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Ramon Casadesus-Masanell
Feng Zhu

Working Paper

10-026

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Ramon Casadesus-Masanell
Associate Professor
Harvard Business School
Boston, MA 02163
Phone: +1 (617) 496-0176
Email: casadesus@gmail.com

Feng Zhu
Assistant Professor
Marshall School of Business
University of Southern California
Los Angeles, CA 90089
Phone: +1 (213) 740-8469
Email: fzhu@marshall.usc.edu

February 13, 2010

*We thank the Department Editor, the Associate Editor, and two referees for insightful comments that helped improve the paper. We also also thank Paul Adler, Jim Dana, Ana Leticia Gonzalez-Palomares, Andres Hervas-Drane, Gaston Llanes, Francisco Ruiz-Aliseda, Lourdes Sosa, Botao Yang and seminar participants at the London Business School, LeBow College of Business, Drexel University, Emory University, and HBS Strategy Senior *Brown Bag* series for helpful comments and discussions. We gratefully acknowledge financial support from the NET Institute (www.netinst.org). Casadesus-Masanell thanks the HBS Division of Research and the Public-Private Sector Research Center at IESE Business School.

Strategies to Fight Ad-Sponsored Rivals

Abstract

We analyze the optimal strategy of a high-quality incumbent that faces a low-quality ad-sponsored competitor. In addition to competing through adjustments of tactical variables such as price or the number of ads a product carries, we allow the incumbent to consider changes in its business model. We consider four alternative business models, a subscription-based model, an ad-sponsored model, a mixed model in which the incumbent offers a product that is both subscription-based and ad-sponsored, and a dual model in which the incumbent offers two products, one based on the ad-sponsored model and the other based on the mixed business model. We show that the optimal response to an ad-sponsored rival often entails business model reconfigurations. We also find that when there is an ad-sponsored entrant, the incumbent is more likely to prefer to compete through the subscription-based or the ad-sponsored model, rather than the mixed or the dual model, because of cannibalization and endogenous vertical differentiation concerns. We discuss how our study helps improve our understanding of notions of strategy, business model, and tactics in the field of strategy.

1 Introduction

Ad-sponsored business models appear to be increasingly prevalent in today's economy. Many companies choose to finance themselves using ad revenues and offer their products or services free to consumers. These products and services range from newspapers to software applications and from television programs to online searches.

The emergence of ad-sponsored entrants in various industries poses significant threats to the incumbents in these markets whose business models are often based on subscriptions or fees charged to their customers. For example, newly-launched music-service providers such as Imeem give users free access to ad-supported, streaming music files, while industry leaders such as Apple's iTunes music services and RealNetwork's Rhapsody are fee- or subscription-based. NetZero offered free ad-sponsored dial-up Internet access and attracted many users away from AOL's subscription-based dial-up service.

Ad-sponsored business models are not limited to Internet-related industries. Free ad-sponsored broadcast television channels have been competing with subscription-based cable channels such as HBO for many years. And Metro, the world's largest newspaper measured by circulation, is free and ad-sponsored. It is published in more than 100 cities in 18 countries.[1] In each city it enters, it competes with local newspapers sold at positive prices.

Faced with the threat from ad-sponsored entrants, incumbents must choose strategies to respond. The New York Times Co., which owns The Boston Globe, bought a 49 percent stake in Metro Boston in 2006. In September 2007, the company also stopped charging readers to access certain articles on NYTimes.com and began to use ads exclusively to finance its online news services. Recoletos, one of the biggest Spanish media groups, launched Qué!, a free newspaper in 15 cities to compete against Metro Spain.[2] Apple, on the other hand, chose not to respond to ad-sponsored free music sites and continues its business as usual.

These empirical observations suggest that incumbents use a variety of measures to respond to ad-sponsored rivals. They not only use tactics such as adjusting their prices, but also consider the adoption of new business models by switching from subscription-based models to ad-sponsored models, or by extending their product lines to include ad-sponsored versions of their offerings. Some of these strategic responses have not worked well. The New York Times Co., for example, is planning to charge for access to some of its online content once again.[3]

[1] See www.metro.lu/about/metro_facts, accessed 04/09.
[2] See Khanna et al. (2007).
[3] See http://bit.ly/FANJZ, accessed 04/09.

How should an incumbent react to an ad-sponsored entrant? The goal of this research is to develop an analytical framework to establish guidelines for incumbent firms facing these issues.

We consider a game with an incumbent that faces an ad-sponsored entrant. In responding to the entrant, the incumbent chooses the business model through which it would like to compete. We consider four business models: a *subscription-based model* where the firm sells the product without ads for a positive price (e.g., HBO), an *ad-sponsored model* where the product is bundled with ads and given away for free (e.g., Metro), a *mixed model* where the product has advertisements and it is sold at positive price (e.g., New York Times), and a *dual model*[4] where the firm offers two products, a high-quality product that, just as in the mixed model, is sold at positive price and comes with a few ads, and a low-quality product that is ad-sponsored (e.g., Pandora). We refer to the subscription-based model and the ad-sponsored model as *pure* models because they entail one single source of revenue (price or advertising), and the mixed model and the dual model as *hybrid* models because they are the result of combining pure business models.

Building on Ghemawat (1991) and Casadesus-Masanell and Ricart (2010), we refer to the choice of business model as *strategy*: the business model is a set of committed choices that lays the groundwork for the competitive interactions that will occur between the incumbent and the ad-sponsored entrant down the line. After the business model has been chosen, the incumbent and the entrant make *tactical* choices simultaneously: the entrant chooses advertising intensity (i.e., the number of ads the entrant's product carries) as it is assumed to compete through an ad-sponsored business model, and the incumbent chooses price and/or advertising intensity, depending on the business model through which it has decided to compete.

The analysis reveals that the incumbent's optimal strategy changes dramatically in the presence of an ad-sponsored rival, compared to the monopoly situation. In particular, we find that when there is an ad-sponsored competitor, the incumbent is more likely to prefer to compete through a pure, rather than a hybrid, business model. The use of a hybrid model when competing against the ad-sponsored entrant results in cannibalization or in the erosion of vertical differentiation.

[4]The expression *dual business model* was coined by Markides (2008) to refer to a situation where a firm offers two products each through a different business model. We have also considered another hybrid of two pure business models: the firm offers two products, a high-quality product that is subscription-based and a low-quality product that is ad-sponsored. As we will show in the analysis, this business model is dominated by the dual model in both the monopoly and duopoly settings. Hence, we focus on the dual model in this paper.

We also find that the entrant is pushed out of the market when the incumbent competes through the ad-sponsored model or the dual model. Otherwise, both firms coexist with strictly positive profits. Moreover, eliminating the entrant is optimal only when the prevailing advertising rate is high. Therefore, the incumbent's reaction to the entry by an ad-sponsored rival is most aggressive when advertising rates are high. Ironically, this is the situation when, absent the incumbent's reaction, the entrant would have had the strongest incentives to enter.

Our analysis shows that the emergence of an ad-sponsored entrant does not necessarily increase the level of competition in a market, as the entrant may strategically design its product to avoid competitive interactions with the incumbent by targeting at non-adopters of the incumbent's product. Policy makers thus need to examine business models employed by firms in a market to evaluate changes in market power and social welfare.

We present a discussion of the notion of business model with an emphasis on how it is different from strategy. Our formal model allows us to clearly separate the two notions and helps us better understand how they relate. The analysis reveals that there is value in distinguishing between strategy and business model and that incumbents facing ad-sponsored rivals may benefit substantially from developing strategies that call upon business model reconfigurations conditional on entry or lack thereof.

Our study is the first to provide a comprehensive analysis of the competition between a free ad-sponsored entrant and an incumbent that has the option of choosing different business models. The analysis shows the importance of considering modifications to a firm's business model when deciding how to compete.

The paper is organized as follows. Section 2 discusses the related literature. Section 3 presents our model setup. Sections 4 and 5 analyze the monopoly benchmark and the duopoly case in which an incumbent competes with an ad-sponsored entrant, respectively. Section 6 discusses the results and Section 7 presents four empirical implications. Section 8 concludes. We provide the proofs in an Appendix.

2 Related literature

The paper is related to several strands of literature. First, it contributes to the literature on ad-sponsored business models. Prasad et al. (2003) and Gabszewicz et al. (2005) examine a monopolist's pricing decisions when it is ad-sponsored. Their results are akin to our mixed model in that the monopoly will lower the subscription price as the willingness to pay of the advertisers increases. Several studies (e.g., Steiner 1952; Beebe 1977; Spence and Owen

1977; Doyle 1998; Gal-Or and Dukes 2003; Bourreau 2003; Gabszewicz et al. 2006; Peitz and Valletti 2008) look at the product positioning of ad-sponsored firms. In general, they find that with advertising, firms tend to provide less horizontally-differentiated products. Our study focuses on vertically-differentiated products and allows firms to strategically decide the level of product quality. Choi (2006) and Crampes et al. (2009) examine entry of media firms and find that with free entry, there may be an excessive number of firms in such markets. While we only look at the competition between one incumbent and one entrant, we allow the incumbent to use different business models.

The economic model we work with is close in spirit to the literature on product-line extension. Mussa and Rosen (1978) and Deneckere and McAfee (1996) consider product-line decisions of a monopolist. Different from these studies, in our model, the incumbent can use ads to degrade the quality of the product. Shaked and Sutton (1982) examine a duopoly setting and find that when each firm is allowed to offer one quality, the two firms will want to maximize quality differentiation to soften price competition. In our mixed model, after introducing the ads, the quality differentiation between the incumbent and the entrant is no longer maximized in equilibrium.

Our paper also contributes to an emerging literature in strategy that explores competitive interaction between organizations with different business models. Casadesus-Masanell and Ghemawat (2006), Economides and Katsamakas (2006) and Lee and Mendelson (2008) for example, study duopoly models in which a profit-maximizing competitor interacts with an open source competitor. Casadesus-Masanell and Yoffie (2007) study competitive interactions between two complementors, Microsoft and Intel, with asymmetries in their objectives functions stemming from technology—software vs. hardware, and Casadesus-Masanell and Hervas-Drane (2009) analyze competitive interactions between a free peer-to-peer file sharing network and a profit-maximizing firm that sells the same content at positive price and that distributes digital files through an efficient client-server architecture. Seamans (2009) looks at strategies used by incumbent cable TV firms to deter entry by public and private entrants. Zhu (2008) examines networks' incentives to establish compatibility under subscription and ad-sponsored business models. This paper contributes to this literature by endogeneizing the choice of business model: We allow the incumbent to choose the business model with which it would like to fight a rival that competes with an ad-sponsored product.

Finally, this paper is related to the literature on two-sided markets (e.g., Spulber 1996, 2006; Rochet and Tirole 2003; Caillaud and Jullien 2003; Armstrong 2006; Hagiu 2009; Casadesus-Masanell and Ruiz-Aliseda 2009; Zhu and Iansiti 2009). A market is two-sided

when it is intermediated by a platform which enables transactions between participants on both sides. In most applications in the literature (e.g., the video game industry), the two sides attract each other. In contrast, when a platform is ad-sponsored, consumers are attracted by the product offered by the platform *per se*, rather than the ads, and they, in general, would prefer to watch fewer ads. Our paper contributes to this literature by explicitly addressing the question of when it is optimal for a firm to use a one-sided business model by excluding the side that produces the negative effect.

3 The model

We consider a high-quality incumbent (firm h) that faces a low-quality ad-sponsored potential entrant (firm l).[5] On the demand side, there is one unit mass of consumers. Consumers are differentiated by their type θ, which represents their marginal willingness to pay for product quality and is uniformly distributed on $[0, 1]$. The utility that a consumer of type θ receives from product $i \in \{h, l\}$ is $U(\theta) = \theta(q_i - \beta A_i^2) - p_i$, where $q_h > q_l$ denote the (exogenous) quality of products h and l, $\beta > 0$ is a constant, A_i is the number of ads that product i carries, and p_i is the price of product i. The firms choose advertising intensity and price. We assume that the marginal cost of producing the product or introducing an ad is zero. The assumption $q_h > q_l$ holds for most of the examples of ad-sponsored entrants that we observe in the real world.[6]

Consumers have to view ads that come with the product. Recent work on media industries generally characterizes advertising as a nuisance (e.g., Anderson and Coate 2005). Empirical studies in the television industry and the magazine industry (Wilbur 2008; Depken and Wilson 2004) find that ads indeed reduce viewers' utilities. Hence, we assume that the total nuisance cost of the ads is βA_i^2, where $\beta > 0$. The functional form implies that the marginal disutility of ads increases with the amount of ads. Moreover, the first few ads are tolerated well by consumers, but as more and more ads are shown, consumers become increasingly

[5]The extension to multiple ad-sponsored entrants is trivial given the Bertrand-like interactions between ad-sponsored firms. See Section 3.1.

[6]For example, if we take out the ads of an issue of the *Metro Boston* and compare it to an issue of *The Boston Globe* without ads, *Metro Boston* is of much worse quality. Likewise, Gmail is a high-quality email system: It offers an unmatched search capability, over seven gigabytes of free storage space, online and offline access, and all the bells and whistles to which users of paid email systems, such as Microsoft *Outlook* or Apple's *Mail*, have grown accustomed. However, when it was first launched as a beta version, Gmail had numerous problems such as security flaws and unexpected service outages. At that point it was of lower quality than paid email services.

irritated by them.[7]

We refer to $q_i - \beta A_i^2$ as the net quality of product i after taking the nuisance cost of ads into consideration. We impose a non-negativity constraint on price (i.e., $p_i \geq 0$) and normalize consumers' utility from outside options to be zero.

We assume that each consumer only adopts one product. The assumption is appropriate for our setting, as we have vertically-differentiated products. When a consumer owns two products, she has two products at her disposal, one providing greater (or equal) utility than the other. Since the two products have no horizontal differences, the consumer may have little incentive to use the product providing lower utility. For example, consumers may pay for high-quality wireless service or use low-quality ad-sponsored wireless service at an airport. In most cases, consumers will choose one service only. Similarly, free newspapers and paid newspapers in a local market often focus on the same type of news, except that the free ones provide lower quality editorials, less news, and less extensive coverage than paid newspapers. Consumers will likely read one newspaper only. Indeed, the literature on multi-homing generally considers *horizontally* differentiated products (Gabszewicz and Wauthy 2004; Doganoglu and Wright 2006).[8]

We also adopt two tie-breaking rules: 1) consumers who are indifferent to the incumbent's product and the entrant's product will adopt the incumbent's product, and 2) consumers who are indifferent to adopting a product or not adopting a product will choose to adopt the product.[9]

When a product is sponsored by advertisers, the larger the number of consumers, the more attractive the product is for the advertisers. Following Gabszewicz et al. (2004), we assume that the advertising fee charged to each advertiser, r_i, is an increasing linear function of the demand for the product, D_i. Mathematically, $r_i = \alpha D_i$, where $\alpha > 0$, and is the (per-consumer) advertising rate charged to each advertiser.

Because the entrant uses an ad-sponsored business model, its product is given away for

[7]While it is possible that consumers may like to see a few ads, as more and more ads are shown it gets to a point after which, for most consumers, ads become annoying, irritating, and exasperating. Clearly, all of our results go through if we interpret q_i not as product i's quality in the absence of ads but as its quality exactly at the point in which having one more ad begins to decrease utility (the point at which β becomes positive).

[8]For example, two newspapers are horizontally differentiated if one focuses on sports and the other focuses on business and finance. Consumers may adopt both newspapers if each provides positive utility to them.

[9]Because $q_h > q_l$, the incumbent could always reduce the amount of ads or price by ϵ (positive and small) so that the utility provided by its product is greater than that of the entrants product. Similarly, either the incumbent or the entrant could reduce the number of ads or price by ϵ so that they offer above-zero utility and the consumers will strictly prefer adoption to non-adoption. We choose to use the tie-breaking rules to simplify exposition.

free. Thus, $p_l = 0$. Let A_l be the amount of ads the entrant introduces. On the one hand, the entrant would like to have many ads; on the other hand, having many ads reduces the product's quality and, as a result, reduces the number of consumers adopting it. The entrant also needs to take the incumbent's responses into consideration when choosing the number of ads. Note that consumers will consider the entrant's product only if $q_l - \beta A_l^2 \geq 0$.

The timing of the game is as follows. First, the entrant decides whether to enter or not. Second, the incumbent chooses a business model. Third, tactical choices (price and/or advertising intensities) are made by both the entrant and the incumbent, and demand and profits are realized. Figure 1 illustrates the sequence of moves.

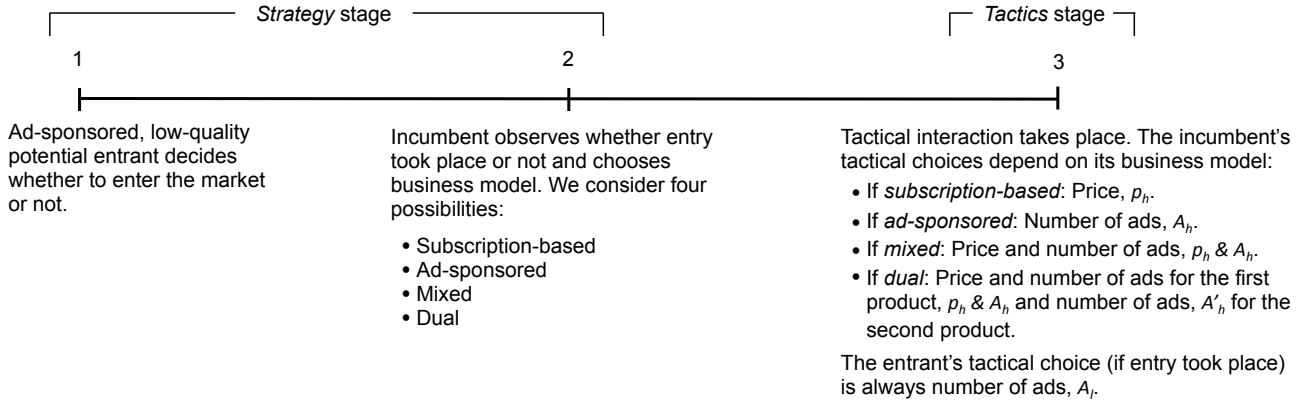


Figure 1: Timing of the model.

3.1 Four business models

In popular parlance, *business model* refers to "the logic of the firm, the way it operates and how it creates value for its stakeholders" (Baden-Fuller et al. 2008). We represent different business models through different profit functions. Therefore, the choice of the particular business model with which to compete corresponds, in our development, to the choice of a particular profit function. Zott and Amit (2010) propose the use of Porter's (1996) activity systems to represent business models. Activity systems are richer representations of business models, compared to the highly stylized profit functions that economic analyses use. The advantage of using activity systems is that they give a rich picture of the logic of the firm and the way it operates. Activity systems emphasize that a firm is more than the mere addition of activities; complementarities may result in important competitive advantages. On the negative side, activity systems are not amenable to game theoretical analysis because, in most cases, they are too complex.

We now present the four profit functions that correspond to the four business models that we consider. We normalize the fixed cost of competing through a pure business model to zero and denote by $f \geq 0$, the additional fixed cost incurred when a hybrid business model is employed.[10]

Subscription-based model. The incumbent maximizes profits by setting p_h and the entrant maximizes profits by setting A_l subject to the constraint that $q_l - \beta A_l^2 \geq 0$. As the entrant product is free, consumers who do not adopt product h will adopt product l. The type of the indifferent consumer between the two products, θ^*, is defined by $\theta^* q_h - p_h = \theta^*(q_l - \beta A_l^2)$. Profits of the incumbent and the entrant are: $\pi_h^S = (1-\theta^*)p_h$ and $\pi_l^S = \alpha\theta^* A_l$, subject to $0 \leq \theta^* \leq 1$, and $q_l - \beta A_l^2 \geq 0$.

Ad-sponsored model. When both the incumbent and the entrant provide free products, all consumers will buy the product with higher net quality. This competitive situation is similar to Bertrand competition, except that now the two firms are setting the number of ads, not prices. The profits are:

$$\pi_h^A = \begin{cases} \alpha A_h & \text{if } \; q_h - \beta A_h^2 \geq q_l - \beta A_l^2 \\ 0 & \text{otherwise,} \end{cases} \qquad \pi_l^A = \begin{cases} 0 & \text{if } \; q_h - \beta A_h^2 \geq q_l - \beta A_l^2 \\ \alpha A_l & \text{otherwise,} \end{cases}$$

subject to $q_h - \beta A_h^2 \geq 0$ and $q_l - \beta A_l^2 \geq 0$.

Mixed model. The incumbent product now comes with ads, A_h, and is priced at $p_h > 0$. The indifferent consumer is defined by $\theta^*(q_h - \beta A_h^2) - p_h = \theta^*(q_l - \beta A_l^2)$. Hence, the profits are: $\pi_h^M = (1-\theta^*)(p_h + \alpha A_h) - f$, $\pi_l^M = \theta^* \alpha A_l$, such that $0 \leq \theta^* \leq 1$, $q_h - \beta A_h^2 \geq 0$, and $q_l - \beta A_l^2 \geq 0$. For this business model to be meaningful, we need that $p_h > 0$ and $A_h > 0$. Otherwise, one of the pure business models is the effective one.

Dual model. The incumbent introduces two products, product h that is both subscription- and ad-based, and product h' that is purely ad-sponsored. The incumbent creates the second product by introducing ads to product h.[11] Let A'_h be the advertising intensity of product h' and its quality is thus $q_h - \beta A_h'^2$.

Suppose that the advertising intensities A'_h and A_l are such that the entrant is pushed out of the market. Then, consumers either buy the high quality product of the incumbent

[10] It is reasonable to expect that dealing with both advertisers and consumers will be more costly: As the two groups are very different and do not overlap with each other, there will be little economy of scope. On the other hand, it is trivial to generalize the analysis to the case $f < 0$.

[11] While the incumbent could create a different, brand-new h', it would prefer to create h' by adding ads to product h as ads will bring additional profits.

or consume the free ad-sponsored product of the incumbent. In this case, the indifferent consumer θ^* is determined by $\theta^*(q_h - \beta A_h^2) - p_h = \theta^*(q_h - \beta A_h'^2)$. Suppose, instead, that the advertising intensities A_h' and A_l are such that the entrant is *not* pushed out of the market. Then, consumers either buy the high quality product of the incumbent or consume the free ad-sponsored product of the entrant. In this case, the indifferent consumer θ^{**} is determined by $\theta^{**}(q_h - \beta A_h^2) - p_h = \theta^{**}(q_l - \beta A_l^2)$.

As product h is not free, we must have that $A_h < A_h'$. That is, the net quality of h has to be greater than that of h'. Otherwise, product h will have no demand. The profits are:

$$\pi_h^D = \begin{cases} (1-\theta^*)(p_h + \alpha A_h) + \theta^*(\alpha A_h') - f & \text{if } \; q_h - \beta A_h'^2 \geq q_l - \beta A_l^2 \\ (1-\theta^{**})(p_h + \alpha A_h) - f & \text{otherwise,} \end{cases}$$

$$\pi_l^D = \begin{cases} 0 & \text{if } \; q_h - \beta A_h'^2 \geq q_l - \beta A_l^2 \\ \alpha\theta^{**} A_l & \text{otherwise,} \end{cases}$$

subject to $0 \leq \theta^* \leq 1,\ 0 \leq \theta^{**} \leq 1,\ q_h - \beta A_h'^2 \geq 0, \quad q_l - \beta A_l^2 \geq 0, \quad \text{and} \quad A_h < A_h'$. This business model is meaningful only when $p_h > 0$, $A_h > 0$, and $A_h' > 0$.

While it may seem as if the ad-sponsored, the subscription-based, and the mixed business models are special cases of the dual model (as if they were points on a continuum), once we zoom down to the concrete system of activities that those profit functions aim to capture it becomes clear that they are *not* points in a continuum. Put differently, real companies do not think of their profit functions as completely "plastic." For example, if one initially competes through a subscription-based model and considers putting "a little bit of ads," or introducing an ad-sponsored product, he will likely need some important changes in his activity system (activities to negotiate with advertisers, collect ad revenues, access to different distribution channels, and so on).

4 Monopoly benchmark

It is helpful to begin our analysis by studying the optimal strategy and tactics of a monopolist incumbent. This simple case serves as a benchmark against which to compare the duopolistic industry structure of Section 5. The monopoly model is a special case of the model described in Section 3. It is obtained by setting $q_l = 0$. We solve the optimization problem backwards.

4.1 Monopoly tactics

We use the term *tactics* to refer to the choices that the firm makes after the business model has been chosen. The tactical options available to the firm depend on the business model under consideration.[12] For example, in the ad-sponsored business model, the tactics entail the choice of the number of ads, A_h, and in the dual business model, they entail the choice of price and the number of ads for the high-quality product, p_h and A_h, and the number of ads for the low-quality product, A'_h.

The following proposition summarizes the optimal tactical choices for each business model that we consider.

Proposition 1 *The optimal price and number of ads under each business model are:*

- *Subscription-based model:* $p_h = q_h/2$.
- *Ad-sponsored model:* $A_h = (q_h/\beta)^{1/2}$.
- *Mixed model:* A_h *solves* $A_h^3\beta^2 + q_h(\alpha - A_h\beta) = 0$, *and* $p_h = (q_h - \beta A_h^2 - \alpha A_h)/2$.[13]
- *Dual model:* $A'_h = (q_h/\beta)^{1/2}$, $A_h = \frac{1}{2}((A'_h(4\alpha + A'_h\beta)/\beta)^{1/2} - A'_h)$, *and* $p_h = \frac{1}{2}(A'_h - A_h)(\alpha + (A_h + A'_h)\beta)$.

The intuitions for these results are as follow:

Subscription-based model. The monopolist trades off demand against mark-up. It is well-known that when the demand function is linear and marginal cost is zero, the optimal solution has a price equal to one-half the choke price and half of the market is served.

Ad-sponsored model. The monopolist introduces the maximum number of ads possible making sure that the resulting net quality is not so low that there is no willingness to pay. Because $p_h = 0$, as long as $q_h - \beta A_h^2 \geq 0$, every consumer buys the product regardless of the number of ads that it contains. Thus its profits are maximized at $A_h = (q_h/\beta)^{1/2}$. We note also that as β increases, the equilibrium A_h is smaller. Clearly, if consumers become easily irritated by ads, the number of ads that results in zero net quality is smaller.

Mixed model. Given A_h, the net quality of the product is $q_h - \beta A_h^2$. A monopolist earning profits from subscription only with a product of quality $q_h - \beta A_h^2$ would charge a price of $\hat{p}_h = (q_h - \beta A_h^2)/2$. However, the optimal price in the case of a monopolist that *also*

[12] See Casadesus-Masanell and Ricart (2010) for a discussion of this issue.

[13] The solution to A_h is too lengthy to be shown here.

earns profits from advertising is $p_h = (q_h - \beta A_h^2 - \alpha A_h)/2 < \hat{p}_h$. The reason is that, with advertising, the firm considers the profits accrued from both sides of the market. To earn more from advertising, it is optimal for the firm to choose a low p_h to increase demand. In addition, as α increases, the monopolist decreases p_h to increase the number of adopters. The equilibrium A_h is increasing in α.

Dual model. The ad-sponsored product has the lowest possible quality in equilibrium. In other words, A'_h is such that the willingness to pay for the low-quality product is zero. Therefore the consumers who consume the ad-sponsored product would not have bought the high-quality product had the ad-sponsored product not existed. As a consequence, there is no cannibalization between the two products.

4.2 Monopoly strategy

We use the term *strategy* to refer to the choice of business model for the different situations that might arise.[14] Strategy is a high-order choice that has important implications on competitive outcomes. Choosing a particular business model means choosing a particular way to compete, a particular "logic of the firm:" a profit function and the associated set of possible tactics that will be used to maximize profits in the market place. This concept of strategy agrees with Porter's (1996, p. 68) notion: "strategy is the *creation* of a unique and valuable position, involving a different set of activities" [emphasis added]. According to this definition, the activity system is the firm's realized strategy. Strategy proper, however, is not the activity system itself but the *creation* of the activity system. Likewise, in our language, strategy is concerned with the choice of a business model, and business models are represented formally through profit functions.

Figure 2 shows the optimal strategy for the monopolist as a function of α and f.[15] Note first that only three of the four business models that we consider may arise in equilibrium as the dual model dominates the mixed model. Under the mixed model, not all consumers adopt the product because the price is positive. The monopolist could improve its payoff by offering an ad-sponsored free product that gives zero utility. The ad-sponsored product does not cannibalize the sales of the high quality product. Those who choose the outside option

[14]Since in the monopoly situation there are no contingencies upon which to base the choice of business model, the above definition is equivalent to strategy as the choice of business model. See Section 6.1 for a discussion of this issue.

[15]While we set the parameter values to $q_h = 3$ and $\beta = 1$ when producing the figure, the result (three regions only, their shapes, and location) is general. For a proof, see the working paper version of this paper: `http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1476530`.

would now adopt the ad-sponsored product and would bring ad revenue to the monopolist.

Also, when $f = 0$, the dual model dominates the subscription-based model. The reason is that the marginal effect of ads on consumer utility evaluated at $A_h = 0$ is zero. On the other hand, the marginal revenue of ads is constant and equal to $\alpha > 0$. Therefore, when the additional cost of using a hybrid model, f, is zero, it is always optimal to have a few ads, even if α is very small.

Finally, the figure shows that low (high) α favors the subscription-based (ad-sponsored) model. Moreover, as f increases, the range of α such that the dual model is optimal shrinks.

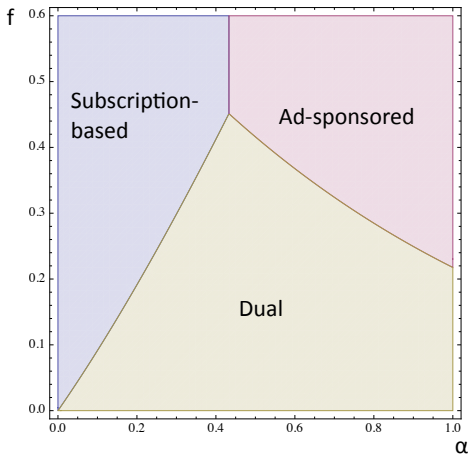


Figure 2: Optimal business model in the monopoly case.

5 Duopoly

We now examine the optimal strategy of an incumbent that faces an ad-sponsored entrant. We assume that the entrant faces no entry costs and thus it enters as long as the profits that it expects to earn are greater than zero. We solve for the sub-game perfect equilibria.

5.1 Duopoly tactics

The following proposition shows the equilibrium tactics for each business model.

Proposition 2 *The optimal price and the number of ads under each business model are:*

- *Subscription-based model: When $q_h < 2q_l$, we have an interior solution where $q_l - \beta A_l^2 > 0$, $p_h = q_h - q_l$ and $A_l = (\frac{q_h - q_l}{\beta})^{1/2}$; when $q_h \geq 2q_l$, we have a corner solution where $q_l - \beta A_l^2 = 0$, $p_h = q_h/2$ and $A_l = (q_l/\beta)^{1/2}$.*

- *Ad-sponsored model:* $A_h = ((q_h - q_l)/\beta)^{1/2}$ *and* $A_l = 0$. *The entrant is pushed out the market.*

- *Mixed model: At the interior solution where* $q_l - \beta A_l^2 > 0$, A_h *and* A_l *solve the following system:*[16]

$$\begin{cases} (q_h - q_l)/\beta + A_l^2 = \frac{A_h^3}{A_h - \alpha/\beta} \\ A_l = ((q_h - q_l - A_h^2\beta)/\beta)^{1/2} \end{cases},$$

  and $p_h = \frac{1}{2}\left(q_h - q_l - \alpha A_h - \beta(A_h^2 - A_l^2)\right)$.

  At the corner solution where $q_l - \beta A_l^2 = 0$, A_h *solves:* $A_h^3\beta^2 + q_h(\alpha - A_h\beta) = 0$, $A_l = (q_l/\beta)^{1/2}$, *and* $p_h = (q_h - A_h(\alpha + A_h\beta))/2$.

- *Dual model:* $A_h' = ((q_h - q_l)/\beta)^{1/2}$, $A_h = \frac{1}{2}((A_h'(4\alpha + A_h'\beta)/\beta)^{1/2} - A_h')$, $p_h = \frac{1}{2}(A_h' - A_h)(\alpha + \beta(A_h + A_h'))$, *and* $A_l = 0$. *The entrant is pushed out the market.*

We now present the intuitions behind these results:

Subscription-based model. The optimal tactics of the incumbent depend on whether the entrant sets its number of ads at the corner or not ($A_l = (q_l/\beta)^{1/2}$ or $A_l < (q_l/\beta)^{1/2}$), which in turn depends on the exogenous vertical differentiation between the incumbent's and the entrant's products. Recall that the entrant's profits increase with its market share and the number of ads its product has. When the entrant's product is of very low quality ($q_h \geq 2q_l$), it is best for it to maximize the number of ads because its market share, $\theta^* = \frac{p_h}{q_h - q_l + \beta A_l{}^2}$, is insensitive to the amount of ads that it offers (the derivative of θ^* with respect to A_l approaches zero as the difference between q_h and q_l increases). On the other hand, if its quality is close to the high quality product ($q_h < 2q_l$), θ^* is sensitive to the number of ads and it makes sense for the entrant to reduce the number of ads to gain some market share.

When $q_h \geq 2q_l$, there is no cannibalization between the two products, as $q_l - \beta A_l^2 = 0$. The indifferent consumer obtains zero utility. When $q_h < 2q_l$, the net quality of the entrant in equilibrium is positive: $q_l - \beta A_l^2 = 2q_l - q_h > 0$. The indifferent consumer has positive utility from both products. Note that the solution for $q_h \geq 2q_l$ is the same as in the monopoly case for the incumbent. This result suggests that the incumbent may not have to adjust its tactics when facing an ad-sponsored rival.

Ad-sponsored model. The incumbent uses the free ad-sponsored product to "kill" the entrant. This means that the incumbent cannot introduce too many ads as it has to offer at

[16]The solution to A_h is too lengthy to be shown here.

least the same amount of utility as the entrant *without ads* because the entrant will respond by lowering the amount of ads in order to survive. Hence, the optimal amount of ads is constrained by $q_h - \beta A_h^2 \geq q_l$. Under this constraint, all consumers will adopt product h. Therefore, it is in the interest of the incumbent to maximize A_h, subject to the constraint that $q_h - \beta A_h^2 \geq q_l$.

Mixed model. As the incumbent product is not free, consumers with low θ will not buy from the incumbent. As long as the entrant's product offers positive utility, these consumers will adopt the entrant's product. As a result, both the incumbent and the entrant co-exist in equilibrium.

Similarly to the subscription-based model, the solution may be at a corner where the entrant sets the maximum number of ads ($A_l = (q_l/\beta)^{1/2}$) such that the utility for its product is zero, or it may be interior ($A_l < (q_l/\beta)^{1/2}$). When $q_h \leq 2q_l$, we are at the interior solution and the entrant's product offers strictly positive utility. The indifferent consumer thus gets positive utility. Surprisingly, in this case, the derivative of π_h^M w.r.t. α is negative, as stated in the following lemma.

Lemma 1 *Under the mixed model, when we have interior solutions, the incumbent's profits, π_h^M, decrease with the advertising rate, α; when we have corner solutions, the incumbent's profits, π_h^M, increase with the advertising rate, α. In addition, when $q_h \leq 2q_l$, we will always have interior solutions; when $q_h > 2q_l$ and α is smaller than a given threshold, $\alpha^* > 0$, we will have corner solutions.*

To understand this result, recall that when we have interior solutions, the entrant's best-response function is $A_l = ((q_h - q_l - A_h^2\beta)/\beta)^{1/2}$, which decreases with A_h. When α increases so does A_h. As a result, A_l will decrease with α. Therefore, as α increases, the vertical differentiation between the two products diminishes and the increased competition lowers the incumbent profits. The interior case happens when the equilibrium A_l is less than $(q_l/\beta)^{1/2}$, the maximum number of ads that the entrant can possibly have. A sufficient condition for the equilibrium to be interior is $q_h < 2q_l$.

The corner solution happens when the quality difference is large (i.e., $q_h > 2q_l$). In this case, the unconstrained profit-maximizing A_l (i.e., $((q_h - q_l - A_h^2\beta)/\beta)^{1/2}$) would exceed $(q_l/\beta)^{1/2}$. The entrant chooses to set A_l at $(q_l/\beta)^{1/2}$, and the indifferent consumer receives zero utility. The number of ads and the price that the incumbent sets are the same as in the monopoly mixed model because there is no interaction between the incumbent and the entrant when the entrant is at the corner. Moreover, the incumbent's profits increase with

α as long as the entrant is at the corner. But as α keeps increasing, the entrant eventually finds it optimal to have fewer ads to enlarge its market share and we move into the interior case. Once we are in the interior case, the incumbent's profits decrease with α.

Dual model. In this case, the entrant will be pushed out of the market by the ad-sponsored product of the incumbent for the same reason as in the ad-sponsored business model. All consumers adopt the incumbent's products. In order to push the entrant out, the net quality of the ad-sponsored product, $q_h - \beta A_h'^2$, has to be no less than q_l. On the other hand, in order to minimize cannibalization between incumbent's two products, the incumbent wants to set A_h' such that the net quality of the ad-sponsored product will be as low as possible. Hence, A_h' is determined by $q_h - \beta A_h'^2 = q_l$. The utility of the indifferent consumer over the two products is thus $\theta^* q_l > 0$.[17]

We also note that the equilibrium A_h is greater than zero. That is, it is always optimal for the incumbent to introduce some ads with product h. Hence, this business model dominates the one where the incumbent offers a subscription-based product and an ad-sponsored product.[18]

The entrant and the incumbent co-exist in the equilibrium under the subscription-based model and the mixed model. The entrant is pushed out only when the the incumbent competes with an ad-sponsored product (ad-sponsored model or dual model).

5.2 Duopoly strategy

We now characterize the incumbent's optimal strategy when there is an ad-sponsored entrant through a series of simple lemmas.

Lemma 2 *When α is small, either the subscription-based or the mixed model is optimal; when α is large, the ad-sponsored model is optimal.*

When α is small, the incumbent prefers to co-exist with the entrant, as the additional ad profits from its ad-sponsored product after killing the entrant would be small and there

[17] Our assumption of no entry costs means that even if the potential entrant obtains no demand, it has an effect on market: the number of ads in the incumbent's ad-sponsored product is lower than what it would be if the potential entrant were not there. If there was a positive cost of entry, the incumbent would typically choose to display a larger number of ads. This assumption favors entry. On the other hand, we also assumed that the incumbent can best respond instantly (through tactics and business model reconfigurations) to the choices of the potential entrant. Our assumptions of no entry costs and instantaneous tactical responses provide a benchmark against which more realistic settings (such as those with positive entry costs and/or delays in responses) may be compared. We thank an anonymous referee for pointing this out.

[18] As mentioned in footnote 4, this is the reason why we do not consider this business model in this paper.

is also cannibalization in the case of the dual model; but when α is large, the incumbent has incentives to push the entrant out, as it wants the market share from the entrant to earn ad profits even at the cost of cannibalization.

Lemma 3 *Compared to the monopoly case, neither the mixed model nor the dual model dominates the subscription-based model for all α when $f = 0$.*

As Lemma 1 indicates, when $q_h \leq 2q_l$, the incumbent's profits decrease with α when competing through the mixed model. In this case, the incumbent profits are maximized when the advertising rate approaches zero. But when $\alpha = 0$, the incumbent is effectively using the subscription-based model. Hence, the subscription-based model provides greater profits than the mixed model.

In the case of the dual model, the incumbent uses the free ad-sponsored product to "kill" the entrant. As a result, the incumbent cannot introduce too many ads to its ad-sponsored product. Hence, there is cannibalization between the incumbent's two products, which lowers profits for the incumbent. Cannibalization becomes more intense when q_l approaches q_h. Thus, competing through a subscription-based model may be better when the effect of cannibalization dominates the additional ad profits from the ad-sponsored product of the incumbent.

Lemma 3 implies that the subscription-based model may be the superior business model when $\alpha > 0$ and $f = 0$. This was *never* the case in the monopoly setting.

Lemma 4 *Compared to the monopoly case, the dual model no longer dominates the mixed model.*

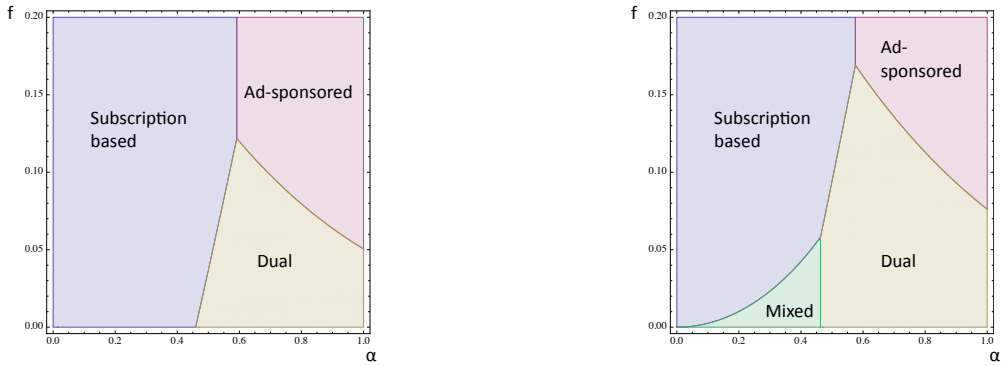
The intuition is the same as in Lemma 3. Compared to the monopoly case, we now have cannibalization between the two products offered by the incumbent in the dual model. When the cannibalization is intense (this happens when q_h and q_l are close), the mixed model may be better. This was *never* the case in the monopoly setting.

Lemma 5 *When α is sufficiently large, the ad-sponsored model is the optimal business model. When f is sufficiently large, only one of the two pure business models can be optimal.*

When α is large, the incumbent wants to give away the product for free to maximize its market share. The situation is similar to the monopoly but, because the incumbent needs to make sure that the entrant is pushed out, there is a tighter constraint on the amount

of ads that the incumbent can include with the product. The profits are lower than in the monopoly case. The second part of the lemma is straightforward as f is incurred for hybrid models only.

Proposition 3 *When $q_h \leq 2q_l$, three possible business models might be optimal (the mixed model is dominated); when $q_h > 2q_l$, all four business models may be optimal.*



(a) $q_h \leq 2q_l$. (b) $q_h > 2q_l$.

Figure 3: Optimal business models in duopoly.

Figure 3 illustrates our results.[19] Comparing Figures 3a and 3b, we see that depending on q_h and q_l, the set of possible optimal business models changes. When $q_h \leq 2q_l$, the equilibrium tactics in the mixed model are such that $q_l - \beta A_l^2 > 0$ (interior solution). In this case, as argued above, the mixed model is dominated by the subscription-based model and, thus, we are left with three possible optimal business models.

6 Discussion

6.1 Strategy *versus* business model

Although in Section 4.2 we have defined strategy as *the choice of business model for the different situations that might arise*, in the simple situations of Figures 2 and 3 an outside observer can easily determine the firm's strategy by just looking at the business model employed. For example, if the incumbent operates the dual model, the observer will trivially know that the incumbent's strategy is to choose the dual model. The question arises: If a

[19] All three figures have $q_h = 3$ and $\beta = 1$. Only q_l varies. For Figure 3a, $q_l = 1.6$. For Figure 3b, $q_l = 1.3$.

strategy is simply the choice of a business model, what is the value of distinguishing between strategy and business model? It would seem that there is no value: if the observer sees a particular business model being employed, the strategy is fully revealed (and *vice versa*).

The reason why it is valuable to separate the two notions is that, in many occasions, there is *not* a one-to-one mapping between business model and strategy. To see this, consider a slightly richer setting than Sections 4 and 5. Specifically, suppose that there is a monopolist incumbent that has been operating the dual business model for some time. Suppose that it becomes aware of an ad-sponsored firm that is considering entering the industry. What is a strategy for the incumbent in this case? Now there is a contingency upon which to base the choice of business model; whether the ad-sponsored rival enters or not. One possible strategy is: "if the potential entrant does not enter, then continue operating with the dual business model, but if the potential entrant does enter, then adopt the subscription-based model."[20] If the potential entrant stays out, the strategy is not fully revealed because the contingency upon which the strategy calls for a change in business model has not happened. A notable difference between a firm's business models and strategy is that while the business model is observable, the strategy is typically not (fully) observed: all that an observer can see are the equilibrium outcomes of strategies but *not* the strategies themselves.

In this example, when evaluating whether to enter or not, if the potential entrant thought that the incumbent's strategy was equal to its business model, it would (wrongly) stay out of the market because, as Proposition 2 reveals, if the incumbent competes with the dual model, the ad-sponsored rival is killed. However, if the entrant understands that the incumbent's strategy calls for a change to the subscription-based business model if it enters, then it will enter (as, in this case, profits are positive after entry). The example illustrates that equating strategy to business model may lead to wrong decisions.

6.2 The value of a (contigent) strategy

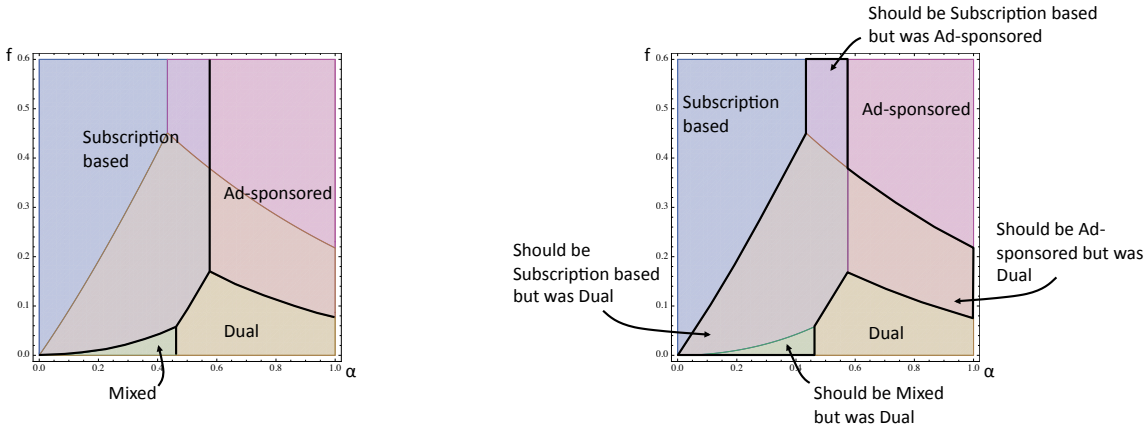
Having established that it is valuable to distinguish between strategy and business model when strategies prescribe different choices for contingencies that may arise, we examine the following question: Will firms *want to develop* contingent strategies? If the answer is negative, then distinguishing between strategy and business model would be of little relevance.

To answer the question, consider Figure 4 which superimposes Figure 2 on top of 3b.[21] Figure 4a shows that the optimal response of an incumbent to an ad-sponsored entrant often

[20] Figure 4 (below) shows that there are parameter values for which such a strategy is optimal.

[21] Of course, the same conclusions can be drawn by superimposing Figures 2 and 3a.

involves reconfiguration of its business model. The figure demonstrates that there is value in having contingent strategies.



(a) Monopoly and duopoly regions.

(b) Reacting to the entrant through tactics only.

Figure 4: Competing through business models.

To see how substantial is the value of business model reconfigurations, we compute the cost of *not* having a contingent strategy. Suppose that the incumbent reacts by modifying its tactics but not by changing its business model. Figure 4b shows the region (α, f) where the incumbent should reconfigure its business model if the ad-sponsored rival enters.[22] Let $\pi_{\max}$ be the incumbent's profits when it makes use of strategy and tactics to fight the ad-sponsored rival. Let $\pi_{\text{constrained}}$ be the incumbent's profits when it does not consider changing its business model but reacts by optimally changing its tactical choices. In this case, the profit loss, defined as $\frac{\pi_{\max}-\pi_{\text{constrained}}}{\pi_{\max}}$, ranges from 0% to about 60%. We conclude that there may be substantial value in having a (contingent) strategy. The ultimate implication is that it is relevant to distinguish between strategy and business model.

6.3 Increased strategic focus

Having established that there is value in having (contingent) strategies, we now study the final question: What should such strategies look like? Specifically, compared to the monopoly situation, should we see the incumbent become "more pure" or "more hybrid" in response to the contingency that the ad-sponsored rival enters?

Figure 4 reveals that the region of parameters such that it is optimal to compete through a hybrid business model *shrinks*: a pure business model becomes more desirable when there

[22] In this particular example, $\beta = 1$, $q_h = 3$, and $q_l = 1.3$.

is an ad-sponsored rival. This effect becomes stronger as q_l approaches q_h. The reason is that, compared to the monopoly case, in the duopoly the use of a hybrid model implies either cannibalization (in the case of the dual model) or erosion of vertical differentiation (in the case of the mixed model). These two forces reduce the incumbent's incentives to using hybrids.

We conclude that *increased focus* (by competing through a pure business model that precludes the firm from being "all things to all people") is more likely to be optimal when facing an ad-sponsored rival compared to the monopoly situation. Remark 1 follows directly:

Remark 1 *If it is not optimal for the monopolist to compete through a hybrid business model, it is even less optimal to do so in the presence of an ad-sponsored rival.*

That firms should not try to be "all things to all people" was identified first by Porter (1996). Porter's argument is that when a firm attempts to make everyone happy, its activity system will likely lead to internal inconsistencies resulting in a loss of competitive advantage. Our reasoning is different. The suboptimality of hybrid models is due to the nature of the competitive interactions that ensue when there is an ad-sponsored rival.

7 Empirical implications

While most empirical studies examining incumbent responses to entry focus on tactical changes such as adjusting prices, quality levels or production capacity (e.g., Lieberman 1987; Yamawaki 2002; Frank and Salkever 2004; Simon 2005; Seamans 2009), our theoretical analysis generates several predications related to firms' strategic decisions. Reduced-form regressions are more amenable than structural estimation to testing these predications for a couple of reasons. First, our model is highly stylized. To ensure tractability, we have made several simplifying assumptions. We have assumed, for example, that consumers' marginal willingness to pay for product quality is uniformly distributed and the nuisance cost of the ads is a quadratic function of the number of ads. These functional and distributional assumptions may not be immediately usable for structural estimation. Second, structural estimation often requires hard-to-gather, individual-level data to estimate consumers' utility functions and their taste distribution. Our model predictions, however, can be tested with market-level data without estimating these utility functions.

We can formulate the following hypotheses based on our findings:

Hypothesis 1. *An incumbent's optimal business model when competing with an ad-sponsored entrant depends on the cost difference between employing a pure business model and employing a hybrid business model, f, the prevailing advertising rate, α, and the quality ratio between incumbent product and entrant product, q_h/q_l. In particular, the mixed model can only be optimal when $q_h > 2q_l$.*

This hypothesis derives from Proposition 3. To test it, data should be collected on the business models used by incumbents to fight ad-sponsored entrants in as many markets as possible, and the values of f, α, q_h and q_l in each market. The researcher could then examine whether the mixed model is indeed rarely employed when the quality ratio between the incumbent product and the entrant product is less than 2. A multinomial discrete choice model that regresses the probability of choosing a particular model on f and α across different markets could be used. If a sufficient number of observations are available, the analysis should be conducted separately for markets where $q_h < 2q_l$ and $q_h > 2q_l$, as the number of optimal business models differs in these two cases. For example, if the region where the ad-sponsored business model is used as the benchmark group in the regression analysis, we would expect that the probability that an incumbent chooses a subscription-based model increases as α decreases in both cases, as Figure 3 illustrates.

Comparing the monopoly case to the duopoly case, we find that incumbents are more likely to choose pure, rather than hybrid, business models in the duopoly case. This likelihood increases as the entrant quality, q_l, approaches the incumbent quality, q_h. Therefore, the following hypothesis can be tested:

Hypothesis 2. *The likelihood of choosing a pure, rather than a hybrid, business model for an incumbent increases after an ad-sponsored entrant emerges, and is increasing with the quality difference of incumbent quality and entrant quality.*

One could thus examine business models of incumbents before and after the entry of ad-sponsored entrants and test whether the probability of choosing pure business models for the incumbents increases after the entry relative to the probability prior to the entrant and whether this probability increases with the quality difference of the two products.

In addition, our study finds that an ad-sponsored entrant is less likely to survive in markets with high advertising rates than in ones with low advertising rates due to its strategic interaction the incumbent. We could thus formulate the following counterintuitive hypothesis:

Hypothesis 3. *An entrant is less likely to choose an ad-sponsored model when the prevailing advertising rate is high in a market.*

One could thus collect a dataset with advertising rates for a particular product (e.g., newspaper) in different geographic regions, or advertising rates across multiple products, and the business models of the entrants into these markets. One could then test whether the entrants' probability of choosing ad-sponsored models is lower in markets where the prevailing advertising rates are higher. In addition, one could conduct a survival analysis for the ad-sponsored entrants and test whether there is an inverse relationship between their chance of surviving and the prevailing advertising rates of these markets.

Finally, our analysis shows that the emergence of an ad-sponsored entrant does not necessarily increase the level of competition in a market, as the entrant could strategically design its product to avoid competitive interactions with the incumbent by targeting at non-adopters of the incumbent's product. This happens only when the subscription-based model is the optimal choice for incumbents before and after the entry of entrants. When $q_h > 2q_l$, incumbents do not change their prices. When $q_h < 2q_l$, however, the incumbents' prices decrease with the entrant quality. We thus hypothesize:

Hypothesis 4. *For incumbents that choose to stay with the subscription-based business models before and after the entry of ad-sponsored entrants, their optimal prices drop with entrant quality if the ratio of incumbent quality to entrant quality is smaller than 2; the optimal prices stay unchanged with entrant quality if the quality ratio is greater than 2.*

One could thus examine the changes in incumbents' prices before and after the entry and their relationship with the entrant quality for cases where $q_h > 2q_l$ and $q_h < 2q_l$, respectively.

Overall, these empirical analyses will help shed lights on the importance of considering both business model choices and tactical decisions for both incumbents and entrants when they interact.

8 Conclusion

Competing through business model reconfiguration is more relevant everyday given the increasing number of opportunities for business-model innovations enabled by technological progress, changes in customer preferences, and deregulation. IBM's 2006 and 2008 *Global*

CEO Study,[23] for example, show that top management in a broad range of industries are actively seeking guidance on how to innovate in their business models to improve their ability to both create and capture value.

We hope that our analysis of strategies to fight ad-sponsored rivals is helpful to researchers and practitioners willing to consider competition beyond tactics in all sorts of competitive settings. From a conceptual point of view, the two-period game that we have presented with firms choosing business models that set the boundaries of the tactical game that follows, is applicable to other competitive situations where firms choose strategies to fight low-cost entrants (Ryanair, Telmore...), open source projects (Linux, Apache...), platform players (shopping malls, video game systems...), mass customizers (Dell, Timbuk2...), or the like.

The most obvious aspect of our approach to modeling competition through business model reconfigurations that demands further development is allowing not only the focal firm (the incumbent in our setting) but also all other industry participants (the entrant in our setting) to choose business models. The analysis of endogenous business models for all players is technically challenging as it requires working with best-response functions at the business model level, a construct that is difficult to handle. It is our hope to have provided a solid first step towards a more general framework for the study of competition through business models.

References

Anderson, Simon P., Stephen Coate. 2005. Market provision of broadcasting: A welfare analysis. *Review of Economic Studies* **72**(4) 947–972.

Armstrong, Mark. 2006. Competition in two-sided markets. *Rand Journal of Economics* **37**(3) 668–691.

Baden-Fuller, Charles, Ian MacMillan, Benoît Demil, Xavier Lecocq. 2008. Special issue call for papers: Business models. Long Range Planning.

Beebe, Jack H. 1977. Institutional structure and program choices in television markets. *Quarterly Journal of Economics* **91**(1) 15–37.

Bourreau, Marc. 2003. Mimicking vs. counter-programming strategies for television programs. *Information Economics and Policy* **15**(1) 35–54.

Caillaud, Bernard, Bruno Jullien. 2003. Chicken & egg: Competition among intermediation service providers. *RAND Journal of Economics* **34**(2) 309–328.

[23]IBM Global Business Services, "The Global CEO Study 2006," IBM Corporation, 2006; IBM Global Business Services, "The Global CEO Study 2008," IBM Corporation, 2008.

Casadesus-Masanell, Ramon, Pankaj Ghemawat. 2006. Dynamic mixed duopoly: A model motivated by Linux vs. Windows. *Management Science* **52**(7) 1072–1084.

Casadesus-Masanell, Ramon, Andres Hervas-Drane. 2009. Peer-to-peer file sharing and the market for digital information goods. Forthcoming, *Journal of Economics & Management Strategy.*

Casadesus-Masanell, Ramon, Joan-Enric Ricart. 2010. From strategy to business models and onto tactics. *Long Range Planning* (Special Issue on Business Models, forthcoming).

Casadesus-Masanell, Ramon, Francisco Ruiz-Aliseda. 2009. Platform competition, compatibility, and social efficiency. Net Institute Working Paper.

Casadesus-Masanell, Ramon, David Yoffie. 2007. Wintel: Cooperation and conflict. *Management Science* **53**(4) 584–598.

Choi, Jay Pil. 2006. Broadcast competition and advertising with free entry: Subscription vs. free-to-air. *Information Economics and Policy* **18**(2) 181–196.

Crampes, Claude, Carole Haritchabalet, Bruno Jullien. 2009. Advertising, competition and entry in media industries. *Journal of Industrial Economics* **57**(1) 7–31.

Deneckere, Raymond J., R. Preston McAfee. 1996. Damaged goods. *Journal of Economics & Management Strategy* **5**(2) 149–174.

Depken, Craig A. II, Dennis P. Wilson. 2004. Is advertising a good or a bad? Evidence from U.S. magazine subscriptions. *Journal of Business* **77**(2) 61–80.

Doganoglu, Toker, Julian Wright. 2006. Multihoming and compatibility. *International Journal of Industrial Organization* **24**(1) 45–67.

Doyle, Chris. 1998. Programming in a competitive broadcasting market: entry, welfare and regulation. *Information Economics and Policy* **10**(1) 23–39.

Economides, Nicholas, Evangelos Katsamakas. 2006. Two-sided competition of proprietary vs. open source technology platforms and the implications for the software industry. *Management Science* **52**(7) 1057–1071.

Frank, Richard G., David S. Salkever. 2004. Generic entry and the pricing of pharmaceuticals. *Journal of Economics & Management Strategy* **6**(1) 75–90.

Gabszewicz, Jean J., Dider Laussel, Nathalie Sonnac. 2004. Programming and advertising competition in the broadcasting industry. *Journal of Economics & Management Strategy* **13**(4) 657–669.

Gabszewicz, Jean J., Didier Laussel, Nathalie Sonnac. 2005. Does advertising lower the price of newspapers to consumers? A theoretical appraisal. *Economics Letters* **87**(1) 127–134.

Gabszewicz, Jean J., Didier Laussel, Nathalie Sonnac. 2006. Competition in the media and advertising markets. *Manchester School* **74**(1) 1–22.

Gabszewicz, Jean J., Xavier Y. Wauthy. 2004. Two-sided markets and price competition with multi-homing. *Mimeo, CORE, Louvain-la-Neuve University* .

Gal-Or, Esther, Anthony J. Dukes. 2003. Minimum differentiation in commercial media markets. *Journal of Economics & Management Strategy* **12**(3) 291–325.

Ghemawat, Pankaj. 1991. *Commitment: The Dynamic of Strategy*. Free Press.

Hagiu, Andrei. 2009. Two-sided platforms: Pricing and social efficiency. *Journal of Economics & Management Strategy,* **18**(4).

Khanna, Tarun, Felix Oberholzer-Gee, Anders Sjoman, Ane D. Jensen, Vincent Dessain. 2007. Metro International S.A. *Harvard Business School Case* **708-429**.

Lee, Deishin, Haim Mendelson. 2008. Divide and conquer: Competing with free technology under network effects. *Production and Operations Management* **17**(1) 12–28.

Lieberman, Marvin B. 1987. Excess capacity as a barrier to entry: An empirical appraisal. *Journal of Industrial Economics* **35**(4) 607–627.

Markides, Constantinos C. 2008. *Game-changing Strategies: How to Create New Market Space in Established Industries by Breaking the Rules*. Jossey-Bass.

Mussa, Michael, Sherwin Rosen. 1978. Monopoly and product quality. *Journal of Economic Theory* **18**(2) 301–317.

Peitz, Martin, Tommaso M. Valletti. 2008. Content and advertising in the media: Pay-tv versus free-to-air. *International Journal of Industrial Organization* **26**(4) 949–965.

Porter, Michael E. 1996. What is strategy? *Harvard Business Review* **November-December** 61–78.

Prasad, Ashutosh, Vijay Mahajan, Bart Bronnenberg. 2003. Advertising versus pay-per-view in electronic media. *International Journal of Research in Marketing* **20**(1) 13–30.

Rochet, Jean-Charles, Jean Tirole. 2003. Platform competition in two-sided markets. *Journal of European Economic Association* **1**(4) 990–1029.

Seamans, Robert. 2009. Fighting city hall: Entry deterrence and new technology deployment in local cable TV markets. Working Paper, University of California, Berkeley.

Shaked, Avner, John Sutton. 1982. Relaxing price competition through product differentiation. *Review of Economic Studies* **49**(1) 3–13.

Simon, Daniel. 2005. Incumbent pricing responses to entry. *Strategic Management Journal* **26**(13) 1229–1248.

Spence, Michael, Bruce Owen. 1977. Television programming, monopolistic competition, and welfare. *Quarterly Journal of Economics* **91**(1) 103–126.

Spulber, Daniel F. 1996. Market making by price setting firms. *Review of Economic Studies* **63**(2) 559–580.

Spulber, Daniel F. 2006. Firms and networks in two-sided markets. *Terrence Hendershott, Ed., Handbooks in Information Systems* **1**(1) 137–200.

Steiner, Peter O. 1952. Program patterns and preferences, and the workability of competition in radio broadcasting. *Quarterly Journal of Economics* **66**(2) 194–223.

Wilbur, Kenneth C. 2008. A two-sided, empirical model of television advertising and viewing markets. *Marketing Science* **27**(3) 356–378.

Yamawaki, Hideki. 2002. Price reactions to new competition: A study of US luxury car market, 1986-1997. *International Journal of Industrial Organization* **20**(1) 19–39.

Zhu, Feng. 2008. Business models and compatibility incentives. NET Institute Working Paper No. 08-20.

Zhu, Feng, Marco Iansiti. 2009. Entry into platform-based markets. Working paper, University of Southern California.

Zott, Christoph, Raffi Amit. 2010. Designing your future business model: An activity system perspective. *Long Range Planning* (Special Issue on Business Models, forthcoming).

Appendix

Proof of Proposition 1. The result follows immediately by simple resolution of the maximization programs under each business model. For details, see the working paper version (`http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1476530`). ■

Proof of Proposition 2.

Subscription-based model. We have $\theta^* = \frac{p_h}{q_h - q_l + \beta A_l^2}$. The FOC condition of the profit function, $\pi_h^S = (1-\theta^*)p_h$, gives the optimal price $p_h = \frac{1}{2}(q_h - q_l + \beta A_l^2)$.

The FOC condition of the profit function, $\pi_l^S = \alpha\theta^* A_l$, gives the optimal amount of ads of product l, $A_l = \sqrt{\frac{q_h - q_l}{\beta}}$. The constraint that $q_l - \beta A_l^2 \geq 0$ gives $A_l \leq \sqrt{\frac{q_l}{\beta}}$.

Therefore, when $q_h < 2q_l$, we have an interior solution. In this case, $A_l = \sqrt{\frac{q_h - q_l}{\beta}}$. Substituting it to the expression of equilibrium p_h, we have $p_h = q_h - q_l$. Hence, $\pi_h^S = \frac{q_h - q_l}{2}$ and $\pi_l^S = \frac{\alpha}{2}\sqrt{\frac{q_h - q_l}{\beta}}$. When $q_h \geq 2q_l$, we have a corner solution. In this case, $A_l = \sqrt{\frac{q_l}{\beta}}$. Thus, $p_h = \frac{q_h}{2}$, $\pi_h^S = \frac{q_h}{4}$ and $\pi_l^S = \frac{\alpha}{2}\sqrt{\frac{q_l}{\beta}}$.

Ad-sponsored model. If $q_h - \beta A_h^2 < q_l$, then the entrant will choose a small A_l such that $q_h - \beta A_h^2 < q_l - \beta A_l^2$ and get all the demand. The best response for the incumbent is to decrease A_h. Then the entrant will decrease A_l. This process ends when $q_h - \beta A_h^2 = q_l$.

Hence, the equilibrium amount of ads for the incumbent is $A_h = \sqrt{\frac{q_h - q_l}{\beta}}$. All consumers purchase product h. The profit of the incumbent is $\alpha\sqrt{\frac{q_h - q_l}{\beta}}$. The entrant obtains no profits.

Mixed model. We have $\theta^* = \frac{p_h}{q_h - q_l - \beta A_h^2 + \beta A_l^2}$. The incumbent profits are thus $\pi_h^M = (1 - \frac{p_h}{q_h - q_l - \beta A_h^2 + \beta A_l^2})(p_h + \alpha A_h) - f$. The FOC of π_h^M w.r.t. p_h gives $p_h = \frac{1}{2}(q_h - q_l - \alpha A_h - \beta A_h^2 + \beta A_l^2)$. Substituting p_h into the profit function, we have: $\pi_h^M = \frac{(q_h - q_l + \alpha A_h + \beta(A_l^2 - A_h^2))^2}{4(q_h - q_l + \beta(A_l^2 - A_h^2))} - f$. We can then take FOC w.r.t. A_h and obtain

$$A_l^2 + \frac{q_h - q_l}{\beta} = \frac{A_h^3}{A_h - \alpha/\beta}. \tag{1}$$

The entrant profits are $\pi_l^M = \frac{p_h}{q_h - q_l - \beta A_h^2 + \beta A_l^2}\alpha A_l$. Hence, its best response function is

$$A_l = \sqrt{\frac{q_h - q_l - \beta A_h^2}{\beta}}. \tag{2}$$

We also need $q_l - \beta A_l^2 \geq 0$, i.e., $A_l < \sqrt{\frac{q_l}{\beta}}$. Hence, when $q_h \leq 2q_l$, $\sqrt{\frac{q_h - q_l - \beta A_h^2}{\beta}} \leq \sqrt{\frac{q_l}{\beta}}$ and we always have an interior solution. In this case, we could solve equations (1) and (2) for A_h and A_l, and obtain the expressions for equilibrium profits π_h^M and π_l^M.

When $q_h > 2q_l$, we may have a corner solution: this happens when A_l computed from equation (2) is greater than $\sqrt{\frac{q_l}{\beta}}$. When we are at a corner, $A_l = \sqrt{\frac{q_l}{\beta}}$ and A_h is solved by equation (1).

Dual model. The incumbent maximizes π_h^D by setting p_h, A_h and A_h'. The FOC w.r.t. p_h gives: $p_h = \frac{1}{2}(A_h' - A_h)(\alpha + \beta(A_h + A_h'))$. Hence $\theta^* = \frac{1}{2}(1 + \frac{\alpha}{\beta(A_h + A_h')})$. We then substitute p_h into the profit function and obtain:

$$\pi_h^D = \frac{1}{4}\left(2\alpha(A_h + A_h') + (1 - \frac{2A_h}{A_h + A_h'})\frac{\alpha^2}{\beta} + \beta(A_h'^2 - A_h^2)\right) - f. \tag{3}$$

It is easy to see that π_h increases in A_h'. We conclude that the incumbent will set A_h' to the maximum. The upper bound of A_h' is imposed by q_l. Hence, $A_h' = \sqrt{\frac{q_h - q_l}{\beta}}$.

We then take the FOC of equation (3) w.r.t. A_h and solve for optimal A_h. We have: $A_h = -\frac{A_h'}{2} + \frac{\sqrt{A_h'}\sqrt{4\alpha + \beta A_h'}}{2\sqrt{\beta}} = \frac{-\sqrt{q_h - q_l} + (\frac{q_h - q_l}{\beta})^{\frac{1}{4}}\sqrt{4\alpha + \sqrt{\beta(q_h - q_l)}}}{2\sqrt{\beta}}$. Hence, $\theta^* = \frac{1}{2} + \frac{\alpha}{\sqrt{\beta}\left(\sqrt{q_h - q_l} + (\frac{q_h - q_l}{\beta})^{\frac{1}{4}}\sqrt{4\alpha + \sqrt{\beta(q_h - q_l)}}\right)}$.

For the solution to be interior, we need $\theta^* \in [0, 1]$. Hence, we need $\alpha \leq 2\sqrt{\beta(q_h - q_l)}$. Substituting the expressions of A_h and A_h' into equation (3), we obtain the profits for firm

h:

$$\begin{aligned}\pi_h^D &= (2\alpha^3 + (9\sqrt{\beta(q_h - q_l)} - 5\sqrt[4]{\beta(q_h - q_l)}\sqrt{4\alpha + \sqrt{\beta(q_h - q_l)}})\alpha^2 + 2\alpha\beta(q_h - q_l) + \\ &\quad (\beta(q_h - q_l))^{5/4}(\sqrt{4\alpha + \sqrt{\beta(q_h - q_l)}} + \sqrt[4]{\beta(q_h - q_l)}))/ \\ &\quad \left(4\beta(-2\alpha + \sqrt{\beta(q_h - q_l)} + \sqrt[4]{\beta(q_h - q_l)}\sqrt{4\alpha + \sqrt{\beta(q_h - q_l)}})\right) - f.\end{aligned}$$

When $\alpha > 2\sqrt{\beta(q_h - q_l)}$, only the ad-sponsored product is active and it has demand of 1. Hence, the business model effectively becomes an ad-sponsored model. In both cases, the entrant is pushed out of the market. ■

Proof of Lemma 1. When we have corner solutions, $A_l = \sqrt{\frac{q_l}{\beta}}$, the profit function of the incumbent can be simplified to: $\pi_h^M = \frac{(q_h + A_h(\alpha - \beta A_h))^2}{4\left(q_h - \beta A_h^2\right)} - f$. The FOC of π_h^M w.r.t. A_h gives: $\alpha = \frac{A_h q_h \beta - A_h^3 \beta^2}{q_h}$. Thus, $\frac{dA_h}{d\alpha} = 1/\frac{d\alpha}{dA_h} = \frac{q_h}{q_h\beta - 3A_h^2\beta^2}$. We then differentiate π_h^M w.r.t. α, taking into consideration that A_h, the equilibrium ad intensity, is a function of α. We have:

$$\frac{d\pi_h}{d\alpha} = \frac{\left(q_h + \alpha A_h - \beta A_h^2\right)\left(q_h\alpha\frac{dA_h}{d\alpha} + \beta A_h^3\left(-1 + \beta\frac{dA_h}{d\alpha}\right) + A_h\left(q_h - q_h\beta\frac{dA_h}{d\alpha}\right)\right)}{2\left(q_h - \beta A_h^2\right)^2}.$$

Substituting the expression for $\frac{dA_h}{d\alpha}$ into the above expression, we have:

$$\frac{d\pi_h}{d\alpha} = \frac{\left(q_h + \alpha A_h - \beta A_h^2\right)\left(q_h^2\alpha - 3q_h\beta^2 A_h^3 + 3\beta^3 A_h^5\right)}{2\beta\left(q_h - 3\beta A_h^2\right)\left(q_h - \beta A_h^2\right)^2}.$$

Using conditions such as $q_h > \beta A_h^2$ and $\alpha = \frac{A_h q_h \beta - A_h^3\beta^2}{q_h}$, we could show that $\frac{d\pi_h}{d\alpha} > 0$. Therefore, when we have the corner solution, the incumbent profits increase with the advertising rate.

We now proceed to examining the interior case following a similar approach. In the interior case, A_h and A_l are the solutions of a system of two equations:

$$\begin{cases}(q_h - q_l)/\beta + A_l^2 = \frac{A_h^3}{A_h - \alpha/\beta} \\ A_l = ((q_h - q_l - A_h^2\beta)/\beta)^{1/2}\end{cases}.$$

Substituting the expression of A_l from the second equation to the first equation and solving for α, we have:

$$\alpha = \frac{2\beta A_h(q_h - q_l - \beta A_h^2)}{2(q_h - q_l) - \beta A_h^2}. \tag{4}$$

Thus,

$$\frac{dA_h}{d\alpha} = 1/\frac{d\alpha}{dA_h} = \frac{\left(2(q_h - q_l) - \beta A_h^2\right)^2}{2\beta\left(2(q_h - q_l)^2 - 5(q_h - q_l)\beta A_h^2 + \beta^2 A_h^4\right)}. \tag{5}$$

We can also substitute the expression for A_l into the profit function of the incumbent and obtain: $\pi_h^M = \frac{(2(q_h-q_l)+A_h(\alpha-2A_h\beta))^2}{8\left(q_h-q_l-\beta A_h^2\right)} - f$. We note that A_h here is the equilibrium ad intensity and is a function of α.

We now differentiate π_h^M w.r.t. α and obtain:

$$\frac{d\pi_h^M}{d\alpha} = \frac{\left(2(q_h - q_l) + A_h(\alpha - 2\beta A_h)\right)\left((q_h - q_l)\alpha\frac{dA_h}{d\alpha} + \beta A_h^3\left(-1 + 2\beta\frac{dA_h}{d\alpha}\right) + (q_h - q_l)A_h\left(1 - 2\beta\frac{dA_h}{d\alpha}\right)\right)}{4\left((q_h - q_l) - \beta A_h^2\right)^2}.$$

We then substitute $\frac{dA_h}{d\alpha}$ into the above equation and obtain:

$$\begin{aligned}\frac{d\pi_h^M}{d\alpha} \quad = \quad & \frac{(q_h - q_l)(2(q_h - q_l) + A_h(\alpha - 2\beta A_h))}{8\beta(q_h - q_l - \beta A_h^2)^2(2(q_h - q_l)^2 - 5(q_h - q_l)\beta A_h^2 + \beta^2 A_h^4)} \times \\ & \left(4(q_h - q_l)^2\alpha + \beta A_h(-4(q_h - q_l)^2 + A_h(-4(q_h - q_l)\alpha + \beta A_h(2(q_h - q_l) + A_h(\alpha + 2\beta A_h))))\right).\end{aligned}$$

We check the sign for each component in the above expression. We find that except $(4(q_h - q_l)^2\alpha + \beta A_h(-4(q_h - q_l)^2 + A_h(-4(q_h - q_l)\alpha + \beta A_h(2(q_h - q_l) + A_h(\alpha + 2\beta A_h)))))$, the four other terms: $(q_h - q_l)$, $(2(q_h - q_l) + A_h(\alpha - 2\beta A_h))$, $8\beta(q_h - q_l - \beta A_h^2)^2$ and $(2(q_h - q_l)^2 - 5(q_h - q_l)\beta A_h^2 + \beta^2 A_h^4)$ are all positive. Hence, we conclude that $\frac{d\pi_h}{d\alpha}$ is negative.

We now show that when $q_h < 2q_l$, we always have interior solutions. We have interior solutions if $A_l = ((q_h - q_l - \beta A_h^2)/\beta)^{1/2} < (q_l/\beta)^{1/2}$. That is: $q_h - \beta A_h^2 < 2q_l$. We know that in equilibrium $A_h > 0$. Hence, this condition is always satisfied. Hence, we always have interior solutions when $q_h < 2q_l$.

We now show that when $q_h > 2q_l$ and α is small, we always have corner solutions. We have corner solutions when $q_h - \beta A_h^2 > 2q_l$. Consider the case where $\alpha = 0$. In this case, the business model is equivalent to the subscription-based model and we know when $q_h > 2q_l$, we have corner solutions. Now consider when $\alpha = \epsilon$, a very small positive number. From equations (4) and (5), we have when $\alpha \to 0$: $A_h \to 0$ and $\frac{dA_h}{d\alpha} = 1/\beta$. Hence, $A_h = \epsilon/\beta$. We can always find a small enough ϵ such that when $q_h > 2q_l$, $q_h - \beta A_h^2 = q_h - \beta(\epsilon/\beta)^2 = q_h - \epsilon^2/\beta > 2q_l$. Hence, we know when $\alpha < \alpha^* = \epsilon$, we are at the corner. ■

Proof of Lemma 2. It is easy to see that when α is small, the subscription-based model is better than ad-sponsored model. We now compare the profits from the subscription-based

model to the dual model. When $\alpha \to 0$, $\pi_h^D \to \frac{q_h - q_l}{4} - f$. We also know that

$$\frac{d\pi_h^D}{d\alpha} = \frac{3((q_h - q_l)\beta)^{1/4}\sqrt{4\alpha + \sqrt{(q_h - q_l)\beta}} - 2\alpha - \sqrt{(q_h - q_l)\beta}}{4\beta},$$

which is positive when $\alpha < 2\sqrt{\beta(q_h - q_l)}$. Hence, we know that π_h^D increases from $\frac{q_h - q_l}{4} - f$ as α increases. The profits from the subscription-based model, π_h^S, do not change with α and are either $\frac{q_h - q_l}{2}$ or $\frac{q_h}{4}$. In either case, $\pi_h^S > \frac{q_h - q_l}{4} - f$. Hence, when α is small, the subscription-based model provides more profits than the dual model. We also know that when $q_h \leq 2q_l$, the subscription-based model is better than the mixed model. Hence, in this case, when α is small, the subscription-based model is the best model among the four. When $q_h > q_l$ and α is small, the mixed model is better than the subscription-based model. Hence, the mixed model is the best model among the four. Therefore, when α is small, either the subscription-based or the mixed model is optimal.

The second part is straightforward. As α increases, in both the mixed model and the dual model, the optimal price of the high quality product decreases. At some point, the incumbent is willing to give the product away for free and make money exclusively from ads. It is also easy to see that with a big α, the profits from the ad-sponsored model are greater than the ones from subscription-based model. Hence, when α is sufficiently large, the optimal business model is the ad-sponsored model. ■

Proof of Lemma 3. The simplest way to show this is to provide an example in which the subscription-based model is better than the mixed model and the dual model. Consider the case in which $q_h = 3$, $q_l = 1.6$, $\alpha = 0.4$, $\beta = 1$ and $f = 0$. We have $\pi_h^S = 0.7$, $\pi_h^A = 0.473$, $\pi_h^M = 0.696$ and $\pi_h^D = 0.648$. Hence, the subscription-based model is the best among the four even in the case where $f = 0$. ■

Proof of Lemma 4. As the example in the proof of Lemma 3 shows, π_h^M could be greater than π_h^D. Hence, the dual model no longer dominates the mixed model. ■

Proof of Lemma 5. It is easy to see that when α is sufficiently large, $\pi_h^A = \alpha\sqrt{\frac{q_h - q_l}{\beta}}$ will be greater than π_h^S, which is $\frac{q_h - q_l}{2}$ or $\frac{q_h}{4}$ depending on the relative size of q_h and q_l. Similarly, in the mixed model, as α increases, A_h will increase and A_l will eventually decrease (it could be at the corner initially). Hence, p_h will decrease. When α is sufficiently large, p_h becomes zero and effectively we have an ad-sponsored model. In the dual model, we know when $\alpha > \sqrt{\beta(q_h - q_l)}$, the model becomes an ad-sponsored model. Hence, when α is sufficiently large, the optimal business model is the ad-sponsored model. As the additional cost f is

only introduced in the hybrid models, when f is sufficiently large, only the pure business models can be optimal. ■

Proof of Proposition 3. The proposition follows straightly from Lemma 1. Consider the mixed model. When $q_h \leq 2q_l$, we are always at the interior and π_h^M decreases with α. Hence, the incumbent will earn more profits if $\alpha = 0$. In other words, the profits from the subscription-based model will be higher. Thus, the mixed model is always dominated by the subscription-based model (even if $f = 0$). As a result, we may only have three optimal business models, as shown in Figure 3a.

When $q_h > 2q_l$, we know that when α is small, we are at the corner and π_h^M increases with α. Hence, in this case, when f is small, π_h^M will be greater than π_h^S, the profits from the subscription-based model. Therefore, there is always a region in which the mixed model is better than the subscription-based model and is thus not dominated. As illustrated in Figure 3b, indeed all four business models may be optimal. ■