DESIGNING INTERNET-BASED SELLING MECHANISMS: MULTI-CHANNEL MARKET TRANSPARENCY STRATEGY

Nelson F. Granados, Alok Gupta, Robert J. Kauffman
Information and Decision Sciences, Carlson School of Management, University of Minnesota
{ngranados, agupta, rkauffman}@csom.umn.edu

ABSTRACT

The Internet has transformed the nature of business-to-consumer transaction-making practices in many industries. Sellers now attract customers with innovative Internet-based selling mechanisms that can reveal or conceal market information. We define *market transparency* as a design dimension for Internet-based selling that involves firm choices about the level of availability and accessibility of information about products and prices. Firms can influence market transparency either by designing and implementing their own Internet-based selling mechanism, or by offering their products through an existing electronic market. We develop an economic model of a supplier that price discriminates across distribution channels based on their market transparency levels. The model provides normative guidelines for firms to set transparency levels and prices across distribution channels in order to maximize profits. We empirically evaluate airline pricing and market transparency to show the applicability of these guidelines. The evidence suggests that relative prices and transparency levels across the Internet and traditional air travel channels are sub-optimal.

Keywords: Air travel industry, Internet-based selling, market transparency, mechanism design, pricing.

I. INTRODUCTION

Internet technologies have brought about significant changes to market transparency in business-to-consumer (B2C) markets. To the benefit of consumers, it has reduced search costs for information about products and prices. And sellers now attract customers with innovative selling mechanisms that can reveal or conceal market information. Today, organizations are faced with the paradox that the very benefit of the Internet—making information available to facilitate product marketing and distribution—also makes it difficult to capture profits (Porter, 2001). Market transparency, the selective revelation of product and price information, is now a design variable in Internet-based selling mechanisms, and it is increasingly viewed strategically by firms as they consider the trade-off between attracting consumers with market information and the risks of losing information advantages (Tapscott and Ticoll, 2003).

In the air travel industry, some major airlines have taken advantage of the Internet to develop innovative and transparent mechanisms. For example, in 2001 five major U.S. airlines introduced Orbitz (www.orbitz.com), an online travel agency (OTA) that displays a wide range of travel options based on combinations of airline carrier, flight schedules, travel dates, and price. On the other hand, some OTAs exhibit opaque selling mechanisms that conceal product or price information until after purchase (e.g., www.priceline.com). Meanwhile, traditional travel agencies continue to play a significant role in Internet-based air travel distribution.

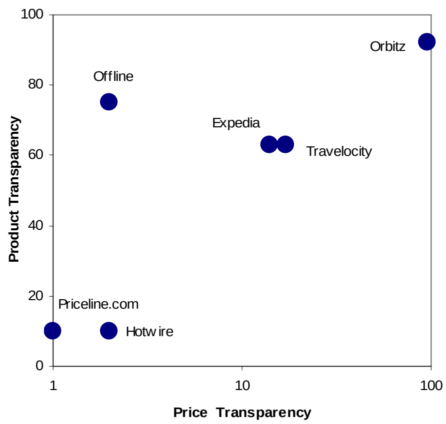
In this paper, we model the impact of information transparency on consumers' economic behavior and derive optimal transparency levels and prices across channels that a supplier should adopt to maximize profits. Using the guidelines from the model, we analyze a large data set of airline tickets to evaluate transparency levels and prices in air travel.

II. IT AND MARKET TRANSPARENCY IN B2C MARKETS

We define *market transparency* as the level of availability and accessibility of market information. A firm can design its market transparency by implementing selling mechanisms with a desired transparency level, or by joining an electronic market that meets certain transparency requirements. We focus on two design dimensions of market transparency: product and price transparency. *Product transparency* exists when product information and characteristics are visible to consumers. *Price transparency* exists when market prices and related information are visible, such as quotes and transaction prices. A more transparent mechanism will result from greater transparency in either dimension.

Internet-based sellers can compete by selecting a *transparency tuple*, [Product Information Available, Price Information Available] in the space of possible alternatives. For example, OTAs have adopted different combinations of product and price transparency with the support of IT-enabled selling mechanisms (Granados, et al., 2005, 2006). (See Figure 1.) Orbitz, Expedia, and Travelocity offer multiple itineraries with the respective prices, although Orbitz has state-of-the-art technology and special agreements with its suppliers to show more priced itineraries in the first screen. On the other hand, *opaque* OTAs such as Hotwire and Priceline.com conceal product or price information until a transaction is complete, in exchange for lower prices. However, as pressure on price competition intensifies, even these opaque Web sites have been pressured to move towards higher transparency by presenting an Orbitz-like display to customers.

Figure 1. Air Travel Transparency



E-commerce technologies add complexity to airlines' multi-channel distribution strategy. They can sell products through channels with different levels of transparency, and travelers will differ in their valuation of information regarding products and prices. More generally, how should suppliers strategize in a market with heterogeneous transparency levels? We answer this question by modeling supplier decisions about pricing and transparency levels across distribution channels.

III. MODELING TRANSPARENCY STRATEGY IN INTERNET-BASED SELLING

We now summarize the results of a model of transparency choice. It characterizes scenarios that arise in the competitive environment of the Internet where there is no pre-existing market-wide level of transparency. In this model, a firm (e.g., an airline) makes choices regarding transparency and prices by channel. This set of choices constitutes a *transparency strategy*, which can be implemented due to the advancement of Web-based technologies. In the interest of tractability of our model and the development of practical guidelines, we derive optimal *relative* transparency levels and prices across channels.

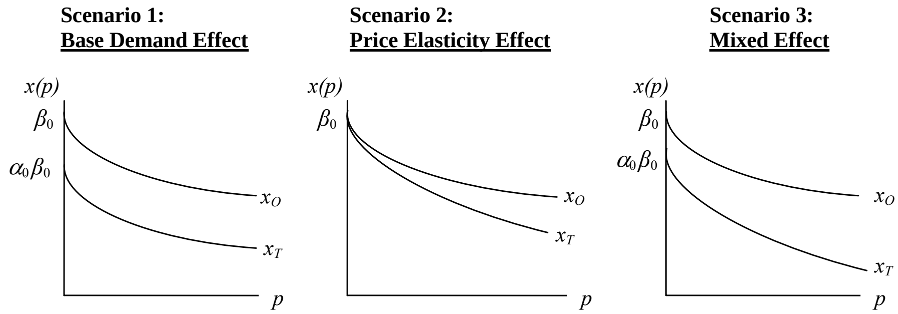
A. Profit Model

Consider a market with one monopolist that sells a good through two distribution channels, with demand of the form $x(p) = \lambda_0 - \lambda_1 p^\theta$, where $\lambda_0, \lambda_1, \theta > 0$. λ_0 represents the base demand, or the number of consumers that have a positive valuation for the good. The demand function is convex if $0 < \theta < 1$, linear if $\theta = 1$, and concave if $\theta > 1$. Market transparency may influence the base demand λ_0 or the price elasticity, which is a function of λ_1.

Suppose the two channels exhibit different levels of market transparency. Channel *T* is transparent, while Channel *O* is less transparent or *opaque*, with respective demand functions, $x_T(p_T) = \alpha_0\beta_0 - \frac{\beta_1}{\alpha_1} p_T^\theta$ and $x_O(p_O) = \beta_0 - \beta_1 p_O^\theta$. α_0 and α_1 are relative impacts of market transparency on consumer willingness-to-pay (WTP). If there is no impact, then $\alpha_0 = 1$and $\alpha_1 = 1$, so the demand functions are the same across channels. If transparency *decreases* WTP, there are three possible scenarios: (1) base demand decreases, so $\alpha_0 < 1$, (2) price elasticity increases, so $\alpha_1 < 1$, and (3) base demand decreases and price elasticity increases (i.e, a mixed effect), so $\alpha_0 < 1$ and $\alpha_1 < 1$. (See Figure 2.) If market transparency *increases* WTP, we will see the opposite effects.

The supplier's profit function is $\pi(p_T, p_O, x_T, x_O) = p_T x_T(p_T) + p_O x_O(p_O) - C(x)$, where $C(x)$ is the cost function. We assume that marginal costs are constant and do not differ across channels, so $C'(x) = c$.

Figure 2. Demand for Transparent and Opaque Channels



The profit maximizing prices are characterized by the equation $\alpha_0\alpha_1 = \left(\frac{p_T^*}{p_O^*}\right)^{\theta} \frac{1+\theta\left(1-c/p_T^*\right)}{1+\theta\left(1-c/p_O^*\right)}$, which suggests that the seller should price discriminate across distribution channels:

> **Proposition 1 (The Transparency Strategy Proposition)**: *If market transparency decreases (increases) willingness-to-pay, the price of the transparent channel should be lower (higher) than that of the opaque channel.* (Proofs are available from the authors.)

B. Revenue Model

If the goal is to maximize revenue, the objective function is $R(p_T, p_O, x_T, x_O) = p_T x_T(p_T) + p_O x_O(p_O)$. Solving the revenue maximization problem yields optimal prices, $p_O^* = \left(\frac{\beta_0}{(\theta+1)\beta_1}\right)^{\frac{1}{\theta}}$ and $p_T^* = \left(\frac{\alpha_0\alpha_1\beta_0}{(\theta+1)\beta_1}\right)^{\frac{1}{\theta}}$. The ratio of these optimal prices is shown in $P^* = \frac{p_T^*}{p_O^*} = (\alpha_0\alpha_1)^{1/\theta}$, the *optimal price ratio equation*.

Enhanced Revenue Model - Practical Guidelines. The profit and revenue models so far provide a theoretical optimal relationship between transparency levels and prices across channels. But in practice this optimal relationship is difficult to derive, because it depends on prior knowledge of transparency's impact on WTP, α_0 and α_1. We now enhance the model by deriving optimal prices and transparency levels based on historical sales by channel. For clarity of exposition, in this sub-section we assume that market transparency decreases WTP.

Let $S = x_T / x_O$ be the *channel share ratio*, or the relative share of sales between transparent and opaque channels *T* and *O*. Substituting the demand functions of channels *T* and *O* and performing some algebraic manipulation leads to:

> **Proposition 2 (The Channel Share-Base Demand Proposition)**: *The optimal channel share ratio is equal to the base demand ratio, thus* $S^* = \alpha_0$.

This proposition suggests that the effect of transparency on base demand can be observed in the channel share ratio *if* the prices are optimal. To determine the prices that lead to optimal channel shares, we substitute $S^* = \alpha_0$ in the *optimal price ratio equation*, so $P^* = (S^*\alpha_1)^{1/\theta}$.

> **Corollary (The Optimal Price Ratio):** *The optimal price ratio is a function of the channel share ratio.*

However, if the relative transparency levels and prices are not optimal, channel shares will not be optimal. In a sense, by selecting a transparency level, sellers indirectly set the base demand for the product, so any attempt by a supplier to artificially increase or decrease sales through a channel with prices will be sub-optimal. Next, we characterize these general findings in terms of each possible scenario of the impact of transparency on demand. (See Figure 2 again.)

Case 1: Base Demand Scenario. Transparency may attract or deter consumers in Internet-based selling. For example, an electronic mechanism that displays more product variants may attract more consumers with different tastes, which will lead to a higher base demand. The following proposition summarizes the implications for relative prices and channel shares.

Proposition 3 (The Base Demand Effect Proposition): *If the supplier sets prices by channel to maximize revenue, the channel share ratio will be equal to the θ^{th} power of the price ratio, thus* $P^{*\theta} = S^*$.

Here, sales by channel and an estimate of θ will be sufficient for the supplier to assess whether the relative prices and transparency levels by channel are optimal. For example, if the firm observes that $P^{\theta} > S$, then the cross-channel transparency strategy is sub-optimal and the firm should either decrease the transparency level of channel *T*, increase the transparency level of channel *O*, or increase the price differential between channels to maximize revenue.

Notice that in the particular case of linear demand, $\theta = 1$ and hence $P^* = S^*$:

Corollary (The Linear Demand Channel Share Ratio): *For linear demand, the optimal price ratio will equal the optimal channel share ratio.*

This corollary suggests that if relative shares are not equal to relative prices in a market with linear demand, prices or transparency levels should be adjusted to maximize revenue.

Case 2: Price Elasticity Scenario. In some situations, transparency may have an impact on sensitivity to prices for existing customers. Assuming there is no impact on the base demand, the following proposition characterizes optimal prices and channel shares:

Proposition 4 (The Price Elasticity Effect Proposition): *If the supplier sets prices by channel to maximize revenue, both channels will have an equal share of sales, thus* $S^* = 1$.

This proposition suggests that the firm should price such that each channel has equal sales volume. For example, if the firm observes that the channel *T*'s sales are lower than channel *O*'s so that $S < 1$, then it should either decrease the transparency level of channel *T*, increase the transparency level of channel *O*, or increase the price differential between the channels to maximize revenue.

Case 3: Mixed Effect Scenario. If the relative transparency levels differ significantly between two channels, transparency is likely to affect both base demand and price elasticity of demand. We summarize the implications for optimal prices and channel shares with:

Proposition 5 (The Mixed Effects Proposition): *If the supplier sets prices by channel to maximize revenue, the price differential between channels will be higher than in the base demand scenario.*

This proposition suggests that the mixed effect of market information on base demand and price elasticity compounds the cross-channel price differential necessary to maximize revenue. Therefore, the guidelines from the base demand scenario should be applied, but to a larger extent.

IV. EMPIRICAL ANALYSIS OF MARKET TRANSPARENCY IN AIR TRAVEL

We evaluated U.S. airlines' transparency strategy in online (i.e., transparent OTA such as Orbitz, Travelocity, and Expedia) and offline (i.e., traditional travel agencies) channels using a database of airline tickets sold by travel agencies through *global distribution systems* (GDSs) between September 2003 and August 2004. The database contains information on 3 million economy class tickets sold in 210 U.S. point-of-sale city pairs, aggregated by agency type and destination region (i.e., domestic and Europe). This aggregation level results in a broad measure of the average fare for all airlines, or an estimate of industry level fares by channel.

The average one-way price of tickets sold offline was $248, compared to $143 for tickets sold online. This price differential is consistent with our *Transparency Strategy Proposition*, which suggests that airlines should price discriminate in these channels because they have different transparency levels. We now assess whether the relative transparency levels and prices across these channels are optimal.

We used the demand model, $x_{ij} = \beta_0 + \beta_1 o_{ij} + \beta_2 a_{ij}{}^{\phi} p_{ij}^{\theta} + \varepsilon_{ij}$, where x_{ij} represents *tickets sold* by *agency type i* to region *j*, *o* is a dummy variable for *online sales* (0 for offline, 1 for online), *a* is the *advance purchase time* measured in weeks before departure (0 to 30 weeks), *p* is *price paid*, and ε is the error term. This model is analogous to the demand form $x(p) = \lambda_0 - \lambda_1 p^{\theta}$ in our analytical model, where $\beta_0 + \beta_1 o$ is an estimate of the base demand λ_0, and $\beta_2 a^{\phi}$ is an estimate of $-\lambda_1$.

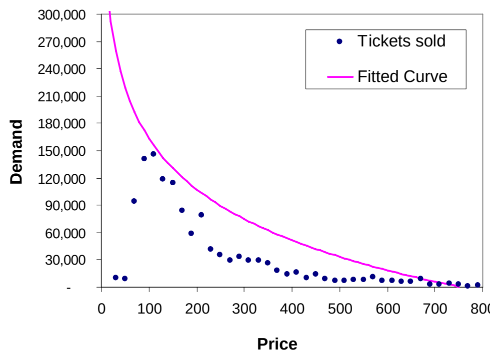
We ran *iterative non-linear least squares* (NLS) regressions. The model converged on the 592nd iteration with a 79% R^2, and all variables were significant at the $p = 0.001$ level, as follows:

$$\hat{x} = 2.76 * 10^7 - 421{,}420 o - 2.57 * 10^7 a^{0.010} p^{0.009} + e$$

S.E.	2.9*10⁶	22,868	2.7*10⁶	0.001	0.001
p	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

$\hat{\beta}_1$, the coefficient estimate of *o*, is -421,420 (standard error = 22,868, $p = 0.001$), which suggests that base demand in the more transparent online channel is lower than in the offline channel. However, this result cannot be fully attributed to transparency, because *o* also incorporates all other channel-specific effects such as quality of service. In the following analysis, we use historical sales by channel and guidelines from the model to assess whether air travel transparency strategy is optimal across distribution channels.

Figure 3. Air Travel Fitted Demand Curve – Economy Class, Low Season



A. Base Demand Analysis

The estimate of θ is 0.009 (std. error = 0.001, $p = 0.001$), which suggests that the air travel demand curve is convex. (See Figure 3). With this estimate of θ we now evaluate airline transparency strategy for each scenario.

To evaluate the relative price levels across channels, let us assume initially that the base demand scenario applies, so transparency decreases base demand but it does not affect price elasticity. Referring to the *Base Demand Effect Proposition*, if relative prices are optimal, airlines should observe $P^{*\theta} = S^*$. The mean estimate of $P^{\theta} = (143/248)^{0.009} = 0.995$. On the other hand, the observed channel share ratio is $S = 0.28$, so $P^{\theta} > S$, which suggests the transparency strategy is sub-optimal. However, the observed channel shares may be affected by other factors such as the maturity of the Internet channel and structural differences in service quality and convenience. Therefore, we adjusted the channel share ratio using the *estimated channel effect*, or the coefficient of *o*, which led to an adjusted $S = 0.45$. Since this observed channel effect includes the effect of market transparency, *S* is over-adjusted, yet the inequality $P^{\theta} > S$ remains, so airline transparency strategy is sub-optimal. Therefore, airlines can increase revenues by either decreasing the transparency level of their OTA channels, or by increasing the price differential between channels that satisfy the condition $P^{*\theta} = S^*$.

B. Price Elasticity Analysis

We analyzed price elasticities by channel. We conclude that the online travel channel has a higher price elasticity compared to traditional travel agencies. We estimated the price elasticity by channel based on a log-linear demand model, $x_i = A t^{\phi} p_i^{\eta}$, where $-\eta$ is the price elasticity and $i \in$ {online, offline}. Applying the log transformation results in a linear equation. These demand functions by channel represent a system of equations which have a linked set of error terms since the demands are determined in the same market context and period. Therefore, we used *seemingly unrelated regressions* to estimate the system of equations. The offline and online price elasticity estimates (i.e., the coefficients of $\ln(p_i)$) were

1.4 and 3.7, respectively. We performed a Wald test (Greene, 2002) for the null hypothesis, H_0: $\eta_{offline} = \eta_{online}$. The hypothesis was rejected ($p = 0.01$). Therefore, we conclude that online demand exhibits higher price elasticity than offline demand.

Referring to the *Price Elasticity Effect Proposition*, $S^* = 1$. However, the observed value of S, adjusted for channel-specific effects, is 0.45. Therefore, analogous to the result in the base demand scenario, the price elasticity analysis suggests that air travel transparency strategy is sub-optimal, and airlines should decrease the transparency level of the online OTA channel or increase the price differential across channels until their sales are equal.

C. Mixed Effects Analysis

From the base demand and price elasticity analysis, we conclude that transparent OTAs have a lower base demand but a higher price elasticity than traditional travel agencies. Moreover, both the base demand scenario and price elasticity scenario analyses suggest that the offline channel may be sub-optimally cannibalizing travelers from the online channel. Given the observed mixed effect of transparency on consumers, airlines should decrease the transparency of their Internet-based selling mechanisms or increase the price differential between traditional and Internet channels to a larger extent than what the guidelines of the base demand and price elasticity scenarios suggest.

V. CONCLUSIONS

Internet-based sellers face strategic issues related to the development of technology that determines market presence, positioning, and information disclosure. Our analytical model provides guidelines for multi-channel transparency strategy where technology and transparency levels differ across sales channels. We found that multi-channel transparency strategy may be sub-optimal in the air travel industry and provided recommendations on how airlines can increase revenues.

The model is based on reasonably general assumptions regarding the impact of market transparency on willingness-to-pay. It is attractive because it provides guidelines based on observed historical sales by channel for a firm to diagnose whether its multi-channel transparency strategy is sub-optimal, and the directional corrective actions that need to be taken. Our analysis of the air travel industry shows how the model can be used to make such a diagnosis, despite no prior knowledge of the impact of transparency. We have empirical research underway to examine the influence of product and price transparency on consumer demand, which will inform this model and the guidelines it yields.

Our model is particularly useful for firms that have a captive market where the valuation of market transparency may differ among the consumers. As sellers manipulate market information across channels, some multi-channel shoppers may switch to a different channel, and others may not switch yet become more sensitive to prices. With the normative guidelines that we have derived, firms can make sound decisions when confronted with this problem in an environment where technological capabilities allow them to price-discriminate and set transparency levels by channel.

REFERENCES

Granados, N. F., Gupta, A., and Kauffman, R. J. "Transparency Strategy in Internet-Based Selling," in K. Tomak (Ed.) *Advances in the Economics of Information Systems*, Idea Group Publishing, Harrisburg, PA, 2005, 80-112.

Granados, N. F., Gupta, A., and Kauffman, R.J. "IT-Enabled Transparent Electronic Markets: The Case of the Air Travel Industry," *Information Systems and e-Business Management*, forthcoming, 2006.

Greene, W. *Econometric Analysis, 5th Ed.*, Prentice Hall, Englewood Cliffs, NJ, 2002.

Porter, M. E. "Strategy and the Internet," *Harvard Business Review*, 79(1), 2001, 62-78.

Tapscott, D., and Ticoll, D. *The Naked Corporation: How the Age of Transparency will Revolutionize Business*, Free Press, New York, NY, 2003.