Social Media Competition: Differentiation with User-Generated Content

Kaifu Zhang Miklos Sarvary[1]

Feb, 2012

[1]Kaifu Zhang is a Ph.D. student in Marketing and Miklos Sarvary is Professor of Marketing at INSEAD, Bd. de Constance, Fontainebleau, France. kaifu.zhang@insead.edu, miklos.sarvary@insead.edu.

Social Media Competition: Differentiation with User-Generated Content

Abstract

This paper studies competition between social media sites in a game theoretic framework. We model three important institutional features of social media sites: (i) firms' content is usually "user-generated"; (ii) consumers' preferences are governed by local network effects, and (iii) consumers have strong tendencies to multi-home. In such a setting, ex-ante identical sites can acquire differentiated market positions that spontaneously emerge from user-generated content. Furthermore, sites may obtain unanticipated and sometimes ambiguous market positions, wherein one site simultaneously attracts multiple distinct consumer segments that are isolated from each other. The degree of "spontaneous differentiation" increases with the localness of network effects. Spontaneous differentiation increases firms' profits but may imply too much consumer segregation and lower social welfare. In most equilibria, a subset of consumers multi-home. Interestingly, more multi-homing consumers imply reduced differentiation and higher site competition. In an extension, we examine the case where firms explicitly position their sites by designing website features. We find that user-generated content can either enhance or override the sites' positioning decisions, leading to interesting situations where sites acquire 'unintended' market positions. Our findings shed light on a few stylized facts related to the rapid evolution of the social media industry and also highlight the incentives of competing industry players.

1 Introduction

Social media applications, such as classic social networks (e.g., Facebook, LinkedIn), video sharing sites (e.g., YouTube), virtual world platforms (e.g., Second Life), on-line dating communities

(e.g., eHarmony, Match.com) represent a diverse and rapidly growing industry. In this industry, typically, multiple sites compete in a relatively well-defined category (e.g., video sharing or on-line dating). While these categories are quite different, social media sites share a number of important features. First, most of these sites rely extensively on user-generated content where *consumers* largely define the firms' product offerings. Typically, users have very heterogeneous content preferences and prefer sharing content with similar users, leading to large but *local* network externalities. In addition, it is easy for consumers to join multiple communities (multi-homing), and typically, sites compete for share of consumer time. While the overall business impact of social media has been well documented, the competitive implications of these economic properties have not been formally addressed. The goal of this study is to close this gap. We study the competition between social media sites defined by the above features in a game theoretic framework.

Although the social media industry is still young, a few stylized facts seem to emerge. First, as a consequence of user-generated content, the content positioning of competing firms can be strongly influenced by their *users*. As a result, firms may acquire largely unintended and sometimes ambiguous product positioning. Consider the early players in the social networking industry. Myspace, Friendster and Google's Orkut were notable competitors between 2002-2004. All three websites started in California and, initially, they targeted the US market. Over time, however, Friendster became popular in South East 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, didn't realize their popularity in the South East Asia until one engineer noticed that its website traffic was spiking in the middle of the night, San Francisco time[2]. For a few years, Friendster's management considered its unexpected popularity among Asian users 'as a problem' and continued to focus on the US market[3].

[2]See http://www.inc.com/magazine/20070601/features-how-to-kill-a-great-idea.html for an account of the events.
[3]See the New York Times report 'Wall ower at the Web Party' (2006)

Upon Facebook's entry into the market in 2004, differentiation also spontaneously emerged between Myspace and Facebook, the major contestants for US market leadership. In an ethnographic study, Boyd (2010) documents a so-called 'white flight' from MySpace to Facebook, and suggests that the two leading players in the US social networking market acquired differentiated market positions with racial connotations.[4] The above examples describe situations where user-generated content has a key role in determining the firms' market positions. This effect can be so strong - as in the case of social networking sites - that sites with similar designs can acquire differentiated market positions. We later call this phenomenon 'spontaneous product differentiation'.

In another domain of social media, on-line dating, consumers have highly heterogeneous preferences for either long-term or short-term relationships. As such, a website's appeal strongly depends which type of users it attracts in the first place. Differentiation along this dimension is evident among the major dating sites[5]. The market perception of a website is influenced by its user base even when the websites offer 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 matching algorithms. While some consumers consider Chemistry.com's algorithm to be superior, they frequently find that eHarmony offers better chances for long-term relationships due to its 'pool of serious daters'[6]. Put differently, 'user-generated content' may interact with product features and they jointly determine a site's market position.

Second, while network externalities are clearly significant in all social media markets, different social media categories exhibit widely varying levels of concentrations. In some markets, we observe the emergence of a dominant site (e.g., YouTube in the video-sharing industry, and most recently, Facebook in the social-networking industry) and a 'winner-take-all' market struc-

[4]It is important to note that more recently (starting 2010), the social networking market has been systematically dominated by Facebook, not just in the US but also elsewhere in the world. As we will argue below, this may be the result of a fundamental change in the value proposition of the social networking category.

[5]See http://www.psfk.com/2009/04/the-state-of-online-dating.html for a two dimensional perceptual map of the online dating industry.

[6]See http://www.edatereview.com/ for examples of consumer comparisons of these services.

	Approx. Herfindahl Index
Mobile Community	0.1427
Casual Gaming	0.1583
Social Networks	0.3919
Auto Classified	0.4861
Video Sharing	0.5840

Table 1: Herfindahl Indices in different social media categories.

ture, which is the typical market outcome in traditional network industries. In other markets, as discussed above, competing firms are able to coexist with differentiated positions despite strong network externalities. Table 1 lists the approximate Herfindahl indices in 2009 for five social media markets and shows that the index exhibits large variations across these domains.[7]

A third important feature of social media markets is that *some* consumers have strong tendencies to multi-home in competing communities while others are loyal to one site. A survey by *Pew Research* on North American adult social network users reveals that over 40% of the respondents actively maintain multiple profiles on different websites while 43% of respondents state that they only maintain one profile in a single community[8]. In other words, consumers are clearly divided in their multi-homing behavior.

Our paper seeks to shed some light on these stylized patterns and trends in the social media industry. Beyond replicating market outcomes, we are also interested in identifying the determinants of firm profits and study competing firms' strategic choices. To do so, we develop a model of competing social media sites with the following institutional features:

[7]The index has been derived from the top ten sites in each category, with the following formula $H = \sum_{i=1...N} s_i^2$, where s_i is the market share of firm i (Hirschman 1964). Data source: Hitwise 2009.

[8]See the report 'Social Networks Grow: Friending Mom and Dad' (Lenhart 2009).

- User-Generated Content: In the baseline model, we assume that the websites don't provide content on their own. Each user generates content corresponding to his/her preference and has access to to the content generated by other members. In an extension, we allow the websites to have their own content and explore the interaction between site-provided content and user-generated content.

- Local Network Effects: The marginal utility from sharing content with someone increases with the similarity between the two members. In other words, consumers have stronger preferences for content generated by similar others.

- Saturation from Content Consumption: Repeated consumption of similar content yields decreasing returns to consumers.

In accordance with these main features, our model assumes that consumers develop expectations about firms' user bases and maximize utility by freely allocating a limited amount of time between competing social media sites. On the supply side, we consider a duopoly of social media firms who set advertising levels to maximize advertising revenues from their user base.[9] We start with a base-line model where the competing firms pursue no particular product designs, they simply invite consumers to share their content on the firm's platform. Later, we also analyze the case when firms explicitly contribute to consumers' utility (e.g. by providing their content or design website features).

Our first set of results speak to the equilibrium market structures. The analysis reveals the existence of several qualitatively different types of equilibria. When network effects are relatively global (i.e., consumer similarity has little effect on utility), there exists a winner-take-all equilibrium where all consumers join a single, dominant site. When network effects are relatively local, ex-ante identical sites can obtain differentiated market positions that emerge spontaneously from

[9] In additional analysis, we show that other, common revenue models (subscription, or a transaction tax) lead to an identical model structure.

user-generated content. The sites attract different but overlapping consumer segments who generate content consistent with their respective tastes. When network effects are sufficiently local, there exist interesting equilibria where each site simultaneously attracts multiple distinct consumer segments who are isolated from each other. These consumer segments join the same website although they have low valuation of each other's content. In most equilibria, we also observe a segment of consumers who multi-home. Stronger saturation from content consumption enlarges this segment.

Our second set of results sheds light on the properties of spontaneous differentiation and the determinants of firm profits. On the firm side, we show that spontaneous differentiation reduces firm competition similar to the case of classic horizontal differentiation. As expected, the degree of spontaneous differentiation is increasing in the localness of network effects. Thus, firm profits rise when members strongly favor the content generated by similar members. Interestingly, more multi-homing consumers result in fiercer competition between the communities and lead to lower profits. We show that this is a unique implication of user-generated content. It arises from the fact that as more users multi-home, the competing communities end up hosting overlapping content and face reduced differentiation. From a welfare point of view, we show that spontaneous differentiation may imply 'too much' consumer segregation and lower social welfare. These results resonate to many stylized facts describing the evolution of social media in the last decade. Furthermore, we also discuss how the results relate to a broader set of (traditional) industries where products or brands are co-created by the firm and its consumers.

The last part of the paper examines two extensions. The first extension allows each firm to explicitly target a consumer segment by designing website features. For example, a dating site may introduce personality tests and compatibility matching algorithms to attract the users who value long-term relationships. A social networking service can introduce on-line CV features to appeal to professional users. In these cases, the consumers benefit from both firm-provided features and user-generated content. We find that in equilibrium, user-generated content can either

enhance or override the firm's positioning. In the former case, both user-generated content and site designs contribute to product differentiation. When user-generated content overrides site design, firms attract the consumer segments that they did not intend to target ex ante. Another extension explores the case when consumers do not interact with all members of the site. For example, social networks have recently introduced features (e.g. 'friend list' by Facebook or 'circles' by Google+) that restrict the scope of content sharing. We find that our key results remain intact compared to the baseline model.

The rest of the paper is organized as follows. In Section 2, we review the relevant literature in marketing and economics. Section 3 presents the model. Section 4 presents the analyses and discuss the equilibrium results. We present the extensions in Section 5. Section 6 discusses other aspects of the social media industry and concludes. To facilitate reading all proofs have been relegated to an appendix.

2 Literature Review

Our paper is related to several literature streams. First, it is related to the emerging literature on user-generated content and social media. Previous work has examined, for example, users' incentives to share content (Berger and Milkman 2011, Huang, Singh, and Ghose 2011), the interplay between content generation and content consumption (Ghose and Han 2011, Yang, Hu, Assael, and Winer 2011) and the impact of user-generated content on sales (Chevalier and Mayzlin 2006, Trusov, Bucklin, and Pauwels 2009). In contrast, the emphasis of this paper is on competition, in particular, product differentiation between social media sites.

On the conceptual front, the paper is related to the economics literature on 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, Gabszewicz, and Thisse 1979, Salop 1979). In a user-generated content context, we study product

differentiation in a model where "content positioning" depends on which users a site attracts. This setup is similar to Kuksov and Shachar (2010) where a brand's identity depends on the consumers who own it. However, Kuksov and Shachar's setup is a monopoly. In contrast, we study competitive outcomes in this 'spontaneous' differentiation context and compare it with classic horizontal differentiation.

Our study is also closely related to the vast literature on network externality, in both economics (Katz and Shapiro 1985, 1986, Farrell and Klemperer 2005) and marketing (Xie and Sirbu 1995, Ofek and Sarvary 2001, Sun, Xie, and Cao 2004, Chen and Xie 2007, Goldenberg, Libai, and Muller 2010, Tucker and Zhang 2010). Most of the analytical models in this literature assume a consumer utility function that is linear in network size. This simple assumption is sufficient to explain general industry outcomes such as the winner-take-all market structure. However, the social media industry is typically characterized by local, as opposed to global network effects. Local network effects have been studied by a few recent papers in economics (Fjeldstad, Moen, and Riis 2009, Banerji and Dutta 2009). Our model is similar to these papers but, in line with the social media context, has other features such as saturation from repeated content consumption. More importantly, we apply a more general solution concept to the game. To our knowledge, ours is the first model with local network effects that yields the winner-take-all outcome and the 'spontaneous differentiation' outcome as multiple equilibria.

To model advertising competition between communities, we adopt the standard 'advertising disutility' paradigm (Dukes and Gal-Or 2003, Dukes 2004, Gabszewicz, Laussel, and Sonnac 2004, Anderson and Coate 2005, Anderson and Gans 2010). This framework assumes that consumers consider advertising as nuisance. The tendency of ad avoidance has found much empirical support (see Wilbur (2008) for a recent example). Our paper is also broadly related to the literature on competing two-sided platforms (Armstrong 2006, Rochet and Tirole 2006, Baye and Morgan 2001).

Finally, we assume consumer multi-homing and as a result, the paper is also related to papers on multiple buying and variety seeking (Kahn 1995, Seetharaman and Che 2009, Sajeesh and Raju 2010, Caillaud and Jullien 2003, Doganoglu and Wright 2006, Guo 2006, Xiang and Sarvary 2007). In particular, Caillaud and Jullien (2003), Doganoglu and Wright (2006) both study the impact of multi-homing behavior on platform competition under network effects. We demonstrate that when content is user-generated, multi-homing behavior has novel implications for product differentiation and firm profits.

3 The Model

We consider a simple social media market with two ex-ante identical sites indexed $i = 1, 2$ competing for a heterogeneous set of consumers. In the baseline model, sites do not produce any content on their own. Sites earn profits from advertising[10]. A site's subscribers derive utility from consuming the content generated by other members in the same community and choose to allocate their limited amount of time between the competing sites (multi-homing). Site's content type depends on the type of consumers they attract (user-generated content). Consumers prefer the content from similar users (local network effect) and derive disutility from advertising. We adopt a general notion of 'content' which also encompasses direct social interaction as in the case of on-line dating.

The game consists of the following stages. First, all parties (both consumers and firms) form expectations about which users will join which website and how much time they will spend on the sites. Firms set advertising levels according to their expectations about the type and amount of content they will host. Then consumers make time allocation decisions based on the advertising levels and the expected type and amount of content in each community. We seek the Fulfilled Expectation Equilibrium where the expected consumer time allocation pattern coincides with the

[10]There are three major revenue models for social media websites: advertising (as in YouTube, Facebook), membership fees (as in the case of dating websites) and taxing the virtual economy (as in Facebook). In an analysis available from the authors, we show that all three revenue models have similar mathematical properties and lead to the same results. We consider advertising throughout the paper to facilitate reading.

realized time allocation pattern (Katz and Shapiro 1985, Farrell and Klemperer 2005). Below, we elaborate on these features in greater details.

3.1 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 clock-wise on the circle. She allocates two units of time between the competing sites: $T_i(x) = k$ ($k = 0,1,2$), where $T_i(x)$ is the time consumer x spends on site i. Multi-homing takes place when a consumer allocates 1 unit of her time in each community. Each consumer is simultaneously content consumer and content contributor. By making the time allocation decision, a consumer decides (1) in which community her content will appear, (2) whose content she will consume and how many times.

Content Contribution: At the beginning of the game, every consumer generates one unit of content at her location x. If a consumer spends time in a community i, she uploads that unit of content onto this site. Every consumer derives a constant benefit c from the intrinsic enjoyment of content generation and the consumers are homogeneous in this respect[11].

Content Consumption: If consumer x spends one unit of time in community i, she has access to every other consumer's content in that community. Note that in this setup, consumer x may consume y's content multiple times. Let $T_1^e(y)$ be the expected time allocation decision of y. Given $T_1^e(y)$, the number of times that consumer x consumes y's content is $\sum_{i=1,2} T_i(x) I(T_i^e(y) > 0) \in \{0,1,2\}$, where $I()$ is the indicator function. For example, when $T_1(x) = T_2(x) = 1$ and $T_1^e(y) = T_2^e(y) = 1$, both x and y multi-home, and x consumes y's content two times in two different communities. When $T_1(x) = 2, T_1^e(y) = T_2^e(y) = 1$, x consumes y's content two times in the same

[11] Note that our model does not address the otherwise relevant question of how consumers differ in allocating their time between content contribution and content consumption. We assume an 'average' consumer recognizing that in reality consumers may be heterogeneous in their tendency to contribute or consume content. This simplification allows us to focus on consumer *'preference'* and horizontal differentiation.

community. When $T_1(x) = T_2(x) = 1, T_1^e(y) = 2$, x consumes y's content only once.

Consumers prefer content from similar other members and browsing the same content twice yields decreasing marginal utility. Consumers derive disutility from advertising. When the market is covered, we have $T_2(x) = 2 - T_1(x)$ and consumer x's total utility is:

$$\begin{aligned} & u_x(T_1(x); T_1^e(y), a_1, a_2) \\ & = c + \underbrace{\int_{y\in[0,1)} \delta(x, y, T_1(x), T_1^e(y))dy}_{\text{utility from content consumption}} \underbrace{- T_1(x)a_1 - (2 - T_1(x))a_2}_{\text{disutility from ads}} \end{aligned} \tag{1}$$

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

We explain the different components in this utility function in turn. First note that $u_x(.)$ captures consumer x's *total* utility, which depends on x's time allocation decision $T_1(x)$, as well as the expected time allocation of all the other consumers, $T_1^e(y)$. $T_1(x)$ and $T_1^e(y)$ govern the number of times x consumes y's content. $\delta(x, y, T_1(x), T_1^e(y))$ denotes the marginal utility consumer x derives from consuming y's content. This marginal utility function captures two effects:

- Local network effects: x prefers the content generated by other members who have similar tastes. Specifically, we assume δ is linearly decreasing in the distance between x and y, $|x-y|_d = min\{|x-y|, 1-|x-y|\}$. The parameter β measures how much a consumer values similarity and thus the localness of network effects[12]. It is related to the familiar 'transportation cost' parameter where a consumer favors a piece of user-generated content that is at a closer location. This formulation also allows for negative marginal utility when β is large and x and y have very different tastes.

- Satiation effects: we assume that consumer x experiences satiation when she consumes the content from consumer y in both units of her time. For example, $\delta(x, y, 1, 2) = \alpha - \beta|x-y|_d$

[12]Note that the utility from content consumption reduces to the classic network externality function proposed by Katz and Shapiro (1985, 1986) when $\beta = 0$.

denotes the utility when x consumes y's content only once. When x spends two units of time in community 1, the utility from content consumption is $\delta(x,y,2,2) = (1+\gamma)(\alpha - \beta|x-y|_d)$. $\gamma < 1$ captures the satiation effect and implies a concave marginal utility function.

Finally, we assume that advertising disutility is proportional to advertising intensity a_1 and a_2 as in the literature (Dukes and Gal-Or 2003, Anderson and Gans 2010)[13].

Let $T_1^r(x, T_1^e, a_1, a_2) = \arg\max_{T_1(x)} u_x(T_1(x); T_1^e(y), a_1, a_2)$. A consumer's time allocation decision depends on her expectation about all other consumers' time allocation decisions and the firms' advertising levels. The expectation variable T_1^e is a function in itself. As will be defined in Section 3.3, the equilibrium time allocation function involves self-fulfilling expectation and is denoted as $T_1^*(x)$.

3.2 Firms

We consider two competing sites setting their advertising intensities $a_i > 0$. Ad intensity can be thought of as the number of ads displayed on each page. The site's profit is proportional to the number of ads multiplied by the price for each ad:

$$\Pi_i = a_i \, p\Big(\int_{x\in[0,1]} T_i^r(x, T_1^e, a_1, a_2)dx\Big). \tag{2}$$

$p(\cdot)$ is the mapping from the consumer impressions a website receives to an advertiser's willingness to pay for an ad slot on this website. We assume that advertisers have higher willingness to pay for an ad slot with more consumer impressions. Specifically,

$$p\Big(\int_{x\in[0,1]} T_i^r(x, T_1^e, a_1, a_2)dx\Big) = s \int_{x\in[0,1]} T_i^r(x, T_1^e, a_1, a_2)dx, \tag{3}$$

where $\int_{x\in[0,1]} T_i^r(x, T_1^e, a_1, a_2)dx$ is the total amount of consumer time spent in community i. s is the cost per unit of site traffic and is normalized to 1.

[13] We do not model the fact that under certain cases, consumers may actually derive positive utility from seeing a well-designed ad.

Recall that we assume that displaying more ads in general leads to less enjoyable consumer experience since consumers find ads a nuisance. When consumers spend less time on a community, the advertising price on this website will also drop. The profit function captures this tradeoff between ad intensity and ad price and is a standard formulation from the literature (Dukes and Gal-Or 2003, Gabszewicz et al. 2004, Anderson and Gans 2010).

3.3 Equilibrium Concept

We generalize the solution concept of Fulfilled Expectation Equilibrium (FEE) from the network effect literature (see e.g., Katz and Shapiro). In its classic form, a Fulfilled Expectation Equilibrium consists of a network size that is a fixed point of the mapping from expected network size to realized network size $x^r = \Gamma(x^e)$[14]. The FEE solution concept has a straightforward extension in our setup. We consider the mapping Γ that maps the expected time allocation function T_1^e to the realized time allocation pattern T_1^r when firms set advertising levels taking T_1^e as given. The consumer time allocation pattern in a Fulfilled Expectation Equilibrium satisfies $T_1^* = \Gamma(T_1^*)$. Equivalently, the equilibrium consists of a time allocation function T_1^* and advertising levels a_1^* and a_2^* such that:

$$\begin{cases} a_1^* = \arg\max_{a_1} a_1 p(\int_{x\in[0,1]} T_1^r(x, T_1^*, a_1, a_2)dx) \\ a_2^* = \arg\max_{a_2} a_2 p(\int_{x\in[0,1]} 2 - T_1^r(x, T_1^*, a_1, a_2)dx) \\ \forall x,\ T_1^*(x) = T_1^r(x, T_1^*, a_1^*, a_2^*). \end{cases} \tag{4}$$

The mapping Γ is defined as $\Gamma(T_1^*)(x) = T_1^r(x, T_1^*, a_1^*, a_2^*)$. We further restrict our interests to stable FEEs. The precise definition of stability is given in the appendix. While conceptually straightforward, generalizing the expectation variable from a real number to a function leads to considerable complexity in solving the fixed-point problem of Γ, which we address in the Ap-

[14]Let x^e denote the expected network size 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 $\Gamma(x^e) = x^r(x^e, p_1^*(x^e), p_2^*(x^e))$.

pendix.

4 Analysis

We first discuss equilibrium results from the basic model concentrating on the pattern of product differentiation. Then we examine firms' profits and explore other comparative statics.

4.1 Equilibrium Outcomes

Consistently with the network externality literature, there are many possible equilibria and uniqueness can rarely be obtained. Our analysis focuses on existence results to highlight interesting outcomes that may relate to the stylized facts discussed in the introduction. First we provide a unified characterization of consumers' equilibrium time allocation patterns in Proposition 1. Then we discuss different types of equilibrium patterns sequentially.

Proposition 1. *For any odd number N,* $\frac{1}{4} < \frac{\alpha}{\beta} < \frac{4N^2\gamma-3N^2\gamma^2+3N^2+3\gamma^2+6\gamma+3}{16N^2\gamma-12N^2\gamma^2+12N^2}$ *is sufficient and necessary for a spontaneous differentiation equilibrium to exist, in which each site attracts N disjoint segments of single-homing consumers. Between two segments served by different sites a certain proportion of consumers multi-home. Formally,*

$$T_1^*(x) = \begin{cases} 2 & \text{if } x \in [\frac{2k}{2N}, \frac{2k}{2N} + x^*), \\ 1 & \text{if } x \in [\frac{2k}{2N} + x^*, \frac{2k+1}{2N}) \bigcup [\frac{2k+1}{2N} + x^*, \frac{2k+2}{2N}), \quad (k = 0...N) \\ 0 & \text{if } x \in [\frac{2k+1}{2N}, \frac{2k+1}{2N} + x^*). \end{cases} \tag{5}$$

where $x^* = \frac{\beta/2+2N^2\alpha-N^2\beta/2}{N\beta} - \frac{4N^2\alpha-N^2\beta}{(1+\gamma)N\beta}$.

If $\alpha > 4\beta$ *and* $\gamma > \frac{1}{2}$*, a winner-take-all equilibrium also exists:* $T_i^*(x) = 2$*,* $x \in [0,1)$.

Figure 1 maps the equilibrium conditions in the parameter space for $N \leq 5$. To set a benchmark, let's first consider the extreme case on the upper left corner. When $\beta = 0$ and $\gamma = 1$, in particular, the model reduces to the classic global network externality model without multi-homing.

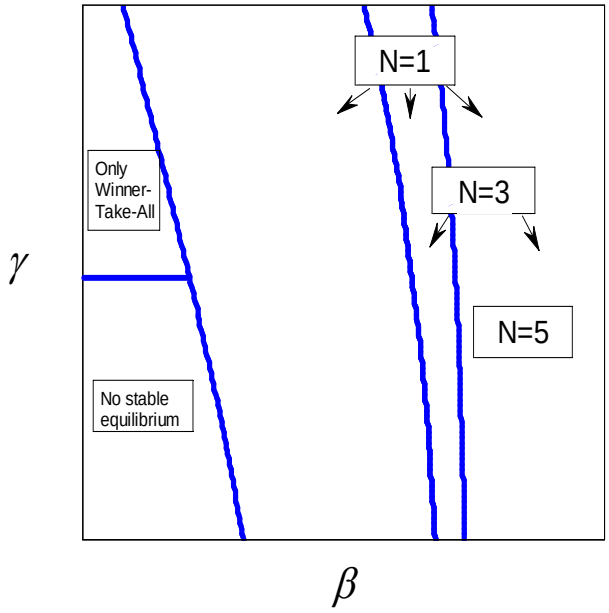

Figure 1: Illustration of equilibrium patterns.

Consistent with the literature, the only possible equilibrium in this case is a winner-take-all outcome where all consumers single-home in the same website. Proposition 1 further establishes that the winner-take-all equilibrium exists as long as β is not too large and γ is not too small [15].

When network effects are sufficiently local ($\frac{\alpha}{\beta} < \frac{4N^2\gamma-3N^2\gamma^2+3N^2+3\gamma^2+6\gamma+3}{16N^2\gamma-12N^2\gamma^2+12N^2}$), there exists an equilibrium where ex-ante identical firms host differentiated user-generated content. Let's start from the simplest case where $N = 1$. Figure 2 illustrates the time allocation pattern.

We name this equilibrium outcome 'spontaneous differentiation' to reflect the fact that the firms offer ex-ante identical platforms and product differentiation is entirely driven by user-generated content. In the case $N = 1$, the equilibrium pattern resembles that of a classic Hotelling model where the firms pursue maximal differentiation. However, the 'market positions' emerge as a result of consumer coordination instead of firm choices. The spontaneous differentiation equilibrium has the following features:

[15] In a circular city model, for certain parameter combinations, both the winner-take-all outcome and spontaneous differentiation can be equilibria. In a linear city model, the winner-take-all equilibrium and the spontaneous differentiation equilibrium exist in mutually exclusive parameter regions.

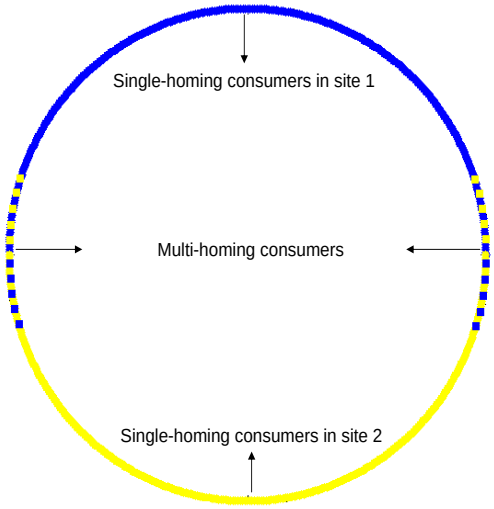

Figure 2: Spontaneous differentiation: $N = 1$.

- Similar to the classic horizontal differentiation, spontaneous differentiation reduces the intensity of competition and leads to higher profits. Both firms earn non-zero profits even if they are ex-ante identical.

- The spontaneous differentiation equilibrium only exists when network effects are sufficiently local. When network effects are sufficiently global, the winner-take-all outcome is the only equilibrium.

- Spontaneous differentiation equilibria always exist in multiplicity. In a circular city model, for $N = 1$, there is an infinite number of ways in which the firms can divide the market in a symmetric fashion [16].

- The multi-homing consumers are located between two neighboring segments using different platforms. The size of the multi-homing segment increases in the strength of the satiation effect.

[16] To see this, note that each point on the circle can be considered as the origin in Proposition 1. N is required to be an odd number, which is an artifact of the model and has no qualitative meaning.

In many social media markets, we observe instances where certain groups of consumers 'hijack' a website and grant the website a 'market position' that the firm did not intend to obtain. The early players in the social networking industry, Orkut, Friendster and Myspace, all started in the US. Soon after, however, Orkut started taking 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[17]. Until very recently, Orkut remained the biggest social networking website in Brazil despite strong competition from Facebook. Similarly in her ethnographic study, Boyd (2010) suggests that a type of differentiation shaped by 'race and class' emerged between MySpace and Facebook during the years 2006-2009. Drawing from interview and observation data, Boyd (2010) suggests that "subculturally identified teens appeared more frequently drawn to MySpace while more mainstream teens tended towards Facebook."

We find that multi-homing consumers are those who have intermediate preferences in relation to the core users of different platforms. This is consistent with anecdotal observations. For example, Brazilians who live in the US are the most likely to join both Myspace and Orkut to connect to friends in both countries[18]. In the *Pew Research* survey on social network users (Lenhart 2009), the most stated reasons for multi-homing include 'keeping up with friends on different sites', 'separating personal and professional life' and 'representing different parts of my personality'.

When network externalities are sufficiently local, there exists interesting equilibria where each firm simultaneously attracts multiple disjoint consumer segments. Figure 3 illustrate the case where $N = 3$:

In a symmetric equilibrium, three disjoint consumer segments join site 1 while the other three segments join site 2. Unlike in the $N = 1$ case, the firms do not have clear defined market

[17] See http://slashdot.org/article.pl?sid=04/07/17/2243232 and http://www.nytimes.com/2006/04/10/technology/10orkut.html.

[18] See this argument examined in http://www.zephoria.org/thoughts/archives/2010/08/17/social-divisions-between-orkut-facebook-in-brazil.html.

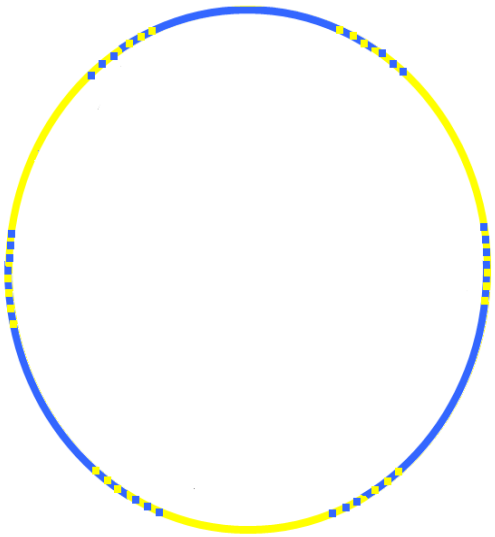

Figure 3: Spontaneous differentiation: $N = 3$.

positions. Each firm actually attracts multiple isolated consumer segments who are different from each other and may have *low* valuation of each other's presence. Interestingly, this can be sustained as a stable outcome and it decreases firm competition and leads to higher profit. Proposition 1 states that when network effects are sufficiently local, there exist such an equilibrium for any odd number of N. For example, there exists a spontaneous differentiation equilibrium where each firm attracts five disjoint segments when $\frac{\alpha}{\beta} < \frac{100\gamma-75\gamma^2+75+3\gamma^2+6\gamma+3}{400\gamma-300\gamma^2+300}$. As illustrated in Figure 1, for any $N_2 > N_1$, the existence of the N_2 equilibrium implies the existence of the N_1 equilibrium. It is also worth noting that the inequality defined in Proposition 1 implies a non-empty set of parameters for any N.

Qualitatively, this result establishes that with user-generated content, competing firms can sometimes attract multiple consumer segments with quite different tastes. It is reminiscent of Orkut's simultaneous success in three culturally distinct countries: Brazil, India and Estonia. Orkut became one of the most visited websites in Brazil and India until 2010. As of April 2010, 48% of Orkut's traffic comes from Barzil while 39% of its traffic is from India. At the same time, it has also

become the most used social network platform in Estonia[19]. Although these three user groups are simultaneously present in the Orkut community, they form sub-communities that seldom interact with each other.

4.2 The Role and Nature of Competition

Clearly, spontaneous differentiation is a consequence of user-generated content as well as local network effects. But do sites also play a role in the creation of spontaneous differentiation? Asked differently, would spontaneous differentiation exist without the firms' active participation? We find that site competition is often a necessary condition for spontaneous differentiation to be sustained. To illustrate this point, consider a model where the firms do not interact in a competitive way (e.g., advertising levels are fixed). Proposition 2 states the existence condition for spontaneous differentiation when firms don't compete. We focus on the case $N = 1$.

Proposition 2. *When $a_1 = a_2 = a^*$, the stable spontaneous differentiation equilibrium with $N = 1$ exists if and only if $\frac{\beta}{4} < \alpha < \frac{\beta+3\gamma\beta}{8\gamma-2\gamma^2+2}$. Since $\frac{1+3\gamma}{8\gamma-2\gamma^2+2} < \frac{5\gamma+3}{8\gamma-6\gamma^2+6}$, the spontaneous differentiation equilibrium with $N = 1$ is more likely to exist when firms compete with each other. When $\frac{\alpha}{\beta} > \frac{1+3\gamma}{2+10\gamma}$, social welfare is lower in the spontaneous differentiation equilibrium than in the winner-take-all equilibrium.*

Proposition 2 states that when firms do not compete (advertising levels are fixed[20]), the spontaneous differentiation equilibrium is less likely to exist. For example, when $\frac{1+3\gamma}{8\gamma-2\gamma^2+2} < \frac{\alpha}{\beta} < \frac{5\gamma+3}{8\gamma-6\gamma^2+6}$, firm competition is a necessary condition for the existence of spontaneous differentiation equilibrium. When $\frac{\alpha}{\beta} > \frac{1+3\gamma}{2+10\gamma}$, interestingly, consumers are collectively better off if they join the same community. Thus, competition between the firms may lead to *too much* 'consumer segregation' and lower social welfare.

[19] http://en.wikipedia.org/wiki/Orkut.

[20] a^* can be any advertising level provided that it doesn't lead to negative consumer surplus.

In the early days of social networking, a number of competing websites dominated different markets. More recently, however, Facebook is emerging as the dominant social networking service across the world. It surpassed Friendster as the most popular social networking site in the Philippines and Orkut as the most popular site in India and Brazil. Essentially, the social networking market has turned from a divided market into a winner-take-all market. Observers of the social networking industry have proposed a plethora of reasons for Facebook's international dominance. Among other things, the shift in market concentration coincided with an interesting technological shift that changed the nature of competition. Prior to 2007, social networking users were primarily engaged in sharing messages, photos and other content with their friends. In May 2007, Facebook introduced the so-called third party developer platform, which allowed third party developers to develop games and applications for Facebook users. Myspace, Friendster and Orkut all followed suit soon after. These games and apps quickly became an important activity on social networks. As of 2010, 53% of Facebook users play games and 50% of the log-ins are specifically to play games[21].

In our terminology, when social network users' primary activity is browsing the photos and posts by their friends, the network effects are local in nature. Photos posted by one consumer are only (or mostly) of interest to her friends. When third party apps entered the picture, the network effects become *indirect* and much more global. Apps and games created for US consumers also have strong appeal to the Brazilian users. Developers want to create more apps for large sites, which further enables the largest site to leverage its app base to increase market share. The rise of applications and games makes network effects much more global, and this could be one of the many reasons that eventually led to the global dominance of a single website.

[21] http://www.allfacebook.com/facebook-games-statistics-2010-09.

4.3 Firm Profits

Finally, we study the profit implication of spontaneous differentiation. In particular, we present a number of comparative static results to examine how the localness of network externalities (measured by β when α is fixed) and saturation from repeated content consumption (measured by γ) impact consumer behavior and firm profits. Corollary 1 describes the equilibrium firm profits in a spontaneous differentiation equilibrium with N segments.

Corollary 1. *In the symmetric spontaneous differentiation equilibrium with N segments, the equilibrium firm profits are* $\frac{\beta+\gamma(\beta+4N^2\alpha-N^2\beta)-4N^2\alpha+N^2\beta}{16N^2}$. *Equilibrium profits are increasing in* β *and* γ. *In words, profits increase in the localness of network effects. More multi-homing consumers coincide with lower profits.*

In the classic horizontal differentiation literature, the degree of product differentiation is usually measured by a 'transportation cost' parameter t a la Hotelling. Higher transportation cost implies higher profits. In the social media setup, we observe that the localness of network effects, β is the analogy of the transport cost parameter in the classic scenario. Firm profits rise as network effects become more local.

More interestingly, we find that stronger satiation from content consumption leads to lower firm profits. Stronger satiation implies that more consumers will multi-home. When content is user-generated, multi-homing will reduce the degree of spontaneous differentiation. When a user participates in competing websites, the content she contributes appears on both websites. Thus, multi-homing behavior leads to greater overlap of content and therefore less product differentiation. Reduced differentiation intensifies competitive pressure and leads to lower profits. Figure 4 illustrates the degree of product differentiation (as measured by $u_0(2;T_1^*(y),a_1^*,a_2^*) - u_0(0;T_1^*(y),a_1^*,a_2^*)$) and the number of multi-homing consumers as a function of γ. The figure shows a clear negative relationship between the two variables: the degree of spontaneous differen-

tiation is maximized when no consumer multi-homes.

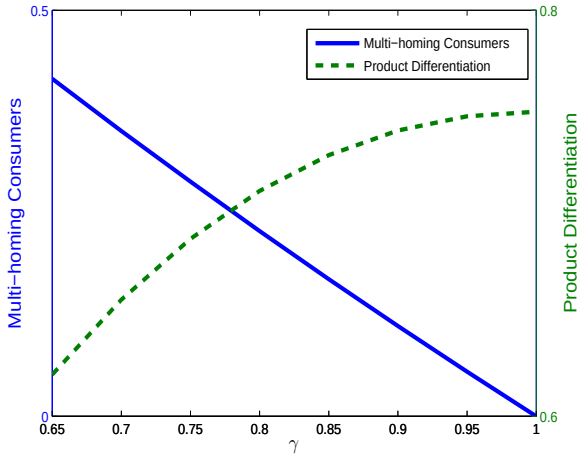

Figure 4: Multi-homing Coincides with Less Spontaneous Differentiation.

It is worth pointing out that saturation from repeated content consumption is just one of the many possible causes to consumer multi-homing behavior. However, we believe that the above link between multi-homing and the degree of product differentiation is a more general result. The comparative static result is likely to generalize to other scenarios where the driver of multi-homing is different.

Finally, observe that in an equilibrium where the firms attract multiple disjoint consumer segments ($N > 1$), the equilibrium profits are lower. This result is intuitive since firms have stronger incentives to undercut their competitors when they 'border' each other on multiple 'fronts'.

5 Designing Social Media Sites

5.1 Explicit Firm Positioning

In the baseline model, we consider a duopoly of social media sites that are ex-ante identical. Thus, user-generated content is the only driver of content differentiation. This setup highlights the core competitive dynamics that user-generated content imposes on the market. In many cases, however,

competing firms can explicitly differentiate their services by introducing design features that appeal to a certain consumer segment. Put differently, market positions and, therefore, differentiation can be jointly determined by firm design and user-generated content. For example, LinkedIn has features such as on-line CV that appeals to professionals. An on-line dating website can introduce personality test and compatibility matching algorithms as part of the service. These features appeal to the users who seek long-term relationships. When a user evaluates a dating site, both the design features and the quality of the user pool (i.e., the match between that site's users and herself) will enter her utility function. To reflect this idea, we modify our original consumer utility function as follows:

$$u_x(T_1(x);T_1^e(\cdot),a_1,a_2) = c + \int_{y\in[0,1]} \delta(x,y,T_1(x),T_1^e(y))dy - T_1(x)a_1 - (2-T_1(x))a_2 \\ - T_1(x)(x-x_1)^2 t - (2-T_1(x))(x-x_2)^2 t,$$

where all prior definitions are maintained, x_i defines the location of firm i in the consumer preference space and t is a classic transportation cost. The last two components of the utility function capture consumers' 'transportation disutility' term in case they allocate their time to either of the platforms. Clearly, in this setup, the relative magnitudes of α, β with respect to t determine the importance of user-generated content vs. firm design.

In the first stage of this game, sites choose their location x_1 and x_2. In the second stage, firms set their advertising levels and the consumers make time allocation decisions. As in the previous section, we seek the Stable Fulfilled Expectation Equilibrium in the second stage. Since the second stage subgame usually has multiple equilibria, subgame perfection in the first stage is not straightforward. Therefore, we discuss the equilibrium market outcomes in the subgame where the firms maximally differentiate. For simplicity, we fix $\gamma = 1$. Proposition 3 outlines the equilibrium market structures.

Proposition 3. *Consider two maximally differentiated firms with* $x_1 = \frac{1}{4}$ *and* $x_2 = \frac{3}{4}$*:*

- *When* $\frac{\beta}{4} < \alpha < \beta + \frac{3t}{4}$*, there exist an equilibrium where* $T_1^*(x) = 2$ *if* $x < \frac{1}{2}$ *and* $T_1^*(x) = 0$ *if* $x > \frac{1}{2}$.

- *When* $\frac{\beta}{4} < \alpha < \beta - \frac{3t}{4}$*, there exist an equilibrium where* $T_1^*(x) = 0$ *if* $x < \frac{1}{2}$ *and* $T_1^*(x) = 2$ *if* $x > \frac{1}{2}$.

- *When* $\alpha > \frac{\beta}{4} + \frac{3t}{4}$*, winner-take-all is an equilibrium outcome.*

Proposition 3 highlights the interesting interaction between user-generated content and firm design. Independently, both user-generated content and firm's product design can lead to product differentiation. When both factors are present, however, they may either enhance or contradict each other. When the localness of network effects is intermediate ($\beta - \frac{3t}{4} < \alpha < \beta + \frac{3t}{4}$), firms may attract the consumer segments they intend to target. User-generated content will further enhance product differentiation. In light of the on-line dating example, a website with a superior personality matching algorithm will attract the long-term daters, who will further enhance the website's image as a destination for serious relationships.

Interestingly, when the localness of network effects is high ($\alpha < \beta - \frac{3t}{4}$), user-generated content may override firms' product designs. The firms may attract the consumer segment they do not intend to target. The firm located at $x_1 = \frac{1}{4}$ may attract the consumers centered around $x = \frac{3}{4}$. Although these consumers actually prefer the website features offered by site 2, they will collectively join site 1 because of user-generated content. This is a self-fulling outcome and reflects the path dependent nature of social media competition: once a website attracts a critical mass of a certain type of users, more users of the same type will favor the website and its feature design becomes less relevant. 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 the features the website provides.

Finally, Proposition 3 states that when sites pursue differentiated feature designs, the like-

lihood of winner-take-all outcome is reduced. This is consistent with the literature on network effects, where product differentiation typically makes it easier for the firms to co-exist.

The interaction between user-generated content and site design has interesting profit implications. When user-generated content enhances the firms' chosen market positions, firms profits increase in both β and t. When user-generated content is misaligned with site design, however, firm profits increase in β but decrease in t. The equilibrium profits can be lower compared with the cases where only one source of differentiation is present (i.e., either user content or feature design is absent). Higher β increases differentiation from user-generated content, but also increases the likelihood of such misalignment.

5.2 Limiting User Interaction

In the baseline model, we consider a marginal utility function which is linearly decreasing in the distance between two users. The formulation implies negative marginal utility between users that are sufficiently different. In many social media markets, anecdotal observations suggest that negative network effects do exist. Users complain about unpleasant experience in both on-line dating and virtual world platforms. Under many circumstances, however, social media users are able to manage their interactions so as to minimize negative network effects. This is facilitated by tools that control and filter content sharing. For example, the 'circle' feature in Google+ and the 'Friend List' feature in Facebook both enable the users to be more selective in sharing content. We capture this idea by the following marginal utility function:

$$\delta^{'}(x,y,T_1(x),T_1^e(y)) = \max\{\delta(x,y,T_1(x),T_1^e(y)),0\} \tag{6}$$

$\delta()$ is defined as in Section 3.1. Essentially, this new specification ensures that the marginal utility function is bounded above zero. For simplicity, we consider the special case where $\gamma = 1$ such that the consumers do not multi-home. This formulation introduces discontinuities into the

demand functions and leads to the lack of pure strategy equilibrium for many parameter combinations. Due to this technical complexity, Proposition 4 states existence conditions that are sufficient but *not necessary*.

Proposition 4. *When* $\frac{1}{4} < \frac{\alpha}{\beta} < 1$*, there exists a spontaneous differentiation equilibrium where* $T_i^*(x) = 2$ *if* $x < \frac{1}{2}$ *and* $T_i^*(x) = 0$ *if* $x > \frac{1}{2}$*. When* $\frac{1}{4N} < \frac{\alpha}{\beta} < \frac{1}{2N}$*, a spontaneous differentiation equilibrium with* $N > 1$ *segments exists. A winner-take-all equilibrium exists for any parameter combination.*

Qualitatively, Proposition 4 highlights that "spontaneous differentiation" is a fundamental feature of markets with user-generated content and local network effects. In addition, greater localness in network effects leads to more fragmented outcome, where a community simultaneously attracts multiple isolated consumer segments.

6 Concluding Remarks

In this paper, we study the competition between social media sites. We model three unique aspects of the social media industry, namely (i) user-generated content, (ii) local network externalities and (iii) consumer multi-homing. We find that these characteristics lead to an intriguing pattern of equilibria in which firms spontaneously acquire differentiated market positions by attracting different groups of content contributors. More interestingly, as the localness of network effects increases, firms may acquire ambiguous positions as they acquire disjoint consumer segments who seldom interact with one another. We study the properties of spontaneous differentiation and find that more local network effects increase the degree of differentiation while multi-homing coincides with reduced differentiation. We also show that competition has an important role in such spontaneous customer segregation, which may thus lead to lower consumer surplus. In one extension we consider the interaction between user-generated content and the websites' design

features. While both user content and site design can lead to product differentiation, these factors may either enhance or contradict each other, leading to interesting situations where sites might end-up with customers they did not target. Our results help understand the competitive forces of this industry and shed light on a number of stylized facts observed in the decade-long history of the social media industry.

The social media industry is a fast developing industry with many innovations in both the technology and business domains. Our model may be extended to study the impact of these innovations on the industrys evolution. For example, future research could explore the effect of content sharing across social media platforms, which is in the process of being implemented by some sites (see e.g., the recent content sharing agreement between LinkedIn and Twitter or the OpenSocial standard advocated by Google). What equilibrium patterns are likely to emerge under content sharing and what are firms' incentives to share content in a competitive setup. Similarly, in our model, we have considered consumers to be homogeneous with respect to their content contribution and content consumption behaviors. Consumer heterogeneity in this respect is definitely an interesting research question to explore. A third aspect of the industry that we ignored relates to the intensity and the timing of entry. This is relevant because despite Facebooks increasing dominance a multitude of specialized social networks still launch their platforms. We show that, contrary to the findings of the classic network literature, local network effects reduce competition, which may mean that late entrants could easily co-exist with incumbents. It would be interesting to see the pattern of industry evolution and the equilibrium number of players in a dynamic entry model. Clearly, a lot of interesting questions remain unanswered in the current setup.

Finally, it is important to realize that some of our key insights have more general theoretical implications for economics and marketing. While user-generated content and local network effects are dominant features of the social media industry, they are certainly present in many microeconomic contexts. In marketing for instance, so-called ego-expressive brands are largely built by

the consumers who use them. In this sense, the same nominal brand might represent different value in different cultures (e.g. the meaning of BMW might represent 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.

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 plans. We say $T_1^{'}$ is an ε-marginal perturbation of T_1^* if $T_1^{'}(x)$ and $T_1^*(x)$ 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 $T_i^*(x)$ that satisfies the following condition: $\exists \delta$, $\forall$ symmetric ε-marginal perturbation $T_i^{'}(x)$ of $T_i^*(x)$ where $\varepsilon < \delta$, $\left\| \Gamma(T_i^{'}(x)) - \Gamma(T_i^*(x)) \right\| < \left\| T_i^{'}(x) - T_i^*(x) \right\|$, 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[22].

References

Anderson, S.P., S. Coate. 2005. Market Provision of Broadcasting: A welfare analysis. *Review of Economic Studies* **72**(4) 947–972.

Anderson, S.P., J. Gans. 2010. Platform Siphoning: Ad-Avoidance and Media Content. *CEPR Discussion Papers* .

Armstrong, M. 2006. Competition in Two-sided Markets. *RAND Journal of Economics* **37**(3) 668–691.

Banerji, A., B. Dutta. 2009. Local Network Externalities and Market Segmentation. *International Journal of Industrial Organization* **27**(5) 605–614.

Baye, M.R., J. Morgan. 2001. Information gatekeepers on the internet and the competitiveness of homogeneous product markets. *American Economic Review* 454–474.

Berger, J., K. Milkman. 2011. What Makes Online Content Viral? . forthcoming in Journal of Marketing Research .

Boyd, D. 2010. White Flight in Networked Publics? How Race and Class Shaped American Teen Engagement with MySpace and Facebook. Lisa Nakamura, Peter Chow-White, eds., *Digital Race Anthology*. Routledge.

Caillaud, B., B. Jullien. 2003. Chicken & Egg: Competition Among Intermediation Service Providers. *Rand Journal of Economics* **34**(2) 309–328.

Chen, Y., J. Xie. 2007. Cross-market Network Effect with Asymmetric Customer Loyalty: Implications for competitive advantage. *Marketing Science* **26**(1) 52.

Chevalier, J.A., D. Mayzlin. 2006. The Effect of Word of Mouth on Sales: Online Book Reviews. *Journal of Marketing Research* **43**(3) 345–354.

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

d'Aspremont, C., J.J. Gabszewicz, J.F. Thisse. 1979. On Hotelling's" Stability in Competition". *Econometrica: Journal of the Econometric Society* **47**(5) 1145–1150.

Doganoglu, T., J. Wright. 2006. Multihoming and Compatibility. *International Journal of Industrial Organization* **24**(1) 45–67.

Dukes, A. 2004. The Advertising Market in a Product Oligopoly. *The Journal of Industrial Economics* **52**(3) 327–348.

Dukes, A., E. Gal-Or. 2003. Negotiations and Exclusivity Contracts for Advertising. *Marketing Science* **22**(2) 222–245.

Farrell, J., P. Klemperer. 2005. Coordination and Lock-in: Competition with Switching Costs and Network Effects. *Handbook of Industrial Organization* **3** 1967–2072.

Fjeldstad, Ø., E.R. Moen, C. Riis. 2009. Competition with Local Network Externalities. *Working Paper, Norwegian School of Management* .

Gabszewicz, J.J., D. Laussel, N. Sonnac. 2004. Programming and Advertising Competition in the Broadcasting Industry. *Journal of Economics & Management Strategy* **13**(4) 657–669.

Ghose, A., S. Han. 2011. An Empirical Analysis of User Content Generation and Usage Behavior on the Mobile Internet. forthcoming in Management Science .

Goldenberg, J., B. Libai, E. Muller. 2010. The chilling effects of network externalities. *International Journal of Research in Marketing* **27**(1) 4–15.

Guo, L. 2006. Consumption Flexibility, Product Configuration, and Market Competition. *Marketing Science* **25**(2) 116–130.

Hirschman, A.O. 1964. The paternity of an index. *The American Economic Review* 761–762.

Huang, Y., P. Singh, A. Ghose. 2011. A Structural Model of Employee Behavioral Dynamics in Enterprise Social Media. Working Paper .

Kahn, B.E. 1995. Consumer variety-seeking among goods and services: An integrative review. *Journal of Retailing and Consumer Services* **2**(3) 139–148.

Katz, M.L., C. Shapiro. 1985. Network Externality, Competition and Compatibility. *American Economic Review* **75**(3) 424–440.

Katz, M.L., C. Shapiro. 1986. Technology Adoption in the Presence of Network Externalities. *The Journal of Political Economy* **94**(4) 822.

Kuksov, D., R. Shachar. 2010. User Generated Content and Image Advertising. *Working Paper, Washington University and Tel Aviv University* .

Lenhart, A. 2009. Social Networks Grow: Friending Mom and Dad. http://blogs.hbr.org/cs/2009/11/six_social_media_trends.html. [Online; accessed 04-Nov-2010].

Ofek, E., M. Sarvary. 2001. Leveraging the Customer Base: Creating Competitive Advantage Through Knowledge Management. *Management Science* **47**(11) 1441.

Rochet, J.C., J. Tirole. 2006. Two-Sided Markets: A Progress Report. *The RAND Journal of Economics* **37**(3) 645–667.

Sajeesh, S., J.S. Raju. 2010. Positioning and pricing in a variety seeking market. *Management science* **56**(6) 949–961.

Salop, S.C. 1979. Monopolistic competition with outside goods. *The Bell Journal of Economics* 141–156.

Seetharaman, PB, H. Che. 2009. Price competition in markets with consumer variety seeking. *Marketing Science* **28**(3) 516–525.

Sun, B., J. Xie, H.H. Cao. 2004. Product Strategy for Innovators in Markets with Network Effects. *Marketing Science* **23**(2) 243–254.

Trusov, M., R.E. Bucklin, K. Pauwels. 2009. Effects of Word-of-mouth Versus Traditional Marketing: findings from an Internet social networking site. *Journal of Marketing* **73**(5) 90–102.

Tucker, Catherine, Juanjuan Zhang. 2010. Growing Two-Sided Networks by Advertising the User Base: A Field Experiment. *Marketing Science* **29**(5) 805–814.

Wilbur, K.C. 2008. A Two-Sided, Empirical Model of Television Advertising and Viewing Markets. *Marketing Science* **27**(3) 356.

Xiang, Y., M. Sarvary. 2007. News Consumption and Media Bias. *Marketing Science* **26**(5) 611–628.

Xie, J., M. Sirbu. 1995. Price Competition and Compatibility in the Presence of Positive Demand Externalities. *Management Science* **41** 909–909.

Yang, S., M. Hu, H. Assael, R. Winer. 2011. The Interdependence of Word-of-Mouth Generation and Consumption. Working Paper .