Differentiation with User-Generated Content

Kaifu Zhang
Cheung Kong Graduate School of Business, 100738 Beijing, China, kfzhang@ckgsb.edu.cn

Miklos Sarvary
Columbia Business School, New York, New York 10027, miklos.sarvary@columbia.edu

This paper studies competition between firms whose "products" (content) are generated by their customers (users). Video sharing sites, social networks, online games, etc. all rely heavily on user-generated content and have been growing significantly in the last decade. We model a Hotelling style market in which consumers have heterogeneous tastes along a circular city. In a first step, we consider two ex ante identical firms whose offerings entirely depend on user-generated content. Consumers contribute content to the firm they join and benefit from the content provided by the others, their valuation being higher the closer the content contributor is to the content consumer (i.e., there are local network effects). In such a setting, we show that ex ante identical firms can acquire differentiated market positions that spontaneously emerge from user-generated content. Moreover, such differentiation may take interesting patterns, wherein a firm simultaneously attracts multiple distinct consumer segments that are isolated from each other. Greater segregation, measured by the number of disjoint segments in each platform, reduces consumer valuation for content, but interestingly, it intensifies firm competition. We show that this insight can help us refine the set of possible equilibria. In a second step, we consider firms that explicitly differentiate their offerings by generating some content on their own. We show that user-generated content may strengthen or defeat firms' intended positioning (i.e., firms attract consumers located opposite to their chosen positions) and consumer surplus may be higher in the latter case. Finally, we allow multihoming by consumers and show that the previous equilibrium patterns remain valid, but in most equilibria, a subset of consumers (located between rival firms' core clienteles) are multihomers. More multihoming consumers imply reduced differentiation and higher degree of platform competition. We relate these findings to anecdotal evidence and explore their strategic implications for competing firms relying on user-generated content.

Keywords: competitive strategy; game theory and bargaining theory; advertising and media
History: Received October 15, 2012; accepted November 19, 2013, by J. Miguel Villas-Boas, marketing. Published online in *Articles in Advance* July 18, 2014.

1. Introduction

User-generated content is an important characteristic of many fast-developing online or mobile applications. Video sharing sites (e.g., YouTube, Vine), social networks (e.g., Facebook, LinkedIn), and dating communities (e.g., eHarmony, Match.com) represent diverse and rapidly growing categories, which often command very high valuations for relatively young firms. It is the millions of pictures, videos, and comments uploaded by their customers that is behind the financial success of these platforms. Although user-generated content creates enormous opportunities, it also represents an interesting challenge for social media firms. Notably, compared to their traditional counterparts, firms that rely on user-generated content have less control over their product offerings. A firm's "product design" largely depends on the coordinated efforts by its content contributors. Examined from a theoretical angle, the notion of user-generated content leads to a scenario where a firm's horizontal position is no longer a choice variable of its own. This paper studies such a setup to understand how horizontal differentiation may emerge between competing firms when their content is user generated.

Anecdotal evidence suggests that firms relying on user-generated content may sometimes acquire largely unintended market positions. As an example, consider the early players in the social networking category. Myspace, Friendster, and Google's Orkut were notable competitors between 2002 and 2004. All three websites initially targeted the U.S. market. Over time, however, Friendster became popular in Southeast Asian countries, and Orkut became one of the most visited websites in three culturally distinct countries: Brazil, India, and Estonia. There is strong evidence that this divergence was not a consequence of the firms' deliberate strategic choices. Friendster, for example, did not realize its popularity in Southeast Asia until an engineer noticed that its website traffic was peaking in the middle of the night, San Francisco time.[1] For a few years, Friendster's management considered its unexpected popularity among Asian users "a problem" and attempted to focus on the United States, despite rapidly losing share in the American market (see Rivlin 2006).

Similarly, upon Facebook's entry in 2004, differentiation spontaneously emerged between Myspace

[1] See Chafkin (2007) for an account of the events.

and Facebook, the major contestants for U.S. market leadership. In an ethnographic study, Boyd (2012) documents a so-called "white flight" from MySpace to Facebook, and suggests that, in 2007, the two leading players in the U.S. social networking market acquired differentiated market positions with racial connotations. The above examples describe situations where user-generated content had a key role in determining the firms' market positions. This effect can be so strong—as in the case of social networks—that sites with similar designs can acquire differentiated positioning. We later call this phenomenon "spontaneous product differentiation."

When firms attempt to differentiate their products by design, user-generated content may interact with product features to jointly determine a site's market position. In the category of online dating, for instance, consumers have highly heterogeneous preferences for either long-term or short-term relationships.[2] Thus, the market perception of a website is influenced by its user base even when the website offers product features that explicitly appeal to a certain segment. For example, the websites eHarmony and Chemistry both target the serious, marriage-minded daters by offering personality analysis and matching algorithms. Although some consumers considered Chemistry's algorithm to be superior, they sometimes found that eHarmony offers better chances for long-term relationships because of its better pool of serious daters.[3]

The goal of this paper is to explore the competitive implications of user-generated content. In particular, our primary interest is in understanding how user-generated content drives horizontal differentiation. We ask the following questions: (1) What are the conditions under which horizontal differentiation can emerge from user-generated content? (2) What are the possible patterns of such differentiation? (3) What determines firm profits and consumer surplus? By answering these questions, we hope to shed light on the anecdotal evidence mentioned above and provide practical insights to firms competing in markets where user-generated content is dominant.

We model the market with a circular city, along which consumers are uniformly distributed and two sites compete for consumers by setting advertising levels.[4] Each consumer contributes content to the site she joins. We assume that the content generated by a

consumer is consistent with her taste (location). Each consumer derives utility from the content provided by all the other consumers in the same site. However, consistent with the Hotelling model, consumer utility declines linearly with the distance between the content provider and the content consumer according to an exogenous "transportation cost." As such, this formulation introduces "local" network effects into the product market. Users benefit from the presence of many other users (i.e., more content) but they prefer the content provided by others with similar preferences.

In a first step, we assume that firms do not choose their locations on the circle, i.e., their offerings entirely depend on user-generated content from their customers. In this setup, two qualitatively different types of equilibria emerge depending on the magnitude of the transportation cost. Consistent with previous research, when the transportation cost is low (or network effects are relatively global), the unique equilibrium is a winner-take-all outcome where all consumers join a single, dominant firm. However, when the transportation cost increases (or network effects are relatively local), we show that ex ante identical firms can acquire horizontally differentiated market positions that spontaneously emerge from user-generated content. Moreover, such spontaneous differentiation may take interesting patterns, wherein a firm simultaneously attracts multiple distinct consumer segments that are isolated from each other. In such an outcome, *disjoint* segments on the circle belong to the *same* firm's customer base. The degree of "segregation," measured by the maximal number of disjoint segments on the circle that can be supported in an equilibrium, increases with the transportation cost, or the localness of network effects. In general, there are multiple equilibria with different levels of segregation. In a more segregated equilibrium, consumers' valuation for content is lower. Interestingly, however, greater segregation also leads to smaller differentiation between platforms and intensifies competition, which may benefit consumers. Based on this insight, we suggest an approach to refine the number of equilibria. Specifically, if we consider the model as a coordination game among consumers, then the payoff-dominance criterion selects a greatly reduced set of equilibria (often a unique equilibrium). Finally, we show that firm competition is often a necessary condition for spontaneous differentiation. Said differently, when firms do not compete in advertising (advertising levels are fixed), a winner-take-all outcome is the unique outcome for a larger region of the parameter space.

In a second step, we consider firms that have limited influence over their positioning. For example, firms can generate some content on their own (in addition to user-generated content) or design their website features in order to target a certain segment. In these cases,

consumers value both user-generated and firm-generated content (or design features), which introduces two transportation costs into the model. Although, firms may choose their "intended" positions, the final outcome depends on both user-generated content and firm design. We show that user-generated content may strengthen firms' intended positioning or it may defeat firms' intentions (i.e., each firm attracts consumers whose preferences are diametrically different from its intended position). The market outcome in this case depends on the relative magnitudes of the two transportation costs.

Next, we consider a finer demand model, wherein consumers can join multiple sites (multihome) by allocating their time across the sites. We model multihoming as a mean to seek diversity in content and overcome satiation. We show that multihoming has important competitive implications. The previous equilibrium patterns remain valid but in most equilibria, a subset of consumers—those located between rival firms'core clienteles—multihome. The extent of multihoming depends on the intensity of the satiation effect and more multihoming consumers implies reduced differentiation between the sites.

The rest of the paper is organized as follows. In §2, we review the relevant literature in marketing and economics. Section 3 describes the base model. Section 4 presents the analyses and discusses the equilibrium results and comparative statics. We consider explicit firm positions in §5, and in §6, we introduce multihoming. Section 7 concludes, discusses limitations and practical implications, and relates the results to a broader set of (traditional) industries where products or brands are cocreated by the firm and its consumers. To facilitate reading, proofs and a variety of additional analyses have been relegated to the appendix, part of which is available from the authors upon request.

2. Literature Review

Our paper is related to several literature streams. On the conceptual front, the paper is related to the economics literature on horizontal product differentiation. Classic product differentiation models often assume a two-stage process where competing firms choose their product positioning in the first stage and then compete in prices (d'Aspremont et al. 1979, Salop 1979). In a user-generated content context, we study product differentiation in a model where "content positioning" also depends on which users a site attracts. This setup is similar to Kuksov (2007) and Kuksov and Shachar (2010), where a brand's image depends on the identities of the consumers who own it. Although these papers consider a monopoly setup, we study competitive outcomes in this spontaneous differentiation context and compare it with classic horizontal differentiation. In spirit, the paper is also related to

Dellarocas et al. (2013) in which the appeal of a site depends on the link structure it belongs to.

Our study is also related to the vast literature on network externalities, in both economics (Katz and Shapiro 1985, 1986; Farrell and Klemperer 2005) and marketing (Xie and Sirbu 1995, Ofek and Sarvary 2001, Sun et al. 2004, Chen and Xie 2007, Goldenberg et al. 2010, Tucker and Zhang 2010). Most of the analytical models in this literature assume global network effects—a consumer utility function that is linear in network size. Local network effects have been studied by a few recent papers in economics (Fjeldstad et al. 2009, Banerji and Dutta 2009). In particular, Banerji and Dutta (2009) discussed the possibility that ex ante identical firms can coexist with positive profits. However, their model assumes a restrictive market expectation function that is inconsistent with the notion of "market tipping"—so fundamental to standard models with network effects in the literature.[5] Thus, even when network effects are strictly global, a winner-take-all outcome does not emerge in the model of Banerji and Dutta (2009). We adopt a model that does not have these restrictions and yields the winner-take-all outcome when network effects are global. We show how horizontal differentiation can counterbalance the market tipping effect of network externalities. We provide a comprehensive characterization of the outcome space and a new set of results/insights (e.g., segregation patterns, multihoming, consumer surplus implications) that are not discussed in Banerji and Dutta (2009).

To model advertising competition between websites, we adopt the standard "advertising disutility" paradigm (Dukes and Gal-Or 2003, Dukes 2004, Gabszewicz et al. 2004, Anderson and Coate 2005, Anderson and Gans 2011). This framework assumes that consumers consider advertising as a nuisance. The tendency of ad avoidance has found much empirical support (see Wilbur 2008 for a recent example). To the extent that we assume an advertising market, our paper is generally related to the literature on competing two-sided platforms (Armstrong 2006, Rochet and Tirole 2006, Baye and Morgan 2001).

Broadly speaking, the paper belongs to the emerging literature on user-generated content and social media. Previous work has examined, for example, users' incentives to share content (Toubia and Stephen 2013, Berger and Milkman 2012, Huang et al. 2011), the interplay between content generation and content consumption (Ghose and Han 2011, Yang et al. 2012), and the impact of user-generated content on sales (Chevalier and Mayzlin 2006, Trusov et al. 2009).

---

[5] See Assumptions 1 and 2 in Banerji and Dutta (2009). The standard network effects model assumes that the firm with a larger network can dominate the market even if it charges a slightly higher price. This possibility is ruled out by Assumption 1 in Banerji and Dutta (2009).

In contrast, the emphasis of this paper is on competition, and in particular, product differentiation between firms.

3. Baseline Model

We present a simple model of horizontal differentiation with user-generated content. We consider two firms (or sites) competing for consumers located on a circular city.[6] Consumers value each firm based on the content generated by that firm's users. In the benchmark case, we consider the simple scenario where the sites do not produce any content of their own but simply provide a platform for consumers to share content/interact. Each firm collects revenues from advertising. Consumers choose between firms based on their content as well as their advertising levels. In §§5 and 6, we investigate in turn the cases where the firms also produce some content on their own and where the consumers can join multiple sites (multihoming).

The timing of the game is as follows. First, all parties (both consumers and firms) form expectations about which users each firm will attract. Then, firms set their advertising levels; consumers decide which site to join.[7] We first seek the fulfilled expectation equilibrium where the players' decisions coincide with market expectations (Katz and Shapiro 1985, Farrell and Klemperer 2005). Next, we explore the effect of an intuitive equilibrium refinement based on the payoff dominance criterion (Driskill 2006, Harsanyi and Selten 1988). Below, we elaborate on these features in greater detail.

Consumers. Consumers have heterogeneous tastes and are uniformly distributed on a circular city of perimeter 1. Denote an arbitrary consumer as 0. Each consumer $x \in [0, 1)$ can be identified by her distance from 0 if she travels clockwise on the circle. Consumers are simultaneously content contributors and content consumers. Consumer x values the content generated by consumer y at

$$\delta(x, y) = \alpha - \beta |x - y|_d, \tag{1}$$

where $|x - y|_d$ denotes the distance between the two users, $|x - y|_d = \min(|x - y|, 1 - |x - y|)$. The β parameter

is akin to the "transportation cost" parameter in a classic Hotelling model, wherein a consumer's valuation of a product decreases with the "distance" between the product and her ideal point. The linear transportation cost assumption is chosen to ensure tractability of the model. In §4, we highlight the results that depend on this specific assumption.

When the firms' content is completely user generated, a consumer's valuation of a *firm* depends on the users the firm attracts. Denote by $T_i^e(y) \in \{0, 1\}$ the market expectation about whether consumer y will join firm i ($i = 1, 2$). As such, consumer x's valuation of site i is

$$v_x(T_i^e) = \int_{\{y \mid T_i^e(y) = 1\}} \delta(x, y) \, dy. \tag{2}$$

In words, consumer x's valuation of site i equals the total utility she gets from all the user-generated content present in site i. This valuation function has a number of key features. First, note that $v_x(T_i^e)$ depends not only on the horizontal "type" of content in a site, but also on the amount of content the site hosts. This feature essentially introduces *network effects* into the model. In fact, when $\beta = 0$, the valuation function in Equation (2) reduces to the classic network effect function as in Katz and Shapiro (1985). When $\beta > 0$, the network effects become "local": a consumer may derive higher utility from a larger network, but a piece of content that is far from the consumer's location has smaller marginal impact. Second, the valuation function allows negative marginal utility if β is sufficiently large. This is an interesting aspect in many settings involving user-generated content. Often, negative marginal utility can come from a "clutter effect": As a site hosts more content, it becomes more difficult for a user to find her preferred content. If a piece of content is relatively distant from a user, its search cost may outweigh the content's consumption value. Negative marginal utility is also possible when the consumers find some others' content disturbing. Finally, in many user-generated content applications, consumers not only derive utility from consuming content, but also from contributing content. Since $\delta(x, y) = \delta(y, x)$, Equations (1) and (2) may potentially incorporate the utility x gains from *sharing* content with y, provided that consumers also prefer to share content with others who are similar. A detailed modeling of the content contribution process is an interesting issue, which we discuss in §7.

Finally, we assume that advertising incurs disutility on the consumers, which is proportional to the ad intensity on a site, denoted a_i (Dukes and Gal-Or 2003, Anderson and Gans 2011).[8] Collecting all these features,

---

[6] The circular city setup avoids the end-point problem and guarantees that the consumer base is completely symmetric. In Appendix B, we replicate the entire analysis on a linear city. The main insights are preserved but we also observe some interesting differences, the most notable being the existence of a type of asymmetric equilibrium. Similarly, in Appendix C, we explore a model with three firms.

[7] Note that the timing of the game is thus consistent with that of Katz and Shapiro (1985, 1986). It essentially assumes that the market expectation is not influenced by the firms' decisions. In Appendix E (available from the authors), we explore and discuss an alternative timing assumption, where consumers form expectations after firms' choice of advertising levels. The results are qualitatively similar. Allowing the firms to influence market expectation with their advertising levels gives them additional incentives to compete, leading to lower equilibrium profits. We thank one of the anonymous reviewers for suggesting this exercise.

[8] For most of the analysis, we adhere to the standard assumption of linear advertising disutility. In Appendix D, we also discuss the effect of convex and concave disutility on the relative measure of

the total utility consumer x derives from joining firm i is, therefore,

$$u_x(T_i^e, a_i) = c + v_x(T_i^e) - a_i, \tag{3}$$

where c captures any other nonnetwork benefits and ensures market coverage.[9] Consumer x will join firm i if $u_x(T_i^e, a_i) > u_x(T_{-i}^e, a_{-i})$. Note that if the market is covered, $T_i^e = 1 - T_{-i}^e$, so the market expectation can be characterized by $T_1^e(x)$. Given T_1^e, a_1, and a_2, we denote the decision of consumer x as $T_i^r(x; T_1^e, a_1, a_2)$. When consumer x joins firm i, $T_i^r(x; T_1^e, a_1, a_2) = 1$.

Firms. Firms set their advertising intensities, $a_i > 0$. Ad intensity can be thought of as the number of ads displayed on a webpage, for instance. Each firm's profit is proportional to the number of ads multiplied by the size of its user base:

$$\Pi_i = a_i \int_{x \in [0, 1)} T_i^r(x; T_1^e, a_1, a_2) \, dx. \tag{4}$$

This profit function is a standard formulation in the media competition literature (Dukes and Gal-Or 2003, Gabszewicz et al. 2004, Anderson and Gans 2011). It captures the trade-off between showing more ads and maintaining the customer base. Because consumers find ads a nuisance, showing too many ads will reduce demand and lead to lower advertising revenue. As such, compared with a monopoly, competition between firms leads to lower advertising levels. Note that the a_i variables are equivalent to a price that the consumers have to pay in order to use the firm's service. In fact, this model of advertising competition is equivalent to a model where firms charge subscription fees.

It should be noted that the above formulation, being a standard one in the literature, assumes that a firm's advertising revenue is proportional to the size of its user base.[10] It is a limitation of the model, that the *composition* of a firm's user base has no impact on its ad revenue. This is a simplifying assumption that facilitates our analysis. It is an interesting direction for

future research to consider firms' profit as a function of both the size and composition of its user base. Heavy users, or the users who have strong preference for the firms' content, may value the service more and therefore be more profitable to the firm. Similarly, the disutility a consumer derives from advertising may also depend on her engagement level. We revisit this issue in §6 and discuss it in greater detail in §7.

Equilibrium Concept. We generalize the solution concept of fulfilled expectation equilibrium (FEE) in the network externality literature. In its classic form, an FEE considers a mapping from the expected market share to the realized market share, where it is assumed that consumer utility depends only on firms' market shares. The equilibrium market share is a fixed point of this mapping $x^r = \Gamma(x^e)$. Let x^e denote the expected network size (i.e., market share) of firm 1. Firm 2's network size is therefore $1 - x^e$. The mapping Γ is derived as follows. Consumers make purchase decisions based on x^e and prices, and the demand function is $x^r(x^e, p_1, p_2)$. Firms set prices to maximize profits, leading to $p_1^*(x^e), p_2^*(x^e)$. The mapping Γ is defined as $\Gamma(x^e) = x^r(x^e, p_1^*(x^e), p_2^*(x^e))$. The FEE solution concept has a straightforward extension in our setup. We consider the mapping Γ that maps the expected consumer decision *function*, T_1^e to the realized consumer decision *function*, T_1^r when firms set advertising levels taking T_1^e as given. The FEE then satisfies $\forall x, T_1^*(x) = \Gamma(T_1^*)(x)$. Equivalently, the equilibrium consists of a consumer choice function, T_1^*, and advertising levels a_1^* and a_2^*, such that

$$\begin{cases} a_1^* = \arg\max_{a_1} a_1 \int_{x \in [0, 1)} T_1^r(x; T_1^*, a_1, a_2) \, dx \\ a_2^* = \arg\max_{a_2} a_2 \int_{x \in [0, 1)} (1 - T_1^r(x; T_1^*, a_1, a_2)) \, dx \\ \forall x, \quad T_1^*(x) = T_1^r(x, T_1^*, a_1^*, a_2^*). \end{cases} \tag{5}$$

The mapping Γ is thus defined as $\Gamma(T_1^e)(x) = T_1^r(x, T_1^e, a_1^*(T_1^e), a_2^*(T_1^e))$. Note that Γ is a mapping whose argument T_1^e is a function in itself. This extension is necessary to study horizontal differentiation, where each firm's content can no longer be summarized by a real number (i.e., market share/network size). Instead, we need the function $T_1: [0, 1) \to \{0, 1\}$ to completely describe each firm's content—which and how many consumers join the firm and what are the horizontal locations of the content they generate. The fulfilled expectation mapping, Γ takes the T_1^e function as an argument and maps it to the optimal decisions each consumer makes, T_1^r.

As is common in the literature, we focus on stable equilibria. When the fulfilled expectation mapping is a real valued function, stability requires $d\Gamma(x^*)/dx^* < 1$. Put differently, in equilibrium, given any perturbation in market expectation, the change in realized market

---

consumer versus firm welfare. Specifying ad disutility as $-a_i^\kappa$, $\kappa \neq 1$, we show that the main equilibrium patterns remain qualitatively intact. Consumer welfare is increasing in the degree of segregation as long as κ is not too high. Consumer welfare is decreasing in the degree of segregation when κ is sufficiently high—advertising disutility is sufficiently convex. This will be important later when we propose equilibrium selection based on payoff dominance.

[9] Market coverage is a relatively standard assumption in the literature. Here, c should be large enough to ensure market coverage for both high and low levels of segregation (see §4), and it can be shown that to guarantee market coverage in the N equilibrium, we need $c + \frac{1}{2}(\alpha - \beta/4 + \beta/(8N^2)) - \beta/(4N^2) > 0$. It is an interesting direction for future research to relax the market coverage assumption and study the expansion of primary demand. We thank one anonymous reviewer for pointing this out to us.

[10] This limitation is somewhat alleviated in §6, where we consider multihoming.

share is smaller than the perturbation (see Farrell and Klemperer 2005). We generalize this idea by defining a metric on the function space $T_1: [0, 1) \rightarrow \{0, 1\}$, which we explain in greater detail in Appendix A.

Equilibrium Refinement. In many models involving rational expectation, it is typical for multiple equilibria to coexist (Evans 1986, Cooper and John 1988). To yield sharper predictions, refinement criteria can be applied to select a subset of equilibria that are more "natural" than others (Driskill 2006, Harsanyi and Selten 1988). We introduce a simple refinement strategy by reformulating the game as a coordination game among the consumers. We add another stage to the beginning of the game, during which the consumers coordinate on the possible self-fulfilling market expectations, T_1^{e*}'s. Consumers receive zero payoff if they choose different T_1^{e*}'s, and they receive the equilibrium payoff under T_1^{e*} if they successfully coordinate. Thus, each fulfilled expectation equilibrium in the baseline model corresponds to a Nash equilibrium in the coordination game. These Nash equilibria can be partially ordered in terms of payoff dominance (Harsanyi and Selten 1988): an equilibrium payoff dominates another if every player is better off in the former compared with the latter. Pruning the payoff-dominated equilibria may drastically reduce the number of equilibria and in most cases may leave a unique equilibrium.

Important caveats apply to this refinement strategy. In the particular context of user-generated content (e.g., social networks), this specific refinement strategy has intuitive appeal because consumer coordination is indeed a possibility. However, this approach does not consider the firms' payoffs when applying the payoff-dominance criterion. If we were to make firms part of the coordination game, this would not select a unique class of equilibria as firms' profits and consumers' surplus are negatively correlated. Also, payoff dominance is not the only possible equilibrium selection criterion and it is *not* justified with equilibrium properties such as stability (Foster and Young 1990). Kandori et al. (1993), for example, showed that when the game is played in a large population, the evolutionary approach may select the risk-dominant equilibrium that can be payoff dominated. However, note that in a symmetric finite coordination game, as is our case, when the off-diagonal payoffs are assumed to be zero, payoff dominance and risk dominance are equivalent. Nevertheless, we acknowledge the specificity of our equilibrium selection strategy. In §4, we first explicitly present the multiple equilibria result *without* applying any refinement (Proposition 1), and then we apply the proposed refinement strategy and discuss equilibrium selection (Proposition 2). We refer interested readers to Harsanyi and Selten (1988) and Kandori et al. (1993) for more detailed discussions.

4. Analysis

In the baseline model, we consider two ex ante identical firms whose content is entirely user generated. As such, firms' horizontal positions are defined by the content-generating users they attract. Solving the benchmark model reveals two overarching insights. First, horizontal differentiation cannot always emerge from user-generated content, even when users have heterogeneous tastes. Second, when differentiation does take place, it can take many different *patterns* that nevertheless follow a general regularity. Interestingly, in many cases, firms obtain "ambiguous" market positions where each firm has a *segregated* consumer base.

Given the symmetry of our setup, in the baseline model, we will only focus on symmetric equilibria. These are summarized in Proposition 1.[11] We provide all the possible symmetric equilibria. Note that our analysis includes the cases where β is large such that consumers derive overall negative network externalities, i.e., $v_x(T_i^e) < 0$. When we restrict $\beta/\alpha < 4$, the total network externalities will be positive in all equilibria and the main insights do not change.

PROPOSITION 1 (SYMMETRIC FEE OUTCOMES). *Assume an arbitrary consumer to be at $x = 0$. For any odd number N, if $\beta/\alpha > (4N^2)/(N^2 + 3)$, a spontaneous differentiation equilibrium exists in which each firm attracts N disjoint segments of consumers. Specifically, $x \in [(2k)/(2N), (2k + 1)/(2N))$ join firm 1 and $x \in [(2k + 1)/(2N), (2k + 2)/(2N))$ join firm 2, $k = 0, \ldots, N - 1$. Firms' profits are $\Pi_1 = \Pi_2 = \beta/(8N^2)$. There do not exist such equilibria for even number of segments. If $\beta/\alpha < 4$, there also exists a winner-take-all equilibrium where all consumers join one of the firms. This winning firm's profit is $\Pi_w = \alpha - \beta/4$ and the losing firm's profit is 0.*

Consistent with extant literature, the winner-take-all equilibrium exists as long as β is not too large.[12] In fact, when β is sufficiently small, winner-take-all is the unique equilibrium and the firms *cannot* differentiate with user-generated content. Strong network externalities have a tipping effect that makes it impossible for the firms to coexist with positive market shares.

When β is sufficiently large, there exists a class of stable equilibria where ex ante identical firms can coexist with differentiated user-generated content. We call this class of outcomes "spontaneous differentiation." In the simplest case ($N = 1$), one firm attracts the consumers

---

[11] Technically, each equilibrium corresponds to an infinite number of "configurations" as $x = 0$ can be chosen arbitrarily on the circle. These equilibria however, are equivalent in every respect. We simply refer to them as one equilibrium. It is worth noting that with more than two firms or on a linear city, we did find asymmetric equilibria. These results are presented in Appendices B and C and we discuss them in §7.

[12] This result generalizes the findings from the (global) network externality literature in which $\beta = 0$.

Figure 1   Spontaneous Differentiation Equilibria (with $N = 1$ and $N = 3$)

located at $x \in [0, \frac{1}{2})$ and the other firm attracts $x \in [\frac{1}{2}, 1)$. This is reminiscent of a classic maximal differentiation scenario, where the firms position their products at two diametrically opposite points on the circle. Different from the familiar model of maximal differentiation, each firm's content is a user-generated *continuum* instead of a single point on the circle. Such spontaneous differentiation reduces competition between ex ante identical firms.

Interestingly, spontaneous differentiation can take many different patterns, some of which have no counterparts in the classic horizontal differentiation literature. When $N > 1$, the firms attract multiple disjoint consumer segments and, as a result, lack clearly defined market positions. Figure 1 compares the case $N = 1$ with the case $N = 3$. When $N = 3$, in a symmetric fashion, three disjoint consumer segments join site 1 and the other three segments join site 2. Each firm's content is now three nonadjacent *continua* and there is no clearly defined product position. In fact, the consumer valuation function $v_x(T_i^e)$ is now multipeaked in x. As we "move" clockwise from $x = 0$ to $x = 1$ on the circle, consumer preferences "flip" between firm 1 and firm 2 six times.

In our special case of linear transportation cost, an even number N implies no product differentiation. Consider a case where each firm attracts $N = 2$ nonoverlapping segments of consumers. Assume $T_1^e(x) = 1$ if $x \in (0, \frac{1}{4}] \cup (\frac{1}{2}, \frac{3}{4}]$, and $T_2^e(x) = 1$ if $x \in (\frac{1}{4}, \frac{1}{2}] \cup (\frac{3}{4}, 1]$. Without loss of generality, consider $x \in (0, \frac{1}{4}]$. From Equation (2), we have the following:

$$v_x(T_1^e)$$

$$= \int_0^1 (\alpha - \beta|x - y|)\, dy$$

$$= \left[\int_0^x (\alpha - \beta(x - y))\, dy + \int_{1/2+x}^{3/4} (\alpha - \beta(1 - y + x))\, dy \right]$$

$$+ \left[\int_{1/2}^{1/2+x} (\alpha - \beta(y - x))\, dy + \int_x^{1/4} (\alpha - \beta(y - x))\, dy \right]$$

$$= \frac{\alpha - (3/8 - x)\beta}{4} + \frac{\alpha - (x + 1/8)\beta}{4}$$

$$= \frac{1}{2}\left(\alpha - \frac{\beta}{4}\right). \tag{6}$$

Note that $v_x(T_1^e)$ is not a function of x and $v_x(T_1^e) = v_x(T_2^e)$ for any x. The two sites' content is therefore undifferentiated. Thus, the advertising subgame resembles Bertrand competition where ad levels are driven to zero, leading to a symmetric but *unstable* equilibrium. The equilibrium "tips" toward the winner-take-all outcome when there is a small perturbation in market expectation. This logic carries through when each firm attracts an even number of equal-sized segments but the segment sizes are allowed to differ between firms. In that case, the advertising subgame resembles Bertrand competition where one site is valued higher by a constant. Although a specific feature of the linear transportation cost model, this result highlights that with user-generated content, hosting *different* content bases does not automatically imply content *differentiation*.

To summarize, in the circular city model, spontaneous differentiation equilibria follow a regular pattern; under larger β, an equilibrium with a greater number of disjoint segments N can be sustained, as long as N is odd. Thus, the game has a great multiplicity of spontaneous differentiation equilibria especially when β is large. To sharpen the model's prediction, we next apply our proposed refinement strategy to reduce the number

of equilibria. Proposition 2 summarizes the results if we reformulate the game as a coordination game played by the consumers and prune the payoff-dominated equilibria, as described in §3.

PROPOSITION 2 (EQUILIBRIUM REFINEMENT). *Higher segregation decreases content valuation but lowers equilibrium advertising levels. In the baseline model, the payoff dominance criterion selects a unique winner-take-all equilibrium when $\beta/\alpha < 1$. When $1 \leq \beta/\alpha < 4$, only spontaneous differentiation equilibria exist. The number of segments joining each firm must fall into the range $N \in [N_{\text{low}}, N_{\text{high}}]$, where $N_{\text{high}} = 2\lceil \lfloor \sqrt{(3\beta)/(4\alpha - \beta)} \rfloor /2 \rceil - 1$ and $N_{\text{low}} = \lceil (\sqrt{3}/2)N_{\text{high}} \rceil$. When $\beta/\alpha < 225/57$, the equilibrium is unique. As before, N must be an odd integer.*

Proposition 2 states that higher segregation decreases consumer valuation of content but intensifies firm competition. More specifically, greater segregation of the content base has three effects on consumers' payoff: a *valuation effect*, a *competitive effect*, and a *preference heterogeneity effect*.[13] We explain these in turn.

First, as the firms' content bases become more segregated and diverse, a typical consumer's valuation of the firms' content base decreases because of a greater mismatch between her preference and the site's overall content. For example, the infra-marginal consumer at $x = 1/(4N)$ values site 1 at $v_{1/(4N)}(T_1^*) = \frac{1}{2}(\alpha - \beta/4 + \beta/(8N^2))$, which equals to $\frac{1}{2}(\alpha - \beta/8)$ for $N = 1$ and approximates $\frac{1}{2}(\alpha - \beta/4)$ as $N \to \infty$. As N increases, content value decreases as each consumer now consumes a more "dispersed" set of content. We term this effect the valuation effect.

Second, when the firms' content base becomes more segregated, as Figure 1 suggests, firms compete on multiple "fronts." Put differently, the number of marginal consumers (i.e., those who are indifferent between the sites) increases. As such, the firms have greater incentives to cut advertising when N is larger. We term this effect the competitive effect.

Finally, the preference heterogeneity effect refers to the impact of greater segregation on the heterogeneity of consumer preferences. When firms compete, heterogeneity in consumer preferences governs the degree of horizontal differentiation and therefore, the intensity of competition. Interestingly, as the sites' content bases become more *diverse* because of greater segregation, consumer valuations of each site's content become more *homogeneous*. Put differently, when segregation increases, a site attracts a more diverse set of users in terms of their locations (x's become diverse). However, these users tend to have similar valuation of the site's content as determined by $v_x(T_i)$. To see the intuition, consider the case when N approaches infinity. In this case, each firm's content base is dispersed over the entire circle. Consumers have homogeneous valuation for each site's content base regardless of their locations. We term this effect the preference heterogeneity effect. More homogeneous consumer preferences reduce differentiation and intensify competition, which leads to lower advertising levels.

In summary, greater segregation decreases content valuation, intensifies competition, and makes consumer preferences more homogeneous. Directionally, these effects are robust, but the overall welfare impact depends on their relative magnitudes. In the *specific case* with linear advertising disutility and linear transportation cost, the competitive effect and the preference heterogeneity effect dominate the valuation effect. As a result, consumers' payoff is higher in a more segregated outcome. As such, when we select equilibria according to payoff dominance in the coordination game, the equilibria with a higher degree of segregation are more likely to survive. As long as the localness of network effects is moderate (e.g., as long as $\beta/\alpha < 225/57$) the refinement results in a unique equilibrium, which corresponds to the FEE with the highest level of segregation.[14]

Spontaneous differentiation is clearly a consequence of user-generated content. But do firms also play a role in shaping the market outcomes? Asked differently, would spontaneous differentiation exist without the firms' active participation? To answer this question, we consider an alternative setup where the firms do not interact in a competitive way (e.g., advertising levels are fixed). Intuition may suggest that coexistence is more likely in the absence of competitive interaction, whereas our analysis shows the opposite. Proposition 3 states the results.

PROPOSITION 3 (IMPORTANCE OF STRATEGIC INTERACTION). *When $a_1 = a_2 = \bar{a}$, the winner-take-all equilibrium is the unique equilibrium for a larger range of the parameter space. In particular, a spontaneous differentiation equilibrium with N segments exists only if $\beta/\alpha > (4N^2)/(N^2 + 1)$.*

Interestingly, when strategic interaction is absent (advertising levels are fixed[15]), the spontaneous differentiation equilibria exist under a smaller range of parameters. The intuition is as follows. When firms do not change their advertising levels, the firm with a smaller market share cannot compensate its users with a lower level of advertising. As a result, consumers

---

[13] We thank one of the reviewers for pointing this out to us.

[14] Note that when we allow sufficiently convex advertising disutility, greater segregation may decrease overall consumer surplus. In this case, payoff dominance always selects $N = 1$ as the unique equilibrium. We provide more detailed analysis of the effect of convexity in Appendix D. We are grateful to the review team for drawing our attention to this issue.

[15] Quantity $\bar{a}$ can be any advertising level provided that it does not lead to negative consumer surplus.

have a greater tendency to migrate to the firm with a larger market share. This favors the winner-take-all equilibrium.

The above results come from a highly stylized model that does not capture all the complexities in the user-generated content world. We explore a few additional important features in the next sections. Nevertheless, the findings so far speak to some of the anecdotal observations mentioned in the introduction. For example, the early players in the social networking industry, Orkut, Friendster, and Myspace, all targeted the U.S. users initially but spontaneously diverged later. Friendster became the most popular social network in Southeast Asian countries. Orkut took off in Brazil and became "Portuguese speaking" (after which some English speaking users started switching to competing services). This process was unanticipated even by the website's management (see *Slashdot* 2004, Kugel 2006). Another striking qualitative result is that with user-generated content, competing firms can sometimes attract multiple consumer segments with quite different tastes. This is reminiscent of Orkut's simultaneous success in three culturally distinct countries: Brazil, India, and Estonia.

Even more interesting is the finding that, although consumers have lower valuation for more segregated content bases, they may prefer a more segregated platform in anticipation of lower advertising. This finding is an important insight for firms relying on user-generated content, and it resonates to the attention that firms attribute to the strategic question "how much advertising should be provided" on their platforms and "how to manage consumer expectations on advertising levels."

So far, we considered two ex ante identical firms. User-generated content was the only driver of differentiation. In reality, beyond consumers, firms can and do contribute to the positioning of their platforms. Then, user-generated content interacts with firm positioning. We explore this setup next.

5. Firm Positioning

Reliance on user-generated content does not always prevent a firm from positioning itself. Two measures are typically pursued when competing firms attempt to differentiate their services. First, a site can generate some content of its own in addition to user-generated content. Many video-sharing websites, for example, host professional clips that are either produced by the firm or acquired upon the firm's decision. Second, firms can introduce design features that appeal to certain consumer segments. For example, LinkedIn has features such as online curriculum vitae that appeals to professionals. An online dating website can introduce personality tests and compatibility matching algorithms as part of the service. These features appeal to the

users who seek long-term relationships. In both cases, product positioning is jointly determined by firm decision and user-generated content. To reflect this idea, we modify our original consumer utility function (3) as follows:

$$u_x(T_i^e, a_i) = c + \int_{\{y \mid T_i^e(y)=1\}} \delta(x, y)\, dy - t|x - x_i|_d^2 - a_i. \quad (7)$$

All prior definitions are maintained. x_i defines the *intended* location of firm i in the consumer preference space and t is a classic transportation cost. Firm i may indicate x_i either by generating content at that location or designing product features that have strongest appeal to x_i. The $t|x - x_i|_d^2$ component of the utility function captures a consumer's disutility resulting from the misfit between her taste and the firm's intended product positioning.[16] Clearly, in this setup, the relative magnitudes of α and β with respect to t determine the importance of user-generated content versus firm design. We start by discussing the equilibrium market outcomes in the subgame where the firms choose $x_1 = \frac{1}{4}$ and $x_2 = \frac{3}{4}$. Put differently, they pursue maximal differentiation via product design or by adding professional content.[17] Proposition 4 outlines the equilibrium market structures. Unlike Proposition 1, the results only speak to the existence of certain equilibria and do not cover all symmetric equilibria.

PROPOSITION 4. *Consider two firms with $x_1 = \frac{1}{4}$ and $x_2 = \frac{3}{4}$. When $\alpha > \beta + (3t)/4$, there is a* unique *winner-take-all equilibrium. The winning firm's profit is $\alpha - \beta/4 - t/4$. When $\alpha < \beta/4 + (3t)/4$, only* spontaneous differentiation *equilibria exist. There exists an equilibrium where consumers in $[0, 1/2)$ join firm 1 and consumers in $[1/2, 1)$ join firm 2. Firm profits are $(\beta + t)/8$. Furthermore, when $\alpha < \beta - (3t)/4$, there is another equilibrium where consumers in $[0, 1/2)$ join firm 2 and consumers in $[1/2, 1)$ join firm 1. Firm profits are $(\beta - t)/8$. When both equilibria coexist, payoff-dominance selects the latter. When $\beta/4 + (3t)/4 < \alpha < \beta + (3t)/4$, the winner-take-all equilibrium* coexists *with the spontaneous differentiation equilibrium (equilibria).*

Proposition 4 carries two main messages. First, it states that explicit differentiation makes the winner-take-all outcome less likely: When $t > 0$, the parameter range in which the winner-take-all equilibrium exists is smaller. This is consistent with the insight from the

---

[16] Note that the assumption of quadratic transportation cost is not critical for the current analysis when firms are maximally differentiated. It helps ensure a pure strategy equilibrium in the pricing subgame when firms are located closer to each other. See d'Aspremont et al. (1979) for details.

[17] It can be proved that with quadratic transportation cost, maximal differentiation is indeed the equilibrium location choice. However, this is not always true when we consider other specifications of transportation cost. See De Frutos et al. (1999) for a comprehensive discussion.

network effect literature that horizontal differentiation counterbalances the tipping effect. Second, and more importantly, Proposition 4 highlights the interesting interaction between user-generated content and firm design. Independently, both user-generated content and firms' product designs can lead to product differentiation. When both factors are present, however, they *may* in fact weaken each other. When $\alpha < \beta - (3t)/4$, there exists an equilibrium in which user-generated content overrides firms' product designs. Firms may attract the consumer segments they do not intend to target. The firm located at $x_1 = \frac{1}{4}$ may attract the consumers in $[\frac{1}{2}, 1]$. Although these consumers, individually, prefer the design features offered by site 2, they collectively join site 1. In the baseline model, this equilibrium is in fact selected by the payoff dominance criterion.[18] This self-fulfilling outcome reflects the path-dependent nature of competition when user-generated content is present: once a platform attracts a critical mass of a certain type of users, more users of the same type will favor the platform and its feature design becomes less relevant. For example, if a dating website attracts a critical mass of users who seek short-term relationships, it will inevitably be considered as a destination for short-term relationships regardless of how it advertises itself or what features it provides.

6. Multihoming Consumers

In many contexts where user-generated content is involved, maintaining memberships in multiple sites is not very costly for consumers, and a significant proportion of them are regularly present on multiple, competing platforms. A survey by Pew Research on North American adult social media users reveals that over 40% of the respondents *actively* maintain multiple profiles on competing websites (see Lenhart 2009). Since each user typically has a limited amount of time to allocate between the social networks that she is a member of, competition between firms boils down to the amount of consumer time a firm can win. Consumers will allocate more time to their preferred site and less time to the less preferred destination. A consumer will split her time more evenly when she has similar preferences for both sites.

In this section, we present a model of multihoming consumers with time allocation. For tractability reasons, we consider a discrete setup, where each consumer has two units of time at her disposal. She will allocate both units of time in one site when she strongly prefers that site; she will allocate one unit of time in each site when she has similar (but not necessarily identical)

valuations for both sites. This simple setup allows us to study the qualitative impact of consumer multihoming on firm differentiation. In particular, we find that since users generate content, multihoming creates greater overlap between the firms' content. This leads to smaller product differentiation that (i) makes coexistence more difficult and (ii) lowers firm profits.

We extend the baseline model as follows: $T_i(x)$ represents consumer x's time allocation decision and can now take three possible values, 0, 1, and 2. As each consumer divides a total of two units of time between two firms, we have $T_2(x) = 2 - T_1(x)$. When $T_1(x) = 1$, consumer x allocates one unit of time on each site (e.g., multihomes). When $T_1(x) = 0$ or $T_1(x) = 2$, the consumer concentrates both units of her time to the preferred site (site 2 and site 1, respectively). We assume that consumers derive decreasing marginal utility from a piece of content when they are exposed to that content for two units of time. Put differently, there is a satiation effect in content consumption. As such, consumers have incentives to allocate their time evenly across sites as long as their valuations of the two sites are not very different. Formally, each consumer chooses $T_1(x)$ to maximize the following utility function:

$$u_x(T_1(x); T_1^e, a_1, a_2) = c + \underbrace{\int_{y \in [0,1)} \delta(x, y, T_1(x), T_1^e(y)) \, dy}_{\text{utility from content consumption}}$$

$$- \underbrace{T_1(x) a_1 - (2 - T_1(x)) a_2,}_{\text{disutility from ads}} \quad (8)$$

where

$$\delta(x, y, T_1(x), T_1^e(y))$$
$$= \begin{cases} 0 & \text{if } \sum\limits_{i=1,2} T_i(x) I(T_i^e(y) > 0) = 0, \\ \alpha - \beta |x - y|_d & \text{if } \sum\limits_{i=1,2} T_i(x) I(T_i^e(y) > 0) = 1, \\ (1+\gamma)(\alpha - \beta |x - y|_d) & \text{if } \sum\limits_{i=1,2} T_i(x) I(T_i^e(y) > 0) = 2, \end{cases}$$

and I is the indicator function. The above utility function captures consumer x's *total* utility from consuming content in both firms. In (8), $T_i^e(y) \in \{0, 1, 2\}$ represents the market's expectation of consumer y's time allocation decision. We introduce an additional parameter $\gamma < 1$ to capture the strength of the satiation effect. Note that when $\gamma = 1$, the utility function reduces to the baseline case in §3. When $\gamma < 1$, consumer x experiences satiation when consuming a piece of content at location y for two units of time. This happens when $\sum_{i=1,2} T_i(x) I(T_i^e(y) > 0) = 2$. The FEE for such a game can be defined in the same fashion as in §3.[19]

We note that the discrete time allocation model represents a simplification for tractability reasons. This

---

[18] Again, this is because competition is intensified when user-generated content is misaligned with firm design leading to reduced advertising levels. In our setup, this competition effect dominates consumers' reduced valuation for the sites.

[19] This utility specification is similar to the idea in Zeithammer and Thomadsen (2013).

model does imply that a consumer will allocate more time to her preferred site, but the two units of time cannot be further divided. The model also implies that consumers that really prefer a site, and hence allocate more time to it, will contribute more to the site's revenue. As such, there is heterogeneity across consumers of a site in terms of how profitable they are to the site. Proposition 5 presents the equilibria of the discrete time allocation model.

PROPOSITION 5. *For any odd number N, when $\beta/\alpha > (16N^2\gamma - 12N^2\gamma^2 + 12N^2)/(4N^2\gamma - 3N^2\gamma^2 + 3N^2 + 3\gamma^2 + 6\gamma + 3)$, a spontaneous differentiation equilibrium exists in which*

$$
T_1^*(x) = \begin{cases}
2 & if\ x \in \left[\dfrac{2k}{2N}, \dfrac{2k}{2N} + x^*\right), \\[2ex]
1 & if\ x \in \left[\dfrac{2k}{2N} + x^*, \dfrac{2k+1}{2N}\right) \\[2ex]
 & \quad \cup \left[\dfrac{2k+1}{2N} + x^*, \dfrac{2k+2}{2N}\right), \\[2ex]
0 & if\ x \in \left[\dfrac{2k+1}{2N}, \dfrac{2k+1}{2N} + x^*\right),
\end{cases}
$$
$$(k = 0, \dots, N-1), \quad (9)$$

where $x^* = (\beta/2 + 2N^2\alpha - N^2\beta/2)/(N\beta) - (4N^2\alpha - N^2\beta)/((1+\gamma)N\beta)$. Firm profits are $(\beta + \gamma(\beta + 4N^2\alpha - N^2\beta) - 4N^2\alpha + N^2\beta)/(16N^2)$, which is increasing in γ and β. If $\beta/\alpha < 4$ and $\frac{1}{2} < \gamma$, a winner-take-all equilibrium also exists: $T_i^*(x) = 2$, $x \in [0, 1)$. The winning firm's profit is $(1 + \gamma)(\alpha - \beta/4)$.

Consistent with Proposition 1, we find that when β is sufficiently large, there exists a spontaneous differentiation equilibrium where each firm attracts N segments of consumers who spend two units of time in the preferred site. These consumers have strong preference for their chosen site and do not multihome despite the satiation effect. Compared to the baseline model, here a certain proportion of consumers multihome. These consumers are located between neighboring segments belonging to different firms. Multihoming consumers are those who have intermediate preferences in relation to the core users of different platforms. The size of the multihoming segments decreases as satiation from repeated content consumption becomes weaker (i.e., γ increases). Figure 2 illustrate the case when $N = 1$. As before, payoff dominance selects a reduced set of equilibria with higher degrees of segregation.

The conditions specified in Proposition 5 state that multihoming actually makes firm coexistence *less* likely. This counterintuitive result is due to an interesting link between consumer multihoming and the degree of horizontal product differentiation, when users generate content. When a user joins both competing sites, the

Figure 2   Spontaneous Differentiation Equilibrium with Consumer Multihoming

Single-homing consumers in site 1

Multihoming consumers

Single-homing consumers in site 2

$N = 1$
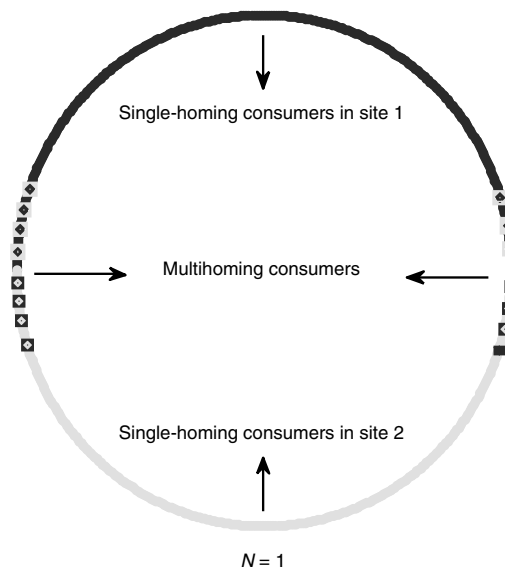
content she contributes appears on both websites. Thus, multihoming behavior results in greater overlap of content and, therefore, leads to less product differentiation. Reduced differentiation makes the winner-take-all outcome more likely. By the same token, greater multihoming tendency (lower γ) also *reduces* firm profits in any spontaneous differentiation equilibrium. An important implication for firms is that beyond the previous effects related to the degree of segregation (namely, that firms compete on multiple fronts), multihoming is another factor that may strongly limit firms' capacity to monetize their platforms.

7.   Discussion and Concluding Remarks

In this paper, we study the competition between firms whose offerings are largely based on the content generated by their consumers. On the consumer side, we assumed heterogeneous preferences and local network effects, and we have considered multihoming with consumer satiation. On the firms' side we assumed a quite generic revenue model with and without explicit firm positioning. In all the different setups, we found an intriguing pattern of equilibria in which firms spontaneously acquire differentiated market positions by attracting different groups of content contributors. We show that competition has an important role in the emergence of such spontaneous differentiation. More interestingly, as network effects become more local, firms may acquire ambiguous positions as they acquire disjoint consumer segments who seldom interact with one another. Greater segregation reduces consumer valuation for content but intensifies firm competition. In additional analysis we explored the impact of consumer multihoming, a model of three competitors,

a model with modified timing, and alternative utility functions for consumers (e.g., assuming a more convex advertising disutility or the possibility for consumers to filter negative content). We found that the model is quite robust to these modifications. As such, it helps understand the competitive patterns observed in growing social media industries, which heavily rely on user-generated content.

Implications for Firms. Our results have a number of important implications for firms. Overall, we find that with local network effects, user-generated content may differentiate competing platforms in ways unanticipated by the firms, and this may happen even if firms actively position their sites by contributing themselves a proportion of the content. This highlights the care that is required in monitoring consumer dynamics on sites heavily relying on user-generated content. Importantly, we show that with user-generated content, hosting different segments of content contributors does not automatically imply content differentiation. When a firm tries to differentiate its content base from that of its competitor, it should take a holistic view of its content base. It is not enough to attract several groups of content contributors who do not join the competing site. The site should make sure that collectively, its content contributors build a community that is perceived as different as possible from the competitors'. Put differently, differentiation should be measured based on consumers' perception of content, instead of merely based on the fact that the sites have unique content contributors. Finally, the conventional wisdom of "increasing transportation cost" (i.e., differentiation) is less straightforward in the user-generated content context.[20] Although the increased localness in network effects decreases competition in a *given* equilibrium, it may shift the market outcome to a more segregated configuration in which competition becomes more intense, reducing firms' capacity to monetize their platforms. This ambiguous impact of the localness of network effects, with a sudden qualitative shift in market outcome, may be particularly dangerous for firms and may also be hard to anticipate. Firms should be careful in increasing the localness of network effects on their platform and should take explicit measures to prevent market segregation.

Our analysis on multihoming also provides important practical implications. We find that with multihoming, competition between firms intensifies, coexistence is less likely, and profits become lower. Thus, competing platforms should take caution in encouraging the users to join multiple platforms or even share content across the platforms, even if this appears tempting from

a market share perspective. Indeed, although more multihoming consumers expand each firm's user base, they also decrease the platforms' ability to monetize these users.

Last, our analysis with multiple firms shows that asymmetric equilibria can emerge in a configuration where one firm dominates the market with its consumers distributed in multiple distinct segments, whereas the other firms only claim single isolated segments bordered by those of the dominant site's. This configuration is particularly interesting as it represents an outcome where a dominant site competes on multiple fronts with isolated specialist sites that do *not* compete with each other. The dominant site has large market share but in fact faces the greatest competitive pressure. As discussed above, this limits its ability to monetize its user base.[21]

Limitations. Our analysis has a number of limitations. First, although we strongly suspect that there are no asymmetric equilibria in the base model, we were not able to formally prove this.[22] Second, we assumed that firms' advertising revenues are uniform across all consumers. Although this may be realistic under a few scenarios, it is clearly a limitation of the model that our extension with multihoming only partially addressed. In future studies, it would be a fruitful direction to explore a model in which advertising revenue is proportional to a consumer's surplus. This captures the fact that consumers who are more engaged in a website's content also tend to make greater revenue contributions. In such a model, profit maximizing sites may have greater incentives to increase the "stickiness" of their website. A website's stickiness does not necessarily increase its market share, but makes consumers who join the site spend more time on it. Likewise, more engaged consumers may be more tolerant toward advertising. Formally modeling these ideas calls for a model in which each consumer's revenue contribution differs, akin to models of price discrimination where firms can extract each consumer's surplus by charging an individualized price. Finally, we adopted a simple model of content generation where all users contribute content. It would be interesting to explore the case

---

[20] It is a classic result that higher transportation cost benefits firms when firms compete in prices. It is also true when firms compete in advertising and the content is not user generated.

[21] A related debate has emerged on Facebook's capability to monetize its clearly dominant platform among social networks. A recent post on BusinessInsider.com, entitled "It's Official: Teens Are Bored With Facebook" quotes: "[…] people are looking for more intimate places to share items with a handful of people, like Snapchat. There's a sense of privacy there, and it meets a need Facebook has grown too big to serve. […] this doesn't mean teens are deleting their Facebook profiles. They're just looking to use the service less, and they're open to communicating on other platforms" (see Shontell 2013).

[22] Note that even when we find asymmetric equilibria in, for example, a model with three firms, the configuration of segment distributions is symmetric. With two firms such configurations prevent any asymmetric outcome.

where users have heterogeneous tendencies for content generation. As such, the users may endogenously bifurcate into content consumers and content contributors. This latter group's content may reflect not only their preferences, but also the preferences of their "audiences" (see Toubia and Stephen 2013 for a similar empirical finding on Twitter). We have left these issues for future research.

In closing, it is important to realize that some of our key insights have more general theoretical implications for economics and marketing. Although user-generated content and local network effects are dominant features of the social media industry, they are certainly present in many other microeconomic contexts. In marketing for instance, so-called ego-expressive brands are largely built by the consumers who use them. Attracting the "wrong" consumers may tarnish the brand image, which the firm attempts to build. The same nominal brand might represent different values in different cultures (e.g., the meaning of BMW might be something slightly different in China, Europe, or the United States). This may represent a challenge for global brands, for example. Some of the competitive dynamics that we identify in the paper may, therefore, be relevant in a broader context.

Acknowledgments

Appendix A. Stable Fulfilled Expectation Equilibrium

In this section, we provide definitions for stable fulfilled expectation equilibrium. Stability implies that in equilibrium, when there is a small perturbation in the market expectation, the consequent market outcome (consumer time allocation pattern) is not "too different" from the equilibrium. We assume that when the market expectation changes, the market expects the marginal consumers (those who are the most likely to change their time allocation pattern) to change their time allocation decisions first.

Definition 1 (ϵ-Marginal Perturbation). In any FEE equilibrium T_1^*, a_1^*, a_2^*, a marginal consumer is defined as $x \in [0, 1]$ who is indifferent between two alternative time allocation choices. We say T_1' is an ϵ-marginal perturbation of T_1^* if T_1' and T_1^* are different only in ϵ intervals around the marginal consumers. Furthermore, T_1' is a symmetric

ϵ-marginal perturbation of T_1^* if $\forall x_1, x_2, \forall T_x, u_{x1}(T_x, T_1^*, a_1^*, a_2^*) = u_{x2}(T_x, T_1^*, a_1^*, a_2^*) \Rightarrow \forall T_x, u_{x1}(T_x, T_1', a_1^*, a_2^*) = u_{x2}(T_x, T_1', a_1^*, a_2^*)$.

Definition 2 (Stable Fulfilled Expectation Equilibrium). A stable fulfilled expectation equilibrium consists of a time allocation pattern T_i^* that satisfies the following condition: $\exists \delta$, $\forall$ symmetric ϵ-marginal perturbation T_i' of T_i^* where $\epsilon < \delta$, $\|\Gamma(T_i') - \Gamma(T_i^*)\| < \|T_i' - T_i^*\|$, where $\|\cdot\|$ is the 1-norm of real-valued functions: $\|f(x)\| = \int_{x \in [0,1]} |f(x)|\, dx$.

Intuitively, the above condition states that given any small perturbation in market expectation, the change in realized time allocation patterns is not too large. This condition is a generalization of the stability conditions in the classic network externalities literature, which are shown to be necessary to rule out implausible outcomes.[23]

Appendix B. Linear City Model

Our baseline model considers a circular city model, which assumes complete symmetry. Given our focus on user-generated content, it is imperative to examine whether our results hold true in a demand model where complete symmetry is absent. For example, in a linear city model, the consumers located on the edge of the $[0, 1]$ line may behave quite differently from the consumers located at the center of the line.

In this section, we replicate our analysis with a linear city model. This exercise reveals several main insights. First, as in the circular city model, ex ante identical firms can spontaneously acquire product differentiation from user-generated content. On a linear city, the simplest spontaneous differentiation equilibrium has consumers located on $[0, \frac{1}{2}]$ joining firm 1, and consumers located on $(\frac{1}{2}, 1]$ joining firm 2. Second, interestingly, although the winner-take-all equilibrium can coexist with the spontaneous differentiation equilibrium in a circular city model, they are mutually exclusive outcomes on a linear city. Said differently, the linear city model gives sharper predictions concerning these two qualitatively different outcomes. Finally, the lack of complete symmetry in the linear city model leads to an interesting, asymmetric equilibrium that is not observed in the circular city model. In this equilibrium, one firm attracts the consumers located at the *middle* of the linear city, and the other firm attracts the consumers located at the two *ends* of the linear city. We elaborate on these results in Proposition 6.

Proposition 6 (Linear City Model). *When consumers are distributed on a linear city, $x \in [0, 1]$, the following fulfilled expectation equilibria exist:*

• *When $\beta/\alpha > \frac{2}{3}$, there exists a spontaneous differentiation equilibrium where $T_i^*(x) = 1$ if $x \in [0, \frac{1}{2}]$ and $T_i^*(x) = 0$ if $x \in (\frac{1}{2}, 1]$, $i = 1, 2$. Firm profits are $\beta/4$.*

---

[23] See Farrell and Klemperer (2005). For example, without the stability condition, the outcome that each firm has a 50% market share is always an FEE. This outcome, however, is not stable when network effects are global. Any infinitesimal perturbation in market expectation will lead to the winner-take-all outcome.

- When $\beta/\alpha > 1$, there exists a spontaneous differentiation equilibrium where

$$T_i^*(x) = \begin{cases} 1 & \text{if } x < \dfrac{1}{2} - \dfrac{4\alpha + \beta + 2\sqrt{4\alpha^2 - 5\alpha\beta + 2\beta^2}}{14\beta}, \\[3mm] 0 & \text{if } \dfrac{1}{2} - \dfrac{4\alpha + \beta + 2\sqrt{4\alpha^2 - 5\alpha\beta + 2\beta^2}}{14\beta} \\[3mm] & \quad \leq x \leq \dfrac{1}{2} + \dfrac{4\alpha + \beta + 2\sqrt{4\alpha^2 - 5\alpha\beta + 2\beta^2}}{14\beta}, \\[3mm] 1 & \text{if } x > \dfrac{1}{2} + \dfrac{4\alpha + \beta + 2\sqrt{4\alpha^2 - 5\alpha\beta + 2\beta^2}}{14\beta}. \end{cases}$$

- When $\beta/\alpha \leq \frac{2}{3}$, there exist a winner-take-all equilibrium where all consumers join a dominant firm. Formally, $\forall x$, $T_i^*(x) = 1$ $(i = 1, 2)$. The dominant firm's profit is $\alpha - \beta/2$ and its competitor's profit is 0.

Figure B.1 illustrates the two types of spontaneous differentiation equilibria described in Proposition 6. We discuss the several key differences between the linear city model and the circular city model. First, the winner-take-all outcome and the spontaneous differentiation outcome are now mutually exclusive outcomes. This happens for the following reason. On a circular city, when one firm dominates the entire market, consumers have homogeneous valuation for this site's content. The winning firm should always extract the consumer surplus completely by setting its advertising level at the consumers' valuation, which fulfills the consumer expectations. On a linear city, in a winner-take-all outcome, the consumers have heterogeneous valuation for the winning firm's content. For the outcome to be self-fulfilling, the winning firm has to lower its advertising sufficiently such that the consumers at $x = 0$ and $x = 1$ are willing to join its site. When $\beta/\alpha > \frac{2}{3}$, the winner-take-all equilibrium is not self-fulfilling because the winning firm has an incentive to raise advertising levels. This condition coincides with the stability condition for the spontaneous differentiation equilibrium.

Second, when consumers are located on a linear city, there exists another type of equilibrium where one firm attracts the consumers at the center of the linear city, and the other firm attracts the consumers located at the two ends of the linear city. This leads to a type of "product differentiation" that is notably different from the familiar pattern of horizontal differentiation. Interestingly, although the mass centers of the two firms' content overlap (at $x = \frac{1}{2}$),
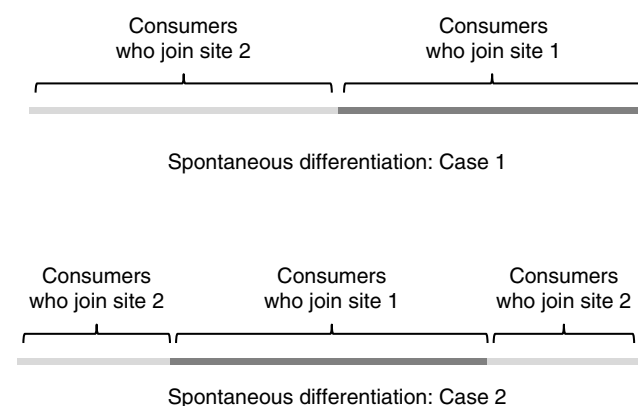
the sites are differentiated because of the highly localized content preferences. Higher β reduces competition and leads to higher profit. This outcome is somewhat reminiscent of a market in which one dominant firm attracts most "mainstream" users and the others attract niche consumers.

The above result further reveals the complex patterns of the spontaneous differentiation equilibrium. Not only can firms attract disjoint segments of consumers in equilibrium, the pattern of differentiation can be asymmetric in which one firm attracts one consumer segment and the other attracts two segments. Unlike in Proposition 1, we do not describe a general class of equilibria with any number of segments. The lack of symmetry makes the model technically challenging when the firms attract disjoint segments of consumers. Nevertheless, the analysis conforms the qualitative insights from Proposition 1. Finally, it can be shown that the linear city model with multihoming also preserves the qualitative insights gained from Proposition 5.

Appendix C. Three Firms

In this section, we consider a simple model where three firms compete with user-generated content. Introducing a third firm greatly increases the possible patterns of spontaneous differentiation. Because of the technical complexity of this model, we do not provide a comprehensive characterization of the equilibrium patterns as in Proposition 1. Instead, we prove the existence of several types of equilibria where three firms achieve differentiated positions on the circular city. The results show that having multiple competitors can lead to interesting outcomes that are not observed in the baseline model. We state the existence results for two possible equilibria in Proposition 7. As before, let $T_i^e(x)$ denote whether consumer x joins site i. We seek the fulfilled expectation equilibrium characterized by $T_1^*(x)$, $T_2^*(x)$, and $T_3^*(x)$. Introducing three firms slightly changes the definition of stability, on which we elaborate in the online appendix (available from the authors).

PROPOSITION 7 (THREE FIRMS). *Assume an arbitrary consumer to be at $x = 0$. When $\beta/\alpha > \frac{4}{3}$, there exists a spontaneous differentiation equilibrium in which $T_1^*(x) = 1$ for $x \in [0, \frac{1}{3})$, $T_2^*(x) = 1$ for $x \in [\frac{1}{3}, \frac{2}{3})$, and $T_3^*(x) = 1$ for $x \in [\frac{2}{3}, 1)$. Firm profits are $\Pi_1 = \Pi_2 = \Pi_3 = \beta/27$.*

When $3 > \beta/\alpha > 12/5$, there exists a spontaneous differentiation equilibrium in which $T_1^*(x) = 1$ for $x \in [0, (2\alpha)/\beta - \frac{1}{2})$; $T_2^*(x) = 1$ for $x \in [(2\alpha)/\beta - \frac{1}{2}, \frac{1}{2}) \cup ((2\alpha)/\beta, 1]$; and $T_3^*(x) = 1$ for $x \in [\frac{1}{2}, (2\alpha)/\beta)$. Firm profits are $\Pi_1 = \Pi_3 = (4\alpha - \beta)^3/(16\beta^2)$ and $\Pi_2 = ((2\alpha - \beta)^2(4\alpha - \beta))/(2\beta^2)$.

Figure C.1 illustrates the spontaneous differentiation equilibria described in Proposition 7. The left panel shows the first type of equilibrium where each firm captures one third of the market. This outcome is akin to the Salop (1979) model of maximal horizontal differentiation with three firms. Each firm competes with its two neighbors and the equilibrium advertising levels are $\beta/9$.

When β/α is intermediate, there exists an asymmetric spontaneous differentiation equilibrium, as illustrated in the right panel of Figure C.1. In this equilibrium, one firm, labeled firm 2, attracts two disjoint segments of consumers and the other two firms each attract one consumer segment. Interestingly, firm 2 competes with both of the other firms whereas

Figure B.1 **Spontaneous Differentiation on a Linear City**

Consumers who join site 2   Consumers who join site 1

Spontaneous differentiation: Case 1

Consumers who join site 2   Consumers who join site 1   Consumers who join site 2

Spontaneous differentiation: Case 2

Figure C.1   Spontaneous Differentiation with Three Firms

Spontaneous differentiation with three firms: Case 1

Spontaneous differentiation with three firms: Case 2
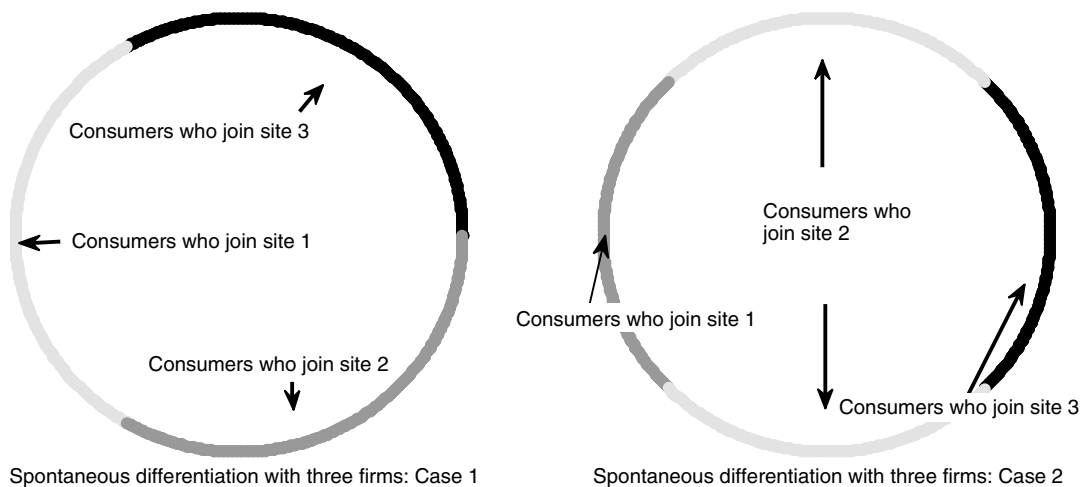
firm 1 and 3 do not compete with each other. The three firms achieve content differentiation in a nonsymmetric fashion. It can also be verified that it can not be sustained as an equilibrium when every firm attracts an even number of segments in a symmetric fashion, mirroring the insights from Proposition 1. This equilibrium points to an interesting outcome where one "generalist" firm competes with multiple "specialist" firms with more focused positioning. Although the dominant firm typically has larger market share, its ability to monetize its user base is limited because of competition on multiple fronts.

By similar logic, we can solve a game where M firms compete on the circular city. It can be shown that the symmetric equilibrium exists where each firm obtains $1/M$ of the market. As such, segregation can involve a small number of firms with multiple disjoint segments, or a large number of firms with fewer segments each. We next compare the consumer surplus in an equilibrium where $2N$ firms with 1 segment each and another equilibrium where 2 firms with N segments each. It can be shown that firm profits are always higher in the latter case because of a much larger market share ($\frac{1}{2}$ versus $1/N$). Consumer surplus, however, can be either higher or lower in the latter case. Specifically, consider an equilibrium with $2N$ firms capturing one segment each, and an equilibrium with two firms capturing N segments each. Consumer surplus is lower in the former case iff $\alpha - \beta((N+1)/(4N)) > 0$.

The intuition behind this result is quite straightforward. Note that in both cases, the advertising levels are identical. The differences in consumer surplus therefore stems only from the valuation effect. When two firms attract N segments each, each consumer derives utility from the content generated by N disjoint segments of content contributors. When $2N$ firms compete, each consumer only consumes the content generated by one segment of content contributors. Consumer surplus is higher in the case where content valuation is higher.

Appendix D. Segregation and Consumer Welfare: Additional Analyses

In the baseline model, we find that greater segregation has three effects on consumer surplus: the valuation effect,

the competitive effect, and the preference heterogeneity effect. In the model with linear advertising disutility, we find that the valuation effect is dominated by the latter two effects. Thus, greater segregation makes consumers better off. We cautioned that although the directions of these three effects are robust under alternative assumptions, their relative sizes may change. In this section, we provide more discussions on this issue. Consider a generalized version of the utility function introduced in §3:[24]

$$u_x(T_i^e, a_i) = c + v_x(T_i^e) - a_i^\kappa. \tag{D1}$$

When $\kappa = 1$, the utility and profit functions reduce to that in the baseline analysis. Being the standard assumption in the literature, this stands for a special case where advertising represents a welfare transfer from the consumers to the firm. When $\kappa > 1$ or $\kappa < 1$, each "unit" of advertising has different values for the consumers and the firms. We keep the profit function unchanged.

The above model can be solved in the same manner as the baseline model. The equilibrium demand schedules remain unchanged, but equilibrium advertising levels now depend on κ. Specifically, in a spontaneous differentiation equilibrium with N segments joining each firm, advertising levels are $a_1^* = a_2^* = \sqrt[\kappa]{\beta/(\kappa 4N^2)}$. The proof follows the exact same logic as that of Proposition 1. The equilibrium consumer surplus level can be determined accordingly.

As expected, when advertising disutility is more convex, market share shrinks faster as firms increase ad level. As a result, firms choose lower levels of advertising in equilibrium. Specifically, the equilibrium advertising disutility equals $\beta/(\kappa 4N^2)$, which is lower for higher κ and higher N. As segregation increases, firms compete more intensely and consumers suffer less from advertising disutility. As such, the valuation effect, competitive effect, and preference heterogeneity effect remain in the same directions as discussed in §4 but the relative magnitudes of the competitive effect and the preference heterogeneity effect depend on the magnitude

---

[24] We thank two anonymous reviewers, whose conjecture about welfare and segregation motivated this section.

Figure D.1   Marginal Consumer's Surplus as a Function of Content Segregation
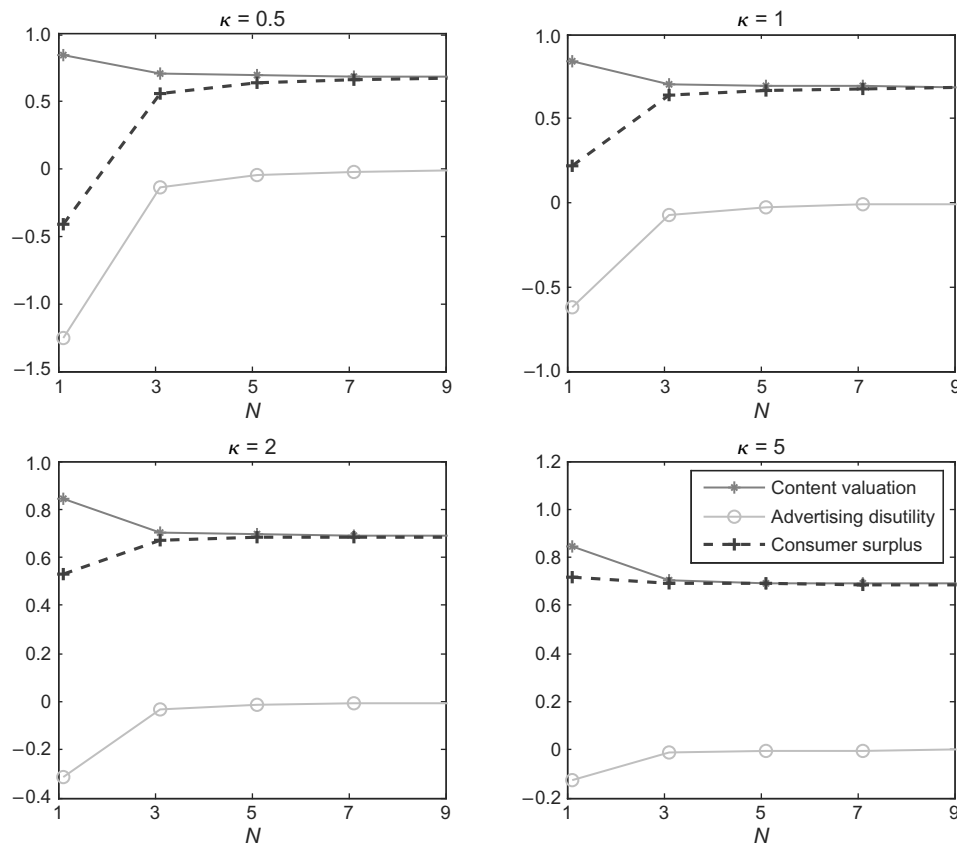
of κ. When κ is larger, firms advertise proportionally less and the competitive/preference heterogeneity effects become less significant. As a consequence, the valuation effect may dominate the other two effects. Figure D.1 depicts the three effects as a function of N for $\kappa = 0.5$, $\kappa = 1$, $\kappa = 2$, and $\kappa = 5$.

As can be seen, when κ is large, the valuation effect dominates the competitive effect and the value heterogeneity effect. As long as the advertising disutility is not too convex (the first three cases above), the competitive effects dominate and consumer surplus increases with segregation. This exercise provides some perspectives on the role of content segregation. Segregation decreases consumer valuation of content but intensifies competition. The overall welfare implication, however, depends on the sizes of these effects.

References

Anderson SP, Coate S (2005) Market provision of broadcasting: A welfare analysis. *Rev. Econom. Stud.* 72(4):947–972.

Anderson SP, Gans J (2011) Platform siphoning: Ad-avoidance and media content. *Amer. Econom. J.* 3(4):1–34.

Armstrong M (2006) Competition in two-sided markets. *RAND J. Econom.* 37(3):668–691.

Banerji A, Dutta B (2009) Local network externalities and market segmentation. *Internat. J. Indust. Organ.* 27(5):605–614.

Baye MR, Morgan J (2001) Information gatekeepers on the Internet and the competitiveness of homogeneous product markets. *Amer. Econom. Rev.* 91(3):454–474.

Berger J, Milkman KL (2012) What makes online content viral? *J. Marketing Res.* 49(2):192–205.

Boyd D (2012) White flight in networked publics: How race and class shaped American teen engagement with MySpace and Facebook. Nakamura L, Chow-White PA, eds. *Race After the Internet* (Routledge, New York), 203–222.

Chafkin M (2007) How to kill a great idea! *Inc* (blog) (June 1), http://www.inc.com/magazine/20070601/features-how-to-kill-a-great-idea.html.

Chen Y, Xie J (2007) Cross-market network effect with asymmetric customer loyalty: Implications for competitive advantage. *Marketing Sci.* 26(1):52–66.

Chevalier JA, Mayzlin D (2006) The effect of word of mouth on sales: Online book reviews. *J. Marketing Res.* 43(3):345–354.

Cooper R, John A (1988) Coordinating coordination failures in Keynesian models. *Quart. J. Econom.* 103(3):441–463.

d'Aspremont C, Gabszewicz JJ, Thisse JF (1979) On Hotelling's "stability in competition." *Econometrica: J. Econometric Soc.* 47(5):1145–1150.

De Frutos M-A, Hamoudi H, Jarque X (1999) Equilibrium existence in the circle model with linear quadratic transport cost. *Regional Sci. Urban Econom.* 29(5):605–615.

Dellarocas C, Katona Z, Rand W (2013) Media, aggregators, and the link economy: Strategic hyperlink formation in content networks. *Management Sci.* 59(10):2360–2379.

Driskill R (2006) Multiple equilibria in dynamic rational expectations models: A critical review. *Eur. Econom. Rev.* 50(1):171–210.

Dukes A (2004) The advertising market in a product oligopoly. *J. Indust. Econom.* 52(3):327–348.

Dukes A, Gal-Or E (2003) Negotiations and exclusivity contracts for advertising. *Marketing Sci.* 22(2):222–245.

Evans GW (1986) Selection criteria for models with non-uniqueness. *J. Monetary Econom.* 18(2):147–157.

Farrell J, Klemperer P (2005) Coordination and lock-in: Competition with switching costs and network effects. *Handbook Indust. Organ.* 3:1967–2072.

Fjeldstad Ø, Moen ER, Riis C (2009) Competition with local network externalities. Working paper, Norwegian School of Management, Oslo, Norway.

Foster D, Young P (1990) Stochastic evolutionary game dynamics. *Theoret. Population Biology* 38(2):219–232.

Gabszewicz JJ, Laussel D, Sonnac N (2004) Programming and advertising competition in the broadcasting industry. *J. Econom. Management Strategy* 13(4):657–669.

Ghose A, Han SP (2011) An empirical analysis of user content generation and usage behavior on the mobile Internet. *Management Sci.* 57(9):1671–1691.

Goldenberg J, Libai B, Muller E (2010) The chilling effects of network externalities. *Internat. J. Res. Marketing* 27(1):4–15.

Gould D (2009) The state of online dating. *PSFK* (April 10), http://www.psfk.com/2009/04/the-state-of-online-dating .html.

Harsanyi J, Selten R (1988) *A General Theory of Equilibrium Selection in Games* (MIT Press, Cambridge, MA).

Huang Y, Singh P, Ghose A (2011) A structural model of employee behavioral dynamics in enterprise social media. Working paper, New York University, New York.

Kandori M, Mailath GJ, Rob R (1993) Learning, mutation, and long run equilibria in games. *Econometrica: J. Econometric Soc.* 61(1):29–56.

Katz ML, Shapiro C (1985) Network externality, competition and compatibility. *Amer. Econom. Rev.* 75(3):424–440.

Katz ML, Shapiro C (1986) Technology adoption in the presence of network externalities. *J. Political Econom.* 94(4): 822–841.

Kugel S (2006) A web site born in U.S. finds fans in Brazil. *New York Times* (April 10), http://www.nytimes.com/2006/04/10/ technology/10orkut.html.

Kuksov D (2007) Brand value in social interaction. *Management Sci.* 53(10):1634–1644.

Kuksov D, Shachar R (2010) User generated content and image advertising. Working paper, Washington University in St. Louis, St. Louis.

Lenhart A (2009) Social networks grow: Friending mom and dad. *Pew Charitable Trusts* (January 14), http://www.pewtrusts.org/en/

research-and-analysis/reports/2009/01/14/social-networks -grow-friending-mom-and-dad.

Ofek E, Sarvary M (2001) Leveraging the customer base: Creating competitive advantage through knowledge management. *Management Sci.* 47(11):1441–1456.

Rivlin G (2006) Wallflower at the Web party. *New York Times* (October 15), http://www.nytimes.com/2006/10/15/business/ yourmoney/15friend.html?pagewanted=all&_r=0.

Rochet JC, Tirole J (2006) Two-sided markets: A progress report. *RAND J. Econom.* 37(3):645–667.

Salop SC (1979) Monopolistic competition with outside goods. *Bell J. Econom.* 10(1):141–156.

Shontell A (2013) It's official: Teens are bored with Facebook. *Business Insider* (blog) (March 3), http://www.businessinsider.com/its -official-teens-are-bored-of-facebook-2013-3.

Slashdot (2004) Language tempest at Orkut. (blog) (July 17), http://tech.slashdot.org/story/04/07/17/2243232/language -tempest-at-orkut.

Sun B, Xie J, Cao HH (2004) Product strategy for innovators in markets with network effects. *Marketing Sci.* 23(2):243–254.

Toubia O, Stephen A (2013) Intrinsic vs. image-related utility in social media: Why do people contribute content to Twitter? *Marketing Sci.* 32(3):368–392.

Trusov M, Bucklin RE, Pauwels K (2009) Effects of word-of-mouth versus traditional marketing: Findings from an Internet social networking site. *J. Marketing* 73(5):90–102.

Tucker C, Zhang J (2010) Growing two-sided networks by advertising the user base: A field experiment. *Marketing Sci.* 29(5): 805–814.

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

Xie J, Sirbu M (1995) Price competition and compatibility in the presence of positive demand externalities. *Management Sci.* 41:909–926.

Yang S, Hu MM, Winer RS, Assael H, Chen X (2012) An empirical study of word-of-mouth generation and consumption. *Marketing Sci.* 31(6):952–963.

Zeithammer R, Thomadsen R (2013) Vertical differentiation with variety-seeking consumers. *Management Sci.* 59(2):390–401.