Search and quality evaluation in competition between online suppliers*

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Abstract

We study competition between two online suppliers of consumer products like books, music CDs, or DVDs, when suppliers can offer either “star” goods (i.e., goods whose quality is known by all consumers), “non star” goods (i.e., goods whose quality is uncertain), or both types of goods. Using a sequential entry game, we show that one supplier offers only “star” goods, whereas its competitor provides only “non star” goods. We also analyze the incentives to introduce “samples” which allow consumer to evaluate the quality of the goods, and “search tools” which enable consumers to search for unknown goods.

Keywords: Internet; E-commerce; Cultural goods; Quality; Search.

JEL codes: L86; L1; D83.

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1 Introduction

Since the beginning of the world wide web, some e-commerce sites have been selling online consumer products, like music CDs, books or DVDs. The competition between online providers of consumer goods has two interesting features. First, online suppliers strongly differentiate their catalogues. Some sites, like Deepdiscounted in the US or Cdiscount in France, offer a limited number of goods, and mainly star goods, i.e., goods for which consumers have a lot of information (about their existence, type or quality). Other sites, like Amazon.com or Amazon.fr, propose a large catalogue of goods, and a large proportion of non star goods, i.e., goods for which consumers lack information.\footnote{Brynjolfsson, Smith and Hu (2003) refer to star goods as “regular goods” and to non star goods as “obscure goods”. Notice that star goods are not necessarily “bestsellers”. Star goods may fail to attract consumers, whereas non star goods may become bestsellers.} Table 1 shows the number of DVD and music CD titles available at various French Internet retailers. Large online stores (Amazon.fr, Fnac.com and Alapage.com) provide at least twice as many titles as small online stores.

<table>
<thead>
<tr>
<th>Internet retailer</th>
<th>DVD titles</th>
<th>CD titles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon.fr</td>
<td>Over 11,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Fnac.com</td>
<td>Over 8,000</td>
<td>100,000</td>
</tr>
<tr>
<td>Alapage.com</td>
<td>8,000</td>
<td>130,000</td>
</tr>
<tr>
<td>Cdiscount.com</td>
<td>4,000</td>
<td>Less than 31,000</td>
</tr>
<tr>
<td>Cinéstore</td>
<td>5,200</td>
<td>None</td>
</tr>
<tr>
<td>DVDshopping</td>
<td>4,500</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 1: Number of titles at various online retailers

Second, some online retailers provide search and evaluation tools to help consumers choose a product. Customers can search by using a search bar, or they can use a topology tool which indicates which goods are nearest to a specific product. Customers can also evaluate the quality and the type of products before purchase by using samples of music or excerpts of books, or by reading...
customer reviews. Table 2 presents the availability of these tools at various Internet retailers. For example, suppliers which offer a large catalogue of goods, like Amazon or Fnac.com, often propose different tools, whereas discounters like Deepdiscounted or Cdiscount propose only a search tool or no tool at all.

The reason seems to be that the latter suppliers offer mainly star goods whereas the former propose non star goods. It is obvious: the role of “recommender systems” is to help consumer discover unknown, hence non star, products (Resnik and Varian, 1997). As the founder and CEO of Amazon.com, Jeff Bezos (1998), states:

“There are more than 3 million different titles available and active in print worldwide. Music is the number two category, and there are about 300,000 active music CDs. When you have this huge number of titles, a couple of things start to happen. First of all, you can use computers to sort, search and organize. Second, you can create a super-valuable customer proposition that can only be done online, and that is selection.”

<table>
<thead>
<tr>
<th>Internet retailer</th>
<th>Samples</th>
<th>Search tool</th>
<th>Topology tool</th>
<th>Customer reviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon.com</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Barnes and Noble</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cdnow.com</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Playcentric</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>CD Universe</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Buy.com</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CDconnection</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Deepdiscounted</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cheap Or What!</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Alphacraze.com</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Fnac.com</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Cdiscount (French)</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 2: Software tools available at various online retailers
The main objective of our paper is to unveil this logic. We study competition between two online suppliers of consumer products like books, music CDs, or DVDs, when the suppliers can provide star goods, non star goods, or both types of goods. We suppose that the quality of star goods is known by all consumers, whereas the quality of “non star” goods is uncertain before purchase, i.e., “non star” goods are experience goods. Using a sequential entry game, we show that one supplier offers only “star” goods, whereas its competitor provides only “non star” goods. We study the incentives of the suppliers to introduce samples and search tools and their effect on the market equilibrium.

Our work addresses the question of competition between online suppliers of cultural goods. Since the early work of Bailey (1998), a large body of empirical literature has analyzed electronic commerce of books or CDs (Bailey, 1998; Brynjolfsson and Smith, 2000; Clay, Krishnan and Wolff, 2001; Friberg, Ganslandt and Sandström, 2001; Larribeau and Pénard, 2002). This literature compares patterns of price of Internet retailers and bricks and mortar retailers. According to the more recent works (e.g., Brynjolfsson and Smith, 2000),\(^2\) online retailers charge slightly lower prices on average than their offline counterparts, and price dispersion among online retailers is large. Goolsbee and Chevalier (2002) estimate the own- and cross-price elasticities of demand for books at Amazon and Barnes and Nobles. They find significant price sensitivity for online book purchases, on both sites. Filson (2002) examines the impact of several e-commerce strategies on the values of Amazon.com, BarnesandNoble.com, CDnow, and N2K. He shows that price reductions, foreign expansion and competition reduce value, whereas product line expansion and service improvement tend to increase value.

However, this research focuses on the operational efficiency gains of online retailing compared to traditional retailing, and ignores the impact of increased variety. Brynjolfsson, Smith and Yu

\(^2\)Bailey (1998) found that prices for books, CDs, and software were actually higher online than offline. This result has not been confirmed by later research.
(2003) is a notable exception. They estimate the economic impact of increased product variety provided by online bookstores. They show an increase in consumer surplus in 2000 by $731 million to $1.03 billion.

The impact of software tools - e.g., samples or customers reviews - on competition has received scant attention. Our goal is to begin to fill this gap.

The paper is organized as follows. We begin by setting up the model in Section 2. In Section 3, we derive the equilibrium and study the catalogue choice of two competing online suppliers. In Section 4, we analyze the incentives of these suppliers to introduce samples and search tools. In Section 5 we conclude.

2 The model

2.1 Cultural goods

Cultural goods are characterized by their type and their quality.

The type of a cultural product is a horizontal differentiation feature, which corresponds to a location on a circle of unit length. The type might represent the “genre” of a cultural product (for music: classical, pop, rock, jazz, etc.). Another interpretation is that the circle of cultural types represents different styles in a given genre. For instance, if the circle represents jazz music, jazz fans trade-off between different styles of jazz (smooth jazz, bebop, etc.).

The quality of a cultural product is a continuous variable, which corresponds to a vertical differentiation feature. The idea is that for a given type, there are low quality products and high quality products. For instance, a consumer might be uncertain about the quality of the new album of its favorite band.

There are two categories of cultural goods: “star” (S) goods and “non star” (NS) goods.
Whereas the quality of S goods, $q_S$, is fixed and known to all consumers, the quality of NS goods, $q_{NS}$, is uncertain. It can take two different values: it is high ($q_{NS} = q^H$) with probability $\alpha$ and low ($q_{NS} = q^L$) with probability $1 - \alpha$, where $\alpha \in (0, 1)$ and $0 \leq q^L < q^H$. The quality levels of NS goods are independent. One interpretation of the difference between S goods and NS goods is that S goods benefit from intensive marketing campaigns, which make consumers learn their quality, while NS goods do not.

We denote $\tilde{q}_{NS} = E[q_{NS}]$ the expected quality of NS goods and $\Delta = q_S - \tilde{q}_{NS}$ the expected quality difference between S goods and NS goods. We assume that $\Delta > 0$, which means that S goods have an expected quality advantage over NS goods: consumers prefer to purchase a S product of their preferred type than a NS product of the same type. This assumption means that when selecting NS goods to create S goods through intensive marketing campaigns, the music industry (i.e., the “majors”) picks products whose average quality ($q_S$) is greater than the average quality of cultural goods ($\tilde{q}_{NS}$).

Finally, we assume that there are $n$ S goods, which are uniformly distributed along the circle; the number of S goods is limited because of marketing budget constraints. There is an infinite number of NS goods, which are uniformly distributed along the circle.\footnote{This assumption is consistent with empirical evidence: there is a large number of cultural goods but only a few are heavily advertised (cf. the citation of Bezos (1998) in the introduction).}

Consumers are aware of the existence of S goods and NS goods. In section 4 we shall introduce a search stage through which consumers get aware of the existence of NS goods.

### 2.2 Consumers

Consumers have varying tastes, which are uniformly distributed along the circle of cultural “types”. When a consumer buys a cultural product which is not of its preferred type, it incurs a loss of utility - or “fit” cost - proportional to the distance between the type of the product, $x_i$, and its preferred
type, $x$. This fit cost is equal to $t \times |x - x_i|$, where $t > 0$.

Consumers can buy either a S product, a NS product or no product at all. If it buys a S product located at $x_i$ from supplier $i$, the indirect utility function of a consumer located at $x$ is

$$u^S_i = v + qS - t \times |x - x_i| - p^S_i,$$

while it gets

$$u^{NS}_j = v + q^{NS} - t \times |x - x_j| - p^{NS}_j,$$

if it buys a NS product offered by supplier $j$ at location $x_j$, where $v$ is a fixed utility obtained from consuming cultural goods, $p^S_i$ is the price of S goods charged by firm $i$ and $p^{NS}_j$ is the price of NS goods charged by firm $j$. We assume that $v$ is sufficiently large so that every consumer is served at the equilibrium.

To clarify the exposition, we denote $h = t/n$; $h$ represents the “distance” between two S goods and it can be viewed as a measure of the degree of horizontal differentiation. We assume that $h > q_S - q^L$. This assumption ensures that vertical differentiation does not dominate horizontal differentiation too much.

Last but not least, we assume that consumers can visit the two suppliers - and hence, compare prices and offers - at no cost.

In the present setting, S goods and NS goods are imperfect substitutes. However, assuming that demands for S goods and NS goods are distinct would not change the essence of the analysis.\footnote{Nonetheless, if demands were distinct, a supplier of S goods would not compete any more with a supplier of NS goods.}
2.3 Online stores

There are two online stores, 1 and 2, which provide cultural goods. Marginal costs of providing cultural goods are constant and normalized to zero. There is a sunk cost $f > 0$ of selling goods online. We suppose that $f$ is sufficiently low so that there is entry.\footnote{The fixed cost $f$ represents the costs of servers and software for selling cultural goods online. It is independent of the number of goods offered online.}

Supplier $i = 1, 2$ has two decisions. First, it must decide on the catalogue, $G_i$, it offers online. It may sell no goods ($G_i = \emptyset$), only S goods ($G_i = S$), only NS goods ($G_i = NS$) or both S and NS goods ($G_i = S + NS$). Second, supplier $i$ must decide on the prices of S goods and/or NS goods, $p_i^S$ and $p_i^{NS}$. For simplicity, we assume that supplier $i$ sets a uniform price within each category (S and NS).

Finally, once the suppliers have chosen their catalogues and observed their rival’s catalogue choice, each one can decide to remove part of its catalogue (i.e., S goods and/or NS goods) at a very low but strictly positive removal cost $\epsilon > 0$ (we shall discuss this assumption below).
2.4 The timing

The timing of the game is as follows.

1. Supplier 1 chooses its catalogue.

2. Supplier 2 chooses its catalogue.

3. Supplier 1 and supplier 2 decide simultaneously whether to remove parts of their catalogues or not.

4. The two sites choose prices simultaneously and consumers buy goods.

We are looking for the Nash equilibrium of this four-stage game.

There are two key assumptions in this setting. First, suppliers choose their catalogues sequentially, not simultaneously. This assumption is consistent with the observed entry strategies of cultural e-commerce sites: there were leaders (like Amazon) and laggards (like Barnes and Noble). Amazon went online in July 1995 and pioneered the online bookstore market. Barnes and Nobles launched its online store later, in 1997. As for music, CDnow was the pioneer in 1996, whereas Amazon launched its music store in June 1998.\(^6\)

Second, we assume that once the suppliers have chosen their catalogues, each one can remove part of its catalogue before setting prices and selling to consumers. The reason why we insert this stage is the following. If we do not allow suppliers to remove part of their catalogue, the game has a unique Nash equilibrium, in which supplier 1 provides both S goods and NS goods and supplier 2 remains out of the market. Indeed, if it provides S goods and NS goods, supplier 1 deters entry

\[^6\]If the suppliers choose their catalogues simultaneously and cannot remove part of the catalogue after their choices, there are four possible Nash equilibria: (S, NS), (NS, S), (∅, S + NS) and (S + NS, ∅). If we allow suppliers to remove part of their catalogue in a third stage, the two last equilibria disappear. Hence, we end up with the same differentiated equilibrium as in the sequential game. However, in the simultaneous game, we cannot tell which equilibrium is selected. Besides, suppliers may be better off if they play mixed strategies. Therefore, we think that a sequential game describes better the essence of competition between suppliers of cultural goods, as well as it simplifies the analysis.
from supplier 2 since competition between the same type of goods drives supplier 2’s profit to zero - and zero profit does not cover the entry cost \( f \). However, as Judd (1985) points out, preemption is an equilibrium only if exit costs are very high, i.e., only if preemption is credible. We claim that in the present setting, as suppliers have electronic catalogues, the cost of removing some references from the existing catalogue, hence exit costs, are very low but positive. Therefore, we allow online suppliers to remove part of their catalogues.

3 The equilibrium

In this section, we show that competition for cultural goods leads suppliers to differentiate their catalogues, i.e., the type of goods they provide. At the equilibrium, one supplier provides \( S \) goods only, while its competitor provides \( NS \) goods only.

We solve the game backwards and start with the last stage.

3.1 Stage 4: price competition

We determine the price equilibrium of the fourth stage, for each catalogue configuration. Each supplier has four possible catalogue choices: \( \emptyset, S, NS, \) and \( S + NS \). We denote \( \pi_{k,l}^* \) the equilibrium profit of a supplier which provides a catalogue denoted \( k \) when its competitor provides a catalogue denoted \( l \). In theory we have 16 different configurations. However, it is possible to concentrate on a few of them.

3.1.1 Identical catalogues (\( S \) vs. \( S \) or \( NS \) vs. \( NS \))

If the two suppliers provide the same catalogues, competition drives prices down to marginal cost, hence to zero. This is because suppliers propose the same goods and compete with respect to prices.
Therefore, at the equilibrium,

\[ \pi_{S,S}^* = \pi_{NS,NS}^* = -f. \]

In this setting, offering the same catalogues yields the Bertrand outcome, as there is neither capacity constraint nor locked-in customers.

### 3.1.2 Differentiated catalogues (S vs. NS)

Assume that supplier \( S \) provides \( S \) goods at price \( p_S \), while supplier \( NS \) provides \( NS \) goods at price \( p_{NS} \). If it buys a \( S \) product located at \( x_S \) from supplier \( S \), a consumer of type \( x \) gets

\[ u^S = v + q_S - t \times |x - x_i| - p_S, \]

while it gets

\[ u^{NS} = v + q_{NS} - p_{NS}, \]

if it buys from supplier \( NS \).

Remark that for the NS product we ignore the loss of utility which is due when the consumer does not buy its preferred cultural type. Indeed, if it decides to purchase a NS product, a consumer of type \( x \) is better off consuming the NS product which is at its feet, i.e., at \( x \). This is because there is an infinity of NS goods along the circle whose expected quality is the same.

The consumer who is indifferent between purchasing from \( S \) and purchasing from \( NS \) is characterized by \( u^S = u^{NS} \), hence it has type \( x \) such that \( |x - x_i| = d \), where

\[ d = \frac{\Delta + p_{NS} - p_S}{t}. \]

Demands for suppliers \( S \) and \( NS \) are given by \( D_S = 2nd \) and \( D_{NS} = 1 - D_S \), respectively, provided
that $d < 1/(2n)$. Assume that this condition is satisfied. Supplier $S$ maximizes $p_S D_S$ with respect to $p_S$, while supplier $NS$ maximizes $p_{NS} D_{NS}$ with respect to $p_{NS}$. The first-order condition for profit maximization gives the best responses of suppliers $S$ and $NS$,

$$R_S(p_{NS}) = \frac{p_{NS} + \Delta}{2},$$

and

$$R_{NS}(p_S) = \frac{h}{4} + \frac{p_S - \Delta}{2}.$$ 

Solving for the Nash equilibrium of the subgame gives equilibrium prices

$$p^*_S = \frac{h}{6} + \frac{\Delta}{3}, \quad (1)$$

and

$$p^*_{NS} = \frac{h}{3} - \frac{\Delta}{3}, \quad (2)$$

and equilibrium profits

$$\pi^*_S = \frac{(h + 2\Delta)^2}{18h} - f,$$

and

$$\pi^*_{NS} = \frac{2(h - \Delta)^2}{9h} - f.$$ 

This equilibrium is valid if at the equilibrium $d$ is lower than $1/(2n)$. Inserting $p^*_S$ and $p^*_{NS}$ into $d$ shows that $d < 1/(2n)$ if and only if $\Delta < h$. This condition is always satisfied as $h > q^S - q^L$ (by assumption) implies that $h > \Delta$.

Equations (1) and (2) show that competition between supplier $S$ and supplier $NS$ is structured by a horizontal differentiation effect and a vertical differentiation effect. The first term in the
equilibrium prices represents horizontal differentiation; as \( h = t/n \), it is all the higher as consumers have strong preferences for a given type (high \( t \)) or as there are only a few S goods (low \( n \)).\(^7\) The second term represents vertical differentiation: it is proportional to the expected quality advantage of S goods, \( \Delta \). Note that the horizontal differentiation effect benefits supplier NS more than supplier S, whereas the vertical differentiation effect favors supplier S.

### 3.1.3 Partially differentiated catalogues (S vs. S+NS or NS vs. S+NS)

When supplier \( i \) provides S goods (resp. NS goods), prices, hence profits, of the two suppliers are lower if supplier \( j \) provides S+NS goods than if supplier \( j \) provides only NS goods (resp. S goods).

For instance, consider that supplier \( i \) provides both S and NS goods while supplier \( j \) provides only S goods. Competition for S goods leads prices of S goods to zero, i.e., \( p^*_S = 0 \). Indeed, if \( p^*_S \) were above marginal cost (0), each supplier would have an incentive to lower its S price slightly to capture all demand for S goods. Since at the equilibrium \( p^*_S = 0 \), the equilibrium price of NS goods is given by \( p^*_{NS} = R_{NS} (0) \), which is lower than \( R_{NS} (p_S) \) for any \( p_S > 0 \). Hence, we have

\[
\pi^*_{S+NS,S} < \pi^*_{NS},
\]

which means that competition for S goods cannibalizes the sale of NS goods. Similarly, we find that

\[
\pi^*_{S+NS,NS} < \pi^*_{S}.
\]

---

\(^7\) In its circular model of differentiation, Salop (1979) finds that equilibrium prices are equal to \( h = t/n \) when the marginal cost is equal to zero. In our setting, when \( \Delta \) approaches zero, the equilibrium prices are proportional to \( h \).
3.2 Stage 3: removal decisions

Suppose that the two suppliers have chosen their catalogues, $G_1$ and $G_2$. They can now choose simultaneously to remove part of it.

**Lemma 1** Supplier $i$ removes part of its catalogue only if it provides $S + NS$ goods and supplier $j \neq i$ provides either $S$ or $NS$ goods.

**Proof.** If there is no overlap between the two catalogues, i.e., if $G_i \cap G_j = \emptyset$, then the suppliers have no incentive to remove part of their catalogues. Indeed, a supplier makes no profit after removal, whereas it makes profit without removing references.

If there is an overlap between the two catalogues, i.e., if $G_i \cap G_j \neq \emptyset$, there are two different cases. First, suppose that $G_i = G_j$, with $G_i \in \{S, NS\}$. Then, the incentive of supplier $i$ to remove its catalog is equal to $-\epsilon$, hence negative. Indeed, it makes zero profit whether it removes its catalogue or not, but incurs a removal cost $\epsilon$ if it chooses to remove part of its catalog. Second, suppose that $G_i = S + NS$ and $G_j \in \{S, NS\}$. In this case, supplier $i$ has an incentive to remove the same type of goods as supplied by supplier $j$, i.e., $G_j$, while supplier $j$ has none. Hence, the equilibrium of the third stage is such that supplier $i$ removes $G_j$ from its catalogue, whereas supplier $j$ keeps on offering $G_j$. ■

When a supplier offers both types of goods and faces a competitor within one of these types, say $S$, there are two competitive effects. First, competition for consumers of $S$ goods leads $S$ prices, hence profits from $S$ goods, to zero. Second, as the prices of $S$ goods are very low, the sale of $NS$ goods is cannibalized; hence, profits from $NS$ goods also decrease. This is why it is not credible to provide both $S$ and $NS$ goods, if the removal cost is sufficiently low.\(^8\)

\(^8\)This is the standard result of Judd (1985).
3.3 Stages 1 and 2: catalogue decisions

Now, we determine the optimal catalogue choices of suppliers 1 and 2. To begin with, remark that supplier 2 enters the market if the fixed cost $f$ is sufficiently low. Indeed, lemma 1 shows that supplier 1 cannot deter its rival’s entry by providing the two types of goods. Hence, supplier 1 offers at most one type of goods. Then, since suppliers make zero profit if they provide the same goods, supplier 2 should provide the other type of goods.

Since supplier 2 will choose to differentiate to soften competition, supplier 1 chooses the type of goods which provides the highest profit.

**Proposition 1** Supplier 1 provides $S$ goods when $\Delta > h/4$ and NS goods when $\Delta \in (0, h/4)$. Supplier 2 provides the other type of goods.

**Proof.** Supplier 1 makes higher profit when it offers $S$ goods than when it offers NS goods if and only if $\pi^*_S > \pi^*_{NS}$, which is satisfied if and only if $\Delta > h/4$. ■

This proposition highlights that suppliers of cultural goods have strong incentives to differentiate their catalogues, when consumers are able to compare prices and offers on both sites. The intuition is standard: suppliers differentiate their products to soften price competition. In the present setting, suppliers differentiate their catalogues of cultural goods. Hence, differentiation incentives might be a factor to explain why suppliers of NS goods can coexist with suppliers of $S$ goods.

At the equilibrium, no supplier provides both types of goods. In reality, suppliers of NS goods like Amazon.com propose also $S$ goods. However, Amazon.com does not compete fiercely with discounters for $S$ goods; it merely sells $S$ goods to its own locked-in customers. Hence, the present equilibrium configuration is a reasonable approximation of the market equilibrium. In our setting, a configuration with a $S$ supplier on the one hand and a $S$+NS supplier on the other hand could emerge if we assumed that a proportion of consumers had very high search or switching costs so
that they would be effectively locked in.\textsuperscript{9}

Competition between S and NS goods is shaped by the consumer trade-off between getting higher expected quality (which favors S goods) and getting better matched goods (which favors NS goods). If the vertical differentiation effect dominates the horizontal differentiation effect, the leader provides S goods; otherwise it provides NS goods.

Note that when the leader proposes NS goods, the price of S goods is lower than the price of NS goods, as $\Delta < h/4$. Leaders - like Amazon or Fnac.com in France - focus on NS goods and charge higher prices than discounters. This result is consistent with the empirical analysis of Brynjolfsson, Smith and Hu (2003) for books. They show that the prices of non star goods ("obscure titles" in their terminology) are greater than the prices of star goods ("regular titles" in their terminology).

Finally, we have assumed that $f$ is sufficiently low so that there is entry. Notice that there are higher values of $f$ such that entry with the most profitable type of goods (NS or S) is viable, whereas entry with the less profitable type of goods is not. For such values of $f$, the leader could preempt the market.

4 \textbf{Samples and search tools}

In this section, we introduce a search cost and we allow online suppliers to install \textit{samples}. At the beginning of the game, consumers do not know any NS product, hence that they have to search to find a NS product of their preferred type. However, consumers incur a search cost, denoted $c$, which represents the opportunity cost of time spent at searching. By introducing \textit{search tools}\textsuperscript{10} and improving their quality, a supplier can reduce the search cost.

A consumer can evaluate the quality of a given cultural product by using \textit{samples}. For instance,

\textsuperscript{9}This is a possible and interesting extension of our work. The same equilibrium configuration could emerge if suppliers had capacity constraints due to delivery delays. In this case, competing head-to-head would not be as harmful as it is in our setting, since each supplier would not be able to serve all demand.

\textsuperscript{10}Like topology tools or customer reviews.
the consumer can listen to a sample of a CD or read an excerpt of a book. Consumers incur no cost when using samples.

Suppliers are allowed to introduce samples and search tools at the same time as they choose their catalogues, and we ignore the costs for the suppliers of providing samples and search tools. Since consumers are aware of the quality of S goods, a supplier of S goods has no incentive to introduce samples. Hence, we focus the analysis on NS goods.

We make two assumptions. First, we assume that \( c \) is strictly positive and not too high (i.e., \( c < (q^H - q_S)\alpha) \). Second, we assume that \( h > c + \Delta \). Remark that the basic model studied in section 3 corresponds to the case in which there is no sample and \( c \) is equal to zero.

### 4.1 No samples

To begin with, suppose that samples are not available. Consumers have to decide whether to search or not, then which product to purchase. Consumers search at most once, since they cannot evaluate the quality of NS goods before purchase. We begin by analyzing the search decision.

**Search decision** A consumer of type \( x \) who does not search does not find any NS product. Therefore, he purchases the nearest S product if and only if

\[
v - t \times |x - x_i| + q_S - p_S \geq 0.
\]

If the consumer searches, he incurs a search cost \( c \), and finds a NS product of his preferred type. He decides to purchase this NS product instead of the nearest S product if and only if

\[
v + \tilde{q}_{NS} - p_{NS} \geq v - t \times |x - x_i| + q_S - p_S,
\]
which is equivalent to 
\[ |x - x_i| \geq d(\hat{q}_{NS}), \]
where \( d(q) \) is defined by

\[ d(q) = \frac{q_S - q + p_{NS} - p_S}{t}. \]

A consumer decides to search if he gets higher utility from searching. Consumers who are very near to a S product (i.e., consumers of type \( x \) such that \( |x - x_i| \leq d(\hat{q}_{NS}) \)) do not search, because they buy the nearest S product even when they have found a NS product. This represents the captive demand of S goods. Consumers who are farther from a S product, i.e., consumers of type \( x \) such that \( |x - x_i| \geq d(\hat{q}_{NS}) \), search if they get higher utility by doing so, which is the case if and only if

\[ v + \hat{q}_{NS} - p_{NS} - c \geq v - t \times |x - x_i| + q_S - p_S, \]

or \( |x - x_i| \geq l(c, \hat{q}_{NS}) \), where

\[ l(c, q) = \frac{c}{t} + \frac{q_S - q + p_{NS} - p_S}{t}. \]

As \( c > 0 \), we have \( l(c, \hat{q}_{NS}) > d(\hat{q}_{NS}) \), which means that some non captive consumers do not search.

**Demand** The demand of the S supplier is composed of two populations: consumers of type \( x \) such that \( |x - x_i| \in (0, d(\hat{q}_{NS})) \) who always prefer a S product, and consumers of type \( x \) such that \( |x - x_i| \in (d(\hat{q}_{NS}), l(c, \hat{q}_{NS})) \) who would prefer a NS product, but do not search because the search cost is too high. Finally, consumers of type \( x \) such that \( |x - x_i| \in [l(c, \hat{q}_{NS}), 1/2n] \) search and purchase a NS product. Therefore, we have \( D_S = 2nl(c, \hat{q}_{NS}) \) and \( D_{NS} = 1 - D_S \).
The equilibrium The Nash equilibrium prices are

\[ p_s^*(c) = \frac{h}{6} + \frac{\Delta}{3} + \frac{c}{3}, \]

and

\[ p_{NS}^*(c) = \frac{h}{3} - \frac{\Delta}{3} - \frac{c}{3}. \]

We have to check whether \( l(c, \tilde{q}_{NS}) \in (0, 1/2n) \). At the equilibrium, we have

\[ 2nl(c, \tilde{q}_{NS}) = \frac{1}{3} + \frac{2}{3} \frac{c + \Delta}{h}, \]

hence \( l(c, \tilde{q}_{NS}) > 0 \). Besides, we have \( 2nl(c, \tilde{q}_{NS}) < 1 \) as \( h > c + \Delta \) by assumption.

Supplier \( NS \) can reduce the search cost \( c \) by improving the quality of its search tools. In the proposition below we analyze whether supplier \( NS \) increases its profit by doing so.

**Proposition 2** Supplier \( NS \) gains from improving the quality of its search tools (i.e., from lowering \( c \)).

**Proof.** Indeed, the profit equilibrium of supplier \( NS \),

\[ \pi_{NS}^*(c) = \frac{2 \left( h - \Delta - c \right)^2}{9h} - f. \]

decreases with \( c \). ■

The intuition is clear: when consumers find it difficult or costly to search for NS goods, the demand for NS goods is low. By improving the quality of its search tools, the supplier of NS goods reduces the search cost, hence increases the demand for NS goods.
4.2 Samples

Now, suppose that samples are available, hence that consumers can evaluate the quality of NS goods. When a consumer picks a low quality NS product, he could continue on searching for other NS products, until he finds a high quality NS product. Figure 2 represents the consumer’s decision tree. We begin by analyzing the consumer’s initial search decision. We denote $U^s$ the utility obtained from searching, and $U^{ns}$ the utility obtained from not searching.

No initial search If the consumer makes no initial search, he does not find any NS product. He purchases the nearest S product if and only if

$$v - t \times |x - x_i| + q_S - p_S \geq 0,$$

hence $U^{ns} = v - t \times |x - x_i| + q_S - p_S$ if $v$ is sufficiently high.
Initial search  Now, assume that a consumer of type $x$ makes an initial search and picks a NS product. The consumer then evaluates the quality of the NS product. With the following we determine the consumer expected utility, $U^s$. We have two cases, depending on whether the quality of the NS product, $q$, is low or high. We denote $U^s_H$ the expected utility obtained when $q = q^H$, and $U^s_L$, the expected utility obtained when $q = q^L$.

Case A: $q = q^H$. If the quality of the NS product is high, the consumer does not search for another NS product. He purchases the high quality NS product if and only if

$$v + q^H - p_{NS} \geq v - t \times |x - x_i| + q_S - p_S,$$

or $|x - x_i| \geq d(q^H)$. In the following, we assume that $q^H$ is sufficiently high so that $d(q^H) \leq 0$. This means that any consumer prefers a high quality NS product of his preferred type than a S product. We shall derive below the necessary condition for this to hold at the equilibrium. Therefore, we have

$$U^s_H = v + q^H - p_{NS}.$$

Case B: $q = q^L$. If the quality of the NS product is low, the consumer has two possibilities: he can either trade-off between the low quality NS product and the nearest S product (in which case, he obtains $U^s_L^-$), or search for another NS product which he will evaluate again (in which case, he obtains $U^s_L^+$). First, assume that the consumer does not search. Given its type $x$, the consumer purchases the low quality NS product if and only if

$$v + q^L - p_{NS} \geq v - t \times |x - x_i| + q_S - p_S,$$

or $|x - x_i| \geq d(q^L)$. In the following, we assume that $q^L$ is sufficiently low so that $d(q^L) \leq 0$. This means that any consumer prefers a low quality NS product of his preferred type than a S product. We shall derive below the necessary condition for this to hold at the equilibrium. Therefore, we have

$$U^s_L = v + q^L - p_{NS}.$$
or \(|x - x_i| \geq d(q^L)|). Hence, we have

\[
U^s_L^- = \begin{cases} 
  v + q^L - p_{NS} & \text{if } |x - x_i| \geq d(q^L), \\
  v - t \times |x - x_i| + q_S - p_S & \text{if } |x - x_i| < d(q^L).
\end{cases}
\]

Second, assume that the consumer searches for another NS product (and incurs the search cost \(c\)). With probability \(\alpha\), the consumer picks a high quality NS product. If so, we are back to Case A, hence the consumer obtains \(U^s_H\). With probability \(1 - \alpha\), he picks a low quality NS product. If so, he finds himself in Case B again, hence his expected utility is equal to \(U^s_L\). It follows that

\[
U^{s+}_L = \alpha U^s_H + (1 - \alpha) U^{s+}_L - c,
\]

hence we have

\[
U^{s+}_L = v + q^H - p_{NS} - \frac{c}{\alpha}.
\]

Now we can determine whether the consumer decides to search or not. A consumer of type \(x\) decides to search for another NS product if and only if

\[
U^{s+}_L \geq U^{s-}_L. \tag{4}
\]

When \(|x - x_i| < d(q^L)|\), this condition is equivalent to

\[
v + q^H - p_{NS} - \frac{c}{\alpha} \geq v - t \times |x - x_i| + q_S - p_S,
\]

or \(|x - x_i| \geq l(c/\alpha, q^H)|. Since \(c/\alpha \leq q^H - q^L\) by assumption, we have \(l(c/\alpha, q^H) \leq d(q^L)|, hence consumers of type \(x\) such that \(|x - x_i| \leq l(c/\alpha, q^H)| do not search, whereas consumers of type \(x\) such that \(l(c/\alpha, q^H) \leq |x - x_i| < d(q^L)| search.
When $|x - x_i| \geq d(q^L)$, condition (4) holds always as

$$v + q^H - p_{NS} - \frac{c}{\alpha} \geq v + q^L - p_{NS},$$

is equivalent to $c/\alpha \leq q^H - q^L$, which is satisfied by assumption. Therefore, consumers of type $x$ such that $|x - x_i| \geq l(c/\alpha, q^H)$ search.

The utility obtained by a consumer from searching initially, $U^s$, is given by

$$U^s = \alpha U^s_H + (1 - \alpha) U^s_L,$$

where

$$U^s_L = \begin{cases} v - t \times |x - x_i| + q_S - p_S & \text{if } |x - x_i| < l(c/\alpha, q^H) \\ v + q^H - p_{NS} - c/\alpha & \text{if } |x - x_i| \geq l(c/\alpha, q^H) \end{cases}.$$ 

We can now determine the initial search choice for a consumer of type $x$. To do that, we compare the payoff obtained from not searching, $U^{ns}$, to the payoff obtained from searching, $U^s$.

First, consider a consumer of type $x$ such that $|x - x_i| < l(c/\alpha, q^H)$. Computations show that $U^s \geq U^{ns}$ if and only if $|x - x_i| \geq l(c/\alpha, q^H)$, hence this consumer does not make any initial search and purchases from supplier $S$ (provided that $v$ is sufficiently large so that he obtains positive surplus at the equilibrium).

Second, consider a consumer of type $x$ such that $|x - x_i| \geq l(c/\alpha, q^H)$. We have $U^s \geq U^{ns}$ if and only if $|x - x_i| \geq l(c/\alpha, q^H)$, hence the consumer makes an initial search. Our analysis above shows that, since $|x - x_i| \geq l(c/\alpha, q^H)$, the consumer continues on searching until he finds a high quality NS product, which he purchases.
Demand  The demand for S goods and NS goods are, respectively, 
\[ D_S = 2nl \left( \frac{c}{\alpha}, q^H \right) \] and 
\[ D_{NS} = 1 - D_S. \]

The equilibrium  We denote \( p^*_i(c) \) the equilibrium price of supplier \( i = S, NS \) when samples
are available and the search cost is equal to \( c \). Computing the Nash equilibrium yields

\[
p^*_{S|s}(c) = \frac{h}{6} - \frac{q^H - q_S}{3} + \frac{c}{3\alpha} \quad (5)
\]

and

\[
p^*_{NS|s}(c) = \frac{h}{3} + \frac{q^H - q_S}{3} - \frac{c}{3\alpha}, \quad (6)
\]

We have to check whether \( l(c/\alpha, q^H) \in (0, 1/2n) \) holds at the equilibrium. This is the case if and
only if

\[-h < q^H - q_S - \frac{c}{\alpha} < \frac{h}{2}.
\]

As \( c/\alpha < q^H - q_S \) by assumption, then the left part of the condition is always satisfied; it means
that \( l(c/\alpha, q^H) > 0 \), hence that some consumers search. The right part, which means that the
supplier of S goods makes sales, is satisfied if \( h \) is sufficiently high. We have also to check that
\( d(q^H) \leq 0 \). Inserting values of \( p^*_{S|s}(c) \) and \( p^*_{NS|s}(c) \) into \( d(q^H) \) yields that we have \( d(q^H) \leq 0 \) if
and only if \( h - 2(q^H - q_S) - 4c/\alpha \leq 0 \) or \( q^H - q_S \geq h/2 - 2c/\alpha \).

Let \( \Phi = (h/2 - 2c/\alpha, h/2 + c/\alpha) \). In the following, we focus on the case in which \( q^H - q_S \in \Phi \).
In this case, some consumers search, the supplier of S goods makes sales and consumers always
prefer a NS product of their ideal type than a S product. For lower values of \( q^H - q_S \) (i.e., 
\( q^H - q_S < h/2 - 2c/\alpha \)), there is no equilibrium in which consumers prefer a NS product of their
ideal type than a S product. For higher values of \( q^H - q_S \) (i.e., \( q^H - q_S > h/2 + c/\alpha \)), the supplier
of S goods does not make any sale at the equilibrium.

**Proposition 3** Assume that $q^H - q_S \in \Phi$. The supplier of NS goods gains from introducing samples if and only if

$$q^H - \tilde{q}_{NS} > \left(\frac{1}{\alpha} - 1\right)c.$$

**Proof.** At the equilibrium given by equations (5) and (6), the equilibrium profit of supplier NS is

$$\pi^*_S(c) = \frac{2\left[h + \left(q^H - q_S\right) - c\right]^2}{9h} - f.$$  

We compare the profit with samples, $\pi^*_S(c)$, to the profit without samples, $\pi^*_S(c)$. We find that $\pi^*_S(c) > \pi^*_S(c)$ if and only if $q^H - \tilde{q}_{NS} > (1/\alpha - 1)c$.  

The condition provided in proposition 3 has a nice intuition. When supplier NS provides samples, consumers can search for NS products and evaluate their quality, hence they can search until they find a high quality NS product. The value of samples for consumers is therefore equal to the improvement in quality $(q^H - \tilde{q}_{NS})$ less the net cost of continuing search $(c/\alpha - c)$. If this value is positive the supplier of NS goods increases its profit by introducing samples. Otherwise, it is better off not providing samples.

This result also highlights that the incentives to introduce quality evaluation tools (samples) depend on the quality of search tools (i.e., on $c$). Indeed, the condition of proposition 3 is more easily met when the search cost $c$ is low.

## 5 Conclusion

This paper provides a formal analysis of competition between two online suppliers of cultural goods. Our analysis suggests that suppliers have strong incentives to differentiate their catalogues of cultural goods to soften competition. One supplier introduces “star” goods, i.e., those goods
whose quality is known by all. The other supplier offers “non star” goods, i.e., those goods whose quality is uncertain.

We study the impact of two experience tools. First, suppliers can introduce samples, which allow consumers to evaluate the quality of “non star” goods. Second, suppliers can introduce search tools, which reduce the costs of searching for “non star” goods. We show that the supplier of “non star” goods always benefits from a reduction of the search cost, which provides it with high incentives to introduce such tools. The incentives to introduce samples are more balanced. We show that the supplier gains from installing samples if and only if the expected quality gains for consumers are higher than the search cost multiplied by the expected number of searches. This result outlines the link between quality evaluation tools and search tools.

In the present setting, we assumed that consumers’ uncertainty with respect to “non star” goods was related to the quality of these goods, and not their type. It could also be assumed the contrary, that is that consumers face uncertainty about the type and not the quality of “non star” goods. Our main result - that suppliers differentiate their catalogues - would remain valid in this new setting.

This research could be extended in other directions. First, in our setting, we have assumed that when a supplier offers a type of goods, either S or NS goods, it offers all goods of this type. We could allow suppliers to offer only a part of all S or NS goods. Taking a proportion of NS goods uniformly along the circle would still give an infinity of NS goods, hence would not change the analysis. Another possibility would be to assume that a supplier can provide NS goods along a section of the circle. In that case, other equilibrium configurations could emerge, with each supplier offering some S and NS goods.

Second, the consumption of cultural goods is a dynamic process. In particular, once a consumer has bought the S goods which are not far from its preferred type, incentives to buy NS goods are
increased. If a supplier provides both S and NS goods, it would also be interesting to study its incentive to educate its S consumers so that they buy NS goods.

References


