Versioning information goods of multi-channel publishers in two-sided markets

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Abstract

Purpose – The purpose of this paper was to identify whether the two-sided nature of markets in both online and offline channels affects the versioning strategies of multi-channel publishers in the presence of channel substitutability.

Design/methodology/approach – Using analytical models, the versioning of a multi-channel publisher is analysed, with consideration of advertising revenue and possible channel substitutability.

Findings – The paper shows that not only the two-sided nature of the online market but also that of the offline market affects the versioning strategy online. Multiple online versions are desired when the offline advertising market shrinks and the online advertising market proliferates. In a reverse situation, providing one online version (for free) can be optimal.

Originality/value – Previous studies on versioning have mostly considered only the information market *per se*. However, studies on two-sided markets have shown that analysis that focuses on a single side leads to analytical error due to inter-market network externalities. In this context, it is proven that advertising revenue is a critical factor in the publisher's decision whether to provide multiple online versions.

Keywords Digital communication systems, Print media, Advertising, Income, Publishers

Paper type Research paper

Introduction

As the penetration of the internet progresses, there is an increasing awareness within the traditional publishing community that besides their traditional offline channel, an additional channel for content distribution is available online. Nowadays, most traditional publishers provide their content both online and offline. For example, *The Wall Street Journal* launched *The Wall Street Journal Online* in 1996 and *The Washington Post* established a web site in 1996, while *Britannica Online* has been available since 1994.

In providing information goods through both online and offline channels, publishers such as newspapers and magazines often serve two closely linked markets – advertisers and readers (Rochet and Tirole, 2004). This is referred to as a two-sided market in the economic literature since the willingness of advertisers to pay depends on the size of the readership. Advertisers expect larger gains when the number of readers is larger. In addition, the readers' demand might be a function also of the amount of advertising (Rochet and Tirole, 2004). This property is referred as

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inter-market network externalities. Moreover, this feature is known to have strong implications for pricing (Rochet and Tirole, 2004).

However, it has been widely ignored in the studies on versioning of information goods. Versioning, which is also known as second-degree price discrimination, has long been a practical and useful strategy for pricing and market segmentation by publishers who serve heterogeneous consumers, and who know the aggregate distribution of consumer valuations (Bhargava and Choudhary, 2001; Shapiro and Varian, 1999). It has been recommended that firms and retailers of information goods should use this strategy, especially in the digital economy. This is mainly because the costs of producing different versions of information goods are almost zero, and this strategy can reduce product comparison and help firms to meet the different value perceptions of customers (Ancarani, 2002).

Given the growing importance of versioning, many researchers have analysed this issue. However, in deriving versioning strategies, most previous studies have considered only a single side of the market – the market for readers (Bhargava and Choudhary, 2001). The two-sided nature of markets has been widely neglected in the studies of versioning. Our study aimed to fill this void. The research question that we addressed was whether the two-sided nature of markets in both online and offline channels affects the versioning strategy of publishers.

Using analytical models, we analysed versioning of a multi-channel publisher, with consideration of advertising revenue and possible channel substitutability, as prior empirical studies indicated. Our results show that both online and offline advertising revenues affect the quality and number of versions of information goods online. This implies that not only the two-sidedness within the online channel but also that of the offline channel affects the versioning strategy of multi-channel publishers online.

Literature review

Two-sided markets

"Two-sided markets" is the term used to refer to situations in which businesses cater to two interdependent groups of customers (Rochet and Tirole, 2004). The two-sided market shows that inter-market network externalities have crucial consequences for pricing structure (Parker and Van Alstyne, 2005; Rochet and Tirole, 2004). In the two-sided market, it has been shown that the market that contributes more to demand for its complement is the market that should be subsidised (Parker and Van Alstyne, 2005; Rochet and Tirole, 2004). In case of the advertising and readers' markets, the readers' market has been subsidised by advertising (Chaudhri, 1998; Kaiser, 2004). This implies that publishers have generated most of their revenue from advertising by attracting readers with low prices (sometimes even below-cost) (Chaudhri, 1998; Parker and Van Alstyne, 2005; Rochet and Tirole, 2004). In the case of the print newspapers and magazines, 78 per cent of the revenue has traditionally been generated from advertising income (Eisenmann and Rust, 2000). Online advertising revenue is one of the mostly widely discussed revenue streams for most providers of information goods (Gallaugher *et al.*, 2001). Moreover, online advertising is developing into a major advertising outlet for millions of firms. In 2007, in the USA alone, firms spent $21.2 billion on online advertising, nearly a 26 per cent increase over the spending in 2006 (PricewaterhouseCoopers, 2008).

Versioning

By providing multiple versions of a product with different quality levels and at different prices, which is known as versioning, a publisher can separate consumers into different segments (Bhargava and Choudhary, 2001). The dimensions of versioning that determine the quality levels of information goods include time delay, convenience, features and capability (Shapiro and Varian, 1999). Recently, versioning has become more practical and feasible with the emergence of internet and web technologies that make the reproduction and distribution of information much more flexible, and customisation and personalisation easy (Shapiro and Varian, 1998). For example, some newspaper web sites allow visitors to view some portion of the information for free but require a subscription fee to view all available content in their databases. This kind of versioning is easily achieved by restricting the number of features made available to visitors (Dedeke, 2002).

Given the growing importance of versioning, many researchers have analysed this issue. Mussa and Rosen (1978) were the first to examine versioning in a market with heterogeneous consumers. In a context where marginal costs increase more rapidly than quality, they concluded that the monopolist would find it optimal to price discriminate by offering multiple quality levels. Varian (1992) examined price discrimination for information goods with their special cost structure of zero marginal costs, and demonstrated that price discrimination would not be optimal. Jones and Mendelson (1998) also found that it is not profitable for the monopolist to price discriminate in the context of a linear valuation function and zero marginal costs. Bhargava and Choudhary (2001) generalised prior work along two directions: they formulated their model with both a generalised consumer distribution, which allows for a broad class of continuous consumer distributions, and an arbitrary cost function without making any assumption about marginal cost. They found that versioning is not optimal when the highest quality product has the best benefit (quality)-to-cost ratio. When the highest quality product provides consumers the highest benefit for the cost it incurs, no consumers will choose a lower quality product. Under this condition, the firm cannot segment consumers by offering multiple quality products. Hence, it becomes optimal to provide only the highest quality version.

Looking at the situation in reverse, this implies that providing multiple versions is optimal when the lower quality product has the best benefit-to-cost ratio.

In deriving versioning strategies, most previous studies only considered the market of information consumers (Bhargava and Choudhary, 2001). However, when firms serve two linked markets that show inter-market network externalities, analysis that focuses on a single side leads to analytical errors (Argentesi and Filistrucchi, 2005). In this context, Bhargava and Choudhary (2004) showed that in the presence of inter-market network externalities, it is optimal for an online information intermediary – which serves sellers and buyers – to provide multiple versions (two extreme versions) of service with different qualities to buyers even though the lower quality service does not have the best benefit-to-cost ratio. In spite of the emerging importance of the two-sided nature of markets for an information goods provider, the research regarding versioning in two-sided markets is still lacking, with the exception of Bhargava and Choudhary (2004). Our paper aims to fill this void, and differs from Bhargava and Choudhary (2004) in that we consider the multi-channel context in deriving the versioning strategy.

The relationship between online and offline channels

An issue that we need to consider under the multi-channel context is the relationship between online and offline channels. Regarding the internet channel addition, many researchers are concerned about channel cannibalisation (Alba *et al.*, 1997; Brynjolfsson and Smith, 2000). For the publishers, cannibalisation losses can be reflected in a net reduction in the print newspapers' existing income streams (Deleersnyder *et al.*, 2002). According to a Scarborough Research survey of web site users of 88 newspapers in the top 50 US markets from August 2004 to March 2007, online newspaper readership grew 14 per cent over that period (Reuters, 2008). The increase in web site audience is mitigating print audience losses by 28 per cent (Reuters, 2008).

Still, discussion of the relationship between offline information and its online version has been quite controversial and has yet to be settled to a certain extent. For example, some see the online newspaper as a substitute whose growth will curtail the market for the print newspaper. A 2002 Newspaper Association of America (NAA) online newspaper consumer survey indicated that one-third of its respondents said they were now using the print newspaper less (Coats, 2002). According to the Scarborough Research survey, exclusive online readership – those who do not read the print version – increased 21 per cent from August 2004 to March 2007 (Reuters, 2008).

Others have argued that the online edition will not wipe out print consumption, and may even complement it. A 2002 survey of US online readers by Belden Associates found that 21 per cent of respondents reported buying more print copies since they began using the internet (Belden Interactive, 2002). The same survey found that 7 per cent had started a new print subscription since beginning to read online. As noted by Gentzkow (2007), while the print edition offers particular advantages such as portability, less eye strain, and the tactile experience of a printed page, the online edition also offers specific advantages such as access to breaking news, access to old archives, etc. All these factors tend to lower the degree of interchangeability between the products.

However, recent empirical studies with more statistical rigour show that the online newspaper is a substitute for rather than a complement of the print newspaper (Filistrucchi, 2005; Gentzkow, 2007; Kaiser, 2005). Gentzkow (2007) tested for substitutability and complementarity between *The Washington Post* and its online edition, and found that substitutability between the two exists. Filistrucchi (2005) showed that the online editions of major Italian newspapers appear to have a negative impact on the market shares of their print editions in Italy. Kaiser provided econometric evidence for significant negative effects of companion web site traffic on the print circulation of national newspapers in Germany (Kaiser, 2005). Empirical analysis of the German magazine market has shown that a magazine's companion web site induces channel competition for its print version (Kaiser, 2006). Of course, for some publishers, the online channel strongly complements the offline counterpart (Shapiro and Varian, 1999), so substitutability is not universal. Still, as shown in the above empirical studies, it is an important issue for many publishers. Hence, in this study, we focused on the substitutability between online and offline versions.

Information consumers' attitudes towards advertising

It is clear that the willingness of advertisers to pay depends on the size of the readership. However, the effect of advertising on readers' demand is not clear (Argentesi and Filistrucchi, 2005). If readers are advertisement-lovers, selling advertising space enhances the size of the readership, so that both sources of revenue – readers and advertising – increase with an increase in advertising space. By contrast, if readers are advertising-averse, promotion of advertising sales slows down the circulation. Therefore, the readers' attitudes towards advertising are critical in determining the appropriate level of advertising. However, empirical studies on readers' attitudes towards advertising have provided very mixed evidence at best. Some researchers have insisted on the positive effects of press advertising on circulation because increases in advertising increase the demand for the newspaper or magazine at any given price (Blair and Romano, 1993). This view is supported by empirical analysis of the American press industry (Rosse, 1980). However, the survey results of a study by Sonnac (2000) showed that about half of newspaper or magazine readers in European countries tend to be advertising-avoiders. A total of 51 per cent of newspaper readers in France and Italy, 48 per cent of readers in Spain, and 54 per cent of readers in Germany were reported to be advertising-avoiders. Depken and Wilson (2004) also found it difficult to determine the effect of advertising on readers. Investigating 95 US magazines, they found that for 45 magazines advertising was unambiguously good, for 31 magazines it was unambiguously bad, and for the remainder advertising was moderately good. Kaiser and Wright (2004) found that a very low significance of the effect of advertising on readers' demand for magazines in Germany. In this context, Argentesi and Filistrucchi (2005) have argued that the assumption of independence of readers' demand from advertising is a plausible approximation of reality. Therefore, in this paper, we assume that readers on average are neutral in terms of their perception of advertising. Based on this assumption, it is assumed that advertising has no effect on readers' valuation of the print information goods *per se*.

We confront the same issue when dealing with online versions. Here, it is still difficult to determine the effect of advertising on readers. Mehta and Sivadas (1995) assessed internet users' attitudes towards advertising on newsgroups and through e-mail. They found that consumers held negative attitudes towards such advertising. Cho and Cheon (2004) studied advertising avoidance on the internet given the low click-through rates. However, by interviewing 318 business executives in New York City, Ducoffe (1996) found that they perceived web advertising to be generally useful and valuable. Surveying a larger and more representative sample of readers, Schlosser *et al.* (1999) showed that readers' attitudes towards online advertising were evenly divided among positive, negative and neutral. Similarly, a recent study conducted on online advertising showed that 33 per cent of Latvian internet users perceive that online advertisements are irritating, while the rest of them are willing to accept online advertisements (Gemius, 2008). Therefore, we make the same assumption about readers' attitudes towards advertising online as offline.

The model

The model formulation

Assumptions regarding online and offline versions. In this study, we focus on the substitutability between online and offline versions. Hence, substitutability between channels is assumed. In economics, one good is said to substitute for another good when customers can trade off one good for the other if it is advantageous to do so (Sexton, 2006). Thus an increase in price for one good results in an increase in demand for its substitute (Sexton, 2006). In this model, it is assumed that an increase in price of an offline (online) version increases the demand for the online (offline) version. The demand for the online version, $n_1(p, p_1)$ (shown in the Appendix) increases as the price of the offline version, p, increases. Likewise, the demand for the offline version, $n(p, p_1)$, increases as the price of the online version, p_1, increases.

We assume that a publisher has provided printed information (offline version) in a monopolistic situation before the online channel became available. Since we focus on the emergence of the online channel and versioning through this new medium, it is assumed that only one highest quality version exists offline because of the high cost of producing a degraded version offline.

We assume that consumers (readers) get value not only from the information itself but also from the characteristics of the channel. Hence, it is also assumed that the quality of the printed information is determined by the degree of information completeness, denoted as s, and the physical appearance of the medium, denoted as k, which is based on characteristics such as easy portability, low eye strain and the tactile experience of the printed page, all of which are valued by consumers. Therefore, we denote the quality of printed information g as $g = sk$. Since the level of s is related to a fixed investment that is not easily changeable in the short term, we assume that s is given. The physical appearance aspect of the printed information, k, is exogenously given. The marginal cost for production and distribution of this printed information is c.

With the emergence of internet and web technologies, versioning becomes more practical and costless. In providing online versions of the content, it is assumed that copying the content and putting it on the web does not require additional costs. The marginal cost of providing an online copy to an additional reader is negligible (Shapiro and Varian, 1999).

In reading, the traditional medium is assumed to have several aforementioned advantages over the new electronic medium, such as easy portability, low eye strain and the tactile experience. Shapiro and Varian (1999) also noted that in many cases, the print version is superior in terms of convenience. For example, many readers feel that it is easier to read text on paper than on a screen. That is, the online physical appearance quality k_o is lower than that of the printed goods k. Hence, even though a publisher maintains same information completeness online and offline as s, consumers value more and willingly pay more for the printed version. For example, even though the online edition of *The Wall Street Journal* includes all the news in the print newspaper, the publisher charges only \$79 per year to online edition readers, while it charges \$199 to print edition readers. Another example is that the CD-ROM version of the *Encyclopedia Britannica* is only \$44.99, while the printed *Britannica* is \$1,395. As shown in these examples, the online or digital version, despite its unique features, may be priced lower because it is less attractive in terms of consumption preferences[1].

Given k_o, in providing multiple online versions, the publisher can determine the level of information completeness of those versions in order to differentiate quality levels. Depending on the decision of the publisher, the information completeness of an online version i, s_i, can vary in the range of $0 < s_i \leq s$. Then, the quality of an online version can be expressed as $g_i = s_i k_o$. We denote the highest quality of an online version sk_o as $\bar{g}_o$.

Based on specific online characteristics, it is assumed that free alternative information becomes available online. For example, there are thousands of free news sources online, and we can even find a free encyclopedia, Wikipedia, online. Like the publisher's own online version, the physical appearance of the online channel for free alternative information is limited to the same level, k_o. Therefore, we can define the quality of online free substitutes as $g_c = s_c k_o$, where s_c is the given information completeness of free substitutes. Considering the monopolistic power of the publisher before the age of the internet, we assume that the publisher still remains a dominant provider to potential market readers even after online substitutes become available. Therefore, the information completeness of the printed information provided by the publisher is greater than that of online alternatives. In other words, we assume that $s_c < s$. Therefore, $g_c < \bar{g}_o$. Here, the ratio s_c/s $(= g_c/\bar{g}_o)$ indicates the generality of the content offered by the publisher. As the ratio increases, commoditisation of the information increases.

Assumptions regarding the advertising market. As shown in the previous literature on advertising in media, the demand for advertising is comprised of the mass of advertisers who find that the expected benefit from communicating with a reader (an information consumer) exceeds the per-reader price of the advertisement stipulated by the medium (Anderson and Coate, 2005; Anderson and Gabszewicz, 2005). That is, the demand for advertising depends on the per-reader price of the advertisement.

Assuming that there are m advertisers who consider advertising in the offline version and whose expected profit from contacting a reader is $v \in [0, e]$, the expected benefit for an advertiser from contacting n readers is vn. This implies that an advertiser's willingness to pay increases as the number of readers increases. This assumption is consistent with previous studies on two-sided markets. Since there are m advertisers, the demand for advertising in the offline version is $q(r) = m(1 - F(r))$. Here, r is the per-reader price of the advertisement in the offline version determined by the publisher and the total price is rn. $(1 - F(r))$ is the fraction of advertisers whose expected profit per-viewer exceeds r. We assume that $F(0) = 0$ and that F is increasing and continuously differentiable, with a strictly log concave density. In delivering q offline advertisements to a reader, we assume that it costs the publisher tq where t is the unit cost of an advertisement.

Similarly, we assume that m_o advertisers exists, who consider advertising on the web site of the publisher and whose expected profit from contacting a reader (an information consumer) is $v \in [0, e_o]$. Then, the demand for advertising is $q_o(r_o) = m_o(1 - F(r_o))$ where r_o is the per-reader price of the advertisement online determined by the publisher and $(1 - F(r_o))$ is the fraction of advertisers whose expected profit per reader exceeds r_o. Considering the characteristic of the online medium, we assume that the cost of delivering q_o online advertisements to a reader is negligible.

Assumptions regarding information consumers' decision-making. As in previous studies, we posit that information consumer's valuations are linear in terms of quality level (Bhargava and Choudhary, 2001; Jones and Mendelson, 1998). Hence, it is assumed that there are n potential consumers whose taste parameter for the information goods quality, θ, is distributed according to $U[0,1]$. For simplicity, n is normalised to 1. The publisher knows the distribution of the consumers' taste, but cannot identify θ for each consumer. The utility of a consumer with θ can be defined as:

- $U = \theta g - p$ if a consumer chooses the printed information;
- $U_i = \theta g_i - p_i$ if a consumer chooses an online version i;
- $U_c = \theta g_c$ if a consumer chooses the free online substitutes

where p and p_i represent the price of the printed information and online version i, respectively. It is assumed that prices are always non-negative. This assumption is realistic in general. The consumer chooses among printed information, online versions and online substitutes to maximise his or her utility. The consumers' choices determine the demand for the print and online versions.

Versioning information goods. Under the above assumptions regarding the online and offline versions, information consumers and the advertising market, we derive the optimal number, quality levels and prices of versions that are provided to information consumers. Since we are addressing the versioning issue between channels, it is assumed that online versions do not wipe out the print version, and vice versa. To highlight the effect of the advertising revenue stream on versioning, we first examine the benchmark case of the publisher without advertising revenue (i.e. the case of the publisher that serves only information consumers). Then expand the model to include the advertising revenue stream.

Analysis of the model

Proposition 1. The optimal versioning strategy of the publisher without advertising revenue both online and offline is to provide only one online version – the highest quality ($\bar{g}_o$) version. The price for this version is determined by the quality difference between the publisher's online version and its free substitutes.

Proof. See Appendix 1.

This proposition is consistent with the results of Bhargava and Choudhary (2001), which provide general guidelines for a versioning strategy for publishers without advertising revenue. The benefit (quality)-to-cost ratios of the offline and online versions are c/g and $0/\bar{g}_o$, respectively. Since the online version has a better benefit-to-cost ratio than the higher quality offline version, that is, $0/\bar{g}_o < c/g$, the publisher finds it optimal to provide the online version in addition to the offline version. However, providing more than one online version is not optimal because an additional lower quality online version would not have a better benefit-to-cost ratio, that is, $0/g_2 = 0/\bar{g}_o$. This situation results from the zero marginal cost of online versions.

This proposition shows that the cost efficiency of the online channel motivates the publisher to provide an online version. However, cost efficiency and flexibility in versioning online does not provide the publisher with any incentive to produce multiple versions online.

Analysing versioning of the publisher with advertising revenue, we get the following results. For simplicity, we define $qr - (qt + c)$ as the publisher's offline advertising profit per reader where qr is the advertising income per reader and $(qt + c)$

is the marginal cost to deliver information and advertising to a reader. Likewise, $q_o r_o$ is defined as the publisher's advertising profit per reader online where the marginal cost to deliver information and advertising to a reader is negligible. We denote the optimal online advertising profit per reader as a_o and the optimal offline advertising profit per reader as a in propositions for notational simplicity. We assume $a > 0$ from the fact that revenue generated from print newspapers or magazines has traditionally been roughly split 20 per cent and 80 per cent between subscription and advertising income, and the average profit margin has been 20 per cent to 30 per cent (Eisenmann and Rust, 2000).

Proposition 2. When the offline advertising profit per reader is less than that online (i.e. $a < a_o$), the optimal versioning strategy of the publisher with advertising revenue both online and offline is to provide two extreme online versions, the lowest quality (g_c) version for free and the highest quality ($\bar{g}_o$) version with the same price as in Proposition 1.

Proof. See Appendix 2.

As shown in the previous proposition, if we only consider the cost and benefit sides of possible online versions, the optimal strategy of the publisher should be to provide only one online version, that is, the highest quality one. However, our results show that advertising revenue allows the publisher to provide multiple online versions. This is due to the inter-market network externalities of the two-sided market and it is consistent with the results of Bhargava and Choudhary (2004). This result shows that the optimal multi-version strategy of the publisher with advertising revenue is to provide two extreme online versions: the fee-based version (highest quality) and the free version (lowest quality). By providing a free version of the lowest possible quality[2], the publisher can successfully minimise cannibalisation of revenue from the offline and fee-based online versions. At the same time, by providing a free online version, the publisher can obtain a larger audience online and have greater online advertising revenue. The publisher has an incentive to provide an additional free online version because of the characteristic of the two-sided market in which the larger the audience, the greater the willingness of advertisers to pay.

To practice this versioning strategy, which is a higher version for a fee and a lower version for free, the information that the publisher provides needs to have some degree of specialty that cannot be found elsewhere for free. If the information is easily found elsewhere for free, that is, $\bar{g}_o = g_c$, the only choice of the publisher is to provide one online version of the highest quality for free. Hence, we observe that only the newspaper and magazine publishers of specialised information – where the gap between the highest possible online quality and the quality of online free substitutes is large – practice this versioning strategy. For example, *Fortune*, *The Wall Street Journal* and *Business Week* provide some online information for free to capture an audience for advertising revenue, and the remaining unique content for a fee.

Proposition 3. When the offline advertising profit per reader is not less than that online (i.e. $a \geq a_o$), the optimal versioning strategy of the publisher with advertising revenue both online and offline is to provide only one online version, the lowest quality (g_c) version for free.

Proof. See Appendix 2.

As shown in the previous proposition, the publisher with advertising revenue online is willing to provide a free online version to attract a larger audience. However, unlike the previous proposition, if the publisher generates greater advertising profit offline than online, the publisher has no incentive to provide the highest quality online version that attracts some of the high end print readers. This implies that the firm's incentive to provide the highest quality online version for a fee is affected by offline advertising revenue. If the publisher gets relatively less advertising profit offline than that online, the publisher is willing to charge for online content by providing the highest quality version online. We define advertising profit as advertising income minus the cost of production and distribution of the information goods. Hence, this condition can likely be met with online advertising market proliferation, offline advertising market shrinkage, and the high cost offline. An interesting point is that these tendencies are what we can observe in the market. It has been noticed that publishers' web sites have a higher profit margin than print, because they do not incur the cost of printing or distribution (*Economist, 2006*). Also, the online advertising market continues its high growth while that offline tends to stay still or shrinks since more and more companies focus on marketing online (Project for Excellence in Journalism, 2006). In case of *The Wall Street Journal*, the online division appeared to be collecting much more profit than its print counterpart in 2005 (Project for Excellence in Journalism, 2006). Hence, we can infer that charging online will become a more important market issue among publishers. High growth in the online advertising market does not lessen the need for charging online. On the contrary, growth in the advertising market online, and the accompanying shrinkage of that offline incurs a greater need for charging online.

The effect of online channel enhancement on the publisher. Technological advancement continuously improves physical appearance (k_o) of the online channel. Therefore, given the optimal versioning strategy of the publisher, we investigate how online medium enhancement affects the profit level of the multi-channel publisher.

Proposition 4. In the case of the publisher without advertising revenue, the profit increases as the online physical appearance (k_o) is enhanced when the offline marginal cost is high ($c > \hat{c}$). Otherwise, the profit decreases as the online physical appearance is enhanced.

Proof. For this publisher:

$$\frac{\partial \pi^*}{\partial k_o} > 0 \text{if} c > \hat{c}\left(\hat{c} = \frac{1}{\bar{g}_o}(g - \bar{g}_o)\sqrt{\bar{g}_o g_c}\right), \text{and} \frac{\partial \pi^*}{\partial k_o} \leq 0 \text{otherwise.}$$

The online channel becomes a more powerful substitute for the offline channel as the physical properties of the online channel are enhanced. This proposition implies that when the offline channel is very costly, the enhanced substitutability of the online channel benefits the publisher because it is now able to convert some of its demand from the costly offline version to that of the more cost efficient online one. Otherwise, without much gain from the cost gap, the firm will suffer revenue loss due to the shift of customers to the cheaper online version.

Proposition 5. In the case of the publisher with advertising revenue whose optimal strategy is providing two extreme online versions, the profit increases as the online physical appearance (k_o) is enhanced when the offline advertising profit is small ($a < \hat{a}$). Otherwise, the profit decreases as the online physical appearance is enhanced.

Proof. For this publisher:

$$\frac{\partial \pi^*}{\partial k_o} > 0 \text{if} a < \hat{a}\left(\hat{a} = a_o - \frac{1}{\bar{g}_o}(g - \bar{g}_o)\sqrt{\bar{g}_o g_c}\right). \text{Otherwise,} \frac{\partial \pi^*}{\partial k_o} \leq 0.$$

In this study, we assume that the offline advertising revenue is sufficient to cover the marginal cost of the offline version, that is, $a > 0$. Therefore, the marginal cost of the offline version is not an issue in utilising the online channel for the publisher who generates offline advertising revenue. Instead, the advertising revenue offline matters to the publisher. This proposition shows that when the online version is easily substituted for the offline product, it can benefit the publisher who provides two extreme online versions, because the demand for the offline version is converted to that of the high quality online version. This is especially true when the publisher cannot generate much revenue from its offline advertising.

Proposition 6. In the case of the publisher with advertising revenue whose optimal strategy is providing one free online version only, the profit decreases as the online physical appearance (k_o) is enhanced.

Proof. For this publisher:

$$\frac{\partial \pi^*}{\partial k_o} < 0.$$

We can infer from this proposition that for the publisher who only provides a free online version, enhanced substitutability of the online channel reduces the publisher's profit.

Discussion

Inapplicability of the benefit-to-cost ratio rule in two-sided markets

Bhargava and Choudhary (2001) have presented the most general guideline so far for the versioning of information goods, that is, the benefit (quality)-to-cost ratio. However, we show that this guideline is not applicable to the case of publishers who serve two-sided markets – our analysis produced different results because advertising revenue alters the cost structure. Let's consider the case of a publisher with online advertising revenue. If the publisher does not consider charging a fee to a consumer of an online version, serving a consumer gives the publisher a zero or near zero marginal cost, but generates advertising income. This implies that the net cost to serve a consumer is $-a_o$. As the net cost becomes negative, the benefit-to-cost ratio rule becomes invalid in developing a versioning strategy.

Still, the benefit-to-cost ratio rule is valid as long as the net cost to serve a consumer remains positive, that is, the marginal cost to deliver information and advertising to a reader is not covered by advertising income, $qr - (qt + c) < 0$. However, as mentioned earlier, 78 per cent of revenue is normally generated from advertising income, and the average profit margin is 20 per cent to 30 per cent in the print newspaper and magazine businesses (Eisenmann and Rust, 2000). This implies that advertising revenue covers the marginal cost offline. The marginal cost online is negligible due to the nature of the online channel. Therefore, online advertising revenue can conceivably cover the marginal cost online. Thus, in most cases of publishers with advertising revenue, the benefit-to-cost ratio rule is not appropriate in developing a versioning strategy.

The effect of the two-sided nature of markets on versioning in the multi-channel context
Our results can be summarised in Table I. Table I[3] shows the online versioning strategies of the following publishers: the publisher who generates no advertising revenue either online and offline – "with no ads" in both online and offline channels in the table, the publisher who generates advertising revenue only online – "with ads" in the online channel and "with no ads" in the offline channel, the publisher who generates advertising revenue online and small advertising revenue offline – "with ads" in the online channel and "with small a" in the offline channel, and the publisher who generates advertising revenue online and large advertising revenue offline – "with ads" in the online channel, "with large a" in the offline channel. In the table, the symbol "O" and "X" represent the publisher's strategy to provide or not provide a certain version.

Comparing versioning strategies with and without advertising revenue, we can notice that a publisher that serves both the advertising and readers' markets online has an incentive to provide multiple online versions to readers. This result is consistent with that of Bhargava and Choudhary (2004) that shows inter-market network externalities incur the need to provide multiple versions (two extreme versions) of service for an online information provider. However, the two-sided nature of markets online does not always trigger a publisher to provide multiple online versions. The publisher is better off providing one online version when offline advertising profit per reader is greater than that online. Still, we can notice that the versioning strategy of a publisher with advertising revenue is different from that of a publisher without it. Even when a publisher with advertising revenue provides one online version, what it provides is not the highest quality version but the lowest version for free. This strategy aims to attract a larger audience online to generate greater advertising revenue. Also, it minimises cannibalisation of the print version.

In summary, providing a free online version is desirable as long as the publisher gets online advertising revenue. The need to provide an online version for a fee occurs when a publisher gets small advertising profit offline. These results show that in deciding whether to provide a free online version, only the online advertising revenue matters. However, deciding whether to provide an online version for a fee depends largely on the offline advertising revenue. In a similar context, market practitioners such as Colby Atwood, vice president of Borrell Associates, argue that a big part of the motivation for newspapers to charge for their online content is to cover their loss in the print newspaper market (Project for Excellence in Journalism, 2006). This implies that for a multi-channel publisher, versioning of information goods online and whether to

Table I.
Versioning of a publisher with and without advertising

Advertising revenue for each channel of the publisher			
Online channel	Offline channel	Online version for a fee (Highest quality)	Free online version (Lowest quality)
With no ads	With no ads	O	X
With ads	With no ads	O	O
With ads	With small a ($a < a_o$)	O	O
	With large a ($a \geq a_o$)	X	O

provide an online version for a fee or for free depend not only on the advertising revenue online but also the advertising revenue offline.

Conclusion

Although the prevailing business model of information goods providers includes advertising, previous studies of versioning have mostly considered only the information market *per se*. However, studies of two-sided markets show that the analysis that focuses on a single side leads to analytical error due to inter-market network externalities. In this context, we prove that advertising revenue is a critical factor in the publisher's decision whether to provide multiple online versions. The optimal multi-version strategy of the publisher who relies on advertising revenue is derived as providing two online versions, the fee-based high quality version and the competitive low quality free version. In fact, many publishers practice this strategy online, providing some content for free on an advertising-sponsored site to obtain a larger audience and attract online advertising revenue, and requiring subscription fees for unique content not easily found elsewhere. *Fortune*, *The Wall Street Journal* and *Business Week* are examples. However, the two-sided nature of markets does not always trigger a publisher to provide multiple online versions. Our results show that the need to provide an online version for a fee arises when the online advertising market proliferates while that of the offline market shrinks. This implies that for the multi-channel publisher, versioning information goods online depends not only on the advertising revenue online but also the advertising revenue offline.

In this paper, we have focused on versioning of information goods online, while considering advertising revenue and substitutability between online and printed information. However, there are additional factors not included in our analysis that may motivate publishers to offer multiple versions or free online versions. For example, information goods are defined as experience goods. Therefore, publishers can distribute free samples to inform readers about the value of their products (Shapiro and Varian, 1999). Besides, it has been shown that increasing familiarity with the web site positively affects customer loyalty (Flavián *et al.*, 2006). Hence, with the growing importance of gaining loyalty among consumers, publishers can be motivated to provide a lower quality online version for free for the acquisition of customers and ensuring their loyalty. Moreover, it has been shown that loyalty to the service provider is higher when the service is chosen online than offline. Further research regarding versioning needs to include more of these issues.

Another point is that the versioning that we have focused on in this research is the versioning of the same information good that readers consume once. Therefore, substitutability is an issue between the online and offline channels. However, online, publishers can not only provide the same information that they provide offline but can also provide information and features not available offline such as archives and interactive features. For this type of additional information and features available online, the complementarity issue between channels beyond versioning needs to be addressed in further research.

A limitation of our study also stems from our assumption regarding readers' attitudes towards advertising. We assume that readers' attitudes towards advertising are neutral on average due to mixed evidence. Our results may hold for publishers whose readers in general slightly dislike or like advertising. However, it may not hold for the publishers whose readers in general strongly dislike or like advertising. Further research must take this into consideration.

In this paper, we have derived our results from analytical modeling. A limitation of our research therefore stems from our research methodology. To develop an analytical model and to derive a meaningful message from the model, we have simplified the real world situation. Various real world conditions can create additional complexity in deriving the versioning strategy of publishers. Therefore, further empirical research with sufficient consideration of the real world situation is desired to enhance or complement our results.

Notes

1. From the specific cost structure of information goods, cost-based pricing makes little sense. Rather, value-based pricing is much more appropriate (Shapiro and Varian, 1999). In this context, the less valued version is priced lower. Therefore, we can infer that the market practice of lower prices online indicates that the online versions are valued less by consumers than their offline substitutes.
2. Here, the minimum possible quality of an online version is the quality of a free substitute.
3. In Table I, the versioning strategy of the publisher that generates advertising revenue only online is included since the web, as a new advertising medium, enables even the publisher whose offline business model does not include the advertising revenue stream to have advertising revenue online. For example, Britannica.com provides some content for free on its advertising-sponsored site. However, we do not analyse the reverse case – the case of the publisher with advertising revenue only offline – since it is rarely practiced. In reality, most publishers such as newspapers and magazines that generate advertising revenue offline also attract advertisers online. We omitted the proof of the versioning of the publisher that generates advertising revenue only online since the derivation procedure is similar to that of the publisher that generates advertising revenue in both channels.

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Appendix 1. Proof of Proposition 1

When the publisher decides to provide one online version, the demand for the printed information is derived as:

$$n(p, p_1) = 1 - (p - p_1)/(g - g_1). \tag{1}$$

That of the online version is:

$$n_1(p, p_1) = (p - p_1)/(g - g_1) - p_1/(g_1 - g_c). \tag{2}$$

Note that no consumer will buy online content if its quality is lower than that of free substitutes. Hence, $g_1 \geq g_c$. Given the demand, the publisher's profit function is derived as:

$$\pi(p, p_1, g_1) = n(p - c) + n_1 p_1. \tag{3}$$

Then, the optimal prices of the publisher are:

$$p^* = (g - g_c + c)/2 \text{and} p_1^* = (g_1 - g_c)/2. \tag{4}$$

The condition for the existence of the printed information is $(p^* - p_1^*)/(g - g_1) < 1$. To derive the optimal g_1, we substitute p and p_1 in equation (3) with p^* and p_1^* as in (4). After substituting, we can get $\partial \pi / \partial g_1 > 0$. Hence, $g_1^* = \bar{g}_o$.

Consider the case when the publisher provides multiple online versions. If the publisher provides two online versions, the demand for the printed information is derived as in (1). The demand for the higher quality online version is:

$$n_1(p, p_1, p_2) = (p - p_1)/(g - g_1) - (p_1 - p_2)/(g_1 - g_2). \tag{5}$$

where g_2 and p_2 represent the quality and the price of the lower quality online version, respectively. The demand for the lower quality online version is:

$$n_2(p_1, p_2) = (p_1 - p_2)/(g_1 - g_2) - p_2/(g_2 - g_c). \tag{6}$$

where $g_2 \geq g_c$. Then, the publisher's profit function is derived as:

$$\pi(p, p_1, p_2, g_1, g_2) = n(p - c) + n_1 p_1 + n_2 p_2. \tag{7}$$

We can derive optimal prices of the publisher as:

$$p^* = (g - g_c + c)/2, p_1^* = (g_1 - g_c)/2 \text{and} p_2^* = (g_2 - g_c)/2. \tag{8}$$

From this result, we can see that $n_2(p_1^*, p_2^*) = 0$. This implies that no potential readers intend to read the lower quality online version. Therefore, providing one online version is optimal.

Appendix 2. Proof of Propositions 2 and 3

With one online version, we can derive n and n_1 as in (1) and (2). Then, the publisher's profit function is $\pi(p, p_1, r, r_o, g_1) = n(p + rq - tq - c) + n_1(p_1 + r_o q_o)$. From the first and second-order conditions for the decision variable r, r^* can be derived, which is independent of the number of offline readers, n. For simplicity, we denote $r^* q(r^*) - tq(r^*) - c$ as a ($a > 0$), which is the optimal advertising profit per reader offline. Likewise, we get r_o^* and denote $r_o^* q_o(r_o^*)$

as a_o. The publisher's profit function becomes:

$$\pi(p, p_1, g_1) = np + na + n_1 p_1 + n_1 a_o. \tag{9}$$

Then, the optimal p^* and p_1^* are easily obtained as follows:

$$p^* = (g - g_c - a)/2, \text{ and } p_1^* = (g_1 - g_c - a_o)/2. \tag{10}$$

However, note that $p_1^* \leq 0$ regardless of the quality level of g_1 if a_o is not less than $\bar{g}_o - g_c$. For non-negativity of price, fixing$p_1 = 0$, the profit function is:

$$\pi(p, g_1 | p_1 = 0) = np + na + n_1 a_o. \tag{11}$$

and the optimal p^* is given as:

$$p^* = (g - g_1 - a + a_o)/2. \tag{12}$$

We assume $p^*/(g - g_1) < 1$ for the existence of the printed information even after the publisher decides to provide an online version. Plugging p^* into$p$ in (11), it can be shown that $\partial\pi/\partial g_1 < 0$. Therefore, the optimal g_1 is derived as g_c.

If $a_o < \bar{g}_o - g_c$, p_1^* derived as in (10) is positive for any g_1 in the range $a_o + g_c < g_1 \leq \bar{g}_o$. In other words, in the given quality range, charging for the online version becomes a viable option. In this case, we assume $p_1^*/(g_1 - g_c) < (p^* - p_1^*)/(g - g_1)$ to guarantee coexistence of the online version and the printed counterpart where p^* and p_1^* are as in (10).

Then, in the quality range of $a_o + g_c < g_1 \leq \bar{g}_o$, the profit function of the publisher is that in equation (9). Substituting p and p_1 in (9) with p^* and p_1^* as in (10), we can show that $\partial\pi/\partial g_1 \geq 0$ if $g_1 \geq \hat{g}_1$, and $\partial\pi/\partial g_1 < 0$ if $g_1 < \hat{g}_1$ where π is the profit function in (9). Here, $\hat{g}_1$ is derived as $\hat{g}_1 = (ag_c + a_o g - a_o g_c)/a$. The optimal g_1 is located at the boundary of the interval $a_o + g_c < g_1 \leq \bar{g}_o$. However, even though the optimal g_1 that maximises the profit function (9) is derived in the range of $a_o + g_c < g_1 \leq \bar{g}_o$, we still need to compare the maximum profit of equation (9) with the optimal profit in the range of $g_c \leq g_1 \leq a_o + g_c$.

In the quality range of $g_c \leq g_1 \leq a_o + g_c$, the profit function is derived as in (11) and optimal p^* is as in (12). Since $\partial\pi/\partial g_1 < 0$, the optimal g_1 is at the minimal level g_c.

From the above profit functions, we notice that the available maximum profit in the range $a_o + g_c < g_1 \leq \bar{g}_o$ (the profit at the boundary of the interval) is smaller than that in the range of $g_c \leq g_1 \leq a_o + g_c$. Therefore, the optimal profit is obtained with p^* in (12), $p_1^* = 0$ and $g_1^* = g_c$ when $a_2 < \bar{g}_o - g_c$.

In conclusion, when the publisher provides one online version, the optimal prices and quality of g_1 are p^* as in (12), $p_1^* = 0$ and $g_1^* = g_c$ regardless of online advertising revenue.

Let's consider the case when the publisher provides multiple online versions. If the publisher provides two online versions, the demand for the printed information, higher and lower quality online versions are as in (1), (5) and (6). Then, the publisher's profit function is as in:

$$\pi(p, p_1, p_2, g_1, g_2) = np + na + n_1 p_1 + n_1 a_o + n_2 p_2 + n_2 a_o. \tag{13}$$

The optimal prices of the publisher are straightforwardly derived as:

$$p^* = (g - g_c - a)/2, p_1^* = (g_1 - g_c - a_o)/2, \text{ and } p_2^* = (g_2 - g_c - a_o)/2. \tag{14}$$

If $a_o < \bar{g}_o - g_c$ and $a < a_o$, the optimal prices derived as in (14) are positive and positive demand exists for each version when the publisher sets the quality of the online versions in the range $a_o + g_c < g_2 < g_1 \leq \bar{g}_o$. In this case, $\partial\pi/\partial g_1 > 0$ and $\partial\pi/\partial g_2 < 0$. Therefore the profit function (13) has its maximum at the maximum g_1 and the minimum g_2.

To derive the globally maximised profit, we also need to investigate the profit in the quality range of $g_2 \leq a_o + g_c < g_1 \leq \bar{g}_o$. For non-negativity of price, we fix $p_2 = 0$; then the profit function becomes:

$$\pi(p, p_1, g_1, g_2 | p_2 = 0) = np + na + n_1 p_1 + n_1 a_o + n_2 a_o. \tag{15}$$

Then, the optimal prices are given as in (16).

$$p^* = (g - g_2 - a + a_o)/2, \text{ and } p_1^* = (g_1 - g_2)/2. \tag{16}$$

Plugging p^* and p_1^* into equation (15), we know that $\partial \pi / \partial g_1 > 0$ and $\partial \pi / \partial g_2 < 0$. Therefore, the optimal g_1 is at the maximum level $\bar{g}_o$ and the optimal g_2 is g_c.

In the quality range of $g_2 < g_1 \leq a_o + g_c$, the optimal profit is derived as in (15), where the optimal g_1 and g_2 are $a_o + g_c$ and g_c, respectively.

Comparing the maximum profit levels for the three different quality ranges, we can conclude that the optimal profit in the range of $g_2 \leq a_o + g_c < g_1 \leq \bar{g}_o$ has the highest level. This implies that when the publisher provides two online versions, the optimal choice's prices and the quality of the online versions are p^* and p_1^* as in (16), $p_2^* = 0$, $g_1^* = \bar{g}_o$, and $g_2^* = g_c$.

We also investigate whether the publisher has any incentive to provide more than two online versions when $a_o < \bar{g}_o - g_c$ and $a < a_o$. If the publisher adds one additional lower quality online version, the demand for the printed information and the higher quality online version are as in (1) and (5). The demand for the middle quality online version is derived as:

$$n_2(p_1, p_2, p_3) = (p_1 - p_2)/(g_1 - g_2) - (p_2 - p_3)/(g_2 - g_3). \tag{17}$$

where g_3 and p_3 represent the quality and the price of the lower quality online version, respectively. The demand for the lower quality online version is derived as:

$$n_3(p_2, p_3) = (p_2 - p_3)/(g_2 - g_3) - p_3/(g_3 - g_c). \tag{18}$$

Based on this, we can derive the optimal prices as:

$$p^* = (g - g_c - a)/2, p_1^* = (g_1 - g_2)/2, p_2^* = (g_2 - g_c - a_o)/2, \text{ and } p_3^* \\ = (g_3 - g_c - a_o)/2. \tag{19}$$

To investigate the publisher's incentive to provide three online versions, we need to investigate its profits in the quality range of $a_o + g_c < g_3$ and $g_3 \leq a_o + g_c$.

In the case where the publisher sets online quality levels to be $a_o + g_c < g_3$, the optimal prices derived as in (19) are positive. However, we can easily observe that $n_2(p_1^*, p_2^*, p_3^*) = 0$. This implies that when the publisher sets the online quality levels to be $a_o + g_c < g_3$, the publisher is better off not providing the middle quality online version, g_2.

In the case where the publisher sets online quality levels to be $g_3 \leq a_o + g_c$, $p_3^* \leq 0$. For non-negativity of price, we fix $p_3 = 0$, then derive p^*, p_1^* and p_2^*. The profit function is:

$$\pi(p, p_1, p_2, g_1, g_2, g_3 | p_3 = 0) = np + na + n_1 p_1 + n_1 a_o + n_2 p_2 + n_2 a_o + n_3 a_o. \tag{20}$$

Then, the optimal prices are:

$$p^* = (g - g_3 - a + a_o)/2, p_1^* = (g_1 - g_3)/2, \text{ and } p_2^* = (g_2 - g_3)/2. \tag{21}$$

It still holds that $n_2(p_1^*, p_2^* | p_3 = 0) = 0$. This also implies that the publisher is better off not providing the middle quality online version, g_2 in this case, either. Summarising our results, we conclude that the publisher is better off not providing more than two online versions when $a_o < \bar{g}_o - g_c$ and $a < a_o$.

Now, we investigate the optimal versioning strategy when online or offline advertising revenue does not satisfy the above conditions. Because of the similarity of the derivation process, we omit the detailed proofs. If $a_o \geq \bar{g}_o - g_c$ and $a < a_o$, it is optimal to provide two online versions. The optimal prices and quality of the online versions are p^* and p_1^* as in (16), $p_2^* = 0$, $g_1^* = \bar{g}_o$, and $g_2^* = g_c$.

Irrespective of online advertising revenue, if $a \geq a_o$, providing multiple online versions is not optimal, since the n_1^* of both equations (13) and (15) is negative. Hence, it is optimal to provide only one online version. The optimal prices and quality of the online version are p^* as in (12), $p_1^* = 0$, and $g_1^* = g_c$.

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