MARKET TRANSPARENCY AND MULTI-CHANNEL STRATEGY: MODELING AND EMPIRICAL ANALYSIS OF ONLINE TRAVEL AGENTS

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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 the 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 or brick-and-mortar channel. We develop an economic model of a monopolist that can set heterogeneous transparency levels and price discriminate across distribution channels. The model provides normative guidelines for firms to set relative transparency levels and prices in order to maximize profits. We empirically evaluate pricing and market transparency strategy in the U.S. air travel industry 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: E-commerce, Internet-based selling, market transparency, multi-channel strategy, pricing, online travel agencies.

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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 losing information advantages (Tapscott and Ticoll, 2003).

Additional strategic questions arise for brick-and-mortar firms that also distribute their products in e-commerce channels such as the Internet. A representative case occurred in the air travel industry. 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. Other OTAs have since changed their market mechanisms to try and match the level of transparency of Orbitz (Granados, et al., 2006). However, not all strategies have been towards higher levels of market transparency. Major U.S. airlines also introduced Hotwire, an OTA with an opaque market mechanism that offers less information about the product and the carrier, albeit at discounted prices. (See Figure 1.) Meanwhile, traditional travel agencies continue to play a significant role in the sale of airline tickets.

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
Figure 1. U.S. Airline Transparency Strategy: A Transparent and an Opaque Mechanism

Note: This figure contains screenshots of two OTAs launched by major airlines. Orbitz was launched in 2001. It is a transparent selling mechanism that shows multiple options and prices from different airlines in the first screen, with the use of a matrix display. In addition, details about each offer are available by scrolling down. For this example, 169 travel options were offered. Hotwire was launched in 2000. It has an opaque mechanism with one or two clearance fares, and the airline name and itinerary are only shown after a purchase is completed.

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, others must respond with sound pricing and transparency strategies. Some relevant questions to ask are: How does IT-enabled 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 *multi-channel transparency strategy*, building on the work of existing marketing and IS research (Zettelmeyer, 2000; Riggins, 2004), which suggests that firms have an opportunity to strategize at the channel level to take advantage of consumer heterogeneity. In line with observations of real-world Internet-based strategies, we assume that firms innovate to attract consumers with novel selling mechanisms and that a market is in transition to equilibrium as firms seek differentiation in the presence of diverse information endowments and IT capabilities. Therefore, multiple channels may exist with different transparency levels. We model the impact of market transparency on consumers’ economic behavior in terms of demand shifts across channels and in terms of changes in the price elasticity of demand. The results broadly suggest that if the degree of information disclosure to consumers affects their economic behavior, relative prices should be adjusted accordingly. We then derive the relative prices and transparency levels that a firm should adopt across channels to maximize profits.

One advantage of our modeling approach is that it can be empirically tested. We evaluate the multi-channel transparency strategy of U.S. airlines using a large set of airline ticket data. This empirical analysis not only provides insights regarding strategy in the airline industry, but it also illustrates how the model and its guidelines can be applied to other industries.
The rest of this paper is organized as follows. In the next section, we provide a conceptualization of market transparency and multi-channel strategy, and describe recent related developments in the air travel industry. 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. MARKET TRANSPARENCY IN B2C ELECTRONIC MARKETS

To provide a foundation for a model of transparency strategy, we first conceptualize market transparency based on relevant finance, marketing and economics literature. We then summarize existing literature on multi-channel strategy. Finally, we characterize market transparency developments in the air travel industry since the advent of the Internet.

A. What is Market Transparency?

We define market transparency as the level of availability and accessibility of market information. In B2C electronic markets, market transparency is composed of several elements: price transparency, product transparency, supplier transparency, and availability transparency.\(^1\) We will focus on just two, product and price transparency. Price transparency exists when market prices and related information are made available, such as quotes and transaction prices. Product transparency (also called characteristics transparency) exists when the characteristics of the product are made available, including quality information. A more transparent market will

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\(^1\) Availability transparency refers to the extent to which inventory information on the seller’s side is available to potential buyers. Supplier transparency refers to identifying the identity of the supplier. This information may be valuable to the consumers in several ways. For example, Sinha (2000) suggests that the Internet often allows consumers to ascertain sellers’ costs, which allows them to negotiate or stand firm on lower bids, effectively reducing market prices.
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 price 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. In B2C electronic markets, while price transparency generally attracts consumers, it may deter sellers that may see their pricing strategies or cost structure exposed (Zhu, 2002). *Price discovery* is the process by which market prices are established. In B2C markets, price discovery enables consumers to ascertain their willingness-to-pay. Price transparency plays a role in this process by reducing uncertainty about trading prices.

**Product Transparency.** Marketing research offers valuable insights to conceptualize product transparency. Consumer behavior researchers have found evidence that consumers may view a product with suspicion upon the absence of information about a salient attribute. For example, Johnson and Levin (1985) observed lower product ratings when the appropriate product information in a purchase process was missing. Table 1 lists determinants of product

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

<table>
<thead>
<tr>
<th>PRODUCT CHARACTERISTICS</th>
<th>CONSUMER OBJECTIVES</th>
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<tbody>
<tr>
<td></td>
<td>Maximize</td>
</tr>
<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).

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. 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. The more digital are the characteristics of a product—up to the point where the product becomes a pure information good, the higher is the potential for product transparency in an electronic market setting. For example, airline tickets are information-based products that can be described electronically better than tangible goods, such as food or clothes, or intangible goods, such as tax consulting services or home repair services. Conversely, the greater the extent of *non-digital characteristics* such as intangible or experience-based features, the higher is the potential for transparency in traditional brick-and-mortar channels, where physical inspection or live demonstrations are possible.

**B. Multi-channel Strategy and IT-Enabled Market Transparency**

A single channel used to be how companies reached out to their customers. Today, thanks to e-commerce technologies, firms are increasingly using multiple distribution channels, including
traditional brick-and-mortar channels and the Internet. The behavior of consumers in a multi-channel environment is diverse (Balasubramanian, et al., 2005). *Single channel shoppers* continue to use a conventional channel or they may shift completely to a new one, while *multi-channel shoppers* use multiple channels at one stage or at different stages of the purchase process. Firms are increasingly recognizing the need to have a presence in multiple channels to satisfy this diversity in shopping behavior by implementing *multi-channel strategies*.

There are technological factors that influence the ability of firms to implement an effective multi-channel strategy (Cappielo, et al., 2003). But given the diversity of behavior by consumers in multi-channel purchases, there are different possible approaches. One approach is to serve multi-channel shoppers by making the multi-channel shopping experience as seamless and integrated as possible. Through this approach, a seller synchronizes product offerings across channels and reengineers the organization for that purpose. In addition, an integrated systems architecture is necessary to effectively manage customer relationships (Sawhney, 2001). However, there is an emerging strategic perspective that suggests firms can profitably perform channel-based segmentation. Firms can take advantage of consumer heterogeneity to steer customers to specific channels to the benefit of the firm (Myers, et al., 2004). Riggins (2004) modeled consumer heterogeneity in terms of willingness-to-pay and access to the online channel, and found that firms can differentiate products and price discriminate across channels to maximize profits. Zettelmeyer (2000) showed that if Internet penetration is low, firms will offer lower prices and provide more information to consumers in the online channel. We embrace the latter approach to examine the benefits for firms that strategically select information to disclose to consumers in different channels.

Prior to the advent of e-commerce technologies, sellers were restricted in their ability to
disclose information to consumers, or their transparency potential. 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 particular, they can develop electronic markets with a desired level of market transparency, or join existing ones. In other words, firms compete by selecting a market transparency tuple, [Product Information Available, Price Information Available] in the space of possible distribution alternatives. For example, U.S. airlines have adopted different combinations of product and price transparency by implementing IT-enabled, innovative selling mechanisms, by offering their tickets via existing electronic markets, and by maintaining distribution through offline channels (i.e., traditional travel agencies. (See Figure 2.)

**Figure 2. U.S. Airline Multi-Channel Market Transparency Space**

![U.S. Airline Multi-Channel Market Transparency Space](image)

**Note:** In this graphic market transparency space, we depict the points at or below the transparency potential where the main air travel distribution channels were located as of 2003, based on analysis and measures by Granados, et al. (2005a, 2005b). Since then, Priceline.com and Hotwire have significantly changed their strategies (see dotted arrows) to position themselves at product and price transparency levels that compete with the industry leaders Orbitz, Expedia, and Travelocity.
At the high end of product and price transparency is Orbitz, (www.orbitz.com), an OTA launched in 2001 by U.S. major airlines, which claimed that it is the most transparent air travel Web site. Orbitz uses top-of-the-art technology to price and display more itineraries than other OTAs, and it uses preferred agreements with other airlines and travel agencies to offer the lowest prices in the market (Granados, et al., 2006). Airlines also offer tickets through other transparent OTAs such as Expedia (www.expedia.com) and Travelocity (www.travelocity.com). Meanwhile, traditional travel agencies continue to play a significant role in the distribution of airline tickets, despite increased competition by OTAs. In this channel, although product information is readily available by phone or fax, there is a limit to the number of priced itineraries that can be offered. On the other hand, in 2000 U.S. airlines introduced an opaque Web site called Hotwire (www.hotwire.com), with a selling mechanism that targets price-sensitive customers by concealing product information for one or two priced itineraries until the transaction has been completed. Airlines also participate in other opaque Web sites such as Priceline.com (www.priceline.com), which has a patented “name-your-own-price” mechanism. Through this mechanism, consumers electronically submit a contract-binding bid with no prior details on the airline, itinerary, or market price of the airline ticket that may be awarded.

E-commerce technologies added complexity to multi-channel distribution strategy. Suppliers such as airlines can sell products through channels with different levels of transparency, and consumers will differ in their valuation of information regarding products and prices. In the next section, we present an innovative way of modeling this problem that alleviates its inherent complexity. We then derive normative guidelines that firms can use to make decisions in a multi-channel environment with heterogeneous IT capabilities and transparency levels.
III. A MODEL OF MULTI-CHANNEL TRANSPARENCY STRATEGY

In this section, we present a model of transparency choice for sales distribution, where markets are in a state of flux as firms seek out differentiation strategies based on their information endowments and IT capabilities. This scenario, typical in the Internet era, arises in the presence of continuous technological innovation that leads to novel selling mechanisms, so 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, we assume that a seller has the technological ability to reveal or conceal information in conjunction with price-setting. This set of choices to establish prices and transparency levels by channel constitutes a multi-channel transparency strategy. We model the typical profit-maximizing and revenue-maximizing choices that a seller faces in a market where distribution channels with different transparency levels co-exist in a medium or short-term horizon.

A. Model Setup – Impact of Market Transparency on Consumer Demand

Consider a market with one monopolist that sells one good through two distribution channels, with total demand 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 \( \theta > 1 \).

Suppose the two channels exhibit different transparency levels. Channel \( T \) has a high-transparency mechanism to sell the good, while Channel \( O \) has a low-transparency or opaque
mechanism. If consumers value market transparency, their willingness-to-pay may differ by channel. We assume that the impact of market transparency on willingness-to-pay is reflected in the base demand $\lambda_0$ or the price elasticity of demand, which is a function of $\lambda_1$. Let the respective demand functions for channels $O$ 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 prices are fixed and set at the optimal level in both channels, such that the third term in each channel’s demand function is constant. Combining constants yields new $y$-intercepts and the corresponding demand functions:

$$x_O(p_O) = \beta_0 - \beta_1 p_O^\theta$$

and

$$x_T(p_T) = \beta_7 - \beta_5 p_T^\theta.$$  

(4), (5)

The base demands $\beta_0$ and $\beta_7$ are composed of single-channel shoppers for channels $O$ and $T$ respectively, and multi-channel shoppers that prefer each channel based on the relative transparency levels and prices.

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

Substituting these into Equation 5 results in

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

(6)

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 $\alpha_i < 1$, and (3) base demand decreases and
price elasticity increases, so $\alpha_0 < 1$ and $\alpha_1 < 1$. (See Figure 3).

**Figure 3. Characterization of Demand for Transparent and Opaque Channels**

![Diagram](image)

**Note:** In a market with heterogeneous transparency strategies across channels, if market transparency affects willingness-to-pay, individual demand functions may differ. In particular, market transparency may affect the base demand, the price elasticity of demand, or both. This figure depicts the case where the base demand for the transparent channel ($x_T$) is lower than that of the opaque channel ($x_O$), while its price elasticity is higher.

**B. Profit Maximization**

Let the profit function be

$$\pi(p_T, p_O, x_T, x_O, C) = p_T x_T(p_T) + p_O x_O(p_O) - C(x_T) - C(x_O),$$

where $C(x_i)$ is the cost function per channel. In a medium or short-term horizon, it is reasonable to assume that marginal costs are constant, so we denote $C'(x_T) = c_T$, and $C'(x_O) = c_O$. We also assume that marginal costs in the transparent channel are lower, either because it is more technologically advanced so distribution costs are lower (Riggins, 2004), or because the costs of facilitating consumer search are lower (Zettelmeyer, 2000). Therefore, $c_T < c_O$. Under these assumptions, the firm should price discriminate across distribution channels as follows:

**Proposition 1 (The Transparency Strategy Proposition):** The transparent channel should have a lower price than the opaque channel to maximize profits.

**Proof:** The profit maximizing prices for the transparent and opaque channels are given by

$$\alpha_0 \alpha_1 \beta_0 = \beta_1 p_T^{*} \left[1 + \theta \left(1 - c_T / p_T^{*} \right) \right] \quad \text{and} \quad \beta_0 = \beta_1 p_o^{*} \left[1 + \theta \left(1 - c_o / p_o^{*} \right) \right].$$

(See Mathematical Appendix). Dividing the first equation by the second equation leads to
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 Equation 7, it follows that $p_T^* < p_O^*$, so the transparent channel should have a lower price relative to the opaque channel to maximize profits.

The Transparency Strategy Proposition suggests that if the degree of information disclosure to consumers affects their economic behavior, prices should be adjusted accordingly to maximize profits. This result is valid when search costs or distribution costs are lower in the more transparent channel, which applies to many real-world comparative scenarios such as Internet vs. traditional channels, or transparent vs. opaque Internet-based selling mechanisms (e.g., Orbitz vs. GDS-based OTAs). This proposition is analogous to the notion of price discrimination in the presence of different product quality levels, but in this case differentiation occurs in the market transparency dimension rather than in the quality dimension.

### C. Revenue Maximization

If the goal is to maximize revenue, $R$, the objective function, is represented by the equation $R(p_T, p_O, x_T, x_O) = p_T x_T(p_T) + p_O x_O(p_O)$. The revenue maximizing prices are

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

(See the Mathematical Appendix for additional information.) The ratio of these optimal prices is

\[
P^* = \frac{p_T^*}{p_O^*} = \left( \frac{\alpha_0 \alpha_1}{\alpha_0 \alpha_1} \right)^{1/\theta},
\]

which we call the **optimal price ratio equation**.
Notice that this price ratio also results from substituting $e_i = 0$ in (7). Therefore, this result from the revenue model characterizes the instance of the profit model where marginal costs of production are close to zero, which applies to short-term decision scenarios with fixed production capacity, and to markets for information goods. In addition, the optimal price ratio equation 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 channels $O$ and $T$ in order to maximize revenue. (See Figure 4.)

**Figure 4. Market Transparency and Prices under Concave, Convex, and Linear Demand**

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

Note: This figure depicts three demand curves with different values of $\theta$. The parameter $\theta$ characterizes the curvature of the demand function. The function is concave if $\theta > 1$, linear if $\theta = 1$, and convex if $\theta < 1$. Based on (10), the lower is $\theta$, the higher should be the price differential between channels with different transparency levels to maximize revenue.

**D. An Enhanced Revenue Model: Practical Guidelines**

The profit and revenue models so far provide a theoretical optimal relationship between transparency levels and prices across channels. However, the magnitude of the optimal price difference between channels is difficult to derive, because it depends on prior knowledge of the impact of market transparency on willingness-to-pay, in terms of $\alpha_0$ and $\alpha_1$. In particular, an estimate or knowledge of the demand function for all channels would be necessary. We will next enhance the model by deriving optimal prices in terms of information about sales by channel, which is more commonly available.
To begin, let $S = x_T / x_O$ be the channel share ratio of the transparent and opaque channels $T$ and $O$. The representation of channel shares as a ratio has the advantage of measuring in a simple one-to-one context how one channel 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). The following proposition characterizes the optimal channel share ratio in terms of the relative transparency levels across channels:

**Proposition 2 (The Channel Share-Base Demand Proposition):** The optimal channel share ratio between two channels with heterogeneous transparency levels is equal to the base demand ratio, thus $S^* = \alpha_o$.

**Proof.** Substituting the demand equations (4) and (6) for channels $O$ and $T$ into $S = x_T / x_O$ yields the equality $\beta_o (\alpha_i S - \alpha_o \alpha_i) - \beta_T (\alpha_i S \theta_o - \theta_T \theta_o) = 0$. By substituting the optimal prices $p_o^*$ and $p_T^*$ from (8) and (9) into this equation, it follows that $S^* = \alpha_o$. (See Math Appendix.)

The Channel Share-Base Demand Proposition suggests that the effect of market transparency on the base demand can be observed in the historical sales across channels 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, channels are indirectly setting the market potential or base demand for their product. Through price competition, a supplier can pursue more market share than the one dictated by the base demand of its distribution channels, but this attempt will be sub-optimal. The following corollary formally links channel shares to their respective prices.

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

**Proof.** Substituting $S^* = \alpha_o$ in (10) results in $P^* = \frac{p_T^*}{p_o^*} = (S^* \alpha_i)^{\theta_o}$. \hfill (11)

The Optimal Channel Share Ratio corollary suggests that by tracking sales by channel, a supplier
can determine whether the relative price and transparency levels across channels 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 channel 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 lowers search costs for promotional prices may shift the range of consumers’ reservation prices downwards. This, in turn, should lead to a lower base level of demand. (See Figure 5.)

**Figure 5. Characterization of Demand in the Base Demand Effect Scenario**

![Figure 5](image)

**Note:** This figure depicts a scenario where market transparency affects the base demand but not the price elasticity of demand.

The positions in the market transparency space of transparent OTAs such as Expedia and offline travel agencies provide an illustrative comparison. (See Figure 2 again.) Both channels provide similar levels of product transparency, but transparent OTAs provide many more priced offers per search request, to the direct benefit of all consumers. Under this scenario, the
following proposition summarizes the implications for relative prices and channel shares.

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

**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 (10) leads to $P^*_{BD} = S^\theta$.

In this base demand scenario, channel share information and an estimate of $\theta$ will be sufficient for a seller to assess whether the relative prices and transparency strategies are optimal. For example, if the seller observes $P^\theta > S$, then the multi-channel transparency strategy is sub-optimal and the seller 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 for a linear demand function, $\theta = 1$ and hence $P^*_{BD} = S^\theta$, so the optimal price ratio and the optimal channel share ratio are equal. This result leads to the following corollary:

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

**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 mechanism. The likely effect is that, due to higher price transparency, Hotwire’s
mechanism may have a lower 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**

![Graph](attachment:figure6.png)

**Note:** This figure depicts a scenario where price transparency affects the price elasticity of demand but not the base demand.

In this scenario, the following proposition characterizes optimal prices and market shares:

**Proposition 4 (The Price Elasticity Effect Proposition):** *If the seller sets prices by channel to maximize revenue, both channels will have an equal share of sales.*

**Proof.** If market transparency only affects the relative price elasticities, \( \alpha_o = 1 \). Recall that \( S^* = \alpha_o \). Therefore, \( S^* = 1 \).

The *Price Elasticity Effect Proposition* suggests that the firm should price such that both channels have equal share of sales. For example, if the firm observes that channel \( T \) has a lower share than channel \( O \) such that \( S < 1 \), then it should decrease the transparency differential or increase the price differential between the two channels to maximize revenue.

**Case 3: The Mixed Effect Scenario**

If the relative transparency levels differ significantly between two channels, the effect of market transparency is likely on both the base demand and the price elasticity of demand. (See Figure 3 again.) This mixed effect is well illustrated by a comparison of opaque OTAs such as Hotwire and transparent OTAs such as Orbitz. While transparent OTAs provide multiple offers
for a traveler’s search request, Hotwire typically offers just a few priced options with little product information, resulting in significantly different positions in the market transparency space in both price and product transparency dimensions. (See Figure 2 again.) The following proposition summarizes the implications for optimal prices and channel shares:

**Proposition 5 (The Mixed Effects Proposition):** If the seller sets prices by channel to maximize revenue, the price differential between channels 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, (11) holds so $P^*_{ME} = S^* \alpha_1$. Recall that $P^*_{BD} = S^*$. Since market transparency decreases willingness-to-pay, $\alpha_1 < 1$, so $P^*_{ME} < P^*_{BD}$.

The Mixed Effects Proposition suggests that the mixed effect of market transparency 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. For example, if the seller observes $P^*_{BD} > S$, then it should decrease the transparency differential or increase the price differential across channels to a level higher than it would in the base demand scenario.

**IV. DISCUSSION**

We have shown how sellers should strategize in the presence of IT-enabled distribution channels where transparency levels by channel are heterogeneous. Our core proposition, the Transparency Strategy Proposition, suggests that prices should be linked to the transparency level of each distribution channel. This proposition supports existing models of multi-channel strategy which suggest that firms can strategize across channels to their benefit by revealing or concealing market information in coordination with price-setting. The broad result that the more
transparent channel should be priced lower than the opaque channel is analogous to the finding of Zettelmeyer (2000) for the Internet vs. the conventional channel. However, a key contribution from our analysis is that, by modeling consumer behavior in terms of consumer demand shifts or changes in the price elasticity of demand, we derive practical guidelines that firms can follow in order to implement multi-channel transparency strategy. Next, we discuss these guidelines in more detail.

The results suggest that there are several factors that firms must consider as they adopt a multi-channel transparency strategy. (See Table 2.) First, the domain-specific economic objective, decision making process, and industry profile should be considered. The specific guidelines for multi-channel transparency strategy vary depending on whether the objective is to maximize profits or revenues. 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 are negligible (i.e., \( c \cong 0 \)) the guidelines of the revenue model can be applied.

Second, 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., the value of \( \theta \)) can help sellers to better estimate the optimal multi-channel transparency strategy.

Third, 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
### Table 2. Multi-Channel Transparency Strategy Guidelines

<table>
<thead>
<tr>
<th>MODEL TYPE</th>
<th>ASSUMPTION OR CONDITION</th>
<th>KEY RESULT</th>
<th>STRATEGY GUIDELINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit Model</td>
<td>Market transparency decreases WTP, so $\alpha_o &lt; 1$ or $\alpha_i &lt; 1$, $c_i &lt; c_o$</td>
<td>$\alpha_o\alpha_i = \left(\frac{p_i}{p_o}\right)^\theta \frac{1+\theta(1-c_i/p_i)}{1+\theta(1-c_o/p_o)}$</td>
<td>Price relative to the level of market transparency (this applies for all cases below).</td>
</tr>
<tr>
<td>Revenue Model</td>
<td>$c_i = 0$</td>
<td>$\left(\frac{p_i}{p_o}\right)^\theta = \alpha_o\alpha_i$</td>
<td>Price and set transparency levels taking into account the convexity or concavity (i.e., $\theta$) of the demand function.</td>
</tr>
<tr>
<td>Revenue Model with channel share-based guidelines</td>
<td>Base demand scenario: $\alpha_i = 1$. Linear demand: $\theta = 1$</td>
<td>$\left(\frac{p_i}{p_o}\right)^\theta = \frac{x_i}{x_o}$</td>
<td>Price and set transparency levels such that the price ratio is equal to the $\theta^{th}$ root of channel share ratio.</td>
</tr>
<tr>
<td></td>
<td>Price elasticity scenario: $\alpha_o = 1$.</td>
<td>$S^* = 1$</td>
<td>Price and set transparency level such that channel shares equate.</td>
</tr>
<tr>
<td></td>
<td>Mixed effect scenario: $\alpha_o, \alpha_i &lt; 1$</td>
<td>$\left(\frac{p_i}{p_o}\right)^\theta = S^*\alpha_i$</td>
<td>Opaque channel should be priced higher (or its transparency level set lower) than in base demand scenario.</td>
</tr>
</tbody>
</table>

**Note:** The results in this table assume that market transparency decreases willingness-to-pay (WTP).

These guidelines will be. Nevertheless, the model provides guidelines where knowledge about historical sales by channel can be used to determine whether transparency strategies are optimal. These guidelines are particularly useful because a firm can diagnose whether its multi-channel transparency strategy is sub-optimal, and the directional corrective actions that need to be taken.

In the next section, we apply these channel share-based guidelines to evaluate online vs. offline transparency strategy in the air travel industry, using a large data set of airline tickets.

### V. ANALYSIS OF MULTI-CHANNEL TRANSPARENCY STRATEGY 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 the multi-channel transparency strategy 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 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 peak or off-peak season (peak season is June-August and December 15-January 15), 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 peak season observations from this study. Also, we excluded the opaque Web sites 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 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 optimal, we first estimated the demand function, based on the following econometric specification of demand:

$$ x_{ij} = \beta_0 + \beta_1 \cdot \text{ONLINE}_{ij} + \beta_2 \cdot \text{ADVPURCH}_{ij} \cdot \theta \cdot \text{PRICE}_{ij} + \epsilon, $$

where $x_{ij}$ represents tickets sold by agency type $i$ to region $j$, $\text{ONLINE}_{ij}$ is a dummy variable for online or offline sales (0 for offline and 1 for online), $\text{ADVPURCH}_{ij}$ is the time of purchase measured in weeks before departure (from 0 to 30 weeks), $\text{PRICE}_{ij}$ is the average price paid, and $\epsilon$ is the error term. This model is analogous to the demand function $x(p) = \lambda_0 - \lambda_1 p^\theta$ in the analytical model, where $\beta_0 + \beta_2 \cdot \text{ONLINE}_{ij}$ is an estimate of the base demand $\lambda_0$, and $\beta_3 \cdot \text{ADVPURCH}_{ij} \cdot \theta$ 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 model converged on the 592nd iteration with a 77% $R^2$, and all the variables were significant at $p < 0.001$. The resulting model is:

$$ \hat{x}_{ij} = 2.76 \cdot 10^7 - 421,420 \cdot \text{ONLINE}_{ij} - 2.57 \cdot 10^7 \cdot \text{ADVPURCH}_{ij} \cdot 0.001 \cdot \text{PRICE}_{ij} \cdot 0.001 + \epsilon \quad (13) $$

<table>
<thead>
<tr>
<th>Std. Err.</th>
<th>2.9*10^6</th>
<th>22,868</th>
<th>2.7*10^6</th>
<th>0.001</th>
<th>0.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p$</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)(0.001)</td>
<td></td>
</tr>
</tbody>
</table>

$\hat{\beta}_1$, the coefficient estimate of $\text{ONLINE}$, is -421,420 (std. error = 22,868, $p = 0.001$), which suggests that base demand for OTAs is lower than in the offline channel. However, this result cannot be fully attributed to transparency, because $\text{ONLINE}$ also incorporates all other channel-specific effects such as quality of service and channel maturity. Nevertheless, in the following analysis, we are able to use historical sales by channel and guidelines from the model to assess whether air travel transparency strategy is optimal across distribution channels.
‘To begin, recall that knowledge of \( \theta \) is necessary to apply the guidelines from the revenue model. The estimate of \( \theta \) in the air travel demand model is 0.009 (std. error = 0.001, \( p < 0.001 \)), which suggests the air travel demand curve is convex. (See Figure 7).

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

![Graph showing fitted demand curve](image)

**Note:** The fitted curve uses mean values for ONLINE and ADVPURCH. Data points are tickets sold in $20 price intervals.

### A. Base Demand Analysis

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,

\[
P^* = \left( \frac{P^\text{online}}{P^\text{offline}} \right)^{\theta} = S^* \cdot \theta \]

The mean estimate of \( P^\theta = (143 / 248)^{0.009} = 0.995 \), and the observed channel share ratio is \( S = 0.28 \), so \( P^\theta > S \). This inequality suggests that online vs. offline 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 ONLINE, 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 we
conclude that airline multi-channel transparency strategy is sub-optimal and that there is revenue opportunity by attracting more customers to the online channel. From a pricing perspective, airlines can either raise offline prices, or lower online prices until the equality $P^o = S$ holds. Alternatively, airlines can further decrease the transparency level of their Internet-based selling mechanisms to shift consumers from the offline to the online channel.

B. Price Elasticity Analysis

We performed an analysis to examine 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

$$x_i = \beta_o * ADVPURCH^i PRICE_i^{-\eta},$$

where $\beta_o$ is a constant, $\eta$ is the price elasticity, and $i \in \{\text{online, offline}\}$. By applying a log-transformation of (12) we obtain a linear specification where the negative of the coefficient of $\ln(PRICE_i)$ 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. We ran OLS regressions for the online and offline channels. Results are shown in Table 3.

The online and offline price elasticity estimates were 3.69 and 1.43, respectively. We performed a Wald test for the null hypothesis, $\eta_{\text{offline}} = \eta_{\text{online}}$ (Greene, 2002). The hypothesis was rejected at the $p = 0.01$ level. Thus, we conclude that demand in the online
Table 3. Regression Results for Online and Traditional Travel Agencies

<table>
<thead>
<tr>
<th>Variables</th>
<th>Online</th>
<th></th>
<th></th>
<th>Offline</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std. Error</td>
<td>Coefficient</td>
<td>Std. Error</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRICE</td>
<td>-3.69***</td>
<td>0.21</td>
<td>-1.43***</td>
<td>0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADVPURCH</td>
<td>-2.25***</td>
<td>0.11</td>
<td>-2.24***</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONS</td>
<td>30.17***</td>
<td>1.25</td>
<td>22.20***</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.88</td>
<td></td>
<td>0.89</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $N_{online} = 120$, $N_{offline} = 60$. The significance levels for the coefficients are * = $p < 0.05$, ** = $p < 0.01$, and *** = $p < 0.001$. We performed regression diagnostics tests with satisfactory results for non-linearity, multicollinearity, heteroskedasticity and the normality of the distribution of the residuals.

channel exhibits higher price elasticity than the offline channel.

The Price Elasticity Effect Proposition suggests that if market transparency only affects price elasticity of demand, then sales should be equal in both channels if prices are set optimally. However, the adjusted channel share ratio is $S = 0.45$. 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, decreasing online prices, or decreasing the transparency differential between these two channels until their sales are equal.

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. Given this mixed effect of transparency on consumers, the Mixed Effects Proposition suggests that airlines should decrease the transparency differential 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.

More generally, our results indicate that price differentiation may not be producing the managerially-desirable outcomes that are expected in air travel multi-channel strategy. The
offline channel may be sub-optimally cannibalizing travelers from the online channel—if price and transparency alone are considered as the key strategy variables. Based on our analysis, we would encourage air travel managers to raise their offline prices, reduce their Internet prices, or decrease the transparency level of the online channel in order to increase revenues.

VI. CONCLUSIONS

In the presence of advanced e-commerce technologies, sellers face strategic issues related to the development of technology that determine market presence, positioning, and information disclosure in multiple distribution channels. Our analytical model supports these decisions by offering guidance to the economic soundness of multi-channel transparency strategy in B2C electronic commerce. The analytical approach is based on the relative rather than the absolute value that consumers place on different levels of market transparency, which alleviates the inherent complexity in assessing the impact of market transparency on consumers in order to develop an optimal multi-channel strategy. The resulting guidelines for managers are based on a diagnosis of historical sales information by channel, which is commonly available to firms.

This 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 consumers may switch to a different channel, and other consumers may not switch, although they may 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 they can price-discriminate by channel, and where technological capabilities allow them to set transparency levels by channel.

Our modeling approach and empirical analysis echo 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 perpetual transition to equilibrium (Clemons and Weber, 2002). Our results are based on reasonably general assumptions regarding the impact of market transparency on willingness-to-pay. The empirical analysis of the air travel industry shows how the guidelines can be used to assess whether a multi-channel transparency strategy is optimal, despite no prior knowledge of the impact of transparency is on demand. Nevertheless, empirical research is underway to examine the influence of product and price transparency on consumer demand, which will inform this model and the corresponding guidelines.

REFERENCES


**MATHEMATICAL APPENDIX**

In this Mathematical Appendix, we provide additional background on our profit and revenue maximization procedures, as well as a proof for the Optimal Channel Share Ratio Proposition.

**The Profit Maximization Procedure.** The profit function is

\[ \pi(p_T, p_o, x_T, x_o, C) = p_T x_T (p_T) + p_o x_o (p_o) - C(x_T) - C(x_o) \]

\[ = p_T \alpha_0 \beta_0 - \frac{\beta_1}{\alpha_1} p_T^{(\theta+1)} + p_o \beta_0 - \frac{\beta_1}{\alpha_1} p_o^{(\theta+1)} - C(x_T) - C(x_o). \]

Solving the optimal price for transparent channel \( T \) yields the following expression:
\[ 0 = \alpha_0 \alpha_1 \beta_0 - \theta \beta_1 p_0^* \beta_1 + \beta_0 p_0^* \theta + c_0 \theta p_0^* \] \( \theta + 1 - c_0 \theta / p_0^* \). Rearranging terms leads to \( \alpha_0 \alpha_1 \beta_0 = \beta_1 p_0^* [1 + \theta (1 - c_0 / p_0^*)] \). Similarly, for channel \( O \), \( \beta_0 = \beta_1 p_0^* [1 + \theta (1 - c_0 / p_0^*)] \).

**The Revenue Maximization Procedure.** The revenue function is

\[
\pi(p_T, p_O, x_T, x_O) = p_T x_T(p_T) + p_O x_O(p_O) = p_T \alpha_0 \beta_0 - \beta_1 \alpha_1 p_T^* \theta p_0^* \theta + p_0^* \beta_0 = \beta_1 \alpha_1 p_o^* \theta \]

Solving for the optimal price of the transparent channel \( T \) yields the following expression:

\[ 0 = \alpha_0 \alpha_1 \beta_0 - (\theta + 1) \beta_1 p_T^* \]. 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 channel \( O \), \( p_O^* = \left( \frac{\beta_0}{(\theta + 1) \beta_1} \right)^{\frac{1}{\theta}} \).

**Proof of the Optimal Channel Share Ratio Proposition.** Let \( S = x_T / x_O \) be the channel share ratio. Substituting the demand functions yields \( S = \frac{\alpha_0 \beta_0 - \beta_1 p_T^* \beta_1}{\beta_0 - \beta_1 p_0^*} \). Rearranging terms leads to

\[ \alpha_0 \beta_0 (S - \alpha_0) - \beta_1 (\alpha_0 S p_0^* \theta - p_T^*) = 0 \]. Substituting the optimal prices and rearranging terms results in

\[ \alpha_0 \beta_0 (S^* - \alpha_0) - \beta_1 \left( \alpha_0 S^* \frac{\beta_0}{(\theta + 1) \beta_1} - \frac{\alpha_0 \alpha_1 \beta_0}{(\theta + 1) \beta_1} \right) = S^* - \alpha_0 = \frac{S^* - \alpha_0}{\theta + 1} = 0 \]. Therefore, \( S^* = \alpha_0 \).