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Is Zero the best Price? - Optimal Pricing of Mobile Applications

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Is Zero the best Price?
Optimal Pricing of Mobile Applications

1 Introduction

Mobile markets, and in particular mobile applications, as disruptive innovations, have revolutionized the software industry. Whereas software has its usage in an organizational, job- or efficiency-related environment, mobile application changed the way we use software as everyday life artifacts. Mobile applications in combination with smart mobile devices can be regarded as today's archetype example of ubiquitous computing. This development has considerably contributed to the emergence of a new type of users. By the use of mobile applications, consumers are enabled to benefit from supporting software in their everyday life, which causes a revolution of the software industry: the disclosure of the consumer market. Mobile applications can be used to perform every kind of task, and users benefit while handling their everyday routine. Everyday activities, e.g., comprise navigation, buying lists, communication, scheduling, gaming, information, sports, and learning are almost "naturally" carried out or supported through the use of mobile applications. Or as Apple phrases it in one of their slogans: "There is an app for that" [1].

In terms of sheer numbers, mobile application markets are by no means comparable with markets for traditional software products. More than 2 million mobile applications are currently provided in the leading app stores (Google Play, Apple App Store, Windows Phone Store) and 21 billion apps were downloaded worldwide in 2013 [2]. Despite of the various purposes and functionalities of mobile applications, the pricing structure of the market is very simple: most apps are offered for free. According to estimates, roughly 95% of mobile applications in 2017 will be offered for free [3], while the small group of fee-based mobile applications generates about 50% of app store revenue [4].

The decision about the price of mobile applications is one of the most important managerial decisions [5], and the prices set for a mobile application play an important role in positioning, and thereby can have a huge economic impact [6], [7], [8]. In the market of mobile applications, pricing should be a topic of interest from an economic, management science, marketing, and, increasingly, computer science perspective [7].

This leads us to our major research question: How to optimally set prices of mobile applications depending on their utility-classification?

Each of the following chapters sequentially contributes to the answer of this question. Chapter 2 focuses on the managerial relevance of pricing and the specific characteristics of mobile applications. In chapter 3, we develop a model for mobile application pricing and derive advises for profit-maximizing mobile application pricing. The article closes with a discussion and conclusion in chapter 4.

2 Pricing and mobile application markets

2.1 Relevance of pricing

The decision about the price of a good is one of the most important managerial decisions [5].[1] Strategic decisions to influence markets are called instruments of marketing [9]. In the (marketing) literature, these instruments are grouped into three to five submixes – the so-called marketing mix [10]. [10]´s marketing mix of 4 "P´s" (product, promotion, place, and price) is a well-known classification of strategic marketing [10]. This classification includes the kind of product or service offered to the consumer ("P" = product), the way it is communicated to the customer ("P" = promotion), the way of offering the product or service to the customer ("P" = place), and the amount of money the customer will have to pay for the product or service ("P" = price).

The prices set for a product or service play an important role in positioning a product or service, and thereby can have a huge economic impact [6], [7], [8]. First of all, the pricing decision has direct influence on the profitability, and thus it plays an important role concerning companies' strategic focus [11]. Besides the direct impact on the financial performance, prices have an important influence on various marketing decisions, e.g. price as proxy measure for quality, price as an anchor for customers, and low prices to attract additional customers [6]. [6] attribute different roles to pricing; according to them it is a signal to the buyer, an instrument of competition, the improvement of financial performance and the result of marketing program considerations.

Pricing is becoming the more and more dominate "P" in the marketing mix. While determining an amount of money for a products or services often was seen as the "remaining" "P", which was set at the last stage, and used for merely tactical reasons, pricing as a strategic decision in the very early stage of the development becomes more and more relevant [12]. [6] point to the strategic role of pricing: "Strategic choices about market targets, positioning strategies, and products and distribution strategies set guidelines for both price and promotion strategies. Product quality and features, type of distribution channel, end-users served, and the functions performed by value chain members all help establish a feasible price range. When an organization forms a new distribution network, selection of the channel and intermediaries may be driven by price." [6]

Consequently, pricing as an interdisciplinary field is a topic of interest in various fields, e.g. economics, management science, marketing, and, increasingly, computer science [5], [7]. In terms of pricing theory, two main lines of research are established: the behavioral science approach and the decision science approach [5]. Whereas the behavioral science approach has its roots in empirical research, the decisional approach is based on the tradition of micro-economic theory. The goal of the latter approach is to search for optimal prices, making use of theoretical models [5].

A lot of work was done in the field of pricing, but the literature concerning mobile application pricing is scarce. In mobile apps markets, we observe the phenomenon

[1] The focus of this article is mainly the price a profit-maximizing company sets.

that prices are set in a standardized way. Despite the uniqueness of several mobile applications, most apps are given for free.[2] It also seems that there exist price thresholds, including 0.19 Euro, 0.79 Euro or 0.99 Euro. To get a deeper understanding of pricing in mobile application markets, we outline the specific characteristic of mobile application markets. Subsequently we provide a formal pricing model for apps markets.

2.2 Characteristics mobile applications

The pricing decision, and at the end of the day the prices set in the market, depend on various factors. [9] group the factors which affect the pricing decision into three levels: internal factors, external macro factors and external micro factors. Internal factors like the goals and the strategy of the company, the type and cost structure of the product, and economies of scope are important for pricing, too [9]. In terms of external macro factors they identify macroeconomic, societal, governmental, and technological circumstances. In the micro sphere pricing has to be done, taking into account the competitors and the reactions of the customers [9].

Consequently, the most important factors for pricing decisions are the nature of the product or service. Apps, like traditional application software, can be characterized as closed and not integrated software packages, which are dependent on their underlying OS [13]. We follow the definition of Buck et al. who defines apps "as application software programs, which use web and cloud applications and run on smart mobile devices (SMDs) [like smartphones and tablets]. They can be purchased and installed depending on their operating system and perform highly fragmented everyday tasks. Importantly, mobile applications are embedded in mobile ecosystems, i.e. OS-based platforms, which provide profile-bound ubiquitous services for mobile devices." [14]

According to the underlying definition, mobile applications are digital goods and therefor have specific characteristics. In terms of pricing, the most important characteristic is that marginal costs are not relevant in the context of mobile applications [15].[3] This means, that only the first copy of the software product has possibly relatively high fixed costs, but every following copy does not cause any additional variable cost, like costs for copying and providing.

Furthermore, software products can be classified into two main groups: standard software and individual software [16]. Standard software is a pre-developed and completed software package which provides a uniquely defined set of applications for the mass market and can be purchased in the open market. Individual software is developed for a single entity and provides a customized problem solution. Apps are pre-developed software packages, which are sold via online stores to the mass market, and thus can be characterized as standard software. Thus, the full function of mobile applications can be sold by degrees in little slices via so called in-app-purchases (which can also be seen as complementary goods or upselling) [8].

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[2] In terms of direct monetization.

[3] In this paper we do not consider the very little cost for copying and providing software in cloud environments.

The third specific characteristics of mobile applications are possible network effects [17], [18]. There exists a broad literature concerning network effects and the utility consumers derive from networks; including for example [19], [20], [21], and [22]. Network effects exist, when "[…] the utility a given user derives from the good depends upon the number of other users who are in the same "network" […]."[19] In digital networks, the increase in utility depends on the diffusion and the reach of a critical mass of a mobile application.

The fourth specific characteristic has to be seen in personal data as currency in mobile application markets. Mobile application markets are typical examples for so-called free or freemium markets, i.e. most apps include at least a free basic version. However, this does not mean that consumers do not have to pay for the benefits they derive. Although there is often no money involved in the economic exchange situation of an mobile application purchase, the provider does not offer the mobile application "for free" More precisely, private information of the consumer is generated as the majority of apps receive, store, or process personal data, although other revenue mechanisms are used simultaneously (e.g. monetary payment for the app, in-app advertising).

The fifth specific characteristic constitutes the monopolistic purchase channel of mobile applications. Mobile applications, according to their definition, have to be bought via mobile ecosystems which provide apps in a closed online store (e.g., Apple app store, Google play store). The system entry is only provided through the SMD. Apps have to fulfil strict requirements in terms of design, in order to generate a "one face to the customer feeling", and are therefore frequently perceived as part of the underlying OS and SMD, although they are separate, 3rd-party products.

2.3 Pricing modalities of mobile applications

Pricing decisions depend strongly on their context. Consequently, different approaches in pricing are used for different products, services, or industries. Pricing in different industries is addressed extensively in the Oxford Handbook of Pricing Management [23].

To address the question of why there exists a lot of disparity in mobile application pricing [24] introduced the concept of pricing modalities: "The pricing modality is the way that buyers, sellers, and intermediaries interact in a market to determine the price for a particular transaction." [24] Thus, pricing modalities can be seen as the external influence factors introduced by [9].

[24] describes pricing modalities as the "rules of the game" which are – caused by the characteristics of mobile applications shown above; specifically, when considering mobile markets, particularly application stores of mobile ecosystems [24]. [24] provides three pure approaches to explain pricing modalities in market like application stores: market equilibrium, institutional history, and economic sociology.

Application stores can be characterized by the approach of institutional history as an outcome of the development of experiential computing, the technological evolution of smartphones and mobile ecosystems and the digital industry structure. Apple, with the further development of iTunes into iOS and the invention of the first iPhone as first mover, created a path dependence for the whole digital consumer industry [25], [26]. With developing (closed) mobile digital ecosystems, they created a market structure where the "rule-maker" is the intermediary who links consumers and providers in a closed environment. The pricing modality in mobile application markets is fixed, where sellers choose a price which is posted at the market. Prospective buyers either pay the price or do not purchase or download the mobile application [24]. According to [24], the fixed pricing modality incorporates four elements:

1. Unilateral selection of a price by the 3rd-party-app-vendor
2. The 3rd-party-app-vendor posts the price in the application store
3. Consumers observe the price and choose whether or not to purchase
4. The download takes place exclusively at posted or advertised prices

As shown above, in terms of the pricing modality, mobile applications basically show fixed pricing. Nevertheless, fixed pricing is merely the direct and obvious pricing modality, and therewith one part of the business model and the (monetization) strategy of mobile applications. Furthermore, consumers give access to their personal data when downloading mobile applications without knowing what is the value of their personal data currently and in the future.

3 Modelling mobile application pricing

3.1 Utility dimensions and price of mobile applications

Based on their specific characteristics mobile applications have various value dimensions. Consumers are willing to pay the price for a mobile application on the value or utility they receive or perceive to receive [8]. These dimensions lead to the assumptions of the model presented in the following section. To explain the assumptions of the underlying model, we choose the mobile application of "Quizduell" as an archetype for mobile applications with two value dimensions. "Quizduell" is an interactive mobile application where consumers can answer questions in several knowledge categories. The questions can be answered in a single mode (consumers can challenge themselves) and in a multiplayer mode (consumers can challenge other consumers). Consumers derive utility from using mobile applications. We argue that, based on the specific characteristics shown above, the utility of using mobile applications can be separated into two components, according to the main focus of the mobile application.

The first dimension stems from the native value the mobile application provides when using its basic functionalities in an individual way. We call this part of utility *individual utility*. Individual utility is achieved, when the consumers uses the mobile application and is not in-app-connected with other (anonymous) consumers. In the example of "Quizduell", consumers derive utility when using the mobile application in the single mode.

The second dimension is call *collective utility*. The consumers benefit from integrating interconnected (anonymous) users. In the example of "Quizduell", consumers can derive additional value when challenging other interconnected users. The concept of collective utility is based on the related papers, focusing on network effects. While [20] and [22] study a monopolistic setup with network externalities, we focus on a model with two competing firms. As we do, [19] study goods for which "[…] the utility a given user derives from the good depends upon the number of other users who are in the same "network" […]. " However, contrary to our model, [19] assume the firms to compete in quantities instead of prices. Furthermore, they answer questions of compatibility of two or more networks. However, our model focuses on the question of optimal pricing and the optimal amount of advertisement in the context of mobile applications and network effects.

In terms of mobile applications, price can be seen as the reward for the utility consumers derive. Consequently, the price reveals a negative utility. We assume that based on the specific characteristics of mobile applications, the disutility when using a mobile application can be interpreted in two ways. According to [27] B2C-income types classification for the internet, we identify price, contact and information as income types from B2C-App-exchanges.

The first dimension of disutility is the monetary price paid when downloading an app.

The second dimension is the price consumers pay for using their personal data received via the permissions consumers grant for when downloading and using the app. In the following we subsume contact and information under the second dimension of negative utility because only with the permission of information of personal data firms can get into contact with consumers. Consumers can benefit from 'free apps' in exchange for their personal data. All these aspects are incorporated in our model, presented in section 3.2.

3.2 Exogenous market share

We model the market for application similar to the model of [28], and assume that two firms, firm 1 and firm 2, serve the market. The market share of each firm is exogenously given by m for firm 1 and by $(1-m)$ by firm 2. Both firms offer an identical app. Each individual *i* or *j* derives the following utility depending on whether she uses the mobile application of firm 1 or 2.

$$u_i(x_i, w_1) = ax_i - bx_i^2 + cx_i m - w_1 x_i \quad (1)$$

in the case of individual *i* buying from firm 1, and

$$u_j(x_j, w_2) = ax_j - bx_j^2 + cx_j(1-m) - w_2 x_j \quad (2)$$

in the case of individual *j* buying from firm 2.

x_i stands for the individual consumption of user i, using the mobile application of firm 1, and x_j is the consumption of individual j, using firm 2's app. m and $1-m$ stand for the market share of firm 1 and firm 2. The utility of individual i and j increase in the consumption x_i and x_j Apart from x_i and x_j the utility also depends positively on the market share m and $1-m$. As user i (j) is assumed to be atomistic small, the number of other consumers ex-cept for the user i (j) may be approximated by m $(1-m)$.

These two components model the fact that the utility from using a mobile application may stem from two sources. On the one hand the individuals derive a positive individual utility from using the app. On the other hand, their utility is positively related to the numbers of other players using the app.

How often a consumer uses the mobile application depends on the utility she derives from using it; e.g. the user maximizes its utility, by deciding about how often to use the mobile application. There is a binding constraint to the usage, as we assume that it is not for free, but users have to pay a usage fee of w_1 or w_2. This may come as a price consumers have to pay each time they use the application, or which is the case we are looking at: consumers are exposed to a certain amount of advertisement each time they use the mobile application. That advertisement can be seen as disutility, as we know from various sources. Consumers report that they do not like or want to see advertisement when using their mobile applications [29].

We assume that there are no differences in the individual and collective utility consumers derive independent from using the mobile application of firm 1 or firm 2.

Solving the above game via backward induction implies staring at the second stage at which the users decide about their optimal usage level. Given an exogenously market share, the firms decide at the first stag about the amount of advertisement w_1 and w_2.

Maximizing equations (1) and (2) with respect to x_i and x_j, leads to

$$x_i(w_1) = \frac{a + cm - w_1}{2b}$$

and

$$x_j(w_2) = \frac{a + cm + c - w_2}{2b}$$

As we assume that all consumers i buying from firm 1 and all consumers *j* buying from firm 2 are identical, their optimal consumptions are equivalent to the optimal consumption levels of all other individuals buying the mobile application from the same firm.[4] Furthermore as explained above, we assume that firms only have to bear fixed costs, but no unit variable cost, neither for producing the mobile application, nor for displaying the advertisement. For sufficiently small fixed costs they do not influence the decision of the firms to be active in the market. Consequently, for simplicity, we assume that the fixed costs are set to zero. Based on these assumptions, the firms maximize their profits given by

$$\pi_1(p_1, w_1) = p_1 m + w_1 x_1 m$$

and

$$\pi_2(p_2, w_2) = p_2(1-m) + w_2 x_j (1-m)$$

In equilibrium firms set

$$w_1^* = \frac{1}{2}(a + cm)$$

and

[4] Alternatively, one can model individual *i* and *j* as average consumer, buying the mobile application from firm 1 or 2, which leaves the results unchanged.

$$w_2^* = \frac{1}{2}(a - cm + c)$$

leading to

$$x_1^* = \frac{a + cm}{4b}$$

and

$$x_2^* = \frac{a - cm + c}{4b}.$$

The corresponding profits in equilibrium are given by

$$\pi_1 = \frac{m((a + cm)^2 + 8bp_1)}{8b}$$

and

$$\pi_2 = \frac{(1 - m)((a - cm + c)^2 + 8bp_2)}{8b}$$

Profits in equilibrium strictly increase in p_1, respectively p_2. Furthermore, a larger market share leads to larger profits in equilibrium. However, the assumption that prices are not related to the market shares may be rather unrealistic in the mobile application market. It is more likely that there exists a negative correlation between prices and market shares. Consequently in section 3.3, we introduce a model in which the market shares are endogenously determined by the prices firms set.

3.3 Endogenous market share

We still assume that firm 1 and firm 2 serve the market, offering a horizontally differentiated app. For each consumer buying the mobile application is related to a fixed utility of V, which is the same independently from buying from firm 1 or 2. The consumers have to pay the price p_2 or p_2, depending on whether they buy their product from firm 1 or firm 2, which reduces their net-utility. Furthermore, we assume the mobile applications to be horizontally differentiated. This means that consumers do not perceive the mobile applications as homogeneous, but to them they differ due to certain characteristics. Examples for such characteristics may be different numbers of downloads, ratings, reviews, and the ranking in the app store. Furthermore, each consumer has an individual concept of her own ideal, fictitious mobile applications, which she compares to the two real world applications of firm 1 and 2. Consumers then chose the mobile application of firm 1 or firm 2 depending on which one comes closest to their ideal mobile application. Or put differently, they choose the mobile application that minimizes the distance between their ideal mobile application and the real mobile application. As in the model of [28], the distance may also be interpreted as causing travelling costs. In our model, we assume that the travelling costs are linear in the distance, and scaled by a parameter t. For illustrative purposes, we assume that the consumers may be ordered on a line with a total length of one, according to their preferences with the mobile application of firm 1 at the left end, and the mobile application of firm 2 at the right end of the line. For the consumer that is indifferent between buying from firm 1 or firm 2 the following has to hold:

$$V - p_1 - ts = V - p_2 - t(1 - s) \quad (3)$$

where $s \epsilon [0,1]$ stands for the position of the consumer. All consumers to the left of this indifferent consumer prefer the mobile application of firm 1, as it gives them a higher net-utility than the mobile application of firm 2. For all consumers to the right of the indifferent consumer the opposite holds, and they prefer the mobile application of firm 2 over the one of firm 1.

Solving equation (3) for the indifferent consumer $\hat{s}$ yields

$$\hat{s} = \frac{1}{2} + \frac{p_2 - p_1}{2t}.$$

$\hat{s}$ may also be interpreted as the market share of firm 1 and 1-$\hat{s}$ as the market share of firm 2. $\hat{s}$ depends negatively on the price of firm 1 and positively on the price of firm 2. Normalizing the total size of the market to one, the market share $\hat{s}$ corresponds directly to the number of consumers each firm serves. At a second step, we assume that the buying decision and the decision of how often to use the mobile application are not related. This means that at the point of time when the consumers decide which mobile application to buy they do not consider how often they are going to use the mobile application and moreover how large the individual and collective utility will be. This assumption is rather straightforward in the context of mobile applications, as their download can be seen as impulsive purchase decisions [14]. How often a consumer use the mobile application depends once more on the utility she derives from using it. Similar to equation (1) and (2), the utilities for the individuals i and j are given by

$$u_i(x_i, \hat{s}, w_1) = ax_i - bx_i^2 + cx_i\hat{s} - w_1x_i \quad (4)$$

and

$$u_j(x_j, \hat{s}, w_2) = ax_j - bx_j^2 + cx_j(1 - \hat{s}) - w_2x_j \quad (5)$$

where $x_i(x_j)$ stands once more for the individual consumption of user $i\ (j)$, $\hat{s}$, $(1 - \hat{s})$, for the market share of firm 1 (firm 2) and $w_{1,}\, w_2$ for the amount of advertisement the user is expose to per usage.

We solve the game once more via backward induction. At the third stage, the users decide about their optimal usage level. At the second stage the users make their buying decision and at the first stage the firms decide about their prices p_1 and p_2 and the amount of advertisement w_1 and w_2.

Maximizing equations (4) and (5) with respect to x_i and x_j, and using

$$\hat{s} = \frac{1}{2} + \frac{p_2 - p_1}{2t}$$

leads to

$$x_i(p_1, p_2, w_1) = \frac{2at - cp_1 + cp_2 + ct - 2tw_1}{4bt}$$

and

$$x_j(p_1, p_2, w_2) = \frac{2at \mp cp_1 - cp_2 + ct - 2tw_2}{4bt}.$$

Based on these findings, the firms maximize their profits given by

$$\pi_1(p_1, w_1) = \ p_1\,\hat{s} + w\hat{s}x_i$$

and

$$\pi_2(p_2, w_2) = p_2 (1 - \hat{s}) + w(1 - \hat{s})x_j$$

Partial derivatives with respect p_1, p_2 and w_1, w_2 lead to

$$p_1{}^* = p_2{}^* = t - \frac{(2a + c)(2a + 3c)}{32b},$$

$$w_1{}^* = w_2{}^* = \frac{2a + c}{4}$$

$$\hat{s}^* = 0.5$$

and

$$x_i{}^* = x_j{}^* = \frac{2a + c}{8b}$$

and consequently

$$\pi_1{}^* = \pi_2{}^* = \frac{t}{2} - \frac{(2a + c)(2a + 3c)}{64b} + \frac{(2a + c)^2}{64b} = \frac{t}{2} - \frac{c(2a + c)}{32b}.$$

Proof: See Appendix.

Whether the mobile application may be classified as an individual or a collective application, depends on the specification of the parameters and in particular on c. Total individual utility a consumer buying from firm 1 derives is given by $u_{ind} = ax_i - bx_i{}^2$ and the collective utility by $u_{col} = cx_i\hat{s}$. Figure 1 depicts the relation between individual and collective utility depending on c for $a = 5$, $b = 2$, $t = 10$, while the dashed curve depicts the individual utility and the solid curve the collective utility. For this example, the two utility curves intersect for $c^* = 6$. For $c < c^*$, the individual utility component exceeds the collective utility component, and or $c > c^*$, vice versa. Consequently, for $c < c^*$ the mobile application may be classified as individual mobile application and for $c > c^*$, as collective mobile application.

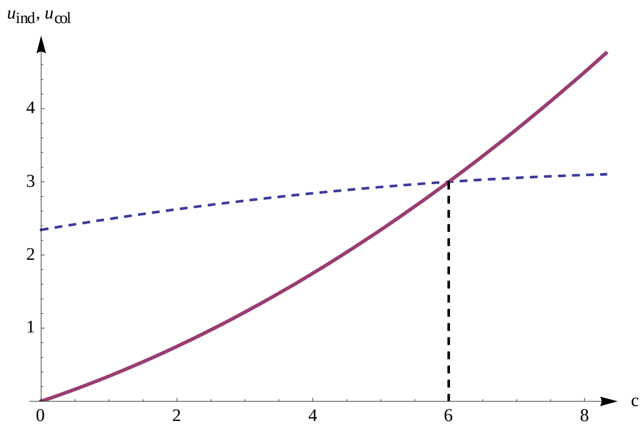

Fig. 1. Individual and collective utility depending on *c*, for *a = 5, b = 2, t = 10*

This distinction also affects the optimal prices in equilibrium and the optimal amount of advertisement. Figure 2 shows that the optimal price p_1 of firm 1 in equilibrium are strictly decreasing in c, while the optimal amount of advertisement $w_1$strictly increases in c. The same relationships hold for firm 2.

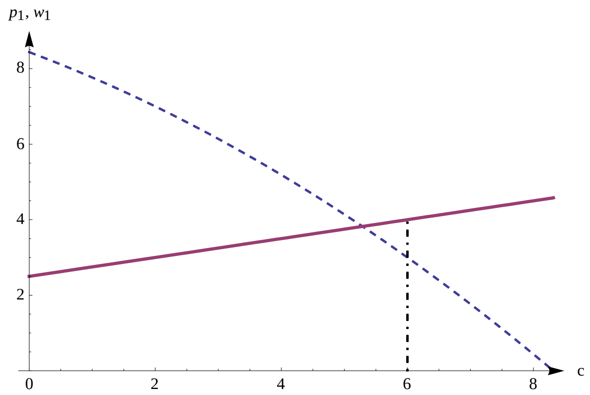

Fig. 2. Optimal price and amount of advertisement depending on *c*, for *a = 5, b = 2, t = 10*

We may classify mobile applications with $c < c^*$ as individual apps, while apps with $c > c^*$are assumed to be collective apps. Figure 2 shows that zero prices for mobile applications may only be optimal in the case of highly collective mobile applications. The corresponding calculations were performed for *a = 5, b = 2, t = 10*. The dashed curve depicts the optimal prices in equilibrium and the solid curve the optimal amount of advertisement, both depending on *c*.

For individual mobile applications, it is according to this model not rational to sell the apps at a price of zero. Furthermore, it may never be rational to have no advertisement at all, ever for an individual mobile application with $c < c^*$. Analyzing firms' profits, we find that profits from selling apps decrease with increasing parameter c and profits from advertisement increase with increasing parameter c.

One could argue that in the case of for example firm 2 committing to selling at $p_2 = 0$, it could be rational for firm 1 to price as well at $p_2 = 0$. However even for that very extreme case it may only in the limit of highly collective mobile applications be rational for firm 1 to decrease prices to zero. Figure 3 shows for *a = 5, b = 2, t = 5*, firm 1's optimal prices in the symmetric benchmark case depicted by the solid curve, and in the case of $p_2 = 0$ depicted by the dashed curve.

Apart from the limit case of highly collective mobile applications, firm 1 reacts to firm 2 setting prices of $p_2 = 0$ with positive prices. However, prices are lower than in the symmetric case.

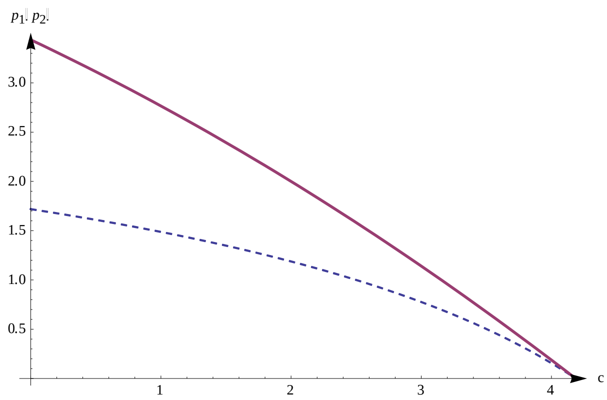

Fig. 3. Optimal pricing strategy depending on *c*, for *a = 5, b = 2, t =5*

4 Discussion and Conclusion

In this article we answer the question of optimal pricing in the market for mobile applications. We classify mobile applications according to their utility components as individual and/or collective mobile applications.

In our theoretical model, we offer a microeconomic approach to the question of optimal pricing and advertisement. Based on the model of [28], we analyze the utility components of mobile applications and introduce the concept of individual and collective utility.

Concerning the optimal pricing scheme, we find that the profit-maximizing price for mobile applications is strictly higher than zero. Only in the limit case of highly collective mobile applications it decreases to zero. Furthermore, we also analyze the optimal amount of advertisement firms should include into their mobile applications. We find a positive correlation between the optimal amount of advertisement and the collectiveness of a mobile application.

However, the assumptions and results of our model are rather narrow. For example we assume that the market is served only by two firms which may not be very realistic. Concerning the income types of [27] we do not consider the use of personal data in terms of private information and usage data. According to their architecture mobile applications provide a vast number of highly personalized user data which can be aggregated and sold by 3rd-party vendors or 4th-party aggregators. Moreover, may not at all be interested in generating monetary profits via their mobile applications. Contrary, mobile applications may be used to increase customer loyalty or customer satisfaction.

Besides our model explains the micro-economic foundation of pricing, however there is also a behavioral component to pricing. For example as we have shown in section 3.3 that is not optimal to decrease prices to zero as a reaction to the other firm pricing at zero. However as [24] argues, "… pricing modalities tend do become normative for all participants – buyers, sellers, and intermediaries. An attempt by any player to unilaterally deviate from the norm may not succeed even if it would lead to an improved situation for all participants."

Another aspect that is not covered in the model is the behavioral impact of pricing decisions. Prices in mobile market can generate signals like quality, trust, image, and maintenance. Furthermore, mobile markets seem to follow threshold prices [5].

Consequently, our model is only the first step in the direction of optimal pricing strategies in the market for mobile applications. Future research should attempt to generalize the underlying assumptions and incorporate more complex pricing schemes.

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Appendix

Proof

Maximizing the utility functions $u_i(x_i,\ \hat{s}, w_1) = ax_i - bx_i^2 + cx_i\hat{s} - w_1x_i$ and $u_j\left(x_j,\ \hat{s}, w_2\right) = ax_j - bx_j^2 + cx_j(1-\hat{s}) - w_2x_i$ with respect to x_i and x_j leads to $x_i(p_1, p_2, w_1) = \frac{2at-cp_1+cp_2+ct-2tw_1}{4bt}$ and $x_j(p_1, p_2, w_2) = \frac{2at+cp_1-cp_2+ct-2tw_2}{4bt}$. Using this and $\hat{s} = \frac{1}{2} + \frac{p_2-p_1}{2t}$, the profit functions of firm i and j are given by $\pi_i(p_1, w_1) = p_1\left(\frac{1}{2} + \frac{p_2-p_1}{2t}\right) + w_1(\frac{2at-cp_1+cp_2+ct-2tw_1}{4bt})\left(\frac{1}{2} + \frac{p_2-p_1}{2t}\right)$ and $\pi_j(p_2, w_2) = p_2\left(\frac{1}{2} + \frac{p_2-p_1}{2t}\right) + w_2(\frac{2at+cp_1-cp_2+ct-2tw_2}{4bt})\left(\frac{1}{2} + \frac{p_2-p_1}{2t}\right)$. Differentiating firm 1´s profit with respect to p_1 and w_1 leads to $p_1 = \frac{-atw_1+2bp_2t+2bt^2-cp_2w_1-ctw_1+tw_1^2}{4bt-cw_1}$ and $w_1 = \frac{2at-cp_1+cp_2+ct}{4t}$. Due to symmetry $p_1 = p_2$, and $w_1 = w_2$ holds, which gives: $p_1^* = p_2^* = t - \frac{(2a+c)(2a+3c)}{32b}$ and $w_1^* = w_2^* = \frac{1}{4}(2a+c)$. Consequently, $\hat{s} = \frac{1}{2}$, and $x_i^* = x_j^* = \frac{2a+c}{8b}$ hold.

Mobile markets as disruptive innovations, have revolutionized the software industry. This paper answers the question of optimal pricing in the market for mobile applica-tions. The decision about the price of mobile applications is one of the most important managerial decisions, and the prices set for a mobile application plays an important role in positioning, and thereby can have a huge economic impact. Based on the model of Hotelling, this paper answers the question of optimal pricing in the market for mobile applications. To the best of our knowledge this paper is the first that classifies mobile applications into individual and collective mobile applications. Concerning the optimal pricing scheme, we find that the profit-maximizing price for mobile applications is strictly positive. These findings are in contrast to the dominant pricing scheme observed in mobile markets. Over 90% of the mobile applications currently offered at the major app stores are for free.

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