Marketing Science Institute Working Paper Series 2017
Report No. 17-115

Post-Purchase Co-Creation: Consumer Segmentation in Consumer-Driven Collaborative Product Development

Keith Marion Smith, John Hulland, and Andrew Stephen

Report Summary

Product co-creation (or collaborative product development) has become increasingly popular among firms in pre-release contexts, such as crowdsourced idea generation and open source product development. Yet few firms have explored post-purchase co-creation, or the modification of existing products following purchase. Customer engagement in post-purchase co-creation raises interesting questions regarding the impact of traditional marketing actions and customer brand communities on customer consumption patterns amongst different segments of the installed product base. Thus, a better understanding of post-purchase co-creation may provide firms with unique levers to influence product consumption and purchase.

In this report, Keith Marion Smith, John Hulland, and Andrew Stephen investigate post-purchase co-creation communities and consumption patterns of software products. The authors propose a segmentation model based on co-creation activity and investigate a complex set of influences on consumption across the different segments.

Utilizing automated online data collection techniques, product co-creation activities following the purchase of a product were observed. Integrating product co-creation activity, community engagement activity, and individual level product consumption activity over 32 weeks, the authors use a dynamic segmentation model to study post-purchase co-creation.

Among their findings:

- Three distinct segments of co-creation participation exist: Co-creation Creators, Co-creation Consumers, and Core Product Users.
- Co-creation Creators are motivated by interaction and communication with likeminded Creators, but not other Creators' co-creation activity, nor interaction with the Co-creation Consumer community.
- Co-creation Consumers are self-focused on their own behavior and relatively insensitive to the community, despite the fact they rely on Creators to generate content for consumption.
- Core Consumers are influenced by Co-creation Consumer community activity, suggesting that despite their lack of participation, they may listen to, and act upon trends within the community.
- Product promotions influence Co-creation Creators and Core Consumers to consume the product more, despite the fact that all individuals have already purchased the product, providing interesting support for the role of post-sale promotions.
- Co-creation media coverage negatively influences Core Consumer consumption.

Managers need to recognize that Co-Creation Creators and Co-Creation Consumers comprise a disproportionate percentage of total consumption, and may respond to different motivators than traditional Core Consumers. Management of both segments may be best achieved through maintenance of a healthy community and through motivation of the Co-Creation Creator segment, either by providing software tools or through co-creation incentives. Furthermore, promotions appear to effectively motivate product consumption even post-purchase.

Keith Marion Smith is Assistant Professor of Marketing, D'Amore-McKim School of Business, Northeastern University. John Hulland is Emily H. and Charles M. Tanner, Jr. Chair in Sales Management and Professor of Marketing, Terry College of Business, University of Georgia. Andrew Stephen is L'Oréal Professor of Marketing, Said Business School, University of Oxford.

Acknowledgements
The authors wish to thank the Marketing Science Institute and the University of Georgia for their gracious financial support of this research, and Scott Thompson for valuable research methodology feedback and suggestions.

Academics have long advocated integrating external sources of innovation into the product development process (Chesbrough 2003; von Hippel 1988; Stephen, Zubcsek, and Goldenberg 2013; Toubia 2006). Integrating customers in an otherwise firm-controlled product management process, often called *co-creation*, can provide benefits to the firm. O'Hern and Rindfleisch (2010, p 86) define co-creation as "a collaborative new product development activity in which customers actively contribute and/or select the content of a new product offering."

Co-creation can enhance the speed and effectiveness of product development. Transferring the iterative process of design-prototype-test to customers, who are more intimately aware of their product needs (Thomke and von Hippel 2002), increases the likelihood that development addresses specific customer needs, and reduces the time associated with need assessment and communication between the customer and the firm. It can satisfy a wider range of customer demands, increasing sales and better educating the firm regarding their customer's needs for future product design (Prahalad and Ramaswamy 2000; Ramaswamy 2008). Finally, co-creation, when paired with traditional marketing activities, can enhance communication with customers, influence the customer's product experience, and decrease the cost and risk associated with marketing communication (Ramaswamy 2008; Thomke and von Hippel 2002).

Integrating consumers into the design and development processes can be done in many ways (O'Hern and Rindfleisch 2010), depending on the degree to which the activity is led by the firm or customer, the degree to which the activity is open or restricted, and the marketing goals of the firm. Despite this diversity, however, existing marketing literature has focused almost exclusively on consumer selection of firm-created designs (Bendapudi and Leone 2003; Troye and Supphellen 2011), and pre-release collaboration in either open source product contexts (Grewal, Lilien, and Mallapragada 2006; Mallapragada, Grewal, and Lilien 2012) or user generated content (Albuquerque et al. 2012; Ransbotham, Kane, and Lurie 2012). Relatively little attention has been paid to post-purchase or post-release co-creation (Jeppesen and Molin 2003). This type of co-creation is often found in the software, video game, and music industries, where firms provide consumers with opportunities to modify their products, post-purchase, to best satisfy their own unique preferences. These markets represent significant potential value,; for example the published software market alone generated over 192 billion dollars in sales in

the United States in 2015 (Blau 2015). While not every piece of published software currently has an active co-creation community, the possibility exists for this type of customer co-creation engagement in these product markets. Further, post-release co-creation has a wider potential reach since every consumer who purchases the product is a potential co-creation participant. Pre-release software co-creation in contrast has rarely been adopted by end-users and has been restricted to low level software development of back-end systems ("The 2015 Analytics Software Market" n.d.).

Different types of consumers appear to engage in co-creation for different reasons, including empowerment (Fuchs, Prandelli, and Schreier 2010), self-serving bias (Bendapudi and Leone 2003), and associative self-anchoring (Troye and Supphellen 2011), among others (O'Hern and Rindfleisch 2010). However, much of the empirical literature on co-creation has assumed that each participant in co-creation is essentially similar, or has accounted for heterogeneity by allowing individual level unobserved differences in co-creation participation (Albuquerque et al. 2012; Mallapragada, Grewal, and Lilien 2012; Ransbotham, Kane, and Lurie 2012). The varied motivations identified in the literature suggest that different categories of co-creation participants may exist, and that category membership can influence product purchase and consumption differently. Further, marketing actions taken by the firm may differentially influence these distinct categories.

A small number of studies have identified different types of participants in the co-creation process, including Mallapragada, Grewal & Lilien's (2012) separation of developer and end users in an open source software environment, and Jeppesen & Molin's (2003) identification of different co-creation consumer categories in online computer games. However, existing research on these co-creation categories in a post-purchase co-creation context has been limited to explorative case studies. The post-purchase setting has simply not received attention, despite the greater volume of potential consumer involvement in this stage ("The 2015 Analytics Software Market" n.d.).

The product categories often associated with co-creation (software, music, games) are more accessible to post-purchase co-creation in part due to their digital nature. This same digital characteristic raises the question of consumption separate from purchase. Because these digital products do not degrade over time, repurchase following consumption is not necessary. Thus,

beyond the initial purchase, consumption drives many post-purchase marketing processes, including satisfaction, word-of-mouth, loyalty, and lifetime value.

In order to understand the post-purchase co-creation context, and the related influences on product consumption, consumer engagement in online communities of co-creation, and associated product consumption are examined. Since co-creation category membership is unobserved and needs to be inferred, a latent class cluster methodology is utilized that allows categorization of consumers into different customer segments based on their co-creation activity. Combined with time-series panel modeling, an investigation is conducted to understand how co-creation engagement, the co-creation community, and strategic marketing actions influence product consumption over time, across different co-creation customer segments.

Conceptual Background

Product co-creation

Interest in customer-created content has grown in recent years, with research investigating both user-generated content (Albuquerque et al. 2012; Moe and Schweidel 2012; Ransbotham, Kane, and Lurie 2012) and the open source software community (Grewal, Lilien, and Mallapragada 2006; Kumar, Gordon, and Srinivasan 2011; Mallapragada, Grewal, and Lilien 2012; Oh and Jeon 2007; Singh, Tan, and Mookerjee 2011). These two forms of customer collaboration and interactivity have provided fertile ground for (O'Hern and Rindfleisch 2010) "collaborative new product development activity in which customers actively contribute and/or select the content of a new product," often termed co-creation. Despite the theoretical work on co-creation driven by firm actions, the majority of empirical work in the area has examined user-generated or open-source projects developed by consumer teams, without the input of a firm, and unaffiliated with any existing market products. How do these co-creation contexts and communities influence consumers when the co-creation is affiliated with existing products post-release, and what is post-purchase or post-release co-creation?

This integration of consumers into the post-purchase design and development process goes beyond traditional product customization offerings that allow consumers to change the color of a product (e.g. Timbuk2 Bags) or pick from a few different options (e.g. Dell) to customize the product they desire during the purchase decision. Instead, co-creation in the post-release stage facilitates fundamental changes in the function and form of the core product, permitting customers to innovate and refine the product to meet their unique and specific needs, and access communities of co-creation to implement other customer's innovations into their own products.

Moreover, post-release co-creation provides customers with opportunities to reconfigure and redefine the original product, increasing the time that they find the product interesting. These co-creation activities have the potential to greatly impact the consumer's product experience following product purchase, and represent a part of the consumer product experience that firms can influence on an on-going basis. However, are these consumers all created equal? Are there different ways that consumers may experience products that support post-purchase co-creation, depending on each consumer's engagement in the co-creation community, and does this engagement influence their consumption of the product? This research aims to investigate these relationships and better understand the role of post-purchase co-creation in consumption.

Types of co-creation customers

Based on a synthesis of the literature, three distinct consumer co-creation segments are expected in a post-purchase context: Co-Creation Creators, Co-Creation Consumers, and Core Consumers. Co-Creation Creators modify existing products and generally share their modifications with the community. Co-Creation Consumers do not themselves create modifications, but rather integrate existing modifications published by Creators into their own products. Finally, Core Consumers are either unaware of or uninterested in co-creation and simply consume the core product as offered by the firm.

This consumer structure arises out of past work that has made a distinction between content creators and content consumers in co-creation contexts. Distinct roles for creators and consumers have been investigated in an open source context (Mallapragada, Grewal, and Lilien

2012), and in a user-generated content context (Zhang et al. 2012), providing support for the idea that different categories of co-creation consumers can contribute different value to the firm. Traditional pre-release co-creation literature has rarely examined non-creators however, and certainly not core consumers uninvolved with co-creation. In contrast, Jeppesen & Molin (2003) distinguish between content creators, content consumers, and core product users in the computer game marketplace for post-purchase product modifications, though they focused their investigation on descriptive differences identified via a qualitative analysis. However, no quantitative empirical study has been conducted to confirm the presence and number of groups that arise out of post-purchase co-creation.

Co-Creation Creators actively create new content and/or make modifications to existing products to satisfy their own unique needs for a different product experience (Jeppesen and Molin 2003), driven by feelings of empowerment (Fuchs, Prandelli, and Schreier 2010). They sometimes participate in a product community to share their co-created products with other consumers. Co-Creation Consumers are interested in consuming modified products to meet their unique product needs, but have no interest in devoting the resources to develop the knowledge to make successful modifications, nor the resources to actually modify the products. An extensive level of product knowledge is required in order to successfully modify most products (Kohler et al. 2011; Nambisan and Baron 2009), and customers interested only in consuming co-created products are not likely to have this knowledge, nor be motivated by feelings of empowerment to develop it. Instead, these modification-adopters are likely to seek revised products already available in the community. Finally, Core Consumers utilize the product as designed by the firm. They have no awareness of or desire to make modifications or adjustments to the product.

Co-Creation outcomes and drivers

Much of the co-creation literature has focused predominantly on non-marketing outcomes such as knowledge creation (Kuk 2006), or on pre-purchase open-source outcome measures such as project downloads or project popularity (Mallapragada, Grewal, and Lilien 2012). While these outcomes are themselves important, they fail to examine individual level marketing outcomes of interest to firm managers. Product consumption comprises a unique and separate phase of the

individual consumer experience, and provides a mechanism through which product loyalty, word-of-mouth, and other downstream marketing outcomes are achieved (Holbrook and Hirschman 1982; Schouten and McAlexander 1995). Consumption, like post-purchase co-creation, occurs following purchase, and provides a worthy object of study to understand individual level phenomenon in post-purchase co-creation.

Turning to the identified drivers of co-creation, much of the existing literature has focused on social interactions, social structure, and social capital within a network of creators. Increased social capital, measured through network centrality at the individual level, has been shown to influence commercial and technical success (Grewal, Lilien, and Mallapragada 2006), time to product release (Mallapragada, Grewal, and Lilien 2012), and consumption (Ransbotham, Kane, and Lurie 2012). Social cohesion or strong interpersonal connections within a project, measured via repeat ties, has further been linked to technical success (Singh, Tan, and Mookerjee2011). Finally, imbalances in the structure of a co-creation network have been linked to quality (Ransbotham and Kane 2011) and knowledge creation (Kuk 2006).

Despite the extensive work on social influences in co-creation, almost all of the work explores the structure of the social network. Little is known about how the act of socially interacting influences co-creation and consumption. Furthermore, the majority of the literature has examined the individual within a network, and the connections each individual makes with other co-creators. No work has explored the role that the community has on individual consumers. A rich history of research in brand and online communities (Muniz, Jr. and O'Guinn 2001; Schau, Muñiz Jr, and Arnould 2009) provides a framework to explore social interactions within co-creation communities that extend beyond an individual's structural position within a network of co-creators

Online & brand communities

A healthy body of research has explored the value of brand communities both to consumers and to the firm (Muniz, Jr. and O'Guinn 2001), demonstrating a process of value creation from brand communities through a number of social processes, including community engagement, shared brand use, social networking, and impression management (Schau, Muñiz Jr,

and Arnould 2009). Much of the brand value creation derived from communities arises following purchase of the product. These post-purchase influences from brand communities suggest that these communities may play an important role in post-purchase co-creation.

Increasingly, a number of studies have leveraged behavioral secondary data to link individual level brand community participation measures to marketing outcomes. Brand community participation has been shown to increase sales and retention (Adjei, Noble, and Noble 2010), increase risky behavior through reliance and trust on community members (Zhu et al. 2012), and increase new product success through dissemination of product information (Gruner, Homburg, and Lukas 2014). Brand community participation has also been linked to faster new product adoption, especially when consumers do not participate in multiple communities, or when brands tied to the community are first to market (Thompson and Sinha 2008).

Many products that offer post-release co-creation opportunities additionally provide consumers with the opportunity to engage in social interaction around the creation process. For example, customers can share their designs (e.g., software modifications) with others, vote on other customers' designs, and interact in online communities or social networks(e.g. Threadless, a fashion company that allows customers to vote on product designs to be manufactured (Ogawa and Piller 2006)). These firms facilitate customer communities by providing members with tools that allow them to interact and take part in co-creation activities.

Both brand communities and co-creation tools introduce a source of extended consumer experience with products, and offer firms the ability to continually engage consumers in product experiences that may build additional product value over time. Therefore, an examination of post-purchase co-creation would benefit from an investigation of brand community's role in co-creation engagement and product consumption, and extend the literature on social interactions in co-creation.

Strategic marketing actions

Very little research has explored how marketing managers can influence co-creation environments. Some studies have investigated public relations and price discounts in user-generated content contexts and found that firm-initiated public relations, and creator referrals increase content generation activity, and purchase, while price discounts influence purchase (Albuquerque et al. 2012; Zhang et al. 2012). Investigation of product based elements of the marketing mix in pre-release co-creation have been limited to innovativeness (Fang 2008) and product labeling (Fuchs et al. 2013; Schreier, Fuchs, and Dahl 2012), and have been focused on consumer experimental methodologies.

Ultimately, the same focus on consumer-driven open source contexts that has provided limited insight into post-release co-creation has also made it difficult to understand the tools marketers can leverage to affect co-creation and consumption. Post-purchase or post-release co-creation contexts presents interesting opportunities and challenges to marketers. These products are developed and marketed for the core consumer, and co-creation communities adopt these products that were never intended to be modified, or where those modification opportunities were targeted at a small portion of the customer base. What influence do marketers have on consumption in these contexts then? Further, what distinctions exist between different types of co-creation customers?

Empirical Study

Study context

Existing literature has explored pre-launch product co-creation activity through online communities of software or knowledge development (e.g. Sourceforge, Wikipedia). These same study communities provide a context to investigate post-launch co-creation. For example, post-launch or post-purchase co-creation in the computer game market occurs frequently when games are modified by customers, and then shared with the rest of the community. Customers may add new graphics, items, or quests to an existing game, or even change entire game systems to create

new games. These co-creation projects are typically called ‘mods’ in the video game marketplace.

Steam is the largest online product storefront and digital distributor of computer games, comprising over sixty percent of the market in 2015. In addition to selling computer game products, *Steam* provides support for post-purchase product co-creation activity through their Workshop initiative. Firms partner with *Steam* to include Workshop features in their products, including product co-creation tool-kits, mod websites and forums, and seamless browsing, installation, and updating of consumer developed product mods. The Steam platform additionally provides systems for customers to connect with other customers, and to join groups of like-minded customers.

Steam’s Workshop provides a platform for mod creators to upload their project files for download by others, and provides a communication interface to interact with other consumers. Each project is uploaded to Steam’s servers, and the project creators can include a description of the mod, images associated with the project, and different tags used to categorize projects. *Steam’s Workshop* further provides a mechanism to interact with project creators through comments associated with each project, facilitating a conversation between interested consumers and the mod creator. Mods uploaded to the *Workshop* can be easily searched by interested consumers, installed into each game with a single button, and those mods are automatically updated as project creators make changes.

Steam’s online co-creation Workshop included over 2,250,000 submitted projects for over 300 different games in December of 2015. Users who engage in co-creation through *Steam’s Workshop* system have a corresponding account that tracks their game consumption and community interaction activity, in addition to key information regarding their co-creation activities. Purchased games, game consumption times, online forum activity, online co-creation engagement, and networked friends and their corresponding data are all available for all co-creation customers. Consumer data from *Steam* was captured utilizing custom automated online data collection techniques. This data was combined with marketing activity data and media activity data from public sources (described in more detail below).

Sample

Given the focus on co-creation engagement and product consumption by individual consumers, the unit of analysis for the purposes of this study was the individual consumer. Data was collected for one game, Torchlight 2. This focal game was selected for its active but mature consumer market (six months post-release), active co-creation environment, and developer provided co-creation toolkit that facilitated co-creation. Torchlight 2 is a fairly representative game in the marketplace, a sequel with an established fan base, good critical reception (Metacritic scores of 88/100) ("Torchlight II for PC Reviews - Metacritic" 2016), and solid sales figures, with over one million unit sales in the first 10 months (Farokhmanesh 2013), and around three million in unit sales since launch (Kuchera 2015).

Two phases of data collection were conducted. A Subject Selection phase occurred in an initial eight week window (October to December, 2013), wherein any consumer active in at least one mod project or in the product community forum was identified for inclusion. A Subject Activity phase followed over a 32 week window (December 2013 to August 2014), collected very two weeks, wherein product co-creation activity, product consumption activity, and community engagement activity was collected for each individual identified during subject selection. Individuals with no consumption activity during the 32 week Subject Activity phase were eliminated from the sample, resulting in a final sample of 960 consumers.

Measures

The existing literature suggests that different communities may exist for co-creation creators, co-creation consumers, and core product users, reflecting different consumer motivations and community norms. Data was collected to assess this claim and to better understand consumer segmentation in the collected dataset. Five categories of measures were collected, including profiling measures, time-varying individual measures, time-varying community measures, marketing activity measures, and a number of control measures. Detailed descriptions of those categories and the collected measures follow. Measure definitions and overall descriptive statistics can be found in Table 1, while correlations can be found in Table 2.

Profiling measures

A set of measures was collected that could potentially separate co-creation creators, co-creation consumers, and core product users. Because co-creation segmentation is expected to be relatively stable within the timeframe under investigation (32 weeks) the following measures represent aggregate measures across the entire study window for each consumer.

Frequency of authorship activity. For each period, a dummy measure of authorship activity was collected that identified whether a consumer had uploaded at least one new mod or updated at least one existing mod during that period. These 16 period measures (collected every two weeks) were then summed to obtain a measure of frequency of period authorship activity over the entire 32 week study window, resulting in a measure that ranged from 0-16 across the sample for the entire window. Thus, a consumer who had been active in authoring every period would receive a score of 16 while a consumer that had only been active in authoring for four periods would receive a score of four. Because this measure is summed across the entire study window it provides a time-invariant measure of authorship activity.

Frequency of commenting activity. For each period, a dummy measure of commenting activity was collected that identified whether a consumer had commented on at least one mod during that period. These 16 period measures were then summed to obtain a measure of frequency of period commenting activity over the entire 32 week study window, resulting in a measure that ranged from 0-16 across the sample for the entire study window. Because this measure is summed across the entire study window it provides a time-invariant measure of commenting activity.

Time-varying individual measures

A set of time-varying individual level measures of consumption and co-creation activity was collected that could explain within-group differences in product consumption. Collected

every period over the 16 period window, these measures help explain period to period changes in consumption for each consumer.

Focal consumption. Consumption was measured as the total number of hours the focal game, *Torchlight 2*, was consumed by each customer over the each two week period. Examination revealed a number of extreme values that could influence model estimation; thus, a log normal transformation was performed to reduce the impact of these extreme values.

Author activity. Consumer activity in authorship for a specific period was measured as a simple dummy variable. Consumers were counted as active in authorship if they uploaded a new mod for that period, or if they updated an existing mod in the period. These authoring events capture an endpoint of co-creation development activity, as mod projects are only available to the public following an official release or update by the author. These period level, time-varying measures of authorship, when combined across the entire study window, comprise the time-invariant profiling measure of authorship activity noted above.

Comment activity. Consumer activity in commenting for a specific period was additionally measured as a simple dummy variable. Consumers were counted as active in commenting if they posted a comment on a mod someone else had uploaded. These comments capture engagement in the co-creation community by measuring the degree to which consumers interact with others within the co-creation environment. These period level, time-varying measures of commenting activity, when combined across the entire study window, comprise the time-invariant profiling measure of commenting activity noted above.

Authors who commented on their own uploaded mods were not counted as engaging in commenting activity. Author comments on their own projects were typically responses to other non-author commenters or a part of a discussion with other members of the community related to the development of their own mods. Thus, their own project commenting behavior was characterized as a part of their authorship behavior and not captured in the Commenting Activity measure.

Time-varying community measures

A set of time-varying community level measures of consumption and co-creation activity was collected, to examine community influences on product consumption. Conceptually, the influence from the creator community and consumer community may be different. Thus, these measures were calculated following segmentation of the consumer dataset into creator and consumer clusters (see Latent Class Cluster Model below), by collecting total levels of activity from consumers categorized into the co-creation creator sub-community and the co-creation consumer sub-community.

Creator community author activity. A measure of the level of authorship activity amongst Creators was captured to examine the influence the Creator community has on consumption. A count of the number of total Creators that either uploaded a mod or updated an existing mod in the period was calculated. Corresponding measures of community authorship were not included for either Co-creation Consumers or Core Consumers because of their relative lack of co-creation activity. Measures of these communities would be effectively zero due to a lack of co-creation activity within these consumer segments, and the corresponding variables would be uninterpretable.

Creator community comment activity. Similar to Creator Community Authorship Activity, a count of the number of total Creators who posted a comment to any non-owned mod project for each period was calculated to examine Creator community commenting separate from authoring. As noted above, comments posted to their own mods were excluded as they are more likely to capture co-creation authorship behavior than community commenting behavior.

Consumer community comment activity. A count of the number of total Co-creation Consumers who posted a comment to any mod for each period was calculated to examine Co-creation Consumer community commenting separate from the Creator community. Again, a corresponding measure of community commenting was not included for Core Consumers because of their relative lack of commenting activity. Measures of the Core Consumer communities would be effectively zero due to a lack of co-creation commenting activity within this consumer segments, and the corresponding measure would be uninterpretable.

Controls

A number of controls were collected to rule out alternative explanations or to corroborate prior findings in the co-creation and consumption literatures.

Last period focal consumption. Past levels of the dependent variable were calculated in order to account for unit level effects in the panel dataset, and to control for the influence of past behavior. Like current period consumption, a log normal transformation was performed to reduce the impact of extreme values.

Platform consumption. In order to account for variation in overall game consumption levels, a measure of product consumption on *Steam* was captured, excluding the focal game for any given period. Like focal consumption, this variable had a log normal transformation applied to reduce the impact of extreme values.

Platform investment (platform products owned). A measure of how many total games each consumer owns on the *Steam* platform for each period was collected to provide a control for overall platform investment.

Connections. Steam provides a friend connection system that allows an individual to connect and play with others. This same system allows the capture of a measure of how connected a consumer is within the entire *Steam* network, not simply within the network of co-creators.

Marketing activity measures

In an attempt to examine the influence of strategic marketing actions in a post-purchase co-creation context, a number of variables were collected from the *Steam* platform and PR measures were collected from the top fourteen most visited video game news websites as identified by *Amazon's Alexa* website ranking service (Alexa 2016), at the first data collection window. While the impact of these factors on sales has been well established and deeply explored, their influence on consumption in a post-purchase setting, and especially on different segments of consumers in a co-creation context, is unknown.

Proportion of mod stories in media. The proportion of media stories about co-creation (mods) in our focal game compared to all stories on the focal game was collected for each period, allowing investigation of the influence of the content of public relations on consumption.

Product promotion. Steam offers a number of different promotion types on their platform that range from free play weekends, individual product sales, whole publisher catalog sales, and game competition events. A dummy was captured identifying those periods where the firm organized a promotion on the *Steam* platform to investigate the influence of promotions on consumption

Model and Estimation

Exploring individual co-creation behaviors, group level influences, and marketing actions over time, and considering how these factors may influence consumption across different types of consumers presents a number of modeling challenges, including consumer heterogeneity, panel unit effects, and serial correlation.

One way to investigate co-creation in the presence of consumer heterogeneity would be to model discrete categories of consumers based on consumer characteristics. Implementing hidden markov modeling techniques, we could then model transitions between categories, ultimately identifying both the short-term and long-term influences of different community and marketing mix variables on consumption and co-creation. Such a modeling approach is most effective when transitions occur between the consumer categories. Preliminary analysis of the dataset revealed that while discrete categories existed, little to no transitions occurred between the categories in the timeframe examined. Therefore, alternative modeling techniques were adopted.

Consumer heterogeneity: latent class cluster model

In order to account for consumer heterogeneity in co-creation engagement and to test for the expected presence of three different categories of co-creation consumers, a latent class cluster

model was estimated. By utilizing latent class cluster models that statistically test for the presence of a mixture of multiple distributions within a single distribution of data (Vermunt and Magidson 2002), separate discrete sub-distributions corresponding to Co-Creation Creators, Co-Creation Consumers, and Core Consumers could potentially be identified.

Theoretically, the three clusters under investigation in this study differ primarily in their authorship and commenting behavior. Prior literature in co-creation has established authorship or content creation as the primary outcome of the co-creation process (Goldenberg, Oestreicher-Singer, and Reichman 2012; Grewal, Lilien, and Mallapragada 2006; Mallapragada, Grewal, and Lilien 2012), with a secondary role for communication or interaction within co-creation networks (Albuquerque et al. 2012; Kuk 2006; Ransbotham, Kane, and Lurie 2012). Further, the expected segmentation into Co-Creation Creators, Co-Creation Consumers, and Core Consumers has been previously motivated by the distinctions in authorship and community interaction (Jeppesen and Molin 2003).

Therefore, in support of the previous literature, the latent class cluster model included two variables: Frequency of Authorship Activity, and Frequency of Commenting Activity. Since both of these measures are counts of activity across the entire study window (16 periods), the latent class cluster model was estimated as a multivariate Poisson distribution.[1] The latent model is characterized as follows:

$$f(y_i) = \sum_{x=1}^{K} P(x)\, f\left(\begin{matrix}\text{Frequency of}\\ \text{Authorship Activity}_i\end{matrix}\middle| x\right) f\left(\begin{matrix}\text{Frequency of}\\ \text{Commenting Activity}_i\end{matrix}\middle| x\right)$$

where i=1,...,n individuals, and x is the latent category variable with *K* classes

[1] It is technically possible for consumers to shift between different latent segments over the sixteen periods. In reality, the data revealed relatively stable levels of both authorship and commenting activity, suggesting that such shifts did not occur within the dataset. This stability is unsurprising given the maturity of the game, and likely well established consumer segments.

Panel regression model

Following consumer segmentation into discrete classes, a regression model approach was adopted to examine the influences on product consumption separately for each consumer class. The consumer data contain repeated measures over time for each consumer in the dataset. In order to account for the influence of past levels of consumption, as well as to address unit effects, a lagged value of the dependent variable is included in the model (Beck and Katz 2011). Inclusion of the lagged dependent variable allows for pooled OLS estimation. A separate model is estimated for each of the three hypothesized groups in order to account for heterogeneous influences on consumption.[2] The three regression models are characterized as follows:

Co-creation Creator Focal Consumption$_{it}$ =
β_0 + β_1 Author Activity$_{it}$ + β_2 Creator Community Author Activity$_{it}$ + β_3 Comment Activity$_{it}$ + β_4 Creator Community Comment Activity$_{it}$ + β_5 Consumer Community Comment Activity$_{it}$ + β_6 Proportion of Mod Stories$_{it}$ + β_7 Product Promotion$_{it}$ + β_8 Last Period Focal Consumption$_{it}$ + β_9 Platform Consumption$_{it}$ + β_{10} Platform Investment$_{it}$ + β_{11} Connections$_{it}$ + ε_{it}

Co-creation Consumer Focal Consumption$_{it}$ =
β_0 + β_1 Creator Community Author Activity$_{it}$ + β_2 Comment Activity$_{it}$ + β_3 Creator Community Comment Activity$_{it}$ + β_4 Consumer Community Comment Activity$_{it}$ + β_5 Proportion of Mod Stories$_{it}$ + β_6 Product Promotion$_{it}$ + β_7 Last Period Focal Consumption$_{it}$ + β_8 Platform Consumption$_{it}$ + β_9 Platform Investment$_{it}$ + β_{10} Connections$_{it}$ + ε_{it}

Core Consumer Focal Consumption$_{it}$ =
β_0 + β_1 Creator Community Comment Activity$_{it}$ + β_2 Consumer Community Comment Activity$_{it}$ + β_3 Proportion of Mod Stories$_{it}$ + β_4 Product Promotion$_{it}$ + β_5 Last Period Focal Consumption$_{it}$ + β_6 Platform Consumption$_{it}$ + β_7 Platform Investment$_{it}$ + β_8 Connections$_{it}$ + ε_{it}

[2] Integrating the latent class cluster and the regression into one model, means that community influences would need to calculated in real time as a part of the model estimation, and would result in potentially changing cluster sizes and community measures that would make estimating such a model intractable. As a result, separate regression models have been estimated for each of the consumer clusters.

where i=1,…,n individuals and t=1,…,16 time periods

As noted previously, variables measuring authorship and commenting would be uninterpretable for segments not engaging in these behaviors. Note that Authorship Activity was included only in the Co-Creator model, and that Commenting Activity was included only in the Co-Creator and Co-Creation Consumer models.

Serial correlation

In order to address potential serial autocorrelation in the data, a Woolridge Autocorrelation test (Woolrdige 2010) was conducted for all three consumer regression models, Co-Creation Creators, Co-Creation Consumers, and Core Consumers. All three tests indicated that significant autocorrelation was present in the data. Thus panel corrected standard error estimators that assume the errors are both heteroskedastic and autocorrelated were implemented in all models to correct for the autocorrelation (Beck and Katz 2011).

Results

Complete latent class cluster model results and panel regression results are reported below. Briefly, the latent class cluster analysis revealed a four cluster solution to be the best fitting model. Cluster-specific descriptive statistics support the proposed consumer clusters. Panel regression analysis conducted separately for each of the clusters reveal differing results.

Latent class cluster analysis

Latent Class Cluster models with *Frequency of Authorship Activity* and *Frequency of Commenting Activity* as indicators were estimated. Vermunt and Magidson (2013) recommend AIC and CAIC as the most appropriate fit statistics for latent class cluster models. Table 3 Panel A provides full latent class cluster model fit statistics. Models ranging from one to five classes included were estimated, and model fit statistics consistently indicate that a four class model is

most appropriate (AIC = -1790, CAIC = -2067). The four class model produced the lowest AIC and CAIC values.

Table 3 Panel B provides class profile data that helps illustrate specifically how the four classes differ across *Frequency of Authorship Activity* and *Frequency of Commenting Activity.* The four classes, from smallest to largest in size comprise 0.8%, 1.4%, 6.9%, and 91% of consumers. Initial analysis of the four class model might suggest a poor fit with the proposed three class model based on prior literature and the proposed consumer structure. However, upon closer examination of the class profile descriptive data (Table 3 Panel B), the picture becomes clearer.

The largest class (.910) comprises the group least involved in either co-creation authorship (.011) or co-creation commenting (.142) behavior. This group corresponds to the Core Consumers. The second largest class (.069) has a relatively higher level of commenting activity (1.508), though again negligible levels of authorship activity (.052). This subgroup corresponds to the Co-Creation Consumer segment.

The remaining two groups share similarities with the Co-Creation Creator group. However, a deeper examination of these two groups reveals an interesting dichotomy. Both groups are relatively small and of equal size. Further, both groups have far higher levels of authorship activity than the Core Consumers or Co-Creation Consumers (at a minimum 30 times the authorship activity, and in some cases over 500 times the authorship activity). One of these Co-Creation Creator groups however has very high levels of authorship activity (5.181) and modest levels of commenting activity (1.069). These consumers are termed Code Creators for their overwhelming focus on the activity of developing mod projects. The alternative Co-Creation Creator group has modest levels of authorship activity (1.801) and very high levels of commenting activity (9.384). These consumers are termed Community Creators for their dual focus on both mod project development and community engagement with other creators.

Table 3 Panel C provides the model coefficients and overall model tests. The results from the four class model confirm that both *Frequency of Authorship Activity* and *Frequency of Commenting Activity* play an important role in identifying the multiple unique distributions of

consumers within our greater consumer dataset. Overall model fit statistics indicate the model with *Frequency of Authorship Activity* and *Frequency of Commenting Activity* is significantly better than a constants only model ($X^2 = 5621.69$, $p < .001$).

More specifically, high levels of *Frequency of Authorship Activity* are positively associated with being classified as either a Community Creator ($\beta = 1.801$) or a Code Creator ($\beta = 2.996$). Alternatively, high levels of *Frequency of Authorship Activity* are negatively associated with classification into the Co-Creation Consumer ($\beta = -1.600$) or Core Consumer ($\beta = -3.197$) clusters. A Wald test comparing these coefficients indicates that there is a significant difference between the clusters when considering the influence of Frequency of Authorship (Wald = 329.79, $p < .001$). These results indicate that Code Creators and Community Creators are heavily engaged in product modification behavior and product co-creation, supporting previous evidence that a clear group of creators exist within the co-creation community.

Frequency of Commenting Activity is positively associated with classification into the Co-Creation Consumer ($\beta = .222$) or Community Creator ($\beta = 2.049$) clusters. Alternatively, high levels of Frequency of Commenting Activity are negatively associated with classification into the Code Creator ($\beta = -1.600$) or Core Consumer ($\beta = -1.600$) cluster. A Wald test comparing these coefficients indicates that there is a significant difference between the clusters when considering the influence of Frequency of Commenting (Wald = 543.867, $p < .01$). These results indicate that both Community Creators and Co-Creation Consumers are heavily engaged with the greater community. Previous research in co-creation and online communities has found support for the role of community interaction in creation and consumption.

The dichotomy between different types of creators is interesting and deserving of further exploration. Ideally separate analysis could be conducted on both groups of Creators to better understand these differences. Unfortunately, the small sizes of these groups (.014 and .008 respectively) precludes such an analysis. Thus, for the purposes of this study the two Co-Creation Creator groups were combined into a single group to achieve acceptable sample sizes. Both groups are clearly more engaged in co-creation authorship than the Core Consumers or Co-Creation Consumers.

Cluster-Specific descriptive statistics

Cluster-specific descriptive statistics from the three consumer clusters (Co-Creation Creators, Co-Creation Consumers, and Core Consumers) provide a clearer picture of consumer engagement in co-creation and the resulting consumption. One cluster (Co-Creation Creators) is dedicated to the creation of modified products and community engagement around those co-created modifications. One cluster (Co-Creation Consumers) is dedicated to the community engagement around co-created modifications, but does not engage in co-creation modification. The final cluster (Core Consumers) is either unaware or uninterested in the co-creation community, instead focused on overall platform consumption and investment. These three clusters provide a framework to examine how consumer actions, community-level behavior, and marketing strategy can influence product consumption and engagement in co-creation. Complete cluster-specific descriptive statistics can be found in Table 4.

The smallest cluster (2.08%) comprises the two combined Creator clusters. This group is characterized by high levels of authorship behavior, both in terms of likelihood of engaging in authorship activity (29.38%), and the average number of mod projects uploaded to the Workshop environment (2.383 projects). Their commenting activity also occurs at a high level, with a high likelihood of posting a comment for any period (25.63%) and a higher average number of comments posted per period (.994 comments). Their consumption patterns reveal relatively high high levels of focal consumption (5.322 hours) and moderate levels of platform consumption on *Steam* (24.070 hours). They further have moderate levels of platform investment (83.703 products). Despite their small size, this segment comprises almost ten percent (9.05%) of the total focal consumption in the dataset, far disproportional to their size.

The second largest cluster comprises the Co-Creation Consumers, characterized by their participation in commenting on mod projects. They exhibit a larger likelihood of commenting (7.58%) compared to the Core Consumers, and have a higher average level of comments per period (.185 comments). Their authorship activity is low, with a low likelihood of authorship activity (.66%) and a low number of published mod projects (.222 projects). Yet when examining their consumption activity, this cluster has far higher levels of focal consumption

(5.926 hours) than Core Consumers, and a similar level compared to Co-Creation Creators. Their levels of *Steam* platform consumption are moderate (25.196 hours), though they have a relatively lower level of platform investment (90.891 products) than Core Consumers. This group is relatively small in size (6.88%), though they also comprise a far higher proportion of total consumption activity (33.27%) than would be expected.

Examination of the Core Consumer cluster reveals an essentially zero likelihood of uploading a mod for any single period (.04%), and an essentially zero number of mod projects uploaded on the *Steam* Workshop for any single period (.060 projects). Their likelihood of posting a comment is similarly small with an incredibly low likelihood of posting a comment for any single period (.13%) and an incredibly low number of comments posted for any single period (.002 comments). Turning to their consumption pattern, they have a relatively small amount of focal consumption for any single period (.776 hours), a moderate level of *Steam* platform consumption per period (27.26 hours), and higher levels of platform investment (122.16 products) when compared to the other two consumer clusters. This cluster comprises the largest percentage of consumers (91.04%), however their consumption comprises a much smaller proportional percentage of the overall consumption (57.68%) in the dataset.

Panel regression analysis

Three separate panel regression models on the three identified clusters were estimated to understand the influence of consumer co-creation activity, community co-creation activity, and marketing actions on product consumption. Separate analyses were conducted on each cluster to allow for heterogeneous influences across clusters. One model was estimated for Co-Creation Creators, one for Co-Creation Consumers, and one for Core Consumers. Complete panel regression results for all three clusters can be found in Table 5.

Co-Creation creator panel analysis

Panel estimation results for Co-Creation Creators reveals an interesting influence from author activity, comment activity, creator community comment activity, product promotion, platform consumption, platform investment, and connections on focal consumption. Model Fit tests indicate the model provides an improvement on a constants only model (Wald = 331.04, $p <$ .001). More specifically, author activity has a positive influence on consumption ($\beta = .373$, $p <$ .001), comment activity has a positive influence on consumption ($\beta = .278$, $p < .05$), and creator community comment activity has a positive influence on consumption ($\beta = .097$, $p < .001$). Of the strategic marketing measures, product promotion has a positive influence on focal consumption ($\beta = .440$, $p < .01$). Of the platform measures, platform consumption has a positive influence on consumption ($\beta = .186$, $p < .001$), platform investment has a negative influence on consumption ($\beta = -.002$, $p < .001$), and connections has a positive influence on consumption ($\beta =$ .003, $p < .001$). Last period focal consumption has a positive influence on focal consumption ($\beta = .063$, $p < .001$).

The influence of authorship activity on consumption provides an interesting extension of the existing literature's focus on co-creation activity. Engagement in co-creation appears to actually influence the consumption of the core product in addition to knowledge creation and other established co-creation outcomes. The influence of creator community commenting behavior further extends the effects demonstrated in the community literature by illustrating that creators are motivated by interaction and communication with likeminded creators, but don't appear to be influenced by other creator's authorship behavior, or by online interaction within the co-creation consumer community (the segment that is essentially the creator's target market).

The positive influence of product promotion provides a surprising result that promotions have an impact beyond product sales. Even for those that own the product, promotions can induce increased consumption. The positive influence of connections provides further support for the connected nature of these types of consumers found in past literature.

Co-Creation consumer panel analysis

Panel estimation results for Co-Creation Consumers reveals an interesting dynamic. Only commenting activity, connections, and last period focal consumption have any influence on current period consumption. Model Fit tests indicate the model provides an improvement on a constants only model (Wald = 400.86, $p < .001$). More specifically, commenting activity has a positive influence on consumption ($\beta = .585$, $p < .001$), connections has a negative influence on consumption ($\beta = -..003$, $p < .001$), and last period focal consumption has a positive influence on focal consumption ($\beta = .035$, $p < .001$).

These results seem to indicate a Co-Creation Consumer segment that is self-focused on their own behavior and relatively insensitive to the community. While focused on their own commenting and consumption behavior, it must be noted that their commenting behavior occurs in the context of the co-creation community. While these consumers may not be motivated to consume by others participation in the community, they are motivated by their own participation in the community of co-creation. These results suggest that Co-Creation Consumers are actively invested in their participation in the community and do seek interaction and acceptance amongst the community of co-creators, perhaps aspiring towards creator group membership and attempting to validate that group membership through community engagement. The negative influence of connections is interesting, though may be the result of an increased propensity to engage in shared consumption with a wider variety of products on the platform.

Core consumer panel analysis

Panel estimation results for Core Consumers reveals an interesting set of influences from consumer community comment activity, proportion of mod stories in the media, product promotion, platform consumption, platform investment, connections, and last period focal consumption on focal consumption. Model Fit tests indicate the model provides an improvement on a constants only model (Wald = 246.45, $p < .001$). More specifically, co-creation consumer comment activity has a positive influence on consumption ($\beta = .008$, $p < .001$), the proportion of mod stories in the media has a negative influence on consumption ($\beta = -.075$, $p < .05$), and product promotions have a positive influence on consumption ($\beta = .092$, $p < .001$). Platform

consumption has a positive influence on consumption (β = .021, $p < .001$), platform investment has a negative (though incredibly small) influence on consumption (β = -.00008, $p < .001$), and last period focal consumption has a positive influence on focal consumption (β = .031, $p < .001$).

Core Consumers are characterized by their lack of engagement in either authoring or commenting in the co-creation community. This consumer segment is unaccounted for in the co-creation literature because of the focus on pre-purchase co-creation. In a post-purchase co-creation context, this consumer segment is significant in size, though less so in their levels of consumption. Interestingly, this segment does appear to be influenced by consumer community comment activity, suggesting that while they are not actively participating, they are listening to, and responding to, the trends within a part of the community.

Perhaps more interestingly, this group is influenced by marketing actions, despite the fact that all consumers in the dataset have already purchased the product. The negative influence of co-creation stories suggests that the more this consumer segment is reminded that the product has strong support for co-creation, the less likely they are to consume, perhaps reflecting a preference for pure firm-developed products. The positive influence of promotions provides interesting support for the idea that the influence of promotions can extend beyond sales. Promotions may provide top-of-mind effects that motivate consumers to return to the product and consume after a period of reduced consumption.

Finally, the effects of platform consumption and platform investment suggest a consumer segment that more closely resembles serial game consumers. These individuals are more focused on consuming a wider variety of products within the category, and their cluster descriptive statistics support this concept with a much higher level of platform investment on average compared to the other two clusters.

Discussion

While the Co-Creation Creator is the source of collaborative new product development, and has been the target of much of the existing marketing literature and practitioner interest, a number of different consumer segments clearly exist in post-purchase co-creation. Co-Creation

Creators and Co-Creation Consumers comprise a disproportional percentage of total consumption based on their representation in the consumer base. These two consumer segments, with their increased consumption, are more likely to develop long term relationships with the brand, and exhibit increased loyalty and increased lifetime value than Core Consumers, demonstrating that in the context of post-purchase co-creation, consumers who engage in collaborative development in some way provide value to the firm.

Despite the small size of the Co-Creation Creator segment, this segment of consumers is critically important to the co-creation process. These individuals develop and disseminate shared knowledge about co-creation, and their influence on fellow creators is manifested through their community interaction. Their influence on Co-Creation Consumers however cannot be understated. Without their product modifications shared with the community, the Co-Creation Consumer would not even exist, and the increased value generated from those Consumers would be lost to the firm.

The disproportional levels of consumption amongst Co-Creation Consumers combined with their larger representation in the consumer base establishes a clear value for the firm. That these individuals are unaffected by community levels of authorship and commenting provides challenges to marketing managers attempting to directly influence this segment. Yet a strong relationship between consumption and their own comment activity suggests these consumers are heavily engaged in the online community, just not influenced by others within the community. Management and influence of this segment may be best achieved through maintenance of a healthy community and indirectly through management of the Co-Creation Creator segment.

Core Consumers represent an important segment unique to the post-purchase co-creation context. These individuals represent a large proportion of the total consumer base, but a smaller percentage of total consumption. Interestingly, they are not entirely ignorant of the co-creation process, as at least some Core Consumers are influenced by the conversation in the Co-Creation Consumer community. These findings suggest that marketing managers may be capable of converting consumers into Co-Creation Consumers, and reaping the increased value associated with that conversion.

Online communities

Support for the influence of online brand communities on consumption is further supported within the post-purchase co-creation context. The role that these communities play are complex and varied across the different segments of consumers however. The consumption of Co-Creation Creators is influenced by fellow creator's social interaction, but not fellow creator's author activity. Furthermore, Co-Creation Creator consumption appears unaffected by Co-Creation Consumer community activity, despite the fact that often the consumer is the creator's target market.

As noted previously, the role of the online community for Co-Creation Consumers seemed tied exclusively to their own interaction in that community. Beyond direct social interactions, the overall activity of either creator or consumer communities appears not to influence Co-Creation Consumers. Somewhat surprisingly, Core Consumers, who are segmented as such by virtue of their lack of engagement in co-creation, are still somewhat influenced by Co-Creation Consumer community activity. While this effect is small, it suggests that the co-creation community has an influence outside of those involved in co-creation.

Strategic marketing actions

Product promotion strategies have a rich and detailed history in marketing research and are one of the primary tools marketing managers have at their disposal. Traditionally, promotions have been studied and utilized as a tool to motivate product purchase. However, this research would suggest that product promotions have a role beyond the purchase decision. Amongst two of the three co-creation segments, product promotions stimulate consumption. Both Co-Creation Creators and Core Consumers exhibit increased levels of consumption in the presence of product promotions, though it is likely that the drivers motivating this consumption are different for each group. Top-of-mind promotion strategies may be useful tools to trigger product consumption. For firms that generate value through consumption, product promotion strategies could provide mechanisms to extend the customer's relationship with the product, and thus increase the likelihood of increased loyalty, word-of-mouth, and lifetime value.

Earned and owned media exposure has also been of interest to both marketing researchers and managers. Results from this study would suggest that generating media mentions specifically related to co-creation actually provide no benefit to the firm, and actually may damage relations with customers. Co-Creation Creators and Co-Creation Consumers see no change in the presence of a higher proportion of mod stories. Core Consumers however see a decrease in consumption as a result of those higher mentions. If this effect is the result of an aversion to co-creation by this customer segment, it would follow that firms should avoid actively seeking media coverage for co-creation. Instead, firms may benefit more from allowing these customers to discover and learn about co-creation from the community itself. Thus, strategies that bridge the gap between Core Consumers and the co-creation community may be more beneficial than specifically targeting more broad media exposure.

Platform influences

Increasingly, online and media products are being delivered through product platforms that provide an interface between the consumer and the firm. Therefore, it is interesting to examine different characteristics of that platform to better understand its effects. Increased platform consumption appears to be associated with higher levels of focal product consumption for both Co-Creation Creators and Core Consumers. This should provide encouraging evidence to both platform owners and firms that these platforms provide a benefit beyond simple access to products. A platform inertia effect may provide increased levels of consumption to firms who chose to sell their products through a successful platform.

However, the opposite seems to be the case with platform investment. The more a consumer is invested in a single platform, the less their level of consumption for each individual product. As the overall level of investment increases, the consumer has an increasing draw on their limited time from each unique product, likely driving this effect. That Co-Creation Consumers are resistant to either platform consumption or platform investment is potentially interesting and worthy of further study. Perhaps firms can leverage some characteristic of this group to benefit from the increased consumption effect but insulate themselves from the increased investment effect.

The interrelationship between platform consumption and platform investment provides a confusing and counterintuitive situation for firms. Highly successful platforms provide an increase in consumption, but these same platforms are likely to attract an increasing number of firms that facilitates more deeply invested consumers. How these two characteristics of a platform influence purchase and consumption are worthy of future research and could reveal interesting phenomenon associated with online platforms.

Limitations and future research

Limitations in such a complex set of data and analysis should of course be considered. While product co-creation can occur in a wide select of different product categories, this research focused on a single category, video games, and on a single product within that category. Post-purchase co-creation occurs across digital and physical goods, across low-cost and high-cost items, and across durable and consumer packaged goods products. Future research should explore different product categories to more fully understand post-purchase co-creation.

Post-purchase co-creation activity may further change significantly over the lifecycle of a product. Often, product knowledge takes time to be gathered in such a context, and the creators in the community may share quite different types of mod projects as the maturity of the product develops. The product under study in this research was examined after it had reached maturity in the marketplace. It would be interesting to examine a product from product release to better understand the shifting influences of co-creation and community over time.

Conclusions

Post-purchase co-creation is a new but important concept for the marketing literature to grasp and understand. It provides opportunities to marry traditional product development and consumer-led co-creation in interesting and unique ways that can generate significant value. The results of this study suggest that very different constituents exist within the co-creation landscape, and that firms may need to implement very different strategies to influence each of those segments effectively. Both community management and more traditional marketing

strategies can provide levers to affect consumption and downstream value, and this study provides evidence on how these drivers can be implemented.

REFERENCES

Adjei, Mavis T., Stephanie M. Noble, and Charles H. Noble (2010), "The Influence of C2C Communications in Online Brand Communities on Customer Purchase Behavior," *Journal of the Academy of Marketing Science*, 38 (5), 634–53.

Albuquerque, P., P. Pavlidis, U. Chatow, K.-Y. Chen, and Z. Jamal (2012), "Evaluating Promotional Activities in an Online Two-Sided Market of User-Generated Content," *Marketing Science*, 31 (3), 406–32.

Alexa (2016), "About," *Alexa*, (accessed March 11, 2016), [available at http://www.alexa.com/].

Beck, Nathaniel and Jonathan N. Katz (2011), "Modeling Dynamics in Time-Series–Cross-Section Political Economy Data," *Annual Review of Political Science*, 14 (1), 331–52.

Bendapudi, Neeli and Robert P. Leone (2003), "Psychological Implications of Customer Participation in Co-Production," *Journal of Marketing*, 67 (1), 14–28.

Blau, Gavan (2015), "IBISWorld Industry Report 51121 Software Publishing in the US."

Chesbrough, H. (2003), *Open Innovation: The New Imperative For Creating and Profiting From Technology*, Cambridge, MA: Harvard Business Press.

Fang, Eric (2008), "Customer Participation and the Trade-Off Between New Product Innovativeness and Speed to Market," *Journal of Marketing*, 72 (July), 90–104.

Farokhmanesh, Megan (2013), "Torchlight 2 sold more than two million copies | Polygon," *Polygon*, (accessed March 18, 2016), [available at http://www.polygon.com/2013/7/25/4556436/torchlight-2-sold-more-than-two-million-copies].

Fuchs, Christoph, Emanuela Prandelli, and Martin Schreier (2010), "The Psychological Effects of Empowerment Strategies on Consumers ' Product Demand," *Journal of Marketing*, 74 (January), 65–79.

———, ———, ———, and Darren W Dahl (2013), "All that is Users Might not be Gold: How Labeling Products as User-designed Backfires in the Context of Luxury Fashion Brands," *Journal of Marketing*, 1–47.

Goldenberg, Jacob, Gal Oestreicher-Singer, and Shachar Reichman (2012), "The Quest for Content: How User-Generated Links Can Facilitate Online Exploration," *Journal of Marketing Research*, XLIX (August), 452–68.

Grewal, Rajdeep, Gary L. Lilien, and Girish Mallapragada (2006), "Location, Location, Location: How Network Embeddedness Affects Project Success in Open Source Systems," *Management Science*, 52 (7), 1043–56.

Gruner, Richard L., Christian Homburg, and Bryan A. Lukas (2014), "Firm-hosted online brand communities and new product success," *Journal of the Academy of Marketing Science*, 42 (1), 29–48.

von Hippel, Eric (1988), *The Sources of Innovation*, *October*, New York: Oxford University Press.

Holbrook, Morris B. and Elizabeth C. Hirschman (1982), "The Experiential Aspects of Consumption: Consumer Fantasies, Feelings, and Fun," *Journal of Consumer Research*, 9 (2), 132–41.

Jeppesen, Lars Bo and Måns Molin (2003), "Consumers as Co-developers: Learning and Innovation Outside the Firm," *Technology Analysis & Strategic Management*, 15 (3), 363–83.

Kohler, Thomas, Johann Fueller, Kurt Matzler, and Daniel Stieger (2011), "Co-Creation in Virtual Worlds: The Design of the User Experience," *MIS Quarterly*, 35 (3), 773–88.

Kuchera, Ben (2015), "How Runic games was reborn after Torchlight: The story behind Hob | Polygon," *Polygon*, (accessed March 18, 2016), [available at http://www.polygon.com/features/2015/8/17/9153363/runic-games-hob].

Kuk, George (2006), "Strategic Interaction and Knowledge Sharing in the KDE Developer Mailing List," *Management Science*, 52 (7), 1031–42.

Kumar, Vineet, Brett R. Gordon, and Kannan Srinivasan (2011), "Competitive Strategy for Open Source Software," *Marketing Science*, 30 (6), 1066–78.

Mallapragada, Girish, Rajdeep Grewal, and Gary Lilien (2012), "User-Generated Open Source Products: Founder's Social Capital and Time to Product Release," *Marketing Science*, 31 (3), 474–92.

Moe, Wendy W. and David A. Schweidel (2012), "Online Product Opinions: Incidence, Evaluation, and Evolution," *Marketing Science*, 31 (3), 372–86.

Muniz, Jr., Albert M. and Thomas C. O'Guinn (2001), "Brand Community," *Journal of Consumer Research*, 27 (4), 412–32.

Nambisan, Satish and Robert A Baron (2009), "Virtual Customer Environments: Testing a Model of Voluntary Participation in Value Co-creation Activities," *Journal of Product Innovation Management*, 26 (518), 388–406.

O'Hern, Matthew and Aric Rindfleisch (2010), "Customer Co-Creation: A Typology and Research Agenda," in *Review of Marketing Research*, N. K. Malhotra, ed., Emerald Group Publishing Limited, 84–106.

Ogawa, Susumu and Frank T Piller (2006), "Reducing the Risks of New Product Development," *MIT Sloan Management Review*, 47 (Winter), 65–72.

Oh, Wonseok and Sangyong Jeon (2007), "Membership Herding and Network Stability in the Open Source Community: The Ising Perspective," *Management Science*, 53 (7), 1086–1101.

Prahalad, C.K. and Venkatram Ramaswamy (2000), "Co-opting Customer Competence," *Harvard Business Review*, 2000 (January-Febrary).

Ramaswamy, Venkat (2008), "Co-creating value through customers' experiences: the Nike case," *Strategy & Leadership*, 36 (5), 9–14.

Ransbotham, Sam and Gerald C. Kane (2011), "Membership Turnover and Collaboration Success in Online Communities: Explaining Rises and Falls From Grace in Wikipedia," *MIS Quarterly*, 35 (3), 613–27.

———, ———, and Nicholas H. Lurie (2012), "Network Characteristics and the Value of Collaborative User-Generated Content," *Marketing Science*, 31 (3), 387–405.

Schau, Hope Jensen, Albert M. Muñiz Jr, and Eric J. Arnould (2009), "How Brand Community Practices Create Value," *Journal of Marketing*, 73 (5), 30–51.

Schouten, John W and James H McAlexander (1995), "Subcultures of Consumption: An Ethnography of the New Bikers," *Journal of Consumer Research*, 22 (1), 251–75.

Schreier, Martin, Christoph Fuchs, and Darren W Dahl (2012), "The Innovation Effect of User Design: Exploring Consumers' Innovation Perceptions of Firms Selling Products Designed by Users," *Journal of Marketing*, 76 (September), 18–32.

Singh, Param Vir, Yong Tan, and Vijay Mookerjee (2011), "Network Effects: The Influence of Structural Capital On Open Source Project Success," *MIS Quarterly*, 35 (4), 813–29.

Stephen, Andrew T., Peter Pal Zubcsek, and Jacob Goldenberg (2013), "Product Ideation in Social Networks."

"The 2015 Analytics Software Market" (n.d.), (accessed March 13, 2016), [available at http://techcrunch.com/2016/01/09/the-year-in-analytics/].

Thomke, Stefan and Eric von Hippel (2002), "Customers as Innovators: A New Way to Create Value," *Harvard Business Review*, 2002 (April).

Thompson, Scott A. and Rajiv K Sinha (2008), "Brand Communities and New Product Adoption:The Influence and Limits of Oppositional Loyalty," *Journal of Marketing*, 72 (6), 65–80.

"Torchlight II for PC Reviews - Metacritic" (2016), *Metacritic*, (accessed March 18, 2016), [available at http://www.metacritic.com/game/pc/torchlight-ii].

Toubia, Olivier (2006), "Idea Generation, Creativity, and Incentives," *Marketing Science*, 25 (5), 411–25.

Troye, Sigurd Villads and Magne Supphellen (2011), "Consumer Participation in Coproduction: 'I Made It Myself' Effects on Consumers' Sensory Perceptions and Evaluations of Outcome and Input Product," *Journal of Marketing*, 1–14.

Vermunt, Jeroen K. and Jay Magidson (2002), "Latent Class Cluster Analysis," in *Applied Latent Class Analysis*, J. A. Hagenaars and A. L. McCutcheon, eds., Cambridge University Press, 89–106.

Woolrdige, Jeffrey M. (2010), *Econometric Analysis of Cross Section and Panel Data*, The MIT Press.

Zhang, K., T. Evgeniou, V. Padmanabhan, and E. Richard (2012), "Content Contributor Management and Network Effects in a UGC Environment," *Marketing Science*, 31 (3), 433–47.

Zhu, Rui Juliet, Utpal M Dholakia, Xinlei Jack Chen, and René Algesheimer (2012), "Does Online Community Participation Foster Risky Financial Behavior?," *Journal of Marketing Research*, 49 (3), 394–407.

TABLE 1

EMPIRICAL MEASURES

Category	Measure	Description	Mean	SD
Profiling Measures	**Frequency of Authorship Activity**	Number of time periods the individual uploaded or updated a mod over the entire study window. (0-16)	.110	.918
	Frequency of Commenting Activity	Number of time periods the individual commented on a non-owned mod over the entire study window. (0-16)	.330	1.12
Time Varying Individual Measures	**Focal Consumption**	Number of hours the individual played the focal game in the observed time period.	1.510	7.34
	Author Activity	Dummy representing whether the individual uploaded or updated a mod in the observed time period. (0/1)	.010	.083
	Comment Activity	Dummy representing whether the individual commented on a non-owned mod in the observed time period. (0/1)	.020	.138
Time-Varying Community Measures	**Creator Community Author Activity**	Number of total Creators who uploaded or updated a mod in the observed time period.	5.88	1.77
	Creator Community Comment Activity	Number of total Creators who commented on a non-owned mod in the observed time period.	5.12	1.73
	Consumer Community Comment Activity	Number of total Consumers who commented on a non-owned mod in the observed time period.	5.00	5.30
Controls	**Last Period Focal Consumption**	Number of hours the individual played the focal game in the previous time period.	1.56	7.49
	Platform Consumption	Number of hours the individual played another game on *Steam* besides the focal game in the observed time period.	27.41	39.95
	Platform Investment	Number of games owned on *Steam* in the observed time period.	117.98	142.88
	Connections	Number of connected friends on *Steam* in the observed time period.	34.83	51.78
Marketing Activity Measures	**Proportion of Mod Stories in Media**	Proportion of focal game media stories on co-creation to total focal game media stories in the observed time period. (0-1)	.089	.199
	Product Promotion	Dummy representing whether the firm engaged in a promotion on *Steam* for the focal game in the observed time period. (0/1)	.063	.242

TABLE 2

CORRELATIONS

		1	2	3	4	5	6	7	8	9	10	11
1	**Focal Consumption**											
2	**Author Activity**	.06 ***										
3	**Comment Activity**	.11 ***	.23 ***									
4	**Creator Community Author Activity**	.05 ***	.00	.00								
5	**Creator Community Comment Activity**	.06 ***	.00	.00	.29 ***							
6	**Consumer Community Comment Activity**	.08 ***	.00	.00	.40 ***	.77 ***						
7	**Last Period Focal Consumption**	.48 ***	.05 ***	.12 ***	.07 ***	.12 ***	.16 ***					
8	**Platform Consumption**	.10 ***	-.01	-.03 ***	.00	.02 *	.03 ***	.11 ***				
9	**Platform Investment**	-.03 ***	-.01	-.09 ***	-.05 ***	-.04 ***	-.05 ***	-.05 ***	.18 ***			
10	**Connections**	-.02 ***	.01	-.01	-.03 ***	-.03 **	-.03 ***	-.03 ***	.20 ***	.34 ***		
11	**Proportion of Mod Stories in Media**	.03 ***	.00	.00	.14 ***	.33 ***	.56 ***	.08 ***	.02 *	.00	.00	
12	**Product Promotion**	.04 ***	.00	.00	.16 ***	.28 ***	.39 ***	.04 ***	.02 **	-.03 **	-.02 *	.21 ***

* = p < .05, ** = p < .01, *** = p < .001

TABLE 3

LATENT CLASS CLUSTER ANALYSIS

A: MODEL FIT COMPARISON

# of Classes	BIC	AIC	CAIC
1	-916	475	-1202
2	-1706	-329	-1989
3	-1762	-399	-2042
4	-1790	-442	-2067
5	-1780	-446	-2054

B: CLASS PROFILES – 4 CLASS MODEL

(Mean # of time periods active out of 16)

	Community Creator	Code Creator	Consumer	Core
Frequency of Authorship Activity	1.589	5.181	.052	.011
Frequency of Commenting Activity	9.384	1.069	1.508	.142
Cluster Size	.008	.014	.069	.910

C: MODEL COEFFICIENTS – 4 CLASS MODEL

	Community Creator	Code Creator	Consumer	Core	Wald Test
Frequency of Authorship Activity	1.801	2.996	-1.600	-3.197	329.79***
Frequency of Commenting Activity	2.049	-.124	.220	-2.145	543.867***
Model Fit (X^2)	5621.69*** (df 277)				

* = p < .05, ** = p < .01, *** = p < .001

TABLE 4

CLUSTER-SPECIFIC DESCRIPTIVE STATISTICS

		Creator		Consumer		Core	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Consumption	**Focal Consumption**	5.322	10.149	5.926	16.761	0.776	4.781
	Platform Consumption	24.070	35.626	25.196	31.671	27.260	40.597
	Platform Investment	83.703	90.682	90.891	95.200	122.160	147.624
Author Activity	**Authored Mods**	2.383	2.975	0.222	.739	0.0596	.297
	% Periods with Mod Activity	29.38%	45.62%	.66%	8.12%	.04%	1.89%
Comment Activity	**Comments**	0.994	4.084	0.185	1.211	0.002	.084
	% Periods with Comment Activity	25.63%	43.72%	7.58%	26.47%	0.13%	3.59%

Population	**% of Population**	2.08%	6.88%	91.04%
	% of Total Consumption	9.05%	33.27%	57.68%

TABLE 5

CONSUMPTION MODELS W/ PANEL CORRECTED STANDARD ERRORS

(CONSUMPTION: LN(GAME HOURS)

		Creator	Consumer	Core
Co-Creation Activity	**Author Activity**	.373***		
	Comment Activity	.278*	.585***	
Creator Community Activity	**Creator Community Author Activity**	.028	.014	
	Creator Community Comment Activity	.097***	.012	-.08
Consumer Community Activity	**Consumer Community Comment Activity**	-.021	.014	.008***
Strategic Marketing Activity	**Proportion of Mod Stories in Media**	-.325	-.098	-.075*
	Product Promotion	.440**	.079	.092***
Controls	**Last Period Focal Consumption**	.063***	.035***	.031***
	Platform Consumption	.186***	.007	.021***
	Platform Investment	-.002***	.000	-.00008***
	Connections	.003***	-.003***	.000
	Constant	-.449**	.345***	.106***

Serial Corelation	**F Test**	116.04***	113.99***	218.41***
Model Fit	**Wald Test**	331.04***	400.86***	246.45
Sample	**n**	20	66	874
	t	16	16	16
R2		.569	.334	.118

* = p < .05, ** = p < .01, *** = p < .001