Electron Commer Res (2016) 16:217–243
DOI 10.1007/s10660-016-9221-z

Customer co-creation in B2C e-commerce: does it lead to better new products?

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Published online: 6 April 2016

Abstract The business-to-consumer e-commerce platform facilitates direct reach to customers and is especially conducive to large-scale customer co-creation. Many major e-commerce businesses have begun to leverage the platform to co-create with customers in new product development (NPD), in anticipation of new products that are more innovative and sell better. Yet, empirical evidence for the impact of customer co-creation is still scarce. This study investigates the impact by distinguishing among different co-creation tasks (idea co-creation and decision co-creation) and NPD stages (product design and commercialization). Based on the co-creation and innovation literature, it is hypothesized that idea co-creation has a stronger impact when there is also decision co-creation. Further, co-creation in the product design stage is expected to have a stronger effect on product innovativeness, while co-creation in the commercialization stage has a stronger effect on product sales. The hypotheses were tested with data on 107 actual products. Looking beyond a homogenous conceptualization of co-creation enhances our understanding of how it influences different aspects of new product success. This is also one of the earliest studies to report empirical evidence for the impact of customer co-creation in e-commerce. The findings offer specific insights into the co-creation tasks and NPD stages to open for customer co-creation in practice.

Keywords Customer co-creation · B2C e-commerce · New product sales · Product innovativeness · NPD performance

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1 Introduction

Business-to-consumer (B2C) e-commerce businesses, being on an Internet-based platform and having direct reach to customers, are especially well positioned to leverage customer co-creation in the development of new products. Customers' increasing participation in new product development (NPD) is fueled by the evolution of social commerce, which is enabled by Web 2.0 technology and has evolved to engage customers in making product recommendations [1], providing financial resources [2], as well as co-creating value and making strategic decisions [3]. For instance, Dell Inc., a poster child for selling custom-built computer products directly to customers through the e-commerce platform, launched the IdeaStorm website "to give a direct voice to … customers and an avenue to have online 'brainstorm' sessions to allow … customers to share ideas and collaborate with one another and Dell" [4]. The website collected ideas for new products or services that customers would like to see, and the ideas were gauged by Dell's managers and executives to decide which get further developed and implemented. Since its launch in 2007, IdeaStorm had received more than 23,000 ideas and implemented more than 550 of them. Another example is the Kindle Scout publishing program by Amazon.com, one of the largest e-commerce retailers. Aspiring authors could submit their unpublished book manuscripts online while Amazon customers could read the collection and nominate their favorite. Highly voted titles were likely to be published by Amazon. In the program, customers' input is sought in the design of new products (in the form of unpublished manuscripts from aspiring authors) as well as the selection of products to be commercialized (through reader nominations). As these initiatives by major B2C e-commerce businesses show, engaging customers in the generation and selection of new products is congenial to the e-commerce platform and the separation between the production and consumption domains in e-commerce is quickly becoming a matter of the past.

The growing interest in customer co-creation comes with a general anticipation that it would lead to better new products. Input from customers can help to generate new products that fit consumption needs [5, 6] and therefore sell better; The Internet-based e-commerce platform increases reach to a diversity of customers, who constitute a rich source of novel ideas for innovative new products [5, 6]. However, there is still a lack of empirical evidence for the positive impact of customer co-creation on product sales and innovativeness, which are two critical aspects of *new* product success [7, 8]. The purported value of customer co-creation is the premise of business investment and research interest on the topic and should be strongly established. This study addresses the gap by empirically assessing the impact of customer co-creation on product sales and product innovativeness.

Although customer co-creation in e-commerce shares some similarities with phenomena such as lead-user participation in NPD, integration of marketing and research and development functions in NPD, and virtual NPD teams, research findings on the impact of these phenomena may not be directly applicable. Customer co-creation in e-commerce is distinct in that it involves a much larger

number of customer participants, who self-select into the stages and tasks of NPD, and participate through the Internet [9]. The hosting firm has less control over the participants and input compared to that in other forms of customer participation [10]. Instead, the focus of the hosting firm is on deciding what co-creation tasks and NPD stages to open for customer participation. Given the differences, the impact of customer co-creation in e-commerce warrants specific research attention.

For a more refined understanding of the impact of customer co-creation, this study goes beyond regarding co-creation as a homogenous activity and accounts for different co-creation tasks in different NPD stages. Co-creation has been generally defined as the activity of customers or users in the production domain to create value in the marketplace, at the behest of a firm [11, 12]. In co-creation, customers often engage in the tasks of generating and selecting the content of a new product offering [12]. The content depends on the NPD stage of focus [13], with product design stage and commercialization stage being the most common in customer co-creation [5, 6, 14]. In the product design stage, content of interest are ideas related to a product's technical function and visual design [15], which directly affect the product's attributes and differentiation from existing products. In the product commercialization stage, the focus is on ideas related to the marketing and promotion of product to drive sales [16, 17]. Building on the co-creation and innovation literatures, we hypothesize that different customer co-creation tasks (i.e., idea generation and idea selection) interact such that they have a greater positive impact on the resultant product than either alone, and the interaction in different NPD stages (i.e., product design and product commercialization) has different influence on the resultant product's innovativeness and sales. Together, the set of hypotheses examined in this study aims to provide a more detailed explanation of the impact of customer co-creation.

In sum, our research objectives are (1) to empirically assess the impact of customer co-creation on product innovativeness and product sales, which are key measures of new product success, and (2) to understand the impact of different co-creation tasks in different NPD stages. Our hypotheses were tested with objective data on 107 actual products developed through varying degree of customer co-creation on an e-commerce platform. The findings offer early empirical evidence for the impact of customer co-creation. More importantly, this study contributes to the theoretical development of customer co-creation by identifying the impact of different co-creation tasks and NPD stages. For B2C e-commerce firms intending to leverage their online presence to benefit from customer co-creation, the findings offer suggestions in terms of the NPD stages and activities to open in order to meet their specific objectives.

2 Literature review

This section first reviews empirical studies on the impact of co-creation. To understand the state of research on co-creation and clarify the gap this study addresses, we also reviewed other empirical studies on customer co-creation. To

provide a conceptual background for hypothesis development, the common NPD stages and tasks open for customer co-creation are also described.

2.1 Empirical studies on the impact of customer co-creation

Customer co-creation is an important stream of research on open innovation. Open innovation advocates using purposive inflows of knowledge from external sources to accelerate internal innovation, and outflows of knowledge to expand the markets for external use of innovation [18]. In contrast, in closed innovation, the process is predominantly internal and self-reliant—firms depend mainly on employees to generate and develop innovations [18]. The shift towards open innovation is largely driven by information technology (IT), which has made it possible for firms to overcome geographical and organizational boundaries and engage in more open, collaborative, and network-centered innovation practices efficiently [19]. Customer co-creation, which is our subject of interest, facilitates the inflow of knowledge from external entities—firms collect valuable knowledge about consumption needs and wants by opening up the innovation process and encouraging customers to contribute and select ideas to decide which get implemented.

The potential benefit of customer co-creation can be broadly understood in terms of the resource dependence theory. The theory characterizes a firm as an open system that is influenced by external factors and posits that survival is contingent on the firm's ability to access and control environmental resources [20]. Firms can manage resource dependence by establishing links with those who control important external resources. New product development is important to firm survival and requires knowledge about customer needs and wants. The knowledge resource is vital to the success of new product development, customers have discretion over the resource, and it can only be obtained from customers themselves [21]. From the resource dependence theory's perspective, customer co-creation allows firms to link with a large base of customers, access their consumption knowledge and experience, and use the critical external knowledge resource to improve the outcomes NPD.

Recent literature reviews have highlighted the paucity of research on the impact and value of co-creation and stressed the need for more empirical evidence [11, 27, 28]. Our review of empirical studies that examined online customer co-creation for the purpose of NPD (see Table 1) shows that previous studies have observed improvement in customer satisfaction, loyalty [24], and customer productivity [25]. Supporting conceptual analyses [e.g., 29], there is also evidence that co-creation increases purchase intention and behavior [22–24]. For the hosting firms, co-creation has been found to improve "customerization" capability and service capability [26].

The review reveals several gaps in research on the topic. First, much of the existing evidence is based on survey data. Assessing the impact of co-creation using data that relies less on individuals' perception should improve the validity of findings. Second, previous studies have focused mostly on customer-side and firm-level impacts. Although the final output of customer co-creation in NPD is the new product and it has a direct impact on business performance, studies at the product level (e.g., comparison of products developed with different levels of co-creation)

Table 1 Empirical findings on the impact of customer co-creation

Study	Key findings	Method and sample
Blasco-Arcas et al. [22]	Co-creation experience positively influences customers' purchase intentions	Survey of 332 students who used a simulated e-commerce website
Gebauer et al. [23]	Participants' satisfaction with the outcome of co-creation (i.e., final design idea) positively influences willingness to pay for the resultant new product	Observation and survey of 213 participants of an online co-creation initiative
Grissemann and Stokburger-Sauer [24]	(1) The degree of co-creation has a positive effect on the customers' satisfaction with the company (2) The degree of co-creation has a positive effect on the customers' loyalty with the company (3) The degree of co-creation has a positive effect on the customers' expenditures	Survey of 185 customers of a travel agency in Austria
Ramaswamy [25]	The Nike+ website generated economic value outcomes for both the customer co-creators and company. For the customer, there is a reduced cost of training and enhanced productivity when seeking to improve running performance. For the company, the risk of customer dissatisfaction and costs of marketing are reduced	Observation of participants of the Nike+ website
Zhang and Chen [26]	(1) The emphasis on co-creating activities has a positive impact on customerization capability (2) The emphasis on co-creating activities has a significantly positive impact on service capability (3) The service capability has a significantly positive impact on customerization capability	Survey of 300 managers of companies in China

have been lacking. Our understanding of the impact of co-creation on the resultant product (e.g., innovativeness, sales) remains limited. Third, customer co-creation has been largely treated as a homogenous activity. Previous studies have not distinguished among different co-creation tasks (e.g., idea generation, idea selection) and NPD stages.

2.2 Other empirical studies on customer co-creation

The paucity of empirical studies on the impact of customer co-creation indicates that researchers' attention might have been on the antecedents instead. To verify this, we expanded our literature review to other empirical studies on online customer co-creation in NPD (see Table 2). We found that there have been indeed more empirical studies on factors affecting customers' participation in co-creation.

Table 2 Other empirical studies on customer co-creation

Study	Key findings	Method and sample
Balka et al. [30]	(1) Transparency perceived by a community member → involvement in an innovation project (2) Accessibility perceived by a community member → involvement (3) Involvement → effort of contribution	Online survey; 309 participants of 20 communities in the consumer electronics and IT hardware industries
Bayus [34]	(1) An individual's likelihood of proposing an implemented idea is negatively related to their past success in generating implemented ideas (2) An individual's likelihood of proposing diverse ideas is negatively related to their past success in generating implemented ideas	Observation of 1539 Dell IdeaStorm participants
Chen et al. [31]	(1) Peer feedback → participants' contribution of ideas in Company-Sponsored Online Co-creation Brainstorming (COCB) (2) Company feedback → contribution of high-quality ideas (3) Company responsiveness → contribution of ideas (4) Company responsiveness → contribution of high-quality ideas (5) Individual connectedness → participation duration (6) Peer feedback → participation duration (7) Company responsiveness → participation duration	Observation of 6142 Dell IdeaStorm participants
Elsharnouby and Mahrous [33]	The e-service quality (website fulfillment, compensation, availability of contact, and efficiency) of a company positively relates to customers' willingness to participate in co-creation	Survey of 215 users Egyptian mobile operators
Füller et al. [13]	(1) A customer's intention of future participation in Internet-based co-creation is influenced by perceived empowerment and enjoyment (2) Perceived empowerment is influenced by product involvement, experienced tool support, and enjoyment (3) Experienced tool support → enjoyment	Online survey; 825 consumers who had participated in at least one virtual NPD co-creation project
Nambisan and Baron [32]	(1) Product involvement moderates the effects of learning, personal integrative, and hedonic benefits on customer participation in product support in virtual customer environments (2) Community identification moderates the impact of personal integrative on customer participation (3) Attitude towards the hosting firm → customer participation	Online survey; 152 customers of Microsoft and IBM

Table 2 continued

Study	Key findings	Method and sample
Riedl et al. [35]	(1) Users of multicriteria scales have a higher decision quality than users of single-criterion scales (2) The gain in decision quality of multicriteria scales over single-criterion scales is lower for well-elaborated ideas (3) Users of multicriteria scales have a more favorable attitude (4) The effect of the rating scale on a user's attitude toward the Web site is mediated by the attitude toward the rating scale	Experiment involving 231 undergraduate and graduate students

Those identified are related to emotions [e.g., enjoyment; 13], the process of co-creation [e.g., transparency; 30], and the hosting firm [e.g., responsiveness; 31].

More importantly, this review reaffirms our observation that product-level study of customer co-creation has been lacking. Previous studies have mostly conceptualized co-creation from customers' perspective or in terms of ideas, measuring participants' involvement [30, 32], contribution effort [30–32], willingness to participate [33], quality of ideas [31, 34], and quality of decisions [35] by participants. To investigate the impact of co-creation on new product success, it is more appropriate to measure co-creation directly (e.g., extent to which decisions are co-created with customers) and conceptualize co-creation from the NPD project perspective (e.g., NPD stages open for co-creation). Therefore, this study considers different co-creation tasks and NPD stages in measuring the impact of co-creation.

2.3 Customer co-creation tasks and new product development stages

The customer co-creation literature suggests that co-creation involves two key tasks of contributing new ideas and selecting the idea to be implemented [12, 36, 37]. Unlike traditional NPD projects in which both the tasks of idea generation and idea selection are closely guarded and typically conducted by employees, in customer co-creation the firm releases control and empowers customers to become active idea co-creators and/or decision co-creators. Firms may opt to open either or both of the idea generation and decision making tasks for customer participation [37]. For instances, Dell IdeaStorm engaged customers in idea co-creation but the decision of which idea to implement was made by internal staff. In contrast, ModCloth, an online retailer specializing in vintage and vintage-inspired clothing, designed products internally and then asked customers to "heart" products (i.e., indicate their preference). The data were aggregated to gauge fashion trends and determine which design to produce for sale. Co-creating both ideas and decisions with customers, Quirky.com allowed customers to submit ideas for new product and vote for their favorite ideas.

Customers have been involved in idea co-creation and decision co-creation in different stages of NPD [38], notably product design and product commercialization. In the product design stage, customers could provide input for the design and

prioritization of product features, specification of product interface requirements, validation of product architectural choices, and the establishment of design priorities and metrics [5, 6]. In the product commercialization stage, where the attention is on generating profit through promoting sales [17], customers could contribute to the crafting of marketing tactics and messages (e.g., tagline), product naming, and packaging [14, 16].

3 Hypotheses development

The resource dependence theory generally suggests that customer co-creation has a positive impact on NPD. To deepen our understanding of the impact, we draw on the theoretical literature on innovation and co-creation to develop hypotheses that account for different co-creation tasks and NPD stages. Broadly, we posit that (1) idea co-creation and decision co-creation tasks interact, (2) the interaction in different NPD stages influence the resultant product's innovativeness and sales differently. The relationships hypothesized are depicted in Fig. 1 and detailed next.

3.1 Interaction between customer co-creation tasks

The co-creation literature suggests that customers' participation offers access to consumption knowledge and experience. Customers as a collective uses the product in the most diverse circumstances and possesses comprehensive understanding of consumption needs and wants [6, 11, 39]. For the *idea* co-creation task, in which customers generate ideas, the comprehensive knowledge serves as a basis for innovation. New knowledge can be generated by integrating customers' knowledge about existing products and/or technologies with their knowledge about a usage or application context [6]. Customer participation in idea co-creation also leads to

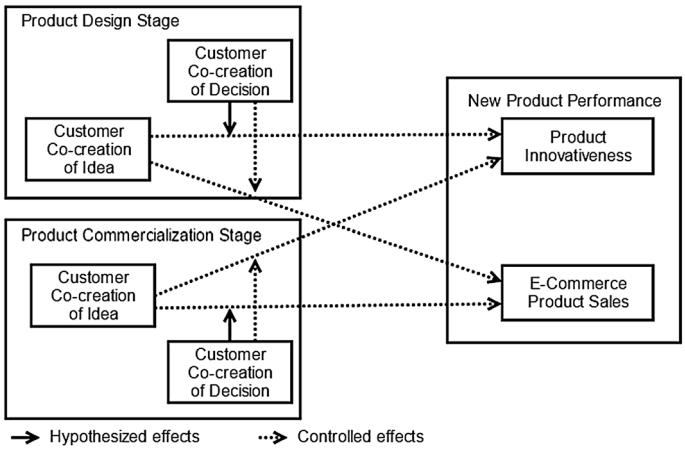

Fig. 1 Relationships in hypotheses

ideas that are relevant for solving important consumption problems and results in a product that has a greater fit to market needs [5]. For the *decision* co-creation task, in which customers select ideas, customers bring their depth of knowledge and experience to discern ideas that are relevant and innovative from those that are unproductive or less appealing. As a collective, customers' selection highlights the solution that is most likely to appeal to the majority of the market [40]. From the evolutionary and ecological perspective, the processes of variation and selection exist in customer co-creation [40]. That is, more customers, coming from diverse backgrounds and having different experiences, are likely to offer a greater variety of relevant ideas and solutions to a consumption problem. Further, customers bring their knowledge and experience to bear in filtering through and identifying the best idea.

The innovation literature acknowledges that idea generation and idea selection are in virtually all innovation processes [41]. However, prior research has mostly focused on idea generation and there has been less attention on idea selection [42]. Idea selection is at least as important as idea generation in that only the selected ideas would be realized and have an actual impact. Researchers have pointed out that the generation of many novel or unique ideas alone does not necessarily ensure a successful and creative outcome [42]. Often, many ideas are generated to address an issue but only one or a few of these ideas is ever selected for implementation [43]. For creativity to become innovation, divergent idea generation must be followed by convergent idea selection [44].

The above suggests that co-creation leads to better new products when both ideas and decision are co-created with customers (i.e., there exists a positive interaction effect between idea co-creation and decision co-creation). Co-creating both ideas and decision helps to ensure that the implemented idea is not only new and relevant to customers, but also appeals to the majority of customers. Decision co-creation can enhance the positive impact of idea co-creation by highlighting the most popular idea and realizing its value. In contrast, failing to adopt or rejecting popular ideas co-created with customers may limit the impact of co-creation as it falls short of contributing actual product value.

Co-creation of both ideas and decision can also generate two other synergies that lead to better new products than either alone. First, allowing customers to create as well as choose ideas constitutes a form of customer empowerment that can improve their perception of the resultant new product [45]. The customer empowerment literature has analyzed customer power from the perspectives of the consumer sovereignty model, cultural power model, and discursive power model [46]. Among them, the discursive power model focuses on discursive co-production with customers and is more inclusive and less antagonistic than the notion of the sovereign consumer and the opposition between powerful marketers and resisting consumers posited by the cultural model. Consumers and producers are seen as more overlapping, mutual, and interdependent than in the other models. Co-creation is in line with the discursive power model and empowering customers by allowing them to collectively create and select new product ideas instills a sense of control over a product's development. This can increase purchase intention and demand for the resultant product [29] as customers assume more psychological ownership. It

has been observed that the demand is stronger even when the product is of identical quality with others in objective terms [45].

Second, involving customers in the co-creation of ideas as well as decision may appeal to customers' ethical considerations with regard to the co-creation process when making their purchase decision. In customer co-creation, ethics refer to the firm's ability "to create the kinds of affectively significant relations, the ethical surplus, that are able to tie participants to a project, motivate them to keep supplying their productive input, and give a sense of meaning and purpose to their participation" [47, p. 270]. As co-creation initiatives flourish, customers have become more aware of related ethical issues and increasingly expect to be treated fairly in the process [48]. Some anecdotal evidence indicates that customer co-creators develop negative sentiments when they believe that their collective views are not given due attention by the hosting firm [6, 23, 49]. For instance, Dell IdeaStorm users expressed their dissatisfaction at Dell's inaction concerning the adoption of popular ideas, by posting comments such as:

> … Dell has NOT responded in so MANY areas. It's been extremely frustrating…
> Many individuals have lost interest in IdeaStorm lately because IdeaStorm, the way it stands now is, frankly, stagnant… I'm sure many individuals have lost interest in IdeaStorm in part because they're led to believe that their ideas are disregarded/ignored now…
> Dear Dell, Why do you not give people a choice? Here's a choice for you: 1. Either listen to these ideas and give people an Open Source non Microsoft choice or 2. Go the way of the dinosaur. I urge you to choose pro-actively

The above indicates that when customers contribute ideas, they also expect to be involved in the decision of which idea to implement. Indeed, it has been observed that when co-creators are allowed to decide the idea to be implemented and the hosting firm shows its willingness to comply, they regard the co-creation as being more transparent and have better procedural fairness [48]. They are therefore likely to view the resultant product more favorably. In sum, we hypothesize that:

H1 There is significant interaction between the idea co-creation and decision co-creation tasks, such that the positive impact of idea co-creation is stronger as decision co-creation increases.

3.2 Impact of customer co-creation in different NPD stages

By definition, the success of *new* product development is reflected in the innovativeness and sales of the resultant new product. The salience of product innovativeness and product sales in new product success is well recognized in the NPD literature [e.g., 50–53]. E-commerce businesses operate under conditions that emphasize rapid change, constant innovation, and fierce competition. Product innovativeness and online sales are therefore fundamental to their competitive advantage and financial success as well. In this study, we posit that the interaction

between idea co-creation and decision co-creation tasks in different NPD stages influence product innovativeness and product sales differently.

Product innovativeness refers to the extent to which a product is new, unique, and different from other products in a market [50]. A product may be innovative in terms of technical function and/or visual design [15]. While technical newness focuses on a product's core technology components and architecture, design newness looks at the product's external appearance (e.g., color, material, finish). The more innovative a product is, the less technical functions and/or visual attributes it shares with other products available in the market. This implies that a product's innovativeness can be determined by comparing it with other competing products.

Since product innovativeness is determined by technical function and visual design, it is likely to be more strongly affected by activities in the product design stage than those in the product commercialization stage. Customer co-creation in the product design stage focuses on ideas related to the technical features, functions, and architecture of the new product [5, 6]. Customers' involvement in the design stage contributes to product innovativeness in several ways. First, customers have knowledge of the functions and designs of existing products in the market based on their first-hand usage experience. This serves as a basis for them to identify ideas that are novel and not yet available in existing products. In line with this, Ye and Kankanhalli [54] suggest that including external sources of knowledge such as customers in innovation can help firms obtain continuous innovation and avoid being trapped by previous performance.

Second, because product innovativeness is determined from the customer's perspective of the market and available product offerings, co-creation of product design with a large number of customers should improve the likelihood that a product is seen as unique by customers in general. In support, Li and Calantone [55] found that market knowledge competence (defined as acquiring, interpreting, and integrating customer information) significantly improved new product advantage (measured in terms of uniqueness and newness). This suggests that having knowledge and understanding of customers as input into NPD is likely to result in new products that incorporate distinctive functions and design and thereby perceived as innovative. With input from those on whom the product has a direct impact, customer co-creation in the product design stage increases the odds of producing an innovative product that successfully addresses technical and operational requirements.

Although product innovativeness is likely to be strongly influenced by co-creation in the product design stage, it is plausible for co-creation in the commercialization stage to have an influence. Research on marketing has suggested that marketing and promotional messages created in the commercialization stage could signal the novelty or differentiating feature of a new product and thereby influence customers' perception of its innovativeness. For example, Lambert [56] pointed out that promotional messages could clearly stress the newness of a product. Several experiments have designed product taglines to manipulate product newness and found the manipulation to be effective [e.g., 57]. In our sample of co-created products (described later), customers have submitted tagline ideas such as "same

piggy—new generation" and "piggy bank gets smarter" for a piggy bank that allows the user to manage savings via mobile devices over the Internet. These taglines signal that the piggy bank has new features compared to traditional products and can thereby communicate its innovativeness to customers. Nevertheless, the effect of marketing and promotional messages created in the commercialization stage is likely to be limited by the novelty of product attributes and functions determined in the product design stage. Therefore, we hypothesize that:

H2 Product innovativeness is more strongly affected by the interaction between idea co-creation and decision co-creation tasks in the product design stage than that in the commercialization stage.

NPD involves the transformation of a market opportunity and a set of assumptions about product technology into a product available for sales [53]. Product sales indicate the adoption and diffusion of a new product by the market [58]. It is therefore likely to be strongly affected by activities in the product commercialization stage, which aims specifically at planning the marketing and promotion of a new product [17]. Customers are the targeted recipient of communications in marketing and promotion and they are in the best position to determine what is attractive. Marketing and promotion often seek to increase awareness about valuable product attributes and customers constitute a reliable source of opinion on the appropriate focus of marketing and promotion tactics. Also, Internet-based co-creation typically garners a large number of customer participants, which provides a cost-effective platform for testing whether a marketing and promotion plan is appealing to the range of customers in a market [14]. In line with these, contemporary research and practice view marketing as economic and social interactions in which customers are active participants in relational exchanges rather than an operand resource that is acted on to generate sales [59]. For instance, Whitla [14] suggests that for firms seeking to appeal to a younger audience raised on music television (MTV) and YouTube videos, often "a less professional but edgy, user-created promotion will be more meaningful and persuasive to them than something slicker created by an established agency and produced by crafted audio/visual technicians".

It is conceivable for product sales to be influenced by co-creation in the product design stage, whose main output is a set of decisions about product attributes and functions. Having access to information about product design could influence purchase by helping customers determine whether the new product addresses their consumption problems. However, customers who are unaware of the existence of the product or those who have not developed favorable attitudes towards the product are unlikely to acquire information about product design at all. Marketing and promotion address this gap by publicizing a new product to the mass to increase potential customers' awareness and highlighting its most valuable aspect [60]. Co-creation in the commercialization stage is likely to have a stronger impact on sales by enticing not just experienced consumers, but also attracting those who are new to the product category and even unplanned, impulse purchase [61].

H3 Product sale is more strongly affected by the interaction between idea co-creation and decision co-creation tasks in the product commercialization stage than that in the design stage.

4 Research method

4.1 Data collection

The hypotheses were tested with data from a private firm specialized in consumer electronic products.[1] The firm was founded in 2009 and its headquarters were in the United States. In 2012, its revenue was about 18 million and increased to about 50 million in 2013. At the time of the study, the firm had developed more than 120 products through customer co-creation and sold the resultant new products on its e-commerce website. We limited our sample to 107 products that had been on sale for at least 4 months. To further control for variations in entry timing across products, we measured average monthly sales rather than total sales. The oldest product had been on sale for 48 months. The products were in the categories of: computer accessories (17.8 %), mobile device accessories (5.6 %), home connectivity appliances (30.8 %), health and personal care electronics (27.1 %), and kitchen appliances (18.7 %). Co-creators could contribute and/or select ideas related to product function in the product design stage and tagline in the commercialization stage. Customers' participation was voluntary and the firm did not actively recruit specific customers. Co-creators would receive a monetary incentive when their ideas are selected for implementation. The same incentive program was used for all NPD projects.

The dataset is appropriate for several reasons. First, since all data were from the same firm, organizational differences, such as firm size, culture, brand name/reputation, experience in customer co-creation, and co-creation platform, were naturally controlled for. Second, the dataset permitted product-level analysis, which is the unit of interest of this study. As we show in our data analysis in Sect. 5, there is considerable variance in the extent of co-creation across products in our sample—some products were developed with no involvement of customers in product design but high involvement of customers in product commercialization, while some were developed with a high level of idea co-creation but not decision co-creation (i.e., customers generated ideas but the final decision of which idea to implement was not co-created). This allowed us to assess the impact of different levels of co-creation. Third, the firm permitted access to data on product innovativeness and sales, which is typically not publicly available for research studies. Fourth, as will be detailed in the next section, the dataset allowed co-creation and new product success to be measured more accurately since it was not affected by recall error and nonresponse bias.

[1] The company is not named to maintain the confidentiality of sales data.

4.2 Measurement of variables

The variables measured in this study are summarized in Table 3. Given our focus on the extent to which customers participate in the co-creation of new products, idea co-creation was measured in terms of the number of customers who contributed ideas, while decision co-creation was measured in terms of the number of customers who supported the final-implemented idea through voting. When there is a high level of decision co-creation, the final implemented idea should be the one that is selected by the majority of customers. In contrast, the level of decision co-creation is low when the hosting firm goes against the wish of the majority of voters and chooses to implement an idea that is not most voted. For illustration, Fig. 2 shows the distribution of votes for different tagline ideas for a product. The level of decision co-creation is highest when idea A, the most voted idea, is chosen for implementation. The level of decision co-creation is lower when idea C is implemented, because the decision is made against the majority who voted for idea A. Accordingly, decision co-creation was calculated as the proportion of co-creators

Table 3 Measurement of variables

Variable	Operational definition	Objective measure
Product design idea co-creation	Extent to which customers participated in contributing ideas	Number of customers who participated in generating ideas for product design
Commercialization idea co-creation		Number of customers who participated in generating ideas for product tagline
Product design decision co-creation	Extent to which decision (of the idea to implement) is made by customer co-creators	Number of customers who voted for the final-implemented product design idea ÷ total number of customers who voted
Commercialization decision co-creation		Number of customers who voted for the final-implemented tagline idea ÷ total number of customers who voted
Product innovativeness	Extent to which a product is different from other products in the market	Number of similar products identified by customers (reverse coded)
Product sales	Number of units sold	Average number of units sold per month

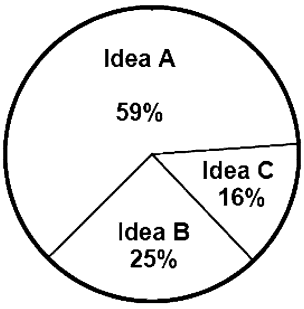

Fig. 2 Example of vote distribution in a decision co-creation task

who indicated support for the final-implemented idea (i.e., number of co-creators who voted for the final-implemented idea divided by the total number of co-creators who voted). A low proportion indicates that the final decision is supported by fewer co-creators and is thus decided with a lower degree of decision co-creation. In contrast, a high proportion indicates that the final decision is made in line with the opinion of the majority of co-creators. To test the differential impact of co-creation in different NPD stages, we calculated decision co-creation in product design and decision co-creation in product commercialization separately.

Product innovativeness is the extent to which a product is new in a market [15]. It was measured by the number of similar products identified by customers, which was reverse coded to indicate product innovativeness (i.e., the greater the number of similar products identified, the less innovative a product is). Measuring product innovativeness in terms of the number of similar products is more objective than a scale-type measure in that specific similar products need to be identified. The data was recorded by the company as part of customer reviews—customers had the option of identifying similar products by providing the product website address or product brand name, when they chose to submit product reviews on the e-commerce website.

We measured product sales in terms of the average number of units sold per month, as commonly used in prior e-commerce studies [e.g., 62]. Average monthly sales account for variations in entry timing across products. Product price, customer review rating, product development duration of a product, and the number of months a product had been on sale were included as control variables in our analysis. In analyzing product sales, the effect of product innovativeness was also controlled for, considering that some studies have found a significant relationship between them [63].

5 Data analysis and results

The mean, standard deviation, and correlation among variables are shown in Table 4. On average, the products in our sample gathered 148 product design ideas and 265 commercialization ideas from customer co-creators. The final product design idea was supported by 31 percent of the co-creators while the final commercialization idea was supported by 11 percent of the co-creators. The average product was identified as being similar to 4 other existing products in the market and had an average monthly sale of 1280 units. The correlations do not indicate problems with multicollinearity and variance inflation factor statistics ranged between 1.02 and 1.32.

The hypotheses related to product innovativeness, which was measured with a count variable (i.e., number of similar products identified by customers), were assessed using Poisson regression. When the dependent variable is measured as counts, traditional models using ordinary least squares are biased and inconsistent [64]. Poisson models are often employed in such cases. In our analysis, the predictor variables were standardized in order to aid the interpretation of interaction terms as well as to reduce multicollinearity. Variables were added in a stepwise fashion. Variables added in Model 1 represent the control variables. In Model 2, the co-

Table 4 Descriptive statistics and correlation

Variable	Min	Max	Mean	SD	1	2	3	4	5
(1) Design idea co-creation	0	2605	148.40	326.65					
(2) Design decision co-creation (proportion)	0	1	0.31	0.27	0.05				
(3) Commercialization idea co-creation	0	2010	265.68	306.73	−0.05	−0.18			
(4) Commercialization decision co-creation (proportion)	0	0.67	0.11	0.12	−0.10	0.03	0.16		
(5) Product innovativeness (no. of similar products[a])	0	15	4.51	4.19	0.27**	0.28**	0.17	0.02	
(6) Product sales (monthly)	12	14,650	1280.19	2589.43	0.13	0.06	0.26**	0.45**	−0.18

Min minimum, *Max* maximum, *SD* standard deviation

** $p < 0.01$

[a] Reverse coded

creation variables were added. In Model 3, interaction terms involving idea co-creation and decision co-creation were added.

The assumption of mean–variance equality in Poisson regression was tested with regression-based tests for overdispersion [65]. We tested for the null hypothesis of Poisson variation, H0: $V(y) = \mu$, against an alternative that the variance has a particular form depending on the mean, $V(y) = \mu + \alpha \times f(\mu)$, where $f(\mu)$ is a given transformation function of the mean. The common transformation functions are linear variance function (NB1) and quadratic variance function (NB2). Overdispersion corresponds to $\alpha > 0$. We tested both NB1 and NB2 models, using the *dispersiontest*() function in the AER package [66]. The results indicate that there was no significant overdispersion (NB1: $\alpha = 0.13$, $z = 0.81$, $p = 0.21$; NB2: $\alpha = 0.001$, $z = 0.04$, $p = 0.48$). Therefore, Poisson regression is appropriate for analyzing the data.

The results of Poisson regression (see Table 5) showed that there was significant interaction between idea co-creation and decision co-creation ($b = 3.19$, $p < 0.001$), supporting H1. In line with H2, the interaction effect between tasks in the product design stage ($b = 3.19$, $p < 0.001$) had a stronger effect on product innovativeness than that in the commercialization stage ($b = 0.02$, $p > 0.05$). We tested the difference by comparing the model with both interaction effects to a nested model that excludes the interaction between tasks in the product commercialization stage. We found that adding the interaction between tasks in the product commercialization stage did not significantly improve model fit (change in residual deviance statistic $= 0.13$, $p = 0.72$). This is in line with the finding that the interaction was not statistically significant. As shown in Fig. 3, products developed with a high level of idea co-creation and decision co-creation in the product design phase had the highest level of product innovativeness. Products developed with a low level of idea co-creation or decision co-creation were less innovative.

Table 5 Results of Poisson regression for testing H1 and H2

Variable	Model 1 (control variables)	Model 2 (co-creation variables added)	Model 3 (interactions added)
Price	−0.03	−0.08	−0.07
Development duration	0.02	0.10*	0.15**
Review rating	−0.05	−0.05	0.05
Months on sales	0.52***	0.56***	0.37***
Design idea co-creation (DI)		0.63***	3.42***
Design decision co-creation (DD)		0.20***	1.41***
Commercialization idea co-creation (CI)		−0.10*	−0.11*
Commercialization decision co-creation (CD)		−0.08	−0.03
DI × DD			3.19***
CI × CD			0.02

Dependent variable: product innovativeness

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

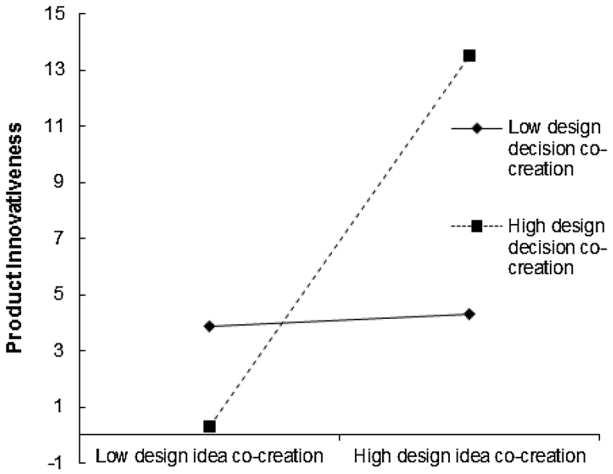

Fig. 3 Plot of interaction effect in the product design phase

The extent to which the Poisson model fits our data was assessed with the residual deviance statistic. The statistic (d = 101.36, $df = 96$, $p = 0.67$) was not significant, indicating a good fit. The Omnibus Test also showed that our model was strongly significant (likelihood ratio = 386.72, $df = 10$, $p < 0.001$).

The hypotheses related to product sales, which is a continuous variable, were analyzed using ordinary least square (OLS) regression in a stepwise fashion similar to that in the analysis of product innovativeness. We log-transformed the product sales variable to meet the normality assumption of OLS regression and ascertained that the residuals were normally distributed after the transformation (Skewness = 0.21, Kurtosis = 0.14, Shapiro–Wilk Statistic = 0.98, $df = 107$, $p = 0.21$). This is also supported by the normal Q–Q plot (see Fig. 4).

The results of OLS regression are presented in Table 6. The interaction between idea co-creation and decision co-creation in the commercialization stage was significant, supporting H1. In line with H3, the interaction between co-creation tasks in the commercialization stage had a stronger effect on product sales (b = 0.28, $p = 0.003$) than that in the product design stage (b = −0.15, $p = 0.14$). We tested the difference by comparing the model with both interaction effects to a nested model that excludes the interaction between tasks in the product design stage. We found that adding the interaction between tasks in the product design stage did not significantly increase the variance explained (change in $r^2 = 0.02$, $p > 0.05$). This corresponds with the finding that the interaction effect was not statistically significant. As shown in the plot of the interaction effect (see Fig. 5), products developed with a high level of idea co-creation and high level of decision co-creation garnered the most sales. The model with interaction effects is a good fit for the data (F = 3.87, $df = 11$, $p < 0.001$) and explained 31.2 percent of the variance in product sales.

We also tested whether product category had a significant effect. Product innovativeness and sales were regressed on product categories with Poisson

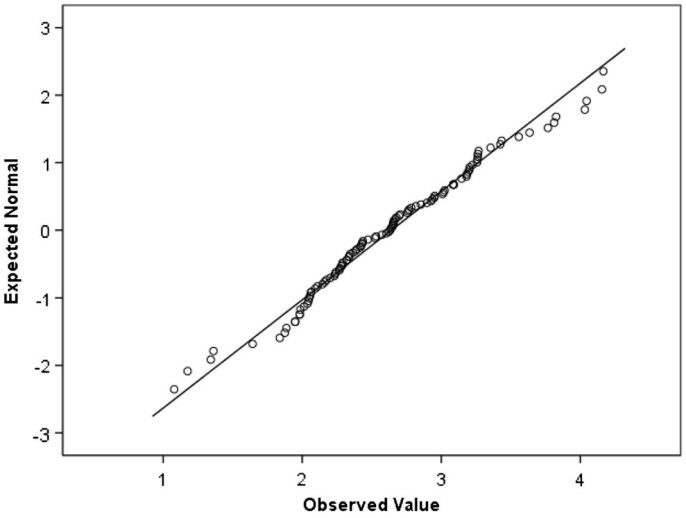

Fig. 4 Normal Q–Q plot of product sales after log transformation

Table 6 Results of ordinary least square regression for testing H1 and H3

Variable	Model 1 (control variables)	Model 2 (co-creation variables added)	Model 3 (interactions added)
Price	−0.15	−0.22*	−0.25*
Development duration	−0.21*	−0.15	−0.16
Review rating	0.02	0.01	0.01
Months on sales	0.18	0.12	0.06
Product innovativeness	0.06	0.04	0.06
Design idea co-creation (DI)		0.04	−0.07
Design decision co-creation (DD)		0.15	0.15
Commercialization idea co-creation (CI)		−0.03	−0.09
Commercialization decision co-creation (CD)		0.25*	0.30**
DI × DD			−0.15
CI × CD			0.28*

Dependent variable: product sales

* $p < 0.05$; ** $p < 0.01$

regression and OLS regression respectively. Dummy coding was used with mobile device accessories as a randomly chosen comparison category. We found that the mean innovativeness of other product categories were all slightly higher than mobile device accessories (coefficients were positive), while the mean sales of other product categories were all slightly lower (see Table 7). However, none of the differences were statistically significant. We concluded that product innovativeness and sales did not differ by product category.

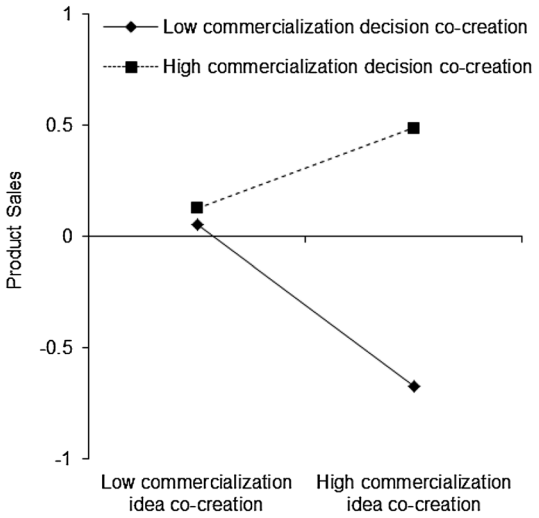

Fig. 5 Plot of interaction effect in the product commercialization phase

Table 7 Effects of product category

Product category	Product innovativeness		Product sales	
	Coefficient	*p* value*	Coefficient	*p* value*
Computer accessories	0.04	0.78	−0.11	0.47
Health and personal care electronics	0.07	0.50	−0.02	0.93
Kitchen appliances	0.10	0.45	−0.06	0.66
Home connectivity appliances	0.15	0.27	−0.07	0.59

6 Discussion

This study aimed to empirically assess the impact of customer co-creation on product innovativeness and product sales and improve our understanding of the impact by accounting for different co-creation tasks (i.e., co-creation of idea and co-creation of decision) in different NPD stages (i.e., product design and product commercialization). Supporting our hypotheses, we found that there is significant interaction between idea co-creation and decision co-creation tasks such that opening up both to customers has a more positive impact than either alone. Further, product innovativeness is more strongly affected by idea and decision co-creation in the design stage than that in the commercialization stage, while product sales is more strongly affected by idea and decision co-creation in the commercialization stage. Overall, this study has provided some empirical evidence that customer co-creation leads to better and more novel products.

Unexpectedly, we observed that product innovativeness decreases (i.e., customers identified a greater number of similar products) as idea co-creation in the commercialization stage increases (see Table 5; $b = -0.11$, $p < 0.05$). In the

context of this study, this suggests that products are seen as less novel when ideas for product taglines are co-created with customers. A plausible explanation for this is that in the course of trying to generate creative and catchy taglines, customers might seek information about other products in the market and this led them to identify a greater number of similar products. This suggests that not only is opening up the commercialization stage for customer co-creation unhelpful for improving product innovativeness, it may even be detrimental.

6.1 Implications for research and theoretical development

The theoretical contributions of this study are summarized in Table 8. The finding that customer co-creation in different NPD stages has different impacts indicates the need for a finer conceptualization of co-creation in terms of the *content* of co-creation. As demonstrated in this study, distinguishing between ideas related to product design and ideas related to commercialization affords a more nuanced understanding of how customer co-creation influences different aspects of new product success. Future studies can extend this line of inquiry by considering other NPD stages that are increasingly being opened for customer co-creation, such as product testing and product support [32]. Customers' involvement in these stages could impact other aspects of new product performance, such as perceived product quality and customer satisfaction.

The interaction effect between the NPD tasks of idea co-creation and decision co-creation identified in this study sheds further light into our theoretical understanding of customer co-creation. Although idea co-creation and decision co-creation can be treated as separate in practice in that firms can open one to customers but not the other, our findings indicate that their impacts are not independent. We explained the conceptual underpinnings of the interaction effect and found empirical evidence for their significance. The interaction effect should be taken into account in future studies examining both idea co-creation and decision co-creation to improve model accuracy. Given that many customer co-creation initiatives focus on idea generation and selection [37], it is imperative to further ascertain the interaction effect by assessing them in other settings (e.g., other e-commerce firms, industries, countries).

This study also addresses a gap in prior research, which has mostly focused on customer-side (e.g., customer satisfaction) and company-level impacts (e.g., "customerization" capability), by examining customer co-creation at the product-level. Since the new product is the key output manifesting the value of co-creation in NPD and an important source of revenue for e-commerce businesses, studies on co-creation that consider the product as the unit of analysis is essential. This study has extended the focus of research on customer co-creation by taking a relevant yet overlooked perspective.

We have also provided the much needed empirical evidence for the impact of customer co-creation. As shown in our literature review, much of the existing evidence is based on survey data. Our study analyzed objective data on 107 actual products and the results showed strong support for the positive impact of customer co-creation. This serves as an impetus for further research on the topic to better understand how firms and customer participants can benefit from customer co-

Table 8 Summary of theoretical and practical contributions

State of the literature	This study	Relevance	
		Theory/ empirics	Practice
Customer co-creation in NPD has been anticipated to have a positive impact [5, 6, 67]	(1) Product innovativeness is more strongly affected by customer co-creation in the NPD stage of product design, while product sales are more strongly affected by co-creation in the product commercialization stage	✔	✔
	(2) The positive impact of customer co-creation in B2C e-commerce is empirically supported		
The degree of customer co-creation varies [5]	(1) Customer co-creation varies in terms of NPD stages and tasks. A finer conceptualization of customer co-creation can augment our understanding of its impact	✔	✔
	(2) E-commerce businesses can opt to vary these aspects depending on their objectives		
Idea generation and idea selection have not been clearly distinguished. In the few exceptions, they have been treated as independent [e.g., 13, 68]	There is significant interaction between co-creation of ideas and co-creation of decision (to select the idea to implement)	✔	
Research has focused on customer-side and company-level impacts (see our literature review in Sect. 2)	The final output of customer co-creation in NPD is the new product and it is therefore necessary and important to study product-level impact. This study found that customer co-creation improves product innovativeness and sales	✔	

creation and, contributes towards the development of a theory of customer co-creation. Our results are also useful for justifying customer co-creation initiatives in practice. More specific implications of our findings for practice are discussed next.

6.2 Implications for practice

The finding that customer co-creation in different NPD stages has different impact on product innovativeness and sales can help e-commerce businesses decide which NPD stage to open for customer co-creation, given their specific objectives. For firms that are seeking to improve product innovativeness, the product design stage should be open for customer co-creation. For firms that are aiming for new products that would be popular, customers should be involved in co-creation in the product commercialization stage. With this understanding of the differential impact, managers are better able to channel their financial and other firm resources into co-creation initiatives that are relevant and valuable.

King and Lakhani [37] observed that "in every firm and industry, executives…had to determine (1) whether to open the idea-generation process; (2) whether to open the idea-selection process; or (3) whether to open both". As shown earlier, some anecdotal evidence from co-creation initiatives such as Dell suggests that opening only one but not the other can breed negative emotions and beliefs. Supporting these observations, our findings suggest that firms should open *both* the tasks of idea generation and idea selection for customer co-creation considering that it results in significantly better products in terms of innovativeness and sales.

6.3 Limitations and suggestions for future research

This study is limited in several ways. First, data were collected from one e-commerce retailer selling consumer electronics. To establish the generalizability of the findings, it is necessary to test our hypotheses further with data from other firms, industries, and countries. Second, as an initial empirical study on the product-level impact of co-creation, we focused on studying the NPD stages that are commonly open for customer co-creation. As mentioned earlier, a more comprehensive understanding could be gained by examining other stages such as product testing and product support. This would also allow other aspects of new product performance to be considered. Third, although product innovativeness and sales are vital aspects of performance, they are largely cross-sectional in this study. The positive impact found in our study suggests that it could be fruitful to study performance longitudinally, such as following through the product life cycle of co-created products.

Other than improving on the limitations, future studies could focus on deepening our understanding of the relationships found in this study. For example, a multi-level study that incorporates factors related to individual customers (i.e., motivation, e-loyalty) and ideas (e.g., idea quality) into our proposed model could offer a more comprehensive insight into the cross-level relationships underlying the impact of customer co-creation on e-commerce business performance.

7 Conclusion

This study has shown that e-commerce customer co-creation in key NPD stages and tasks indeed leads to better new products in terms of innovativeness and product sales. The underlying objective of this study is to improve our understanding of the performance impact of co-creation, which is a central concern of firms hosting co-creation. E-commerce firms do not open up their NPD simply because the e-commerce platform is conducive to reaching customers or to be on the bandwagon of social commerce or other related trends such as crowdsourcing and open innovation. There is a pressing need to demonstrate customer co-creation's economic impact [11] and develop better and more comprehensive knowledge of the mechanisms through which co-creation impacts financial performance. Starting with the new product as the most relevant entity, this study serves as a step stone for

future research endeavors on the phenomenon and hopes to inform e-commerce businesses which are increasingly engaging in customer co-creation.

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