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Pricing strategies for tied digital contents and devices ☆

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ABSTRACT

Media companies are increasingly offering digital content to consumers. Many of these companies are tying digital content with their proprietary digital devices. In this study, we develop a consumer demand model for digital device and digital content based on a constant elasticity demand function. In modeling consumer valuation of the digital device, we take consumer surplus on digital content into account. We further derive equilibrium prices for digital devices based on an oligopoly competition model with horizontal product differentiation. We analyze the equilibrium prices and how prices affect firm profits. We find product differentiation and the level of product substitutability affect prices. We also find that content price plays a significant role in affecting the price of the digital device. Content price can either increase or decrease the tied digital device price depending on the profit margin and demand elasticity of the digital content. We further analyze how content and device prices affect their respective profits and the overall profit of the firm. We extend our model to vertical product differentiation and find vertical product differentiation and the level of product quality affect prices.

1. Introduction

Media companies are increasingly offering digital content online. Apple Computer is one of the pioneers in selling digital music at its iTunes store. Consumers can buy digital songs and videos starting at just 99 cents a piece [25]. With the high speed Internet, Apple, Netflix, TiVo and some other companies are providing videos directly to televisions at home [15,22]. As “the last bastion of analog”, according to Amazon's founder Jeff Bezos, books will be digitized as well [11]. The competition in digital books market has been heated. About 2 years after Amazon introduced its popular e-book reader Kindle in 2007. Barnes and Noble announced its digital book reader in 2009 [27]. In 2010, Apple introduced its competing iPad device, aiming to break Amazon's lead in the digital book market [14].

There are different ways to sell digital contents. While some companies provide “free” content with advertising on the Internet, many of the media companies are selling digital content with their proprietary formats and digital devices. For example, Apple sells digital songs in iTunes format using Advanced Audio Coding that can only be played with iPod. If consumers want to stream videos to their TVs from iTunes store, then they have to purchase Apple TV, which costs $229 [8]. Netflix has teamed up with LG to introduce its own video player that can play movies on Netflix's streaming on-demand service [22]. The e-books sold by Amazon are tied to its proprietary Kindle digital reader. Amazon sells digital versions of New York Time best sellers and new releases for $9.99 [23]. Amazon also provides some books at $0.00 for its Kindle customers. The new version of Amazon's e-book readers Kindle 2 was initially priced at $359, which was quite expensive to many customers [23].

In all of the above examples, a firm makes the sale of its product, e.g. e-books, conditional upon the purchasers also buying another product, e.g. Kindle, from the same firm. This type of business practice is called tying in economics literature [28]. While Apple's core product is iPod, many companies' main products are digital contents. Although companies can make profit through digital devices, one of the goals of tying digital contents with a proprietary device is to help sell content for those companies.

In this study, we aim to address the following questions:

1) How do consumers value tied products such as digital contents that they are likely to buy repeatedly?
2) What are the factors affecting consumers' adoption of an expensive digital device?
3) What are the equilibrium prices for the digital devices?
4) How do the prices of digital contents and devices affect a firm's profit?

The paper is organized as follows. We review related literature in Section 2, followed by the model setup in Section 3. In Section 4, we

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present our model analysis. We make an extension to the model in Section 5. We discuss our results in Section 6 and provide conclusions in Section 7.

2. Prior literature

In a broad sense, digital media belongs to information goods, which are goods whose main value is derived from their digital content [21]. Information goods usually incur large fixed development costs and low production costs. There is a rich literature on information goods from information systems (IS) area, for example, Riggins [18] studied a separating equilibrium for a two-tier fee-based and sponsorship-based information Web site. Lang and Vragov [10] examined a pricing scheme for distributing digital content over centralized versus decentralized networks. Chellappa and Kumar [3] studied how "free" product-augmenting services affect pricing and customer retentions online. Fan et al. [6] developed a model to examine optimal strategies for media providers to utilize the online channel to distribute digital media. Mantena et al. [13] studied vendors of platforms such as video game consoles and vendors of complement goods. Li [12] examined the pricing and distribution channels of digital contents.

The literature on complementary and tying products is mostly from economics. Shaked and Sutton [19,20] developed models for products with vertical differentiation, in which products or services had different levels of quality. Church and Gandal [5] assessed the effect of hardware control of software provision in markets in which the consumption benefit of a durable or hardware good is a function of the variety of complementary products or software available. Strauss [24] discussed marketing strategies for a manufacturer of a composite product with cross-market network externalities. Chen and Xie [4] examined the competitive implications of asymmetric customer loyalty in a cross-market. They found a middle level of loyalty advantage in the primary product market can lead to an overall profit disadvantage. In the IS area, Arakji and Lang [2] studied digital consumer networks and producer–consumer collaboration, which used economic modeling to derive firm strategies based on the complementarities between video game engines and video game content.

Laffont et al. [9] developed a model of unregulated competition between interconnected networks and analyzed the mature and transition phases of the industry in this deregulated environment. In their model, consumers derive their utilities from the networks by using the communication service repeatedly. This demand model is mostly relevant to the problem we analyze. Thus, we use the basic structure of Laffont et al. [9] in modeling consumer demands.

This paper analyzes pricing strategies for a digital device and the tied contents. The results provide interesting implications to companies that compete in this growing market.

3. Model setup

While the basic idea of tying is not fundamentally different between information goods and physical products, there is an interesting difference. For physical goods, the two tied products are usually consumed in fixed proportions. For the case of digital goods, applications or content are tied to a platform and the demand for the digital goods are endogenously determined. Following Laffont et al. [9], we model a consumer's demand for digital content as a constant elasticity demand function $q_e = p_e^{-\eta}$, where p_e is the price of the electronic content and q_e the quantity of the electronic content a consumer buys. The constant elasticity of the demand function is η, which is assumed to exceed one [9] . Thus, the pricing function is $p_e = q_e^{-1/\eta}$.

When a hardware device is not free, consumers need to take into account the quantities of the electronic content they may consume in order to assess the overall benefits of adopting the digital device. Therefore, the utility function for consumers depends on consumer surplus of the consumption. We first calculate a consumer's gross surplus, which is:

$$\int_0^{q_e} p_e dp_e = \int_0^{q_e} q^{-1/\eta} dq = \frac{q_e^{1-(1/\eta)}}{1-1/\eta}.$$

The consumer's variable net surplus is:

$$v(p_e) = \frac{q_e^{1-(1/\eta)}}{1-1/\eta} - p_e q_e = \frac{p_e^{-(\eta-1)}}{\eta-1}.$$

Lemma 1. *The consumer's variable net surplus of the digital content is a convex function of the price for the digital content, i.e.* $\frac{\partial v(p_e)}{\partial p_e} < 0$, $\frac{\partial v^2(p_e)}{\partial p_e^2} > 0$.

The proofs for this Lemma and other propositions are provided in the Appendix.

It is not surprising that consumers' surplus strictly decreases in the price of the digital content. In addition, Lemma 1 suggests that as price decreases, consumers' surplus increases sharply because consumers benefit not only from a lower price but also a higher demand for the contents.

We next analyze the demand for two competing firms. The analysis generalizes straightforwardly to the case of multiple firm oligopoly [26]. We follow the Hotelling model [26] and assume consumers are uniformly located on the segment [0, 1]. There are two companies competing with their proprietary devices and contents. They are located at the two extremities of the segment, namely $\alpha_1 = 0$ and $\alpha_2 = 1$. A consumer located at location α will have a utility

$$v(p_{ei}) - t|\alpha - \alpha_i| - p_{ki}$$

where $t|\alpha - \alpha_i|$ denotes the cost of using a company with location $\alpha_i (i = 1,2)$, and p_{ei} and p_{ki} are the prices for digital content and device, respectively, from company i $(i = 1,2)$.

A consumer is indifferent between the two companies' products if

$$v(p_{e1}) - t\alpha - p_{k1} = v(p_{e2}) - t(1-\alpha) - p_{k2}.$$

We can solve for the indifference point α^* that the consumer has the same utility in adopting products from either of the two companies. The consumer demand for the digital device offered by company 1 is therefore

$$D_1 = \alpha^* = \frac{1}{2} + \sigma[v(p_{e1}) - v(p_{e2})] + \sigma(p_{k2} - p_{k1}), \quad (1)$$

and the consumer demand for the digital device offered by company 2 is

$$D_2 = 1 - \alpha^* = \frac{1}{2} + \sigma[v(p_{e2}) - v(p_{e1})] + \sigma(p_{k1} - p_{k2}), \quad (2)$$

where $\sigma \equiv \frac{1}{2t}$ is an index of substitutability between the products of the two companies.

The demand functions clearly indicate that the consumer's adoption of a company's device and contents depends on (i) the substitutability between two devices, (ii) the variable net surplus of digital contents, and (iii) the prices of the digital devices.