

Pricing decisions of consumer innovators

Tobias Ebbing, Christian Lüthje

Hamburg University of Technology

*Accepted for publication in Research Policy in December 2020. This is our working copy.
Please cite and find the final published version at: <https://doi.org/10.1016/j.respol.2020.104169>*

Abstract

Increasing numbers of consumers who engage in the development of new products are selling their innovations on online marketplaces. We contribute to the scarce research on the commercialization activities of consumer innovators by comparing the consumers' price decisions with the pricing of firms. Our predictions build on the baseline assumption that the price decisions of consumers are influenced by the same motivations that originally prompt them to innovate. We use a sequential mixed-method approach with a quantitative main study and follow-up qualitative research. The quantitative results draw on a matched-pair analysis of 4,242 computer games released on the online game platform Steam. We find that consumer innovators charge lower prices than firms for comparable games and that consumers and firms show different inclinations in aligning prices with the games' development costs and perceived quality. The subsequent interview study with 29 hobbyist game developers provides clear support for the motivational explanations of consumers' pricing decisions. The findings contribute to research on consumer innovation marketing and nascent entrepreneurship. They also improve the understanding of welfare effects resulting from increasing commercial activities of consumers.

Keywords: innovation; consumer innovators; user innovation; pricing; computer games; marketplaces

1. Introduction

Research has documented high levels of innovation activities performed by non-firms, i.e. innovators who are not directly paid for their engagement and who are not innovating in and for legal entities (Bogers et al., 2010; de Jong, 2016). There are many names for these individuals, including amateurs, hobbyists, users, and tinkerers. Recently, they have been termed *household sector innovators*, encompassing all innovating members of the consuming population (ESA, 2010; Gault, 2018; OECD, 2018).

We investigate the pricing practices of consumers who seek to capture the economic value of their innovations by offering them for sale. They can be seen as an intermediate or hybrid innovator type that is positioned between free innovation, with its purely self-rewarding nature, and traditional firm innovation, which has the core objective of selling innovations to others (von Hippel and von Krogh, 2006; von Hippel, 2017). Only a small research stream has investigated how entrepreneurial consumer innovators behave in the pursuit of commercialization. Early studies highlighted the “accidental” nature of user entrepreneurship activities. It was found that user innovators usually engage in innovation to meet personal needs and only opt for commercialization after receiving signals that their inventions are also valued by other users (Shah and Tripsas, 2007). Subsequent research analyzed a few fundamental aspects of the users’ commercialization approach. Notably, several studies document the importance of user communities as a complementary asset for industry entry, and empirical research highlights the tendency of users to avoid direct competition with incumbents by pioneering in emerging fields or taking unobserved market niches (Baldwin et al., 2006; Haefliger et al., 2010; Fauchart and Gruber, 2011; Shah and Tripsas, 2012; Agarwal and Shah, 2014; Oo et al., 2018).

However, we know little about specific marketing- and sales-related decisions that consumer innovators take after deciding to sell their innovations. This is particularly true for pricing, which is a key instrument in the commercialization of new products and services. Pricing is comparatively flexible in use and, in most markets, pricing effects manifest strongly and swiftly in new product success (Ingenbleek et al.,

2010). To our best knowledge, there has been no empirical study of how consumer innovators set prices and whether their prices differ systematically from those set by firms. Hence, our objective in this study is to investigate the pricing practices of consumer innovators relative to those of firms.

Making progress to understand the pricing behavior of consumer innovators seems promising in light of the existence of numerous online (maker) marketplaces for digital and physical goods (Kuznetsov and Paulos, 2010; Crogan, 2018; Whitson et al., 2018). These markets open low-cost paths to innovation diffusion and create opportunities for users to gain monetary returns (Baldwin and von Hippel, 2011; Halbinger, 2018; Claussen and Halbinger, 2020).

Platform-based markets also provide a favorable context for triggering opportunity recognition and exploitation as they make the commercialization of consumer innovations visible to a broader public. These online marketplaces provide an ideal ground to encounter examples of commercially active and successful consumers. This increases social acceptance of user entrepreneurship and stimulates consumers to develop own opportunity beliefs (Autio et al., 2013, 2014). All these favorable conditions have boosted and will probably continue to boost the number of commercially active consumers, which in turn makes consumer innovators' pricing decisions a relevant research topic.

The study framework builds on user innovation research, showing that consumers' innovation activities tend to be initially stipulated by a mixed set of expected self-rewards (e.g. enjoyment and learning, solving own problems) that precede or complement interest of monetary returns (Hertel et al., 2003; Shah and Tripsas, 2007; Stahlbrost and Kareborn, 2011). We posit that, rather than being obliterated by commercial interest, these expected self-rewards remain salient and impact consumers' pricing decisions and commercialization activities down the road. This compact theoretical logic allows us to develop basic hypotheses regarding differences in price levels that consumers and firms charge for innovations. We also

develop hypotheses regarding the relative impacts of costs, perceived quality, and product competition on both innovator groups' pricing.

We test the hypotheses in an explanatory sequential mixed-method study (Johnson et al., 2007). The research sequence begins with the collection of quantitative data, followed by a qualitative phase helping to validate the explanations that underpin the quantitative research model (Creswell and Plano Clark, 2018). The quantitative main study draws on rich data from the computer games marketplace *Steam*. We compared 2,121 matched pairs of novel firm-developed and consumer-generated computer games published on the platform. The analysis confirmed that consumer innovators charge lower prices than their firm counterparts for computer games of similar size and quality. Our findings also show that innovating consumers account for key price determinants differently than firms. Development costs are less important for consumers than for firms, while perceived quality plays a significantly stronger role in consumers' pricing decisions than in those of firms. Contrary to our expectation, competitive intensity did not show a stronger effect in consumers' price setting than in firms' pricing.

The qualitative follow-up study analyzes data collected in interviews with 29 consumer innovators, adding in-depth explanatory insights to our model. The analysis of interview responses provided clear support for our proposed motivational explanation. Most respondents' innovation efforts were in fact not dominated by monetary expectations, but driven by a mix of self-rewards. The results also support the validity of the motivational explanations regarding the weaker importance of cost and the stronger role of perceived quality as determinants of the consumers' pricing decisions.

This is one of the few studies on innovating consumers' exploitation of business opportunities. Thus, we contribute to research on the motivational basis of user innovation. The results also add to the user entrepreneurship research by highlighting the role of non-monetary expectations to explain decisions in value capturing. The findings on different pricing practices of consumers vs. firms also provide a starting

point for a better understanding of innovating users' effects on competitive dynamics and welfare creation in markets that are characterized by a mix of amateur consumers and professional firms. After all, consumers' pricing has the potential of putting price pressure on incumbent firms and to allow customers to satisfy their needs at a higher surplus (Jeppesen and Frederiksen, 2006; Markman and Waldron, 2013; Boudreau and Jeppesen, 2015; Halbinger, 2018). Finally, our study results have practical implications for firms that compete with an increasing number of innovating consumers in online market platforms.

2. Theoretical Background

2.1 Linking innovation-related motives and pricing decisions

Most research on the subject of pricing is based on normative frameworks that assume rational decision-making (Tellis, 1986; Diamantopoulos, 1995; for an overview see Kienzler and Kowalkowski, 2017). Stimulated by the large body of research into behavioral decision-making, a much smaller research stream found that observable outcomes of pricing decisions often deviate from assumptions of perfect rationality (Liozu and Hinterhuber, 2013; Kienzler, 2018). One broad theme is that deciders in pricing may not conform to a standard utility framework that solely includes the maximization of the own monetary payoff. For instance, it has been shown that several types of social preferences such as fairness orientations or generosity as well as interpersonal relationships influence how individuals and groups decide on prices (Kahneman et al., 1986; Uzzi, 1997; Mandel, 2006).

In line with this scant research work, we adopt a behavioral lens to propose differences between consumer innovators and firms. Personal dispositions can be expected to more strongly influence consumer innovators' pricing than that of firms. After all, consumers do not need to align their decisions to company strategies and organizational structures (Homburg et al., 2012; Liozu et al., 2014). The theoretical framework of this study builds on the key assumption that consumer innovators' pricing is influenced by the same motives that stimulate them to start innovating in the first place (Stahlbrost and

Kareborn, 2011; Hienerth et al., 2014; Stock et al., 2015). Two basic considerations underpin this central assumption.

First, we question that commercializing innovating consumers are primarily motivated by expectations of financial return when they start innovating. This stands in contrast to classical research in entrepreneurship. In this widely shared view, purposive entrepreneurial processes begin with the identification and evaluation of business opportunities, followed by the deliberate decision to commercially exploit the feasible and desirable ones (Shane and Venkataraman, 2000; Carter et al., 2003; Autio et al., 2013). However, Shah and Tripsas' (2007) results paint a completely different picture, suggesting that most end-user entrepreneurship activities can be termed accidental. Consumers often first discover non-commercial opportunities that do not require compensated transactions on markets; most start to innovate for self-rewards. It is only after receiving positive feedback to their innovations that innovating consumers may decide to exploit their innovations' commercialization potential (Haefliger et al., 2010; Halbinger, 2018). In other words, even consumers who eventually decide for commercialization are initially not primarily or not at all driven by the expectation of monetary profits (Shah and Tripsas, 2007; Haefliger et al., 2010; Oo et al., 2018).

Second, we suggest that when consumer innovators embark on a path towards entrepreneurship and commercialization, the initial innovation-related personal and social goals do not fade away. Psychological research found that values and preferences, which form the basis for key personal goals or a person's social identity, rarely change fundamentally; if they do, such changes take long (Kasser et al., 1995; Burroughs and Rindfleisch, 2002). Because innovation-related self-rewards and motivations can in fact be interpreted as direct expressions of central values and internalized norms, we expect that the original motives cast a long shadow on the commercialization decisions of aspiring consumer entrepreneurs (Hitlin and Piliavin, 2004).

In this study, we investigate how consumer innovators' pricing decisions differ from those of commercial firms. We investigate the extent to which consumer innovators deviate from firm innovators regarding the price levels charged for similar products and services. Besides the price levels, we explore factors that are commonly suggested to influence pricing. Most normative economic frameworks describe price as a function of cost, customer value, and competition (Ohmae, 1982; Hinterhuber and Liozu, 2019). These three categories of price determinants are colloquially referred to as the 3 Cs of pricing and were translated into three pricing approaches: cost-informed pricing, customer value-informed pricing, and competition-informed pricing (Nagle and Müller, 2018). We structure our expectations along this triad of pricing determinants and develop expectations of how strongly they affect the pricing decisions of consumers and firms.

<< INSERT FIGURE 1 ABOUT HERE >>

2.2 Price differences between comparable consumer-developed and firm-developed innovations

The innovation activities of firms and consumers have different rationales. Innovating firms are rewarded by appropriating economic benefit from their creations (von Hippel, 2017). Realizing profit-maximizing prices is a key objective for them (Tellis, 1986; Diamantopoulos, 1995; El-Ansary, 2006). This implies that if companies identify room to increase their profit by setting higher prices, they will likely exploit this opportunity.

There is reason to believe that consumers deviate from this practice. While consumer innovators' decision to commercialize can in fact be interpreted as a manifestation of self-interested behavior, consumers are usually not solely driven by the goal to maximize profits but are rather motivated by a

mixture of different benefit expectations (Raasch and von Hippel, 2013a; Hienerth et al., 2014; Stock et al., 2015). Some self-rewards are directly tied to the innovation work and rather independent from the social context. Most notably, many consumer innovators report having started to innovate because they hoped to develop a solution for their own use (von Hippel, 2005; Hienerth et al., 2014). They often also indicate seeing their engagement as fulfilling, generating personal enjoyment and offering multiple learning opportunities (Lakhani and Wolf, 2003; Raasch and von Hippel, 2013a). Other self-rewards that drive individuals to innovate are linked to the social context insofar that they require interactions with others. These motivations may include the desire to contribute to a community or to solve others' problems (Hars and Ou, 2002; Lakhani and Wolf, 2003). They are often activated by socially endorsed norms (e.g. altruism or reciprocity) in which appropriate behaviors are instrumental to achieving social rewards such as appreciation and allegiance amongst peers or communities (Benkler, 2006; Kathan et al., 2015).

In alignment with motivational theories, we propose that innovation-related rewards are in a synergistic, compensatory relationship to one another: a higher reward of one type compensates for a lower level on another reward. Rewards constitute elements of an additive or multiplicative utility function (Vallerand, 1997; Cialdini et al., 1998). This implies that the need to set prices to maximize profit is alleviated, because innovating consumers already benefit in various other ways in the development process (Shah and Tripsas, 2007; Gambardella et al., 2017).

In addition, setting fairly low prices, with its effect of increasing adoption, is also directly instrumental to satisfying socially activated motivations, since harvesting these self-rewards is enhanced by diffusion (Harhoff et al., 2003; Hau and Kim, 2011). For instance, increasing one's status within a community of peers is not possible without positive feedback from other users. Similarly, satisfying altruistic motives needs a minimum level of adopters to benefit from an innovation. Innovating consumers should be inclined to charge lower prices to increase the number of adopters, even at the costs of pecuniary profits. Thus, we propose:

H1: Consumer innovators charge lower prices than firm innovators for similar products.

2.3 The relationship between development costs and prices

Cost-informed pricing starts from the variable and fixed costs for the development, production, and marketing of a product, and adds a profit margin to arrive at the sales price (Ingenbleek et al., 2003; Nagle and Müller, 2018). Since information about costs is fairly easy to collect, this approach enjoys constant popularity, despite its frequently discussed theoretical inferiority (Hall et al., 1997; Larson, 2019). Thus, there is very likely a strong correlation between the innovation-related costs and the prices that firms charge for their innovations.

While consumer innovators also incur costs of development, production, and diffusion, they have been found to operate in low-cost corridors in the design and development stage of their innovation projects (von Hippel, 2005; Hienerth et al., 2014; Lüthje and Stockstrom, 2016). For innovators whose primary purpose is not return on investment, it does not seem appropriate to invest heavily in the acquisition of new and dedicated resources (Riggs and von Hippel, 1994). Making considerable investments may even be detrimental for achieving high self-rewards. For instance, designing solutions that can only be developed at high risk and high expenditures may decrease the prospects of successful completion and thus the likelihood to benefit from the innovation process and the innovation outcomes (Csikszentmihalyi, 2000).

Consumer innovators' tendency to rely primarily on available or easily accessible resources implies that the largest share of innovation-related costs should be associated with the time consumers spend on development activities (Hienerth et al., 2014). This is particularly so for digital products that are typically associated with low or no production and distribution costs and primarily incur development costs in the form of human effort (Huang and Sundararajan, 2010; Jones and Mendelson, 2011). The time consumers invest in the creation of innovations constitutes costs, but primarily has the character of opportunity costs

rather than de facto payouts. Other than firms with employees, developing consumers don't need to compensate their innovation effort by cash inflows in order to ensure financial solvency (Bowman and Ambrosini, 2000; Baldwin and von Hippel, 2011).

Innovating consumers can be assumed to not consider the opportunity costs of time at all when thinking about appropriate prices. Most consumers innovate in areas of high personal involvement and interest (Bogers et al., 2010; Roszkowska-Menkes, 2017), such as sports and other leisure time activities (Lüthje et al., 2005; Hiennerth, 2006). The high enjoyment and learning motivation should influence the interpretation of innovation effort and move opportunity costs of time out of the set of factors that consumers use when making their pricing decisions (Csikszentmihalyi, 2000; Shah and Tripsas, 2007; Raasch and von Hippel, 2013b). The cost of time and effort may even be perceived as negative by consumer innovators (Harhoff et al., 2003).

In sum, consumer innovators incur fairly negligible monetary expenses in the development process, alleviating the need to charge cost-covering prices. Further, consumers rarely consider their working time as a cost that should be compensated by revenues. Thus, we conclude:

H2: Consumer innovators relate prices less strongly to the development costs than firm innovators.

2.4 The relationship between perceived quality and prices

Value-informed pricing has gained high popularity among marketing researchers and practitioners (Ingenbleek et al., 2003). This approach puts the benefits that are created for customers at the center of pricing decisions (Hinterhuber, 2008; Kienzler and Kowalkowski, 2017). In the consumer behavior literature, customers' perceptions of the gross benefits of a product or service are termed *perceived quality*, defined as the subjective evaluation of excellence of goods that excludes the disutility or cost to obtain them (Zeithaml, 1988; Priem, 2007). Notably, by excluding the price to pay for the benefit, our

conceptualization and that of others differs from the concept of *net value* or the colloquial notion of *value for money* (Bowman and Ambrosini, 2000; Li and Hitt, 2010; Liozu and Hinterhuber, 2013). According to this definition, perceived quality reflects an overall assessment or second-order construct, that results from a multi-attributive evaluation of all attributes that are important for a consumer to accomplish favorable ends (Zeithaml, 1988; Woodruff, 1997; Stylidis et al., 2020).

Consistent with our baseline assumption, we propose that the tendency to focus on perceived quality in pricing is particularly high among consumer innovators because their behavior is partially driven by socially activated motivations such as receiving approval and respect from the peer group (Hars and Ou, 2002; Hertel et al., 2003; Lakhani and Wolf, 2003). Consumer innovators can be expected to care about how their pricing decisions are interpreted by other users, particularly by the future buyers of their innovations.

One of the most salient interpretations of prices by customers is perceived price fairness (Maxwell, 2002; Bolton et al., 2003). Buyers subjectively assess whether a price is reasonable, acceptable, and justifiable (Bolton et al., 2003; Xia et al., 2004). Such distributive justice is assessed if the perceived quality is at least proportional to the payment. To benefit from diffusion and to maintain social rewards, consumer innovators should avoid dissatisfaction, altruistic punishment, and negative word-of-mouth from adopters that could result from unfavorable ratios of perceived quality and asking price (Campbell, 1999). On the contrary, consumer innovators should have a high inclination to set prices that are interpreted as a fair reflection of quality so as to maintain a positive self-image (Halpern, 1997; Mendes-Da-Silva et al., 2008).

In contrast, in a classical economic business logic, implementing prices is mainly a competitive zero-sum game in which suppliers and customers fight to maximize their own surplus: “What is gained by the firm is lost by the customer and vice versa” (Hinterhuber, 2004). A profit-oriented firm is less likely to

strongly socially identify with prospective buyers. Thus, socially endorsed norms are unlikely to complement the orientation towards clear financial performance indicators of firms (Burkert et al., 2017).

This does not imply that quality-informed pricing is irrelevant in firms' pricing decisions. However, even firms that wish to deploy quality-informed pricing often lack the intimacy with their customers to develop a valid understanding of the drivers of perceived quality, whereas consumer innovators are in a much better position to arrive at accurate estimations of the customers' quality perceptions (Liozu et al., 2012; Töytäri et al., 2015).

We therefore propose that consumer innovators charge prices for their innovations that mirror the perceived quality more accurately than prices set by commercial firms:

H3: Consumer innovators relate prices more strongly to the perceived quality of their product than firm innovators.

2.5 The relationship between competitive intensity and prices

Most theoretical models of imperfect competition predict that a higher number of substitutes correlates with lower price levels by putting more competitive pressure on suppliers in a market (Day and Montgomery, 1999). One explanation for this effect is that vendors are willing to accept lower margins to uphold their sales volume and market shares (Shipley and Jobber, 2001; Liu, 2010). Yet, reacting to higher competition levels with lower prices can lead to price battles, with economically devastating consequences. Thus, commercial suppliers tend to consider other options before adjusting their prices (Geylani et al., 2007; Cachon and Swinney, 2008). Firms can for instance take advantage of economies of scope in communication activities to increase their brands' reputations. They also use their marketing budgets to build a stronger awareness about the differentiation value of their products. By achieving a unique position on customers' perceptual maps, innovators can work on partly detaching from the number of available substitutes to avoid having to reduce prices (Leuthesser and Kohli, 1993).

We propose that firms will more often decide for these nonprice-related marketing measures, whereas consumer innovators have a higher inclination to adapt their prices to competitive intensity. De-commoditization of own products via marketing activities should not be a viable option for consumers who widely lack appropriate assets (e.g. sizeable financial resources and managerial execution excellence) to conduct such activities beyond their communities (Burger-Helmchen, 2008; Agarwal and Shah, 2014). Even more importantly, consumers should not even have a high interest in eluding competition as a factor in their pricing decisions. Some of the most salient reward expectations can only be met if a consumer innovation reaches a minimum adoption level in the market. Direct competition negatively impacts on the likelihood of widespread adoption when own prices are higher than those of the substitutes. Thus, consumer innovators may tend to purposefully react to competitive intensity by setting lower prices to boost the adoption of their innovations. To conclude, we expect:

H4: Consumer innovators relate prices more strongly to competitive intensity than firm innovators.

3. Method

This research is based on a sequential explanatory mixed-methods design in which the main quantitative research is followed by a qualitative study (Creswell et al., 2003; Johnson et al., 2007; Creswell and Plano Clark, 2018). First, we rely on quantitative data gathered in a large sample of new product releases to statistically compare the pricing decisions between consumers and firms. Second, we conducted open-ended interviews with consumer innovators to illuminate the rationales behind their pricing decisions by revealing the consumers' underlying motivations. These qualitative results not only validate the theoretical explanations that underpin the quantitative study, but they also expand the quantitative findings by highlighting interesting differences among consumer innovators and by illustrating some outlier results (Morgan, 2017).

3.1 The empirical setting and the quantitative dataset

We chose the product area of computer games as our research setting. The computer games industry has seen a surge of platform-based marketplaces on which amateurs and hobbyists offer their games alongside professional computer game companies. The games market platform Steam, which is run by the Valve Corporation, is by far the most prominent among them and has received increasing attention from other researchers in different fields (Sifa et al., 2014; Lin et al., 2018).

Soon after its establishment in 2003, Steam was opened to third-party developers in 2005. At first, the submissions were manually evaluated and selected for publication on the platform. In 2017, Valve decided to publish games without extensive evaluation against a recoupable submission fee of USD 100 per game. Following this change, individuals, amateurs, and hobbyists, i.e. developers that fit our definition of commercially active consumer innovators, increasingly populate the Steam marketplace.

For the quantitative main study, we compiled a cross-sectional dataset of 13,969 computer games available on the US Steam platform in April 2018. The API of the Steam store was used to extract relevant game information (e.g. game titles, developer names, game genre). We blended this data with information extracted from the third-party sites Steam Spy and Steam DB (e.g. average playtime, rating score, price history). We identified 11,986 games that at some point were sold for a non-zero price and offered no in-game purchases. These games form the basis for the following three-step screening process.

To categorize the game developers as consumer innovators or firm innovators, we used the foundation of a legal business entity administered as per corporate law as the key criterion. In step 1, we linked the developer names to information from three further game developer databases (Indiedb, Moddb, Wikipedia entry titles). By reading through 500 randomly selected developer profiles, we created a list of terms describing a legal institution in the business sector (e.g. firm, corporation, enterprise) and legal company suffixes (e.g. LLC, GmbH, S.A., Ltée, N.V.). Next, we machine-scanned the profiles and categorized all entries that matched at least one list term as a firm. For now, we categorized all game developers with no

match as consumer innovators. This led to a preliminary categorization of our sample into 1,426 firm developers with 3,535 games and 5,916 non-firm developers who had created 8,451 games.

The next step 2 was an extensive manual screening to reduce the risk of false positives in the consumer innovators group. A random subsample of 3,001 developers, representative of the preliminary identified consumer innovators regarding size and game ratings, was drawn and manually controlled. We entered the developer names in combination with 'game' into a search engine and read the first 10 search results for any indication for an existing firm. In the 520 cases of matching indications, the developers were re-assigned to the group of firms, yielding 1,946 confirmed firms (1426 + 520) that are responsible for 4,412 games. After this second screening, we confirmed 2,481 developers (83% of the pre-identified sample) as consumer innovators, having published 3,622 games.

In step 3, we excluded all games commercialized by publishers rather than the games' originators. Handing a project to a publisher moves the pricing decision away from the game developer and thus decouples the innovation work from commercialization decisions. This should have significant effects on the pricing of games. For instance, the prices are likely to be affected by strategic considerations of publishers managing a broad portfolio of games from different game development entities. Further, most publishers have no own game development costs. This makes it less likely that the development costs influence the publishers' pricing. The exclusion of publisher game titles left us with 2,649 firm-developed and 2,725 non-firm-developed games. These two sub-samples constituted the basis for the subsequent matching procedure.

3.2 Sample of matched-pairs

As common in retrospective categorization in cross-sectional studies, our units of analysis are not randomly assigned to the different categories of consumer innovator games and firm games (Brazauskas and Logan, 2016). To reduce the likelihood of receiving biased estimates owing to imbalanced observable

variables between the two game categories, we built a matched-pair sample by applying nearest neighbor propensity score matching (Rubin, 1979). We selected the game size in MB and the average user ratings of the games as continuous matching variables. These characteristics are important in our study and showed the largest deviation in means. The resulting sample of 2,121 pairs of games is free of significant group differences between mean game size ($t(4238.9) = 0.696, p = 0.486$) and ratings ($t(4215.3) = 1.1055, p = 0.269$). For descriptive statistics, see table 1.

<<INSERT TABLE 1 ABOUT HERE >>

3.3 Variables of quantitative research

3.3.1 Dependent variable: Game prices

New computer games are often published at a discounted introduction rate to encourage early purchases before they are sold at a regular price (Nair, 2007). To avoid distortion by these short-term promotional prices, we chose the first undiscounted price in USD as dependent variable in our analysis.

3.3.2 Independent variables

Developer type: Consumer innovator vs. firm innovator

As indicated in 3.1, we employed a formal criterion to distinguish the two focal game developer types. We categorized all legal and separately identifiable entities as firm innovators; these serve as the reference level in the analysis. We classified all game developers for which we found no indication for the existence of a company as consumer innovators. By this, we followed the definition of the statistical office of the European Union Eurostat (2010): “[..] the households sector consists of individuals or groups of individuals as consumers and as entrepreneurs producing market goods and non-financial and financial services (market producers) provided that the production of goods and services is not by separate entities treated as quasi-corporations. It also includes individuals or groups of individuals as producers of goods and nonfinancial services for exclusively own final use.”

The foundation of a legal entity is not a perfect separator between the two focal innovator groups. The world is hybrid and the wide range of users, hobbyists, amateurs, indie developers, professional innovators, entrepreneurs, start-ups, innovating SMEs, and large corporations makes it difficult to draw an exact line between consumer innovators and firms. The creation of a legal commercial entity is still the clearest observable event that signs a move toward a paid, professionally organized, and more time-consuming development activity aimed at profit generation.

Programming effort: Games' file size

Assessing software development costs is deemed to be a difficult task (Jørgensen, 2004). In the IT project management literature, the most frequently mentioned measurable cost driver is software program size (Mislick and Nussbaum, 2015). However, there are valid criticisms of the use of software size as an indicator of the programming hours it required (Boudreau, 2018). For instance, it is noted that a comparatively smaller file size can be the result of the developers' attempt to create elegant and clean code, which in turn is usually associated with a higher programming effort (Boehm and Papaccio, 1988). However, resources like disk space are no longer very limited, so that using extensive programmer time in order to lower the amount of code is not the first priority in games anymore (Koster, 2005). Further, in today's game development, a very high share of the total game development time is consumed by the creation of complex multi-media content to design immersive game scenarios. A higher sophistication in the self-programmed graphics closely relates to the required time to render them and translates into a larger file size. Thus, in multimedia development, there is a strong relationship between development effort and file size. The validity of the file size as effort indicator has further increased by the widespread use of development engines. A study by Koster (2018) shows that the emergence of popular development engines led to fairly uniform cost per byte ratios across game developers. Consumer innovators can be expected to program with these professional game development engines too, since license fees are only imposed when games generate substantial revenues.

In sum, the file size of a computer game captures the effort invested in its development. We used the minimum disk space needed to install a game as our measure of development effort.

Perceived quality: User ratings

Following the outlined conceptualization, perceived quality is defined as a consumer's global judgment relating to the superiority of a product or service (Parasuraman et al., 1988; Zeithaml, 1988). The overall quality perception results from the subjective evaluation of the array of attributes that a consumer considers relevant. Thus, the overall game ratings given by the players constitutes a valid measure of the perceived quality of games. On Steam, game ratings can be either positive or negative, represented by a thumb up or a thumb down. The total Steam score is calculated as the percentage of positive ratings on all the ratings of a game. We employed this percentage of positive evaluations as the measure of perceived quality.

Notably, there is substantial discussion in the literature on the validity of unidimensional ratings as a measure of quality perception. A problem would arise if ratings did not only reflect the gross benefit derived from the game but were also significantly influenced by the evaluation of the price paid. However, studies raising this matter were conducted for product categories in which specific and quantifiable functional parameters dominate the product ratings (e.g. cameras; Li and Hitt, 2010). For utilitarian purchases, buyers can develop clear expectations about appropriate quality-price ratios based on previous purchase experiences and by comparing the focal product to similar product alternatives. In turn, this could make it more likely that prices matter in the ratings. We suggest that the price paid plays a weaker role in the ratings of hedonic experience goods such as computer games. Their evaluation is mainly affective and primarily associated with abstract, intrinsic experiential attributes such as pleasure and excitement. This makes it harder for buyers to determine a reference for an appropriate relationship between benefits and purchase price (Alba and Williams, 2013).

We conducted two analyses to explore the sensitiveness of reviews to price and one analysis to estimate the impact of noisy ratings on the quality assessments. First, a content analysis of a random sample of review texts was used to assess how often the reviews were clearly influenced by price considerations. We found that almost 93% of the reviews contained no reference to prices. Second, we observed if price changes of games led to changes of ratings and found no significant differences between the ratings before and after price variations. Third, we assessed whether reviews are confounded with non-quality related issues. Via a content analysis of a random sample of reviews, we found that only 3% of the reviews primarily referred to technical problems or support request. To conclude, the results provide support for using the game ratings as a measure of perceived quality. A detailed description of the three analyses is provided in Appendix A2.

Competitive intensity: Number of similar games available at the time of release

The competitive intensity is often defined as market concentration captured by the distribution of market shares of the suppliers in a market (Dufwenberg and Gneezy, 2000). Steam is a marketplace with low barriers to entry and a large variety of suppliers in every game category. Thus, the concentration of game suppliers per game genre or game type is negligibly small. We therefore decided to capture the intensity of direct product competition rather than using a market concentration measure. For each game in our sample, we determined how many similar games were released on the platform within 180 days prior to the focal game's release. For identifying the substitutes, we used a list of the 350 most frequent tags that Steam customers assigned to games as indicators of genre (e.g. action), game's thematic environment (e.g. soccer), and playing mode (e.g. shooter). We compared each game's tags (mean = 8.44 tags; sd = 5.5) to the tags of all games released in the previous six months. We categorized game *B* as a potential substitute for the focal game *A* if more than two-thirds of game *A*'s tags matched game *B*'s tags.

3.3.3 Control variables

To account for inflation and technical progress, we controlled for the release year of the game as a categorical variable. From three years we had just one game in the sample and therefore excluded these. We used genre fixed effects to unambiguously control for cross-genre variation. To arrive at monosemous genre classifications, we conducted a k-mode cluster analysis aggregating the games in eight genre clusters: action, action-adventure, adventure, casual, roleplaying, simulations, sports and racing, and strategy games (for descriptive statistics, see Appendix A5). We also included a covariate for the average playing time to account for relevant game characteristics. Next, to control for market and sales experience, we included the number of games a developer had published before introducing the focal game. Finally, we integrated the number of game screenshots provided in the game description and the number of different languages available as indication of the game presentation's professionalism.

3.4 Quantitative analysis method

We used an ordinary least squares regression (OLS) analysis to estimate the determinants of computer game prices. Table 2 reports the descriptive statistics and the correlation matrix. Correlations are low ($< |0.15|$; Variance Inflation Factor < 1.85 , Durbin-Watson = 1.88) and the model shows adequate linear fit in visual control of Q-Q and residual plots. With all observations' leverage below 0.1 and unsuspecting Cook's distances, no observations were removed. We refrained from applying fit-increasing transformations in favor of interpretability. Heteroskedasticity concerns were indicated by a significant Breusch-Pagan test. Thus, our result reports are based on robust standard errors (Lumley et al., 2002).

<<INSERT TABLE 2 ABOUT HERE>>

3.5 Qualitative follow-up study

To examine the validity of the theoretical propositions that underpin the quantitative study, the qualitative phase of this research focused on obtaining deeper information on the motivational structure of innovating consumers in the innovation and pricing process (Castro et al., 2010). We returned to the

consumers of our initial sample and contacted a random sample of 200 consumers who had recently released a computer game on Steam. We asked them to answer a set of open-ended questions in a telephone interview. In two reminders, we added the option to answer our interview questions in writing in order to increase the number of participants. We still preferred telephone interviews whenever they were offered. 29 consumer innovators took part in the study (adjusted response rate: 16.3%): 10 participants opted for an interview and 19 for a written reply. For information about the participants, see Appendix A6. The phone interviews lasted between 30 minutes and 2 hours (mean = 56 minutes).

The first part of the interview focused on the consumers' functional role at the outset of their innovation endeavors. We asked them to specify their initial motivations and the personal resources they had invested in the game's development. We then asked the respondents to describe when and how they decided to sell their computer games. Finally, the respondents were inquired about the factors and information they had considered in the pricing process. We analyzed the responses and assigned extracted text fragments to the content categories of innovation-related motivations and rewards, types of personal investments, triggers to sell the game, and considered price determinants.

4. Results

4.1 Findings from quantitative research

The results of the OLS regression models, predicting the computer game prices, are reported in table 3. The baseline Model 1 reports the control variables' estimates. Model 2 includes all independent variables whose main effects on prices did not form part of the hypotheses. In Model 3 the developer type (consumer vs. firm) is added. Model 4 includes the interactions between the developer type and the three potential price determinants. The fit for the complete Model 4 is adequate (Adjusted $R^2 = 33.7\%$; $F = 70.47$; $p < 0.001$). Adding the main effects in Model 2 and the hypothesized main and interaction effects in Model 4 to the baseline model significantly increases the explained variance (99% and 8.4%, respectively).

<<INSERT TABLE 3 ABOUT HERE>>

In the following we only consider the results of the complete Model 4. As one could expect, file size as a proxy of development cost is significantly positively related to prices ($b = 0.123$; $p < 0.01$). Confirming conventional expectation, the number of similar games available on the platform (competitive intensity) shows a negative association with prices ($b = -1.549$; $p < 0.01$). No significant relationship is given between the mean user rating and game price ($b = 0.021$; $p = \text{n.s.}$). In line with numerous investigations of the correlation between prices and quality, the prices of games in our sample did not unconditionally reflect a game's quality as perceived by the players (Curry and Riesz, 1988).

Fulfilling our first expectation (H1) in the matched-pair sample of comparable games, consumer innovator games were priced significantly lower than firm-developed ones ($b = -429.75$; $p < 0.01$).

Consistent with our prediction in H2, the interaction term of developer type and development effort is negative and significant ($b = -0.040$; $p < 0.01$). The file sizes, and thus the development costs, show weaker relationships with prices for consumer-developed games than for firm-developed games. In other words, consumer innovators seemed to have a lower inclination to price in their development effort than their firm counterparts.

The strongly positive and significant ($b = 3.028$; $p < 0.01$) interaction of perceived quality and developer type provides support for H3. The largest share of the strong and positive main effect of perceived quality on price in Model 3 without interaction effects can in fact be traced back to the group of consumer-developed games. A relationship between user ratings and prices is almost non-existent for firm-generated games, while being notably positive and significant for games developed by consumers. This confirms that consumer innovators show a much stronger inclination than firms to account for perceived game quality in their pricing decisions. The effects of H2 and H3 are graphically illustrated in Appendix A1.

Our quantitative results lend no support for H4: The interaction term of the developer type and competitive intensity is insignificant ($b = 0.304$; $p = n. s.$). Consumer game developers and professional game companies appear similarly reactive to numbers of available substitutes at the time of market introduction. Various explanations could apply. In contrast to our motivational explanation of H4, consumer innovators may not perceive a clear advantage in adapting prices to competitive intensity. Conversely and similar to the game developing firms, consumer innovators might try to at least partly escape from competition-based pricing by promoting the uniqueness of their games via promotional activities. However, the data did not provide support for this explanation. When comparing the commercialization efforts of both innovator groups, consumer innovators put significantly less effort than their firm counterparts into showcasing their games to a broad customer set with e.g. languages and screenshots (see table 1). The question why there is no support for a stronger effect of competitive intensity on consumer innovators' prices remains unanswered. This calls for additional explanation. We explore this in more depth in section 4.2 using the findings of the qualitative study (Castro et al., 2010).

In the following, we summarize a series of robustness checks which are documented in greater detail in Appendix A3. First, we accounted for price dynamics and strategic considerations of pricing by using the average price over the lifetime of a game as dependent variable - rather than using the first undiscounted introductory price as we did in our main analysis. Further, to control for unobserved changes that may arise if a game developer has published several games (e.g. higher reputation), we reran the analysis exclusively including each developer's first game. Next, to account for possible herding bias in game assessments, we recalculated the model excluding the 30% best-rated and the 30% worst-rated games. At last, to account for unobserved characteristics of game developers and to further reduce concerns of omitted variable bias, we introduced the developer as random-effect coefficient. In all additional tests the results remain steady as reported in Appendix A4.

4.2 Qualitative research findings

Since the quantitative study did not directly capture motivational and behavioral variables of the consumer game developers, one cannot completely exclude the possibility that pricing differences revealed by the quantitative analysis were caused by factors other than those proposed in the hypotheses. The following results from our qualitative interview study seek to validate the quantitative results by reviewing the motivational accounts of the innovating consumers' pricing decisions.

4.2.1 Functional role and innovation-related motivations

All 29 respondents indicated that they were avid computer gamers and had been playing computer games for many years when they decided to develop an own game. They started game development as a hobby and devoted their personal discretionary time (see table 5 for examples). Thus, all interviewees can be categorized as users.

Their innovation activities were stimulated by a mixture of self-rewards. Most innovating consumers (24 of 29 respondents) deliberately sought to develop a game that they themselves found valuable. They looked forward to playing the game themselves and enjoyed the development process. Many readily stated seeing the game's development as a perfect way to use their creativity and to self-express (25 of 29 developers). The third most mentioned reasons for innovating was learning by doing (15 of 29 respondents). Developing a game was an opportunity to extend their experiences and improve their skillsets. The results match the empirical evidence of several studies documenting the motivations of own use, enjoyment, and learning as key drivers of innovation activities of users (Hertel et al., 2003; Roszkowska-Menkes, 2017).

Less than one-third of the participants (9 of 29) stated that some commercial interest was already present at the start of their development work. Of these, just one exceptional participant, hoping for revenues to enable him to quickly quit his job, rated economic return as the main driver for innovating. The other eight brought it up as complementary expectation that was not sole key to the decision to start developing an

own game. Counts of motivation statements are listed in table 4 while table 5 displays quotes illustrating the importance of these innovation-related motivations.

<< INSERT TABLE 4 ABOUT HERE >>

Most respondents who referred to their commercial interest reported that the idea to sell emerged fairly late in the development process (14 of 22). Very often, they realized the potential of their innovation only after receiving signals of interest from their family, friends, and/or other gamers. In sum, almost all the respondents made clear that economic incentives were not the vital cause to initially justify their innovation efforts and only became more important later. This aligns well with the results of Shah and Tripsas (2007) for user entrepreneurs and those of Halbinger (2018) for makerspace innovators.

Interestingly, some interviewees reported that even after releasing the game for a price, revenue generation was not the sole objective. Five sampled consumer innovators offered the same game at no charge on another platform or were willing to share their game for free when gamers contacted them. Another interviewee invited others to contribute changes to his game and shared revenues with contributors. Similarly, four developers reported that they deliberately decided against implementing features frequently requested by customers because they did not match their personal vision of what their game should be. Apparently, they were willing to sacrifice revenue potential for personal aspirations.

<< INSERT TABLE 5 ABOUT HERE >>

4.2.2 The roles of development cost, perceived quality, and competitive intensity as price determinants

Consistent with the quantitative results, *cost considerations* were of only moderate importance: 11 of 29 developers reported thinking about development costs when openly asked how they set their prices (see the example quotes in table 6). The marginal role of costs in consumer innovators' pricing was further reflected in the interpretation of what respondents considered as development costs. About one-third of all respondents stated that they had born no costs. Personal time was rarely considered as a cost, and many respondents even forgot the mandatory USD 100 Steam publishing fee. Except for one game developer, none of the participants kept proper track of the hours invested into their games. When asked to quantify their total development effort, they based their answer on spontaneous and rough estimations (e.g. "past holidays", "all available time"). The one innovating consumer who recorded his working hours still hardly used this to determine the price floor for his game. Although time tracking made him aware of the unfavorable effort-return ratio, charging a relatively high price to increase his margin was still not an option.

Across the entire interviewee sample, the articulation of cost-related considerations was most frequent among those who also reported having had some commercial interest early in the innovation process. Apparently, development effort matters more if there is at least some vague hope to eventually make a living from game development down the road.

Concerning *perceived quality* as a price determining factor, 22 of the 29 respondents emphasized aligning the price with the fun and quality playtime provided by their game. To assess the monetary equivalent of the total entertainment benefit, developers asked themselves and friends how much they would be willing to pay. They put much thought into which price would be considered fair by buyers, showing interest in achieving a positive perception among their user peers. Unsurprisingly, 23 of the 29 respondents reported seeing potential buyers of their game as their equals rather than as transaction partners.

Three games developed by the respondents were outliers in that they showed an unfavorable price-quality ratio. They originated from the small subsample of hobbyists who reported strong initial commercialization aspirations. They all saw their game release as a training field for game development and testing to learn about the Steam marketplace. Conversely, the nine top-rated games in our sample were all developed by respondents with high and long-term personal involvement in the innovation process. These consumers emphasized how important it was for them to share a reliable and entertaining game with fellow gamers.

In line with the theoretical reasoning, *competitive-intensity-related considerations* are present in consumer innovators' price-setting: in the open-ended questions, 18 of the 29 developers reported having considered similar games when setting prices. As proposed in the development of H4 and in alignment with the quantitative results, no respondent reported having tried to escape the price implications of competitive intensity by strengthening their game's perceived uniqueness. Six respondents explicitly stated that they had conducted no promotion or marketing activities to differentiate their game from those of competitors. Overall, the interview and survey responses suggest that the consumer innovators in fact strongly acknowledge the need to adapt their prices to the competitive intensity.

This observation seems inconsistent with the lack of statistical support for H4 in the quantitative study. After all, this non-finding suggests that innovating consumers did not have a higher inclination to adapt prices to competitive intensity than their firm counterparts. This apparent inconsistency is resolved by looking closely at how consumer innovators specifically evaluate the competitive intensity. Different to our expectations, most respondents stated that they did little market scanning when assessing competitive intensity. They hardly considered the number of potential substitutes after conducting a systematic competition analysis. Rather, they scanned a limited convenience sample of games they considered similar. These references are used as competition anchor. Apparently competitive intensity is assessed by using simple heuristics. Further, some respondents explained that scanning the marketplace for all

available offers that buyers may consider as substitutes to their own game is not at all straightforward. As noted earlier, computer games are not evaluated along a clear set of functional attributes that are likely to be rated in a similar way by most buyers. They are rather characterized by experience and emotional attributes whose evaluation can differ across buyers. This complicates the identification of games that are regarded by customers as competition or substitutes. Thus, the nonsignificant interaction effect may be attributed to the fact that a high readiness of consumers to adjust prices to competitive intensity is countervailed by an underestimation of the actual number of potential substitutes.

<<INSERT TABLE 6 ABOUT HERE>>

5. Discussion

The establishment of online marketplaces in a wide range of product categories has created multiple opportunities for consumers to commercialize their self-developed innovations (Wolf and McQuitty, 2011; Crogan, 2018). An increasing number of innovators from the household sector is using these low-cost commercialization channels (Whitson et al., 2018). We sought to enrich the understanding of one key aspect of the market behaviors of these hobbyist or amateur developers by comparing their pricing decisions to firms' pricing.

The main quantitative study drew on an original dataset of computer games published on Steam. The results document that consumer innovators charge lower prices than firms for games of similar size and perceived quality (H1). We also found that consumer innovators and firms respond differently to key determinants of pricing. Specifically, consumer innovators related prices less strongly to the development

costs than firms, while consumers' prices, compared to firms', were stronger linked to perceived quality measured by the after-launch user ratings of the games (H2 and H3).

The qualitative research provides convergent evidence for the motivational accounts that guided the quantitative phase of this research. Consumer innovators' pricing decisions are largely explainable by non-economic motivations. The interview results illustrated that development costs did not strongly translate into prices, because the consumer innovators incurred low monetary expenditures. Even more importantly, the respondents did not assess their invested free time as (opportunity) costs that need to be monetarily compensated. The consumer innovators also confirmed that their origins as users made them very aware of price fairness, which prompted them to set prices that mirrored their games' perceived quality.

The qualitative research results also helped us to interpret the lack of support for H4, according to which consumer innovators should adapt their prices more to competitive intensity than their firm counterparts. The qualitative results illustrated that most consumer innovators in fact did consider similar games that had been released on Steam. Many consumer innovators in our sample were aware that, considering their limited resources, they could hardly expect to escape competitive price pressure with alternative marketing. However, when thinking about appropriate prices, consumer innovators tended to limit their attention to an idiosyncratic small set of comparable games they knew about. Thus, the consumers accounted for competitive intensity, but in truncated, over-simplified ways. Our measure of competitive intensity on the other hand implicitly assumed that consumers engage in a systematic and complete scan of potential substitutes, failing to quantitatively capture their effort.

5.1 Theoretical implications

Our study contributes to the research on the sources of innovation by linking it to extant research on pricing and price determinants. The user and free innovation literatures have provided abundant theoretical insights and empirical results on innovation generation (von Hippel, 2005, 2017; Raasch and von Hippel,

2013b; Stock et al., 2015). By investigating consumers who decided to bring their innovations to market, we shifted the focus towards the exploitation of innovations. Our results provide first support that the same motivational structure that triggers the creation of consumer innovations also affects their commercialization. Thus, one does not need an entirely new set of theoretical lenses to explain consumer innovators' behaviors in marketplaces.

The results presented here also extend our understanding of the early activities of non-firm entrepreneurs (Carter et al., 2003). We responded to calls for more research on user entrepreneurs as a distinct group of entrepreneurial actors (Oo et al., 2018). We have provided evidence that their original role as consumers and users manifests in distinct entrepreneurial decisions. Overall, this research suggests that it is fruitful to extend attention beyond the motivation for monetary gain when seeking to explain decisions relating to opportunity exploitation and value capturing (Fauchart and Gruber, 2011). For instance, our study may stimulate more research into how non-firm entrepreneurs handle potential trade-offs between economic and non-economic considerations when exploiting business opportunities (Shepherd et al., 2015).

Our paper also informs research on consumer innovators' impacts on market dynamics and welfare. Research has indicated that a growing proportion of non-firm innovators on markets positively impacts welfare, product quality, and customer satisfaction (Boudreau, 2018; Halbinger, 2018). The positive effects are mainly explained by a higher variety of available product alternatives (Boudreau and Jeppesen, 2015; Gambardella et al., 2017; Boudreau, 2018). Our study suggests product prices as an additional avenue via which commercially active consumer innovators affect markets. In the quantitative study, we found that the prices of consumer-generated innovations were lower than those of the comparable firm-developed products of similar size and perceived quality. This suggests that the market entry of innovating consumers enables buyers to satisfy their needs at a lower sacrifice. The findings of the qualitative research indicate that the higher rents on the buyers' side did not come at the expense of lower benefits on the side

of the consumer innovators. In sum, we have provided a first and preliminary indication that the increasing number of consumer innovators who sell on marketplaces is associated with a positive total welfare effect.

5.2 Practical implications

Firms face an increasing number of hobbyists, amateurs, or users that are entering markets with self-developed products. As witnessed in open source software development before, consumers who progressively use commercial channels to diffuse their innovations foreshadow a massive transformation of leisure activities into commercially viable work (Fitzgerald, 2006). This first investigation of their marketing behaviors proved that consumer innovators to some extent do not play by the same rules as firms usually do. The results suggest that commercially active consumers are willing and able to undercut firm prices by deliberately investing their discretionary time for personal self-rewards and community-related benefits instead of monetary returns. This may pose an even stronger threat to the financial success of firms than the existence of free innovation. After all, commercialized consumer innovations are uploaded to the same platforms and are presented similarly to firm-generated products. An increasing number of consumer innovations who put low price tags on workable products can put pressure on firms to lower their prices. Boudreau (2018) found at least weak evidence for a downward pressure on prices by showing that professional developers charge slightly lower prices for top apps after a large number of amateurs had entered the market. However, our results strongly suggest that engaging in price competition will not pay off for firms, since price reductions are likely to be mirrored by consumer innovators, who do not have to consider a cost-based price floor. Rather, product differentiation (e.g. organizing competitions and events for their games) and/or collaborating with innovating consumers (e.g. taking the role of publishers of consumer games) seem to be the more promising routes. Overall, our research results call for a careful consideration of appropriate reactions by firms.

5.3 Limitations and future research

Our results may be influenced by the specific empirical context. For instance, the cost structures of digital products are very different to those of manufactured goods (Huang and Sundararajan, 2010; Jones and Mendelson, 2011). Fixed costs mainly consist of development costs and are therefore sunk. Variable production and diffusion costs are close to zero. These conditions may enhance consumer innovators' inclination and ability to charge lower prices and to relax the link between development costs and prices. Future work should explore whether the presented evidence is generalizable beyond computer games and the area of digital products.

The theoretical explanations of this study are based on innovation-related motivations. Although the findings of our qualitative study provided clear support for the key role of self-rewards for consumers' pricing decisions, notably, the motivations of consumers and firms have neither been quantified nor purposefully varied. We are aware that we cannot completely rule out all alternative explanations for the pricing outcomes found in this study. Further research could employ large-scale surveys of commercially active consumer innovators to collect more statistical evidence on how innovation-related motivations correlate with marketing and sales decisions. An alternative approach is the intentional alteration or manipulation of the sources of self-rewards in experimental studies.

When comparing pricing decisions between firms and consumer innovators, we did not embrace the full heterogeneity that exists within these two vendor groups. The firms differ regarding size, development stage, firm culture, strategic focus, available capital, and financial performance. The consumer innovators are diverse regarding dominating values, goals, expertise, and (social) capital (Stock et al., 2014; Pongtanalert and Ogawa, 2015). The many names used in the literature for non-firm innovators indicates this heterogeneity (e.g. amateurs, hobbyists, tinkerers, fanatics, DIYers, hackers, users). Developing a more fine-grained classification of consumer innovators is likely to bear considerable potential for intriguing insights. For instance, by looking closely at our interviewees' commercial aspirations in the qualitative study, we could see indications of the existence of two different groups: a large group of part-

time hobbyist opportunistic sellers, who do not plan to turn their hobby into a professional business, and a smaller group of aspiring entrepreneurs, who accidentally find themselves on their way to the creation of a company. In future studies, researchers may want to compare the decisions of hobbyist sellers and nascent entrepreneurs. This could enrich the understanding of the early stages of the entrepreneurship process.

As pointed out before, our findings indicate interesting implications for market dynamics and welfare. However, we acknowledge that our data did not allow to measure changes in the average customer surplus, nor could we track the price dynamics stimulated by the entry of consumer innovators. Similarly, we did not explore the relationship between pricing and market success. The findings of this research could stimulate scholars to quantify the direct effects of prices on consumer innovations' market performance. For example, since prices serve as proxies for quality inferences, low prices might have a detrimental impact on the success of consumer innovations.

Another welfare-related aspect we did not explore is a potential crowding-out effect that higher numbers of commercialized consumer innovations may have on free innovations. The most evident consequence is that adopters increasingly need to pay for products they otherwise may have received for free. Crowding-out may also have drastic effects on communities in which, so far, open licenses, free revealing, and mutual support have prevailed to date (West and Gallagher, 2006).

With valid estimations of the multiple welfare effects at hand, researchers could explore whether and under which conditions the welfare-enhancing effects mitigate or even outweigh negative consequences associated with an increasing market participation by consumer innovators. We trust that our findings will motivate further research into consumer-innovators' marketing decisions in different empirical settings.

Appendix: Supplementary material can be found in the online version of this article at:
<< INSERT DOI HERE >>

5. References

- Agarwal, R., Shah, S.K., 2014. Knowledge sources of entrepreneurship: Firm formation by academic, user and employee innovators. *Res. Policy* 43, 1109–1133.
- Alba, J.W., Williams, E.F., 2013. Pleasure principles: A review of research on hedonic consumption. *J. Consum. Psychol.* 23, 2–18.
- Autio, E., Dahlander, L., Frederiksen, L., 2013. Information Exposure, Opportunity Evaluation, and Entrepreneurial Action: An Investigation of an Online User Community. *Acad. Manage. J.* 56, 1348–1371.
- Autio, E., Kenney, M., Mustar, P., Siegel, D., Wright, M., 2014. Entrepreneurial innovation: The importance of context. *Res. Policy* 43, 1097–1108.
- Baldwin, C., Hienert, C., von Hippel, E., 2006. How user innovations become commercial products: A theoretical investigation and case study. *Res. Policy* 35, 1291–1313.
- Baldwin, C., von Hippel, E., 2011. Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation. *Organ. Sci.* 22, 1399–1417.
- Benkler, Y., 2006. *The wealth of networks: how social production transforms markets and freedom.* Yale University Press, New Haven [Conn.].
- Boehm, B.W., Papaccio, P.N., 1988. Understanding and Controlling Software Costs. *IEEE Trans. Softw. Eng.* 14, 1462–1477.
- Bogers, M., Afuah, A., Bastian, B., 2010. Users as Innovators: A Review, Critique, and Future Research Directions. *J. Manag.* 36, 857–875.
- Bolton, L., Warlop, L., Alba, J., 2003. Consumer Perceptions of Price (Un)Fairness. *J. Consum. Res.* 29, 474–91.
- Boudreau, K., 2018. *Amateurs Crowds & Professional Entrepreneurs as Platform Complementors (No. w24512).* National Bureau of Economic Research, Cambridge, MA.
- Boudreau, K.J., Jeppesen, L.B., 2015. Unpaid crowd complementors: The platform network effect mirage. *Strateg. Manag. J.* 36, 1761–1777.
- Bowman, C., Ambrosini, V., 2000. Value Creation Versus Value Capture: Towards a Coherent Definition of Value in Strategy. *Br. J. Manag.* 11, 1–15.
- Brazauskas, R., Logan, B.R., 2016. Observational Studies: Matching or Regression? *Biol. Blood Marrow Transplant.* 22, 557–563.
- Burger-Helmchen, T., 2008. *Are Users the Next Entrepreneurs? A Case Study on the Video Game Industry.* SSRN Electron. J.
- Burkert, M., Ivens, B.S., Henneberg, S., Schradi, P., 2017. Organizing for value appropriation: Configurations and performance outcomes of price management. *Ind. Mark. Manag.* 61, 194–209.
- Burroughs, J.E., Rindfleisch, A., 2002. Materialism and Well-Being: A Conflicting Values Perspective. *J. Consum. Res.* 29, 348–370.
- Cachon, G.P., Swinney, R., 2008. Purchasing, Pricing, and Quick Response in the Presence of Strategic Consumers. *Manag. Sci.* 55, 497–511.
- Campbell, M., 1999. Perceptions of Price Unfairness: Antecedents and Consequences. *J. Mark. Res.* 36.
- Carter, N.M., Gartner, W.B., Shaver, K.G., Gatewood, E.J., 2003. The career reasons of nascent entrepreneurs. *J. Bus. Ventur.* 18, 13–39.
- Castro, F.G., Kellison, J.G., Boyd, S.J., Kopak, A., 2010. *A Methodology for Conducting Integrative Mixed*

Methods Research and Data Analyses. *J. Mix. Methods Res.* 4, 342–360.

- Cialdini, R.B., Eisenberg, N., Green, B.L., Rhoads, K., Bator, R., 1998. Undermining the Undermining Effect of Reward on Sustained Interest. *J. Appl. Soc. Psychol.* 28, 249–263.
- Claussen, J., Halbinger, M.A., 2020. The role of pre-innovation platform activity for diffusion success: Evidence from consumer innovations on a 3D printing platform. *Res. Policy*.
- Creswell, J., Clark, V., Gutmann, M., Hanson, W., 2003. Advance Mixed methods Research Designs, in: *Handbook of Mixed Methods in Social and Behavioral Research*. pp. 209–240.
- Creswell, J.W., Plano Clark, V.L., 2018. *Designing and conducting mixed methods research*, Third Edition. ed. SAGE, Los Angeles.
- Croghan, P., 2018. Indie Dreams: Video Games, Creative Economy, and the Hyperindustrial Epoch. *Games Cult.* 13, 671–689.
- Csikszentmihalyi, M., 2000. *FLOW: The Psychology of Optimal Experience*. Harper Row 6.
- Curry, D.J., Riesz, P.C., 1988. Prices and Price/Quality Relationships: A Longitudinal Analysis. *J. Mark.* 52, 36–51.
- Day, G., Montgomery, D., 1999. Charting New Directions for Marketing. *J. Mark.* 63, 3–13.
- de Jong, J.P.J., 2016. The importance of measuring household sector innovation - OECD Blue Sky Paper.
- Diamantopoulos, A., 1995. Pricing, in: *Marketing Theory and Practice*. Macmillan Education UK, London, pp. 182–197.
- Dufwenberg, M., Gneezy, U., 2000. Price competition and market concentration: an experimental study. *Int. J. Ind. Organ.* 18, 7–22.
- El-Ansary, A.I., 2006. Marketing strategy: taxonomy and frameworks. *Eur. Bus. Rev.* 18, 266–293.
- ESA, E., 2010. *European System of National and Regional Accounts - Paragraph 2.118*.
- Fauchart, E., Gruber, M., 2011. Darwinians, Communitarians, and Missionaries: The Role of Founder Identity in Entrepreneurship. *Acad. Manage. J.* 54, 935–957.
- Fitzgerald, B., 2006. The Transformation of Open Source Software. *MIS Q.* 30, 587–598.
- Gambardella, A., Raasch, C., von Hippel, E., 2017. The User Innovation Paradigm: Impacts on Markets and Welfare. *Manag. Sci.* 63, 1450–1468.
- Gault, F., 2018. Defining and measuring innovation in all sectors of the economy. *Res. Policy* 47, 617–622.
- Geylani, T., Dukes, A.J., Srinivasan, K., 2007. Strategic Manufacturer Response to a Dominant Retailer. *Mark. Sci.* 26, 164–178.
- Haefliger, S., Jäger, P., von Krogh, G., 2010. Under the radar: Industry entry by user entrepreneurs. *Res. Policy* 39, 1198–1213.
- Halbinger, M.A., 2018. The role of makerspaces in supporting consumer innovation and diffusion: An empirical analysis. *Res. Policy* 47, 2028–2036.
- Hall, S., Walsh, M., Yates, A., 1997. How do UK companies set prices? (Bank of England working paper). Bank of England.
- Halpern, J.J., 1997. Elements of a Script for Friendship in Transactions. *J. Confl. Resolut.* 41, 835–868.
- Harhoff, D., Henkel, J., von Hippel, E., 2003. Profiting from voluntary information spillovers: how users benefit by freely revealing their innovations. *Res. Policy* 32, 1753–1769.
- Hars, A., Ou, S., 2002. Working for Free? Motivations for Participating in Open-Source Projects. *Int. J. Electron. Commer.* 6, 25–39.

- Hau, Y.S., Kim, Y.-G., 2011. Why would online gamers share their innovation-conducive knowledge in the online game user community? Integrating individual motivations and social capital perspectives. *Comput. Hum. Behav.* 27, 956–970.
- Hertel, G., Niedner, S., Herrmann, S., 2003. Motivation of software developers in Open Source projects: an Internet-based survey of contributors to the Linux kernel. *Res. Policy* 32, 1159–1177.
- Hienert, C., 2006. The commercialization of user innovations: the development of the rodeo kayak industry. *RD Manag.* 36, 273–294.
- Hienert, C., von Hippel, E., Berg Jensen, M., 2014. User community vs. producer innovation development efficiency: A first empirical study. *Res. Policy* 43, 190–201.
- Hinterhuber, A., 2004. Towards value-based pricing—An integrative framework for decision making. *Ind. Mark. Manag.* 33, 765–778.
- Hinterhuber, A., 2008. Customer value-based pricing strategies: why companies resist. *J. Bus. Strategy* 29, 41–50.
- Hinterhuber, A., Liozu, S.M., 2019. *Pricing Strategy Implementation: Translating Pricing Strategy into Results.* Routledge.
- Hitlin, S., Piliavin, J.A., 2004. Values: Reviving a Dormant Concept. *Annu. Rev. Sociol.* 30, 359–393.
- Homburg, C., Jensen, O., Hahn, A., 2012. How to Organize Pricing? Vertical Delegation and Horizontal Dispersion of Pricing Authority. *J. Mark.* 76, 49–69.
- Huang, K.-W., Sundararajan, A., 2010. Pricing Digital Goods: Discontinuous Costs and Shared Infrastructure. *Inf. Syst. Res.*
- Ingenbleek, P., Debruyne, M., Frambach, R.T., Verhallen, T.M.M., 2003. Successful New Product Pricing Practices: A Contingency Approach. *Mark. Lett.* 14, 289–305.
- Ingenbleek, P.T.M., Frambach, R.T., Verhallen, T.M.M., 2010. The Role of Value-Informed Pricing in Market-Oriented Product Innovation Management. *J. Prod. Innov. Manag.* 27, 1032–1046.
- Jeppesen, L.B., Frederiksen, L., 2006. Why Do Users Contribute to Firm-Hosted User Communities? The Case of Computer-Controlled Music Instruments. *Organ. Sci.* 17, 45–63.
- Johnson, R.B., Onwuegbuzie, A.J., Turner, L.A., 2007. Toward a Definition of Mixed Methods Research. *J. Mix. Methods Res.* 1, 112–133.
- Jones, R., Mendelson, H., 2011. Information Goods vs. Industrial Goods: Cost Structure and Competition. *Manag. Sci.* 57, 164–176.
- Jørgensen, M., 2004. A review of studies on expert estimation of software development effort. *J. Syst. Softw.* 70, 37–60.
- Kahneman, D., Knetsch, J.L., Thaler, R., 1986. Fairness as a Constraint on Profit Seeking: Entitlements in the Market. *Am. Econ. Rev.* 76, 728–741.
- Kasser, T., Ryan, R.M., Zax, M., Sameroff, A.J., 1995. The relations of maternal and social environments to late adolescents' materialistic and prosocial values. *Dev. Psychol.* 31, 907–914.
- Kathan, W., Hutter, K., Füller, J., Hautz, J., 2015. Reciprocity vs. Free-Riding in Innovation Contest Communities. *Creat. Innov. Manag.* 24, 537–549.
- Kienzler, M., 2018. Value-based pricing and cognitive biases: An overview for business markets. *Ind. Mark. Manag.* 68, 86–94.
- Kienzler, M., Kowalkowski, C., 2017. Pricing strategy: A review of 22 years of marketing research. *J. Bus. Res.* 78, 101–110.
- Koster, R., 2005. *Moore's Wall: Technology Advances and Online Game Design.*

- Koster, R., 2018. The Cost of Games [WWW Document]. Gamasutra - Art Bus. Mak. Games. URL https://www.gamasutra.com/blogs/RaphKoster/20180117/313211/The_cost_of_games.php (accessed 7.9.18).
- Kuznetsov, A., Paulos, E., 2010. Rise of the expert amateur: DIY projects, communities, and cultures, in: NordiCHI 2010: Extending Boundaries - Proceedings of the 6th Nordic Conference on Human-Computer Interaction. pp. 295–304.
- Lakhani, K.R., Wolf, R.G., 2003. Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects (SSRN Scholarly Paper No. ID 443040). Social Science Research Network, Rochester, NY.
- Larson, R.B., 2019. Promoting demand-based pricing. *J. Revenue Pricing Manag.* 18, 42–51.
- Leuthesser, L., Kohli, C.S., 1993. Product Positioning: A Comparison of Perceptual Mapping Techniques. *J. Prod. Brand Manag.* 2, 10–19.
- Li, X., Hitt, L.M., 2010. Price Effects in Online Product Reviews: An Analytical Model and Empirical Analysis. *MIS Q.* 34, 809–831.
- Lin, D., Bezemer, C.-P., Hassan, A.E., 2018. An empirical study of early access games on the Steam platform. *Empir. Softw. Eng.* 23, 771–799.
- Liozu, S., Hinterhuber, A., Somers, T., 2014. Organizational design and pricing capabilities for superior firm performance. *Manag. Decis.* 52, 54–78.
- Liozu, S.M., Hinterhuber, A., 2013. Pricing orientation, pricing capabilities, and firm performance. *Manag. Decis.* 51, 594–614.
- Liozu, S.M., Hinterhuber, A., Perelli, S., Boland, R., 2012. Mindful pricing: transforming organizations through value-based pricing. *J. Strateg. Mark.* 20, 197–209.
- Liu, H., 2010. Dynamics of Pricing in the Video Game Console Market: Skimming or Penetration? *J. Mark. Res.* 47, 428–443.
- Lumley, T., Diehr, P., Emerson, S., Chen, L., 2002. The Importance of the Normality Assumption in Large Public Health Data Sets. *Annu. Rev. Public Health* 23, 151–169.
- Lüthje, C., 2004. Characteristics of innovating users in a consumer goods field. *Technovation* 24, 683–695.
- Lüthje, C., Herstatt, C., von Hippel, E., 2005. User-innovators and “local” information: The case of mountain biking. *Res. Policy* 34, 951–965.
- Lüthje, C., Stockstrom, C., 2016. Cost Advantages in Innovation - A Comparison of Users and Manufacturers, in: *Revolutionizing Innovation*.
- Mandel, D.R., 2006. Economic transactions among friends: Asymmetric generosity but not agreement in buyers’ and sellers’ offers. *J. Confl. Resolut.* 50, 584–606.
- Markman, G., Waldron, T., 2013. Small Entrants and Large Incumbents: A Framework of Micro Entry. *Acad. Manag. Perspect.* 28.
- Maxwell, S., 2002. Rule-based price fairness and its effect on willingness to purchase q. *J. Econ. Psychol.* 22.
- Mendes-Da-Silva, W., De Brito, T.F.S., Fama, R., Liljegren, J.T., 2008. Effects of Friendship in Transactions in an Emerging Market: Empirical Evidence from Brazil (SSRN Scholarly Paper No. ID 1084249). Social Science Research Network, Rochester, NY.
- Mislick, G.K., Nussbaum, D.A., 2015. Software Cost Estimation, in: *Cost Estimation*. John Wiley & Sons, Inc, Hoboken, NJ, USA, pp. 257–269.
- Morgan, D.L., 2017. Integrating qualitative and quantitative methods: a pragmatic approach.
- Nagle, T.T., Müller, G., 2018. The strategy and tactics of pricing: a guide to growing more profitability, Sixth

edition. ed. Routledge, New York London.

- Nair, H., 2007. Intertemporal price discrimination with forward-looking consumers: Application to the US market for console video-games. *Quant. Mark. Econ. QME* 5, 239–292.
- OECD, 2018. Oslo Manual 2018 - Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities. OECD.
- Ohmae, K., 1982. *The mind of the strategist: the art of Japanese business*. McGraw-Hill, New York.
- Oo, P.P., Allison, T.H., Sahaym, A., Juasrikul, S., 2018. User entrepreneurs' multiple identities and crowdfunding performance: Effects through product innovativeness, perceived passion, and need similarity. *J. Bus. Ventur.*
- Parasuraman, A., Zeithaml, V.A., Berry, L.L., 1988. SERVQUAL: A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. *J. Retail.* 64, 30.
- Pongtanalert, K., Ogawa, S., 2015. Classifying user-innovators – An approach to utilize user-innovator asset. *J. Eng. Technol. Manag.* 37, 32–39.
- Priem, R., 2007. A Consumer Perspective on Value Creation. *Acad. Manag. Rev. Priem Butl.* 32, 219–235.
- Raasch, C., von Hippel, E., 2013a. Innovation process benefits: the journey as reward. *MIT Sloan Manag. Rev.* 55, 33.
- Raasch, C., von Hippel, E.A., 2013b. Innovation Effort as “Productive Consumption:” The Power of Participation Benefits to Amplify Innovation (SSRN Scholarly Paper No. ID 2167948). Social Science Research Network, Rochester, NY.
- Riggs, W., von Hippel, E., 1994. Incentives to innovate and the sources of innovation: the case of scientific instruments. *Res. Policy* 23, 459–469.
- Roszkowska-Menkes, M., 2017. User Innovation: State of the Art and Perspectives for Future Research. *J. Entrep. Manag. Innov.* 13, 127–154.
- Rubin, D.B., 1979. Using Multivariate Matched Sampling and Regression Adjustment to Control Bias in Observational Studies. *J. Am. Stat. Assoc.* 74, 318–328.
- Shah, S.K., Tripsas, M., 2007. The accidental entrepreneur: the emergent and collective process of user entrepreneurship. *Strateg. Entrep. J.* 1, 123–140.
- Shah, S.K., Tripsas, M., 2012. When Do User Innovators Start Firms? A Theory of User Entrepreneurship (SSRN Scholarly Paper No. ID 2016384). Social Science Research Network, Rochester, NY.
- Shane, S., Venkataraman, S., 2000. The Promise of Entrepreneurship as a Field of Research. *Acad. Manage. Rev.* 25, 217–226.
- Shepherd, D.A., Williams, T.A., Patzelt, H., 2015. Thinking About Entrepreneurial Decision Making: Review and Research Agenda. *J. Manag.* 41, 11–46.
- Shipley, D., Jobber, D., 2001. Integrative Pricing via the Pricing Wheel. *Ind. Mark. Manag.* 30, 301–314.
- Sifa, R., Bauckhage, C., Drachen, A., 2014. The Playtime Principle: Large-scale cross-games interest modeling, in: 2014 IEEE Conference on Computational Intelligence and Games. pp. 1–8.
- Stahlbrost, A., Kareborn, B.B., 2011. Exploring users motivation in innovation communities. *Int. J. Entrep. Innov. Manag.* 14, 298.
- Stock, R.M., Oliveira, P., von Hippel, E., 2015. Impacts of Hedonic and Utilitarian User Motives on the Innovativeness of User-Developed Solutions. *J. Prod. Innov. Manag.* 32, 389–403.
- Stock, R.M., von Hippel, E., Gillert, N.L., 2014. Impacts of Personality Traits on Consumer Innovation Success (SSRN Scholarly Paper No. ID 2467152). Social Science Research Network, Rochester, NY.

- Stylidis, K., Wickman, C., Söderberg, R., 2020. Perceived quality of products: a framework and attributes ranking method. *J. Eng. Des.* 31, 37–67.
- Tellis, G., 1986. Beyond the Many Faces of Price: An Integration of Pricing Strategies. *J. Mark.* 50.
- Töytäri, P., Rajala, R., Alejandro, T.B., 2015. Organizational and institutional barriers to value-based pricing in industrial relationships. *Ind. Mark. Manag.* 47, 53–64.
- Uzzi, B., 1997. Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. *Adm. Sci. Q.* 42, 35–67.
- Vallerand, R.J., 1997. Toward A Hierarchical Model of Intrinsic and Extrinsic Motivation, in: *Advances in Experimental Social Psychology*. Elsevier, pp. 271–360.
- von Hippel, E., 2005. *Democratizing innovation*. MIT Press, Cambridge, Mass.
- von Hippel, E., 2017. *Free innovation*. The MIT Press, Cambridge, MA.
- von Hippel, E., von Krogh, G., 2006. Free revealing and the private-collective model for innovation incentives. *RD Manag.* 36, 295–306.
- West, J., Gallagher, S., 2006. Challenges of open innovation: the paradox of firm investment in open-source software. *RD Manag.* 36, 319–331.
- Whitson, J.R., Simon, B., Parker, F., 2018. The Missing Producer: Rethinking indie cultural production in terms of entrepreneurship, relational labour, and sustainability. *Eur. J. Cult. Stud.* 22.
- Wolf, M., McQuitty, S., 2011. Understanding the do-it-yourself consumer: DIY motivations and outcomes. *AMS Rev.* 1, 154–170.
- Woodruff, R.B., 1997. Customer value: The next source for competitive advantage. *J. Acad. Mark. Sci.* 25, 139.
- Xia, L., Monroe, K.B., Cox, J.L., 2004. The Price is Unfair! A Conceptual Framework of Price Fairness Perceptions. *J. Mark.* 68, 1–15.
- Zeithaml, V.A., 1988. Consumer Perceptions of Price, Quality, and Value: A Means-End Model and Synthesis of Evidence. *J. Mark.* 52, 2.

Table 1

Group comparisons between firm-developed and consumer-developed games in the sample of matched-pairs (file size and user ratings as matching criteria; n = 4,242).

Variable	<i>Firm (n = 2,121)</i>		<i>Consumer (n = 2,121)</i>		<i>t-test between groups</i>		
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>
First undiscounted price (US-cents)	1270.11	1025.31	863.50	689.80	15.153	3712.8	<0.001
Perceived quality (ratings 0 to100)	76.94	17.66	76.32	19.06	1.1055	4215.3	0.269
Development effort (MB)	2269.54	3289.14	2198.66	3343.64	0.6961	4238.9	0.486
Competitive intensity (# of similar games)	24.88	60.04	45.17	84.10	-9.044	3835.3	<0.001
Commercialization effort 1 (# of screenshots)	10.69	6.25	9.98	5.87	3.783	4223.4	<0.001
Commercialization effort 2 (# of languages)	3.76	4.01	3.32	4.70	3.255	4139.2	0.001
Median playtime (minutes)	239.52	493.87	202.95	417.31	2.605	4125.1	0.009
Developer experience (# of previous games)	3.88	5.30	1.92	2.10	15.841	2765.7	<0.001

Notes: The results of a Welch t-test per variable between the groups are reported in the columns t, df and p. For genres see Appendix A5.

Table 2*Descriptive statistics and correlation matrix (n = 4,239).*

Variables	Mean	SD	Min.	Max.	1	2	3	4	5	6	7
1 First undiscounted price (US cents)	1066.14	897.03	59	19999							
2 Perceived quality (ratings 0 to 100)	76.62	18.37	5	100	-.01						
3 Development effort (MB)	2235.30	3317.16	10	59000	.41**	-.13**					
4 Competitive intensity (# of similar games)	35.05	73.78	0	463	-.20**	-.08**	-.06**				
5 Commercialization effort 1 (# screenshots)	10.34	6.07	2	76	.24**	-.07**	.15**	-.14**			
6 Commercialization effort 2 (# languages)	3.54	4.37	1	27	.07**	.06**	.04**	-.08**	.03		
7 Median playtime (minutes)	221.18	457.61	1	10595	.22**	.03*	.04**	.00	.03	.01	
8 Developer experience (# previous games)	2.90	4.15	1	39	.09**	-.00	-.01	-.02	-.02	.05**	.09**

*Notes: * p < .05. ** p < .01.*

Table 3*OLS regression models of computer games' prices.*

<i>Dependent variable:</i>	Initial undiscounted price (US cents)			
	(1)	(2)	(3)	(4)
Constant	2,105.424*** (585.751)	1,774.777** (646.872)	1,840.055** (666.637)	1,960.562** (686.250)
Development effort		0.104*** (0.008)	0.102*** (0.008)	0.123*** (0.010)
Perceived quality		2.696*** (0.756)	2.461** (0.748)	0.772 (1.305)
Competitive intensity		-1.424*** (0.116)	-1.353*** (0.113)	-1.549*** (0.212)
Consumer (vs. firm producer)			-277.099*** (23.012)	-429.747*** (128.553)
Consumer x development effort				-0.040** (0.014)
Consumer x perceived quality				3.028* (1.482)
Consumer x competitive intensity				0.304 (0.236)
Release years	y	y	y	y
Commercialization effort 1: # of languages	12.587*** (3.233)	7.097** (2.653)	5.941* (2.528)	4.316+ (2.474)
Commercialization effort 2: # of screenshots	29.582*** (2.976)	19.516*** (3.036)	19.316*** (3.002)	19.365*** (2.953)
Developer experience	19.645*** (4.307)	19.096*** (3.375)	12.216*** (3.382)	11.723*** (3.284)
Median playtime	0.383*** (0.088)	0.354*** (0.082)	0.343*** (0.079)	0.339*** (0.077)
Genre: Action and adventure	-2.509 (35.671)	-35.653 (31.185)	-26.881 (30.516)	-18.019 (30.609)
Genre: Adventure	-61.371+ (34.319)	-63.046* (30.320)	-49.197 (30.021)	-45.490 (29.906)
Genre: Casual game	-366.304*** (61.030)	-285.652*** (60.523)	-268.593*** (60.101)	-266.230*** (58.140)
Genre: Role playing game	5.525 (49.978)	13.332 (45.476)	14.164 (45.512)	15.362 (46.264)
Genre: Simulation	317.937*** (58.716)	283.784*** (51.818)	254.799*** (51.275)	257.523*** (51.200)
Genre: Sports and racing	363.251** (135.588)	215.996+ (115.190)	200.466+ (113.047)	178.284 (112.156)
Genre: Strategy	68.172 (58.868)	129.034* (55.126)	132.400* (53.708)	131.748* (53.444)
Observations	4,239	4,239	4,239	4,239
R ²	0.161	0.315	0.335	0.342
Adjusted R ²	0.156	0.311	0.330	0.337
Residual standard error	824.104 (df = 4214)	744.553 (df = 4211)	734.000 (df = 4210)	730.429 (df = 4207)

F statistic	33.633*** (df = 24; 4214)	71.870*** (df = 27; 4211)	75.701*** (df = 28; 4210)	70.474*** (df = 31; 4207)
-------------	------------------------------	------------------------------	------------------------------	------------------------------

Notes:

*** p<0.001; ** p<0.01; * p < 0.05; + p < 0.10

Unstandardized coefficients are shown. Huber-White robust standard errors are in brackets (Lumley et al., 2002). Release years are integrated as categorical control variables, indicated by 'y'(es) in the table, but not individually reported for reasons of comprehensibility.

Table 4

Innovation-related motivations reported in semi-structured interviews.

Type of motivation	Respondents (n=29)
Create something they want to play themselves	24
Process enjoyment	25
Achieve or improve (game) development skills	15
Commercial interest	9

Table 5

Exemplary consumer innovator quotes on motivation and commercialization decision.

Functional role and innovation-related motivations
<i>Consumers deciding to sell their innovations to others start their innovation work as users. The decision to innovate is primarily triggered by the expectation of nonpecuniary self-rewards (e.g. own use, enjoyment, learning). In this, they resemble free innovators.</i>
“When we [brothers] started it was a hobby and we both had full time jobs that paid [...] living so this was on nights and weekends only” – Aw
“I wanted to play it [the game], but I couldn’t, because it didn’t exist yet.” – Ed
“We [married couple] have kids, and we were playing with them with real wooden pieces, having lots of fun. The problem is, pieces and space are limited. That is why the project came to life.” – Dd
“I did a game I like myself. [...] to learn something new (C# and Unity).” – Ps
“If I had a recipe for a million-dollar game that I don't feel excited about, I wouldn't do it.” – Mc
“Making games has become my hobby. This is extremely exciting and fun. Besides, it is a suitable way for me to express myself creatively.” – Yk
Decision to sell the game
<i>The expectation of economic returns is not a key motivator. The idea to sell the innovation for a price often arises in later stages of the innovation process. Consumers are often stimulated by others to exploit a commercialization opportunity.</i>
“Selling was never a focus. [...] The] main reason not to give it away for free - because we [classmates] didn't want to give the impression that it's worthless.” – Vk
“I especially enjoy developing games. That the game on Steam made some money is an extra bonus.” – Oa
“If I had a recipe for a million-dollar game that I don't feel excited about, I wouldn't do it.” – Mc
“I honestly felt a little guilty [charging a price] because this is what I’d be doing for fun anyway. – Ed
“Versions of that game were published on a small indie website for free. One day I set a very small and not mandatory price on it to see what would happen.” – Mc
“People started telling us [...] it is so good, we should charge for it. We were like ‘oh I don't know..’ and just put it on sale for a dollar. Later we’re like: ‘wait a minute, can we pay our bills with this?’” – Aw
“I wanted to give [Game] away for free. [...] but my friends insisted I charge something for it. [...]It's scary to think of treating making things with love as a business.” – Sh
“Originally, I was just making it for myself, but then I decided to share the story with others. [...] Even though the game is priced [...] when anyone emails me about the game, I send them a free copy.” – Dv

Table 6*Exemplary consumer innovator quotes on considerations involved in the pricing decision*

Cost considerations in the pricing decision
<i>Monetary expenses of consumer innovators are kept on a low level. Time invested in product development is rarely tracked. Most consumers do not consider their working time as development costs.</i>
“The money was spent, I watched it, but it wasn't high enough to have a negative effect on my life. It's about as much as I give for a beer.” – Oa
“No costs, because you have a computer and you have a brain” – Yi
“I actually don't [track costs]. I could give you an estimate but [...] I really just do it.” – Ch
“If I approached this more like a business [...] I'd have to consider more up-front costs I imagine.” – Sh
“Making the game never felt like hard work to me. So, I didn't feel like I need to be compensated for my time.” – Fw
Quality considerations in the pricing decision
<i>Consumer innovators try to assess the benefits that players will be able to derive from playing their games. They give a lot of consideration on charging fair prices by drawing from their personal experiences and by collecting feedback from their community. They do not think about customers as buyers but as peers.</i>
“I think it's more of a moral thing as well [...] knowing that there are people who got a certain experience out of it.” – Jr
“I was very social about that. It is important to listen to players.” – Ak
“I just sell games when I think they are actually worth the price. [...] To me it is to get the players. Getting the money is just an extra thing. Just to have more development funds.” – Ch
“If it's affordable for me, then it's affordable for pretty much anybody.” – Fw
“not looking for the price sweetpot. More for a simply reasonable price in relation to game quality” – Vk
“We [gaming friends] had no notion of customers. We were making a game for players just like us.” – Xt
“I never think of players as clients. More like friends who try my ideas.” – Hs
Competition considerations in the pricing decision
<i>Consumer innovators mainly make use of their personal knowledge when estimating the level of competition. They rarely conduct a systematic and comprehensive market analysis. Prices of a small set of similar games they know about are used as anchor for pricing.</i>
“I judge on my own merits. [.. Looking at others] I guess it's good for some kind of bearing.” – Jr
“I gave a look at other indie's prices, but I didn't make other kind of marketing analysis.” – Mc
“I've seen games like mine, but I didn't make any real analysis or something.” – Du
“We [married couple] searched on Steam to see if there was something similar [...] There was nothing similar, but we discovered after some time that Steam has a lot of buried games.” – Dd

Figure 1
The research model.

