is becoming more important given the rapid emergence of new media technologies as marketing communication options.[1]

Our paper makes four important contributions. First, we derive from first principles a comprehensive model of both sides of the media business. This model yields the insight that the commonly held assumption that prices decline because of competition may not hold in media markets. Second, we provide prescriptions with respect to the amount of advertising that media firms should bundle as a function of media-level parameters (e.g., its value for advertisers and the disutility consumers experience from ads) as well as competitive intensity. Notably, we find that while the ad bundling decision is insulated from content market factors, ad bundling declines in within-medium competitive intensity in the ad market. Third, we provide insights into media firm behavior when rivalry originates from a different medium. In particular, if the platforms of separate media are substitutable in the eyes of advertisers, there exist cases in which firms in a more competitive medium (defined as a medium with more firms in it) bundle more advertising and earn higher overall profits than a less competitive medium. Finally, we show that when separate media platforms produce complementarities (e.g., when placing ads on two different media is more effective than placing them all on a single medium), greater complementarity may result in higher content prices charged in the more competitive medium—once again counter to standard economic theory that would predict lower product prices in more competitive markets.

These findings shed light on the strategic decisions made by economically important firms. Media firms—for example, Disney, Viacom, NBC, Time Warner, Clear Channel Communications—represent a sizable proportion of the domestic U.S. economy and are of particular relevance to marketers. They provide the channel through which most firms' marketing messages are delivered to consumers.[2] Understanding how this particular form of two-sided competition affects media firms' marketing mix decisions—their pricing of content and the amount of ads to bundle—thus represents a domain of inquiry that is both theoretically and practically important. None of these results have been demonstrated in either the marketing or economics literatures.

The rest of the paper is organized as follows. Section 2 relates our work to the relevant literature. Section 3 lays the foundations of the modeling approach. Section 4 solves the model, starting with the monopoly

[1] According to a 2006 Forrester report, at least one in four marketing executives were either using or expecting to test new media options, such as e-mail marketing, search marketing, rich media, blog marketing, Real Simple Syndication (RSS), mobile marketing, and advergames, in addition to the use of traditional media (VanBoskirk et al. 2006).

[2] Revenues from advertising in the United States across all media industries were nearly $200 billion in 2005. Source: *Marketing News* (2006). Several media firms, like Time Warner, Disney, Yahoo!, and NBC (owned by General Electric), are Fortune 500 companies.

case and followed by analyses of within- and across-media competition. Finally, §5 discusses the limitations of our study, proposes future research directions, and concludes. To enhance readability, we have relegated all proofs to the appendix.

2. Related Literature

Our paper is broadly related to the rapidly growing literature on *two-sided markets*. A general review of this literature can be found in Rochet and Tirole (2004). Among the papers focusing specifically on media markets, one can identify two distinct approaches, characterized by whether or not the media firm charges a price for its content. With respect to the latter case of no content pricing, Gal-Or and Dukes (2003) and Dukes and Gal-Or (2003) consider media firm decisions about differentiation of programming content and the amount of advertising, respectively. This work shows that lower levels of advertising (either because of substitutability among media or exclusive contracting with one advertiser) result in less informed consumers and thus softer price competition among advertisers. Other papers in this stream focus on the welfare implications of media competition or on the diversion effect of advertising (i.e., viewers switching channels to avoid commercials). For instance, Anderson and Coate (2005) analyze conditions under which advertising is over- or underprovided by competing media firms relative to the social optimum, and Masson et al. (1990) focus on the disutility imposed on customers that have to endure ads. In contrast to the papers in this stream, we allow competing media firms to charge a price for their content. Our insights come from the impact of competition on the media firm's marginal profit available in each market. In some cases, the firm is willing to earn low profits in the content market to capitalize on a high margin per customer impression in the ad market, and consumers benefit from this via lower content prices. In other cases, the firm is less willing to do so and prefers to extract more customer surplus from its content. Such a comparison cannot, of course, be made in models that do not allow firms to charge a fee for content.

Among the relatively limited research that explicitly considers profits in both the content and advertising markets, prior work does not tackle the questions we address here. For instance, Chaudhri (1998) studies output levels for media monopolies (but does not consider media firm competition), and Chen and Xie (2007) study the role of asymmetric customer loyalty on firm profits (where an incumbent media firm that has loyal customers faces an entrant). Kaiser and Wright (2006) estimate a model that demonstrates that "subsidization" exists between content and advertising in the magazine business but do not investigate the implications of this subsidization for firm behavior. In particular, Kaiser and Wright (2006) do not study how competition (its intensity or source) impacts the subsidization effect, thereby affecting media firm strategy.

Finally, our paper examines not only competition among firms within a single medium but also competition between two different media. This issue is important as the boundaries between media are blurred for many advertisers that can reach relevant consumers through separate media (e.g., radio, TV, and the Internet). Our paper is the first to address this issue.

3. Model Setup

Each media firm in our model competes in two markets: content[3] and advertising. For example, *Newsweek* profits from consumers who purchase or subscribe to the magazine, as well as from advertisers' desire to communicate with these readers. Firm i's total profits Π_i are thus the sum of its content profits $\pi_{\mathrm{co},\,i}$ and advertising profits $\pi_{\mathrm{ad},\,i}$: $\Pi_i = \pi_{\mathrm{co},\,i} + \pi_{\mathrm{ad},\,i}$.

Each firm chooses content price $p_i \in [0, \infty)$, yielding demand x_i. With variable costs of production c, the firm's margin in the content market is $(p_i - c)$. Content profits for firm i are $\pi_{\mathrm{co},\,i} = (p_i - c)x_i$. This leads to a Bertrand game between media firms in the content market. We allow for the possibility that firm i charges a price in the range $p_i \in [0, c)$, which would imply that the content is sold *at a loss*. Of course, there are often significant fixed costs associated with the production of content: studios, printing facilities, real estate, etc. However, these would have no impact on the pricing game equilibrium, so they are normalized to zero.[4]

Each firm also chooses how many ads y_i will be shown to the x_i content customers. For instance, y_i may capture how many pages will be devoted to ads in an edition of *Newsweek*. This gives rise to the price per impression q_i, i.e., the inverse demand for advertising. Normalizing the variable cost of placing ads to zero and aggregating over all x_i impressions for firm i yields advertising profits $\pi_{\mathrm{ad},\,i} = x_i y_i q_i$. Thus $y_i q_i$ is the margin the firm makes in the ad market per customer impression. Our specification reflects an important institutional characteristic of the ad market: media firms consider the amount of ads they bundle to be a strategic decision.[5] This leads to a Cournot

[3] For the rest of the paper, we refer to a media firm's product as its *content*.

[4] The *quality* of the firm's content is exogenous; thus our normalization is without loss of generality. In a richer model with endogenous quality, it would be important to specify costs as a function of content quality.

[5] For example, Clear Channel Communications recently announced plans to reduce the number of ads to affect revenues: "Clear

game between firms in the ad market, which has been extensively used in other theoretical papers of media competition (e.g., Dukes 2006, 2004).

3.1. Demand from Consumers: The Content Market

To ensure that our model properly reflects the strategic decisions in each market, we build it from first principles based on the work of Vives (2001) and Singh and Vives (1984).[6] Let the representative consumer's[7] utility from buying x_i units of firm i's content at prices p_i be

$$U(x_i, \ldots, x_N) = \sum_{i=1}^{N} x_i(v - dy_i) - \frac{1}{2}\left(\sum_{i=1}^{N} x_i^2 + 2\gamma \sum_{i \neq i'} x_i x_{i'}\right) - \sum_{i=1}^{N} x_i p_i, \quad (1)$$

where $i = 1, \ldots, N$ are the media firms, v is the inherent value of the content to consumers, d is the "disutility" from each ad: hence y_i ads create negative value of dy_i.[8] The specification captures decreasing marginal utility from consuming more of each firm's offering via the quadratic term (x_i^2) and the cross-terms ($x_i x_{i'}$). Notice that γ captures the extent to which the content offered by each firm is substitutable with that of its competitors. Since $\partial^2 U/\partial x_i \partial x_{i'} = -\gamma$, higher values of γ imply a bigger decline in the marginal utility for x_i associated with purchases of $x_{i'}$. The consumer maximizes (1) with respect to each x_i separately. This gives rise to a system of N equations, which can be solved to yield N inverse demand functions of the form $p_i = v - dy_i - x_i - \gamma \sum_{i \neq i'} x_{i'}$. Direct demands are then found by inverting these and solving simultaneously for x_i ($i = 1, \ldots, N$). We will work with the following monopoly and duopoly cases (denoted by the superscripts M and D, respectively) throughout the paper.

$$x^M = v - dy^M - p^M, \quad (2)$$

$$x_i^D = \frac{1}{1-\gamma^2}(v(1-\gamma) - dy_i^D + \gamma dy_{i'}^D - p_i^D + \gamma p_{i'}^D), \quad i = \{1, 2\},\ i \neq i'. \quad (3)$$

As should be clear from the denominator of (3), we need to impose the regularity condition $0 < \gamma < 1$, which ensures that own price sensitivity is greater than cross-price sensitivity.[9] We retain the assumption made in the literature (e.g., Vives 2001) that γ and v are mutually orthogonal.[10]

3.2. Demand from Advertisers: The Ad Market

We take a similar approach in the advertising market. Here, we assume the existence of a representative advertiser (e.g., a major brand in a given category). By running y_i ads on media firms $i = 1, \ldots, N$, an advertiser creates impressions on customers of the media content. Let the representative consumer's utility from buying content—x_i units from each firm i at price p_i—be

$$\psi = A(\vec{y}) - G(\vec{y}), \quad (4)$$

where $\vec{y}$ is the vector of number of ads an advertiser runs on each media outlet (e.g., Microsoft might advertise its new Vista operating system in *Wired Magazine* and in *PC World*), and $G(\cdot) \equiv \sum_{i=1}^{N} y_i q_i$ is the cost per customer impression to the advertiser of running its ads on the media outlets (q_i is the price per impression defined earlier). The function $A(\cdot)$ is the advertising response function, i.e., the impact of advertising on expected profits per consumer exposed to the ad. Exposure to an ad increases the "awareness," "interest," or "preference" of a given consumer.[11] This translates into a higher likelihood

Channel Radio, the largest U.S. radio station chain, will significantly *reduce commercial time sold* on its stations to stem pricing weakness" (Gershberg 2004). When considering their business model at launch, XM executives set the number of ad minutes per broadcast hour at six (Godes and Ofek 2004).

[6] A competitive pricing analysis without this utility basis may yield an implausible interpretation of results. It is common in marketing and economics to specify demand in the form $x_i = v - bp_i + dp_j$ ($j \neq i$). However, the parameter "d" is not a proper measure of substitutability or competitive intensity. To see why, note that with this specification (assuming zero marginal cost), the duopoly equilibrium solution is $p_i^* = v/(2b - d)$ and $\pi_i^* = v^2 b/(2b - d)^2$. From this solution, a firm's equilibrium price and profits increase with d. But if "d" is to capture competitive intensity, we would expect prices and profits to *decrease* with d. This issue disappears when one derives demand from a consumer utility maximization standpoint and where the parameter γ, as in (1), measures substitutability. We thank Xavier Vives for his helpful discussions on the specification used in this paper.

[7] In reality, media consumers can exhibit heterogeneity. Moreover, media firms often react to this heterogeneity by targeting content to specific segments. The magazine industry is such an example. One way to interpret our results, then, is that our analysis covers the competitive dynamics at the *segment* level as opposed to the overall *market* level. We revisit this issue in the paper's concluding section.

[8] It is conceivable that over a certain range, consumers might derive some positive utility from advertising. This might be because of entertainment, for example, or informational value. This is not a critical assumption, however. We revisit this issue in §5, in our discussion of the model's limitations.

[9] Without loss of generality, in (1), we have normalized to 1 a consumer's decrease in marginal utility from consuming more of the same media content. If one allows a sensitivity of $\beta \neq 1$, the only adjustment needed to ensure that the regularity condition is satisfied is $\gamma \in [0, \beta)$.

[10] See Liu et al. (2004) and Chou and Wu (2006) for a discussion of a model of content competition with endogenous quality. One might view our approach as complementary to theirs in that they endogenize "quality" via a product's location on a line but treat as exogenous prices in both the content and advertising markets.

[11] See Chessa and Murre (2007) for a model of advertising impact.

that the consumer purchases the advertiser's offering, which is then multiplied by the margin the advertiser earns per product it sells. We again use the Vives (2001) framework to model the benefit to a representative advertiser from running y_i ads per consumer exposed to its ads:

$$A(\vec{y}) \equiv \sum_{i=1}^{N} w y_i - t\frac{1}{2}\left(\sum_{i=1}^{N} y_i^2 + 2h\sum_{i\neq i'} y_i y_{i'}\right), \tag{5}$$

where w represents the medium's advertising effectiveness and h measures the degree of media substitutability for advertising, i.e., the similarity between each media outlet from the advertiser's perspective. The advertiser maximizes (4) to determine how many ads to run on each media outlet. This gives rise to the following indirect demands for placing ads on each of the $i = 1, \ldots, N$ media outlets: $q_i = w - y_i - h\sum_{i\neq i'} y_{i'}$. The monopoly and duopoly indirect demands are

$$q^M = w - y^M, \tag{6}$$

$$q_1^D = w - y_1^D - hy_2^D. \tag{7}$$

We require the regularity condition $0 < h < 1$.[12] Given that q_i is the *price per customer impression* of running an ad on media firm i's content, the overall cost of running an ad for the advertiser, which consists of x_i customer impressions, is $q_i x_i$. Our characterization, in which the advertising rate is quoted per customer impression and advertisers pay for the total amount of impressions generated for their ads, is consistent with practice (O'Guinn et al. 2000).[13] Finally, we assume that h and w are independent of each other. Recall that w is essentially the marginal benefit (in terms of increased awareness or interest, for example) that a single ad might yield the advertiser. On the other hand, h captures the decrease in that marginal benefit that the advertiser experiences when running an additional ad on another media outlet. The orthogonality assumption means that media that are more effective advertising vehicles do not necessarily have outlets that are more or less substitutable with each other.

[12] Once again, without loss of generality, in (5), we have normalized to 1 the extent to which more advertising on the same outlet has decreasing marginal returns for the advertiser. If one allows a sensitivity of $\lambda \neq 1$, the only adjustment needed to ensure that the regularity condition is satisfied is $h \in [0, \lambda)$.

[13] In practice, media firms often quote an advertising rate per thousand impressions (CPM), which would just amount to a rescaling of our unit of analysis. Note that our specification in (5) accounts for decreasing marginal impact of more consumer exposure to an advertiser's ad (through the quadratic terms). Yet the resulting advertising rate in our model is a linear function of the demand ($q_i x_i$).

4. Model Analysis

Our approach is to first analyze the monopoly case. This will serve as a benchmark for comparison and allow us to identify several unique features of media firms' actions. We subsequently introduce different sources of competition and assess their impact.

4.1. Monopoly Case

The monopolist solves the following problem:

$$(p^{M*}, y^{M*}) = \underset{(p^M, y^M)}{\arg\max}\, x^M(p^M - c) + x^M y^M q^M, \tag{8}$$

where the specifications of x^M and q^M are given in (2) and (6), respectively. We require sufficient inherent content value and ad effectiveness, such that firms sell nonnegative amounts of content and advertising in equilibrium. Hence we assume that $w > d \geq 0$ and $v > c \geq 0$. To focus on interior solutions for content price, we also assume that $4(v + c) > (w - d)(w + 3d)$.

From (8), the monopolist's first-order conditions, with respect to content price and ad quantity, respectively, are[14]

$$(p^{M*} - c) + y^M q^M = x^M, \tag{9}$$

$$\underbrace{x^M y^{M*} + ((p^M - c) + y^{M*} q^M)d}_{\text{Cost}} = \underbrace{x^M q^M}_{\text{Benefit}}. \tag{10}$$

As shown in (9), the content price is chosen such that the marginal benefit of a small increase in price (the right-hand side (RHS)) is exactly equal to the impact of the lost demand because of the price increase (the left-hand side (LHS)). This latter quantity is comprised of losing margin in both the content market $(p^{M*} - c)$ and the advertising market $(y^M q^M)$. As for ad bundling, from (10), we see that a small increase in the number of ads increases ad revenues (the RHS). This benefit must be balanced against the cost of bundling more ads, which comes in two forms. First, the price of placing an ad declines. Hence, profits fall by an amount proportional to the total ad exposure $(x^M y^{M*})$. Second, the more ads that run, the more disutility customers of the content experience. This causes demand for the content to drop and imposes a cost in proportion to the margin earned per unit of demand from both markets, or $(p^M - c) + y^{M*} q^{M*}$, scaled by the disutility factor d. Solving the above first-order conditions yields the following.

Proposition 1. *The monopolist's problem has a unique solution at* $p^{M*} = ((v + c)/2) - ((w - d)(w + 3d))/8$ *and* $y^{M*} = (w - d)/2$.

[14] We thank an anonymous reviewer for suggesting that we explain the main intuitions by analyzing the first-order conditions. Note that in (9), x^M is a function of p^{M*} and, in (10), x^M and q^M are each a function of y^{M*}. We have suppressed these arguments for clarity of exposition.

The solution implies

$$x^{M*} = ((v-c)/2) + ((w-d)^2/8).$$

The standard outcome for a monopolist in a one-sided content market would be $p^* = (v+c)/2$ and $x^* = (v-c)/2$. Thus, by comparison, the media firm prices its content strictly lower by a factor of $((w-d)(3d+w))/8$. This captures an important and fundamental characteristic of media firms: they have an incentive to charge lower content prices to increase content demand relative to a nonmedia firm. This is profitable because they can expose customers to ads and earn a margin on them from advertisers. This "underpricing effect"—which Kaiser and Wright (2006) refer to as "subsidization"—and factors that affect it, will prove to be important in our subsequent analysis. The way competition impacts the underpricing effect, and the implications for media firm strategy, constitute the unique contribution of our work.

We highlight the key comparative statics for the monopoly model (the complete set appears in the Technical Appendix, which can be found at http://mktsci.pubs.informs.org). An increase in advertising effectiveness (w) results in a higher margin from the ad market (since $y^{M*}q^{M*}$ increases in w). Per (9), such an increase makes the firm more inclined to generate additional demand in the content market to benefit from the higher ad margin. Therefore, as w increases, the firm further underprices its content and increases ad bundling. In turn, content profits go down and ad profits go up. If advertising effectiveness is high enough, the media firm may lower prices below marginal cost and sell its content at a loss.

An increase in the inherent value of the content (v) has the expected effect on the strategic variables of interest, though with one caveat. As long as $p^{M*} > c$ (i.e., a positive margin is earned on each content sale), an increase in v leads to an increase in p^{M*}, x^{M*}, π_{co}^{M*}, and π_{ad}^{M*}. Intuitively, when the content is of greater inherent value, it appeals more to consumers and a firm can sell more content and still charge more for it. Having generated more customer impressions, ad profits (π_{ad}^{M*}) increase as well. However, when $0 < p^{M*} < c$, i.e., content is sold at a loss, π_{co}^{M*} initially decreases in v. In this case, *better* content (higher v) leads to more content sales (higher x^{M*}) but at a negative margin, which widens content losses.

The comparative statics, with respect to advertising disutility (d), are more complex and offer the following insight into the implications of the two-sided nature of media markets.

Result 1. As ads create more consumer disutility: Content sales (x^{M*}), ad bundling quantities (y^{M*}) and ad profits always decrease. However, content prices (p^{M*}) and content profits decrease at low disutility levels and increase at high disutility levels.

Result 1 reveals that the impact of greater advertising disutility (d) on the equilibrium content price (p^{M*}) follows a U-shaped pattern. The intuition is that to continue to appeal to consumers when each ad causes greater disutility, the media firm can do two things: first, it can lower content price to compensate consumers for the displeasure of having to endure the ads, and, second, it can decrease the number of ads (thus balancing the increase in d with a decrease in y^{M*}). Because bundling fewer ads results in a lower margin in the advertising market, initially as d increases, the firm has a greater incentive to cut content prices than to drastically reduce ad quantities. In other words, the firm is willing to take an even harder *hit* in the content market to continue to reap a relatively healthy margin in the ad market. However, when d is very high, the firm must considerably limit the amount of advertising to generate content customers. Consequently, the per unit margin from the ad market ($y^{M*}q^{M*}$) is small, and the firm has less incentive to underprice its content. The firm starts raising content prices, bringing them more in line with the one-sided market case. As a result, while ad profits always decline as ad disutility increases (because the firm is induced to bundle fewer and fewer ads), content profits exhibit a similar U-shaped pattern as content price p^{M*}.

4.2. Within-Medium Duopoly Competition

In a duopoly, each media firm simultaneously maximizes the following profit function, conditional on the competitor's optimal behavior:

$$\Pi_i^D \equiv (p_i^D - c)x_i^D + x_i^D y_i^D q_i^D \quad i = 1, 2, \tag{11}$$

where x_i^D and q_i^D are given in (3) and (7), respectively. Recall that γ and h represent the substitutability (or competitive intensity) between the two firms in the content and ad markets, respectively.

Proposition 2. *The duopoly model has a unique interior equilibrium in which*

$$y_1^{D*} = y_2^{D*} = \frac{w-d}{2+h} \quad \text{and}$$

$$p_1^{D*} = p_2^{D*} = \big[(v+c)(2+h)^2 + d^2(3+2h) - 2dw(h+1) - w^2 - \gamma(2+h)\big(d^2 + (2+h)v - dw\big) \cdot \big((2-\gamma)(2+h)^2\big)\big]^{-1}.$$

Comparing Propositions 1 and 2, one can easily establish that $y_i^{D*} < y^{M*}$, $i = 1, 2$. Facing rivalry in the ad market causes each media firm to lower the number of ads it runs. On the other hand, *overall* ad bundling increases ($2y_i^{D*} > y^{M*}$), leading to a decrease in the advertising price per impression ($q_i^{D*} < q^{M*}$). Consequently, the margin per impression from the ad market is unequivocally lower in a duopoly than in a monopoly ($y_i^{D*}q_i^{D*} < y^{M*}q^{M*}$), and this influences how each media firm prices its content.

Result 2. (i) When competitive intensity in the content market is low, then the equilibrium content price set by the duopolists is higher than that set by a monopolist. (ii) When competitive intensity in the content market is high, then the equilibrium content price set by the duopolists may be lower than that set by a monopolist.

Thus, content prices will be higher in a duopoly than in a monopoly when content substitutability (γ) is not too high. To understand the intuition, it is useful to look at the first-order condition with respect to p_i^D for firm i competing with firm i' (12a) and compare it with the monopolist's corresponding first-order condition, which is reproduced in (12b) for convenience. We write explicit expressions for x^M, x_i^D, q^M, and q_i^D to see the intuition more clearly.

$$(p_i^{D*} - c) + y_i^D(w - y_i^D) - hy_i^D y_{i'}^D = (v - dy_i^D - p_i^{D*}) - \gamma(v - dy_{i'}^D - p_{i'}^{D*}), \quad (12a)$$

$$(p^{M*} - c) + y^M(w - y^M) = (v - dy^M - p^{M*}). \quad (12b)$$

Comparing the RHS of (12a) with that of (12b), we see the standard downward pressure on price because of competition that one would see in a one-sided market model: the marginal benefit of a price increase is lower for a duopolist than for a monopolist by a factor related to $\gamma(v - dy_{i'}^D - p_{i'}^{D*})$, which reflects the demand-stealing effect of competition if a firm raises its price. Comparing the LHSs, we see that having to compete with firm i' in the ad market lowers the margin per impression from each ad (by a factor of $hy_i^D y_{i'}^D$), which, in turn, decreases the incentive to underprice the content. The impact of competition on content prices is therefore governed by the tradeoff between these two forces: (i) a downward force arising from the *traditional* effect of competition that decreases the benefits associated with raising prices, and (ii) an upward force arising from the fact that competition diminishes the incentives to engage in content underpricing because of a lower ad margin per customer impression. When content substitutability (γ) is not too high, the impact of competition on underpricing dominates, and content prices will be higher in the duopoly. Conversely, when content substitutability is high, the traditional effect of competition on prices can dominate and prices in the duopoly will be lower.[15]

The practical implication of Result 2 on media firm strategy is that when confronted with additional competition, a media firm will respond by *increasing* price if the two firms' content is not highly substitutable, and vice versa if the firms are very similar in the eyes of consumers. In the introduction, we described several examples (newspapers, satellite radio, movie theaters, Internet content sites) regarding the impact of competition on media firms' pricing patterns. Result 2 offers some insight into this variance. In particular, prices should rise (fall) because of increased competition when the degree to which the media content is substitutable is low (high).[16]

As one would expect, as the competitive intensity in the market (h) increases, the firms bundle less advertising with their content. We also note that y^{D*} is not a function of γ in this model (see Proposition 2). That is, as the intensity of interduopolist content competition changes, the firms do not alter the amount of advertising they bundle with their content. Nor, in fact, do they do so when v changes. The reason for this can be seen in an inspection of the first-order condition for y_i^{D*}:

$$\frac{d}{1-\gamma^2}(p_i - c) + x_i(q_i + y_i^*) + \frac{dq_i y_i^*}{1-\gamma^2} = 0. \quad (13)$$

By rearranging, and substituting p_i^* from (12a) into (13), we can express the first-order condition for y_i^{D*} as being the solution to $x_i[q_i + y_i^* - d] = 0$. Thus, when content prices are chosen optimally, x_i acts only as a scaling factor in the advertising market, and therefore does not affect the optimal choice of ad quantity. Essentially, content prices *absorb* all exogenous content market shifts, such as a change in the intensity of content competition (γ) or a change in the inherent value of content (v). As we show in the Technical Appendix (which can be found at http://mktsci.pubs.informs.org), when one imposes $p_i = 0$ (as we see in broadcast radio, for example), then y_i^* is no longer insulated from the content market. Instead, in this case, y_i^* is a function of both v and γ.

[15] A firm's desire to charge a high price for content depends on the inherent value it provides (see Propositions 1 and 2). To sustain $p_i^{D*} < p^{M*}$ at high γ levels, we require a minimal level for v. This is formalized in the proof.

[16] For example, in satellite radio, the offerings of XM and Sirius are only moderately substitutable (γ low). Each is offered as optional on different car makes and rentals and they are perceived as selling differentiated programming: Sirius offers exclusive coverage of the National Football League, and its signing of Howard Stern and Eminem give it a particular positioning in consumers' minds. XM, on the other hand, offers exclusive Major League Baseball, exclusively features artists such as Oprah Winfrey and Ellen DeGeneres, and airs shows produced by famous recording artists (e.g., Tom Petty, Snoop Dog, and Bob Dylan). XM is also pitched as having better signal coverage because of robust satellite technology. XM revisited its strategy and increased prices only after Sirius garnered 25% market share in 2005 and exerted more competitive pressure (Murphy 2005). By contrast, in the case of newspapers, one might expect substitutability (γ) to be relatively high as they each tend to provide similar content. Competition intensifies as the number of newspapers in geographic proximity increases. Hence, consistent with our model, in this case, more competition should lead to lower newsstand prices.

We are also able to derive a number of results with respect to equilibrium profits.

Result 3. (i) Advertising profits are always lower for each duopolist than for a monopolist. (ii) When competitive intensity in the content market is low, content profits are higher for each duopolist than for a monopolist. (iii) When competitive intensity in the content market is high, content profits can be lower for each duopolist than for a monopolist.

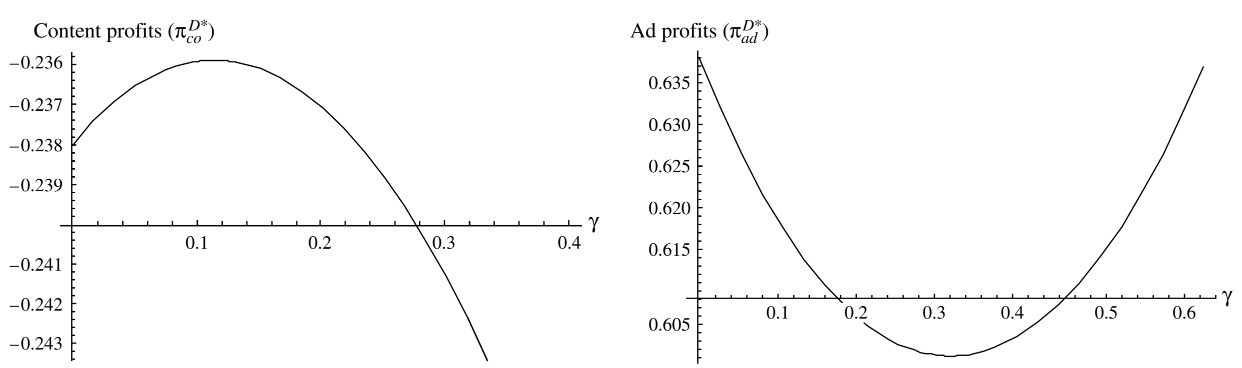
Part (i) of Result 3 is not necessarily surprising since both ad bundling (y^{D*}) and ad prices (q^{D*}) decline because of duopolistic competition. The same, however, is *not* true of content profits as shown in part (ii). When γ is low, we found in Result 2 that $p^{D*} > p^{M*}$, which overshadows the fact that $x^{D*} < x^{M*}$ and results in $\pi_{\text{co}}^{D*} > \pi_{\text{co}}^{M*}$. By contrast, when γ is high, as long as the inherent value of the content v is not too low, the duopoly content price falls below the monopolist's price and we have $\pi_{\text{co}}^{D*} < \pi_{\text{co}}^{M*}$.

Thus far, we have examined how the actions and profits of a media firm in a duopoly differ from those of a monopolist media firm. We now focus on the duopoly case and explore how firm behavior is impacted by varying the degree of competitive intensity (γ). From the equilibrium prices in Proposition 2, it is straightforward to establish that a media firm will sell its content at a loss (i.e., $p_i^{D*} - c < 0$) when the margin per customer in the content market is small relative to the margin per customer in the ad market. In particular, when ad disutility is negligible, we have $p_i^{D*} - c < 0$ iff $(v-c)(1-\gamma) < w^2/(2+h)^2$. This also shows that content is more likely to be sold at a loss the higher the competitive intensity in the content market. This obviously stems from the fact that increased competition for consumers induces media firms to lower content prices ($\partial p_i^{D*}/\partial\gamma < 0$). At the same time, as explained above, ad bundling is immune to changes in the competitive intensity in the content market ($\partial y_i^{D*}/\partial\gamma = 0$). These equilibrium properties have the following implications on the profits firms earn in each market.

Result 4. (i) Ad profits always initially decrease and then increase in the competitive intensity of the content market. (ii) If the inherent value of content is small relative to ad effectiveness ($v - c \ll w - d$), then content profits initially increase and then decrease in the competitive intensity of the content market. If the inherent value of content is high enough, content profits are everywhere decreasing in the competitive intensity of the content market.

An increase in γ implies that the content offered by the firms is more substitutable. Hence one would generally expect content profits to decrease as γ increases—this would indeed be the case given only a content market. Moreover, this is true in our model when the content market is *more important* than the ad market as captured by the relative magnitudes of $v - c$ as compared with $w - d$. However, the opposite is true when the ad margin per customer impression is high compared to the content margin, in which case each firm optimally prices its content below variable cost and every unit is sold at a loss. The intuition is as follows. As γ initially increases, each firm's demand x^{D*} declines. But because each unit of content generates a negative margin, this reduction in demand results in a narrowing of losses in the content market (i.e., content profits become less negative). At the same time, with fewer customer impressions, each firm's ad revenue is decreasing. At higher levels of substitutability, consistent with Proposition 2 and Result 3, each firm will cut prices in the content market to a level where x^{D*} starts increasing. Content profits then decline (because the drop in price offsets the increase in content demand) while ad profits will increase. This results in an inverted U-shaped pattern for content profits and a U-shaped pattern for ad profits as a function of γ (see Figure 1). We stress that because a firm in a traditional one-sided market has only one revenue source, it would never price its product below marginal cost. Hence, we would generally not expect its product profits to increase as a function of greater competitive intensity in that market.

Figure 1 Content Profits and Ad Profits as a Function of Competitive Intensity (γ)



Note. In these plots: $v = 1$, $c = 0.8$, $w = 2.25$, $h = 0.25$, $d = 0.5$.

Given these patterns, the difference between duopoly content profits and ad profits ($\pi_{co}^{D*} - \pi_{ad}^{D*}$) will tend to exhibit an inverse U-shaped relationship with γ. Thus the intensity of content market competition has the effect of altering the relative prominence of each profit source.[17] Finally, although content and ad profits can increase with greater competitive intensity over certain nonoverlapping ranges (Result 4), firms are worse off when they have to compete more intensely as total profits decline with γ (this also implies that $\Pi_i^{D*} < \Pi^{M*}\ \forall\,\gamma$).

4.3. Across-Media Competition

Thus far, we have looked at a single media industry and analyzed the impact of within-medium competition. In reality, though, we often observe firms from separate media competing as well, particularly in the ad market. This occurs because advertisers typically allocate their budgets across multiple media (O'Guinn et al. 2000, Dolan 2000). For example, when Intel introduces a new chip, it might run TV ads in prime time featuring the Blue Man Group, place print ads in *PC World*, air advertisements on local radio shows, and display banners on CNN.com. Although television, magazine, radio, and the Web do not necessarily compete heavily in their respective content markets (e.g., a consumer can only listen to radio when driving, will primarily consider TV viewership in the evening, will read a magazine while lying on the beach, and may browse the Web at work), they all compete in the ad business for a share of Intel's budget. In this section, we examine the impact of such across-media advertising competition.

We analyze the case of two firms that compete within a medium (a duopoly, as in §4.2) that also face competition in the ad market from a single firm in a separate media industry. Denote the two media industries $j \in \{A, B\}$, where A is the *duopoly medium*, and B is the *monopoly medium*. The degree of competitive intensity (or substitutability) across media is measured by $\theta \in [0, 1)$. In the context of our derivation from first principles as in (4), a greater θ means that the advertiser perceives an ad bundled with the content of a firm from medium A to have a more similar effect to an ad bundled with the content of a firm from medium B. We assume that the content associated with these two media are perfectly differentiated in the eyes of the consumer.[18] Referring to the examples above, the utility that a consumer derives from watching a TV show is likely to be considered very differently from, say, reading a magazine, going to the movies, or listening to the radio (e.g., because each is consumed during distinct occasions). Furthermore, the level of inherent value of content can vary across the two media. The same is true with respect to ad effectiveness and disutility. We thus allow v^j, w^j, c^j, and d^j to differ by medium. We also assume that θ is independent of all these parameters.

Each firm seeks to maximize its total profits, conditional on the other two firms' actions:

$$\Pi_i^A = \pi_{ad,i}^A + \pi_{co,i}^A = x_i^A(p_i^A - c^A) + x_i^A y_i^A q_i^A, \quad i = 1, 2.$$
$$\Pi^B = \pi_{ad}^B + \pi_{co}^B = x^B(p^B - c^B) + x^B y^B q^B. \tag{14}$$

Similar to our derivations from first principles in §3, the expressions for demand in the content market are as (2) and (3) for mediums B and A, respectively. The inverse demand in the ad market is given by

$$q_i^A = w^A - y_i^A - h y_{i'}^A - \theta y^B, \quad i \in \{1, 2\},\ i \neq i'.$$
$$q^B = w^B - y^B - \theta(y_1^A + y_2^A). \tag{15}$$

We can now solve for the equilibrium.

Proposition 3. *The oligopoly model* (14) *has a unique interior equilibrium solution in which*

$$y_i^{A*} = y^{A*} = \frac{2(w^A - d^A) - \theta(w^B - d^B)}{2(2 + h - \theta^2)},$$

$$y^{B*} = \frac{(2 + h)(w^B - d^B) - 2\theta(w^A - d^A)}{2(2 + h - \theta^2)},$$

$$p_i^{A*} = p^{A*} = \frac{v^A(1-\gamma) + c^A + (1+h)(y^{A*})^2 - y^{A*}(w^A + (1-\gamma)d^A - \theta y^{B*})}{(2-\gamma)},$$

$$p^{B*} = \frac{v^B + c^B + (y^{B*})^2 - y^{B*}(w^B + d^B - 2\theta y^{A*})}{2}. \tag{16}$$

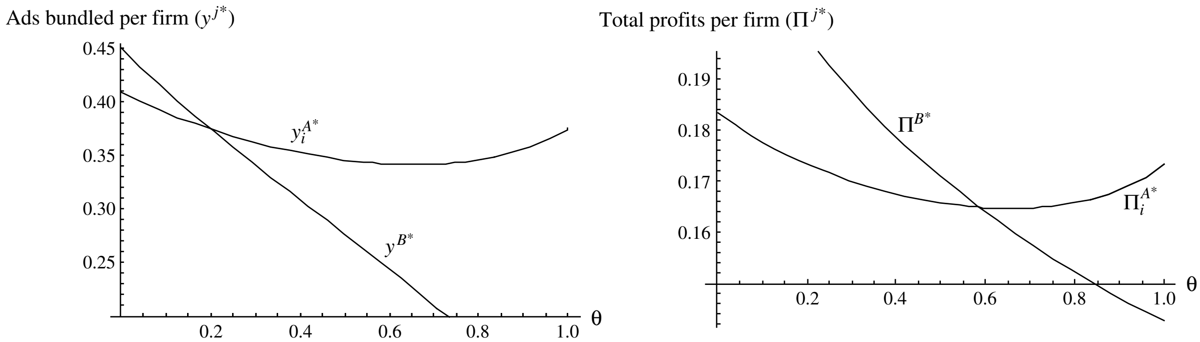
To focus on the competitive effects, we assume that there is not too big of a disparity in the net ad effectiveness or content value between the two media, specifically $(w^j - d^j) \geq ((3+h)/4)(w^{j'} - d^{j'})$ and $|(v^j + c^j) - (v^{j'} + c^{j'})| < \delta$. We later discuss these assumptions and the implications of relaxing them. From the solution given in Proposition 3, we can establish the following implications of across-medium competition on firms' decisions in each medium.

Result 5. As across-medium competition becomes more intense (θ increases): (i) medium A firms decrease (increase) the number of ads bundled and

[17] We formalize this in the Technical Appendix, which can be found at http://mktsci.pubs.informs.org. We also show that an increase in the substitutability in the ad market (h) will unambiguously increase the margin earned in the content market versus the ad market.

[18] Technically, this means that in (1) there are no cross-terms related to $x_i^A x^B$. This simplifying assumption captures the idea that across-medium content substitutability is lower than within-medium substitution. Nonetheless, there are cases in which this substitution may be nonnegligible (for example, a recent study found that young men have decreased TV viewership in favor of Web usage; see Schwartz 2004).

Figure 2 The Impact of Across-Medium Competition: Duopoly Medium vs. Monopoly Medium



Note. In these plots: $v^j = 1$, $c^A = 0.2$, $c^B = 0.25$, $\gamma = 0.25$, $w^j = 1$, $h = 0.2$, $d^j = 0.1$.

increase (decrease) the content price charged at low (high) levels of across-medium competitive intensity. The medium B firm always decreases the number of ads bundled and increases content price: (ii) consequently, for low θ values, each firm in medium A bundles less advertising than the firm in medium B ($y_i^{A*} < y^{B*}$), but for high enough θ values, the reverse is true ($y_i^{A*} > y^{B*}$). Moreover, for θ close to 1, the firm in medium B drops out of the ad market altogether.

Result 5 reveals that when the across-medium competitive intensity is high enough, the firms in medium A will bundle more advertising than the single firm in medium B. This surprising result holds even when firms in medium A have the same or lower net ad effectiveness than the firm in medium B (specifically, in the range $(w^B - d^B) \geq (w^A - d^A) \geq ((3+h)(w^B - d^B))/4$). The intuition is that as the media become more substitutable in the eyes of an advertiser (letting θ increase), firms in industry A face an increased threat from only one firm, while the firm in industry B faces an increased threat from two firms. The direct implication of this is that the margin per customer impression from the ad market ($y^{j*} q^{j*}$) decreases in proportion to $\theta(y_1^A + y_2^A)$ for the monopoly medium, but only in proportion to θy^B for each firm in the duopoly medium.[19] Because of this asymmetric sensitivity, the firm in medium B lowers its ad quantity more precipitously, and this has a strategic implication. Specifically, given Cournot competition in the ad market, firms' ad bundling quantities are strategic substitutes (i.e., $\partial^2 \pi_{\text{ad}}^j / \partial y^j \partial y^{j'} < 0$). At some point, the fact that the firm in medium B is bundling very few ads makes the strategic effect dominant for the firms in medium A and they begin increasing the amount of ads they bundle as θ increases. When θ is high, the firm in medium B may actually drop out of the ad market to concentrate on its content market where it is a monopolist, and we may see only the duopolists bundling advertising. This can be seen on the left panel of Figure 2. In practice then, one may find that in media that are more competitive, each firm bundles a greater number of ads relative to other media that are less competitive; we would expect this to happen when there is considerable substitutability between them in the eyes of advertisers.

Regarding the content pricing decision, as explained above, initially, firms in both media bundle less advertising as across-media competition increases. Hence the incentive to underprice decreases, and content prices go up in both media as θ increases. However, as competition across media further increases, the firm in medium B bundles very little advertising, while the per unit ad margin for firms in medium A becomes more attractive. This results in a greater desire to underprice and, hence a decrease in content prices for the firms in medium A. Note that there can exist a scenario in which $p_i^{A*} > p^{B*}$ for low θ and $p_i^{A*} < p^{B*}$ for high enough θ. This would depend on the within-medium content substitutability (γ) being low enough.

The following result characterizes how the profits in each medium depend on θ.

Result 6. (i) As across-medium competition becomes more intense: for each firm in medium A, total profits and advertising profits initially decrease and then increase, while content profits initially increase and then decrease. For the firm in medium B, total profits and advertising profits both decrease, while content profits increase.

(ii) If content market competitive intensity (γ) is low enough in medium A, then total profits for each duopolist are lower (higher) than total profits for the monopolist in medium B when across-medium competitive intensity is low (high).

Result 6 reveals the surprising finding that *total* profits per firm in the medium A duopoly can

[19] In analogy to (12a), if we write the first-order conditions for (14) with respect to raising content price: for the firm in the monopoly medium, the LHS cost would have a term related to $\theta(y_1^A + y_2^A)$, while for each firm in the duopoly medium, we would have a term related to θy^B.

increase with more intense competition from the medium B monopoly. This result again stems from the impact of competition on the underpricing effect for media firms. When the two media are highly substitutable (large θ), the firm in the medium B monopoly finds the margin that can be earned in the ad market to be very low and foregoes the ad market to focus on the content market (less ad bundling and higher content price), while the firms in the medium A duopoly return to the ad levels and prices they could set when they faced no competition from the rival medium. In some sense, the firms in medium A *crowd out* the firm in medium B from the ad market. Because the ability to leverage the ad market offers firms an additional source of revenue, it allows medium A firms to secure higher total profits as θ increases.

Note that with no across-medium competition ($\theta = 0$), the firm in the monopoly medium has a strong underpricing effect and tends to make significant profits in the ad market compared to each firm in the duopoly medium. However, ad profits for the monopoly medium firm always decline sharply in θ, while those for each duopoly medium firm at some point increase. Hence, if $\pi_{\text{ad}}^{B^*}|_{\theta=0} > \pi_{\text{ad},\,i}^{A^*}|_{\theta=0}$, an interesting implication of Result 6 is that initially as competition across media intensifies, the two media *converge* in terms of the profits they make from the ad market relative to the content market. But as across-medium competition becomes more intense, the firms' primary source of profits will at some point begin to *diverge*. Said differently, as θ continues to rise, the firms in medium A will increasingly be ad driven (i.e., make the bulk of their profits from the ad market), while the firm in medium B will be more content driven (i.e., make the bulk of its profits from the content market).

Reflecting on Results 5 and 6, we note that in a regular one-sided market, a firm reacts to more competition by increasing production or lowering prices while making less profits. This is not the case for media firms that face two-sided competition. As shown on the right panel of Figure 2, profits can increase with greater competitive intensity, and importantly, there can be a crossover of total profits between the media. Specifically, at high levels of substitutability, each firm in the duopoly medium can earn higher profits than the single firm in the monopoly medium.

At a practical level, our findings suggest that if across-medium substitutability is already relatively high, firms in a more competitive medium have an incentive to portray their medium as even more substitutable to other media as an advertising platform. Consider the case of online advertising. Increasingly, website owners are downplaying the uniqueness of online advertising relative to traditional media by, for example, de-emphasizing click through. Instead, they are adopting formats that allow them to claim an impact similar to television advertising. For instance, many website owners have introduced new online formats, such as the "VideoClip Module" for online video sequencing,[20] that use the same metrics to track effectiveness as those used for television commercials (brand awareness and ad recall). Website owners emphasize these similarities in the pitches made to ad agencies for allocating media buys to the Web. Given the myriad number of websites and smaller number of TV stations, and the fact that the two media were already competing at some level for ad dollars, this is consistent with Result 6.[21]

Finally, we discuss the condition imposed on ad effectiveness across the media, $(w^j - d^j) \geq ((3+h)/4)\cdot(w^{j'} - d^{j'})$. This condition ensures that firms in medium j do not have too big of a disadvantage in advertising effectiveness relative to firms in medium j'. If the condition is not met, then firms in medium j have a much lower incentive to participate in the ad market to begin with. For example, if $(w^B - d^B) \gg (w^A - d^A)$, then from the equilibrium solution in Proposition 3: $y^{B^*} \gg (y_1^{A^*} + y_2^{A^*})$, and this would dominate the across-medium competitive effects studied here.[22] Similarly, some of the findings above would be qualified if $(v^A + c^A)$ and $(v^B + c^B)$ are very dissimilar. Although all the comparative statics in Results 5 and 6 hold, the crossover in total profits (or in prices) would not occur if one medium offered vastly superior content.

4.3.1. Advertising Complementarity Across Media. Up to now, we have assumed that firms across media *directly compete* in the sense that, from the advertiser's perspective, placing an ad on the platform of a firm from one medium decreased the benefit of placing an ad on the platform of a firm from the other medium. Said differently, the media exhibited demand substitutability and this was captured by restricting the parameter θ to be nonnegative. Although this is a reasonable assumption in many contexts, there is evidence that reaching the same consumer through multiple media formats can have a reinforcing effect (see, for example, Chang and Thorson 2004, for evidence of synergies between advertising on TV and

[20] See Eyeblaster (2004).

[21] Even though at this point advertising spending is still markedly lower online than on television, from 2006 to 2007 online advertising grew by 19% compared to network TV advertising, which decreased by 1.5% (Nielsen Company 2008).

[22] In the Technical Appendix, which can be found at http://mktsci.pubs.informs.org, we examine the implications of asymmetries in ad effectiveness for across-medium competition. We are able to show that as θ increases, the medium with greater net ad effectiveness $(w^j - d^j)$ will have a pattern of decreasing and then increasing ad bundling, while the other medium monotonically decreases its ad bundling. The reverse pattern holds for content prices.

the Web). This would imply that firms across media are complements and that θ can take on negative values. We analyze this case and contrast it with the previous results in this section (proofs are given in the Technical Appendix, which can be found at http://mktsci.pubs.informs.org).[23]

Let the setup remain identical to that presented in (14) and (15), except that we now restrict $\theta \in (-1, 0)$. As we explain later, it will prove useful to present the case where competition within medium in A is not extreme, so we assume $\gamma \in [\underline{\gamma}, \bar{\gamma}]$, where $0 < \underline{\gamma} < \bar{\gamma} < 1$. To focus on the complementarity effects, we assume that the parameters v^j, c^j, w^j, and d^j are the same in the two media. The following result summarizes our findings.

Result 7. When firms in separate media act as complements in the ad market: total profits and ads bundled are both higher for the firm in medium B than for each of the firms in medium A. Moreover, when across-medium complementarity is high (low), then content prices are lower (higher) for the firm in medium B than for each of the firms in medium A.

Thus, when separate media exhibit complementarity in ad effectiveness, the firm in the monopoly medium will bundle more ads than each of its counterparts in the duopoly medium. However, the ordering of content prices between the two media depends critically on the degree of complementarity. In particular, when complementarity is high ($\theta \to -1$), we should expect content in the monopoly medium to be priced lower than content in a duopoly medium, and the reverse is true for low complementarity ($\theta \to 0$). The intuition is related to the fact that the existence of a separate medium now acts to *increase* the margin per customer that can be earned in the ad market (because advertisers see greater impact for their ads by diversifying into multiple media). Because ads on the platform of the monopoly medium firm can be complemented by ads on the platform of two firms, whereas ads for each firm in the duopoly medium can only be complemented by one firm, the underpricing incentive is always stronger for the firm in the monopoly medium. At the same time, firms in the duopoly medium face the traditional competitive pressure to lower content prices. Hence, when complementarity is weak ($\hat{\theta} < \theta < 0$), the latter effect dominates and content in the duopoly medium will be priced lower, but when complementarity is strong ($-1 < \theta < \hat{\theta}$), the impact on underpricing dominates and content in the monopoly medium will be priced lower. This also explains why we need $\gamma \in [\underline{\gamma}, \bar{\gamma}]$ to get the crossover in pricing: if $0 < \gamma < \underline{\gamma}$, we will have $p^{B^*} < p_i^{A^*}$ $\forall \theta$ as the impact of complementarity on underpricing always dominates, and if $\bar{\gamma} < \gamma < 1$, we will have $p^{B^*} > p_i^{A^*}$ because competition in the content market is very intense in medium A and always dominates. Finally, because the monopoly medium firm benefits more from ad complementarity and does not face competition in its content market, its total profits will always be higher than each of the duopoly medium firms.

[23] We thank an anonymous referee for suggesting this analysis.

5. Discussion and Conclusion

Media firms underprice their content (relative to the one-sided market optimum) to generate additional customer impressions that can be leveraged in the ad market. Competition affects the ad margin that can be earned per customer impression, and therefore impacts the incentive to underprice. In this paper, we analyzed how competition—that can come from within the same medium or across media—bears on the strategic decisions of media firms that operate in such a two-sided context. Our analysis has yielded important managerial insights.

With respect to within-medium competition, our primary result concludes that firms competing in a duopoly may set higher content prices than a monopolist media firm. This would suggest, for example, that when a media firm faces the prospect of rivalry from new entrants, it should not automatically reduce prices to stay competitive. Rather, it should closely examine the degree to which its content offering will be perceived as similar to its rival's in the eyes of consumers. If the degree of substitutability is not too high, then the firm's incentive to underprice its content is lower—and equilibrium content prices should actually be higher—following the rival's entry.

With respect to across-medium competition, our central finding is that facing more intense rivalry in the ad market from a separate medium may encourage more ad bundling and result in higher total profits for one medium, while the opposite is true for the other medium. Interestingly, it is the more competitive medium (i.e., the one with greater within-medium competition) that benefits. This would suggest, for example, that firms in media with more competitors have a strong incentive to portray their medium to advertisers as similar to a rival medium with fewer competitors. This makes the margin in the ad market fall sharply for the rival medium and reduces the desire for firms in that medium to underprice, to the benefit of the firms in the medium with more competitors.

5.1. Limitations and Future Research Directions

Our model has several limitations that merit discussion. First, it is important to acknowledge that any analytic attempt to capture phenomena related to a complex and heterogeneous category as *media firms* is likely to miss potentially important idiosyncrasies associated with individual media. In particular, each medium has its own historical context in which it evolved and that can play a role in explaining certain aspects of currently observed practice. We have attempted to control for this by focusing our analysis on how changes in the competitive context directionally affect firms' decisions, rather than focusing on explaining why we might observe certain absolute levels of these decision variables. Precisely identifying and accounting for these legacy effects would require more detailed modeling at the medium level (e.g., building a model of the radio broadcasting business) and might offer interesting opportunities for future research.

We also assumed that firms are able to charge a positive price for their content. Therefore our analysis would not immediately apply to situations in which content price is fixed or predetermined, such as the case of free broadcast TV in the United States. Notwithstanding, allowing firms to set their content prices clearly reflects the practice of many media industries: magazines, newspapers, movie theaters, etc. Here, it is worth mentioning that even traditional media are changing in this regard. Not only is (paid) cable and/or satellite TV now in most homes, but the radio business is also facing competition from paid rivals on satellite. Moreover, many experts predict that podcasting will present further and significant competition to traditional radio broadcasting in the near future. While the revenue model for this emerging medium remains to be determined, it is not hard to imagine that pay per podcast would represent at least part of the revenues for podcasters. As for video, the transition to pay per content appears to be further underway, as iTunes now offers downloads of popular TV shows for $1.99, and many telecom companies are now offering streaming video services on cell phones for an additional monthly fee. That said, as noted in §4.2, in an extension, we explore the case of media firms that are not able to charge a fee for content. Our analysis shows that, unlike Propositions 1 and 2, advertising quantities are influenced by content quality, v. Moreover, the direction of this influence is ambiguous. For high content quality, firms bundle more advertising, as compared to when content pricing is possible. For low content quality, the opposite is true.

In motivating our contribution, we suggested that media firms are of particular importance to marketers that use different media outlets to reach potential customers. Although the marketing literature has devoted much attention to understanding how consumers are affected by messages delivered through various media, as well as to analyzing the forces behind marketers' advertising spending across media, the extant literature has largely ignored the strategic incentives of media firms. As we have shown, competition impacts media firms' incentives to underprice content and to allow more ads to run on their offerings, which, in turn, impact the advertising rates marketers are quoted and the reach (based on content demand) of different media. These are important factors for marketers to wrestle with when they make media buy decisions. An understanding of the issues addressed here has become even more critical as the competitive landscape is shifting in a number of directions. On one hand, some media (broadcast radio, for example) appear to be in a consolidation phase, while on the other hand, entirely new media markets are appearing each year. Social networking sites like MySpace, massively multiplayer gaming environments such as *Second Life* and *World of Warcraft*, and video-sharing sites like youtube.com all present to marketers with a vast array of opportunities to communicate with their customers. It is for this reason that our modeling approach focuses on media firms, and as such, we assume a relatively simple model of advertiser behavior (see §3.2). In exchange for the tractability this afforded us, it precluded any analysis of the impact of media competition on the intensity of competition between advertisers and, thus, their equilibrium outcomes. One might imagine that a richer model of advertiser competition would yield insights on the interplay between the competitive intensity among media firms and the advertisers' product price and sales. It is possible that this analysis may, in some cases, mitigate the effects we found on the underpricing of the media content and the amount of advertising to bundle.

We assumed that ads impose on those consuming the firm's content a cost, or disutility. However, one can certainly envision examples in which advertising is perceived by consumers to be beneficial. On one hand, we emphasize that this assumption can be relaxed somewhat with little impact on our results. Specifically, Results 1, 2, 3, 5, 6, and 7 all hold as stated above even for small, but negative, values of d. As for Result 4, the finding with respect to ad profits is unchanged for small negative d. However, the region in which content profits are inverted U-shaped in γ disappears for all negative d. One could construct a richer model in which the effect of advertising on content consumers is an initially positive yet declining, or concave, function of the amount of bundled ads. Following Dukes and Gal-Or (2003), we might argue that in equilibrium, the firm would not allow advertising at a level at which advertising is beneficial (as explained in footnote 8). However, it would be interesting for future research to investigate models of advertising utility and disutility, while also relaxing our assumption that there is no marginal cost of advertising production. Indeed, if some advertising were viewed as delivering positive utility and if the marginal cost of placing ads were highly convex, then one might imagine a context in which advertising is beneficial to consumers in equilibrium.

We have also specified a relatively simple model of consumers. With respect to the consumption of different media formats, we have assumed that consumers *partition* their decisions across media. Relaxing this assumption—for example, letting changes in magazine prices have an impact on Internet use—might yield interesting insights. An additional path for future research would be an explicit consideration of the impact of customer heterogeneity on media competition, which we have ignored. Although it is common for analytic marketing and industrial organization models to specify a representative consumer, as we have done, media firms (perhaps more than those in some other industries) target their products at segmented markets. A deeper investigation into this issue may address, for example, whether our across-media results extend to a setting in which firms in the same medium target different segments.

Finally, we assumed that certain aspects of the media firms' problem are exogenous. In particular, media firms' content quality is not modeled as a decision variable, nor are the inherent value of the medium to advertisers or the disutility from enduring ads to customers. In reality, these can be endogenous. One might think about the results reported here as representing the short-term continuation game associated with a long-term more complicated game. Future research could investigate the equilibrium choices of these variables as a function of greater competition. For example, given that we found conditions under which content prices increase with more competitors, it would be interesting to see the impact on content quality. One could imagine that along with the *underpricing effect* that we study, there may also be an *overquality effect* for the exact same reason. It is conceivable that, under some conditions, an increase in competition would not only result in higher content prices, but also lead to lower quality content. We leave these questions for future research.

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Appendix

Proof of Proposition 1. Differentiating (8) with respect to p^M, setting the derivative to zero and solving for p^{M*} yields $p^{M*} = (v + c - dy^{M*} - y^{M*}(w - y^{M*}))/2$. Substituting this into the expression for x^M yields $x^{M*} = v - dy^M - (v + c - dy^{M*} - y^{M*}(w - y^{M*}))/2$. Substituting this into the profit function and maximizing with respect to y^M yields three possible solutions: $y^M = (w - d)/2$, $y^M = (w - d - \sqrt{4(v-c) + (d-w)^2})/2$, and $y^M = (w - d + \sqrt{4(v-c) + (d-w)^2})/2$. It is easy to ascertain that the latter two solutions imply that $x^M = 0$, and thus profits are zero. All that remains to be shown, then, is that the first solution is, in fact, a maximum. The second derivative of the profit function with respect to y^M evaluated at this solution is $-(4(v-c) + (d-w)^2)/4 < 0$. □

Proof of Result 1. The result is obvious for x^{M*} and y^{M*} by inspection. Since $q^{M*} = w - (w-d)/2 = (w+d)/2$, then $y^{M*}q^{M*} = (w^2 - d^2)/4$, which is clearly decreasing in d. Thus $\pi_{\text{ad}}^{M*} = x^{M*}y^{M*}q^{M*}$ is decreasing in d. Differentiation of p^{M*} with respect to d yields $(3d - w)/4$, which is positive (negative) for $w/d < (>)\ 3$. Differentiating $\pi_{\text{co}}^{M*} = x^{M*}\ (p^{M*} - c)$ with respect to d and letting d approach zero yields $-vw/4 < 0$. On the other hand, letting d approach w following differentiation yields $(v-c)w/4 > 0$. □

Proof of Proposition 2. Differentiating the profit functions in (11) with respect to p_i and y_i yields the best response functions for firm i. Solving for the p_i's simultaneously yields the unique solution as a function of y_1: $p_1^*(y_1, y_2) = (v(1-\gamma) + c - dy_1^*(1-\gamma) - y_1^*(w - y_1^* - hy_2^*))/2$. Since the second-order conditions are always met for content prices p_i, we substitute the expressions for p_1^* and p_2^* into the first-order conditions for y_1 and y_2. The best response function for $y_1^*(y_2)$ has three possible solutions: $y_1 = (w - d - hy_2)/2$, and

$$y_1 = \frac{w-d-hy_2}{2} + \big(\gamma h y_2 \pm [(w-d)(2-\gamma^2) - hy_2(2-\gamma(1+\gamma))]^2 + 4(2-\gamma^2)[(v-c)(2-\gamma(1+\gamma)) - \gamma y_2(w-d) + \gamma y_2^2]^{1/2}\big) \cdot (2(2-\gamma^2))^{-1}.$$

Straightforward algebra reveals that $x_1^* = 0$ (and thus $\Pi_1^* = 0$) at the two possible solutions other than $y_1 = (w - d - hy_2)/2$. Thus we can focus on $y_1^*(y_2) = (w - d - hy_2)/2$ as the unique symmetric best response function. An analogous function holds for $y_2^*(y_1)$. Solving them simultaneously yields the solution shown. To see that this solution is indeed a maximum, all one needs to do is show that profit evaluated at $y = (w-d)/(2+h)$ is strictly positive. This is $(1-\gamma) \cdot [(v-c)(2+h)^2 + (d-w)^2]^2/(1+\gamma)(2-\gamma)^2(2+h)^4 > 0$. Substituting $y^{D*} = (w-d)/(2+h)$ back into the expression for p_i^* yields the expression for the content price. □

Proof of Result 2. Let $\Delta p \equiv p^{D*} - p^{M*}$. Differentiation yields

$$\frac{\partial \Delta p}{\partial \gamma} = -\frac{(v-c)(2+h)^2 + (w-d)^2}{(2-\gamma)^2(2+h)^2} < 0.$$

(i) is clear since $\Delta p \xrightarrow{\gamma\to 0} h(w-d)[d(4+3h) + (4+h)w]/8(2+h)^2 > 0$. On the other hand, as $\gamma \to 1$, $\Delta p < 0 \Leftrightarrow v - c > (w-d)(h^2(w+3d) + 4h(d+w) + 4d - 4w)/4(2+h)^2$, which proves (ii). □

Proof of Result 3. (i) Let $\Delta\pi_{ad} \equiv \pi_{ad}^D - \pi_{ad}^M$. Substituting in the equilibrium values from Propositions 2 and 1 and differentiating $\Delta\pi_{ad}$ with respect to γ yields $K(2\gamma-1)$, where $K>0$. It is straightforward to show that $\Delta\pi_{ad}|_{\gamma=0} = \Delta\pi_{ad}|_{\gamma=1}$. Assume that $\Delta\pi_{ad}>0$ for some γ value. Then, it must hold at either $\gamma=0$ or $\gamma=1$. Thus we restrict our attention to

$$\Delta\pi_{ad}|_{\gamma=0} = \left[\frac{w-d}{32}\right]\left[\frac{16[(v-c)(2+h)^2+(w-d)^2](w+d(h+1))}{(2+h)^4} - (w+d)(4(v-c)+(w-d)^2)\right],$$

which is decreasing in v.

$$\Delta\pi_{ad}|_{\gamma=0,\, v=c} < \frac{(w-d)^3}{32}\left[\frac{16(w+d(h+1))}{(2+h)^4} - w - d\right],$$

and since the term inside the brackets is decreasing in h, $\Delta\pi_{ad}|_{\gamma=0} \le 0$, which contradicts the assumption that $\Delta\pi_{ad}>0$. (ii) Let $\Delta\pi_{co} \equiv \pi_{co}^D - \pi_{co}^M$. We first substitute in the equilibrium values and then investigate the behavior of this quantity as $\gamma \to 0$. Note that $\Delta\pi_{co}|_{\gamma=0}$ is increasing in v and that

$$\Delta\pi_{co}|_{\gamma=0,\, v=c} = \frac{h(w-d)^3[d(64+3h(24+h(8+h)))+w(4+h)(8+h(4+h))]}{64(2+h)^4} > 0.$$

(iii) Now, we let $\gamma \to 1$, which yields

$$\Delta\pi_{co} = -\frac{(w-d)(w+d(h+1))((2+h)^2(v-c)+(w-d)^2)}{2(2+h)^2} - \frac{(4(v-c)+(w-d)^2)(4(v-c)-(w+3d)(w-d))}{64}.$$

The first term is always negative and the second term is negative for $4(v-c) > (w+3d)(w-d)$. □

Proof of Result 4. (i) Differentiating the equilibrium values yields: $\partial\pi_{ad}^D/\partial\gamma = K[2\gamma-1]$, $K>0$, which shows that π_{ad}^D is U-shaped in γ. (ii) $\partial\pi_{co}^D/\partial\gamma$ has two roots in γ at $(A \pm \sqrt{A^2-B^2})/B$—to which we refer as the *negative root* and the *positive root*—where

$$A = 2(2+h)^2(v-c) + d^2(7+5h) - wd(4+5h) - 3w^2,$$
$$B = 4(2+h)\big[(2+h)(v-c) - d(w-d)\big].$$

It is straightforward to show that $A \le B$ always, and that, for $(2+h)(v-c) < d(w-d)$, $B<0$. From this, we know that the negative root must be greater than 1, and thus outside the range of analysis. On the other hand, the positive root lies in $\gamma \in [0,1]$. All that remains is to show that $\partial\pi_{co}^D/\partial\gamma|_{\gamma=0} > 0$. Performing this differentiation directly yields

$$K[d(w-d) - (2+h)(v-c)], \tag{17}$$

where $K>0$. This expression is positive for $(2+h)(v-c) < d(w-d)$, which proves that π_{co}^D is decreasing in γ for low $v-c$. Now, if $(2+h)(v-c) > d(w-d)$, this implies that $B>0$. Moreover, it is clear from (17) that $\partial\pi_{co}^D/\partial\gamma|_{\gamma=0} < 0$. When $B>A>0$, no real root exists since $A^2-B^2<0$. When $B>0>A$ and $-A<B$, there can again be no real root since $A^2-B^2<0$. Finally, when $B>0>A$ and $-A>B$, $(A-\sqrt{A^2-B^2})/B<0$. On the other hand,

$$\frac{A+\sqrt{A^2-B^2}}{B<1} \iff \sqrt{A^2-B^2} < B-A$$
$$\iff (A-B)(A+B) < (B-A)^2$$
$$\iff -A-B < B-A,$$

which is impossible in this region. This shows that there's no root lying in $\gamma \in [0,1]$. Combined with the fact that $\partial\pi_{co}^D/\partial\gamma|_{\gamma=0} < 0$, we've shown that $\partial\pi_{co}^D/\partial\gamma < 0\ \forall\ \gamma \in [0,1]$. □

Proof of Proposition 3. We solve for the equilibrium of the system (14), where each firm simultaneously chooses content price and ad quantity. This yields the following first-order conditions:

$$\frac{\partial\Pi_i^A}{\partial p_i^A} = -\frac{1}{1-\gamma^2}\big(p_i^A - c^A + y_i^A q_i^A\big) + x_i^A = 0,$$
$$\frac{\partial\Pi_i^A}{\partial y_i^A} = -\frac{d}{1-\gamma^2}\big(p_i^A - c^A + y_i^A q_i^A\big) + x_i^A(q_i^A - y_i^A) = 0 \quad (i=1,2),$$
$$\frac{\partial\Pi^B}{\partial p^B} = -\big(p^B - c^B + y^B q^B\big) + x^B = 0,$$
$$\frac{\partial\Pi^B}{\partial y^B} = -d\big(p^B - c^B + y^B q^B\big) + x^B(q^B - y^B) = 0.$$

Plugging in expressions for x_i^A, q_i^A, x^B, q^B from the appropriate demand systems and simultaneously solving the first-order conditions yields $p_i^{A^*}$, $y_i^{A^*}$, p^{B^*}, y^{B^*} as reported in the Proposition. Similar to the proof of Proposition 2, we can show that the equilibrium is unique. □

Proof of Result 5. Define $\bar\theta = \min\{(2+h)(w^B-d^B)/2(w^A-d^A), 1\}$. Differentiating the equilibrium content prices and ad quantities for firms in medium A for $\theta < \bar\theta$ yields

$$\operatorname{sgn}\left(\frac{\partial y^{A^*}}{\partial\theta}\right) = -\operatorname{sgn}\left(\frac{\partial p^{A^*}}{\partial\theta}\right) = \operatorname{sgn}[4\theta(w^A-d^A) - (2+h+\theta^2)(w^B-d^B)]. \tag{18}$$

The term $[4\theta(w^A-d^A) - (2+h+\theta^2)(w^B-d^B)]$ is negative at $\theta=0$ and quadratic in θ with only one root in the range $\theta \in [0,\bar\theta]$. This root is given by $\underline{\theta} = (2(w^A-d^A) - \sqrt{4(w^A-d^A)^2 - (2+h)(w^B-d^B)^2})/(w^B-d^B)$. Hence, for $0<\theta<\underline{\theta}$, $\partial p^{A^*}/\partial\theta > 0$, and $\partial y^{A^*}/\partial\theta < 0$, while for $\underline{\theta} < \theta < \bar\theta$ $\partial p^{A^*}/\partial\theta < 0$ and $\partial y^{A^*}/\partial\theta > 0$.

From the solution to y^{B^*} in (16), it is obvious that for $1 \ge \theta > \bar\theta = ((2+h)(w^B-d^B))/(2(w^A-d^A))$ the firm in medium B will choose $y^{B^*}=0$ (i.e., it will drop out of the ad market). Differentiating the equilibrium prices and ad quantities for the firm in medium B in the range $\theta \le \bar\theta$ yields

$$\operatorname{sgn}\left(\frac{\partial y^{B^*}}{\partial\theta}\right) = -\operatorname{sgn}\left(\frac{\partial p^{B^*}}{\partial\theta}\right) = \operatorname{sgn}[(2+h)\theta(w^B-d^B) - (2+h+\theta^2)(w^A-d^A)]. \tag{19}$$

Given the condition stated prior to the proposition, we will always have $(w^A-d^A) > (\sqrt{2+h}/2)(w^B-d^B)$; hence

$\partial p^{B^*}/\partial\theta \geq 0$ and $\partial y^{B^*}/\partial\theta \leq 0$, $\forall\,\theta \leq \bar{\theta}$. Comparing interior equilibrium ad bundling strategies from (16): $y^{A^*} > y^{B^*}$ iff $\theta > ((2+h)(w^B - d^B) - 2(w^A - d^A))/(2(w^A - d^A) - (w^B - d^B))$. Since $(w^A - d^A) \geq ((3+h)/4)(w^B - d^B)$, we can find a nonempty region, where $y^{A^*} > y^{B^*}$. □

Proof of Result 6. Plugging the equilibrium values of $p_i^{A^*}$, $y_i^{A^*}$, p^{B^*}, y^{B^*} into the total profit function for each firm, we get $\Pi_i^{A^*} = \Pi^{A^*} = (x_i^{A^*})^2(1-\gamma^2)$, $i = 1, 2$, and $\Pi^{B^*} = (x^{B^*})^2$. For the proof of part (i), we analyze $\mathrm{sgn}(\partial x^{A^*}/\partial\theta)$ and $\mathrm{sgn}(\partial x^{B^*}/\partial\theta)$, and for part (ii), we determine when $\Pi_i^{A^*}/\Pi^{B^*} > 1$. This involves tedious algebra and details are provided in the Technical Appendix, which can be found at http://mktsci.pubs.informs.org. □

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