MARKET TRANSPARENCY STRATEGY IN E-COMMERCE: MODELING AND EMPIRICAL ANALYSIS

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ABSTRACT

Internet technology has transformed the nature of business-to-consumer transaction-making practices in many industries. One of the significant impacts has occurred with respect to the transparency of markets for end-consumers. Market transparency is defined as the level of availability and accessibility of information about products and prices. We show how firms can leverage different ways to reveal information to consumers in the presence of advanced e-commerce technologies. We develop an economic model that provides normative guidelines for sellers to set prices in a market with heterogeneous transparency strategies. The results suggest that if the degree of information disclosure to consumers affects their economic behavior, relative prices among sellers should be adjusted accordingly to maximize profits. Moreover, knowledge about the demand function and about the impact of market transparency on willingness-to-pay can improve the effectiveness of these guidelines. Finally, we empirically evaluate transparency strategies in the air travel industry to show the applicability of the strategic guidelines derived from the model.

KEYWORDS: Airline industry, B2C e-commerce, economic analysis, Internet-based selling, market transparency, online travel agencies, pricing strategy.
I. INTRODUCTION

The Internet revolution brought about significant changes to market transparency in business-to-consumer (B2C) markets. To the benefit of consumers, it reduced the search costs of information about products and prices. In turn, sellers were able to attract customers with innovative market mechanisms that 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). Therefore, transparency in the digital economy is increasingly viewed strategically by firms as they consider the trade-off between attracting consumers with market information and the risks of reduced information asymmetries (Tapscott and Ticoll, 2003).

A representative case of the market transparency revolution has occurred in the air travel industry, where some firms have chosen to take advantage of the potential offered by the Internet to inform consumers. 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. However, not all players have taken a high market transparency position. OTAs with opaque market mechanisms such as Hotwire (www.hotwire.com) and Priceline.com (www.priceline.com) have emerged with niche strategies to offer less information about the product and the carrier, albeit at discounted prices.

The OTA industry example shows that the impact of e-commerce technologies on the practices of information disclosure is two-fold. First, it has increased the overall ability of firms to disclose market information, their transparency potential. Second, it has increased firms’ choices to conceal and distort product and price information. This process is dynamic. If a
market participant introduces a novel market mechanism, competitors must respond with sound pricing and transparency strategies. Therefore, some relevant questions to ask are: How does market transparency influence consumers’ economic behavior in B2C markets? How should firms strategize in a technological environment that enables multiple market transparency levels?

In this paper, we develop an economic model of heterogeneous transparency strategies for Internet-based selling. We recognize that modeling a market-wide level of transparency may not be representative of e-marketplaces, where firms innovate to attract consumers with novel selling mechanisms. In these markets, there may be no equilibrium level of transparency as firms seek IT-enabled differentiation in the presence of diverse information endowments and IT capabilities. Therefore, rather than searching for equilibrium solutions, in this paper we develop directional guidelines that firms can follow in a market where IT-enabled heterogeneous transparency strategies are present. We model the impact of market transparency on consumers’ economic behavior and derive the relative prices and transparency strategies between two sellers that maximize their profits. The results suggest that if the degree of information disclosure to consumers affects their economic behavior, relative prices should be adjusted accordingly. One advantage of our modeling approach is that it can be empirically tested. In this paper, we evaluate air travel pricing and transparency strategies using a large dataset of airline tickets, to show the value of the directional guidelines to researchers and practitioners.

The rest of this paper is organized as follows. The next section provides a conceptualization and operational definition of market transparency based on existing management and economics literature. In the third section, we present an analytical model of transparency strategy in B2C electronic commerce. In the fourth section we discuss the broader implications of the model for firm strategy. In the fifth section we analyze transparency strategies in the airline industry in both
traditional channels and Internet-based travel agencies. Finally, we present conclusions and directions for future research.

II. INFORMATION REVELATION AND TRANSPARENCY IN B2C MARKETS

To provide a foundation for a model of transparency strategy, we first conceptualize market transparency in terms of the relevant finance, marketing and economics literature.

A. What is Market Transparency?

We define *market transparency* in B2C markets as the level of availability and accessibility of information about product variants and market prices. We focus on two elements of market transparency, product and price transparency. *Product transparency* exists when product variants and their characteristics are made available, while *price transparency* exists when market prices and related information are made available, such as quotes and transaction prices. A more transparent market will result from greater transparency in one or both of these dimensions.

**Price Transparency.** Much of the literature on price transparency exists in the context of financial markets, where researchers have explored the extent to which greater transparency leads to higher market efficiency and liquidity. In this context price transparency is typically modeled as an exogenous variable defined by a policy-maker or a central authority. This approach informs the ongoing policy debate about the appropriateness and breadth of the publication of transaction details to investors (Schwartz, 1995). In the financial market literature, price transparency takes multiple dimensions, such as order flow, transaction history, and price quotes (Biais, 1993; Lyons, 1994; Pagano and Roell, 1996).

Domowitz (1995) breaks down the impact of transparency in financial markets into two categories: provision of liquidity and the price discovery process. *Liquidity* is the extent to which a buyer (seller) is able to find a seller (buyer) to complete a trading transaction in a reasonable
amount of time at a reasonable transaction cost. Liquidity can be further classified into two components. *Insider liquidity* is provided by market intermediaries who aggregate and match orders. *Outsider liquidity* comes from outside investors who make bids and offers. In B2C electronic markets, liquidity can be viewed in a similar way, with insider liquidity provided by digital intermediaries and outside liquidity provided by sellers and buyers.

*Price discovery* is the process by which market prices are established. Price transparency plays a role in this process by reducing uncertainty about trading prices. Moreover, the impact of transparency on the price discovery process is not only determined by the revelation of prices, but also by the structure of the trading process or *market microstructure* (Harbrouck, 1995; O’hara, 1995). Generally, dynamic trading mechanisms such as auctions have high price transparency potential because consumers (sellers) are better able to ascertain their product valuation and their willingness-to-pay (sell).

**Product Transparency.** Marketing research suggests that consumers may view a product with suspicion upon the absence of information about a salient attribute. Johnson and Levin (1985) observed lower product ratings when important product information was missing. Lynch and Ariely (2000) found that lower search costs for product quality information decreased consumers’ sensitivity to prices. Keeney (1999) interviewed Internet users to identify consumers’ information needs. (See Table 1.)

Information about product features described in Table 1 determines product transparency because it contributes to consumers’ economic objectives such as maximizing quality, comfort, and integrity, and minimizing cost and time. In B2C electronic markets, these features can be further broken down into two categories. *Digital product characteristics* are information-based features, such as programming code of a software product or the travel itinerary described by an
airline ticket. *Non-digital product characteristics* are ones that cannot be transformed into digital form, such as smell or friendliness. These are usually experience-based or intangible features. Generally, in B2C electronic markets, products with high non-digital product characteristics exhibit higher transparency potential because they can be easily represented electronically.

**Table 1. Determinants of Product Transparency in E-Commerce**

<table>
<thead>
<tr>
<th>PRODUCT CHARACTERISTICS</th>
<th>CONSUMER OBJECTIVE</th>
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<tbody>
<tr>
<td></td>
<td>Maximize</td>
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<tr>
<td></td>
<td>Quality</td>
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<tr>
<td>Digital</td>
<td>Features</td>
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<td></td>
<td>Market share</td>
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<td></td>
<td>Seller identity</td>
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<tr>
<td>Non-Digital</td>
<td>Features</td>
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*Note:* The consumer objective categorization and the content in each cell was adapted from Keeney (1999)

**B. IT-Enabled Transparency Strategies and Consumer Demand**

Prior to the advent of e-commerce technologies, firms were restricted in their choices to disclose information to consumers. Now, firms are not only faced with higher transparency potential, but they also have the possibility to position themselves at numerous points on or below that potential. For example, they can choose to conceal one or more determinants of product transparency. (See Table 1 again.) In other words, firms compete by selecting a *market 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, innovative selling mechanisms. (See Figure 1.) Orbitz, Expedia, and Travelocity have capitalized on the transparency potential offered by the Internet and existing reservation systems technology. Based on a traveler’s search request, these OTAs offer multiple itineraries with the respective prices. On the other hand, Hotwire and Priceline.com introduced mechanisms with a low level of market transparency. These
mechanisms attract price-sensitive customers by concealing product and price information until the transaction has been completed. In return, travelers are offered promotional prices.

**Figure 1. Online Travel Agency Market Transparency Space as of 2002**

![Figure 1. Online Travel Agency Market Transparency Space as of 2002](image)

**Note:** The *market transparency space* is defined as all the possible transparency strategies that a firm can adopt, at or below the IT-enabled transparency potential. This figure depicts the market transparency space of the OTA market and the transparency position of each OTA as of 2002, relative to traditional agencies. For more details, see Granados, et al. (2004, 2005).

A market transparency tuple that is closer to the transparency potential can increase consumer surplus in three ways. (See Figure 2.) First, the value of a purchase increases if the consumer discerns product characteristics of existing alternatives with higher precision, resulting in more accurate product valuation (Harbrouck, 1995). Second, search costs may decrease such that more product alternatives are made available. For example, through the Internet, major OTAs such as Orbitz, Travelocity, and Expedia now provide immediate and inexpensive access to tables with multiple combinations of air carriers, flight itineraries, and number of stopovers. Third, information may become available that allows a consumer to transact at a lower price for a given product. Stigler (1961) showed that a lower price may result if search costs are reduced such that a lower market price is discovered.

There is inherent complexity in the effort to conceptualize and understand the value of market transparency to consumers. The combined value of product and price information is not
necessarily a monotonically increasing, continuous function, and heterogeneous consumers will
differ in their valuations of the multiple informational determinants of product and price
transparency. In addition, the impact on the consumer will vary depending on the information
disclosed. Therefore, the modeling effort in the next section takes a different approach, by
focusing on the relative rather than absolute impact of changes in transparency on demand.

III. A MODEL OF HETEROGENEOUS TRANSPARENCY STRATEGIES

In this section, we present a model of price competition between two sellers that exhibit
different levels of market transparency. These scenarios, typical in the Internet era, arise in the
presence of continuous technological innovation and novel selling mechanisms, where the
competitive environment is dynamic and there is no steady-state, market-wide level of
transparency. In economic and financial research, transparency is commonly viewed as
exogenous, or imposed by a market regulator. In this model, however, transparency is a decision
variable at the seller level, assuming that firms have the technological ability to select which
information will be revealed or concealed to consumers.
Markets with Internet-based selling are in a state of flux as firms seek out differentiation strategies based on their information endowments and IT capabilities. A representative example is the air travel industry. With the advent of the Internet in the 1990s, some OTAs originally introduced transparent selling mechanisms (i.e., Travelocity, Expedia), while niche players like Priceline.com introduced opaque market mechanisms. At the turn of the millennium, with top-of-the-art technology that challenges legacy reservation systems, airlines introduced Orbitz to push market transparency potential to a new level (Granados, et al., 2005).

In this competitive environment, if an Internet-based seller introduces a market mechanism that changes the market transparency landscape, competitors must react with economically sound price and transparency strategies. In our modeling effort, we support the decisions that firms face in a market where heterogeneous transparency levels co-exist. Therefore, rather than searching for equilibrium solutions, we derive relative optimal strategies between sellers that can be applied in a changing market and technological environment.

A. Profit Model

Consider a market with two sellers, one good, and demand for the good of the form

\[ x(p) = \lambda_0 - \lambda_1 p^\theta , \]

where \( \lambda_0, \lambda_1, \theta > 0 \). The parameters \( \lambda_0, \lambda_1, \) and \( \theta \) characterize the \( y \)-intercept, the steepness, and the curvature of the demand function, respectively. The \( y \)-intercept represents the base demand, or the total 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 \( \theta > 1 \).

The two sellers exhibit different transparency strategies. Seller \( T \) has a high-transparency mechanism to sell the good, while Seller \( O \) has a low-transparency or opaque mechanism. If consumers value market transparency, each transparency strategy will affect consumers’ willingness-to-pay. With respect to the model, we assume that the impact of market transparency
on willingness-to-pay is reflected by the values of $\lambda_0$ and $\lambda_1$. In other words, market
transparency may influence the base demand $\lambda_0$ or the price elasticity, which is a function of $\lambda_1$.

Let the respective demand functions for sellers $O$ and $T$ be $x_O(p_T, p_O) = \beta_2 - \beta_1 p_O^\theta + \beta_3 p_T$
and $x_T(p_T, p_O) = \beta_4 - \beta_5 p_T^\theta + \beta_6 p_O$, where aggregate market demand, $x$, is the sum of the two
individual demand functions, so $x = x_O + x_T$. We assume that the competitive prices are stable at
the optimal levels, such that the third term in each seller’s demand function is constant.

Combining constants yields new $y$-intercepts and the corresponding demand functions:

$$
x_O(p_O) = \beta_0 - \beta_1 p_O^\theta \quad \text{and} \quad x_T(p_T) = \beta_7 - \beta_5 p_T^\theta.
$$

(1), (2)

The base demand and steepness parameters $\beta_7$ and $\beta_5$ for transparent seller $T$ can be
expressed in terms of the parameters of seller $O$, as follows: $\beta_7 = \alpha_0 \beta_0$ and $\beta_5 = \beta_1/\alpha_1$.

Substituting these into (2) results in

$$
x_T(p_T) = \alpha_0 \beta_0 \frac{\beta_1}{\alpha_1} p_T^\theta.
$$

(3)

Parameters $\alpha_0$ and $\alpha_1$ characterize the relative impact of market transparency on consumers’
willingness-to-pay. If there is no impact, then $\alpha_0 = 1$ and $\alpha_1 = 1$. On the other hand, if market
transparency decreases willingness-to-pay, 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, so $\alpha_0 < 1$ and $\alpha_1 < 1$. (See Figure 3). Similarly, if market transparency
increases willingness-to-pay, we will see the opposite effects for each scenario.

Let the profit function be $\pi(p, x, C) = p^* x(p) - C(x)$, where $C(x)$ is the cost function and
the marginal cost is given by $C'(x) = c$. We specifically assume that the marginal cost $c$ is
Figure 3. Characterization of Demand for Transparent and Opaque Sellers

Note: In a market with Internet-enabled, heterogeneous transparency strategies, if market transparency affects willingness-to-pay, demand functions will differ among sellers. In particular, market transparency may affect the base demand, the price elasticity of demand, or both. This figure depicts the case where market transparency decreases the base demand but increases the price elasticity.

constant among technologically advanced sellers despite their heterogeneous market transparency levels. This is a reasonable assumption because in B2C electronic markets, decisions to reveal or conceal information generally do not imply significant variable costs. Changes to the selling mechanism can be usually implemented as a one-time fixed cost to re-design an Internet website or a user interface. Under this assumption, the following proposition summarizes the model’s core result:

**Proposition 1 (The Price-Transparency Strategy Proposition):** Sellers should link pricing strategy to transparency strategy in order to maximize profits. If market transparency decreases (increases) willingness-to-pay, the price of the transparent seller should be lower (higher) than that of the opaque seller.

**Proof:** The profit maximization equations for the transparent and opaque sellers are given by

\[ \alpha_0 \alpha_1 \beta_0 = \beta_1 p_T^* \left[ 1 + \theta \left( 1 - c / p_T^* \right) \right] \text{ and } \beta_0 = \beta_1 p_O^* \left[ 1 + \theta \left( 1 - c / p_O^* \right) \right]. \]  
(See Mathematical Appendix).

Dividing the first equation by the second equation leads to

\[ \alpha_0 \alpha_1 = \left( \frac{p_T^*}{p_O^*} \right) \left( \frac{1 + \theta \left( 1 - c / p_T^* \right)}{1 + \theta \left( 1 - c / p_O^* \right)} \right). \]  
(4)

Recall that if market transparency does not affect willingness-to-pay, then \( \alpha_0 = 1 \) and \( \alpha_1 = 1 \). On
the other hand, if market transparency decreases willingness-to-pay, then \( \alpha_0 < 1 \) or \( \alpha_1 < 1 \).

Therefore, \( \alpha_0 \alpha_1 < 1 \). From (4) it follows that \( p_T^* < p_O^* \), so the transparent seller should discount its price relative to the opaque seller to maximize profits. Likewise, if market transparency increases willingness-to-pay, \( \alpha_0 \alpha_1 > 1 \), and therefore \( p_T^* > p_O^* \), so the transparent seller should have a price premium relative to the opaque seller to maximize profits.

### B. Revenue Model

If the goal is to maximize revenue, \( R \), the objective function is \( R(p, x) = p^* x(p) \). Solving the revenue maximization problem for both Internet-based sellers yields optimal prices

\[
p_O^* = \left( \frac{\beta_0}{(\theta+1)\beta_1} \right)^{1/\theta} \quad \text{and} \quad p_T^* = \left( \frac{\alpha_0 \alpha_1 \beta_0}{(\theta+1)\beta_1} \right)^{1/\theta}.
\]

(5), (6)

(See Math Appendix). The ratio of these optimal prices is \( P^* = \frac{p_T^*}{p_O^*} = (\alpha_0 \alpha_1)^{\theta/\theta} \).

Notice that this price ratio also results from substituting \( c = 0 \) in (4). Therefore, these results from the revenue model characterize the instance of the profit model where marginal costs of production are close to zero. In addition, (7) suggests that the price ratio depends on the shape of the demand function defined by the curvature parameter \( \theta \). The lower is \( \theta \) (i.e., the more convex or less concave is the demand function), the higher should be the price differential between sellers \( O \) and \( T \) in order to maximize revenue. (See Figure 4.)

### C. An Enhanced Revenue Model: Practical Guidelines

The results from the profit and revenue models provide directional guidelines for Internet-based sellers to price depending on the relative transparency level of their market mechanisms. However, the magnitude of the optimal price difference between sellers is difficult to derive, because it depends on prior knowledge of the impact of market transparency on willingness-to-
Figure 4. Market Transparency and Prices under Concave, Convex, and Linear Demand

\[ x(p) \]

\[ \theta > 1 \]

\[ \theta = 0 \]

\[ \theta < 1 \]

Note: This figure depicts three demand curves with different values of \( \theta \). The parameter \( \theta \) is the curvature of the demand function \( x(p) = \lambda_0 - \lambda_1 p^\theta \). The function is concave if \( \theta > 1 \), linear if \( \theta = 1 \), and convex if \( \theta < 1 \). Based on (7), the lower is \( \theta \), the higher should be the price differential between Internet-based sellers with different transparency levels to maximize revenue.

Pay, in terms of \( \alpha_0 \) and \( \alpha_1 \). In particular, an estimate or knowledge of the demand function of competitors would be necessary. We will next enhance the model by deriving optimal prices in terms of market share information, which is more commonly available.

To begin, we let \( M = x_T/x_O \) be the market share ratio of the transparent and opaque sellers \( T \) and \( O \). The representation of market shares as a ratio has the advantage of measuring in a simple one-to-one context how one seller does versus the other, while avoiding the need to presume any \textit{a priori} knowledge about the attributes that determine consumers’ choices (Bastell and Polking, 1985). This proposition describes an optimal market share ratio:

**Proposition 2 (The Market Share-Base Demand Proposition):** The optimal market share ratio between two sellers with heterogeneous transparency strategies is equal to the base demand ratio, thus \( M^* = \alpha_0 \).

**Proof.** Substituting the demand equations (1) and (3) for sellers \( O \) and \( T \) into \( M = x_T/x_O \) yields the equality \( \beta_0(\alpha_1M - \alpha_0\alpha_1) - \beta_1(\alpha_1M_{p_O}^\theta - p_T^\theta) = 0 \). By substituting the optimal prices \( p_O^* \) and \( p_T^* \) from (5) and (6) into this equation, it follows that \( M^* = \alpha_0 \). (See Math Appendix.)

The Market Share-Base Demand Proposition suggests that the effect of market transparency on the base demand can be observed in the relative market shares \textit{if} the prices are optimal. On
the other hand, if relative prices are not optimal, this equality will not hold. The intuition is that by selecting a position in the market transparency space, sellers are indirectly setting the market potential or base demand for their product. Through price competition, a seller can pursue more market share than the one dictated by its base demand, but this attempt will be sub-optimal. The following corollary formally links relative market shares to relative prices.

**Corollary 2 (The Optimal Market Share Ratio):** The optimal price ratio is a function of the market share ratio.

**Proof.** Substituting $M^* = \alpha_o$ in (7) results in $P^* = \frac{P^*}{P_o} = \left(M^* \alpha_1\right)^{1/\theta}$.

(8)

The Optimal Market Share Ratio corollary suggests that if sellers can observe each others’ market shares, they can determine whether their relative price and transparency strategies are optimal or whether they should be modified to maximize revenue.

Moreover, with knowledge about the impact of market transparency on willingness-to-pay, more specific guidelines can be derived based on observed market shares. We next characterize three possible scenarios. In one scenario, we assume transparency impacts the liquidity of market exchange. In the second scenario, we explore the impact of transparency on the price discovery process. Finally, the third scenario combines these two effects of market transparency.

**Case 1: The Base Demand Scenario**

By attracting or deterring consumers, market transparency may influence market liquidity. For example, an electronic mechanism that displays more product variants may attract a larger set of heterogeneous consumers, thus increasing liquidity. This, in turn, should lead to a higher base level of demand. (See Figure 5.)

The positions of Orbitz and Travelocity in the market transparency space provide an illustrative comparison. (See Figure 1 again.) Both websites offer a wide range of travel offers...
Figure 5. Characterization of Demand in the Base Demand Effect Scenario

Note: This figure depicts a scenario where product transparency increases the base demand but does not affect the price elasticity of demand.

for a specific itinerary, with the respective prices. Therefore, they both are located in a similar price transparency position. However, Orbitz uses a matrix display mechanism, which results in a higher level of product transparency relative to Travelocity. Therefore, while the sensitivity to prices in both websites may be similar, the demand base in Orbitz may be higher due to its higher level of product transparency. Under this scenario, the following proposition summarizes the implications for relative prices and market shares.

**Proposition 3 (The Base Demand Effect Proposition):** If two sellers price at different levels of market transparency to maximize revenue, their market share ratio will be equal to the $\theta^{th}$ power of the price ratio.

**Proof.** Let $P_{BD}^*$ be the optimal price ratio under the base demand effect. If market transparency only affects the base demand, $\alpha_1 = 1$. Substituting $\alpha_1$ in (8) leads to $P_{BD}^* \theta = M^*$. In this base demand scenario, market share information and an estimate of $\theta$ will be sufficient for an Internet-based seller to assess whether the relative prices and transparency strategies are optimal. For example, if seller $T$ (e.g., Orbitz) observes $P^\theta > M$ relative to seller $O$ (e.g., Travelocity), then it is overcharging and it should either lower its price or increase its transparency level to maximize revenue.
Notice that for a linear demand function, \( \theta = 1 \) and \( P_{BD}^* = M^* \), so the optimal price ratio and the optimal market share ratio are equal. This result leads to the following corollary:

**Corollary 3 (The Linear Demand Market Share Ratio):** In the presence of linear demand, the optimal price ratio will be equal to the optimal market share ratio.

The *Linear Demand Market Share Ratio* corollary suggests that if relative shares are not equal to relative prices, prices or transparency levels should be adjusted to maximize revenue.

**Case 2: The Price Elasticity Scenario**

In some situations, market transparency may have an impact on the price discovery process, rather than on market liquidity. Innovative market mechanisms observed in Internet markets are a case in point. For example, both Hotwire and Priceline.com targeted price-conscious consumers through their opaque market mechanisms, which offer little information about the travel itinerary or the carrier (albeit at promotional prices). However, though Hotwire posts one or two low promotional prices, Priceline.com’s opaque market mechanism is based on a silent auction structure. The likely effect is that, due to higher price transparency, Hotwire’s mechanism may reduce the price elasticity of demand, while the target market may be the same. (See Figure 6).

**Figure 6. Characterization of Demand in the Price Elasticity Effect Scenario**

\[ x(p) \]

\[ \beta_0 \]

\[ x_T \]

\[ x_O \]

\[ p \]

**Note:** This figure depicts a scenario where price transparency decreases the price elasticity of demand but does not affect the base demand.
In this scenario, the following proposition characterizes optimal prices and market shares:

**Proposition 4 (The Price Elasticity Effect Proposition):** If two sellers price at different levels of market transparency to maximize revenue, their market shares will be equal.

**Proof.** If market transparency only affects the relative price elasticities, \( \alpha_0 = 1 \). Recall that \( M^* = \alpha_0 \), which implies that \( M^* = 1 \). The Price Elasticity Effect Proposition suggests that the two Internet-based sellers should price such that they have equal shares of the market. For example, if seller \( T \) (e.g., Hotwire) observes that its market share is lower than that of seller \( O \) (e.g., Priceline.com) such that \( M < 1 \), then it is overcharging and it should either lower its price or increase its transparency level to maximize revenue.

**Case 3: The Mixed Effect Scenario**

If the relative transparency levels differ significantly between two sellers, the effect of market transparency is likely on both the base demand and the price elasticity of demand. (See Figure 3.) This mixed effect is well illustrated by a comparison of traditional offline brick-and-mortar sales versus online Internet-based sales. For example, while transparent OTAs provide multiple offers for a traveler’s search request, traditional travel agencies typically offer just a few options, resulting in significantly different positions in the market transparency space in both price and product transparency dimensions. (See Figure 1 again.) The following proposition summarizes the implications for optimal prices and market shares:

**Proposition 5 (The Mixed Effects Proposition):** If two sellers price at different levels of market transparency to maximize revenue, the price differential will be higher compared to that of the base demand scenario.

**Proof.** Let \( P_{ME}^* \) be the optimal price ratio under mixed effects. In this scenario, (8) holds so

\[
P_{ME}^* = M^* \alpha_1.
\]

Recall that \( P_{BD}^* = M^* \). If market transparency decreases willingness-to-pay,
\( \alpha_i < 1 \), so \( P_{ME}^* < P_{BD}^* \). If market transparency increases willingness-to-pay, \( \alpha_i > 1 \), so \( P_{ME}^* > P_{BD}^* \).

The Mixed Effects Proposition suggests that if seller \( T \) (e.g., Orbitz, Travelocity, Expedia) observes \( P^o > M \) relative to seller \( O \) (e.g., a traditional travel agency), then it is overcharging. Seller \( T \) should either lower its price to a level lower than what it would discount in the base demand scenario, or increase the level of transparency to a level higher than it would in the base demand scenario. In other words, the effect on both the customer base and price elasticity compounds the price difference necessary for both sellers to maximize revenue.

**IV. DISCUSSION**

We have shown how sellers should strategize in the presence of IT-enabled heterogeneous transparency strategies in B2C electronic markets. The core proposition from the model is that if consumers value market transparency, differentiation strategies through information disclosure or non-disclosure must be followed by respective price adjustments. This result is made evident by the nature of transparency differentiation strategies: marginal production costs are generally constant across different transparency strategies. There may be one-time development costs to make a selling mechanism more or less transparent, but otherwise the variable costs of revealing or concealing private information are usually not significant.

Our analysis provides guidelines for Internet-based sellers to price depending on the level of transparency strategy of their selling mechanisms. The results suggest that there are several factors that firms must consider as they adopt a price-transparency strategy. First, knowledge about the impact of market transparency on willingness-to-pay is important, because it determines whether the relationship between relative prices and transparency levels is positive or negative. Different determinants of market transparency may have different effects, and the more knowledge there is about these effects, the more effective the guidelines will be.
Second, the domain-specific economic objective, decision making process, and industry profile should be considered. The specific guidelines of the *Price-Transparency Strategy Proposition* vary depending on whether the objective is to maximize profits or revenue. On the other hand, the results of the revenue model can be applied to tactical decisions of industries with perishable goods or fixed capacity, where marginal production costs do not play a significant role in tactical pricing decisions. The revenue model also applies to information goods that have low costs of replication. More generally, if marginal costs of production are negligible (i.e., $c \leq 0$) the guidelines of the revenue model can be applied.

Third, knowledge about the demand function may lead to higher precision in the adoption of profit or revenue maximizing strategies. For example, knowledge of the curvature of the demand function (e.g., concave vs. convex) can help sellers to better estimate the optimal price-transparency strategies. Nevertheless, the model provides enhanced guidelines where knowledge about market shares can be used to determine whether price-transparency strategies are optimal. In the next section, we apply these market share-based guidelines to evaluate transparency strategies in the air travel industry, using a large database of airline tickets.

**V. ANALYSIS OF TRANSPARENCY STRATEGIES IN AIR TRAVEL**

Since the advent of the Internet in the 1990s, new transparency strategies emerged in the U.S. air travel industry. Through sites like Expedia, Travelocity, and Orbitz, consumers can explore numerous options for travel, compared to just a few when searching by phone via traditional sales channels such as travel agencies and airline reservation offices. How should airlines price in online versus offline distribution channels, given their different levels of market transparency and the overall increase in market transparency potential offered by OTAs? In this section, we answer this question by analyzing a large sample of airline ticket sales. Based on our analytical
model, we expect to see different price levels in the online and offline channels. We use the model’s guidelines to evaluate the relative price levels between these two channels. Tactical pricing decisions in air travel are usually based on an existing route plan, so in this context the main objective is to maximize revenue for a given fixed capacity. Therefore, in this analysis we use the guidelines from the revenue model.

We analyzed transparency strategies in the air travel industry using a database of airline tickets sold by travel agencies through global distribution systems (GDSs), for travel between September, 2003 and August, 2004. The database contains a sample of economy class tickets sold in 210 U.S. point-of-sale city pairs, aggregated by agency type and the destination. The agency type is online if the ticket is sold by an OTA, and offline otherwise. The destination regions sampled were domestic U.S. and Europe. We further classified the tickets based on weekday versus weekend travel, peak or off-peak season, and time of purchase prior to travel.

The original sample contained information for 4.21 million tickets. Assuming that during peak season tickets sold reflect supply rather than demand patterns due to capacity constraints, we excluded high season observations from this study. Also, we excluded the opaque websites Priceline and Hotwire.com. These exclusions reduced the sample to 2.75 million tickets.

The average one-way price of tickets sold offline was $242, compared to $142 for tickets sold online. As the Price-Transparency Strategy Proposition suggests, prices in the two channels should differ to account for the difference in their transparency levels. In order to determine whether these relative prices are profit maximizing, we first estimated the demand function.

We used the demand model specification  \( x_{ij} = \beta_0 + \beta_1 w + \beta_2 o + \beta_3 p^\theta + \varepsilon \), where \( x_{ij} \) represents tickets sold by agency type \( i \) to region \( j \), \( w \) is a dummy variable for weekday or weekend travel (0 for weekday and 1 for weekend), \( o \) is a dummy variable for online or offline
sales (0 for offline and 1 for online), \( t \) is the time of purchase measured in weeks before departure (from 0 to 50 weeks), \( p \) is the price paid, and \( \varepsilon \) is the error term. This model is analogous to the demand function \( x(p) = \lambda_0 - \lambda_1 p^\phi \) in our analytical model, where \( \beta_0 + \beta_1 w + \beta_2 o \) is an estimate of the base demand \( \lambda_0 \), and \( \beta_3 t^\phi \) is an estimate of \( -\lambda_1 \).

We used STATA 8.0 (www.stata.com) to run iterative non-linear least squares (NLS) regressions until a converging best fit was found. The resulting model had a 77% adjusted \( R^2 \)-square, and all the variables were significant at the \( p = 0.001 \) level. The estimated model is

\[
\hat{x}_y = 1.07 \times 10^7 + 109,091w - 159,504o - 1.02 \times 10^7 t^{0.009} p^{0.008} + e
\]  

(9)

The estimate of \( \theta \) is 0.008 (std. error = 0.0007, \( p = 0.001 \)), which suggests the air travel demand curve is convex. (See Figure 7). With this estimate we can assess prices in the online and offline air travel channels. We report standard errors and significance levels for all variables above.

**Figure 7. Air Travel Fitted Demand Curve, Economy Class, Low Season**

Note: The fitted curve uses mean values for \( w, o, \) and \( t \). Data points are tickets sold in $20 price intervals.

**A. Base Demand Analysis**

The estimate of the coefficient for the dummy variable \( o \) was -159,504 (std. error=5,853,
p=0.001), which suggests that in the more transparent online channel the demand base is lower than in the offline channel. To evaluate the relative price levels, let us assume initially that the base demand scenario applies, where market transparency decreases the base demand but does not affect price elasticity. Referring to the Base Demand Effect Proposition, if relative prices are optimal, \( P^{\star} = \left( \frac{P^\text{online}}{P^\text{offline}} \right)^{\theta} = M^{\star} \). The mean estimate of \( P^{\theta} = (142 / 242)^{0.008} = 0.996 \), and the observed market share ratio is \( M = 0.28 \), so \( P^{\theta} > M \). Therefore, there is revenue opportunity, either by raising offline prices, or by lowering online prices until the equality \( P^{\theta} = M \) holds.

**B. Price Elasticity Analysis**

We performed an analysis that assesses price elasticities by channel, and conclude that the OTA channel has a higher price elasticity compared to traditional travel agencies. We estimated the price elasticity by channel using the log-linear demand specification, \( x_i = A t^{\phi} p_i^{\eta} \), where \( \eta \) is the price elasticity. Applying the log transformation results in a linear equation, where the coefficient of \( \ln(p_i) \) is the estimate of price elasticity \( \eta \).

The 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, estimation based on a seemingly unrelated regression (SUR) model is warranted. On the other hand, because the explanatory variables are the same for each equation, the SUR model and separate OLS regressions are econometric equivalents in terms of their information properties. The adjusted \( R \)-square for the offline and online OLS regressions were 92% and 86%, respectively. The highest variance inflation factors were 1.9 and 2.3, which are less than the threshold value of 20 that could signal multicollinearity (Belsley, et al., 1980; Kennedy, 1998). The offline and online price elasticity estimates were 2.4 and 4.1, respectively. In addition, we
performed a Wald test for the null hypothesis, $H_0: \eta_{\text{offline}} = \eta_{\text{online}}$ (Greene, 2002). The hypothesis was rejected at the $p = 0.03$ level. Thus, we conclude that demand in the online channel exhibits higher price elasticity than the offline channel.

The *Price Elasticity Effect Proposition* suggests that if market transparency only affects the price elasticity, then the market shares should be the same in both channels if prices are set optimally. However, the observed market share ratio is 0.28. Therefore, analogous to the result in the base demand scenario, this analysis suggests that relative prices are not optimal, and there is revenue opportunity by raising offline prices or decreasing online prices.

**C. Mixed Effects Analysis**

Based on the base demand and price elasticity analysis, we conclude that demand for transparent OTAs consists of a lower base demand and a higher price elasticity than the offline channel. The *Mixed Effects Proposition* suggests that offline prices should be raised even higher or online prices lowered even further than in the base demand scenario to maximize revenue.

Our results indicate that price differentiation may not be producing the managerially-desirable outcomes that are expected in the online air travel channel. Moreover, the offline channel may be sub-optimally cannibalizing travelers from the online channel—if price alone is considered as the key strategy variable. Based on our analysis, we would encourage air travel managers to raise their offline prices or reduce their Internet prices in order to maximize revenue. More generally, the directional guidelines of our model and the empirical results suggest that there is an opportunity to enhance cross-channel prices and transparency strategies in air travel.

**VI. CONCLUSIONS**

In the presence of advanced e-commerce technologies, Internet-based sellers face strategic issues related to the development of technology that determine market presence, positioning, and
competition. Our analytical model supports these decisions by offering guidance to the economic soundness of transparency strategies in B2C electronic commerce. Our approach aims at alleviating the inherent complexity of market transparency, which is influenced by multiple determinants and valued differently among consumers. The model that we developed is based on the impact of transparency strategies on the economic behavior of consumers, and on the relative rather than the absolute value that consumers place on different levels of market transparency. Our modeling approach and empirical analysis echoes the recent call for IS research that examines the role that IT plays in changing markets and that supports managerial decisions in markets that are in transition to equilibrium (Clemons and Weber, 2002).

We evaluated the offline and online price and transparency strategies in the air travel industry. While we conclude that there are revenue opportunities based on the normative guidelines of the model, we recognize that other factors may account for the observed prices and shares of offline and online sales. For example, the lower base demand in online channels may be partially driven by the level of Internet penetration in the origin cities of the tickets sampled. On the other hand, the analysis of price elasticities provides additional empirical support for the need to price differentiate online and offline air travel channels. Regardless, our analysis shows the value of the normative guidelines derived from our analytical model and the insights it can provide for market strategists in their effort to correctly set prices in a technological environment that allows multiple transparency levels.

There is a need to further research the influence of both product and price transparency on consumers’ willingness-to-pay in Internet-based selling. Our model is based on general related assumptions (i.e., market transparency decreases or increases willingness-to-pay), but through additional modeling efforts and experimental methods, the economic behavior of consumers in
the presence of specific product and price information can be assessed, which will further inform
normative strategies for price-setting by firms under different market transparency levels.

REFERENCES


Mathematical Appendix

The Profit Maximization Procedure. First we solve the profit maximization problem for seller $T$. The profit function is $\pi_T(p_T, x_T, C_T) = p_T x_T - C_T(x_T) = p_T \alpha_0 \beta_0 - \frac{\beta_1}{\alpha_1} p_T^{\theta+1} - C_T(x_T)$.

Solving for optimal price yields the following expression:

$$0 = \alpha_0 \alpha_1 \beta_0 - \theta \beta_1 p_T^\theta - \beta_1 p_T^\theta \alpha_0 \alpha_1 \beta_0 - \beta_1 p_T^\theta (\theta + 1 - c \theta / p_T^*).$$

Rearranging terms leads to $\alpha_0 \alpha_1 \beta_0 = \beta_1 p_T^* \left[ 1 + \theta \left( 1 - c / p_T^* \right) \right]$. Similarly, for seller $T$, $\beta_0 = \beta_1 p_O^* \left[ 1 + \theta \left( 1 - c / p_O^* \right) \right]$.

The Revenue Maximization Procedure. First we solve the revenue maximization problem for seller $T$. The revenue function is $R_T(p_T, x_T) = p_T x_T = p_T \alpha_0 \beta_0 - \frac{\beta_1}{\alpha_1} p_T^{\theta+1}$.

Solving for the optimal price yields $0 = \alpha_0 \alpha_1 \beta_0 - (\theta + 1) \beta_1 p_T^\theta$. Rearranging terms leads to the optimal price $p_T^* = \left( \frac{\alpha_0 \alpha_1 \beta_0}{(\theta + 1) \beta_1} \right)^{\frac{1}{\theta}}$. Similarly, for seller $T$, $p_O^* = \left( \frac{\beta_0}{(\theta + 1) \beta_1} \right)^{\frac{1}{\theta}}$.

Proof of the Optimal Market Share Ratio Proposition. Let $M = x_T / x_O$ be the market share ratio of sellers $T$ and $O$. Substituting the demand functions yields $M = \frac{\alpha_0 \beta_0 - \frac{\beta_1}{\alpha_1} p_T^\theta}{\beta_0 - \beta_1 p_O^\theta}$.

Rearranging terms leads to $\alpha_1 \beta_0 (M - \alpha_0) - \beta_1 (\alpha_1 M p_O^\theta - p_T^\theta) = 0$.

Substituting the optimum prices and rearranging terms results in

$$\alpha_1 \beta_0 (M^\star - \alpha_0) - \beta_1 \left( \frac{\beta_0}{(\theta + 1) \beta_1} - \frac{\alpha_0 \alpha_1 \beta_0}{(\theta + 1) \beta_1} \right) = M^\star - \alpha_0 - M^\star - \alpha_0 = 0.$$

Therefore, $M^\star = \alpha_0$. 