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A model of advertiser—portal contracts: Personalization strategies under privacy concerns

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Abstract Online portals provide personalization for "free" since the information acquired from consumers' usage of these services is valuable for advertising and targeted marketing purposes. Consumers' usage of services is determined by the tradeoff between their marginal value for personalized services and the resulting information privacy concerns and is captured by their personalization for privacy (P4P) ratio. A portal's decision to offer personalized services is dependent upon its cost of offering the services and revenue due to advertisers' marginal value for information (MVI) acquired therein. Through three models, our paper examines the strategic interaction between a portal that determines the service level to be offered and advertisers who pay the portal for placing advertisements through which they acquire information. Our first model of an independent portal finds that while all profits are increasing in the advertiser's MVI, with increasing P4P ratio the advertiser's profits are increasing at a faster rate than the portal's profits. In our second model, we consider an information sharing regime between two advertisers and find that a high MVI advertiser has a distinct first-mover advantage in announcing the services rate for the entire market. Our final model considers a portal that has its own advertising capabilities and we find that while this case is superior to others in the high MVI advertiser's and portal's profits, the consumer welfare and overall social welfare is dependent on the relative valuations of the two advertisers.

Keywords Electronic commerce · Portals · Personalization · Privacy · Advertising · Game theory

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1. Introduction

Many portals and other websites offer "free" personalization services to online consumers as their access to consumers' preference and usage information is critical for advertisers and direct marketers [8]. While apparently costless from a monetary perspective, research on consumer behavior suggests that online consumers incur privacy costs when sharing information about themselves and their preferences during personalization [18]. Portals not only have to incorporate consumers' demand for personalization services but they also have to take into consideration the value of consumers' preference information to advertisers and marketers. Thus in offering these services portals evaluate the revenue from channeling information to advertisers against the technology, infrastructure and liability costs of acquiring, processing and storing preference information.

Our analytical approach is built upon behavioral work that suggests that consumers are more likely to accept loss of privacy if it accompanies some benefit [11] and that consumers share information based on some "privacy calculus" [6]. In the context of personalization, prior research has abstracted this privacy calculus through the consumers' personalization for privacy tradeoff that is a ratio of their marginal value for personalization and their privacy cost coefficient [3]. In these earlier models, portals were intrinsically endowed with a marginal value for preference information and this value was given exogenously. We extend this stream of research to analyze the relationship between agents further up the supply chain so as to study the contracts between portals who offer personalization and advertisers who value consumer information acquired through the portal offerings. Thus in our model it is the advertisers who posses a marginal value for information (MVI) and they announce a services rate to be paid to the portal offering these services. We consider a market where consumers are distributed on their personalization for privacy tradeoffs and first determine the aggregate information that can be acquired by the advertiser for a given service level offered by the portal. The strategic interaction between the portal and the advertiser has been modeled as a Stackelberg game and we specifically analyze three situations that are representative of current online portal operations. In the first model discussed in Section 3.1, we consider a case where the portal and advertiser operate independently. Subsequently we introduce an information sharing regime to examine the presence of any first-mover advantage when one of the advertisers has a high MVI by comparing the results from a simultaneous move and a leader-follower game. Finally, we model the channel as a single entity that we refer to as the advertising portal and examine the optimal service offerings. By comparing the results from the third model with that of the previous two we discuss implications for practice in terms of investments in trust-building activities.

2. Model

In our model we have 3 types of agents, consumers of personalization services, a portal that offers free personalization services and advertisers that value the information obtained through the portal. Vendors' provision of personalization is dependent upon on two factors: i. the existing state of data mining and other technology that is available to them and ii. the amount of preference information that consumers provide. The technology determines how vendors can use consumer information to tailor services to the consumer's tastes, e.g. tools that interface with consumers over the Web and house personalization engines that are based on various data mining techniques [13,20]. A combination of these technologies allows portals like my-msn to provide consumers with personalized weather information, personalized television listings or personalized news on their stock portfolio depending upon whether consumers have provided their zip code and stock information. Thus for a given amount of consumer information the current level of technology determines how many personalized services can be created.

This information-services mapping is given by a linear function $i = g \cdot s$, where i is customer's preference information (ordered to be increasingly personal), s is the personalization services and g represents the current state of personalization technology [3]. An advanced personalization technology ($g < 1$) would imply even for a single unit of information multiple units of personalization services can be created although it is generally agreed that personalization itself is somewhat still in its infancy even if information acquisition technologies have made significant advances [5]. Hence through out this paper, we assume a simple personalization technology ($g = 1$) where a unit of information leads only to a single unit of service, i.e. $i = s$.

Consumers' usage of personalization services can be understood as a convenience value or as an opportunity cost incurred by them when content is not personalized to their needs and they have to seek it out for themselves. In the physical world, this value has been extracted successfully by luxury hotels that charge a premium to personalize rooms and services to consumers' specific tastes and needs [12]. In the case of online portals, the only cost incurred by the consumers is their privacy cost incurred due to revelation of personal and preference information that may be shared with others by the portal. Consumers balance their perceived benefits of sharing with the risks of disclosure [7] to arrive at their decision to use personalization. Empirical research has also observed that consumers not only differ in their in their value for personalization but they also possess differing concerns for privacy [4]. Considiring these factors together an individual consumer's utility from using personalization services can be represented

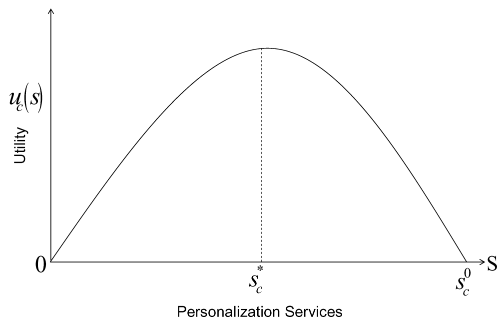


Fig. 1 Consumer utility from personalization services

as

$$u_c(s) = p_c s - r_c i^2 \quad (1)$$

where p_c is the marginal value for personalization andr_c the privacy cost coefficient of the consumer.

It is quite easy to observe that for most part consumer behavior can be largely abstracted by two service levels, services s_c^0 that represent the maximum number of services a consumer would use and her utility maximizing number of services s_c^* (Fig. 1). While the former is the break-even or zero utility service level $u_c(s_c^0) = 0$, the latter is the solution to the maximization problem $u_c(s_c^*) = \max_s p_c s - r_c i^2$. Incorporating the simple personalization technology ($i = s$), equation (1) can be written as

$$u_c(s) = p_c s - r_c s^2 \quad (2)$$

Definition of P4P (personalization for privacy) ratio: The ratio of a consumer's marginal value for personalized services (p) and her information privacy cost coefficient (r)

The P4P ratio is a consumer specific characteristic and is critical in determining her usage behavior in the context of personalization. This ratio is a quantitative representation of the behavioral construct "privacy calculus" as suggested by [6]. Knowing this ratio allows us to determine the optimal information that a consumer will share as well as the maximum information she will provide. In terms of services, this will provide us the optimal number of services she will use (s_c^*) and the maximum number of services (s_c^0) she can be expected to use while enjoying non-negative utility. From equation (2), we can see that $s_c^0 = \frac{p_c}{r_c}$ and $s_c^* = \frac{p_c}{2r_c}$. Realistically, online portals offer a myriad of services and it is consumers who determine the number of services to be used. For our analysis, we consider a market of consumers whose P4P ratio is uniformly distributed, i.e. $\frac{p}{r} \approx U[0, b]$ which automatically implies that the break-even service level and optimal service level are distributed as $s_c^0 \approx U[0, b]$ and $s_c^* \sim U[0, \frac{b}{2}]$ respectively. Thus for a given set of service offerings s by a portal, it is easy to see that some consumers will use their optimal service level s_c^* (consumers with $s_c^* \leq s$) and others will use the given service level.

2.1. Advertiser and portal profit functions

Advertisers on the Web value the information acquired through portals as they not only extract revenue from their client base by reselling this information, but online advertisers themselves employ sophisticated consumer profiling technology to create layers of value added services, e.g., Google's AdSense, AdWords, etc. Moreover, these firms can aggregate information across different product and service categories to create cross-selling recommendations. For example, a firm like DoubleClick has created its own advertising technology called DART through cookies and aggregating it with information acquired from a portal, it can create accurate consumer profiles. Thus the primary value to an advertiser from entering into a contract with a portal is from the acquisition of raw consumer information. If a portal offers personalization services s, then the aggregated information acquired from all consumers who use some or all of these services is denoted by $D(i)|_{i=g\cdot s}$. If R represents an advertiser's MVI, the benefit to the advertiser in contracting with the portal is $R \cdot D(i)$. Hence we can write the advertiser's profit function as

$$\pi_a = R \cdot D(i) - \alpha s - C \quad (3)$$

where C is some fixed cost of maintaining his advertising infrastructure. The parameter α represents the *services rate* or the marginal price paid by the advertiser to incorporate his technology in each of the personalization services provided by the portal and serves as the main source of revenue for the portal. Consumer information is acquired from two segments, the privacy seekers and the convenience seekers; the former consumers are those who are satiated by the service level ($s_c^* \leq s$) offered by the portal and hence only use their surplus maximizing level of services and the latter are those who would ideally prefer more services ($s_c^* > s$) but have to make do with the service level that is being offered. Thus in a market where consumers' P4P ratios are uniformly distributed, we can rewrite equation (3) as

$$\pi_a = R\left(\int_o^s s_c^* U(s_c^*) ds_c^* + \int_s^{\frac{b}{2}} sU(s_c^*) ds_c^*\right) - \alpha s - C \tag{4}$$

In offering online personalization, portals incur different types of infrastructure and information protection or liability costs. In addition to the basic cost of acquiring and managing content, infrastructure costs include the cost of employing personalization technologies such as collaborative filtering systems and rule-based engines [10]. When portals offer personalization services they also need to prepare themselves to protect the information they collect and store and there are specific requirements and guidelines for vendors operating in special domains such as ones that deal with kids and medical information, e.g., Children's Online Privacy Protection Act (COPPA) and Health Insurance Portability and Accountability Act (HIPPA) [1,14]. Along these lines, a portal's cost function is modeled as βs^2, where β is the portal's cost coefficient such that the net costs are convex in the total number of services offered. Note that these costs are infrastructure costs and the marginal cost of serving an additional consumer is zero. Given that the payment for services from advertisers is the only source of revenue, we can write a portal's profit function as

$$\pi_p = \alpha s - \beta s^2 \tag{5}$$

3. Advertiser—portal contracts

In analyzing the nature of advertiser—portal contracts, there are essentially two decisions we need to look at; first, the services rate that an advertiser is willing to pay and second, the optimal level of services that a portal will offer. There are primarily three models that are of interest to us from the perspective of current advertiser-portal relationships. The first model is one where an independent portal contracts with an advertiser where the portal itself has no value for information and its revenue is solely based on the advertiser's payment. In the second model, we allow the portal to sell consumer information to more than one advertiser and we analyze two cases where advertisers differ in their MVI; one where the two advertisers play a simultaneous move game and the other where a high MVI advertiser knows a low MVI advertiser's strategy in advance and acts as the leader. Our third model explores a setup where the portal runs its own advertising network that is similar to a coordinated physical product supply chain [15].

3.1. The independent portal

First, we analyze a simple case that we refer to as the independent portal model. In this model, a portal and an advertiser strategically interact to determine the optimal service level and the optimal service rate. This setup is representative of many portals such as About.com, epinions.com and others that offer personalization to consumers and advertisers such as DoubleClick, Advertising.com and AvenueA.com are allowed to place tracking cookies and other technology to acquire usage information. We model this interaction as a Stackelberg game between the portal and the advertiser where the advertiser is the leader and first announces a services rate α. The portal observes this rate and determines the optimal service level s that it would offer to the consumers. For any rate announced, we know that a rational portal will maximize its profits given by equation (4) and thus we can get the service reaction of portal for different rates α as $s(\alpha) = \frac{\alpha}{2\beta}$. Being the leader, the advertiser will take into account the behavior of the portal in maximizing its own profit and determining its optimal services rate.

Lemma 1. *The optimal services rate announced by the advertiser will be* $\alpha_i^* = \frac{R}{2+\frac{R}{b\beta}}$ *and the corresponding service level offered by the portal will be* $s_i^* = \frac{R}{\beta(\frac{2R}{b\beta}+4})$. *The portal's and advertiser's profit will be* $\pi_{ip}^* = \frac{R^2}{4\beta(\frac{R}{b\beta+2})^2}$ *and* $\pi_{ia}^* = \frac{R^2}{4\beta(\frac{R}{b\beta+2})} - C$

Lemma 1 gives us the optimal decisions of the portal and the advertiser. We can see that the ratio $\frac{R}{b\beta}$ is critical in many of the optimality decisions and that the service level, service rate and all profits are strictly increasing in the advertiser's MVI, R. However, note that a vendor will never offer services greater than $\frac{b}{2}$ as no consumer will find it optimal to use services beyond this level, i.e., $s_i^* \leq \frac{b}{2}$. This is because the consumer with the highest P4P ratio ($\frac{p}{r} = b$), has her utility maximizing service level $s_c^* = \frac{b}{2}$, so even if a portal offers more services, he will not be able to deliver the corresponding information to the advertiser. It can also be observed that when the advertiser's MVI is very high, the service level offered by the portal approaches the utility maximizing service level of the consumer with the highest P4P ratio, i.e., $\lim_{R\to\infty} s_i^* \to \frac{b}{2}$.

We can also see that $\lim_{R\to\infty} \alpha_i^* \to b\beta$, implying that the maximum profit that a portal ever stands to make is $\frac{b^2\beta}{4}$. An important managerial implication of this result pertains to online portals' investments in personalization services; first it is clear that while the advertiser's MVI is important, in large part the portal's profits are limited by its own cost coefficient and more importantly the consumers' P4P ratio. Prior research has shown that consumers' trust in a Web entity is strongly related to their privacy concerns during the usage of personalization services [4]. Thus investing in trust-building activities can increase the consumers' P4P ratio and influence consumers to be more of convenience seekers rather privacy seekers. Our analysis suggests that it is in the best interest of the portals to invest in various trust building activities and assure safeguarding of consumer information beyond nominal compliance requirements set by a regulator such as the FTC. We observe that while both the advertiser's ($\frac{\delta\pi_{ia}^*}{\delta b} \Rightarrow \frac{R^3}{(4(R+2b\beta)^2)} > 0$) and portal's ($\frac{\delta\pi_{ip}^*}{\delta b} \Rightarrow \frac{b\beta R^3}{2(R+2\beta)^3} > 0$) profits are increasing in the consumers' P4P ratios, the advertiser's profits are increasing at a higher rate as $\frac{\delta\pi_{ia}^*}{\delta b} - \frac{\delta\pi_{ip}^*}{\delta b} \Rightarrow \frac{R^4}{4(R+2b\beta)^3} > 0$. Therefore, it is clearly in the best interest of the advertiser to ensure investment in trust building activities. Since it is the portal that directly interfaces with the consumers, the advertiser may consider employing some cost-sharing mechanism through which he can incentivize the portal. We shall further discuss the potential for this cost-sharing mechanism to serve as a basis for channel coordination in Section 3.3.

3.2. Independent portal and information sharing between advertisers

In this model we seek to understand how information sharing amongst two advertisers can affect a portal's optimal service offering and the services rate it receives. We evaluate two possibilities; first we consider a simultaneous move game between two advertisers with varying MVI ($R_1 > R_2$) both of whom are leaders and jointly announce a service rate α and the portal responds with the maximum service level it will offer and second, we consider a case when the high MVI advertiser is the sole leader and announces the services rate taking into account the information sharing of the low MVI advertiser. Note that for digital information such as those acquired from usage of personalization services, the marginal cost of serving an additional client advertiser is zero. Hence once a set of services have been contracted, selling information corresponding to a subset of the service set can be done in a costless fashion. Therefore, the portal without incurring any extra cost can receive revenues from both advertisers. Thus the portal's profit function can be written as

$$\pi_{isp} = \alpha\big(s_1 + s_2\big) - \beta s_1^2 \tag{6}$$

where s_1 and s_2 are the services corresponding to the information acquired by the high and low MVI advertisers respectively. From the advertisers' point of view, the value of the common information is now reduced as it is no more the sole owner of this information. For analytical simplicity, we assume that the value of common information is now equally shared between the advertisers and the part of the information that is proprietary retains its full value. Hence if $D(i_1)$ is the total information acquired and $D(i_2)$ is the information that corresponds to the service level contracted by the low MVI advertiser, then information that is now proprietary to the high MVI advertiser is only $D(i_1) - D(i_2)$. The value of $D(i_2)$ information is equally split between the two. Since the advertisers acquire this information directly from the portal, they individually contract with the portal. Hence we can now write the two advertisers' profit functions as

$$\begin{aligned} \pi_{a1} &= R_1(D(i_1) - D(i_2)) + \tfrac{R_1}{2} D(i_2) - \alpha s_1 - C_1 \\ \pi_{a2} &= \tfrac{R_2}{2} D(i_2) - \alpha s_2 - C_2 \end{aligned} \tag{7}$$

where C_1 and C_2 are some fixed cost. Substituting for information obtained by the two advertisers in terms of service levels, we can re-write equation (7) as

$$\pi_{a1} = R_1\left(s_1 - s_2 - \frac{s_1^2 - s_2^2}{b}\right) + \frac{R_1}{2}\left(s_2 - \frac{s_2^2}{b}\right) - \alpha s_1 - C_1$$
$$\pi_{a2} = \frac{R_2}{2}\left(s_2 - \frac{s_2^2}{b}\right) - \alpha s_2 - C_2 \tag{8}$$

We first consider the case when both the advertisers move simultaneously in contracting with the portal with neither advertiser possessing any advance knowledge of each other's strategy. The portal's decision is based on the service rate that is announced by both advertisers. Both can announce their individual service rates, but the low MVI advertiser knows that the high MVI one's service requirements are higher and hence that rate will be accepted by portal. This is because once the portal is able to offer the higher service level it can extract revenue from the lower service level without incurring any additional cost. Hence, in this setting the high MVI advertiser announces the service rate, the low MVI advertiser determines the information subset it will use and the portal determines the maximum service it will offer.

Lemma 2. *When the high MVI advertiser announces the services rate and the low MVI advertiser simultaneously determines the subset of the total information that he will acquire, the services rate $\tilde{\alpha}_{isp}^*$ paid by both the advertisers and the maximum services that will be offered by the portal $\tilde{s}_1^*$ will be the same as the independent portal case given in Lemma* 1. *The low MVI advertiser will acquire information corresponding to services*

$$\tilde{s}_2^* = \frac{\frac{R_1}{2\beta} - (\frac{R_1}{R_2} - 1)}{\frac{R_1}{b\beta} + 2}$$

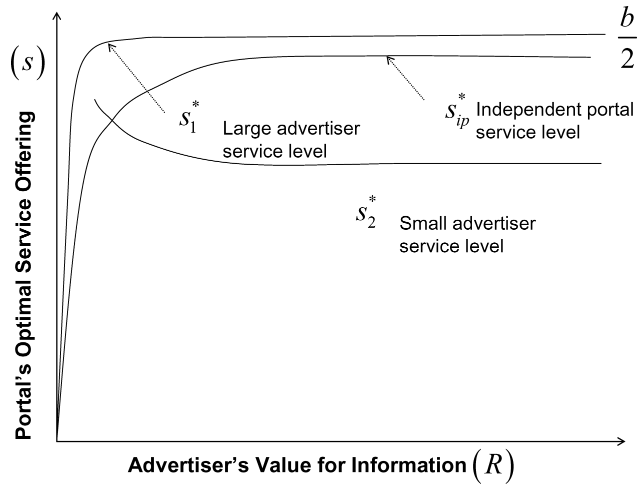
Lemma 2 tells us that presence of an additional advertiser is profitable to the portal as he now gets $\tilde{\alpha}_{isp}^*(\tilde{s}_1^* + \tilde{s}_2^*)$, while only suffering the cost of creating $\tilde{s}_1^*$ services. On the other hand the competition for information from the second advertiser implies that the high MVI advertiser has to pay the same amount to the portal as it might have in the independent case and receives the same amount of information while the value of this information has diminished as part of it is not proprietary anymore. One can observe the similarity of this result with that of a Cournot quantity competition model. Similar to price in a Cournot model, the services rate in our model determines the total services that will be produced, and similar to the quantity sharing in the former, advertisers in our model agree to share the information market. As the low MVI advertiser bids for a greater share of information, the high MVI advertiser's profits decrease, while the portal's profits are rising. The main difference with the Cournot setup is that the actions or characteristic of the low MVI advertiser neither affects the equilibrium services rate (price in the Cournot setup) nor the maximum services offered by the portal (Cournot equivalent of the quantity produced).

The results of Lemma 2 typifies the online context where either a new portal or a portal evaluating new sets of personalization services is soliciting advertisers and letting the market decide the services rate. From the point of view of the advertiser who has a high MVI it is clear that he would prefer to be sole owner of the information as sharing reduces his profit, while on the other hand the portal will definitely prefer more advertisers as he can serve them at no extra costs. Thus if it is inevitable that a portal will not engage in an exclusive contract, we examine the case where the high MVI advertiser acts as a strategic leader in the market so as to determine if there are any first-mover advantages to be gained.

Lemma 3. *When a high MVI advertiser is the leader and announces a service rate taking into account the low MVI advertiser's reaction, the announced service rate, and the maximum number of services offered by the portal will be higher than in Lemma* 2. *The low and high MVI advertisers will contract to use information from services $s_2^* = \frac{b}{2}(1 - \frac{2}{\frac{R_2}{b\beta} + \frac{2R_2}{R_1} - \frac{2b\beta}{R_2}})$ and $s_1^* = \frac{1}{4\beta(\frac{1}{R_1} - \frac{b\beta}{R_2^2} + \frac{1}{2b\beta})}$ respectively at services rate given by $\alpha_{isp}^* = \frac{1}{\frac{1}{b\beta} + 2(\frac{1}{R_1} - \frac{b\beta}{R_2^2})}$.*

The results of Lemma 3 are arrived at by considering the behavior of the high MVI advertiser when he can make the first move in the market. When the high MVI advertiser is the leader, he knows that for an announced service rate, the maximum services that

Fig. 2 Relative optimal service levels



a portal will offer and the portion of the information that will be contracted by the low MVI advertiser, and he will take these reactions into account in maximizing his own profits. While the reaction of the portal is increasing in the services rate announced, the reaction of the low MVI advertiser is decreasing in this rate ($s_2(\alpha) = \frac{b(R_2 - 2\alpha)}{2R_2}$). Thus the optimal strategy of the high MVI advertiser depends upon the tradeoff from increasing service rate (his own cost) and decreasing information sharing (increasing his proprietary base). Comparing the results from Lemmas 2 and 3 provides us with some interesting insights. First, we can see that the profit of the high MVI advertiser is higher in Lemma 3, implying that he can garner a first-mover advantage in announcing the service rate. Note that he announces a higher rate than in Lemma 2 thus forcing the low MVI advertiser to contract for lesser information and therefore leaving a larger portion of information under his sole ownership. We can also see from Fig. 2, that for increasing information value for the high MVI advertiser, the difference between the service levels is weakly increasing and hence the common or shared portion of the consumer information is decreasing. Since the maximum service level offered by the portal in the simultaneous move game is the same as in the case of the independent portal, we know that the net consumer welfare is higher under Lemma 3 when the high MVI advertiser is the first-mover. Finally, the producer welfare is also higher in this case as both the portal and the high MVI advertiser gain in their profits and compensate for the loss that the low MVI advertiser suffers in the process, implying that the social welfare is also higher when the high MVI advertiser moves first.

It is important to note that there are upper limits or bounds on how many services can be offered by the portal and similarly there is also a limit on how much information can be contracted by the low MVI advertiser. While the former is a function of the consumers' P4P ratio, the latter is due to the fact that the low MVI advertiser cannot acquire more information than the high MVI one as the maximum service offered by the portal is limited by the high MVI advertiser's contract.

Proposition 1. *The portal will offer the consumer welfare maximizing level of services ($s_c^* = \frac{b}{2}$) if $R_1 \geq \frac{R_2^2}{b\beta}$ and optimal service levels described in Lemma* 3 *is contracted only if the advertisers' relative MVI is bounded as* $\frac{R_1}{R_2} \in (\frac{\frac{R_2}{b\beta}}{1+\frac{R_2}{b\beta}}, \frac{R_2}{b\beta}]$.

Figure 3 provides an illustration of the relative valuations of the two advertisers for which equilibrium exists. From Proposition 1, we can see that while the service rate and services offered are increasing in the higher MVI, the advertiser knows that the portal will be unable to deliver information beyond the level corresponding to $\frac{b}{2}$ as no consumer will use it. Hence for a relative valuation $\frac{R_1}{R_2} \geq \frac{R_2}{b\beta}$, the advertiser will offer a fixed service rate of $b\beta$. Similarly $\frac{R_1}{R_2} < \frac{\frac{R_2}{b\beta}}{1+\frac{R_2}{b\beta}}$ implies that there is not sufficient differentiation between the two advertisers to reach equilibrium information sharing as the low MVI advertiser prefers consumer

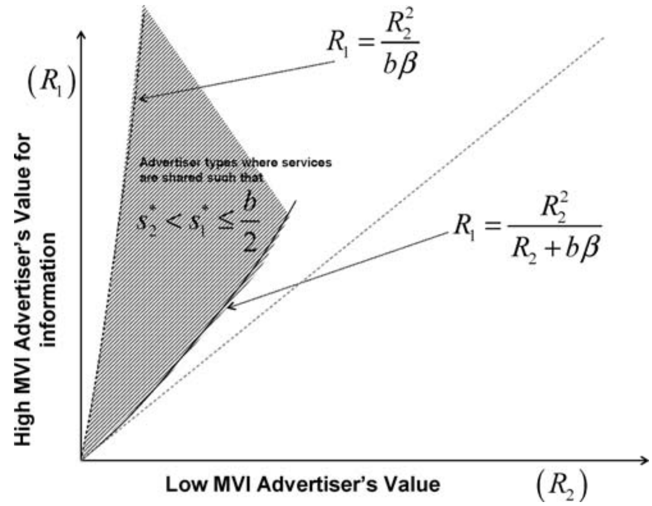


Fig. 3 Information sharing and relative valuations

information as much or higher than the high MVI advertiser.

3.3. The advertising portal

Finally, we consider a model that is representative of portals such as AOL and more recently Yahoo!, where the portals themselves possess vast advertising and consumer profiling abilities. These portals don't merely act as conduit for advertising and rely on income from advertisers; rather they themselves have units that develop tools for targeted advertising and one-to-one marketing. Yahoo's recent acquisition of Overture is primarily geared towards using the latter's sophisticated "contextual advertising" tools in conjunction with its own vastly popular personalized portal services (see www.internetnews.com/IAR/article.php/2235001). Recently Yahoo! has created a program called Consumer Direct that is being run in tandem with ACNielsen's Homescan unit, which records the off-line purchases of roughly 60,000 consumer volunteers. About 19,000 of these consumers have also agreed to let Yahoo track their surfing behavior and offer feedback on purchases to Consumer Direct advertisers [16].

Thus these portals directly interface with clients whose advertisements they carry and provide the marketing and product managers in the client firms with sophisticated consumer research tools. We refer to these portals as advertising portals where the portal and advertising entity are one and the same. Consistent with the MVI parameter and cost coefficient discussed earlier, we can write the profit function of an advertising portal as

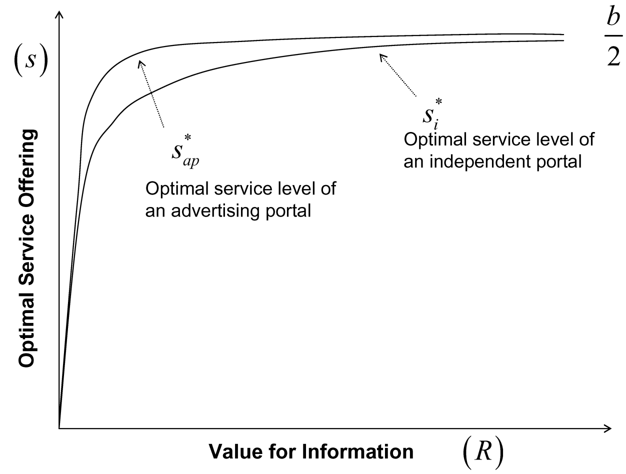
$$\pi_{ap} = R \cdot D(i) - \beta s^2 - C \tag{9}$$

When we compare this model with that discussed in Section 3.1, we can see that the profit function of the advertising portal is nothing but the profit of the entire services channel (equation (9) is the sum of equations (5) and (3)). The importance of comparing channel profits with that of a manufacturer and retailer has mostly been discussed in operations management literature on physical product supply chains [2]. The goal of this literature is to coordinate a channel such that both producers (manufacturer and retailer) are better off through a coordination mechanism than when they operate independently. Hence, in this section where the advertiser behaves like a manufacturer and the portal acts as a retailer, we shall also analyze the possibility and implications of coordinating the portal-advertiser channel.

Lemma 4. *When a portal runs its own advertising network, then the optimal number of personalization services it will offer is* $s_{ap}^* = \frac{R}{2\beta(\frac{R}{b\beta}+1)}$. *The portal's profits will be given by* $\pi_{ap}^* = \frac{R^2}{4\beta(\frac{R}{b\beta}+1)} - C$.

Proposition 2. *The service level offered by the advertising portal is always higher than that offered by the independent portal.*

Fig. 4 Independent and advertising portal's optimal service offerings



It is quite straight forward to compute the optimal service level of an advertising portal and comparing this service level with that from Lemma 1, we can see that the service level offered by the advertising portal is always higher than when the portal and the advertiser are two distinct entities (Fig. 4). This automatically implies that consumer welfare is higher in the advertising portal model as compared to the independent model as the service level of the former is closer to the consumer surplus maximizing level of services $\frac{b}{2}$.

We can also see that the advertising portal's profits are greater than the sum of the independent portal and advertiser's profits as shown in Fig. 5. Given that both the consumer surplus and the producer surplus are higher in the advertising portal case, the social welfare of this system is also higher. Thus one could argue that from a regulator such as the FTC's perspective, a monopoly consisting of an advertising portal is actually beneficial to the society as long as consumers are allowed to choose their optimal service levels from the offered set of services. An important observation that can be drawn from Lemmas 1 and 4 is that the profits are bounded by the value of the consumers' P4P ratio. Since the only way to increase this ratio is to modify consumer behavior or their privacy concerns, investments in trust-building technologies and alliances are warranted.

Trust-building is a costly exercise and in the online context this is primarily achieved through relationships with reputed trusted third-parties (e.g., TRUSTe, WebCPA) and through implementation of security mechanisms offered by firms such as Verisign. These measures can go beyond the required reassurances through

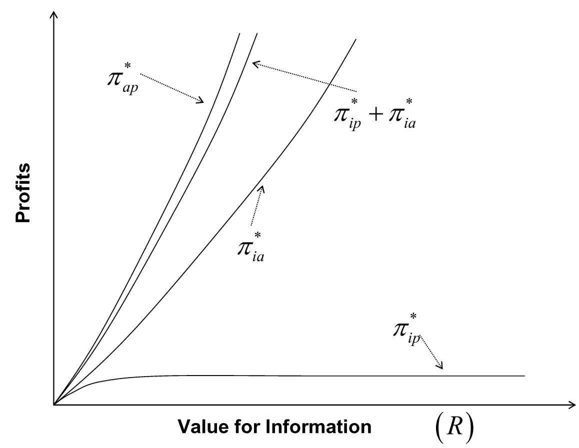


Fig. 5 Profits in the independent and advertising portal models

disclosure notices and mere compliance with the FTC rules [9]. We can see that $\pi_{ap}^* > \pi_{ia}^* + \pi_{ip}^*$ implying that some of the channel profits is lost by the supply-chain inefficiency due to the friction introduced by the independent operations of the portal and the advertiser. Thus if the two agents agree to cooperate and operate as one entity they can be both better off by sharing the profits; however it is well known that profit sharing can be a costly exercise as it requires monitoring of the agents [2]. A more reasonable way to coordinate this channel can be through shared investments in trust-building technologies as both parties stand to gain from increased P4P ratios. Such a mechanism is a reasonable alternative to well known coordinating schemes for physical product supply chains such as quantity buy-back and return policies when products suffer inventory costs.

While the advertising portal model is superior to the independent model in both profits and consumer welfare, it is not clear if the coordinated channel is better than the information sharing regime for both producers and consumers. A reason being that the information sharing model can be considered to be the equivalent of a competitive model and thus one could expect a greater quantity (or greater service level in our case) to be produced which may negatively impact producer surplus while positively affecting the consumers.

Proposition 3. *The maximum service level offered by a portal under the information sharing regime may be higher ($s_1^* \geq s_{ap}^*$) than when it is an advertising portal if $R_1 \geq \frac{R_2^2}{2b\beta}$.*

From Proposition 3, we can see that it is not necessary that an advertising portal will always offer a higher level of service than a portal that allows information sharing. When the MVI of an advertiser is sufficiently high compared to its competitor, it chooses to raise the services rate high enough such that a portal finds it optimal to raise the level of services higher than if the advertiser and portal were one entity. This allows the high MVI advertiser to distance itself from its competitor such that a larger portion of the information is proprietary to itself. Note that once again this raises the consumer welfare, however the producer welfare is still less than in the case where the portal is advertising portal. The intuition behind this observation is that consumer welfare increases as services level approaches $\frac{b}{2}$, but with increasing service levels, the high MVI advertiser is extracting most of its profits from the low MVI advertiser who has to pay a higher services rate and therefore forced to contract for lesser services. Thus from a channel coordination point of view, the channel profits are still their highest when the portal itself engages in advertising, however consumer welfare and potentially social welfare might be higher under information sharing when one advertiser has sufficiently high MVI.

4. Discussion and summary

There is a renewed focus on the business of online advertising with the recent initial public offering of the online giant Google Inc. The sector of online advertising to which Google Inc., Yahoo! (with its recent acquisition Overture Inc.) and many others such as Advertising.com Inc. and Claria belong is called the "behavioral targeting" part of online advertising [19]. Previously dubbed as personal profiling, it is now acknowledged that online advertising has come of age as advertisers and marketers are catching up with technological advances. Portals such as iVillage.com have been working with profiling technology vendors such as Tacoda to conduct targeted advertising campaigns. With every new personalization service offered online, portals expect to gain new consumers and new preference information and based on this behavioral information, advertisers can strategically place advertisements. It is not only expensive for portals and other online publishers to introduce such services, but the returns are intangible for two reasons; one, no price is being charged for these services and second, the targeted consumers may not use them due to privacy concerns.

It is imperative that privacy is taken into account when determining the degree of personalization of these services. Recently Google Inc. has launched Gmail with 1 Gigabyte of free personalized email space for free. However, Gmail would scan consumer emails and while that is helpful in determining what spam-mail is and what is not for a user, it also raises serious privacy concerns for some users and privacy advocate groups [17]. Google's new targeted advertising strategy is highly dependent on its ability to acquire this information and this would be hindered if its target segment consisted of mainly privacy seekers. Our research specifically demonstrates how new personalization services can be determined taking into account consumers' concern of privacy. There are actionable dimensions to privacy protection, particularly those that deal with building consumer trust [4] and our research points that catering to consumer concerns of privacy is critical to not only the portals offering the services but more so for the advertisers who seek to use preference and usage information. While it is beyond the scope of the current paper, our results hint towards channel coordination mechanisms that may be put in place through shared privacy protection investments by both the advertisers and portals.

4.1. Summary

Online portals offer "free" personalization services in the hope of extracting revenue through online advertisers. We model the strategic interaction between these two agents against a backdrop of consumers who are heterogeneous in their personalization and privacy values. We abstract consumer heterogeneity through their P4P ratio and develop three models of advertiser-portal interactions. The independent portal model forms the base case where an advertiser and a portal play the leader-follower game with the former announcing services rate and the latter determining the service offerings in the market. Our results tell us that services contracted and profits are increasing in both the advertiser's MVI and the consumers P4P ratio, although profits of the advertiser gains at a faster rate than the portal's with increasing P4P ratio.

The second model considers two advertisers who vary in their MVIs in an information sharing regime. We explicitly model two scenarios; first where both advertisers simultaneously announce the services rate and second where the high MVI advertiser acts as a leader. A comparison of these two scenarios sheds light on the potential for a high MVI advertiser to extract first-mover advantage in the market. Our results also point that an equilibrium solution in feasible only when the advertisers are sufficiently different in their MVIs. The third and final model focuses on an advertising portal's decisions and is the equivalent of a coordinated channel where the advertiser and portal are one and the same. While the system profits are the highest in this case, our results show that consumers are however better off under the information sharing regime that involves a high MVI advertiser.

4.2. Limitations and future research

As with any modeling exercise, our research is limited by considerations of analytical tractability. Our information sharing regime case, while limited to two advertisers, can be examined further in a more generalizable model consisting of *n*advertisers. Further, we have not considered competition between portals themselves and modeling multiple sources of consumer information in developing advertisers' payments might lend more insights. We have also not explicitly considered the cost of investing in trust-building and future research can abstract this to develop specific recommendations for coordination between portals and advertisers.

Appendix

The independent portal's profit function is given by

$$\pi_p = \alpha s - \beta s^2 \tag{A10}$$

The independent advertiser's function is

$$\pi_a = R\left(\int_o^s s_c^* U(s_c^*)ds_c^* + \int_s^{\frac{b}{2}} sU(s_c^*)ds_c^*\right) - \alpha s - C \tag{A11}$$

Simplifying equation (4), we get

$$\pi_a = Rs\left(\frac{b-s}{b}\right) - \alpha s - C \tag{A12}$$

Proof of Lemma 1: Differentiating equation (5) and setting the FOC equal to zero we get the reaction function of the portal for an announced α by the advertiser as $s(\alpha) = \frac{\alpha}{2\beta}$. Substituting this in equation (A12) and differentiating with respect to α, we have

$$\frac{\delta\pi_a}{\delta\alpha} = \frac{\delta\left(\frac{R\alpha}{2\beta} - \frac{R\alpha^2}{4b\beta^2} - \frac{\alpha^2}{2\beta} - C\right)}{\delta\alpha} \Rightarrow \frac{R}{2\beta} - \frac{R\alpha}{2b\beta^2} - \frac{\alpha}{\beta} \tag{A13}$$

Setting equation (A13) equal to zero, we get optimal service rate as $\alpha_i^* = \frac{R}{2+\frac{R}{b\beta}}$. Substituting this rate in the portal's reaction function, we get the optimal number of services as $s_i^* = \frac{R}{\beta(\frac{2R}{b\beta}+4)}$. Substituting these optimal values in the profit functions given by equations (5) and (A12), we get the portal's and the advertiser's optimal profits as $\pi_{ip}^* = \frac{R^2}{4\beta(\frac{R}{b\beta}+2)^2}$ and $\pi_{ia}^* = \frac{R^2}{4\beta(\frac{R}{b\beta}+2)} - C$. □

Proof of Lemmas 2 and 3: The profit function of the portal when there are two advertisers with both paying a service rate α and contracting for service levels $s_1$and s_2 is written as

$$\pi_{isp} = \alpha(s_1 + s_2) - \beta s_1^2 \tag{A14}$$

Since s_1 is the larger service level implying that the portal can automatically provide any service level $s_2 \leq s_1$, he only incurs a cost of offering the higher service level. The two competing advertisers' profit function is given by

$$\pi_{a1} = R_1(D(i_1) - D(i_2)) + \left(\frac{R_1}{2}\right)D(i_2) - \alpha s_1 - C_1 \tag{A15}$$

$$\pi_{a2} = \left(\frac{R_2}{2}\right)D\big(i_2\big) - \alpha s_2 - C_2 \tag{A16}$$

Equations (A15) and (A16) can be simplified as

$$\pi_{a1} = R_1(s_1 - s_2)\left(1 - \frac{s_1 + s_2}{b}\right) + \frac{R_1 s_2}{2}\left(1 - \frac{s_2}{b}\right) - \alpha s_1 - C_1 \tag{A17}$$

$$\pi_{a2} = \frac{R_2 s_2}{2}\left(1 - \frac{s_2}{b}\right) - \alpha s_2 - C_2 \tag{A18}$$

For the simultaneous move game described in Lemma 2, the reaction function of the portal for an announced α by the high MVI advertiser is $\tilde{s}_1(\alpha) = \frac{\alpha}{2\beta}$. Substituting this reaction function in the profit of the high MVI advertiser given in equation (A17) and differentiation with respect to α, gives the FOC as $\frac{R_1}{2} - \frac{\alpha R_1}{2b\beta} - \alpha$. Setting the FOC to be zero, we get $\tilde{\alpha}^*_{isp} = \frac{R_1}{2+\frac{R_1}{b\beta}}$ and substituting this value in the reaction function of the portal we get the maximum service it will offer (which is the service corresponding to the information that the high MVI advertiser will acquire) $\tilde{s}^*_1 = \frac{R_1}{\beta(\frac{2R_1}{b\beta}+4)}$. For the service rat $\tilde{\alpha}^*_{isp}$, differentiating equation(A18), with respect tos_2 and setting the FOC for the low MVI advertiser as zero, we get

$$\tilde{s}^*_2 = \frac{b}{R_2}\left(\frac{R_2}{2} - \tilde{\alpha}^*_{isp}\right) \Rightarrow \frac{\frac{R_1}{2\beta} - \left(\frac{R_1}{R_2} - 1\right)}{\frac{R_1}{b\beta} + 2}$$

In the game where the high MVI advertiser is the sole first mover, the portal reacts and decides on the maximum service level it will offer and the low MVI advertiser also reacts to determine the subset of information that it will contract. Therefore, for an announced services rate α, service level $s_1(\alpha)$ that will be offered by the portal to the high MVI advertiser and the service level $s_2(\alpha)$ that will be contracted by the low MVI advertiser are given as $s_1(\alpha) = \frac{\alpha}{2\beta}$ and $s_2(\alpha) = \frac{b(R_2-2\alpha)}{2R_2}$. Thus the high MVI advertiser in determining his optimal service rate will take into account both reactions and hence substituting these two service levels in the profit function of the high MVI advertiserπ_{a1} given in equation (A17), and differentiating wither respect to α, we get the FOC as

$$\frac{\alpha b R_1}{R_2^2} + \frac{R_1 - 2\alpha}{2\beta} - \frac{\alpha R_1}{2b\beta^2} = 0 \tag{A19}$$

Solving for α in equation (A19), we get $\alpha^*_{isp} = \frac{1}{\frac{1}{b\beta}+2(\frac{1}{R_1}-\frac{b\beta}{R_2^2})}$. Substituting this optimal rate in $s_1(\alpha)$ and $s_2(\alpha)$, we get the optimal service level offered by the portal to the high MVI advertiser as $s^*_1 = \frac{1}{4\beta(\frac{1}{R_1}-\frac{b\beta}{R_2^2}+\frac{1}{2b\beta})}$ and the service level contracted by the low MVI advertiser as $s^*_2 = \frac{b}{2}(1 - \frac{2}{\frac{R_2}{b\beta}+\frac{2R_2}{R_1}-\frac{2b\beta}{R_2}})$. □

Proof of Proposition 1: The maximum service level that will be offered by the portal (beyond which no consumer will use the services) is $s^*_1 = \frac{b}{2} \Rightarrow \frac{1}{4\beta(\frac{1}{R_1}-\frac{b\beta}{R_2^2}+\frac{1}{2b\beta})} = \frac{b}{2} \rightarrow R_1 = \frac{R_2^2}{b\beta}$. Thus if the advertiser has MVI higher than $R_2^2/b\beta$, he will only contract for $b/2$ services and will pay a maximum service rate of $b\beta$. We also know that the second advertiser's service level is subset of the first, and hence $s^*_1 > s^*_2$, and solving for $\frac{1}{4\beta(\frac{1}{R_1}-\frac{b\beta}{R_2^2}+\frac{1}{2b\beta})} > \frac{b}{2}(1 - \frac{2}{\frac{R_2}{b\beta}+\frac{2R_2}{R_1}-\frac{2b\beta}{R_2}})$, we get $R_1 > \frac{R_2^2}{R_2+b\beta}$. Hence we have $\frac{R_1}{R_2} \in (\frac{\frac{R_2}{b\beta}}{1+\frac{R_2}{b\beta}}, \frac{R_2}{b\beta}]$ □

Proof of Lemma 4: The advertising portal's profit function can be written as

$$\begin{aligned}\pi_{ap} &= R \cdot D(i) - \beta s^2 - C\pi_a \\ &\Rightarrow Rs\left(\frac{b-s}{b}\right) - \beta s^2 - C\end{aligned} \tag{A20}$$

Differentiating equation (A20) with respect to s, and setting the FOC equal to zero, we get the optimal service level as $s^*_{ap} = \frac{R}{2\beta\left(\frac{R}{b\beta}+1\right)}$ and substituting this level in equation (A20), we get the optimal profits as $\pi^*_{ap} = \frac{R^2}{4\beta(\frac{R}{b\beta}+1)} - C$. □

Proof of Proposition 2: Simplifying $s_1^* \geq s_{ap}^*$, where the higher MVI advertiser in the information sharing case and the advertiser in the advertising portal case are comparable, we have $R_1 \geq \frac{R_2^2}{2b\beta}$

Proof of Proposition 3: We can see that $s_{ap}^* - s_i^* \Rightarrow \frac{R}{2\beta\left(\frac{R}{b\beta}+1\right)} - \frac{R}{\beta\left(\frac{2R}{b\beta}+4\right)} \Rightarrow \frac{b^2R\beta}{2(R+b\beta)(R+2b\beta)}$, which is always positive.

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