HOW MUCH CONTENT SHOULD INTERNET OUTLETS GIVE AWAY?

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Abstract

Firms transmit information content over the Internet in forms such as newspapers, magazines, and data sets. Firms may give away some content free of charge in order to provide potential subscribers with a sample on which to make a decision to subscribe. This research examines the conditions necessary for strategic use of information by potential subscribers. That is, we answer the following question. Under what conditions will an Internet content provider release a free sample of content that the consumer will use as a basis for a decision to subscribe? Our analysis suggests that strategic use of information is rare. The conditions for strategic use of information are so restrictive that we do not expect to see many instances of consumers making subscription decisions based on their evaluation of free samples of Internet content.

Introduction and Literature

The Internet allows users to access great volumes of information for no marginal fee. Newspapers, magazines, data, and other information can be accessed quickly, without regard to geographical boundaries. If the information accessed has a relationship to a physical product that one may consume, then the business model is similar to the traditional, offline market model in which consumers are offered advertising regarding products and services. If the information, itself, is the product of the online firm, then the traditional model does not fit as well. VanHoose (2003, p. 76) defines “virtual products” as “items offered for sale in digital form.” Some of these products are information content.

We identify two differences between virtual products and physical products. First, as suggested by VanHoose (2003), virtual products have low cost associated with serving another customer (the marginal cost). Allowing another reader to view an online newspaper adds a minuscule amount to the firm’s costs. In fact, the marginal cost is likely so low that if the firm charged the consumer a price equal to the marginal cost, then unpaid bills might not be collected, since collection costs might exceed the price charged. Second, virtual products are often easily transferable from one consumer to another with little or no loss of quality. Hence, if an online newspaper did charge a fee for access, then a subscriber might be able to give the content away to others or sell the content to others.

If the virtual products that various firms offer are identical in the minds of consumers, then profit-maximizing firms will compete until the price approximates the marginal cost, consistent with the classical model of perfect competition. This happens because if firms can receive a price that gives them a profit, over and above their other profit opportunities, then other firms will enter the industry to earn these above-normal profits. As more firms enter the industry, the price falls, until it is equal to the cost of providing a unit of the service. Since the marginal cost of a unit of virtual product is nil, the price of the virtual product would be nil. If collecting the minuscule subscription fees would cost more than the fees, themselves, virtual products, including information content, could not exist under conditions of perfect competition without payments from another source. Advertisers' payments help defray the losses from providing virtual products that are nearly similar, such as with many online newspapers and magazines.

If a firm's virtual product is seen as differing significantly from other virtual products, its owner may find that the perfectly competitive model does not apply and that there will not be competition to the point that the price falls to equal marginal cost. Preventing competition is only possible if the firm (1) has some product advantage that other firms cannot duplicate or (2) has non-replicable cost advantages such that competitors know that another firm cannot enter the industry and earn the normal profit. We give two examples of firms who sell virtual products for a fee.

SNL Financial (located at http://www.snl.com/) provides data and analysis regarding key financial industries such as banking, insurance, and real estate. SNL specializes in gathering data that other sources do not have. Whereas many data sources have stock prices, SNL also sells data on other firm specific characteristics, organized by industry. SNL data may be purchased piecemeal or, alternatively, an individual or institution may subscribe to all their databases for a yearly fee. SNL attempts to convey the exact nature of the product they sell by detailed descriptions of their data sets, both in content and form.

The *Wall Street Journal* has long been recognized as the United States' premier financial newspaper. Subscribers to the online version of the Wall Street Journal (http://www.wsj.com/) pay fees that are far in excess of the small sums that a perfectly competitive virtual product would command. A basic subscription to the online version of the *Wall Street Journal* costs $99 ($39 for those who also subscribe to the print edition). The *Wall Street Journal's* homepage displays some news items that may be read free of charge and displays links to other news items that are available only to paid subscribers. In addition, a *Wall Street Journal's* site, *OpinionJournal.com*, contains many opinion pieces that are free, but also contains links to the opinion articles offered only to paid subscribers.

Our research focuses on how much of their information content a provider should offer free of charge, in order to encourage a potential subscriber to make an informed decision to purchase a subscription.

In section II we discuss our theoretical model. In section III we will solve for the game-theoretic equilibrium solutions to our model. In section IV we present an illustrative example of a game that is consistent with our model. In section V we summarize and offer concluding remarks.

Our Model

We construct a game-theoretic model in which a content provider and a potential subscriber interact. The game proceeds as follows. The content provider chooses the amount of content to make available to the subscriber, free of charge. The potential subscriber then browses the provider's available content and decides whether or not to purchase a subscription.

We model the content provider as having a limited amount of content; hence, any content that is provided free reduces the amount of content that it can charge for. Thus, not only does the content provider have to consider that the subscriber might be sated on the freely provided content, but must also realize that with a greater offered content, less is available to sell.

We model the potential subscriber as using Bayes' law (using the method of Harsanyi, 1967-1968) in deciding whether or not to subscribe. The subscriber views the free content, assesses its overall quality, and uses Bayes' law to infer the quality of content that is only available for the price of the subscription. We find pure strategy Nash equilibria (Nash, 1952) of the game and show that some are sequential equilibria (Kreps and Wilson, 1982).

The problem that potential subscribers face is one of incomplete information about the content provider. Potential subscribers are not certain that a provider's content would be useful to them. We simplify the language and draw contrast by assuming that there are two types of provider, Good (G) and Bad (B). We assume that potential subscribers have beliefs about the proportion of providers who are of type Good, π, and type Bad, $(1 - \pi)$, but they do not know if a particular provider is Good or Bad.

In our model, the potential subscriber faces only one provider, who may be the Good type or the Bad type. However we model the game as if a Good provider and a Bad provider are formulating strategies. This is because the potential subscriber must conjecture "if this is a Good provider before me, what behavior would I expect; and if this is a Bad provider before me, what behavior would I expect?" Similarly, the Good provider must conjecture, "if I take a certain action, the consumer might infer that I am a Bad provider; hence, I must understand Bad providers." And, importantly, the Bad provider must conjecture, "if I take a certain action, the consumer might infer that I am a Bad provider; hence, I must understand Good providers so that I may mimic their behavior."

We accomplish this modeling by relying on Harsanyi's (1967-1968) construction of games of imperfect information. The model is presented as if there are three players—the potential subscriber, the Good provider, and the Bad provider. The potential subscriber faces a provider and may or may not be able to infer the provider's type from his actions. In any case, the potential subscriber must make plans contingent on the possibility that the provider is of either type and in order for the provider to behave rationally, he must conjecture the behavior of the other type.

We assume that both the Good and Bad type have N articles of content that they may either release to the entire public, free of charge, or release only to subscribers. Articles may be news articles, data, multimedia, or any other electronic content. If Good providers only have *good* content and Bad providers only have *bad* content, then a Good provider could reveal its type (Good) by releasing one *good* article. However, we assume that Good providers might possibly produce some *bad* articles and Bad providers can produce some *good* articles.

An article produced by a Good provider is *good* with probability P_G. An article produced by a Bad provider is *good* with probability P_B. We make the natural assumption that an article provided by a Good provider is more likely to be *good* than an article provided by a Bad provider ($P_G > P_B$). We assume that P_G and P_B are set outside our model—that is, we do not model whether Bad providers will try to become Good or whether Good providers can go astray. We assume that Good and Bad providers know their types and each type sets its own strategy, though one type may purposefully mimic the other's strategy.

We assume that, though both types of provider know their type, that they cannot evaluate the quality of an individual article of content. Hence, when a provider sets its strategy to release articles, it only specifies that it will release a certain number of articles and not whether the articles released are good or bad. Of their N articles, good providers release n_G articles, while Bad providers release n_B articles.

Since the potential subscriber cannot tell whether the provider is Good or Bad, she cannot condition her strategy on the provider's type. The potential subscriber views the release, evaluates the articles, and decides whether or not to subscribe based on the total number of articles released and the number of good articles in the release. The potential subscriber's strategic choice is the probability that this potential subscriber will subscribe upon seeing n articles released, g of which are good (S_{ng}). Clearly $g \leq n$, since the number of good articles released cannot exceed the total number of articles released.

We assume that the cost of a subscription is C for both the Good and Bad provider types. If the subscription cost varied by provider type, then the potential subscriber could infer information from the subscription price. We focus only on the information gained by the potential subscriber's evaluation of the freely provided content (if any). We assume that the value of a good article to a potential subscriber is 1, while the value of a bad article is 0. This means that the expected value of the total number of articles from a good provider is $N(P_G)$ and from a bad provider is $N(P_B)$.

Having specified S_{ng} and C, we can formulate the provider types' payoffs as the expected value of subscription revenues, which depends on C and S_{ng}. We will delay the exact mathematical specification of this expectation. For now, we point out that the provider receives C if the consumer subscribes, and receives 0 if the consumer does not subscribe. Hence, if the provider types can formulate a strategy that makes subscribing with probability equal to one a best reply for the potential subscriber, then the payoff to the provider types is C.

Formulation of Equilibria

Suppose no articles are released. First, suppose that the expected value of the articles from either type of provider is less than the cost of a subscription. That is

$$C > N(P_G) > N(P_B). \qquad (1)$$

Then no matter how many articles are released, the consumer will not subscribe.

Second, suppose the expected value of the articles from either type of provider is greater than the cost of a subscription. That is

$$N(P_G) > N(P_B) > C. \qquad (2)$$

Then if no articles are released, the consumer should subscribe.

Third, suppose that the expected value of the articles from the Good type is greater than the cost of a subscription, but the expected value of the articles from the Bad type is less than the cost of a subscription. That is,

$$N(P_G) > C > N(P_B). \qquad (3)$$

Then if no articles are released, the consumer would wish to subscribe if and only if the provider's type is Good.

Case 1

Of the three cases above, (1) needs no elaboration. Any release strategy by the provider will not induce the consumer to subscribe. The Nash equilibria are of the following form.

Equilibrium Set 1
Providers: $0 < n_G < N$; $0 < n_B < N$.
Subscriber: $S_{ng} = 0$ for all n and g.

Case 2

Case (2) above requires minor elaboration. Both provider types' expected values of subscriptions exceed the subscriptions' cost. In one equilibrium, neither provider type releases any articles but the consumer subscribes.

Equilibrium Set 2
Providers: $n_G = 0$; $n_B = 0$.
Subscriber: $S_{ng} = 1$ for all $n = 0$ and $g = 0$. $S_{ng} = 0$ for all $n \neq 0$ and $g \neq 0$.

Equilibrium Set 2 is the simplest Nash equilibrium to construct. However, it relies on the consumer's threat of not subscribing if any information is revealed. But this threat may not be credible if the consumer were called upon to make good on it; hence, it is not a sequential equilibrium. There exist parameters such that if the consumer saw an article released, she would still subscribe. Such parameters may be informally described as follows. Suppose that for both types, articles are almost surely good. Suppose each type has a large number of articles. Suppose the subscription price is low. Then the release of a small amount of content would not drain the unreleased content greatly. The unreleased items (almost surely good) would retain almost all of their value, compared to the low subscription price. This would lead the consumer to subscribe for some small releases, contrary to the stated strategy. So while Equilibrium Set 2 is a Nash equilibrium, it may not be a sequential equilibrium, since it relies upon a threat that might not be carried out off the equilibrium path.

Sequential equilibria similar to Equilibrium Set 2 may be described more fully, which we now proceed to do. In formulating this description, we fill out our general tool set for exploring case (3), as well.

If n_G articles are released by the Good type and n_B articles are released by the Bad type with $n_G \neq n_B$, then the consumer can infer the provider's type from the release. If, however, $n_G = n_B$ the consumer cannot infer the provider's type from the release and must use Bayes' law to assign probabilities that the type is Good. If neither type releases information, the consumer uses the prior probability that the provider is good, π, as her belief.

If (2) holds and some article(s) is (are) released, consistent with $n_G \neq n_B$, then the consumer infers the provider's type and subscribes from the provider if, for the provider's type, *i*, $(N - n_i)(P_i) \geq C$. That is, the consumer has inferred the provider's type and, given the release, evaluates the expected value of the unreleased items and compares this value to the cost of a subscription. The equilibria are

Equilibrium Set 2a
Providers: Choose n_G and n_B such that $(N - n_G)(P_G) \geq C$; $(N - n_B)(P_B) \geq C$.
Subscriber: $S_{ng} = 1$ if $(N - n_i)(P_i) \geq C$. $S_{ng} = 0$ if $(N - n_i)(P_i) < C$.
Otherwise $S_{ng} = 0$.

In this equilibrium, each provider will release a sufficiently small amount of content such that the remaining content justifies purchasing the subscription. The consumer infers the provider's type and purchases a subscription.

How does the consumer decide to subscribe upon seeing an information release when the providers' strategies are identical? If Case (2) holds and $n_G = n_B$, then the consumer examines the released articles and uses Bayes' law to compute the posterior probability that the type is G.

We simplify our nomenclature by denoting the number of articles released as "n" when $n = n_G = n_B$. Since both types release the same amount of articles in this conjecture, the consumer computes conditional probabilities based on the number of good articles in the release, which we have previously denoted as g. Where "|" is the conditional probability operator and P(G|g) is read as "the probability that the provider is Good, given that g articles were good," the probability may be computed as

$$P(G|g) = P(g|G)\, P(G) / [\, P(g|G)\, P(G) + P(g|B)\, P(B)]. \qquad (4)$$

P(g|G) is the binomial distribution, $b(g; n, P_g)$. Hence (4) becomes

$$P(G|g) = b(g; n, P_g)\, \pi \,/\, [b(g; n, P_g)\, \pi + b(g; n, P_b)\, (1 - \pi)]. \qquad (5)$$

The consumer will subscribe if

$$P(G|g)(N - n)(P_g) + (1 - P(G|g))(N - n)(P_b) \geq C. \qquad (6)$$

Simplifying, the consumer will subscribe if

$$(N - n)\, [P(G|g)\, (P_g) + (1 - P(G|g))\, P_b)] \geq C. \qquad (7)$$

The consumer will know the number of good articles, g, when making her decision. However, the provider cannot know g, only n, when making the decision to release articles. Hence, the provider must decide on the appropriate number of articles to release based on the expected value of the release. If the provider releases n articles, then the number of good articles, g, is an integer less than or equal to n. For each possible g, the consumer uses (7) to decide to subscribe or not—that is, the consumer chooses S_{ng}. If the consumer subscribes, the provider receives a payoff of C; hence, this expected payoff to the Good provider of releasing n articles is

$$\sum_{g \leq n} b(g; n, P_g)\, C^*\, S_{ng}. \qquad (8)$$

The payoff to the Bad provider is, therefore,

$$\sum_{g \leq n} b(g; n, P_b)\, C^*\, S_{ng}. \qquad (9)$$

The Good provider chooses n such that (8) is maximized. If the Bad provider chose a different number of articles to release, Equilibrium Set 2a would obtain. Here we assume that the Bad provider chooses the same number of articles as the Good provider. We have now explained the payoff function of each of the players. We now explore a simple example of the game and the structure of the equilibria involved.

Example Game

The following game clarifies Case 3. Suppose the Good and Bad types are equally likely in the population ($\pi = .5$). Suppose that each type has N = 10 articles to release free of charge or sell for a flat subscription price of C = 5. Suppose that 70% of the articles that Good providers produce are good and 10% of the articles that Bad providers produce are good (that is, $P_g = .7$ and $P_b = .1$). If the consumer subscribes from a Good provider, the expected value of good articles is .70 * 10 = 7. The expected value of subscribing from a Bad provider is .10 * 10 = 1.

Releasing No Articles

If no articles are released, the consumer, knowing that the likelihood of the provider's type being Good is .5, evaluates the expected value of subscribing as .5 (7) + .5 (1) = 4. Since the subscription price is 5, the consumer will not subscribe if zero articles are released. This gives both provider types an expected payoff of 0.

Releasing One Article

If both types release one article, it will either be good or bad. Suppose the article is good. Given the 70% and 10% chances that the types will release good articles, it is intuitively clear that it is mostly likely that a good article will have come from a good provider. To be precise, the consumer uses Bayes law, as in (4), to infer that the probability that the provider's type is Good is equal to.875 and the probability that the provider's type is Bad is .125. Given that an article has been released, the consumer knows that of the 9 which remain, if the provider's type is Good, an expected .70 * 9 = 6.3 good articles remain; whereas, if the provider's type is Bad, an expected .10 * 9 = .9 remain. Applying the probabilities derived above, the expected value of a subscription is .875 * 6.3 + .125 * .9 = 5.625. (this operation is seen on the right left hand side of equation (7)). This value exceeds the subscription price, so the consumer will subscribe if the types release one good article. If the article is bad, however, the consumer concludes from the use of Bayes law that there is a .25 probability that the provider is Good and a .75 probability that the provider is Bad. This yields an expected value to the consumer of .25 * 6.3 + .25 * .9 = 2.25. The consumer will not subscribe for the subscription price of 5. The expected payoff to the good type depends on the probability that the consumer will subscribe. In this case, the consumer subscribes if and only if the freely released article is good. The Good provider knows that this is 70% likely; hence, the expected value of releasing one article is .70 * 5 = 3.5. The Bad provider, similarly, has an expected value of .1 * 5 = .5. For each provider type, this payoff is superior to the 0 payoff from releasing zero articles.

Releasing 2 articles

Following the preceding general method, we evaluate payoffs and best replies for providers releasing two articles. If two articles are released, the number of good articles ranges from 0 to 2. Using (4) we find the following conditional probabilities: P(Good | g=0) = .1, P(Good | g=1) = .7, P (Good | g = 2) = .98. With two of the ten articles revealed, a subscription would give the consumer the remaining 8 articles. If the provider is Good, the consumer expects .7 (8) = 5.6 good articles; whereas, if the provider is Bad, the consumer expects .1 (8) = .8 good articles. Applying the conditional probabilities to these expected payoffs leads the consumer to subscribe if and only if two articles are good. The probability of two good articles is .49 for the Good provider and .01 for the Bad provider, yielding an expected value of releasing two articles of

2.45 for the Good provider and .05 for the Bad provider. Both payoffs exceed that of releasing 0 articles, but are less than the payoffs of releasing 1 article.

Releasing more than 2 articles

If 3 articles are released, then if the provider type is Good the remaining 7 articles can be expected to produce .7 (7) = 4.9 good articles; whereas, if the provider type is Bad the remaining 7 articles can be expected to produce .1 (7) = .7 good articles. With the subscription price of 5, the consumer would not wish to subscribe even if it were certain that the provider was Good. Hence, for any release of more than 2 articles the consumer will not subscribe.

Equilibrium

If N = 10, π = .5, C = 5, P_g = .7 and P_b = .1, the following sequential equilibrium obtains.

Providers: $n_G = n_B = 1$.
Subscriber: $S_{ng} = 1$ for n = 1 and g = 1.
$S_{ng} = 1$ for n = 2 and g = 2.
$S_{ng} = 0$ otherwise.

Example With Other Parameters

In Table 1 we provide the equilibria of games which have N = 10, π = .5, and C = 5. We list equilibria for values of P_g and P_b such that $P_g > P_b$ with both values in even tenths (i. e., they assume values of 1., .2, .3, . . ., .9). The equilibrium that we explained above is shown in the third row of the last column of the table-- P_g = .7 and P_b = .1.

For simultaneously low values of P_g and P_b, at the lower right, the consumer will not subscribe in equilibrium, since the providers are not likely to be able to provide enough good articles to justify a subscription. Hence, the providers can offer any number of free articles in equilibrium and the consumer will not subscribe. Many of these equilibria are described by Case 1 above (we fully map Cases 1 and 2 in the Appendix).

Table 1

Pi =.5	Pb=.9	Pb=.8	Pb=.7	Pb=.6	Pb=.5	Pb=.4	Pb=.3	Pb=.2	Pb=.1
Pg=.9	0-4	0-3	0-2	0-1	0-1	0	0	0	0
Pg=.8		0-3	0-3	0-2	0-1	0	0	0	3
Pg=.7			0-2	0-2	0-1	0	0	1	1
Pg=.6				0-1	0	0	1-10	1-10	1-10
Pg=.5					0	1-10	1-10	1-10	1-10
Pg=.4						1-10	1-10	1-10	1-10
Pg=.3							1-10	1-10	1-10
Pg=.2								1-10	1-10

For simultaneously high values of P_g and P_b, at the upper left, the consumer will subscribe for small releases, since the providers are both likely to provide enough good articles to justify a subscription, as in Equilibrium Set 2a.

For many intermediate values of P_g and P_b, we see 0 articles released. In many of these cases, the constraints under Equilibrium Set 2a bind the providers to release zero articles, because releasing even one article diminishes the available subscription pool of articles to the point that the consumer will not subscribe even if the released sample is good. However, in some of these cases, such as for $P_g = .9$ and $P_b = .4$, the consumer will subscribe with certainty if zero articles are released but will subscribe only if a good sample is obtained from a release of one article. Since even Good providers release bad articles with .1 probability, the consumer will not certainly subscribe if the provider releases an article; hence, the Good provider will release zero articles to avoid taking the chance of sending a faulty signal.

A small number of articles are released with certainty if either $P_g = .7$ and $P_b = .1$; or $P_g = .7$ and $P_b = .2$; or $P_g = .8$ and $P_b = .1$. (We fully illustrate this analysis of Table 1 in the Appendix.) In these cases, the likelihood of seeing good articles is not so high that the consumer subscribes with no information given. Also, the providers are very different, so that information from a free sample would be helpful. Further, when information is given it is likely to be informative—the sample will likely reveal the provider's type. This gives us our main intuitive insights of this work, which we summarize in the following section.

Summary and Conclusions

Internet content providers will release meaningful information to potential subscribers, free of charge, when a few conditions are met. First, Good and Bad providers must jointly be of low enough quality that consumers will not subscribe unless they can obtain a good sample. Second, Good and Bad providers must jointly be of high enough quality that consumers might want to subscribe upon obtaining a good sample. Third, Good providers must differ from Bad providers in significant respects (P_g and P_b must be sufficiently far apart) that are difficult to evaluate without a sample, but are easier to evaluate with a sample. Fourth, the probability that a Good provider will provide Good articles must be sufficiently high so that (1) the sample will reveal the Good type with a high probability and (2) the sample can be so small that the unreleased articles are worth the subscription price.

Given these conditions, it seems rare that providers would strategically release content that provides the consumer with information that the consumer uses to make a decision. It seems much more likely that either the providers will only have to guard against depleting their content by offering it free or that consumers will value the content so low (because P_g and P_b are both low) that consumers would not subscribe in any case.

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Appendix

Case 1 equilibria are found in the lightly shaded portion at the lower right of Table 2, below the hatched shaded portion. Case 2 and 2a equilibria are found in the shaded portion at the left of Table 2, left of the vertically hatched portion. The vertically hatched portions are where Cases 1 and 2 are met with equality.

The diagonal which begins at the upper right cell of the table (P_g = .9, P_b = .1) describes situations in which if no information is released, the consumer is indifferent between subscribing and not subscribing. Everything above and to the left of the diagonal represents situations in which the consumer will subscribe if no articles are released. Everything below and to the right of the diagonal represents situations in which the consumer will not subscribe if no articles are released. The strategic release of articles by the provider types is important only if the consumer will refuse to subscribe if there are no articles released. For high values of combined Pg and Pb in this restricted set (the set below the diagonal), strategic release of information occurs in equilibrium.

Table 2

Pi =.5	Pb=.9	Pb=.8	Pb=.7	Pb=.6	Pb=.5	Pb=.4	Pb=.3	Pb=.2	Pb=.1
Pg=.9	0-4	0-3	0-2	0-1	0-1	0	0	0	0
Pg=.8		0-3	0-3	0-2	0-1	0	0	0	3
Pg=.7			0-2	0-2	0-1	0	0	1	1
Pg=.6				0-1	0	0	1-10	1-10	1-10
Pg=.5					0	1-10	1-10	1-10	1-10
Pg=.4						1-10	1-10	1-10	1-10
Pg=.3							1-10	1-10	1-10
Pg=.2								1-10	1-10
Pg=.1									1-10