

Is there a best opaque booking system for an online travel agency?

Malgorzata OGONOWSKA *

Christian LONGHI *

Dominique TORRE *

** University Nice Sophia-Antipolis - GREDEG (DEMOS) - CNRS
250, rue Albert Einstein, F-06560 Valbonne Cedex
E-mail: {ogonowsk; longhi; torre}@gredeg.cnrs.fr*

Fifth Draft – June 2009

Abstract

This paper analyses the properties of the advanced Opaque booking systems used by the online travel agency, as a complement to their traditional transparent booking system. First we present an updated literature review. This review underlines the interest and the specificities of opaque goods in the Tourism Industry. It also characterises properties of the NYOP channel introduced by Priceline and offering probabilistic goods to potential travellers. In the second part of the paper we present a theoretical model, in which we wonder what kind of opaque system can be implemented by a given online monopoly. We compare the Opaque “Hotwire system”, a NYOP system without any possibility of rebidding and the joint implementation of these two systems. We find that the NYOP system and the joint implementation can have challenging properties if consumer’s information is complete.

Key words: Name Your Own Price, Opaque Selling, Economics of Tourism, Online Travel Agencies, Probabilistic Goods

JEL Codes: D49, L93

1. Introduction

This paper analyses the properties of the advanced Opaque booking systems used by the online travel agency, as a complement to their traditional transparent booking system. First we present an updated literature review. This review underlines the interest and the specificities of opaque goods in the Tourism Industry. It also characterises properties of the NYOP channel introduced by Priceline and offering probabilistic goods to potential travellers. In the second part of the paper we present a theoretical model, in which we wonder what kind of opaque system can be implemented by a given online monopoly. We compare an Opaque posted-price “Hotwire system”, a NYOP system without any possibility of rebidding and the joint implementation of these two systems. We find that the NYOP system and the joint implementation can have challenging properties if consumer’s information is complete.

2. NYOP and opaque products: a literature review

In the last years, the emergence of the Internet has deeply changed the industry of tourism, the organization of markets and the pricing mechanisms developed by firms. Tourism is by far the most developed and innovative online business, fostered by the creation of online travel agencies (OTAs) of different kinds and sophisticated pricing and segmentation strategies. Dominant global OTAs have emerged, Expedia, Travelocity, Orbitz, Opodo, which dominate the distribution of travel and tourism services, but the extensive uses of the Internet have given rise to niche players. Most of these players have specialized in specific segment of the market, in terms of destination or services, but some others have been more inventive, experimenting innovative pricing models. Hotwire.com (acquired by Expedia in 2003) and Priceline.com are the two most important companies having successfully developed this strategy on the US market, to account for 6.7% of worldwide online hotel bookings in 2006 for instance. They have developed online pricing mechanisms such as Name Your Own Price in which instead of posting a price, the seller waits for an offer of the potential buyer that he can then either accept or reject, or such as opaque offers, in which the characteristics of the services are hidden (hotel or airlines brands, travel schedule). These empirical developments open many different questions. Why would hotels and airline companies be willing to sell their products through Priceline/Hotwire and lose the advantage (and profit) that product differentiation gives them (Shapiro and Shi, 2008)? Why firms would deviate from the standard practices of posting a take-it-or-leave-it offer? Certainly firms should find these strategies more profitable. But as pointed out by Pinker *et al.* (2003), and underlined in Wilson and Zhang (2008), ‘though on-line auctions are a multi-billion dollar annual activity, with a growing variety of sophisticated trading mechanisms, scientific research on them is at an early stage’. Nevertheless, some interesting advances can be traced in the recent

literature, related to the innovative strategies implemented by Priceline or Hotwire. This short review focuses on the two main types of related literature which have been developed. The first one analyses Name-Your-Own-Price selling mechanism, while the second focuses on the opaque selling with posted prices.

2.1. Name-Your-Own-Price selling mechanism

Contrary to the approach implemented in our modelling strategy, the majority of papers concerning NYOP mechanism omit the question of product's opacity. Only Wang, Gal-Or, Chatterjee (2005) and Shapiro, Zillante (2007) consider the service's opaque aspect while analysing the impact of implementation of NYOP selling on firm's profits.

Wilson and Zhang (2008) present a model of a NYOP intermediary, who sells economy rental cars on a specific date. The retailer's capacity is in excess. He provides consumers with a function that describes the chance of a bid to get accepted. Intermediary's clients are limited to a single bid. The retailer's objective is to force the consumers to bid maximum that will maximise his profits, while consumers intend to maximise their own surpluses. Consequently, the intermediary will choose an appropriate function of bid's probability of success so as his clients will bid maximum. Since he provides this function, which is the same for all consumers, each of them is treated fairly, even if the prices they pay are different. Using different method (experimental economics), Shapiro and Zillante (2007) analyse seller's profits maximisation. They emphasize that their importance results from a trade-off between the number of bids accepted and their amounts, which depend on the threshold price and on the presence of opacity. They outline that concealing some of good's information is detrimental for consumers and does not change anything for the seller, unless the threshold price is too low. In such case his profits will decrease. On the opposite, Wang, Gal-Or and Chatterjee (2005) show that a moderate opacity level can be profitable for the retailer. Indeed, it helps to segment the demand and though to price discriminate the consumers. It will attract some supplementary clients without creating cannibalization effects of the posted-price channel. The paper considers a monopoly service provider distributing a fixed capacity through its own web site using posted-price mechanism and through a NYOP intermediary during a two stage game. He faces an uncertain and heterogeneous demand. He perceives a signal of the state of the demand after the first stage of the game. On one hand, if the signal is perfectly or highly informative, the uncertainty almost disappears. Then, the market segmentation is only feasible and profitable with sufficiently low or high capacity. On the other hand, if the signal provides no information about the demand and if capacity is high, the service provider will use only the posted-price channel; otherwise, he will use only the NYOP channel. The optimal precision of demand's signal is an intermediate value, what means that some uncertainty remains.

Hann and Terwiesch (2003) identify a double source of profits for the NYOP retailer: intermediary margin, which is a difference between the price paid for the product to a service provider and the threshold price, and the informational margin, which corresponds to the difference between the price paid by a consumer and the threshold price. The customers are heterogeneous in their experience and though in the level of frictional and transaction costs that they afford. This heterogeneity leads to the market segmentation that allows the retailer to price discriminate his clients and improve its profits. Fay (2008) also demonstrates that frictional costs have an influence on market segmentation and on seller's profits. Because of market segmentation, price competition on the market is reduced. The duopoly model¹ developed in the paper emphasizes that implementation of a NYOP channel will reduce the competition and improve overall profits in comparison to the situation when both of retailers choose posted-price market format. The model stresses that if one of competitors chooses NYOP format, while his rival selects posted-price market, he should restrict its customers to only one bid. Because repeated bidding increases consumer's interest for NYOP selling, it causes a loss of posted-price seller's profits, who, in order to attract some consumers, decreases his price, what derives the bid's amounts down. In contrast, Spann, Skiera and Schäfers (2004) demonstrate that allowing consumers to repeat their bids may improve seller's profits, because the possibility of rebidding leads to higher amounts of maximum bids.

Another type of consumer's heterogeneity is presented by Fay (2004). Some of them, called "sophisticated" manage to bypass the restriction of a single bid and the others – do not. This creates a new segmentation of demands. The paper compares three situations: single bid, repeat bidding and partial-repeat bidding. The model demonstrates that intermediary's profits are exactly the same if the restriction of single bid is kept up or if it is not imposed. On the opposite, partial-repeat bidding deteriorates retailer's profits, but this relation is not monotonic. On one hand, if the number of sophisticated consumers is very low, firm's profits will reduce as their number increases. On the other hand, if their percentage is very important, profits will increase with their number. Therefore, this paper gives the guidelines how to well implement a NYOP strategy in order to better segment the demand and thus reduce price competition. Terwiesch, Savin and Hann (2005) present demand segmentation based on differences in haggling costs occurred by consumers. Retailer can price discriminate his clients, because of this differential. They provide a model of an online haggling process at a NYOP seller's web site with no opacity, constant threshold price and possibility of rebidding. Retailer can manipulate consumer's haggling cost by complicating his interface or by modifying the time delay with which the customer is notified that his bid was rejected, in order to diminish cannibalization effect of haggling. Thus, seller's profits increase when consumers are

¹ It is the only existing paper considering the case of competition with NYOP selling.

sufficiently heterogeneous and if there is a positive correlation between their valuations and haggling costs.

Fay and Laran (2008) add an original idea to the literature on NYOP mechanism. They analyze the situation, where the threshold price varies under repeat bidding. Every consumer's bid rejection provides him with new information. If he expects that the threshold price is constant, his bidding pattern is monotonically increasing. However, if he suppose that the threshold price will vary, his bidding behavior will depend on the degree of expected variability and on his patience. The paper's main implication is that changing threshold price may attract and retain more customers.

Spann, Banhardt, Häubl and Skiera (2005) compare the NYOP format with Select-Your-Price mechanism, where consumers are influenced by the range of possible candidate bids. Providing a list of possible bids may be perceived as a format giving more information about the seller's threshold price and thus decreases customer's uncertainty about product's value. The median and mean bids are the lowest in the NYOP format, so it is dominated by the SYP one. As the threshold price increases, seller's profits raise monotonically. They are at their maximum, when the threshold price is equal to variable cost. However, when the candidate bids are high, the profits depend on the tradeoff between the increase in bid's amounts and the reduction in the number of placed bids.

2.2 Opaque Products

The second type of literature analyses another type of opaque selling, where prices are posted. These papers focus on the fact that some of the product's attributes or characteristics are concealed from the consumers. In the traditional channels it was already not always beneficial to fully inform consumers about market prices, because of the risk of increase of their price sensitivity and then - of creation of downward price pressures. In that case it is beneficial for service providers to implement multichannel distribution across the mechanisms with different levels of market transparency. Grandos, Gupta and Kauffman (2008) present a model of a supplier, who distributes his product over two online channels, differentiated by the levels of market transparency, characterized by the same marginal distribution costs. They provide mechanisms for a supplier to set optimally the prices and to influence transparency in order to successfully price discriminate his clients. First, they estimate a demand function of the product, then identify the differences in the demand functions across the two online selling mechanisms and finally, set the optimal prices based on those differences. Empirical analysis presented in the paper confirms the model's results and provides an additional outcome, which states that a supplier in order to increase its revenues can increase the price differential across the selling mechanisms.

Y. Jiang (2007) models a monopolist who is distributing tourism devices (air tickets, hotel rooms) over two types of markets: full-informational and opaque, and wonders what will be the consequences of the use of the opaque channel on the firm's profits and the global welfare. He defines also the conditions of a successful implementation of price discrimination. The firm's profits as well as the overall welfare are greater while serving only the full-informational market. The things get more complicated when the firm decides to serve both of the markets. The firm's strategy will depend on the degree of homogeneity of demand. If the demand is too homogeneous or too heterogeneous, because of the risk of cannibalization effect, the monopolist will choose to serve only the full-informational market. While the demand is heterogeneous enough, the two types of market will co-exist. The dual-market strategy will improve firm's profits, by reducing the unsold inventory and social welfare by serving some extremely price sensitive consumers, who would not travel otherwise. This result is confirmed by Shi and Shapiro (2008), who wonder why the service providers decide to sell their products through opaque sites and though lose the advantages given by product differentiation; for the consumers opaque products are indistinguishable and become perfect substitutes. First of all, selling through the opaque channel helps the service providers to respond to changes in demand without the need to change current branding and pricing policies. In the model the opaque travel agency act as a "collusion device" which facilitates price discrimination between different types of consumers and increases overall profits, even if the total market demand is perfectly inelastic. The model is a variation of Hotelling's (1929) and Salop's (1979) models. The main result of the paper is that for a certain range of parameters' values having the agency with the opaque feature enables hotels to discriminate between their customers. Without the opaque agency the hotels would compete for both high and low type consumers through non-opaque channel. The presence of low-type consumers intensifies the competition and drives down the equilibrium price and profits. When the opaque channel is introduced a new equilibrium arises. The competition through the opaque agency is described by a Bertrand model. In the new equilibrium, hotel's competition for the low-type consumers increases, but decreases for the high-type ones. It still remains a Hotelling competition, but the hotels do no longer compete for the low-type segment. If there are enough high-type consumers, the overall profits will increase. The intensified competition for the low-type consumers enables hotels to decrease the competition for the high type. Another paper, analyzing the case of competition, is the Fay's (2007) one. He models a duopoly competition with multiple service providers who share a common intermediary. One of the innovations of this paper is that it introduces brand loyalty². If there is little brand loyalty in the market, the introduction of opaque sales will raise price competition and lower industry profits. If there is sufficient brand loyalty, the opaque sales will reduce price competition and raise the industry profits. The degree of price competition will depend on the number

² Idea developed also by Fay (2008) in the NYOP channel.

of units allocated to the opaque channel. Service providers have an incentive to contract with the opaque intermediary, if there is enough brand-loyalty in the industry. One of the model's hypotheses is that the firms have no constraints, so the opaque channel will lead to market expansion.

Opaque products can be seen as probabilistic goods, as emphasized by Fay and Xie (2007). They define a probabilistic good as a gamble involving a probability of getting any one of a set of multiple distinct items. Accordingly, we speak about probabilistic selling, when a seller creates a probabilistic good using existing distinct products or services (called component goods), which he offers as additional purchase possibility. Consequently, implementation of probabilistic selling helps the retailer to segment the market by creating a new different type of consumer's uncertainty. Thus, the retailer implements price discrimination that can considerably increase his profits if marginal costs are sufficiently low. When there is an advantage from introducing a probabilistic good, it is generally optimal to assign an equal probability to each component products, even if the demand is asymmetric. On the opposite cannibalization effects may appear. Moreover, probabilistic selling is most advantageous when the component goods have moderate differences. An important advantage of probabilistic selling concerns seller's own demand uncertainty. It provides a buffer against its negative effects and its profit advantages are even greater with demand uncertainty. Indeed, introduction of a probabilistic good reduces or even eliminates the dependence of pricing decisions on the identity of the more popular product. The most optimal results were obtained with sufficiently high demand uncertainty and mid-range capacity level.

2. Is the diversification of Opaque Channels useful for a single travel agency?

Is it suitable and efficient for a given online agency to use simultaneously more than one alternative online channel? This is the point that we rise in the following part of this paper.

The precise answer depends on many circumstances, and mainly on the competitive environment of the agent. If we consider a competitive game where every competitor chooses one single channel, the equilibrium could be for each intermediary to specialize in an asymmetric equilibrium where each one provides travelers with a specific channel. If Agencies A, B and C compete in the alternative channels: posted-price Opaque Channel, Last Minute channel and NYOP channel, each one should specialize in a different type of selling.

If there is one single Agency in a situation of monopole and that the point is to find the best allocation of potential travelers on alternative channels, the best solution is theoretically the one that could mimic as close as possible the first degree differentiation solution. As in many other cases, this

solution is probably not fully implementable due to its complexity. The NYOP opaque solution (the “Priceline system”) seems however to be the closest one. Supposing that the population of traveler is risk neutral, is fully informed about the frequency of remaining flights of alternative channels and about their characteristics (company, hour of departure...) and knows also perfectly the distribution of the propensity to pay of the other potential travelers., each traveler will be able to bid (or not) a price corresponding to his reservation price, given the uncertainty on the number of seats and concerning their attributes. However, this result’s validity depends on the level of incompleteness of information of potential travelers. Suppose for instance that potential travelers with high propensity to pay are also less informed on ticket’s distribution and on the propensity to pay of other agents: they will probably over-estimate the utility they can draw from the NYOP channel and bid at lower price than they would if the information was complete. In this case, implementation of a “Last minute” channel would be a good solution. However, this solution has a disadvantage: it does not resist to time depreciation. If travelers want to book hotel rooms, to rent a car..., more generally if the airline ticket is an element among others of a packaged product providing them a joint utility, the “Last minute” solution will sharply decrease the their utility. Here the “Last minute” selling is not considered, as an isolated solution, but as a complementary one to the opaque channel.

It is more complicated to decide if two or more forms of opaque channels can coexist. Consider for instance the NYOP Priceline channel and the Opaque Hotwire one. Both these channels are opaque, *i.e.* cannot provide precisely the travelers with the certainty on the quality of the travel. Once more, if all passengers had complete information on the flight’s frequency and the other ticket’s attributes and if they knew precisely the distribution of the other’s consumer’s propensities to pay, they would be able to use at their best advantage the NYOP system without any use of the Opaque channel which could be redundant. This observation cannot be generalized with any other assumptions. The basic idea is that, when there is no possibility of rebidding and so to explore the supply curve of the agency, the agents with a high propensity to pay, but with little information could be induced to bid too low in the NYOP channel.

2.1 An illustrative model

We suppose that everyday there are 2 flights from Lisbon to Mexico: the first leaves Lisbon at 7:00 am and the other at 6:00 pm. These flights’ booking level on the traditional channel is ordinarily estimated with a small error only few days before the date of departure. This short slot makes the “Last Minute” solution inappropriate for “impatient” low price travellers. Indeed, it actually concerns a distinct “patient” sub-population of travellers, which we are not going to consider in this paper. Subsequently the agency decides to implement an adapted opaque channel and to offer to the “impatient” low rate

travellers an adapted booking system. The agency knows the distribution of the states of the world, which are defined by table 1.

There are $2n$ potential travellers distributed in two subpopulations of n agents. The travellers belonging to the subpopulation A prefer the 7:00 am flight and the subpopulation B - the 6:00 pm flight. We suppose that there are more potential low rate travellers than available seats in the best state of the world, i.e. $n \geq m$. Each subset of n potential low rate travellers is distributed uniformly on a segment $[0, a]$ with $a > 0$. The gross utility of the traveller located at the point $a_i > 0$ on the segment $[0, a]$ is $a_i(u + \bar{u})$, $\{u, \bar{u} > 0\}$, when he travels at the time of his choice and only $a_i u$ when he takes the other flight. Agents are all risk neutral and their reservation utility vanishes.

States of the world	Number and type of available seats	Probability
1	m at 7:00 am	1/4
2	m at 6:00 pm	1/4
3	$2m$ at 7:00 am	1/8
4	m at 7:00 am m at 6:00 pm	1/4
5	$2m$ at 6:00 pm	1/8

Table 1: Distribution of the available seats for the flights

from Lisbon to Mexico on April 24th 2009

The agency can implement either:

- i) an Opaque “Hotwire style” posted-price system;
- ii) a NYOP “Priceline style” system;
- iii) both of the systems.

The sequence of the actions is as follows:

- At stage 1, the travel agency chooses between i), ii) and iii). If i) or iii) has been selected, the agency fixes the price of the Opaque channel. If ii) or iii) have been chosen, the travel agency launches a single bid process for the tickets
- At stage 2, travellers can purchase (or not) the seats on the Opaque channel at the price previously fixed by travel agency and post or not a single bid at the NYOP channel
- At stage 3, the travel agency knows the number and the nature of the available seats on each flight. If ii) or iii) have been chosen, the agency decides the lower price for the NYOP channel and sells the tickets to those whose bids exceed this rate.

The relevant equilibrium concept is a Stackelberg equilibrium, where the travel agency is leader. The game is solved by backward induction. At stage 3, the travel agency chooses the best action (i.e. fixes the lower limit price of the NYOP channel if the devices ii) and iii) have been selected), given the action previously taken by the travellers at stage 2. At stage 2 the potential travellers choose their own best actions, given the travel agency's decisions at time 1 (the implemented system and the Opaque channel's price if the i) or iii) schemes have been implemented), their expectations of the travel agency's decisions at stage 3 and the level of information on the chance that their bids get accepted, if the information on the characteristics of the auction process, when the devices ii) or iii) are implemented, is imperfect. At stage 1, the travel agency chooses the appropriate device and the rates of the opaque channel if the devices i) or iii) are implemented.

In the next sub-section we analyse the model's Stackelberg equilibriums characteristics, accordingly to the nature of the potential traveller's information on the possible outcomes of the NYOP auction.

2.2 Imperfect but complete information of travelers on the distribution of the states of the world and on their relative propensity to pay

We suppose that information is imperfect but complete (travellers know the states of the world and their respective probability).

Let's consider successively the three kinds of solutions for the travel agency.

i) If the Opaque channel is implemented, the agency fixes at stage 1 the price p^o such that p^o maximises the joint profit of the airline and the travel agency $\pi(p^o) = mp^o$. The quantity of available seats for the Opaque channel is m , because it is the higher level of seats available at stage 3

in all states of the world. The level of p^O is then such that the agency extracts the whole surplus of the last traveller choosing the Opaque channel. Whatever the rate of the Opaque channel fixed at stage 1 would be, the potential travellers whose net utility is greater or equal to zero at this rate will choose to buy a ticket on this channel. The best solution for the travel agency is then to charge a rate that exhausts the last potential opaque channel's travellers' surplus. These travellers will be located on their respective segment on points a_i^1 such that $(a - a_i^1)/a = m/2n$, *i.e.* at $a_i^1 = a(2n - m)/2n$. The resulting value of p^O which vanishes the net utility of the agents located on a_i^1 is then such that $a_i^1(u + \bar{u}/2) - p^O = 0$ since the states of the world and the distribution of agents on the segments $[0, a]$ is common knowledge. Then we obtain $p^O = a(2n - m)(u + \bar{u}/2)/2n$ and

$$\pi^O = mp^O = (2nm - m^2)a(u + \bar{u}/2)/2n \quad (1)$$

ii) If the NYOP channel is the only to be implemented, at stage 3 and in each state of the world, the travel agency will choose the higher threshold value such that all the potential travellers whose bids are greater or equal that the threshold will exhaust the market. As the OTA determines this value after observing the state of the world, there are two possibilities. If only m tickets are available, the price p_H^N will be high: it will correspond to the reservation price of the last of the m high propensity to pay agents that integrate in their expected utility the possibility to pay less if $2m$ seats are available. If the number of available ticket is $2m$, the price p_L^N will be lower as it corresponds to the propensity to pay of the last of the $2m$ travellers who integrate in their expected utility the uncertainty. At stage 2, the bidders will be able to integrate the optimal choices of the agency in their own decision and, among other, to consider their bids getting accepted. From usual deductions relative to the optimal bidders' behaviour, we deduce that, given the resulting expected value of their choices, the bidders will not bid lower price than their reservation price. If they are able to understand correctly the NYOP system, they will calculate the price that they will actually pay as the reservation price of the last successful bid in each state of the world. In fact, there exist two possible bidding prices: bidding prices greater or equal than p_H^N that guarantee the travel and bidding prices greater or equal to p_L^N but smaller than p_H^N that make the travel uncertain. Whatever the level of their bids, if they are greater than p_H^N or between p_L^N and p_H^N , the passengers will only pay p_L^N or p_H^N : their net expected utility is then defined by $a_i(u + \bar{u}/2) - p_H^N$ if they decide to bid at price p_H^N and $[a_i(u + \bar{u}/2) - p_L^N]/2$ if they decide to bid at rate p_L^N . From elementary calculus, we deduce the threshold values a_i^{2*} and a_i^{2**} separating respectively on each segment $[0, a]$ the potential travellers choosing to reserve and the potential

travellers choosing to bid p_L^N , and the potential travellers choosing to bid p_L^N and p_H^N . These values are $a_i^{2*} = a(n-m)/n$ and $a_i^{2**} = a(2n-m)/2n$. Then we deduce the equilibrium prices $p_L^N = a(n-m)(u+\bar{u}/2)/n$ and $p_H^N = a(2n-m)(u+\bar{u}/2)/2n$, the joint profit of the airline and of the travel agency $\pi^N = mP_H^N + mP_L^N / 2$ or

$$\pi^N = (2mp_H^N + mp_L^N) / 2 = (3nm - 2m^2)a(u + \bar{u} / 2) / 2n \quad (2)$$

iii) If the two channels are jointly implemented, the OTA allocates the first set of m seats to the Opaque channel, where it targets the high propensity to pay customers. The second set of m seats is allocated to the NYOP channel - to the travellers with a lower propensity to pay. At stage 1, the agency chooses the price for the Opaque channel and offers to the travellers the possibility to bid in the NOYP channel. As in case i), the price of the Opaque channel is $p^O = a(2n-m)(u+\bar{u}/2)/2n$. The NYOP channel targets the next m passengers and is activated at price $p^N = a(n-m)(u+\bar{u}/2)/n$. The joint profit of the airline and the travel agency is then $\pi^{O/N} = mp^O + mp^N / 2$ or

$$\pi^{O/N} = mp^O + mp^N / 2 = (3nm - 2m^2)a(u + \bar{u} / 2) / 2n \quad (3)$$

Subsequently we deduce the following proposition:

Proposition 1: If potential low rate travellers are completely informed on the random number and distribution of available seats and on the propensity to pay of every agent, there exist two equivalent Stackelberg equilibriums: the implementation of a NYOP channel and the simultaneous implementation of an Opaque and a NYOP channels.

Proof: Expressions (1), (2) and (3) represent the amounts of the joint profits of the airline and the travel agency at Stackelberg equilibriums associated respectively to the implementation of an Opaque channel, a NYOP channel and jointly an Opaque channel and a NYOP channel. The comparison of (1), (2) and (3) proves that, whatever the values of the parameters u, \bar{u}, a, n , and m are, $\pi^{O/N} = \pi^N > \pi^O$ ■

In accordance with our intuition, the Opaque “Hotwire style” channel is no more an optimal solution for potential travellers if it is implemented alone: the travellers with high propensity to pay are indifferent between this selling mechanism and its joint implementation with the NYOP channel, while the travellers with low propensity to pay prefer the two other selling systems. Another observation is that, if travellers are risk neutral (as we have supposed them to be), it is equivalent for

high propensity to pay travellers to pay p^O for the Opaque channel or p_L^N or p_H^N each with a probability $q = 1/2$ when the NYOP channel is the only mechanism to be implemented. Note however that when we introduce even a little risk aversion, the agents with high propensity to pay will prefer to pay p^O : this observation can provide the background for the joint implementation of an Opaque and a NYOP channels which then could be more efficient than the NYOP channel considered alone.

2.3 Incomplete information of travelers on their relative propensity to pay

It is probably beneficial for the airline and for the travel agency to diffuse appropriate statistics concerning the frequency and the nature of the seats. That is why we will now concentrate on another and more relevant origin of imprecision relative to the decisions of potential travelers. Consider the segment where are located all potential travelers preferring the 7:00 am (resp. the 6:00 pm) flight and assume that passenger do not know precisely their position on this segment. This uncertainty implies that their estimations of the distribution of the other passengers on the segment and especially the distance $[a_i, a]$ between their own location and the location of the agent with the highest propensity to pay are imprecise. Then, we suppose that the agent located on a_i estimates a as \tilde{a} with

$$\tilde{a} - a_i = q(a - a_i) + (1 - q)a_i, \quad q \in [0, 1] \quad (4)$$

When $q = 0$, there is full uncertainty on the a 's position and the agent locates himself on the middle of the segment $[0, a]$. When $q = 1$, the information on his position is perfect. If q is strictly between 0 and 1, the uncertainty on the agent's location is more or less moderate. We suppose that the travel agency knows this imprecision of the agents on their relative propensity to pay. At this moment, we consider the three available possibilities of implementation of alternative selling mechanisms.

i) If the Opaque channel is implemented with price p^O , the travellers have all the information on prices while taking their decision at time 2. Their behaviour is then unchanged. They will buy a ticket if $a_i^1(u + \bar{u}/2) - p^O \geq 0$ and do nothing if $a_i^1(u + \bar{u}/2) - p^O < 0$. The result is the same as in case of complete information, i.e., $p^O = a(2n - m)(u + \bar{u}/2)/2n$ and

$$\pi^O = mp^O = (2nm - m^2)a(u + \bar{u}/2)/2n \quad (5)$$

ii) If the NYOP channel is implemented, at time 2 the bidders estimate the probability of success of their bid. Given (4), they still compare $a_i(u + \bar{u}/2) - p_H^N$ if they decide to bid a price higher than p_H^N and $[a_i(u + \bar{u}/2) - p_L^N]/2$ if they decide to bid a price higher than p_L^N , but lower than p_H^N and 0 if

they do nothing. However, in order to evaluate p_L^N and p_H^N , they need to use the estimations of a_i^{2*} and a_i^{2**} . Given (4), they calculate $a_i^{2p*} = (aq - 2a_iq + 2a_i)(n - m) / n$ and $a_i^{2p^{**}} = (aq - 2a_iq + 2a_i)(2n - m) / 2n$ and then deduce $p_{Li}^N = (aq - 2a_iq + 2a_i)(n - m)(u + \bar{u} / 2) / n$ and $p_{Hi}^N = (aq - 2a_iq + 2a_i)(u + \bar{u} / 2)(2n - m) / 2n$ as threshold prices when the total number of seats is respectively m and $2m$. The higher is the passenger's propensity to pay, the greater are his expected prices for the NYOP channel at low and high rate. The potential passengers located at a_i on one of the segments $[0, a]$ consider themselves as marginal agents between the passengers choosing to do nothing and the agents bidding at low price if $a_i = a_i^{2p*} = (aq - 2a_iq + 2a_i)(n - m) / n$, i.e. $a_i = aq(n - m) / [2nq - 2mq - n + 2m]$. Agents located on the same segments at $a_i = a_i^{2p^{**}} = (aq - 2a_iq + 2a_i)(2n - m) / 2n$, i.e. $a_i = aq(2n - m) / (4nq - 2mq - 2n + 2m)$ consider similarly themselves as the limit agents between the low rate bidders and high price ones. Note that these thresholds depend on q , i.e. on the level of uncertainty of the passengers on their relative position on $[0, a]$. Then at stage 2, the bids of the potential passengers depend first on their position on $[0, a]$ and on the level of uncertainty. At stage 3, three cases are possible according to the values of the parameters and the level of uncertainty:

- 1) $a_i^{2*} < a_i^{2p*} < a_i^{2**} < a_i^{2p^{**}}$
- 2) $a_i^{2*} < a_i^{2**} < a_i^{2p*} < a_i^{2p^{**}}$
- 3) $a_i^{2p*} < a_i^{2*} < a_i^{2**} < a_i^{2p^{**}}$

It is convenient to limit our analysis to cases 1 and 3. Suppose however that the parameters a , m , n , q , u and \bar{u} are such that the conditions of case 2) are fulfilled (*figure 1*).

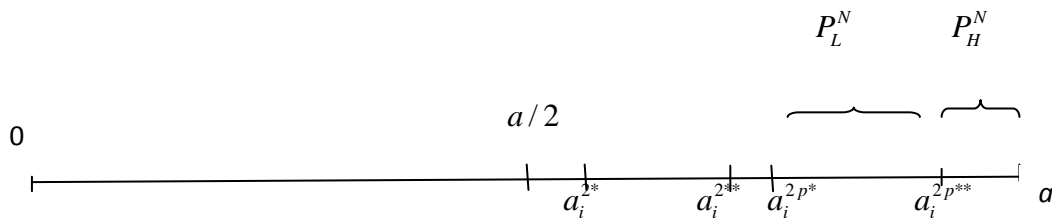


Figure 1 (case 2)

Suppose that the two systems are simultaneously implemented. All travellers located at a_i on one of the segments $[0, a]$ and such that $a_i^{2p^{**}} \leq a_i$ always choose in this case the Opaque channel since they believe that the limit bidding price to obtain the certainty to travel with the NYOP is higher than the price of the Opaque posted-price channel. In the same time, those agents located at a_i such that $a_i \leq a_i^{2p^{**}}$ always choose not to bid. One can conclude that either it is convenient for the OTA to offer Opaque pricing and in this case, no travellers will use the NYOP channel, or it is not convenient to implement it. There is then no place in this case for the implementation of two different systems in this case. According to the values of parameters, implementing only the Opaque posted-price channel or only the NYOP is then still the best solution. Only cases 1 and 3 are then to be considered.

Case 1) corresponds to relatively small values of m when compared with n , and to relatively small levels of uncertainty (large values of q). In case 1) and if there are m tickets available the OTA's profits are:

$$\begin{aligned} \pi^N(m) &= 2 \sum_{k=1}^{m_H^D/2} P_{Hi}^N \left[a_i^{2p^{**}} + (k-1)(a - a_i^{2p^{**}}) / [(m_H^D/2) - 1] \right] + \\ & 2 \sum_{k=1}^{(m-m_H^D)/2} P_{Li}^N \left[a_i^{2p^{**}} + (k-1)(a_i^{2p^{**}} - a_i^{2p^*}) / [((m-m_H^D)/2) - 1] \right] \end{aligned}$$

where $m_H^D = 2n \frac{(a - a_i^{2p^{**}})}{a}$, given the level of uncertainty corresponding to case 1), the

number of tickets obtained by travellers able to bid high prices in order to acquire one ticket in all states of the world.

If there are $2m$ tickets available, the OTA's profits are:

$$\begin{aligned} \pi^N(2m) &= 2 \times \sum_{k=1}^{m_H^D/2} P_{Hi}^N \left[a_i^{2p^{**}} + (k-1)(a - a_i^{2p^{**}}) / (m_H^D/2) - 1 \right] + \\ & 2 \times \sum_{k=1}^{m_L^D/2} P_{Li}^N \left[a_i^{2p^*} + (k-1)((a_i^{2p^{**}} - a_i^{2p^*})) / (m_L^D/2) - 1 \right] \end{aligned}$$

where $m_L^D = 2n \left(\frac{a_i^{2p^{**}} - a_i^{2p^*}}{a} \right)$ figures, given the level of uncertainty, the number of tickets obtained

by travellers bidding low prices in order to acquire one ticket if $2m$ are available.

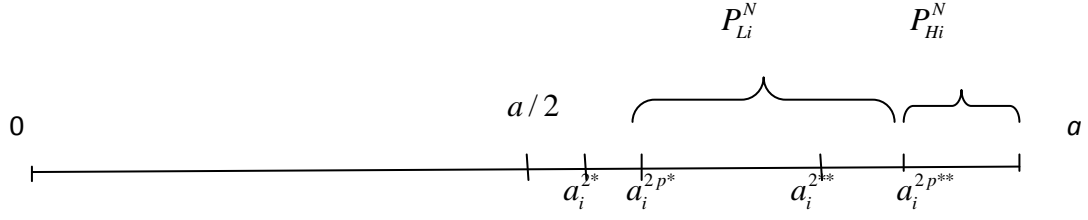


Figure 2 (case 1, $2m$ available tickets)

When there are $2m$ seats available, the market will remain uncleared (cf. figure 2). If all the seats were sold, the threshold price would be lower, and consequently the prices bided by consumers and finally - the intermediary's profits. Even if the market is not completely cleared, the OTA's profits will be higher than in case of complete information.

Finally, the OTA's expected profits are:

$$\pi^N = 1/2\pi(m) + 1/2\pi(2m)$$

Finally, in case 3), if there are m tickets available, the profits will be the same as in first case with m tickets *i.e.*

$$\begin{aligned} \pi^N(m) = & 2 \sum_{k=1}^{m_H^D/2} P_{Hi}^N \left[a_i^{2p^{**}} + (k-1)(a_i - a_i^{2p^{**}}) / (m_H^D / 2 - 1) \right] + \\ & 2 \sum_{k=1}^{(m-m_H^D)/2} P_{Li}^N \left[a_i^{2p^{**}} + (k-1)(a_i^{2p^{**}} - a_i^{2p^{**}}) / ((m-m_H^D) / 2 - 1) \right] \end{aligned}$$

If there are $2m$ tickets available, the OTA's profits are:

$$\begin{aligned} \pi^N(2m) = & 2 \sum_{k=1}^{m_H^D/2} P_{Hi}^N (a_i^{2p^{**}} + (k-1)(a_i - a_i^{2p^{**}}) / (m_H^D / 2 - 1)) + \\ & 2 \sum_{k=1}^{m-m_H^D/2} P_{Li}^N (a_i^{2p^{**}} + (k-1)(a_i^{2p^{**}} - a_i^{2p^{**}}) / ((m-m_H^D) / 2 - 1)) \end{aligned}$$

Finally, the OTA's expected profits are:

$$\pi^N = 1/2\pi(m) + 1/2\pi(2m)$$

In case 3) the number of tickets available is closer to the number of potential travellers than it is in the first case *i.e.* $m > 1/2 n$.

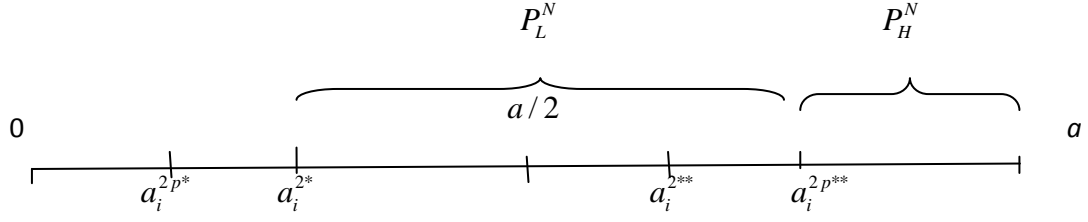


Figure 4 (case 3, $2m$ tickets available)

iii) If the two channels are jointly implemented, the travel agency naturally allocates the first set of m seats to the Opaque channel and targets the high propensity to pay agents. In this channel, the price and profit are unchanged: $p^O = a(2n - m)(u + \bar{u} / 2) / 2n$ and

$$\pi^O = mp^O = (2nm - m^2)a(u + \bar{u} / 2) / 2n \quad (6)$$

The second set of m seats is allocated to the NYOP channel and to travellers with lower propensity to pay. At stage 1, the agency chooses the rates of the Opaque channel and opens the bidding process at the NOYP channel. The NYOP channel corresponds to the following m passengers who expect the threshold price $p_i^N = (aq - 2a_iq + a_i)(n - m)(u + \bar{u} / 2) / n$. The two following cases are possible:

- 1) $a_i^{2*} < a_i^{2p^*}$
- 2) $a_i^{2p^*} < a_i^{2*}$

These cases correspond to cases 1) and 3) of the former paragraph. In both cases, the Opaque channel is used by the travellers willing to obtain the certainty to travel and the NYOP by the agents accepting to travel only in the best state of the world.

In the first case, the agency chooses a threshold price higher than the clearing price for the NYOP channel. OTA's expected profits are then:

$$\pi^{O/N} = \pi^O + \pi^{L'} \Leftrightarrow \pi^{O/N} = (2nm - m^2)a(u + \bar{u} / 2) / 2n + 2 \sum_{k=1}^{(m_L^D / 2) - m / 2} P_i^N \left[a_i^{2p^*} + \frac{(k-1)(a_i^{2p^{**}} - a_i^{2p^*})}{(m_L^D / 2 - m / 2 - 1)} \right]$$

In this case we suppose that the number of seats available is small, when compared to the number of potential travellers, and that uncertainty level is low.

In the second case, m is close to n .

$$\pi^{O/N} = \pi^O + \pi^{L'} \Leftrightarrow \pi^{O/N} = (2nm - m^2)a(u + \bar{u}/2)/2n + 2\sum_{k=1}^{m/2} P_i^N \left[a_i^{2*} + \frac{(k-1)(a_i^{2**} - a_i^{2*})}{(m/2-1)} \right]$$

Proposition 2: When information of passengers is incomplete regarding their relative propensity to pay, the simultaneous implementation of an Opaque system and a NYOP channel could strongly dominate the other solutions and correspond to a unique Stackelberg equilibrium.

Proposition 2 (still a the stage of a conjecture): When information of passengers is incomplete regarding their relative propensity to pay, the simultaneous implementation of an Opaque system and a NYOP channel could strongly dominate the other solutions and correspond to a unique Stackelberg equilibrium.

Intuitioun of the conjecture: Suppose that the parameters of the model are such that $a_i^{2*} < a_i^{2p*} < a_i^{2**} < a_i^{2p**}$. In this case, the profits of the travel agency provided by the agents located between a_i^{2p**} and a are higher when the NYOP channel is implemented alone. However, the profits provided by agents located between a_i^{2**} and a_i^{2p**} are in this case higher when the Opaque posted-price channel is implemented jointly with the NYOP channel. The objective of the research is to find the relevant values of the parameters able to illustrate the conjecture

3. Concluding remarks and further research

In this paper we describe 3 possible strategies of implementation of opaque selling by a monopoly OTA. First part of a model, considering the case of complete information of potential travellers regarding their relative propensity to pay and the state of the world provides benchmark results. Afterwards, we will develop the case of incomplete information and compare the results with the benchmark results.

A further extension could be to consider the case of duopoly as an example of competition. Indeed, in the e-tourism market a great number of OTAs compete and co-exist, implementing different distribution strategies. More precisely, two OTA's compete in the opaque segment, displaying different selling approaches.

We could also evaluate the possibility of threshold price to vary according to the number of tickets available and consumer's arrivals on the market. In fact, it is difficult to pretend that Priceline fixes only once the threshold price at the beginning of the selling period and maintains it unchanged until the date of departure despite the evolution of number of potential travellers and amount of tickets available.

References:

- Fay, S. "Selling an Opaque Product through an Intermediary: The Case of Disguising One's Product", Working Paper, University of Florida, Gainesville, FL, USA, April 2007.
- Fay, S. "Reverse Pricing: The Role of Customer Expectations", Working Paper, University of Florida, Gainesville, FL, USA, June 2008
- Fay, S. "Competitive Reasons for the Name-Your-Own-Price Channel", Working Paper, University of Florida, Gainesville, FL, USA, September 2008
- Fay, S. and Laran, J. "Implications of Expected Variability in the Seller's Price in Name-Your-Own-Price Auctions", Working Paper, 2008, University of Florida, Gainesville, FL, USA, 2008
- Fay, S. and Xie, J. "Probabilistic Goods: A Creative Way of Selling Products and Services", Working Paper forthcoming *Marketing Science*, University of Florida, Gainesville, FL, USA, August 2007
- Grandos, N., Gupta, A. and Kauffman, R.J. "Designing online selling mechanisms: Transparency levels and Prices", *Decision Support Systems*, Vol. 45, 2008, pp. 729-745
- Jiang, Y. "Price discrimination with opaque products", *Journal of Revenue and Pricing Management*, Vol. 6, N° 2, 2007, pp. 118-134
- Shapiro, D., Shi, X. "Market Segmentation: The Role of Opaque Travel Agencies", Working Paper, Belk College of Business, University of North Carolina, Charlotte, NC, USA, University of Toronto, Toronto, ON, Canada, February 2008
- Shapiro, D. and Zillante, A. "Naming Your Own Price Mechanisms: Revenue Gain or Drain?", Working Paper, University of North Carolina, Charlotte, NC, USA, October 2007
- Spann, M., Bernhardt, M., Häubl, G. and Skiera, B. "It's All in *How* You Ask: Effects of Price Elicitation Format on Bidding Behavior in Reverse-Pricing Markets", Working Paper, University of Passau, Passau, School of Business and Economics, Johann Wolfgang Goethe-University, Frankfurt am Main, Germany, School of Business, University of Alberta, Edmonton, AB, Canada, August 2005
- Spann, M., Skiera, B. and Schäfers, B. "Measuring Individual Frictional Costs and Willingness-to-Pay via Name-Your-Own-Price Mechanisms", *Journal of Interactive Marketing*, Vol. 18, N° 4, Autumn 2004, pp. 22-36
- Spann M. and Tellis G., J. "Does the Internet Promote Better Consumer Decisions? The Case of Name-Your-Own-Price Auctions", *Journal of Marketing*, Vol. 70, January 2006, pp. 65-78
- Terwiesch, C., Savin, S. and Hann, I-H. "Online Haggling at a Name-Your-Own-Price Retailer: Theory and Application", *Management Science*, Vol. 51, Vol. 3, March 2005, pp. 339-351
- Wang, T., Gal-Or, E. and Chatterjee, R. "Why a 'Name-Your-Own-Price' Channel Makes Sense for Service Providers (or: Who Needs *Priceline*, Anyway?)", Working Paper, Kent State University, Kent, OH, University of Pittsburgh, Pittsburgh, PA, USA, September 2005

Wilson, J. G. and Zhang, G. "Optimal design of a name-your-own-price channel", *Journal of Revenue and Pricing Management*, Vol. 7, N° 3, 2008, pp. 281-290