

Organizing Distribution Channels for Information Goods on the Internet

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Abstract

Rapid technological developments and deregulation of the telecommunications industry have changed the way in which content providers distribute and price their goods and services. Instead of selling a bundle of content and access through proprietary networks, these firms are shifting their distribution channels to the Internet. In this new setting, the content and Internet service providers find themselves in a relationship that is simultaneously cooperative and competitive. We find that proprietary content providers prefer the Internet channels to direct channels only if the access market is sufficiently competitive. Furthermore, maintaining a direct channel in addition to the Internet channels changes the equilibrium enough that the proprietary content providers prefer having the Internet channels regardless of the level of competition in the access market. Telecommunications technology developments uniformly increase content providers profit. On the other hand, the technology impact on Internet Service Provider profits is non monotonic: their profits may increase or decrease as a result of lower telecommunication costs. While initially the ISP profit increases as more customers are drawn to the Internet, it eventually decreases as the spatial competition becomes more intense. We also show that proprietary content providers should benefit from having some free content available at the Internet Service Providers' sites to induce more customers to join the Internet.

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1 Introduction

Many firms, such as Dialog, Bloomberg, Lexis/Nexis, WestGroup, Medfirst, and First Search, have been providing on-line data covering financial, legal, medical, and academic journal publications, respectively. These and other similar firms have near monopolies in the content they offer. We classify the content over which such a firm has a near monopoly as *proprietary* and call the firm a *proprietary content provider* (PCP).

Before Internet access became common, the PCPs sold a bundle of access and data services. They had to establish *direct* channels using gateways for their customers and set the prices for the bundle. The rapid proliferation of the Internet provides a new channel for distributing proprietary content. PCPs now use the Internet to deliver data to customers all over the world since the price of telecommunication on the Internet is not distance dependent. The Internet Service Providers (ISPs) provide the customers with access to the Internet and the PCP. Some customers get on the Internet in order to access the proprietary content provided by the PCP, while others use only the free content and services available on the Internet as part of ISP services.

The ISPs compete aggressively for customers to provide Internet access and non-proprietary data [Denton, 1997]. In the new channel the PCPs and the ISP independently set the prices for their services. Hence they compete for a share of the surplus created when the customers get access to content and services. Furthermore, because access and data services are complements, the ISPs and the content providers find themselves in a relationship of both competition and voluntary cooperation.

In this paper we examine three sets of issues relating to the provision of proprietary content and access on the Internet:

1. How should the PCPs take advantage of the Internet as a channel of distribution for their data?
2. How will the explosive growth in the number of Internet Service Providers affect the welfare of the PCPs, the ISPs, and the customers?
3. How will the delivery of other Internet services provided by the ISP, such as e-mail and non-proprietary content, affect the market for proprietary content?

Several studies have focused on the impact of Internet-enabled electronic commerce on the retail industry. For instance, Bakos examines the impact of electronic markets on the search costs and equilibrium among producers of a differentiated good [Bakos, 1997]. The new role of intermediation in electronic markets has also been studied [Bailey and Bakos, 1998]. A few other researchers have looked at the provision of content in the Internet industry. McKnight and Bailey provide an overview of technological, economics, and policy-based research on the Internet industry [McKnight and Bailey, 1998]. Other aspects of the same industry have been examined by Dewan, Freimer, and Seidmann [Dewan, Freimer, and Seidmann, 1998]. Mackie-Mason, et al, consider the impact of content-sensitive pricing of telecommunication services on the variety of content available, the consumer surplus, and the profit of the network provider [Mackie-Mason, Shenker, and Varian, 1996]. From another perspective, a number of researchers in library sciences have been studying the impact of the Internet on document publishing, search, and access [Fletcher, 1996] and [Duranceau, 1995].

The issues analyzed here are somewhat different from those generally examined in most of the electronic commerce papers cited above. We concentrate only on information goods, goods that are delivered electronically and at a zero marginal cost of production and no

information asymmetry. We develop a spatial competition model that captures the economic and technological relationship among the access and content providers. Our results explain the complex interplay between the pricing decisions of the ISPs and the PCP and show how their profits will be affected by changes in telecommunication dial-up costs, the addition of ISPs, the provision of free content and changes in the relative value of proprietary content. In the next section we present a spatial model of the Internet economy and our key equilibrium results. Section 4 studies the Internet economy when only proprietary content is of value to a segment of customers, and section 5 looks at the competitive implications of providing both proprietary and non-proprietary content on the Internet. Section 6 concludes our paper.

2 A spatial model of the Internet economy

Customers gain access to the Internet via Internet service providers (ISP.) A common method is to dial up a point of presence of an ISP using a modem. In many countries phone calls are metered for time and distance. The ISP, in turn, connects via a larger-capacity line to a network access point – a connection to the wide-area backbone of the Internet. This arrangement is shown in Figure 1. This figure also depicts customers who use a direct channel to connect to the PCP via proprietary networks.

*** Insert Figure 1***

Customers pick the least expensive way of getting on the Internet. They minimize the sum of dial-up costs and ISP fees. The ISPs take this into account when they set their prices. To capture the impact of distance and ISP fees on the access costs, we use a spatial competition model. The customers are assumed to be located with uniform density on a circle, which without loss of generality is assumed to have a circumference of 2 [Salop 1979].

The customers have heterogeneous values for data. The value of information for each customer is drawn from a uniform distribution over the interval $[0, 2a]$. By combining the variation in location and preference, one can geometrically view the customers as uniformly distributed on a cylinder of circumference 2 and height $2a$. To simplify the analysis we assume that the local dial-up cost is c times the distance along the circle to the provider. While in reality the communication cost is a step-wise, non-decreasing function of distance and time, the linear assumption captures the salient tradeoff between distance and ISP fee while maintaining tractability.

To simplify the analysis, we assume that each ISP owns a single point of presence. There are m ISPs, located symmetrically on the circle, each deciding what fees, p , to charge so as to maximize its profit. We assume that they charge a flat non-discriminating charge independent of a customer's location. In addition, the customer pays a telephone company to dial in to the ISP. This is similar to the 'freight-on-board' tariff. The ISPs incur a fixed cost f for providing a point of presence and a variable cost of k_c and k_i if the customer accesses the PCP or just the ISP, respectively.

Content providers charge a fixed amount p_c for providing data to customers who may access the data directly or through the Internet. They in turn incur a fixed cost for providing service, which includes the costs of acquiring, formatting, editing, indexing, and coding data, as well as acquiring and maintaining data servers. To simplify the analysis, we consider just a single type of data, such as law extracts (Lexis/Nexis), medical abstracts (Medfirst), scientific citations and abstracts (First Search), or real-time financial data (Reuters). Firms that provide these data have near monopolies [Jones & Mendelson, 1997.], because the fixed cost of getting

these data online is so high that in equilibrium only a single content provider exists on the network.

We start by finding the simultaneous Nash equilibrium of the competitive game between the ISPs and the PCP where they make decisions to maximize their own profits. Next, we analyze this equilibrium to determine the impact of the Internet developments on content providers, ISPs, and the customers.

3 The Nash equilibrium between service providers

The equilibrium in the Internet industry is determined by the decisions of three sets of economic agents. These agents have to solve three simultaneous constrained optimization problems as outlined below:

1. Each customer has to pick a specific ISP (location) to *minimize* the sum of his dial-up fee and the ISP access fee (p). A customer will buy in only if his value from Internet content and services exceeds the sum of his telecom dial-up fee, the ISP access fee, and the content fee (p_c). Otherwise, he will be priced out of the market.
2. Each ISP has to pick a *profit maximizing* access fee to charge its customers. These decisions must consider the dial-up fees charged by the local phone companies, the access fees of other ISPs, the PCP fee, and the consumers' values for data.
3. The content provider has to determine the *profit maximizing* content fee given the dial-up fees charged by the local phone companies, the ISP access fees, and the consumers' preference values for data.

The optimization problems discussed above involve three sets of decision variables: ISP assignment by the customers, ISP access fees, and content fees.

3.1 The spatial equilibrium model

Consider a customer located at a distance x from an ISP, with value b for non-proprietary content and services, and value y , $y \sim U[0, 2a]$, for the proprietary content provided by the PCP. This customer has three choices: get neither proprietary nor non-proprietary content, get non-proprietary content alone, or get both proprietary and non-proprietary contents. The choice among these alternatives is governed by:

$$\text{Max} \left\{ \begin{array}{l} 0, \\ b - p - cx, \\ y - p_c + b - p - cx \end{array} \right\},$$

where p_c is the PCP's price, p is the ISP's price, and cx is the local telecommunication cost.

We next examine a symmetric Nash equilibrium between ISPs and PCP in a game in which they simultaneously pick prices. We will determine the conditions for these to be in equilibrium.

Customers whose value for proprietary content is less than p_c will not access proprietary content. Of these customers, those that find the largest value from accessing a particular ISP to be positive will request its services for non-proprietary content alone. Let ISP i consider charging p_i rather than p . The fraction of customers who access the ISP for non-proprietary content alone is (details are in the [Dewan, Freimer, Seidmann, 1999]):

$$q_{in}(p_i, p, p_c) = \begin{cases} \frac{p_c}{2a} \left(\frac{p - p_i}{2c} + \frac{1}{m} \right) & \text{if } p_i < 2(b - \frac{c}{m}) - p & (1) \\ \frac{p_c}{2a} \frac{(b - p_i)}{c} & \text{if } 2(b - \frac{c}{m}) - p \leq p_i \leq b & (2) \\ 0 & \text{if } p_i > b & (3) \end{cases}$$

In our results above we find that $(p_c/2a)$ represents the fraction of customers who would never buy content since their value for content is less than its price. The first term above represents the case in which p is small enough and all will buy access from the ISPs. We find that this happens when $(b-p)/c \geq 1/m$, and each ISP's market share will be $(1/m)$. The second term above represents the case in which some, but not all, customers are priced out even from the access service alone. It shows that the fraction of customers buying access increases with b and p_c , and decreases with p . Note that the size of this customer segment is a function of p_c even when these customers never pay for content. The third term above refers to the case in which all potential customers of that ISP are priced out.

The fraction of customers, each of them accessing *both* proprietary and non-proprietary content, is:

$$q_{ic}(p_i, p, p_c) = \begin{cases} \left(1 - \frac{p_c}{2a}\right)t & \text{if } p_i \leq 2(b-c/m) - p, & (4) \\ \left(1 - \frac{p_c}{2a}\right) \left(\frac{2a - p_c}{2c} + \frac{b - p_i}{c} \right) & \text{if } 2(b-c/m) - p < p_i < b \\ & \text{and } 2a + b - p_c < \hat{p}, & (5) \\ \left(1 - \frac{p_c}{2a}\right)t - \frac{c}{4a} \left(t - \frac{b - p_i}{c} \right)^2 & \text{if } 2(b-c/m) - p < p_i < b \\ & \text{and } \hat{p} \leq 2a + b - p_c, & (6) \\ \frac{t}{2a} (2a - p_c + b - p_i) - \frac{ct^2}{4a} & \text{if } p_i \geq b \\ & \text{and } 2a + b - p_c \geq \hat{p}, & (7) \\ \frac{1}{4ac} (2a + b - p_c - p_i)^2 & \text{if } p_i \geq b \\ & \text{and } p_i < 2a + b - p_c < \hat{p}, & (8) \\ 0 & \text{if } 2a + b - p_c < p_i, & (9) \end{cases}$$

Equation (4) above refers to the case in which p is low enough that all the customers get on the Internet. The fraction of customers who buy proprietary content is $(1 - p_c/2a)$. Equations (5-8) describe the changes in these market segments as p increases. These are discussed in more detail later. Finally, in (9) the prices are so high that no one gets proprietary content.

Given the fractions of customers determined above, the respective profits (per unit customer density) for the ISPs and PCP are:

$$\begin{aligned} \mathbf{P}_i(p_i, p, p_c) &= (p_i - k_i) q_{in}(p_i, p, p_c) + (p_i - k_c) q_{ic}(p_i, p, p_c) - f, \text{ and} \\ \mathbf{P}_c(p, p, p_c) &= m p_c q_{ic}(p, p, p_c), \end{aligned}$$

where parameters k_i and k_c ($k_c \geq k_i$) are the variable costs for the ISP. The variable cost of serving a customer who gets only non-proprietary content is k_i , and the variable cost of serving a customer who gets both contents is k_c . The fixed cost of ISP operations is f (on a per customer basis).

The PCP and each of the ISPs are simultaneously maximizing their profits. We find five symmetric equilibria. In addition to these, when a is very large, there is a symmetric equilibrium in which none of the providers makes any profit. In this degenerate equilibrium, the providers keep reducing their price to capture other providers' territory. Bertrand competition ensues, and the providers will end up making zero profit. This is the situation in the classic model by Hotelling [Hotelling, 1929], D'Aspremont, Gabszewicz, and Thisse [D'Aspremont et al., 1979] point out. This degenerate case of competition is not analyzed further in this paper.

*** Figure 2 ****

The different regions in Figure 2 correlate with the equations determining the fractions of customers at an ISP. The five non-degenerate equilibria identified in Figure 2 are described next.

In region A, all customers get on the Internet, and those with higher value for content buy it from the PCP. In regions B and C, some customers do not get on the Internet, some get

non-proprietary content only and some get both types of content. In region C we find that the telecommunication costs preclude all customers at distant locations from getting on the Internet. In regions D and E the ISP price is so high that customers get on the Internet only if they want to access proprietary content. In D the PCP price (p_c) is low enough that customers from all locations both proprietary and non-proprietary content. This is not so in region E. No customers get proprietary content in the remaining regions (above and to the right of the bold line in the figure.)

The analysis highlights the complex interplay between the distribution channels for content on the Internet. In the following sections we focus our attention on two interesting cases. In the first case, the customers predominantly use the Internet for accessing proprietary content (regions D and E in Figure 2). This is typical in business usage, where the Internet is used to access specialty databases. In the other case, all locations are served, as the average value of proprietary content exceeds the cost of using Internet for even the most distant locations. This case corresponds to regions A, B and D in Figure 2.

4 Only Proprietary Information

In this section we consider the situation when the primary use of the Internet is for accessing proprietary content. For example, a business may pay to access law abstracts and rulings (Lexis-Nexis) or academic journals, abstracts, and papers (First Search) or use the Internet for retrieving the full text of recent medical papers (Medline). Some ISPs concentrate in such business markets. Nysernet in upstate New York is an example of such an ISP.

4.1 The equilibrium prices

To model the Internet economy in this special case, we assume that the value of non-proprietary information is negligible. This considerably simplifies the problem and allows us to exhibit some basic structural properties of the equilibrium that also hold in the more general case.

Theorem 1. *When there is only proprietary content, the two symmetric equilibria in which the Internet service and content providers may make a positive profit before fixed costs are:*

- For $a \leq \frac{c}{m} + \frac{k_c}{2}$, the ISPs pick a price of $p = \frac{a}{2} + \frac{3}{4}k_c$ and the content

provider picks a price of $p_c = \frac{a}{2} - \frac{k_c}{4}$.

- For $a \geq \frac{c}{m} + \frac{k_c}{2}$, the ISPs will pick the price

$$p = \left(a + \frac{k_c}{2} + \frac{9c}{4m} \right) - \sqrt{\left(a + \frac{k_c}{2} + \frac{9c}{4m} \right)^2 - \left(4a\frac{c}{m} + \frac{5c}{2m}k_c + 2ak_c - \left(\frac{c}{m}\right)^2 \right)},$$

and the content providers pick the price

$$p_c = a - \frac{c}{4m} - \frac{p}{2}.$$

The prices and profits are identical in the two cases if $a = \frac{c}{m} + \frac{k_c}{2}$. The proofs of this and subsequent theorems are contained in the Appendix. The proof is relatively straightforward although the details are tedious because of the different geometries involved. The first case in Theorem 1 corresponds to spatial monopoly where the service areas of the ISPs do not abut. We show that the prices and profits of each ISP do not depend on the number of ISPs (m), on the locality, or on the telecommunication cost (c). The second case corresponds to spatial competition, where the ISPs are competing at the margin for the customers in between each other.

*** Insert Figure 3 Here ***

Figure 3 illustrates the theorem for $m = 2$, $c = 4$, $f = k_c = 0$. When a is smaller than $\frac{c}{m} + \frac{k_c}{2} = 2$, a spatial monopoly equilibrium ensues in which the service areas of the ISPs do not abut. Customers far away from ISPs are not served at all. The prices normalized by a are exhibited in the figure. The PCP and ISP each charge $a/2$. For $a > 2$, spatial competition ensues. The prices charged by the PCP and the ISP diverge with an increase in a . The PCP, which has a monopoly over its service, raises its price faster than the ISPs which are now in competition. Figure 3 shows that the profits of the content and Internet service providers increase with a , but the PCP profits always increase faster than ISP profits.

4.2 The impact of increased access to the Internet

In this section we use the equilibrium results derived above to analyze the impact of increasing the number of ISPs and decreasing the local telecommunication costs on content providers, ISPs, and customers.

Decreasing hardware costs, increasing penetration of home personal computers, and deregulation of the telecommunication industry have attracted more ISPs. The ISPs have benefited from increased standardization of hardware, from high speed modems to frame relays, and software, from protocol stacks to browsers. These changes have made it easier technically to become an ISP.

An increase in the number of ISPs affects the profits of the PCP and ISPs in opposite ways. As the number of ISPs increases, the equilibrium shifts from spatial monopoly to spatial competition. The ISP's profits and prices decline. The content provider, on the other hand, finds that its channel costs decrease leading to an increased market size. This increases its profits. This is shown in Figure 4 for $f = k_c = 0$ and $c = 4$. As expected, increasing a results in greater profits for all providers. The marginal impact of a on the ISP profits decreases with m .

*** Figure 4 Here *****

Over the past few years there has been an on-going public policy debate around the issue of local loop charges and their impact on consumers and other service providers. Faster phone modems and competition from other access technologies such as cable modems and direct satellite links have reduced local telecommunication charges. Our results show that a reduction in telecommunication costs may not necessarily benefit the ISPs while the PCP and customers always benefit (Figure 5).

A decrease in telecommunication costs affects ISPs in two ways:

- It increases competition among ISPs, and
- lowers telecommunication costs for the consumer.

While the former reduces ISP prices and profits, the latter makes customers more willing to pay for and obtain Internet services, and this increases ISP profits. Note that these two competing effects give the profit versus telecommunication cost curve a unimodal shape.

*** Figure 5 ***

Finally, we examine the impact of an increase in the number of ISPs on customers. The total generalized price to customers is comprised of PCP and ISP fees and local telecommunication costs. The average telecommunication cost for a customer decreases as the customers find closer points of presence owned by ISPs. The ISP fee declines as the competition in the access market increases. The only part of the cost that does increase with m is the PCP fee. We find that this does not increase faster than the decline in others, so that the total generalized cost declines as the number of ISPs goes up. This results in an increase in the fraction of customers that get on the Internet and access proprietary content. Figure 6 shows that the percentage of customers served asymptotes to 50% as m increases: the PCP behaves more and more like a monopolist and charges a price equal to the average value of proprietary content and consequently half the customers are priced out.

*** Insert Figure 6 here ***

4.3 Comparing direct and Internet channels

Before 1994 when commercial use of Internet was not common, proprietary content providers used a direct channel for distributing their content. They either owned their own networks, as CompuServe did, or they leased access services from Value Added Network providers such as GEIS, Tymenet, and others. By 1995, ISPs provided more points of presence in many localities than these private data networks. As a result, some PCPs began to use the Internet to distribute their content. Others, such as the Bloomberg or Reuters, which provide real

time market information, find that their communications requirements are not satisfied by the current Internet technology and continue to use the proprietary networks.

PCPs face two key questions:

- When should the PCPs replace their direct channels with Internet channels?
- What is the value of maintaining the direct channel along with the Internet channels?

We start with a direct channel. Consider a locality with a single point of presence by the PCP or its agent. The PCP sets the price for the bundle of access and content services. In contrast, customers using the Internet channel pay three sets of fees: local telecommunication charges, ISP fees, and the fee set by the PCP. In return, the customer gets the same content. As shown in the next theorem, this results in smaller profits for the PCP.

Theorem 2: *The proprietary content provider's profit decreases when it replaces all its direct channels with Internet channels if there is no increase in the number of points of presence.*

In the early days a PCP would establish a direct channel with a certain number of points of presence to communicate with its customers without using ISPs. Theorem 2 shows that the PCP will be worse off if it replaces its direct channel with the Internet channel when the number of ISPs is equal to or fewer than the number of direct channel points of presence. As discussed earlier, however the number of ISPs and their points of presence are increasing over time. The next theorem identifies when PCPs will make greater profits from using the Internet channels alone.

Theorem 3: *If $k_c < c/2$ and $k_c < 2a$, then the proprietary content provider's profit is higher with the Internet channel than with the direct channel if the number of ISPs with points of presence in the locality increases beyond a certain number. Furthermore, if $a \geq c$ and $k_c = 0$, then the hurdle value of number of points of presence is:*

$$\left\lceil \frac{20a - 11c + \sqrt{400a^2 - 344ac + 97c^2}}{8a - 2c} \right\rceil$$

It is worth noting that the predicates in the theorem are relatively mild. The first requires that the Internet have a cost advantage over long distance toll calls, and the second requires that at least some customer finds the proprietary content more valuable than the marginal cost of delivering it via the Internet.

Theorems 2 and 3 are illustrated by the example shown in Figure 7 for $a = 2$, $c = 1$, and $f = k_c = 0$. Note that, for m less than 4, the proprietary content provider prefers the direct channel over using the Internet exclusively. For larger m , it prefers the Internet over using its direct channel alone.

*** Insert Figure 7 here ***

Putting Theorems 2, and 3 together, we gain insight into at least one of the ways in which the Internet creates value for proprietary content providers. As the number of points of presence from ISPs increases, the PCP can use their reach to increase its market and profits. It is likely that as the number of ISPs increases further PCPs who are not on the Internet now will find it attractive to invest in using the Internet channel.

Another business policy question considered by the PCP is whether to keep its direct channel while also using the Internet channel. The next theorem addresses this issue, and we

show that the PCP's profits increase even with just one additional Internet point of presence by an ISP.

Theorem 4: *If the proprietary content provider keeps its direct channels then its profit will increase with even just a single additional Internet point of presence provided by an ISP.*

Considering Theorems 3 and 4 together provides insight into the value of having a direct channel even as Internet channels become common. When the direct channel is not maintained, the content provider prefers to use the Internet channels only if there is a sufficient number of ISPs. This is shown in Figure 7, where at least 5 ISPs need to exist in the locality for the proprietary content provider to prefer the Internet channels. On the other hand, as shown by Theorem 4, if the direct channel is maintained in addition to the Internet channels, even one additional ISP increases content provider's profit. In this example it seems that by keeping its direct channel the PCP disciplines the entire ISP market, which helps the PCP in getting a broader reach.

5 Proprietary and Non-Proprietary Content

The previous section presents some structural results for the special case when the value of non-proprietary content and services, b , is zero. In this section, we relax this assumption and examine the equilibrium prices, market segments, and profits when there is substantial non-proprietary content and when the average value of proprietary content is large enough that some customer from every location finds it worthwhile to access the PCP over the Internet. This occurs when the communication costs (including dial-up and ISP marginal costs) are lower than

the average value for proprietary content, a . In this case the dial-up cost is low enough that the ISPs are always competing for the customers on the margin. The new equilibrium is described in Theorem 5 below.

Theorem 5: For $a \geq \frac{k_c}{2} + \frac{c}{m}$ the four symmetric equilibria are:

- For $b \geq \frac{k_c + k_i}{2} + 3\frac{c}{m}$: $p = \frac{k_c + k_i}{2} + 3\frac{c}{m}$ and $p_c = a$.
- For $\frac{k_c + 2k_i}{3} + \frac{7}{3}\frac{c}{m} \leq b \leq \frac{k_c + k_i}{2} + 3\frac{c}{m}$: $p = b - c/m$ and $p_c = a$
- For $k_c + \frac{c}{m} \frac{8a - c/m}{4a + 5c/m} \leq b \leq \frac{k_c + 2k_i}{3} + \frac{7}{3}\frac{c}{m}$

$$p_c = a - \frac{b}{4c/m} (b - 2c/m) + \frac{p}{4c/m} (2b - 2c/m - p) - \frac{1}{4c/m}$$

and p is the smallest real root of the cubic

$$3p^3 - (8b + k_c - 2k_i)p^2 + (7b^2 - 2b(k_c - 2k_i) - 2c/m(10a + b - 3k_c + 2k_i) - 5c^2/m^2)p + b^2(-2b + k_c - 2k_i) + 4ac/m(2b + k_c + 2k_i) + 2bc/m(b - 3k_c + 2k_i) + c^2/m^2(8a + 2b + 5k_c - 2k_i) - 2c^3/m^3 = 0.$$

- For $b \leq k_c + \frac{c}{m} \frac{8a - c/m}{4a + 5c/m}$: $p_c = a + \frac{b}{2} - \frac{p}{2} - \frac{c}{4m}$ and

p solves the quadratic

$$2p^2 - (4a + 2b + 2k_c - 9c/m)p + 2k_c(2a + b) + c/m(8a + 4b + 5k_c - 2c/m) = 0.$$

The cases in the theorem are contained in the regions of spatial competition in Figure 2. The first case of the theorem is contained in region A, the second is contained in the boundary between regions A and B, the third is contained in region B, and the fourth is contained in region D in that figure. All the customers are on the Internet when b is very large, as it is in the first

two cases above. In the third case not all customers are on the Internet, nor do all customers who get Internet service go to the PCP. No customer gets only ISP services in the fourth case. The third case corresponds to the situation in many markets today and is further analyzed below.

Theorem 5 shows that structurally the changes in the value of b determine the prices charged by the ISP and the PCP. To illustrate the impact of changes in value of non-proprietary content, b , on the market, we plot the percentage of customers getting proprietary and non-proprietary content in Figure 8. Customers get ISP services only for accessing proprietary content from the PCP when b is small. As b increases, at some point the equilibrium switches, and some customers get access for ISP services alone. These customers do not access the PCP. It is interesting to see what happens to the proprietary content provider at this point.

Surprisingly, it also sees a sudden expansion in market demand at the same time that the ISP starts selling services for non-proprietary content. Our analysis shows that this switch occurs because the ISP changes its pricing policy. As the relative value of non-proprietary content gets higher, the ISP lowers its flat tariff to attract these customers as well as serve others who go on to access the PCP. As a result, the derived demand for the PCP increases and its profit increases as shown in figure 9. This figure shows that the profits of *both* the ISPs and the PCP increase as the ISPs provide better and better non-proprietary content and services. This is a unique feature of the Internet economy, where the ISP acts as both a conduit and as a competitor to the PCPs.

*** Insert Figure 8 here ***

*** Insert Figure 9 here ***

From the foregoing discussion it becomes clear that even the PCP may have a significant interest in providing some free content to the ISPs as a way to enhance b . In Figure 10 we compute the marginal value-enhancing b to the proprietary content provider.

*** Figure 10 here ****

Interestingly, we see that for the PCP the marginal value of adding free content is unimodal concave with respect to m , the number of ISPs. For example, with smaller m the market for content is still so small that it is not worthwhile for the PCP to make this investment. For larger m , the ISPs are already competing so effectively that the marginal impact of additional non-proprietary content on the market is small. It is therefore not worthwhile for the PCP to enhance the non-proprietary services at this end of the market.

When the marginal cost of creating non-proprietary content and services is 0.20 (on a per customer basis), the proprietary content provider will find it beneficial to invest in non-proprietary content only for $3 \leq m \leq 8$. This result provides a significant input into the current debate on the role played by free content on the Internet. Under our modeling assumptions, free content provides its maximum return to the PCP during the intermediate stage of market development. Over time, as the number of ISPs increases, access fees become sufficiently low that the PCP will have to invest less and less in trying to attract customers to join the Internet.

6 Managerial implications and conclusions

The emergence of the Internet as a ubiquitous service for wide-area telecommunication has had a large impact on providers of on-line financial, market, legal, technical and other proprietary data. The Internet provides many unique advantages as a communication service primarily linking customers through the use of ISPs with each other and with the PCPs in a way that is independent of distance. These features make it attractive for the PCPs to use the Internet as a way to enhance their global reach.

In this paper we determine the equilibrium between customers, ISPs, and proprietary content providers and analyze the impact of channel and content-enhancing policies. We assume

that customers looking for proprietary content have to pay local dial-up fees, ISP fees and PCP fees to obtain proprietary content. Some customers may elect to use the Internet by itself and will not pay the PCP. We find five significant equilibria in which the PCPs and ISPs make non-zero profit. Which one of these equilibria arises depends on the average value of the proprietary content, the value of non-proprietary content, the cost structure of the service providers, and the number of ISPs in the market. The ISPs act both as channel members for the PCP and as competitors while directly selling non-proprietary content and services to the customers. We show that, as the number of ISPs increases over time, their profits and prices decline, while those of the PCP increase. This makes proprietary content valuable while Internet access services get commoditized even as the ISPs provide valuable non-proprietary content and other Internet services such as email, chat room, web hosting, etc. We also find that universal access to the Internet resulting from a hypercompetitive ISP market, or government intervention, is unlikely to result in universal access to proprietary content. In fact, in this instance the PCP raises prices and reduces the distribution of free content.

Deregulation of the telecommunication industry, faster modems, and better access technologies have reduced the dial-up costs for the customers. This initially results in an increase of ISP profits. We show, however, that if this trend continues then the impact on the ISP will change and, beyond a certain point, their profits will start declining, because a great reduction in local dial-up costs puts the ISPs in closer spatial competition with each other. The PCP's profits, on the other hand, monotonically increase with decreases in local dial-up costs.

The preference for Internet channels over a direct channel for distributing proprietary content depends on the level of competition in the ISP market and on the value of non-proprietary content and services available. Since, historically different PCPs had different sizes

and reaches with their own telecommunication networks, they switch over to the Internet at different stages of Internet penetration. Moreover, we find that a PCP will do better if it maintain its direct channel in addition to the Internet channels. Keeping both types of channels for selling information goods disciplines the ISP market to the PCP's benefit.

The impact of these changes on customers depends on their location. Distant customers gain as they use the wide area networking provided by the Internet, but the closer customers lose surplus as the content provider raises prices to reflect the changes in the channel. Moreover, when the ISP provides non-proprietary content and services, its prices and profits increases monotonically with the value of these services. Surprisingly, not only does the PCP also benefit from an increase in non-proprietary content, the marginal impact is even greater for the PCP than the ISP for moderate levels of ISP services. Consequently, even the PCP would consider providing some content for free on the Internet to enhance the value of ISP services. Our analysis shows that this policy is profitable for the PCP only for an intermediate level of competition in the ISP market. This may explain why in some instances PCPs provide both free and fee based content.

Despite the numerous managerial insights provided by our analysis, it has some limitations that arise from the simplifications needed to make the problem tractable. To begin with, we assume that there is a single proprietary content provider. It might be useful to consider multiple content providers in a horizontally differentiated market. We hypothesize that most of the insights discussed above will hold as long as these providers have sufficiently different content.

Appendix: Theorem Proofs

Proof of Theorem 1

First consider the case of spatial competition.

Assume that all ISPs except one and the proprietary content provider (PCP) set prices as hypothesized in the theorem. We will show that the one excepted ISP will also pick the price specified in the theorem.

Let t be the distance from the ISP of the customer who is indifferent between using this ISP and not using it. (Set $t = 1$ if there is only one ISP.) Hence $t = \frac{1}{m} + \frac{p - p_1}{2c}$.

The fraction of customers who will use the ISP under consideration and get proprietary content is

$$q_1(p_1) = \frac{1}{4a} \left(2 \int_0^t (2a - p_c - p_1 - cx) dx \right)$$

The profit for the ISP is $\pi_1(p_1) = (p_1 - k_c) q_1(p_1) - f$, where k_c and f are the variable cost and fixed cost of serving a customer.

The p_c and p , the PCP and all ISP prices from the theorem, respectively, satisfy the first and second order conditions for optimality. To verify that we have spatial competition, the utility of the furthest customer with value for proprietary content of $2a$ is $2a - p_c - p - c/m$. Substituting for the prices, we find it to be positive for $a \geq \frac{c}{m} + \frac{k_c}{2}$.

Hence we have shown that in spatial competition the ISP obtains an interior profit maximizing solution that satisfies the first and second order conditions for optimality.

Now turning to the PCP, we find that the fraction of customers that access it is

$$q_c = m q_1(p) = \frac{2a - p - p_c - \frac{c}{2m}}{2a} \text{ and its profit is } \mathbf{p}_m = p_c q_c \text{ when it charges } p_c \text{ and the ISPs}$$

charge p as specified in the theorem. We find that the PCP too has an interior maximum of its profit at p_c , as specified in the theorem.

The spatial monopoly case is proved similarly.

QED

Proof of Theorem 2

Let $q(p)$ be the fraction of customers who obtain service if there are m symmetric points of presence with a fee of p . The points of presence may be owned by ISPs or the PCP.

It is easy to see that $q(p)$ is strictly decreasing in p for $0 \leq p \leq 2a$.

Let p_{cd} be the optimal direct channel price set by the PCP and let p_{ci} and p_i be the optimal content and ISP services prices set by the PCP and ISP respectively for the Internet channel. Using monotonicity of $q(p)$ we get:

$$p_{ci} q(p_{ci} + p_i) < p_{ci} q(p_{ci}) \tag{1}$$

Furthermore, since p_{cd} is optimal for direct channels:

$$p_{ci} q(p_{ci}) \leq p_{cd} q(p_{cd}) \tag{2}$$

By combining equations (1) and (2), we have the result.

QED

Proof of Theorem 3

Let π_d and π_m be the profits for PCP with only a direct channel and with m internet channels (but no direct channel), respectively.

By theorem 2, $\pi_1 < \pi_d$.

Substituting into the profit function for the PCP derived in the proof of Theorem 1 and using the

fact that $\lim_{m \rightarrow \infty} p = k_c$, we get $\lim_{m \rightarrow \infty} \mathbf{p}_m = \frac{(2a - k_c)^2}{8a}$.

$$\mathbf{p}_d = \frac{(2a - c/2)^2}{8a} < \lim_{m \rightarrow \infty} \mathbf{p}_m \text{ since } k_c \leq \frac{c}{2}.$$

The existence of a value for m at which $\pi_1 = \pi_m$ follows from the continuity of π_m .

Now for the second part of the theorem.

Consider when $k_c = 0$ and $a \geq c$.

From Theorem 1 we know that we will have spatial competition.

The maximum PCP profit for $a \geq c$ can be derived as in the proof of Theorem 1 to be

$$\frac{(4a - c)^2}{32a}. \quad (3)$$

The maximum PCP profit for $a \geq c$ when the ISPs each charge p is

$$\frac{(4a - c/m - 2p)^2}{32a}. \quad (4)$$

Comparing equations (3) and (4), we see that $\pi_d = \pi_m$ for m such that the optimal ISP price in the

spatial competition case as obtained in Theorem 1 is equal to $\frac{c}{2} - \frac{c}{2m}$.

Solving for m , we get the hurdle exhibited in the theorem.

QED

Proof of Theorem 4

First consider the case when there is no ISP. Let $q_0(p_c)$ be the quantity demanded of the content provider at price p_c . Next, assume that an ISP joins the locality and offers connectivity for a price of p . Let $q_1(p_c, p)$ be the total number of customers who request content. These customers may access the content provider directly or via the ISP. Customers who accessed the content

when there was no ISP will continue to do so when there is an ISP, although some may now do so via the ISP. Hence $q_1(p_c, p) \geq q_0(p_c) \quad \forall p_c, p$.

Since the content provider will set $p_c \geq 0$, $p_c q_1(p_c, p) \geq p_c q_0(p_c) \quad \forall p_c, p$.

In particular, this holds for p^* , the price obtained in Theorem 1:

$$p_c q_1(p_c, p^*) \geq p_c q_0(p_c) \quad \forall p_c.$$

Hence, $\max_{p_c} p_c q_1(p_c, p^*) \geq \max_{p_c} p_c q_0(p_c)$.

QED.

Proof of Theorem 5

To evaluate the Nash equilibrium solution, we have to consider a case when an ISP deviates from the equilibrium. Consider an instance in which each ISP, other than ISP i , charges p , the PCP charges p_c , and ISP i charges p_i . The fraction of customers who will get non-proprietary content alone from this ISP is given by equations (1) to (3). The fraction of customers who get both types of content is given by equations (4) to (9).

Given these traffic volumes, the profits of the service providers are

$$\begin{aligned} \mathbf{p}_i(p_i, p, p_c) &= (p_i - k_i) q_{in}(p_i, p, p_c) + (p_i - k_c) q_{ic}(p_i, p, p_c) - f \text{ and} \\ \mathbf{p}_c(p_i, p, p_c) &= m p_c q_{ic}(p_i, p, p_c) \end{aligned}$$

The conditions for Nash equilibrium are

$$p \in \underset{p_i}{\text{Argmax}} \quad \mathbf{p}_i(p_i, p, p_c) \text{ and } p_c \in \underset{p'}{\text{Argmax}} \quad \mathbf{p}_c(p, p, p')$$

We used *Mathematica* to solve the first and second order conditions and check the cross cases to determine the conditions and prices shown in the theorem.

QED.

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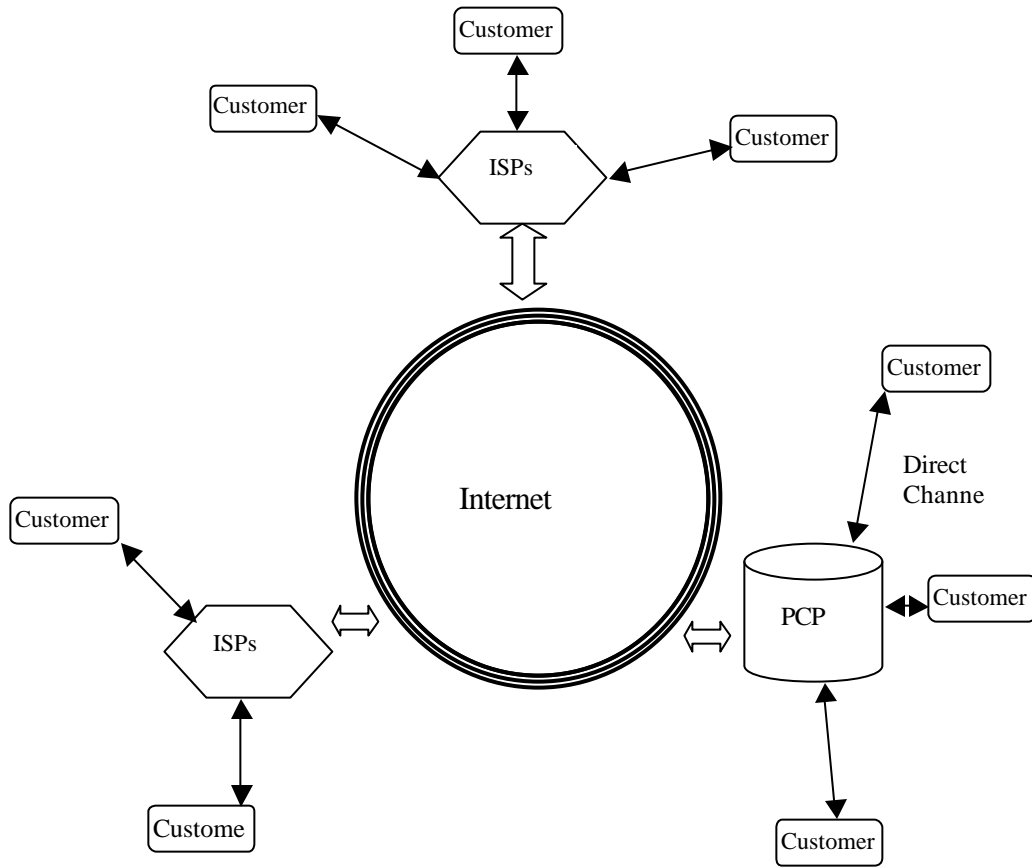


Figure 1: The Internet

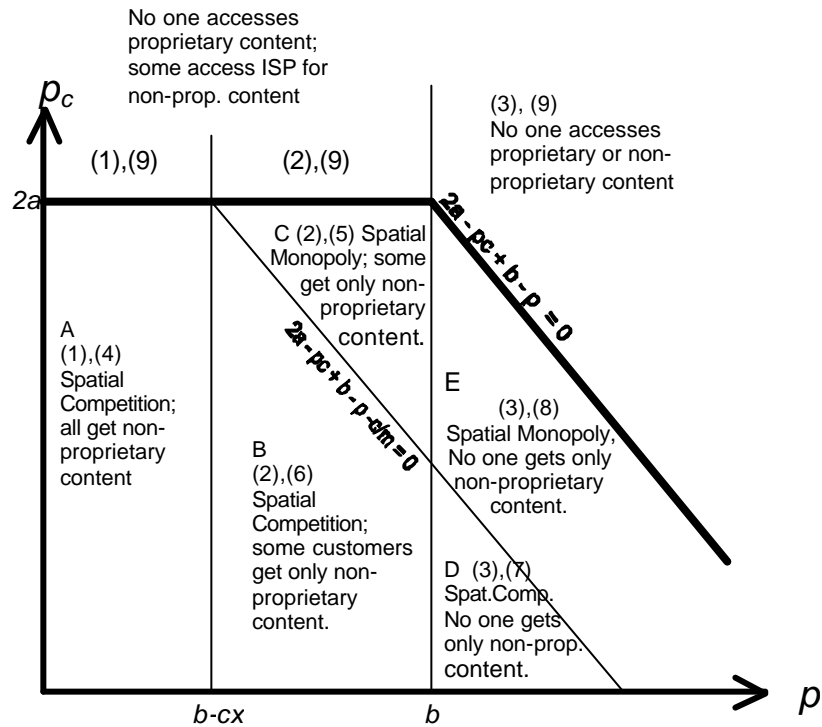


Figure 2: The symmetric equilibria

The numbers in parenthesis refer to equations in Section 3.

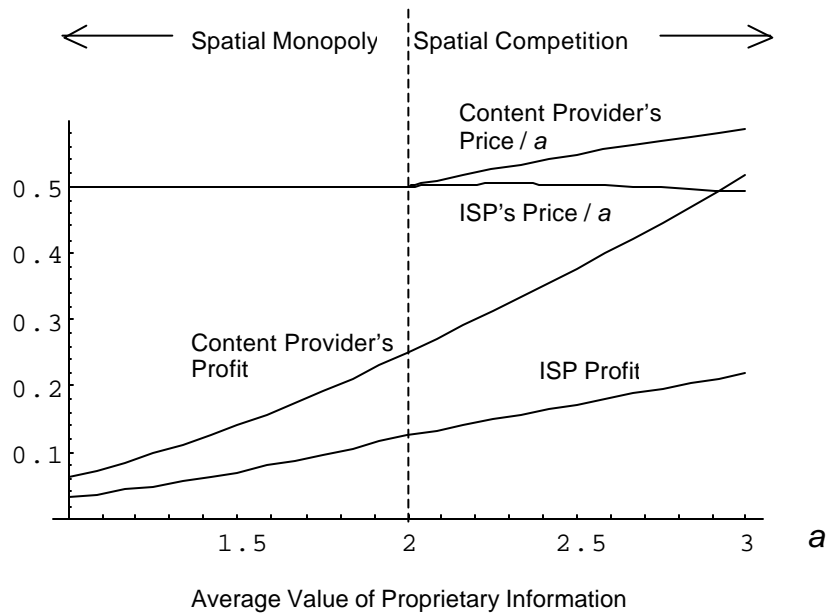


Figure 3: The Spatial Equilibria
 The prices normalized by a and profits per customer are graphed versus a , the average value of proprietary information. Other variables are $m = 2$ and $f = k_c = 0$.

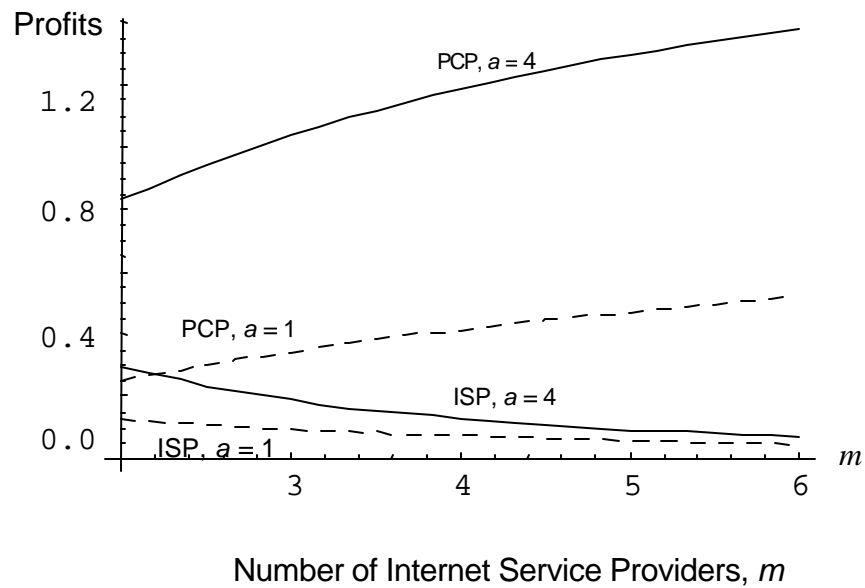


Figure 4: Profits and the Number of Internet Service Providers
 The profits are on a per customer basis. Other variables: $f=0$, $k_c = 0$, $c = 4$. The ISPs are in spatial competition.

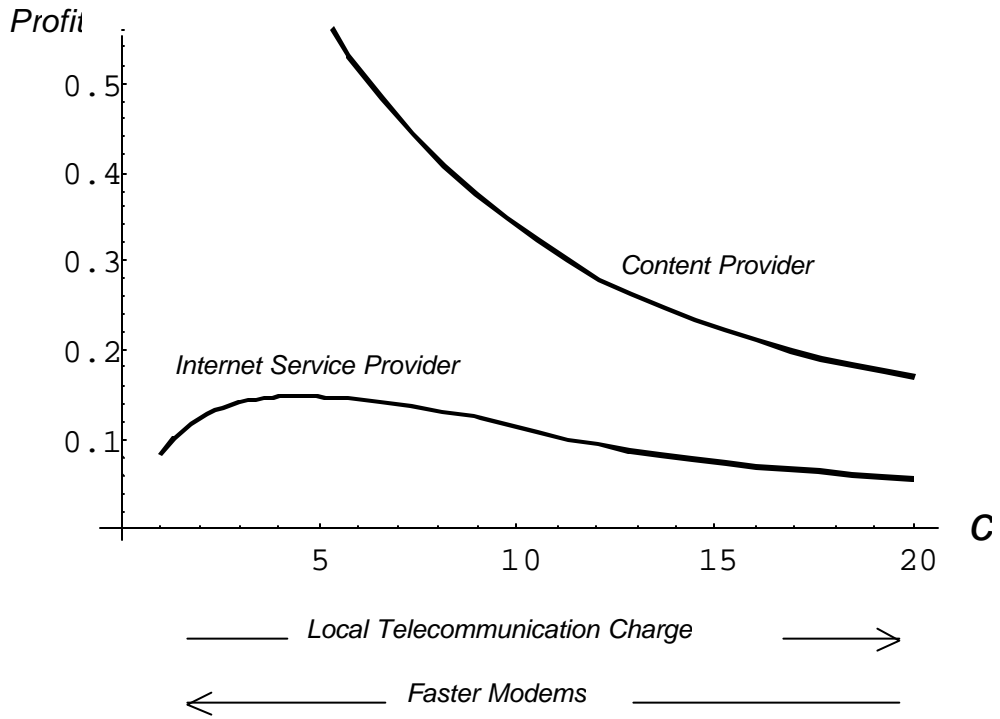


Figure 5: The impact of Local Telecommunication Charges on the Profits of Service Providers.

The profits are on a per customer basis. Other variables: $a = 3, m = 3, f = 0, k_c = 0.2$.

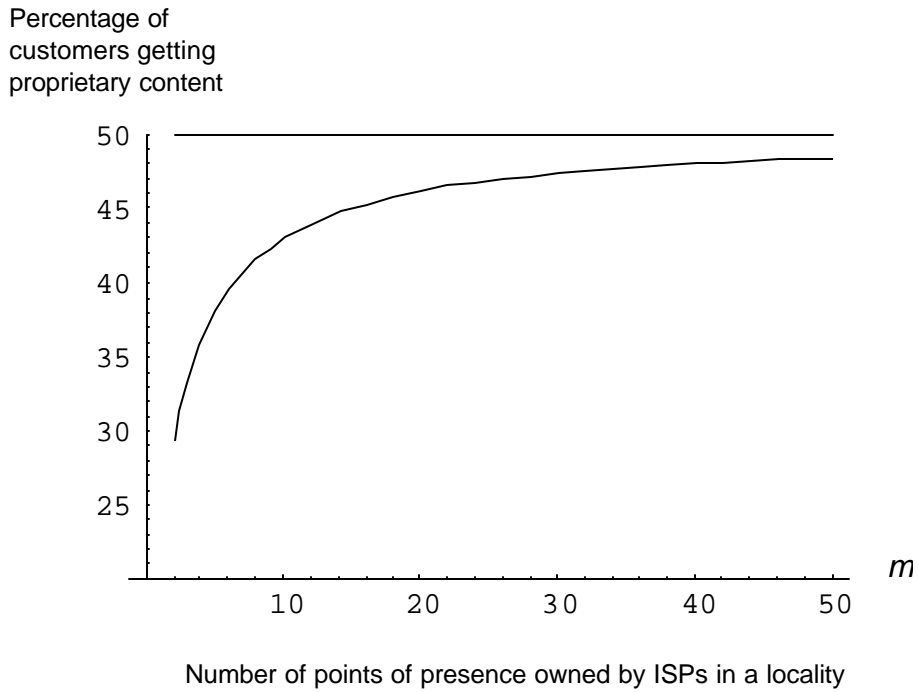


Figure 6: Percentage of the Customers Getting Proprietary Content Vs. the Number Of Points Of Presence Owned By Isps

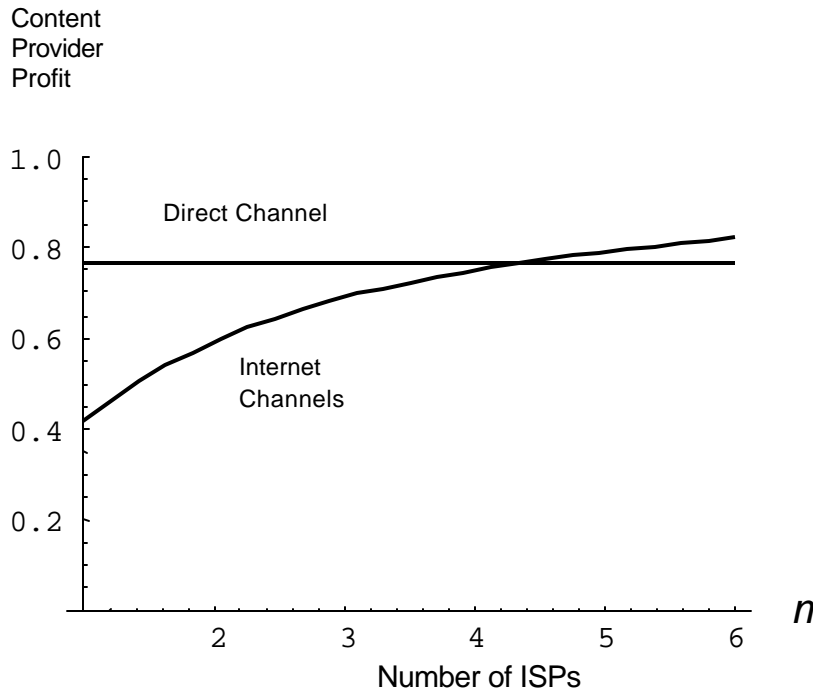


Figure 7: Comparison of the Content Provider's Profits from Direct and Internet Channels.

The profits are on a per customer basis. Other variables: $a = 2, c = 1, f = k_c = 0$.

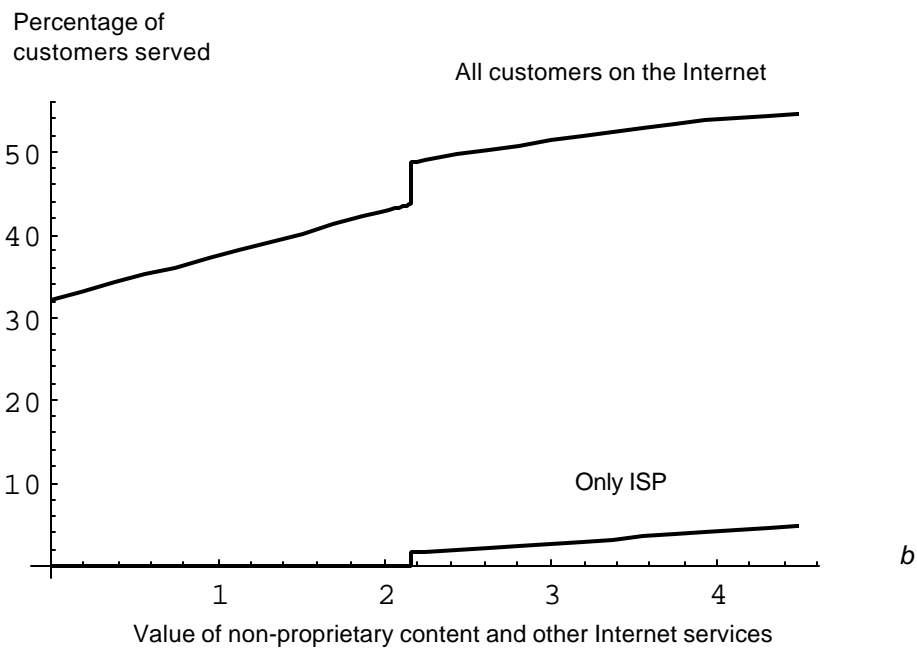


Figure 8: Impact of Value of Non-Proprietary Content and Internet Services on the Percentage of Customers who Get Service

Other variables are: $a = 4, c = 20, f = k_c = k_i = 0, m = 10$.

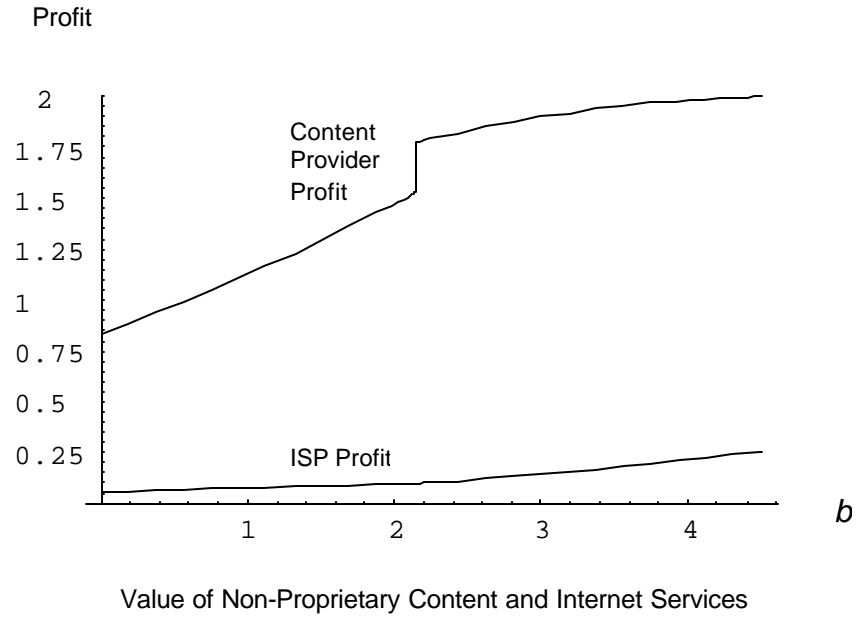


Figure 9: Non-Proprietary Content and Profits

The profits are on a per customer basis. Other variables: $a = 4, c = 20, f = k_c = 0, m = 10$.

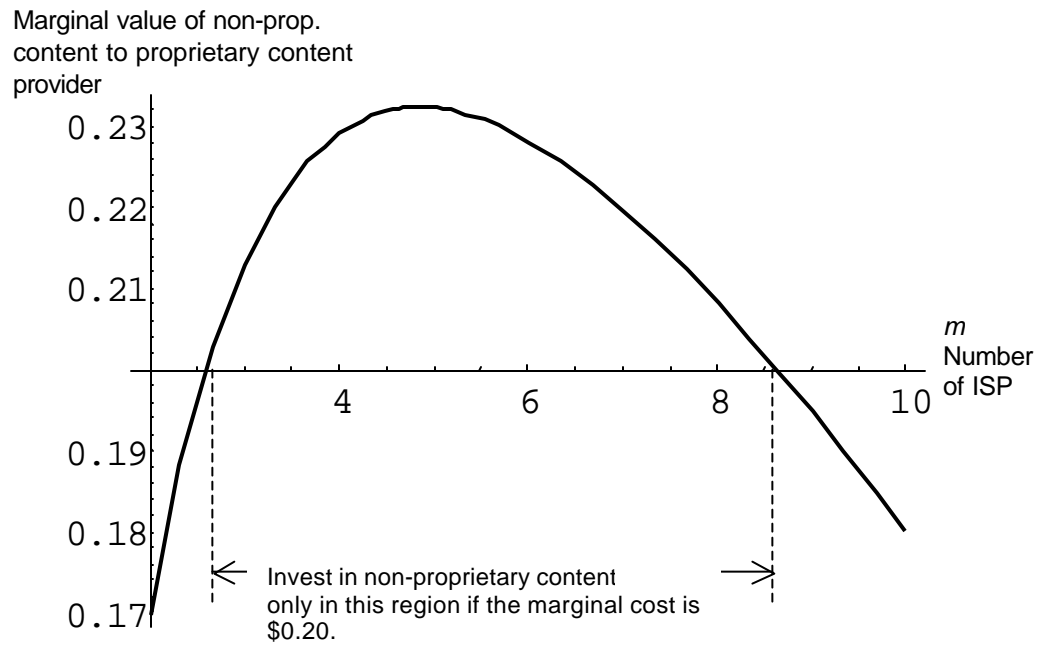


Figure 10: Investment in Non-Proprietary Content by Proprietary Content Provider for Marginal Cost of 0.20 per Customer

The profits are on a per customer basis. Other variables: $a = 12, c = 40, f = k_c = 0, b = 5$.