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How to give away software with successive versions☆

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ABSTRACT

Free software offer as a promotional tool has been employed by software firms of all sizes. In this research, we propose an extended multi-generation diffusion model that separates substitution from switching, and develop methodologies to help a firm determine the optimal number of free adoptions for each version. Our analyses show that due to the word-of-mouth effect, free offer can help increase a firm's total profit for all versions of a product. Furthermore, we find that in the presence of low-valuation free adopters, the optimal number of high-valuation free adopters decreases, the total number of free adopters increases, and the total profit improves substantially as a result.

1. Introduction

An interesting phenomenon observed in today's market is the sheer number of software products being given away through various distribution channels. For instance, in order to promote their new products, many software firms simply make their proprietary products available for free download from either their own websites or other third-party sites such as www.download.com. From the Web, we can find thousands of free software products being offered in various forms. Some free software comes with content limitations. A well-known example is *Acrobat Reader*, which can read PDF files but does not offer the functionality to create PDF files. Other free software products are provided with time limitations. For instance, the 30-day trial version of *Minitab* includes all the functionalities of the full-fledged commercial version, but the free version will stop functioning after 30 days. In addition to these "limited" types, we also observe numerous free software products being given away with neither time nor content limitations. Examples include personal financial management software *Simply Money* [8], small business accounting software *Simply Accounting* [5], and utility software *SpyBlocker* [4].

In this study, we focus on free software offers without time or content limitations. This type of free software is typically available only during a promotional period or for a limited quantity. For instance, *Simply Money* and *Simply Accounting* were given away only to the first million customers who requested for them. Once the promotion ends, a firm starts charging a price for the new product. Although we consider only free software offer without limitations, the analyses and findings of this research provide a basis for studying other types of offerings with time and/or content limitations.

Prior research on free software can be broadly classified into three categories. The first category focuses on the network externality side of the benefit. For instance, Haruvy and Prasad [12,13] study how a firm can take advantage of the network externality effect of a new software product by introducing a limited version to go with the full-fledged commercial version. In another empirical study, Gallaugher and Wang [10] test the impact of free software on commercial software in markets where both freeware and paid software are available. Research in this category concludes that because of network externality, free adopters increase future adopters' valuation of a software product. As shown in prior research, a larger network has a positive effect on price in many software markets [6]. Therefore, free software offer can indirectly lead to a higher profit for a software firm. The second category of research focuses on the demonstration effect of free software versions with limited functionalities. The studies by Manica et al. [19] and Faugère and Tayi [9] propose methodologies to optimize the design of demo versions, i.e., deciding their optimal content and/or time limitations. In a more recent article, Hui et al. [14] study the economics of shareware with limited features. Among others, the authors conclude that shareware quality tends to increase if potential customers are more averse to uncertainty and tends to decrease in the presence of piracy. In the third category of research on free software, the word-of-mouth effect of the free software adopters is examined. Based on a single-version software product, the study by Jiang and Sarkar [16] shows that even if other documented benefits such as network externality and demonstration effect are insignificant, a software firm can still benefit from free offer; this is because the word-of-mouth effect from the free adopters can help speed up the diffusion of a new product. This study is in line with prior research in the third category. We also focus on software products for

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which the word-of-mouth effect is the only significant benefit that a firm can reap from free offer. The primary difference between the prior research by Jiang and Sarkar [16] and this study is that the former considers products with a single version while this study examines software products with multiple successive versions.

For both economic and software engineering considerations, most software firms do not attempt to deliver a complete and perfect product in one development cycle. Instead, they choose to keep rolling out new versions one after another, with later versions typically coming with added functionality [7]. Microsoft Windows and Office represent two good examples of such practice, with new versions released every few years. With software versioning, users enjoy ever-improving features of software products, often at the cost of paying the same line of products more than once in their lifetime. Besides generating repeated sales, successive versioning brings a number of other important benefits to software firms. It delivers quicker return to investment, limits the impact of market uncertainty, reduces the risk of project failure, and provides firms with opportunities to refine their development methodologies and improve product quality in later development cycles.

Although we have not seen any formal analysis on free offer policy for successive software versions, the diffusion of products with multiple generations has been studied in the diffusion literature. The extant multi-generation diffusion models are all extensions of the seminal Bass model [1], which is credited as "the most popular model in the field of marketing" ([21], p.83). The Bass model is applicable only to products with one generation. The first multi-generation extension of the Bass model is proposed by Norton and Bass [20]. Following Norton and Bass, other researchers develop extensions and variations to the Norton and Bass model (e.g., [17,18,22–24]). Empirical verifications in these studies show that multi-generation diffusion models are applicable not only to technological products such as IBM mainframe computers and mobile phones, but also to non-technological products such as milk containers.

With successive software versioning in context, our goal in this research is to develop an optimal free offer policy for a new software product based on various economic factors and market conditions. Specifically, we attempt to answer the following questions: if word-of-mouth is the only significant benefit factor, should free offer be given for the first version only or for subsequent versions as well? If free offer is beneficial for a given version, how many free copies should be distributed? Does the release time of the subsequent versions have an impact on the free offer policy and its profitability? Does the composition of free adopters have an impact on the optimal free offer policy?

The rest of the paper is organized as follows. In Section 2, we introduce diffusion models that have a bearing on our research. In Section 3, the benefit of free offer for a single software version is discussed. The free offer policy for two successive versions is analyzed in Sections 4 and 5, with Section 4 focusing on cases where every free adopter has a reservation price equal to or above the sale price, and Section 5 focusing on cases where at least a portion of the free adopters' reservation price is lower than the sale price. In Sections 4 and 5, the price of the software is assumed to be constant across versions. This assumption is relaxed in Section 6, where we analyze the free offer policy with different prices for successive versions. Lastly, we discuss in Section 7 the managerial implications and future research directions.

2. Diffusion models

In this section, we first review the basic Bass model [1] and the multi-generation diffusion model by Norton and Bass [20], and then propose an extended multi-generation diffusion that is suitable for modeling the diffusion dynamics of multiple successive software versions.

2.1. Bass model

The Bass model is appropriate for a single production generation. The model can be represented by the following equation:

$$\frac{dY(t)}{dt} = \left[p + \frac{q}{m}Y(t)\right][m - Y(t)], \tag{1}$$

where $Y(t)$ represents the cumulative number of adopters by time t, and the three constant parameters m, p, and q denote the potential market size, the *coefficient of innovation*, and the *coefficient of imitation*, respectively. Eq. (1) shows that the diffusion rate at a given time t equals the product of (i) the instantaneous probability of adoption at time t, which increases linearly with the number of existing adopters, and (ii) the number of potential adopters who have not adopted by time t. The cumulative number of adoptions and the non-cumulative diffusion rate at time t, denoted by $S(t)$, can be derived based on Eq. (1):

$$Y(t) = \frac{m\left(1 - e^{-(p+q)t}\right)}{(q/p)e^{-(p+q)t} + 1}, \text{ and}$$

$$S(t) = \frac{m(p+q)^2}{p}\frac{e^{-(p+q)t}}{\left[(q/p)e^{-(p+q)t} + 1\right]^2}.$$

Fig. 1 shows the typical shape of a Bass diffusion curve (with $q > p$). The adoption rate is low when the product is first released. Due to both the word-of-mouth effect and the external influences such as advertisement, the adoption rate gradually picks up until a peak is reached. After the peak time t^*, the adoption rate decreases due to market saturation effect.

2.2. Norton and Bass model

The multi-generation diffusion model proposed by Norton and Bass [20] captures the diffusion dynamics across multiple product generations. The model can be illustrated using two successive product generations. As shown in Fig. 2, the first generation is released at time 0 and the second one is