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Abstract

New forms of implicit consumer collaborations in online communities and social networks influence demand preferences as consumers themselves increasingly participate in creating cultural products that both complements and competes with firm offerings. Although research findings on these issues vary, strong evidence from both theoretical and empirical work suggests that the increased technology affordance on the consumer side challenges the profitability of conventional producer strategies that are based on pushing product designs that serve large segments of consumers while ignoring the service of more nuanced consumer preferences. In this study, we present a market design in which producers create and sell original digital culture product and, examine the effect of consumer co-creation in the presence of consumer sharing (piracy) on market performance in terms of consumer and producer surplus and consumer choice. Using the methods of experimental economics, we find strong interaction effects between consumer sharing and co-creation, and, more specifically, we find that consumer sharing interacts with consumer-based co-creation and increases product variety and consumer surplus while reducing producer benefits from co-creation.

Keywords: *Co-creation, Consumer Sharing, Experimental Economics, Content Reuse, Design Science, Digital Culture Products, Market Design, Open Innovation, Piracy, Remix.*

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Consumer Co-creation of Digital Culture Products: Business Threat or New Opportunity?

1. Introduction

Digital co-creation has emerged as a new practice that is changing how cultural content gets made, used, and exchanged (Katz, 2010)[1]. A new generation of digital consumers increasingly samples and reuses parts of accessible content in an effort to customize the content to their own personal tastes. Many users then share this altered content with others. Such co-creation activities include remixes of music, video, and movies that are posted on content-sharing platforms in online community and social networking sites. An example of such a consumer co-creation activity is a personal mashup home video in which parents film their children in a private setting (e.g., a birthday party or a vacation trip), add commercially released music as a soundtrack, and then share the video with family and friends online.

The traditional business model in the cultural content industries (e.g., music, film, television) is built around the legal principle of strong, exclusive copyrights, and it denies both professionals and amateurs from reusing any content without explicit permission. This approach allows content owners to earn "monopoly" profits that can sustain continuous innovation, to prevent free riding, and also to maintain control over the content (Krasilovsky, Shemel, Gross, & Feinstein, 2007). Until recently, consumers lacked the technical means to significantly participate in content co-creation, but contemporary digital technology now provides cheap and easy ways to use remix and mashup tools, which has fostered a massive amateurization of content co-creation, often in conflict with the current copyright regime. Most of the incumbents in the content industry have viewed co-creation capabilities in the hands of consumers as a threat; however, some business ventures offer content co-creation platforms and explicitly encourage users to remix provided content (Passman, 2012). The need to develop legally supported co-creation platforms to complement the production of creative output in the content industries is the key recommendation of some major legal and government policy studies (e.g., Broussard, 1991; Hargreaves, 2011). Hence, with this research, we help with developing market designs that effectively support content co-creation business models—models in which original creators and users of content collaborate together and produce variations and recombinations of cultural goods.

Some businesses in the culture industries have already adapted to the new environment and incorporated elements of consumer sharing and co-creation into their business model to leverage collective creativity and better serve demand. For example, in music, the Grammy Award-winning band Nine Inch Nails (NIN) has offered new song releases in the form of multi-tracks on their website and has explicitly encouraged fans to remix the original content (Jarvenpaa & Lang, 2011)[2]. Essentially, NIN offers its original content broken down into components (multi-tracks) with a license for users to reuse these components and to freely remix them and post them back to the NIN community. Members of the NIN fan community have co-created more than 10,000 consumer remixes for the NIN community. Interestingly, despite its open content availability on the band's website, the band's 2008 album release, Ghosts I-IV, was still a commercial success in the traditional music formats: it registered as the number one bestselling album of 2008 on Amazon[3].

Consumer co-creation—enabled by technology change (i.e., digital content transmutability and remix capability) and driven by people's desire (i.e., consumer preferences) to participate in the creative process of making and remaking cultural goods—is a new phenomenon that clearly has significant effects on businesses, consumers, and culture in general (see, e.g., von Hippel & Katz, 2002; Prahalad & Ramaswamy, 2004; Hughes & Lang, 2006; Lessig, 2008). However, what the exact economic effects of a more open approach to content reuse by consumers would be is less clear. In a preliminary study, Lang, Shang, and Vragov (2009) looked at this question by examining the

[1] Cultural content products are goods that exhibit three objectively verifiable characteristics: (1) they derive from some form of artistic creativity, (2) they communicate symbolic meaning, and (3) they constitute intellectual property that is protected by copyright law (Thornsby, 2001, p. 4). In this paper, we focus specifically on the cultural product sectors of music and movies. The dynamics of coding software and gaming are quite different from making music and movies and, hence, we exclude these sectors from our study, although we refer to relevant research from open source software and gaming where appropriate.

[2] http://remix.nin.com

[3] http://www.amazon.com/b/ref=amb_link_7866952_18?ie=UTF8&node=1240544011

economic effects of introducing one specific content reuse licensing arrangement in an experimental market environment. Their findings suggest that both consumers and producers can benefit from co-creation in terms of surplus generated in the market. But while Lang et al. (2009) establish a link between co-creation and producer and consumer surplus, they ignore possible effects from consumer sharing (or piracy) and so potentially overestimate the benefits from co-creation. In our study, we address this limitation and particularly look at how consumer sharing and co-creation act together in a digital content market. As several industry surveys, including those of the Business Software Alliance and the Social Science Research Council, have reported, consumer sharing is prevalent in the media industries, and authors/creators have only limited control over the sharing/piracy behavior on the consumer side[4]. The piracy literature largely argues that consumer sharing results in lost sales and undermines the business model of the content producers (e.g., Clemons, Gu, & Lang, 2002; Rob & Waldvogel, 2006; Liebowitz, 2008), which raises the concern that consumer sharing could similarly offset the benefits that might be obtained from consumer co-creation.

We specifically consider two economic shifts that have affected the markets for digital culture products: (1) Increased consumer adoption of co-creation activities, driven by easily available digital content editing and remix tools; and (2) increased sharing of digital content, whether made by professional or amateur creators, whether legally shared or not, and whether shared for simply copying or for creative reuse. Based on Landes and Posner' (1989) formal economic analysis, we suggest that consumer sharing and co-creation are theoretically linked. Landes and Posner generally argue that copyright protection regulates access to previous works, which affects the production cost and the number of new works produced. In this paper, we specifically differentiate two types of access to previous works: the access to previous works through (legitimate) reuse licenses and the access to previous works through (illegitimate) consumer sharing. We explore whether and how the two types of access might interdependently affect the number of new works produced and consumer and producer surplus.

We developed a simplified market design that includes producers and consumers of cultural content and implemented it in the laboratory. Using methods of experimental economics, we then compared two markets for digital culture products: one that permitted consumer co-creation through a content licensing arrangement and another that did not. The latter represents the traditional industry model based on closed content while the former offers consumers a right to non-commercially reuse content that they purchase[5]. In addition, we consider two market environments: one in which consumer sharing is present and one in which it is not.

With this general design in place, we are well situated to explore the following specific research questions:

RQ1: To what extent does consumer sharing (piracy) interact with consumer co-creation in digital content markets?

RQ2: How does this interaction, if present, affect the market in terms of product variety and in terms of producer and consumer surplus?

We use the standard economic market performance variables of producer surplus (measuring the value that is created and kept by the commercial content creator), consumer surplus (measuring the value that the commercial content creator passes on to its customers), and product variety (measuring consumer choice). Hence, while the level of observation in our study is the individual (producer and consumer), the level of analysis is the market (the economy).

We found strong interaction effects between consumer sharing and co-creation on market performance. Our results indicate that consumer co-creation creates surplus through increased

[4] See http://globalstudy.bsa.org/2011/ and http://piracy.americanassembly.org/the-report/

[5] Using the terminology that von Hippel (2005) and Lessig (2008) suggest, we introduce a content reuse license of this sort to represent a hybrid business model that combines elements of both closed (no reuse access to content) and open (free access to content for any purposes) business models.

product selection (a consumer benefit) and higher prices for core products (a producer benefit). Consumer sharing interacts with the effects of consumer co-creation by increasing consumer surplus but reducing producer profits. However, cultural goods markets can tolerate certain levels of consumer sharing if creative consumers focus on co-creating products in the small niches of the "long tail", which represents demand that would otherwise likely go unfulfilled. Producers and consumers become strategic partners who need to collaborate to cost-effectively increase differentiation and also to contain consumer sharing.

This paper proceeds as follows: in Section 2, we briefly review related literature. In Section 3, we develop and formally present our research model. In Sections 4 and 5, we elaborate on our experimental design, and, in Sections 6 and 7, we explain measurement issues and discuss our results. Finally, in Section 8, we discuss implications and offer some final remarks.

2. Related Literature

Two streams of research in particular are relevant to this study. First, the emerging interdisciplinary co-creation literature discusses new forms of collaboration between firms and customers, including producers and consumers of creative content products. Second, the literature on digital piracy examines consumer sharing from the legal and economic perspectives.

2.1. Consumer Co-creation

Zwass (2010) comprehensively reviews co-creation and identifies two types of co-creation activities: sponsored co-creation and autonomous co-creation. In our paper, we model an example of sponsored co-creation with explicit, firm-sanctioned collaboration between the original content producers and consumers. Co-creation has been examined from multiple perspectives in several fields. Many scholars argue that the practice of co-creation spurs creativity and increases the supply of derivative works (e.g., Landes & Posner, 1989; von Hippel & Katz, 2002; Prahalad & Ramaswamy, 2004; Jarvenpaa & Lang, 2011).

Research in economics suggests that the value of co-creation is generated from access to and from reusing and combining knowledge and knowledge components. Modern economic growth theory emphasizes that aggregate knowledge accumulation at the macroeconomic level is specifically based on exploring new combinations of ideas (Weitzman, 1998; Aghion & Howitt, 1999). Romer (1986) concludes that access to knowledge created by individual firms ultimately benefits the entire economy because some of it, whether voluntarily or not, spills over and accumulates as generally available aggregate knowledge in the public domain. Brynjolfsson and McAfee (2014) emphasize that technology acceleration and digitization of content has dramatically increased the potential for recombinant innovation. These studies suggest that access to and re-use of existing knowledge is the main driver for innovation and economic growth.

In the software industry, software reuse has been widely adopted in practice (Sherif & Menon, 2004). Specifically, open source development is fundamentally based on reusing, co-creating, and modularizing software code (Lerner & Tirole, 2002; O'Hern & Rindfleisch, 2010). The openness of this process leverages the power of a community of external professionals who contribute to the further developing the software code. Han et al. (2012) investigate the economic value of open innovation alliances (OIAs) and find that the degree of openness of the OIAs is significantly associated with the amount of returns accruing to the partnering firms.

Marketing research has long recognized consumer knowledge as an important source of firms' R&D to enhance innovation and improve business performance (Gibbert, Leibold, & Probst, 2002). The practice of co-creating brands initially started with firms that engaged consumers with product design processes (Prahalad & Ramaswamy, 2000). Research in the innovation literature argues that, with increased co-creation capabilities, both lead users and regular consumers are now able and willing to effectively participate in the design and production process of new products (von Hippel & Katz, 2002; Kristensson, Gustafsson, & Archer, 2004; Payne, Storbacka, & Frow, 2008; Chen, Marsden, & Zhang, 2012).

But these fundamental changes in the product-design and development process also challenge the traditional roles of firms and consumers and present conflicts with the traditional, firm-centric production and development model (Lilien, Morrison, Searls, Sonnack, & von Hippel, 2002). Today's consumers increasingly expect to be able to obtain highly differentiated products that come very close to their specific taste (Clemons, 2008). This trend is reflected in the long-tail distribution of consumer demand (Anderson, 2006). Leveraging user and customer creativity to increase product innovation and customization has been recognized as a new opportunity to lower the production cost of offering a highly differentiated product selection in the market (e.g., von Hippel, 2005; Arakji & Lang, 2007; Lessig, 2008). Open, collaborative user innovations increasingly compete with or complement producer innovations in many parts of the economy, including the content industries (Baldwin & von Hipple, 2011; Yoo, Boland, Lyytinen, & Majchrzak, 2012).

While software projects are complex, long-term efforts that entail continuous improvements and require the input and coordination of a fairly large and often changing group of mostly professional contributors, cultural content production depends much less on large teams and is most often done by individuals or small teams, including amateurs and hobbyists (Lessig, 2004). Hence, consumers with little professional subject expertise are more likely to contribute finished pieces in cultural domains than in the software sector (Shirky, 2008).

From a legal perspective, the reuse and modification of digital content is regulated by copyright law (e.g., Zittrain, 2005). The goal of copyright regulation is to strike a balance between productive and consumptive efficiency (Landes & Posner, 2003). On the one hand, copyright protection should enable content creators to appropriate enough value from their works to give them incentives to continue creating new works in the future. On the other hand, the intent of copyright protection is also to foster social progress by making products easily available to society at large. Accessing content for the purpose of remaking it into something new and different is not just essential for co-creators of digital culture goods but also conceptually very different from copying content just for sharing. Although copyright legislation has regulated content in both situations the same way and has not clearly distinguished the different purposes for accessing content (Litman, 2001), recent court rulings have also established new case law that recognizes the appropriation and reuse of cultural content components for the purpose of creating transformative new content as a legitimate fair-use exception to federal copyright protection[6]. Finally, different international legal standards have emerged and different digital copyright laws implemented in different countries, which creates several issues regarding the production and distribution of co-created content products in the global economy (Stokes, 2014).

To summarize, the co-creation literature recognizes the importance of consumers' creativity, knowledge, and technological capabilities and argues that firms should consider exploring settings where users can legitimately participate in the processes of designing, developing, and producing products in ways that are, on balance, beneficial for both producers and consumers.

2.2. Consumer Sharing

Although consumers share cultural content products over the Internet both legally (e.g., user-generated pictures, music, or videos) and illegally (e.g., digital products that use copyrighted content without permission from the owners), the extant research has focused mainly on the effects of illegal copying and distributing digital content for the purpose of simple sharing among consumers (piracy). However, user creativity in terms of co-creating content has been recognized as a rising phenomenon that, although conflicts with copyright law, is markedly different from conventional online piracy (Vaidhyanathan, 2004; Shirky, 2008; Hansen & Walden, 2013).

[6] In a recent decision by the U.S. Court of Appeals for the Second Circuit on April 24, 2013, with broad implications for the contemporary art world, the judges sided with the collage artist Richard Prince, who borrowed without permission several photographs from a portrait book by Patrick Cariou and used them prominently in his own collage paintings (Kennedy, 2013). Similarly, in the case of *Perfect 10 v. Google,* the courts held that reusing Web content (images) falls under the fair use clause if "accessing content [is] for the purpose of remaking it into something new and different" (Hansen & Walden, 2013, p. 9).

That piracy hurts sellers when consumers simply substitute legitimate with illegitimate copies of content products is widely accepted. For example, Clemons et al. (2002) analyze the music industry that supports the claim that large-scale consumer piracy destroys producers' profits and threatens the entire industry in the long run. Studying a large sample of college students, Rob and Waldvogel (2006) found that piracy reduces consumer expenditure on music while increasing consumer welfare (in the short term). Liebowitz (2008) presents evidence that file-sharing is indeed the principle reason for the decline of the music industry.

Also recognized, meanwhile, is that piracy can benefit sellers through increased product exposure, which can enhance brand and reputation and may generate new sales later on. Bakos, Brynjolfson, & Lichtman (1999) found that small-scale sharing of digital content in small social communities could actually increase seller profits. Liebowitz (1985) argues that unauthorized copying of content products does not necessarily harm producers as long as they can offset lost direct sales with higher prices for legitimate purchasers.

In general, measuring the effect of copying is complex and imprecise, and the net effect of piracy remains inconclusive. For example, Oberholzer-Gee and Strumpf (2007) report an econometric study that looked at the effect of illegitimate music downloads and CD sales. The authors could not establish a causal link between online piracy and sales. Lahiri and Dey (2013) find that, in certain situations, lower piracy enforcement increases the monopolist's incentive to invest in quality, which contradicts the common thinking that piracy results in lower incentives to invest in innovation and product quality.

Investigating piracy's effect on markets, some researchers have proposed recommendations for digital product providers on how best to address piracy. For example, Khouja and Park (2008) look at the effect of piracy on pricing strategies and find that lowering consumer prices can increase legitimate sales. On a macro-level, Chen and Png (2003) examine copyright enforcement regulation and suggest that the optimal government policy in terms of social welfare combines a tax levy on copying media, a detection mechanism that fines copyright infringers, and subsidies on legitimate content purchases. Other researchers suggest sampling strategies, protection strategies, versioning strategies, and provision strategies for producers to mitigate the loss from piracy (see, e.g. Chellappa & Shivendu, 2005; Johar, Kumar, & Mookerjee, 2012)

Lastly, behavioral researchers have observed that consumers tend to share their own creations quite freely with the public and with commercial entities (e.g., Wasko & Faraj, 2005; Xia, Huang, Duan, & Whinston, 2012) and do not necessarily expect to get tangible rewards from their contributions (Allen, 1983; Boyle, 2008).

To summarize, except for the positive effects from additional product exposure, research in piracy emphasizes the negative effects of consumer sharing on content providers.

3. Research Model and Theoretical Relationships

3.1. Methodological Issues

Because our study has strong elements of design science in that we propose and evaluate a market design for digital content products, we largely adhere to the design theoretical approach (March & Smith, 1995; Hevner, March, Park, & Ram, 2004; Gregor, 2006; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007; Goes, 2013). Thus, we use theoretical concepts and findings from the literature to guide our discussion of theoretical relationships among the variables of interest that structure our market design (i.e., co-creation and piracy and how the two might interact and effect market performance), but we refrain from making strong theoretical predictions and from proposing hypotheses that are deeply grounded in theory.

What co-creation does to a market is fairly well understood, and what piracy (sharing) does is very well understood, but what is not so clear is how the two might interact. We draw on theory to

discuss the main effects of co-creation and piracy on market performance. Because these main effects (in isolation) are already well established in the literature, we do not formally state or test any hypotheses about them.

The real focus of the study, of course, is looking at the interaction effects. However, no solid theory is available that would allow us to theoretically predict how these interaction effects, assuming they are present, will play out specifically on our three dependent variables. Therefore, we merely present plausible working hypotheses, which are more akin to open research questions than theoretical predictions, to indicate that the outcome is exploratory and could very well go either way. According to Oppenheimer and Puttman (1958), working hypotheses are useful as a starting point in designing an empirical research exploration and can lead to valuable theoretical or practical insights. Thus, this approach is appropriate given the limited state of knowledge about interactions between consumer co-creation and sharing, and it is consistent with the design theoretical research method.

3.2. Research Model

The co-creation literature theorizes consumers' digital technology capabilities and views consumer participation in the co-creation process as a stimulus for content innovation. However, co-creation processes involving organizations and consumers are exposed to market environmental factors and cannot be strictly regulated by a "governance layer" through contracts and economic safeguards (Grover & Kohli, 2012). Consumer sharing is a key environmental factor in digital markets and needs to be included when examining the effect of consumer co-creation on market performance. However, previous research has largely ignored the potentially critical interaction between consumer co-creation and consumer sharing. We present our exploratory research model in Figure 1. To the extent possible, we use theoretical arguments to discuss interaction effects on three dependent variables: product variety, consumer surplus, and producer surplus.

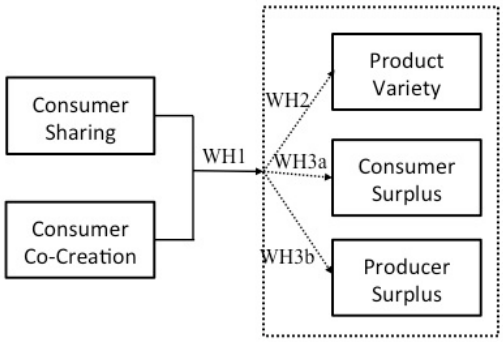


Figure 1. Research Model

3.3. Theoretical Relationships

We consider three effects of interest: (1) the co-creation effect, (2) the consumer sharing effect, and (3) the interaction effects that can occur when both necessary conditions (i.e., the simultaneous presence of co-creation and sharing) are fulfilled. Again, because the two main effects have already been clearly established in the literature, we focus on exploring four possible interaction effects, which the extant literature has not theorized.

3.3.1. The General Interaction Effect of Consumer Sharing and Co-Creation

The (main) effect of co-creation on content markets has been discussed from multiple perspectives in different fields. Culture theory (Jenkins, 2006) asserts that technology-based user co-creation increases the overall variety of cultural products available to consumers. Innovation theory (von Hippel, 2005) similarly suggests that user co-creation increases content innovation. Growth theory in

economics predicts that economic mechanisms that support the recombination of knowledge lead to more innovation and more product variety while also driving economic growth and, thus, benefitting both producers and consumers (Romer, 1986; Weitzman, 1998; Brynjolfsson & McAfee, 2014). At the same time, Lessig (2008) specifically argues that sound (hybrid) business models depend on reuse licenses that grant some access to content for noncommercial reuse purposes while prohibiting free sharing. Although the specific design of such reuse licenses might vary, Lessig emphasizes that permitting legal consumer co-creation activities without endorsing unrestricted consumer sharing is key. Offering consumers a co-creation option gives them more flexibility in getting content and should result in consumer benefits.

The (main) effect of consumer sharing (piracy) on digital content markets has been widely studied both in economics and in information systems with consistent results. Aside from some mitigating benefits, such as increased product exposure, the literature finds that consumer sharing has strong negative effects for businesses. Producers are hurt when consumers substitute illegitimately obtained content for legitimately obtained content, which results in lost sales and reduced profits (Rob & Waldvogel, 2006; Liebovitz, 2008). In the short term, consumer sharing does not affect product variety offered in the market, although content sharing platforms can make finding and obtaining obscure content products easier for consumers. Consumers benefit from sharing because it lets them acquire free copies of valuable content. In the long term, however, consumer sharing presents a strong disincentive for producers to invest in innovating new content and, thus, reduces product variety (Clemons et al., 2002).

In terms of the interdependencies between consumer sharing and co-creation, the literature is underdeveloped. However, in an early work on culture economics that predates the digital age, Landes and Posner (1989) present a theoretical argument that links the two. They theorize cultural content production as a creative process in which new works are necessarily built on previous ones—that is, in which creators are to some degree reusing previous works when they make new ones. Thus, they argue, barriers to accessing previous content, both in terms of legal and technical restrictions, present a cost for acquiring needed input to produce new works, and the higher the cost is, the less reuse will occur and the more the creative choices for the artist are limited. Based on their theory, we differentiate consumer co-creation and consumer sharing as two barriers of access to previous works and posit, in accordance with Landes and Posner (1989), that they interactively affect market performance. On the one hand, (the level of) co-creation presents a barrier to accessing previous content in terms of the rules and restrictions (as specified in a reuse license arrangement) on how consumers are permitted to reuse and recombine previous works. On the other hand, (the level of) consumer sharing is a barrier that determines the access to previous content pieces in terms of using them as inputs to the co-creation process. Hence, we argue that the linking of consumer co-creation and consumer sharing is theoretically plausible, and we explore the possible presence of the following general interaction effect as our first working hypothesis (WH).

> **WH1:** *(Consumer sharing and co-creation interaction effect): consumer sharing and consumer co-creation have an interaction effect on product variety and on consumer and producer surplus.*

In Sections 3.3.2 and 3.3.3, we discuss possible interaction effects specific to each of our three dependent variables individually.

3.3.2. The Interaction Effect on Product Variety

As a way to access previous content, consumer sharing reduces the cost of co-creation because consumers can substitute purchasing the inputs for co-creation with (illegitimately) sharing freely obtained copies. Reducing the cost of co-creation should result in increasing co-creation activities and co-creation outputs (Landes & Posner, 1989). Hence, we should expect a positive main effect from consumer sharing on product variety.

Allowing consumers to make products themselves by recombining components obtained in the market enables them to create products that currently are not offered by producers or are not

offered at affordable prices (e.g., Lessig, 2008). Hence, we can expect a positive main effect of co-creation on product variety.

In addition, according to recombinant growth theory (Romer, 1986; Weitzman, 1998), the spillover of digital contents, which occurs as consumers share content purchased from producers among themselves, should result in the increase of inputs (components) to consumer co-creation and, thus, more outputs (products co-created by consumers). Therefore, product variety could increase more with consumer co-creation when there is also consumer sharing. Thus, we consider the following possible interaction effect.

> **WH2:** *(Product variety interaction effect): when consumer sharing is present, the effect of co-creation on product variety should be stronger than when consumer sharing is not present.*

3.3.3. The Interaction Effect on Economic Surplus

The emerging literature on co-creation (von Hippel & von Krogh, 2003; Lessig, 2008) suggests that an economy that permits consumers to engage in co-creation activities could outperform the traditional economy (based on closed business models) in terms of social welfare (i.e., producer surplus plus consumer surplus). Lang et al. (2009) support this claim with an experimental study. On the producer side, the co-creation literature suggests that a co-creation economy benefits producers indirectly by reducing uncertainty about customer preferences through sales of co-creation tools or by allowing them to charge higher prices (von Hippel & von Krogh, 2003; Lessig, 2008; Lang et al., 2009). However, these positive effects could be offset when consumer sharing is present. For consumers, co-creation should allow them to obtain additional products that were not available or not affordable in the market without co-creation because they can make the products themselves through recombination. They might also replace some previously bought products with more cheaply self-made ones. This opportunity could result in co-creation's having mixed effects on producer surplus. Giving consumers the option to co-create products themselves, in addition to buying them in the market, should result in consumer benefits in terms of consumer surplus.

Consumer sharing generally reduces sales (Clemons et al., 2002; Liebowitz, 2008). In the presence of consumer sharing, consumers substitute illegitimate copies for legitimate products and, thereby, reduce their costs of co-creation. However, this kind of free or uncompensated "spillover" of content that producers develop also reduces the producers' return on investment (von Hippel & von Krogh, 2003). Although consumers might enjoy higher surplus from consumer sharing, producers face compromised benefits. Hence, we should expect a positive main effect of consumer sharing on consumer surplus and a negative main effect of consumer sharing on producer surplus.

The interaction effects, however, are more complex, and the literature offers little guidance on how consumer sharing and co-creation interact specifically on producer and consumer surplus. To illustrate the issue, we add a simple example of a hypothetical buyer, John. Suppose he purchases just one item in the presence of neither co-creation nor sharing. With co-creation, John might purchase an additional item because he could reuse components and then make a third item. However, John might purchase zero in the presence of sharing because he can get one for free. Thus, he purchases one in the absence of co-creation and two when co-creation is an option. Finally, why might John purchase zero or two items if both co-creation and sharing are in effect? Available theory does not help us answer this question. Maybe the co-creation creates more variety and the sharing then creates a larger variety of items that could potentially be acquired or accessed for free. That is, both original manufacturer items and the newly co-created items could be found in the sharing market. Thus, the probability of finding all of the components one needs in the free market increases exponentially, and the value of buying goes down dramatically. However, the secondary market also might make the value of OEM items go up as the number of combinations for potential co-creation increases.

Hence, we explore the following two possible interaction effects regarding consumer and producer surplus.

WH3a: *(Consumer surplus interaction effect): when consumer sharing is present, the effect of co-creation on consumer surplus should be stronger than when consumer sharing is not present.*

WH3b: *(Producer surplus interaction effect): when consumer sharing is present, the effect of co-creation on producer surplus should be weaker than when consumer sharing is not present.*

4. Research Method

Some of the most significant discoveries and useful insights in market design and behavior have emerged from the experimental economics field (Bergstrom, 2003). A growing number of IS scholars have also used experimental economics for testing theory, evaluating market designs, and conducting exploratory research (e.g., Clemons & Weber, 1996; Marsden & Tung, 1999; Bapna, Goes, & Gupta, 2001; Marsden, Pakath, & Wibowo, 2002; Hinz & Spann, 2008; Vragov, Shang, & Lang, 2010; Scheffel, Pikovsky, Bichler, & Guler, 2011; Adomavicius, Curley, Gupta, & Sanyal, 2013; Pelaez, Yu, & Lang, 2013). In particular, Kauffman and Wood (2008) and Bichler, Gupta, and Ketter (2010) recognize and discuss the need for experimental economics in e-commerce research. Economic experiments directly observe actual decisions made by human subjects in an artificial economic setting in the laboratory. Based on induced value theory (Smith, 1976), researchers can induce rational economic behavior by paying subjects according to their economic performance in the experiment. According to Smith (2002), laboratory market experiments are particularly useful and necessary for the following fundamental reasons:

- Outside the laboratory, reliable data about market environment variables, such as real costs and values, are often unavailable.
- One needs fewer auxiliary hypotheses to interpret laboratory data than is needed for the messy data from naturally occurring phenomena.
- All auxiliary hypotheses are also directly testable in the laboratory because the experimenter has control over variables and causality.
- The laboratory allows a controlled comparison of alternative possibilities that have not been encountered in reality or used in the recorded past.
- Current theoretical models are too simple and based largely on constructivist rationality, which cannot account for human behavior stemming from ecological rationality[7].

Using the methods of experimental economics is suitable for our market design evaluation because all five of these principles apply. In online markets, both individual preferences and costs related to the value of time are private and unobservable. Thus, and in accordance with Plott and Smith (2008), we conclude that experimental laboratory research is likely to produce new insights that have both theoretical implications and practical implications for designing and implementing electronic market designs.

5. Experimental Design

In this study, we compare four (electronic) market designs on the basis of their economic performance in terms of surplus and consumer choice. The principle difference between the market designs was the availability of a consumer co-creation capability and the presence of consumer

[7] Constructivist models of rationality use many evidently unrealistic assumptions about the way humans make decisions. Ecological models of rationality try to incorporate imperfect decision making strategies that humans actually use in decision making models. For more detail, see Smith (2003).

sharing. Thus, we developed a market design model that we implemented and experimentally evaluated in the laboratory[8].

Any of the main effects that we identified as a result of the study clearly are contingent on our particular market design. For example, co-creation is better or worse depending on how many products are available in the market and what the demand for these products are. The effect of sharing depends on the level of sharing. We deliberately chose specific parameters to model supply and demand and the level of consumer sharing, included a specific kind of co-creation activity, and chose other design model specifications. However, the negative or positive character of the interaction effect is likely to be the same because we did not directly manipulate these factors. These positive and negative effects happen instead in the subjects' minds as they make tradeoffs and set the bid and ask prices.

5.1. Designing the Experimental Market

To examine a simplified experimental economy in the laboratory, we had to capture the essence of co-creation content markets (i.e., component-based content products, consumer co-creation capabilities, consumer sharing, product and user heterogeneity) while removing complexities that are present in real-world markets but are not directly linked to our specific research question. Thus, we had to sufficiently abstract co-creation capabilities of consumers (to control for individual subject attributes such as media and technology skills, cultural creativity, and task efficiency) and to limit the cognitive complexity of the experimental tasks so that participants could complete the tasks in a suitable timeframe. Finally, we had to make sure that we retained the salient features of co-creation in our experimental market design (i.e., the reuse potential of product components for co-creating new products). To establish some degree of external validity for the experiment, we presented our market design to music executives at an industry conference[9] and, based on the received feedback, refined our design. Overall, these practitioners found our design consistent with their own experience.

Following standard market design principles employed in the experimental economics literature (e.g., Smith, 1976; Durlauf & Blum, 2009), we designed the supply structure (production costs), demand structure (product valuations), and the rules of exchange (auction mechanism) of our experimental economy. Ten consumers and four producers trade in 16 digital content products in our design model, which researchers consider to be sufficient to simulate a robust market in the laboratory (Smith, 2003). Each producer and consumer works with incomplete market information. Producers are given private information about their production costs, and consumers have private information about their product demand and valuations. The bid and ask prices posted on the trading platform are public information. We modeled digital culture products in a stylized manner and focus primarily on capturing the four key properties that enable the emergence of co-creation markets: (1) component-based design, (2) consumer co-creation activities (e.g., remix or mashup capabilities), (3) heterogeneous consumer demand preferences, and (4) heterogeneous production cost.

5.2. Designing Component-Based Products and Consumer Co-Creation

Each product in our simplified experimental economy comprised three components. We automated the consumer co-creation tools we used in the experiment with software and included a decision aid that helped users with identifying co-creation possibilities and processing steps.

Take the product "sit", for example. It comprises the three components "s", "i", and "t". Similarly, the product "bad" comprises the components "b", "a", and "d". Now assume a consumer has already

[8] Market design experiments differ from theory testing experiments in two important ways. While the purpose of the latter is to test predictions that are derived directly from a formal (economic) theory, the former uses the laboratory as a testing ground for examining the performance properties of new forms of exchange (Smith, 1994, p. 115). Market design experiments compare market configurations that differ in one (or more) critical variable(s) (e.g., modeling an important environmental condition, such as consumer sharing, or introducing a new technology-based capability made available to market participants, such as consumer co-creation). The proposed market design changes should be theoretically motivated (if relevant theory is available), or they can be exploratory (e.g., to test effects of newly available technology or technology-based user capabilities).

[9] Music Business and Web 2.0 Workshop, The University of Texas at Austin, Austin, April 25, 2008.

bought these two products but needs “bat”, too. The consumer has the choice either to buy it in the marketplace or to reuse components from the other two products. In this case, the buyer could disassemble the first two products purchased and then recombine component “t” from “sit” with components “b” and “a” from “bad” and make “bat” herself.

5.3. Designing Consumer Demand

For digital culture goods, in particular, the demand is likely to be more variable than for other consumer goods because their value to individuals highly depends on symbolic meanings they communicate (Choi, Stahl, & Whinston, 1997; Thornsby, 2001). In accordance with Bapna, Goes, Gupta, and Jin (2004), we explicitly model user heterogeneity by allowing different valuations (and, thus, willingness to pay) across consumers and products. On the demand side, we assume a set of consumers with heterogeneous preferences (i.e., they prefer different products and have different willingness-to-pay values for the same products) for the 16 products that one can produce in our experimental economy. This degree of heterogeneity is sufficient to approximate a long-tail distribution of demand (see Figure 2).

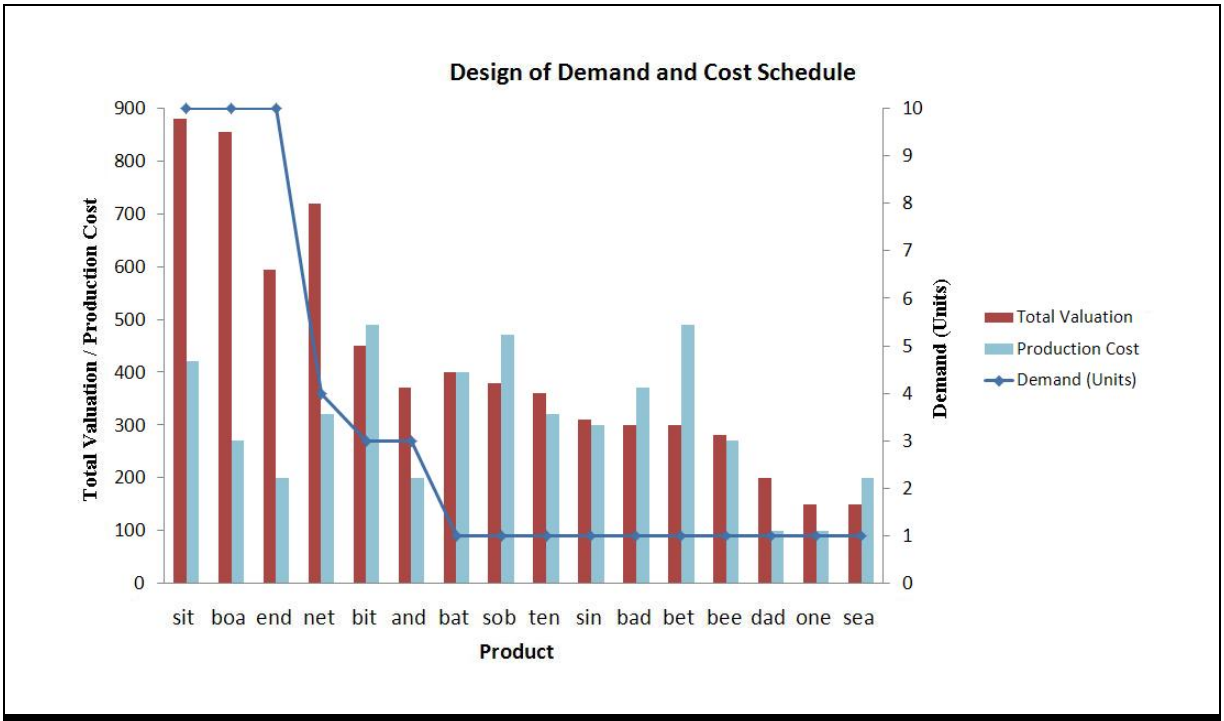


Figure 2. The Design of the Demand and Cost Schedule

Importantly, we distinguished between mainstream products (i.e., the head products, the three most popular products, which in our case are “sit”, “boa”, and “end”) and non-mainstream products (i.e., the tail products, the other 13 products, which include three midrange and ten niche products). Although the niche products were the least popular and least profitable, the sum of the demand for them could match the total demand for mainstream products. This conforms to Anderson’s claim that, although the sale volume of a single niche demand is low, the volume of all niche demands can collectively make up a market share that rivals the bestsellers (Anderson, 2006). As induced value theory prescribes (Smith, 1976), we assigned values, randomly drawn from a uniform distribution, to each buyer for each product to construct specific demand curves for our experiment. For the interested reader, we include some example consumer demand curves for individual products in Appendix A in Figure A-1. Unlike most theoretical work, this modeling choice assumes neither linear demand curves nor homogenous valuations and is, therefore, more realistic.

5.4. Designing the Supply Side

On the supply side, a set of producers has the capacity to produce a predefined set of component-based digital products. Each product had a unique, fixed production cost (indicated in Figure 2) that we drew randomly from a uniform distribution, and that cost is incurred when the first copy of the product is made. The detailed production cost schedule is shown in Table A-1 in Appendix A. Four different producers each controlled the production of four different products. Production costs varied considerably across products. Marginal costs were negligible and generally are assumed to be zero, and supply quantity had no constraints. The producers owned the exclusive copyright of the content they produced.

5.5. Designing the Trading Institution

The economy's trading institution was a version of the continuous double auction. Most digital content products in real markets are offered at posted prices. However, previous experimental studies have shown that markets with posted prices converge very slowly to competitive equilibrium. Because our experimental sessions had a very limited timeframe, we followed common research practice and chose a double auction mechanism to speed up convergence (Coursey & Smith, 1983). Producers could either submit ask prices or accept bids. They could lower ask prices, but they were not allowed to increase them. Consumers could submit bids or accept the asking price. Similarly, they could change bids but not decrease them. These trading rules are widely used in experimental economics to speed up the convergence of market prices to equilibrium levels. They are identical, in particular, to those used by Smith (1962) in his classical market experiments. Bids and asks at the same price were matched automatically by the trading system. This market institution allowed producers to sell the same product at different prices to different consumers.

5.6. Designing the Experimental Treatments

With the principle market design in place, we implemented a full 2x2 design with two levels of consumer co-creation and two levels of consumer sharing (see Table 1) to explore our working hypotheses in Section 3. We ran each of our four experimental treatments four times, and each of these four sessions included ten rounds (i.e., a total of 40 observations per treatment). The first treatment implemented the traditional cultural content production model (neither co-creation nor sharing) and served as the baseline to evaluate the performance generated by introducing a reuse license to enable consumer co-creation. As with co-creation, we modeled consumer sharing by differentiating between two levels of consumer sharing (i.e., present and absent), which yielded a total of four treatments.

Table 1. Experimental Treatments

		Consumer sharing	
		No	**Yes**
Consumer co-creation	**No**	**C_nS_n treatment** 4 sessions; 40 observations	**C_nS_y treatment** 4 sessions; 40 observations
	Yes	**C_yS_n treatment** 4 sessions; 40 observations	**C_yS_y treatment** 4 sessions; 40 observations

The C_nS_n (no co-creation/no sharing) treatment represents our baseline and the currently predominant market practice (closed business model) in the cultural goods industry. On the supply side, producers of content are essentially licensed monopolies in the content markets. They pursue strong copyright enforcement in the markets and do not allow consumers to share or modify their products.

The C_nS_y (no co-creation/sharing) treatment represents the same production practice as in the baseline except that it includes consumer sharing. Half of consumers who buy a legitimate product in

this treatment automatically share it and allow anyone in the community who wants it to get a free copy[10]. Producers are aware of the sharing practice.

The C_yS_n (co-creation/no sharing) treatment represents a hybrid business model in which content producers open up content to consumer co-creation in the post-purchase environment by including a content reuse license with the sold content products. Consumers now acquire reuse rights as part of their user license when they buy a product. They have complete access to the digital content, which gives them the freedom to remix the content they bought. Remix is accomplished by recombining individual components that are sampled from the purchased content products[11]. This ability creates opportunities for consumers to make new products that either are not offered in the market or are too expensive for them to buy directly. Given the availability of low-cost digital editing and remix tools, we assumed the direct co-creation costs to be zero. However, note that only the recombinations that yielded products the consumer needs (according to the specified demand schedule) accrued value to the consumer. In this treatment, there is no consumer sharing.

The C_yS_y (co-creation/sharing) treatment represents the same production practice as in the co-creation/no sharing treatment except that it includes consumer sharing, and this sharing is the same as in the no co-creation/sharing treatment. Because consumers have complete access to the digital content, they can make new products either from the products they buy themselves or from the products that are shared by others. This treatment changes the nature of competition in the market. Producers have monopoly power only over the final products but not over the components that are embedded in them. Thus, consumers can source a component from different producers offering products that include the same components. Although no direct competition exists on final products, producers now compete indirectly on components that are not sold individually.

5.7. Designing the Experimental Tasks

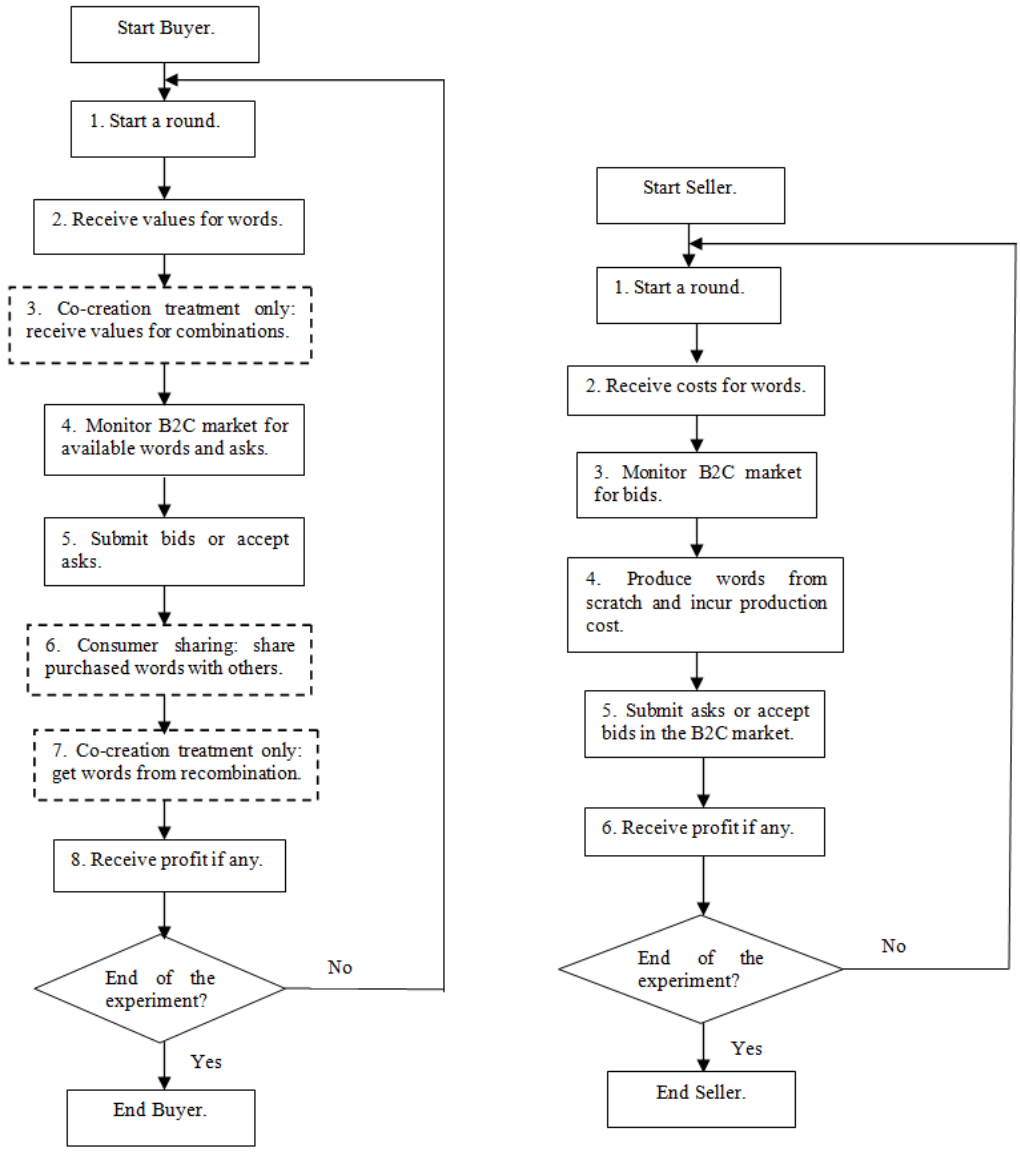
Figure 3 depicts a flowchart that describes the experimental process and shows the tasks and decision points for the subjects in the experiment.

At the beginning of each round, producers received their private information, their production schedule, and the associated fixed costs (as detailed in Table A-1 in Appendix A) for making the four products for which they owned the rights. They knew neither the other producers' production schedules nor any consumer demand schedules. Throughout the round, they monitored the market and check the bids that consumers who were interested in their products were posting. Taking into account market signals about consumer demand and the known production cost, producers decided whether and when to produce a product and offer it in the market. Producers might have decided to offer only those products on which they expected to make money.

Considerable uncertainty remained about the profitability of the different products because of incomplete market information and the high fixed cost that a decision to develop a new product entailed. Once producers chose to offer a product, they needed to set an ask price. During the course of a round, they continued to monitor bids, and, at any point in time, they could accept bids or change ask prices.

[10] The presence of consumer sharing resembles the current level of piracy in the content markets. Based on available data estimates and industry reports (i.e., 9th Annual BSA Global Software 2011 Piracy Study (http://globalstudy.bsa.org/2011/) and Media Piracy in Emerging Economies (Social Science Research Council, March 2011, http://piracy.americanassembly.org/the-report/)), we set the level at 50 percent. However, note that consumer sharing/piracy at the industry level is difficult to measure and varies somewhat across content categories. From an experimental design perspective, the exact percentage is less important than the qualitative distinction.

[11] To experimentally control for different remix skills, we provided subjects with a remix tool that largely automates the remixing process given the specific content products available to the consumer in the market and the consumer's demand schedule.



Note: the boxes with a dashed border highlights the difference between the treatments.

Figure 2. Buyer and Seller Tasks

In addition to the four producers, ten consumers participated. Each consumer had a non-zero demand for a different set of 5 of the 16 traded content products. The buyers (consumers) began each round by receiving their private demand schedule, which told them the products they needed to buy in the present round and what the products were worth to them. They did not know about the other consumers' demand schedules or about the producers' cost figures. However, they could see ask prices of products currently available in the market, enter new bids into the system at any time, and get instant feedback when they completed transactions. Each buyer received a different set of five products that had different valuations. The allocation of products and willingness-to-pay values changed for consumers from round to round. Buyers monitored the market for available products and ask prices. They could have accepted asks or place and change bids for words they needed.

In Appendix B, we present some sample trading screen shots and discuss in greater detail the information with which producers (sellers) and consumers (buyers) were working to make their decisions in the experiment.

5.8. Experimental Participants

We recruited a total of 224 participants from the undergraduate student population at a large public university in the United States and randomly grouped them into 16 cohorts of 14, which included four producers and 10 consumers each. We repeated each treatment four times, and each session used a different cohort of participants. We did not find any significant differences among the cohorts in terms of gender, age, GPA, computer efficacy, or study major. We did not allow subjects to participate in more than one session. After the volunteering subjects came to the experimental laboratory, we randomly assigned them to the roles of a producer or a consumer and seated them at separated, individual workstations that served as trading terminals for selling or buying content products in the market. We did not allow subjects to communicate with each other during the experiment other than posting the bids and asks in the trading periods. We paid the subjects a USD$10 show-up fee and a performance-based payoff that averaged about USD$25 and ranged from USD$0 to USD$75. The payoffs were based directly on experimental profits. The system updated and showed participants' earnings to them after each completed transaction and trading period to provide them with instant feedback on the trading decisions they made in the experiment.

5.9. Experimental Procedures

We asked the subjects to read a set of instructions (included in Appendix C) that explained the market rules and the use of the trading system that we developed for the experiment. The instructions explained to the participants how they could generate profits in the experiment and how they would get paid in real cash dollars. We then quizzed the participants to ensure had a basic understanding of the experiment's rules. The subjects participated in a preliminary practice round that lasted 10 minutes. They could ask questions about the user interface and the trading rules during the practice session. We discarded the data from the practice rounds and did not use it for analysis. We then conducted 10 more rounds of the experimental market for each cohort. We randomly determined the length of each round to last anywhere between five and six minutes with equal probability, which we did to remove the explosive activity that typically occurs when the closing time is known during the last seconds before the market is closed (Roth & Ockenfels, 2002). We recorded the times resulting from the random draws during the first session of the experiment and used them in all following sessions. Thus, we ran the same number of rounds with the same length under all treatments (i.e., for all cohorts).

6. Measurements

We measured market performance with three variables over all rounds and sessions of the experiment—product variety (*PV*), total consumer surplus (*TCS*), and total producer surplus (*TPS*)—and compared these variables across treatments.

Product variety counts the number of unique products, of the 16 possible products, that consumers actually acquired in each round. Among the 16 products in the experimental economy, 11 were theoretically profitable to varying degrees for producers, and 5 were not[12]. Depending on the decisions the participants made, different market outcomes were possible. In any round, any product could be provided by a producer and bought by some consumers, provided but not sold to consumers, or not provided at all.

$$\overline{PV} = \frac{1}{RS}\sum_{s=1}^{S}\sum_{r=1}^{R} PV_{rs}$$

(average number of unique products acquired by consumers per round)

[12] Available industry data indicate that the return on investment in major music or movie productions is highly uncertain and that many of them lose money (e.g., Davidson, 2012; Thomson, 2012).

$$PV_{rs} = \sum_{k=1}^{K} D_k$$ (number of unique products acquired by consumers in round *r* of session *s*)

r = round *1, 2, …, R; R = 10*
s = session *1,2, …, S; S = 4*
k = product *1,2,..,K; K = 16*
D_k : dummy variable; *1* if product *k* is sold to consumers, *0* otherwise.

The individual consumer surplus (*CS*) of each round depended on how many products consumers were able to get and how much they paid for them. If a consumer had a value *v* for a product and bought that product at price *p*, then the consumer's profit on the product was *v – p*. The consumer's surplus *CS* for a round was the sum of the profits of all five of the consumer's products. The *TCS* of the round was the sum of all ten consumers' individual consumer surpluses. The same calculation is performed for every round and over all four sessions.

$$\overline{TCS} = \frac{1}{RS} \sum_{s=1}^{S} \sum_{r=1}^{R} \sum_{i=1}^{I} CS_{irs}$$ (average total consumer surplus per round)

$$CS_{rs} = \sum_{n=1}^{N} \left(V_{in} - P_{in} \right) B_{in}$$ (surplus for consumer *i* in round *r* of session *s)*

V_{in} : valuation for product *n* of consumer *i* (see Appendix A)
P_{in} : transaction price for product *n* of consumer *i*
i = consumer *1,2,…, I; I = 10*
r = round *1, 2, …, R; R = 10*
s = session *1,2, …, S; S = 4*
n = product *1,2,…N; N = 5*
B_{in}: dummy variable; *1* if consumer *i* bought product *n* in the market, 0 otherwise.

The profit a producer earned at the end of a round depended on the number of copies sold for each product and on the price points at which the sales were made. We calculated the individual producer surplus (*PS*) by adding up the prices of all sold copies minus all fixed costs incurred in the production process. The possibility existed for producers that their revenues did not recoup their production costs. In such a case, the round ended with a loss for the producer. The total producer surplus (*TPS*) was the sum of the profits of all four producers in a round. We repeated the same process for each round in each session.

$$\overline{TPS} = \frac{1}{RS} \sum_{s=1}^{S} \sum_{r=1}^{R} \sum_{j=1}^{J} PS_{jrs}$$ (average total producer surplus per round)

$$PS_{jrs} = \sum_{m=1}^{M} \left(S_{jm} - C_{jm} \right) D_{jm}$$ (surplus for producer *j* in round *r* of session *s)*

S_{jm}: sales of product *m* of producer *j*
C_{jm}: production cost of product *m* of producer *j* (c.f. Appendix A)
j = producer *1,2,..,J; J = 4*
m = product *1,2,…M; M = 4*
D_{jm}: dummy variable; *1* if producer *j* developed and offered product *m*, *0* otherwise

7. Results

Each of the 4 treatments obtained 40 observations (4 separate sessions with 10 rounds each), which resulted in a total of 160 observations for the study. We used the Shapiro-Wilk test to examine the sample data for normality, and, based on the results, we concluded that the data came from a normally distributed population. However, we did find some inter-cohort variability. Applying Levene's test indicated a difference between the variances of consumer surplus and producer surplus in our treatments. Therefore, we used Welch-type adjustments in the following ANOVA tests to handle the unequal variances (Welch, 1947).

To minimize potential effects of repeated experimental rounds, we rotated the ten consumer demand schedules between each round so that each subject received a different demand schedule (with different product assignments and willingness-to-pay parameters). Furthermore, to account for potential round effects, we conducted the repeated measures ANOVA test to obtain a better estimate of the treatment effects. Experimental rounds showed no significant effect on the respective tests of product variety, consumer surplus, and producer surplus at the significance level of 0.05.

7.1. General Interaction of Consumer Co-creation and Consumer Sharing

To use separate ANOVA tests to explore possible interaction effects on our three individual dependent variables, we must first show that an interaction occurs in the general model. Thus, we first examine the general interaction effect of consumer co-creation and consumer sharing on product variety, consumer surplus, and producer surplus. Because we wanted to find out whether the three dependent variables taken together are affected by an interaction of consumer co-creation and consumer sharing, we employed a multivariate ANOVA (MANOVA) test to examine WH1. Our results show that the three dependent variables had low to moderate correlation (less than 0.7), meaning that the MANOVA test was suitable for analyzing our data set. As Table 2 shows, both consumer co-creation and consumer sharing did have a strongly significant interaction effect on product variety, consumer surplus, and producer surplus[13]. Hence, using separate ANOVA analyses to explore the specific interaction effects was appropriate.

Table 2. General Interaction Effect

Between subjects factors	**F (Pillai)**	**df**	**p-value**
Consumer sharing	12.793	153	<0.001
Consumer co-creation	43.958	153	<0.001
*Consumer sharing * Consumer co-creation*	*39.748*	*153*	*<0.001*

7.2. Interaction Effect on Product Variety

As Table 3 shows, both consumer co-creation and consumer sharing had positive significant effects on product variety. As effect size indicates, consumer sharing explained about 50 percent of the variance of product variety between treatments after excluding the variance explained by other predictors, while the amount of variance explained by consumer co-creation was about 34 percent[14].

[13] As expected from previous findings in the literature, we also found significant main effects.

[14] However, it is difficult to interpret the main effects by themselves because their effect really depends on the level of the other, interdependent variable if significant interaction effects were present. Hence, the literature recommends focusing on interpreting the (significant) interaction effects. (e.g., Carte & Russel, 2003).

Table 3. Results of Repeated Measures ANOVA Test for Product Variety

Between-subjects factors	F	p-value	Effect size (partial eta^2)
Consumer sharing	9.120	0.014	0.503
Consumer co-creation	4.914	0.028	0.339
*Consumer sharing * consumer co-creation*	140.138	<0.001	0.940

More interesting, however, was the strong interaction effects ($p < 0.001$) of consumer co-creation and consumer sharing on product variety. It explained 94 percent of the variance of product variety between treatments after excluding variance explained by other predictors. As Figure 4 shows, introducing consumer co-creation affected product variety differently in the market settings that allowed and did not allow consumer sharing. When consumer sharing was present, the effect of co-creation on product variety was stronger than when consumer sharing was not present. In the market that disallowed consumer sharing, consumer co-creation increased product variety from an average of 7.3 units to 10.2 units—an increase of about 40 percent. Consumers took advantage of the co-creation option and self-made some products that they could not otherwise get. Among the 10.2 units, 4.4 units were generated from consumer co-creation, which accounted for 43 percent of product variety. When consumer sharing was present, the increase was stronger, raising product variety from 7.4 to 11.9 units—about a 60 percent increase. Having access to the sharing market, consumers were able to source more components that they could reuse to make some additional products themselves. Among the 11.9 units, 6.2 units were generated by consumer co-creation, which accounted for 52 percent of product variety.

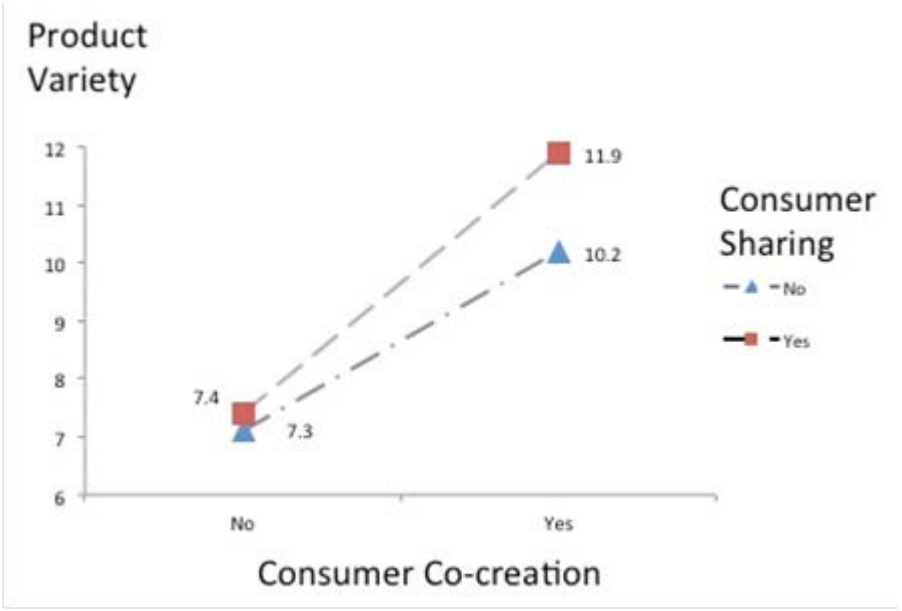


Figure 4. Mean Product Variety Across Treatments

7.3. Interaction Effect on Consumer Surplus

Next, we examine consumer surplus to explore how the interaction of consumer co-creation and consumer sharing affected the consumers in the market.

Table 4. Results of Repeated Measures ANOVA for Consumer Surplus

Between-subjects factors	F	p-value	Effect size (partial eta^2)
Consumer sharing	21.437	0.001	0.704
Consumer co-creation	48.045	<0.001	0.842
*Consumer sharing * consumer co-creation*	13.942	0.005	0.608

Both consumer co-creation and consumer sharing had a significant positive effect on consumer surplus (see Table 4). Consumer sharing explained about 70 percent of the variance of consumer surplus between treatments after excluding variance explained by other predictors, while the respective percentage of variance explained by consumer co-creation was about 84 percent.

In addition, we found a significant interaction effect between consumer sharing and co-creation with respect to total consumer surplus, and this interaction explained 61 percent of the variance of consumer surplus between treatments after excluding variance explained by other predictors. When consumer sharing was present, the effect of co-creation on consumer surplus was stronger than when consumer sharing was not present. We found a stronger association between consumer co-creation and total consumer surplus when we allowed consumer sharing ($p = 0.005$). Consumers were able to take advantage of the sharing market to more effectively apply co-creation, to self-make products that generated additional consumer value, and to obtain value by getting products that had not been available. Hence, they acquired not only more diverse products but also more valuable products. As Figure 5 shows, in the market without consumer sharing, consumer co-creation increased total consumer surplus from an average of 1840.9 to 2708.0—an increase of about 47 percent. When consumer sharing was present, the increase was even more pronounced, raising total consumer surplus from 1916.9 to 3699.4—about a 93 percent increase.

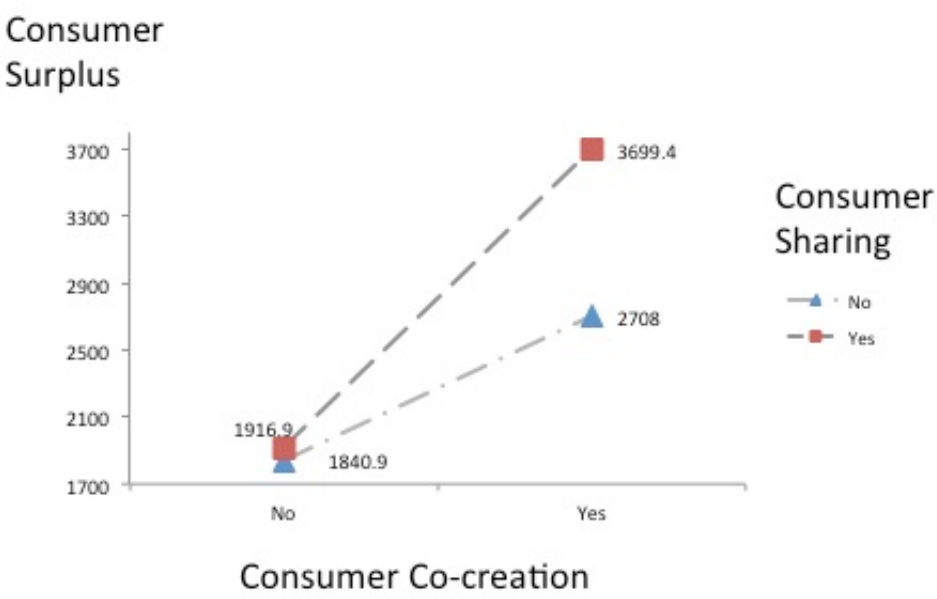


Figure 5. Mean Total Consumer Surplus Across Treatments

As Table 5 shows, by co-creating products that previously were too expensive or not available in the market, consumer co-creation increased the (total) satisfied consumer demand by about 50 percent

(p<0.001). However, total consumer purchases showed a different pattern. Although total sales increased by 11.5 percent (from 1732.4 to 1932.3) when consumer sharing was absent, they fell by 1.8 percent (from 1302.0 to 1278.3) when consumer sharing was present. In other words, when consumer sharing was considered, consumers sourced components from the illegitimate sharing market, which depressed legitimate sales.

Table 5. Means and Standard Deviations of Realized Value and Purchases

			Consumer sharing	
			No	Yes
Total satisfied consumer demand	Consumer co-creation	No	3164.3 (1308.5)	3342.0 (1046.4)
		Yes	4712.8 (1210.3)	4981.4 (1232.8)
Total consumer purchases	Consumer Co-creation	No	1732.4 (606.1)	1302.0 (486.4)
		Yes	1932.3 (1013.8)	1278.3 (501.0)

7.4. Interaction Effect on Producer Surplus

Table 6. Results of Repeated Measures ANOVA for Total Producer Surplus

Between-subjects factors	F	p-value	Effect size (partial eta^2)
Consumer sharing	37.430	<0.001	0.806
Consumer co-creation	3.255	0.105	0.266
Consumer sharing * *consumer co-creation*	15.370	0.004	0.631

From Table 6, we can see that consumer sharing had a significant negative effect on producer surplus, and it explained about 81 percent of the variance of producer surplus between treatments after excluding variance explained by other predictors. However, the effect of consumer co-creation was not significant and only explained about 27 percent of the variance in producer surplus.

In examining the interaction between consumer sharing and consumer co-creation, we found that consumer co-creation and consumer sharing showed a strong interaction effect (p<0.001) on producer surplus, and the interaction explained about 63 percent of the variance of producer surplus between treatments after excluding the variance explained by other predictors. Introducing consumer co-creation affected producer surplus differently in the market settings that included and didn't include consumer sharing. As such, when consumer sharing was present, the effect of co-creation on producer surplus was weaker than when consumer sharing was not present. As Figure 6 shows, in the market that disallowed consumer sharing, consumer co-creation increased producer surplus (reduces losses) from an average of -638.8 to -85.4—a significant increase (p= < 0.001). However, when consumer sharing was present, the change was not significant (p = 0.853). Producer surplus actually decreased slightly from -732.7 to -839.2, which resulted from the significant reduction of consumer purchases (see Table 5 in Section 7.3). In non-co-creation settings, producers incurred a sales loss only from consumers who substituted shared copies for the purchase of legitimate copies. Apparently, producers suffered additional losses when both co-creation and sharing existed and interactively affected producers' sales. In addition to the loss from shared copies, producers also suffered some losses when consumers substituted self-made products for purchases using the co-creation capability. Hence, producer benefits from co-creation appear to be contingent on low consumer sharing levels, which may be difficult to control in real market environments.

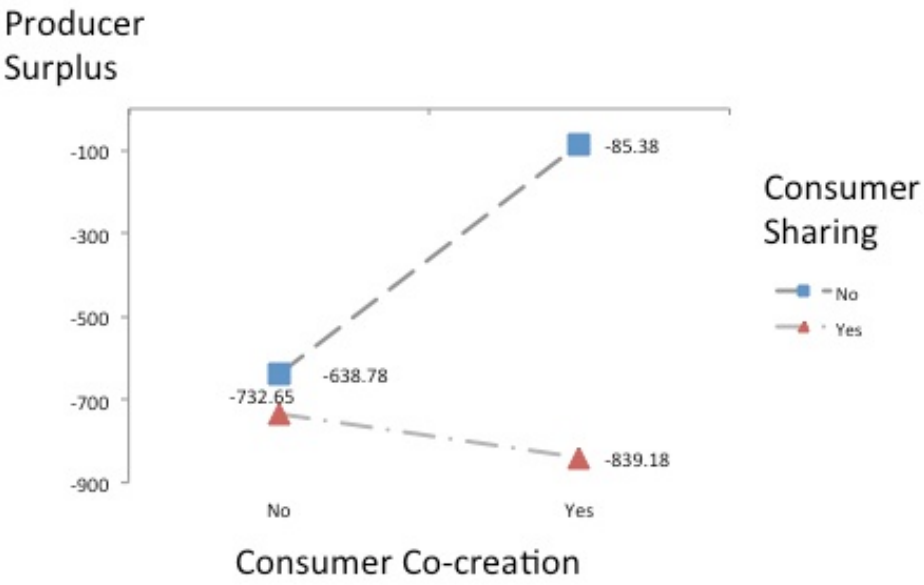


Figure 6. Mean Total Producer Surplus Across Treatments

Lang et al. (2009) suggest that co-creation increases total welfare and benefit both consumers and producers. However, our results qualify these previous findings by showing that consumer sharing and consumer co-creation has a significant interaction effect on producer surplus.

7.5. Additional Analysis

In this section, we present some additional analysis of our experimental data beyond the four research questions we formulate in Section 3.3.

First, we look at total surplus to see how the interaction of consumer co-creation and consumer sharing influenced the market as a whole. In general, the market performed better with consumer co-creation than when the market prohibits co-creation (see Table 7).

From a business perspective, understanding the market environment and how to design co-creation mechanisms that are beneficial to the firm is important because it can effectively mitigate the risk of revenue loss from consumer sharing. In comparison with the baseline, producers allowing consumers to engage in content co-creation were able to charge higher prices on mainstream products (p-value<0.01), and consumers significantly increased the amount of their purchases of mainstream products ($p < 0.01$) (see Table 8). However, when consumer sharing occurred, producers lost their position as the only source of digital content as consumers illegitimately shared digital content among themselves. Consequently, the number of mainstream products sold significantly decreased from 18.2 to 12.0, and revenue from selling them was dramatically down to 827.6 from 1481.5. Therefore, we suggest that the level of consumer sharing is a crucial environmental factor that producers should consider when they adopt co-creation business models.

Interestingly, although sales were down, producer profits in the C_yS_y treatment (co-creation/sharing) were not significantly ($p = 0.853$) different from the baseline, which suggests that producers were able within certain levels of consumer sharing to maintain their business profits. We explain this arguably surprising result by noting the fact that producers were able to charge higher prices for mainstream products when they allowed consumers to engage in content co-creation (with a significant increase in the average price of mainstream products from 55.0 to 75.1).

Table 7. Means and Standard Deviations of Total Surplus

		Consumer sharing	
		No	Yes
Consumer Co-creation	No	1184.3.3 (584.5)	1191.0 (581.3)
	Yes	2860.2 (1256.6)	2594.0 (1343.8)

Table 8. Descriptive Statistics for Mainstream Products

			Consumer sharing	
			No	Yes
Average price of mainstream products	Consumer co-creation	No	55.0 (25.2)	59.9 (28.0)
		Yes	83.6 (44.4)	75.1 (32.0)
Total sales of mainstream products	Consumer co-creation	No	717.3 (234.9)	458.3 (187.9)
		Yes	1481.5 (867.2)	827.6 (364.2)
Number of mainstream products sold	Consumer co-creation	No	14.3 (5.2)	8.9 (3.9)
		Yes	18.2 (6.8)	12.0 (4.3)

8. Conclusions

In this paper, we explore the interactions between co-creation and sharing, both important activities that are actually occurring in the age of digital content. We designed an economic experiment to learn something about these interactions, and what we learned about them contributes to the literature in interesting ways.

In fact, our study makes three contributions. First, it offers a new market design for digital content that supports consumer co-creation in the presence of consumer sharing, which we implemented and evaluated in a laboratory experiment. Second, the findings from our experimental evaluation have some theoretical implications. We found evidence for significant interactions between consumer co-creation and sharing that have not been theorized in the extant co-creation and piracy literatures. Third, our study offers some implications for business practice in terms of designing sustainable digital content markets.

Testing, refining, and extending existing theory and building new theory serve critical roles in information systems research. Critical to these processes is the recognition that multiple types of theory answer different sorts of questions. According to Gregor (2006), theory for prediction and explanation—theory used to identify and propose testable (causal) theoretical relationships to predict and explain real-world phenomena—is the predominant nature of theory in information systems research. But Gregor also discusses design theory as another theoretical approach—one that underlies a growing stream of design research in IS research, including our study.

The main contribution of design science research is typically the proposed and desirably evaluated artifact itself rather than building or testing theory. For example, in our case, the contributed artifact is an electronic market design for a digital content market that includes a content reuse licensing scheme supporting consumer co-creation. However, design theoretical research can be informed by other classes of theory as well, says Gregor (2006), who notes that design theory and theory for

prediction and explanation, in particular, are strongly interrelated. For example, design modeling choices and design evaluation should be guided by theoretical insights when applicable.

From a theoretical perspective, our experimental results provide a potential basis for theory development for the emerging field of co-creation (Davis, Eisenhardt, & Bingham, 2007). We found significant interactions and strong effects between consumer sharing and co-creation. Consumer sharing interacted with consumer-based co-creation to increase product variety and consumer surplus while reducing producer benefits from co-creation; meanwhile, social welfare benefits were robust in the presence of low to moderate consumer sharing. Logical follow-ups to the current study could involve developing theory about co-creation that explicitly incorporates the interaction effects between co-creation and sharing, as our findings indicate, and specifying and testing formal research hypotheses in various settings using the principles found in the theory of prediction and explanation.

In terms of business implications, our study offers some insights for commercial content providers. In content markets, including music and film, producers of niche products are quite often barely profitable. Although many possible niche products are not made available in the market (i.e., they never get produced) because they are not profitable to their producers, consumers through their co-creation activities are able to create some of them by reusing digital content. Our results show that most of the gains in product variety in the two treatments that include co-creation treatments come from the increased number of niche products obtained through co-creation. Accepting the reality of a participatory culture in which consumers of digital content goods increasingly undertake co-creation activities, producers can still sustainably and profitably pursue strategies that allow consumers to access and modify the contents of the producers' mainstream products under appropriate licensing settings. In the presence of a long-tail demand curve, profit-maximizing content producers can focus on producing mainstream products. And, by giving consumers content reuse rights, producers can indirectly generate profits from the long tail because some niche demand will transfer to mainstream products, which co-creators need as a source for input materials to make specialized derivatives. In other words, firms (content producers) can effectively respond to the change in the market environment (introduction of piracy) and offset lost sales (in quantity) by charging and getting higher prices for goods that consumers are permitted to use for component reuse purposes. This capacity suggests that firms can, in principle, redesign their business models and adopt reuse licensing without necessarily hurting their bottom line.

Our findings also offer some empirical evidence to support recommendations for designing content production markets that legally support co-creation platforms; such markets are critical for innovation and economic growth in the digital economy. Hargreaves' (2011) report, for example, makes just such a recommendation to the U.K. Government.)

As with all experimental work, our study has several important limitations. All our findings are based on data generated from one specific experimental design. Obviously, we need to be very cautious about generalizing beyond our experimental economy. More research is necessary to further validate our findings. Experimental research that analyzes variations on market designs for cultural content goods is necessary if we are to fully understand the co-creation phenomenon that we observe in many real-world settings.

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Appendices

Appendix A: Additional Experimental Design Details

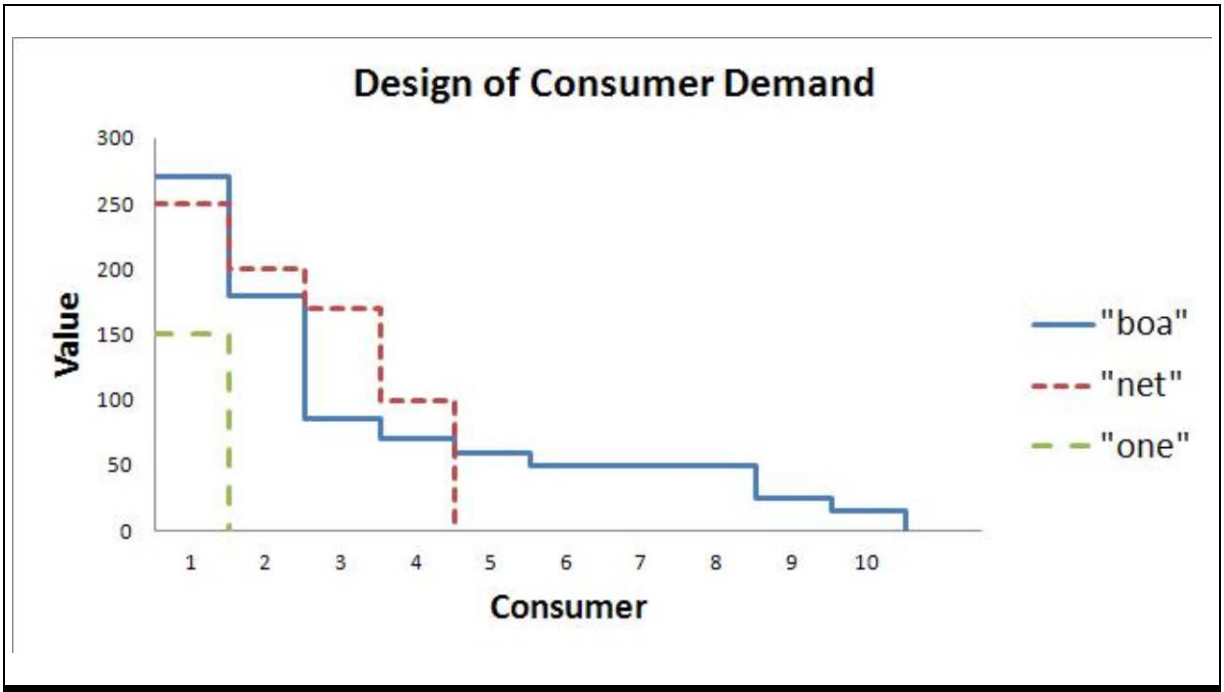


Figure A-1. Consumer Demand for Product "boa"

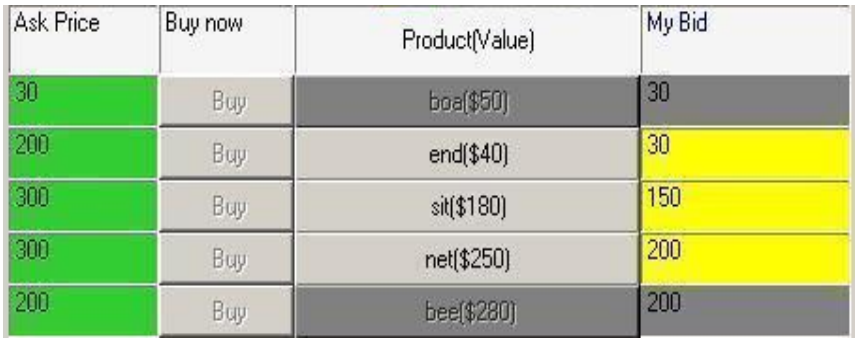
The mainstream products ("sit," "boa," and "end") were demanded by all the consumers. Midrange and niche products made up a category of non-mainstream products. The midrange (specialized) products ("net", "and", and "bit") exhibited some level of specialization and were demanded by only a specific consumer segment. Finally, ten niche products ("bad", "bat", "bee", "bet", "dad", "one", "sea", "sin", "sob", and "ten") were highly specialized and targeted only a single consumer in our experiment.

Table A-1. Fixed Cost Schedule and Units Demanded for All 16 Products

Product	Cost	Units demanded	Producer ID	Product	Cost	Units demanded	Producer ID
and	200	3	4	**dad**	100	1	4
bad	370	1	2	**end**	200	10	2
bit	490	3	3	**one**	100	1	2
net	320	4	1	**sea**	200	1	4
bat	400	1	1	**sin**	300	1	1
bee	270	1	3	**sit**	420	10	4
bet	490	1	1	**sob**	470	1	3
boa	270	10	3	**ten**	320	1	2

Appendix B: Additional Experimental Process Details

Figure B-1 shows an instance of a buyer screen in a particular round of the experiment. Buyers could see which products they needed and what they were worth to them; they could also see ask prices of products currently available in the market. They could enter new bids into the system at any time. They also got instant feedback when they completed transactions and could monitor the cash dollar winnings they accumulated during the session.



Ask Price	Buy now	Product(Value)	My Bid
30	Buy	boa($50)	30
200	Buy	end($40)	30
300	Buy	sit($180)	150
300	Buy	net($250)	200
200	Buy	bee($280)	200

Figure B-1. Buyer Screen (Partial View)

During the experiment, producers worked with a trading screen (see Figure B-2). Producers could see the fixed production cost of the products they controlled and could monitor bids as they are posted in the market. When they decided to produce a product and post an ask price and, thus, make it available in the market, the information was broadcasted to buyers. Producer decisions were entered into the trading system interactively through several specifically designed information fields and action buttons (not shown in the figure). The profits of the current round and the accumulated total profits over all completed rounds were shown to the subject in both experimental currency and real cash dollars. These data again provided participants with instant and real economic feedback on their decisions and performance in the experiment.

Ask Price	Product(Cost)	Bid Price	Bid Price	Bid Price	Bid Price	Bid Price	Bid Price	Bid Price	Bid Price	Bid Price	Bid Price
30	boa ($270)	150	100	50	40	40	30	30	30	10	5
	bit ($490)	100	100	50	0	0	0	0	0	0	0
200	bee ($270)	200	0	0	0	0	0	0	0	0	0
	sob ($470)	250	200	0	0	0	0	0	0	0	0

Figure B-2. Producer Screen (Partial View)

Appendix C: Experimental Instructions for Participants[15]

A. Instructions for Consumers (Baseline)

General Overview of the Game

The purpose of this exercise is to study consumer decision-making in an electronic marketplace. You will be presented with a group of products. Each product has a specific value to you, and this value will be revealed to you. During each round you will try to acquire each of the products for the best (lowest) possible price. Your goal is to generate as much profit as possible, which is equal to the sum of the value of each product minus the amount you pay for it. Each purchasing round will last approximately five minutes.

There will be one practice round, followed by a number of "real" rounds. The total time for the entire exercise will be approximately one hour. The sellers of each product have enough copies in inventory to satisfy any potential demand. Each product traded is symbolically represented by a three-letter word.

The Rules

Once you made a bid, you are only allowed to raise your bid, not to decrease it. You cannot submit a bid that is greater than the revealed value of the product. You can submit a bid at any time during the round. You do not have to wait until the product is available to submit a bid. If you have a question, please call one of the lab assistants. The seller has multiple copies of each product and can continue to lower the price to attract other buyers.

Making Money

The profit you earn from a transaction is equal to the value of the product minus the price you pay for it. For example, if the product "cue" has a value of $140 and you pay $90, you will earn a profit of $140 - $90 = $50. The profit you earn for each round is equal to the values of all the products you bought minus the total price you paid for them. For example, if you purchased the following products, with their values in parenthesis—arm($40), cue($140), den($60), kit(85), and mit($280)—for $30, $130, $50, $75, and $250, respectively, you will earn a profit of: ($40+$140+$60+$85+$280) – ($30 + $130 + $50 + $75 + $250) = $70. Your total game profit will be equal to the total of all your round profits.

Key Summary Points

Your goal is to make money. The asking prices you see may remain the same or drift downward, but they never go up. Keep a close watch on the clock, especially as it counts down to the end of a round. If you have any questions, please ask one of the assistants.

B. Instruction for Producers (Baseline)

General Overview

The purpose of this exercise is to study consumer decision-making in an electronic marketplace. You will be presented with four products that you may produce and offer in the market. Each product may have varying levels of demand in the marketplace. You have the option to build none, some, or all of these products. Each product has a specific fixed production cost, which will be revealed to you.
During each round, you will try to sell copies of all products that you have made and brought to market for the best possible price.

Each trading round will last approximately five minutes. There will be one practice round followed by a number of "real" rounds. The total time for the entire exercise will be approximately 1 hour. The products traded on the market are represented by three-letter words.

[15] Because of space constraints, we include the instructions only for the baseline treatment. The instructions for the other treatments are similar and are available on request from the authors.

The Rules

Once you make a product and offer it in the market, you are only allowed to lower your ask price, not raise it. You can choose to produce a product at any time during the round. You can submit an ask price for the product at any time during the round. You do not have to wait until the demand for the product is indicated by seeing bids in the marketplace. You do not have to make and offer all your products. If you have a question, please call one of the lab assistants. The highest number of potential buyers in the marketplace is ten. The buyer values for individual products range from $0 to $300.

Making Money

The profit you earn from a transaction is equal to the price the buyers pay for the product minus your fixed production costs. For example, if you made the product, "and," for $200 and sold 2 copies to two buyers for $100 each and an additional copy to another buyer for $50, your profit will be ($100 + 100 + $50) - $200 = $50. The profit you earn in each round is equal to the total sales made minus the total costs of producing your products. Your total game profit will be equal to the sum of all your round profits

Key Summary Points

Your goal is to make money. Not all products may be profitable. The bid prices you see will typically drift upward, but never downward. You can make money if you learn which products are profitable and what the best prices are that you can get from each product. Keep a close watch on the

About the Authors

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