ONLINE AND OFFLINE DEMAND AND PRICE ELASTICITIES: EVIDENCE FROM THE AIR TRAVEL INDUSTRY

Nelson Granados
Assistant Professor of Information Systems
Pepperdine University
nelson.granados@pepperdine.edu

Alok Gupta
Carlson Professor and Chair
Information and Decision Sciences
University of Minnesota
agupta@csom.umn.edu

Robert J. Kauffman
W. P. Carey Chair in Information Systems
W.P. Carey School of Business
Arizona State University
rkauffman@asu.edu

Last revised: August 18, 2009

ABSTRACT

The Internet has brought consumers increased access to information to make purchase decisions. One of the consequences is an increase in the *price elasticity* of demand, or the percent change in demand due to a percent change in price, because consumers are better able to compare offerings from multiple suppliers. In this paper, we analyze the impact of the Internet on demand, by comparing the demand functions in the Internet and traditional air travel channels. We use a data set that contains information for millions of records or airline ticket sales in both offline and online channels. To our knowledge, this is the first study that uses massive sales data to compare consumer demand functions in the two channels. The results suggest that consumer demand in the Internet channel is more price-elastic for both transparent and opaque online travel agencies. We discuss the broader implications for multi-channel pricing strategy and for the transparency-based design of online selling mechanisms.

Keywords: Air travel industry, market transparency, price elasticity, online travel agencies.

1. INTRODUCTION

Classic economic theory suggests that higher availability of information brings markets closer to perfect competition and full market efficiency. In particular, with the proliferation of Internet-based markets, there is an expectation that *frictionless commerce* will emerge, where perfect information about product offers and prices online will lead to higher competition and a subsequent erosion of profits (Brynjolfsson and Smith, 2000). This outcome is likely to manifest itself in two ways:

- Suppliers will engage in price competition and lose their ability to price above marginal costs, leading to lower, less dispersed prices (Bakos, 1997; Brynjolfsson and Smith, 2000).
- Buyers enjoy lower search costs so they are able to make purchases that better fit their needs at a lower price (Bakos, 1997), further fueling competition among suppliers.

Since the advent of the Internet, academics have given a lot of attention to the former, by seeking to understand the impact of the Internet on market prices, and by taking advantage of the massive amounts of price information that can be found online. But there is still much research to be done on the latter. Understanding how the Internet impacts consumer demand will provide additional insights on the dynamics of competition in an environment where consumers enjoy better access to market information.

One of the expected impacts of the Internet on demand is an increase in consumers' sensitivity to prices, due to the increased availability of information about competitive offerings (Lynch and Ariely, 2000; Smith, 2002; Smith, et al., 2001). If indeed there is a higher sensitivity to price changes online, competition will intensify, which may lead to lower margins in the long run. We contribute to this line of research by estimating and comparing the industry's demand functions in the offline and online channels, using a data set with information for millions of airline tickets sold in the U.S. market. In our dataset, the *offline channel* represents phone-based or face-to-face reservations via traditional travel agencies, while the *online channel* is related to consumer-direct bookings via online travel agencies (OTAs) such as Expedia and Travelocity. The broad research questions that we examine are:

- What are the differences in price elasticity of demand between the offline and online channels? What factors drive these differences?
- What are the implications for pricing, multi-channel strategy, and IT strategy?

Our empirical results provide a new perspective on how the Internet channel leads to less friction by bringing markets closer to perfect information. This is one of the first studies that uses massive industry sales data to estimate price elasticities in the offline and online channels. We have used sales data to estimate price elasticities, which is a more direct method than the multiple studies that estimate online price elasticity based on sales rank (e.g., Brynjolffson, et al., 2003; Chevalier and Goolsbee, 2003; Ellison and Ellison, 2007; Ghose, et al., 2006). We find broad support for the notion that the Internet as a distribution channel is more competitive, based on our findings that price elasticity is higher for *transparent online travel agencies* (OTAs) and *opaque* OTAs relative to the traditional or *offline* travel agency channel.

2. HYPOTHESES, DATA, AND MODELING PRELIMINARIES

One of the tenets of frictionless markets suggests that *price elasticity*, the percent change in demand due to a percent change in price, will be higher online than offline, on the basis that the Internet allows consumers to search for information about competitive offerings at a lower cost (Smith, et al., 2001; Alba, et al, 1997) (henceforth referred to as the *frictionless markets hypothesis*). To test this broad proposition empirically, we must first e break down the multiple possible effects of information on price elasticity, which we categorize as *direct* and *indirect* effects. Direct effects are related to a decrease in search costs for information. Indirect effects are related to the impact of market information on purchase decisions.

A. Direct Effects

The Internet reduces the cost of searching for alternative offerings prior to purchase. An example is the emergence of shopbots that perform searches across Internet sites to display, and compare product and price information from different suppliers (Smith, 2002). Indeed, travelers are able to construct larger consideration sets while searching online (Oorni, 2003). In addition, search engines such as Google and Bing play an increasingly important role in Internet shopping.

Buyers are likely to benefit directly from this reduction in search costs, even if the amount of inquiries in the search increases (Bakos, 1997). There is some evidence that suggests consumers in the online travel sector “pocket” these search cost savings, which will in turn have a direct positive effect on demand (Johnson et al., 2004; Lynch and Ariely, 2000).

B. Indirect Effects

Once consumers have access to market information, they will in turn use it to the extent that it is a valuable input in the purchase process. The *indirect effects* on demand of better informed consumers can be broken down into the impact of information on the purchase decision and on channel selection. In this paper, we examine the impact of product and price information, since these are the main informational elements that differ across offline travel agencies and OTAs.

Price Information. Stigler (1961) suggests that in an environment of price dispersion, *information about market prices* allows consumers to find lower prices. This higher ability to effectively compare prices for similar product offers should increase price elasticity, because consumers have a larger consideration set to choose from, or a larger number of substitutes (Brons, et al., 2002).

This rationale implies that for highly differentiated markets, the impact of price comparison capability on price elasticity will not be as high as for commodity markets, because product attributes and brand dilute the weight of the price factor in the decision making process (Degeratu, et al., 2000).

Product Information. Increased *information about product characteristics and quality* allows consumers to ascertain their valuation of a product with higher precision and find a product that better fits their needs (Akerlof, 1970; Alba, et al., 1997). Other things being equal, product information is likely to lower price elasticity, as consumers focus their search on product characteristics and quality rather than on price. This assertion is founded on *information integration theory* (Degeratu, et al., 2000), which suggests that consumers assign importance weights and values to available search attributes and then add them to make a purchase decision. Weights will not be assigned to information that is not available, so if product and brand information is not available, more weight will be placed on the price factor.

Product information is likely to reduce price elasticity more in markets with differentiated products, because as consumers are better able to identify products that fit their needs, they will discard other options, effectively limiting the consideration set to the one or few offerings that best fit their needs.

Channel Selection. The information availability about product offers will also influence *channel se-*

lection. Different service features and information levels lead to partially-separable demand sets in the online and offline channels, or the existence of *offline-only shoppers* and *online-only shoppers*. Also, since lower search costs do not necessarily lead to more search (Johnson et al., 2004), some consumers may be locked-in to an online or offline search process that has served them well in the past.

The existence of single-channel shoppers can lead to a difference in the mix of customer segments across channels. Any difference in this mix of customers can at least partially explain differences in price elasticities across channels. In the case of air travel, we can characterize this problem in terms of the mix of business and leisure travelers. Many business travelers have access to or prefer the service of a corporate travel agency so they are offline-only shoppers, while leisure travelers may prefer the availability of offers that the online channel offers.

Summary. The improvements in the availability of market information on the Internet lower search costs, which has a positive direct effect on demand. There are also three possible indirect effects on price elasticity of demand. Price comparison capabilities will increase price elasticity, product information will decrease price elasticity, and price-sensitive consumers will select a channel that offers easier comparison of product offerings and prices. The net change in price elasticity due to price and product information will depend on the individual impacts and the degree of differentiation of the product. For highly differentiated products, the impact of product information may even lead to a decrease in price elasticity.

C. Hypotheses

We formally define *price elasticity* as $\eta = \frac{\delta D}{\delta P} \cdot \frac{P}{D}$, or the percent change in demand D due to a one percent change in price P. Demand decreases if price increases for normal goods such as travel, so η will be negative. If $|\eta| > 1$, demand is said to be elastic, because there is a higher proportional increase in demand due to a change in price. If $|\eta| = 1$, demand is unit-elastic. If $|\eta| < 1$, demand is inelastic. We define $\eta_{TRANSPARENT}$ = price elasticity of transparent OTAs, $\eta_{OFFLINE}$ = price elasticity of the offline channel, and η_{OPAQUE} = price elasticity of the opaque OTAs

Offline vs. Transparent OTAs. The OTA industry has made both price and product information available to travelers. Depending on the OTA, the number of priced itineraries for a search request can fluctuate, but most OTAs display numerous priced itineraries that travelers can choose from (Granados et al., 2007). In 2006, Travelocity, Expedia and Orbitz had approximately 80% market share among all OTAs in the U.S., and these sites typically provide at least 50 search results for a given search request.

Our theoretical review suggests that product and price information represent opposite forces on price elasticity of demand. The frictionless markets hypothesis suggests that the net effect will be a higher price elasticity, such that the effect of price information prevails. This leads to:

- **Hypothesis 1a (The Leisure Segment Transparent OTA Price Elasticity Hypothesis).** *In the leisure segment, demand for transparent OTAs is more price-elastic than offline demand.*
- **Hypothesis 1b (The Business Segment Transparent OTA Price Elasticity Hypothesis.)** *In the business segment, demand for transparent OTAs is more price-elastic than offline demand.*

Regarding channel selection, we find that there is a higher share of business travel offline than online. This makes sense because business travelers are more time-sensitive and likely to delegate the search task to an offline travel agency. In contrast, leisure travelers are more price-sensitive, so they are more likely to value and utilize online search capabilities. The higher share of leisure travelers in the online channel will lead to a higher price elasticity of demand. Based on the expected larger impact of price comparison on price elasticity and the higher share of leisure travelers online, we hypothesize that, overall, air travel demand for transparent OTAs will be more price-elastic than offline demand. This leads us to assert:

- **Hypothesis 1c (The Overall Offline vs. Online Transparent OTA Price Elasticity Hypothesis).** *Air travel demand for transparent OTAs is more price-elastic than offline demand, so that* $|\eta_{TRANSPARENT}| > |\eta_{OFFLINE}|$.

Offline vs. Opaque OTAs. Opaque OTAs such as Hotwire and Priceline.com developed an opaque strategy by providing no information on the airline name and itinerary in exchange for a discount on the price price. Offline agencies typically provide one or two price quotes over the phone or face-to-face, similar to the single price offer of an opaque site like Hotwire. On the other hand, offline travel agencies provide the airline and itinerary while opaque sites conceal them. This difference in the product information is likely to drive the difference in price elasticity of demand between these two channels. In line with information integration theory, we hypothesize that the lack of information about the airline carrier and the itinerary details will lead to a higher price elasticity for the opaque OTAs relative to the offline channel, as consumers turn their attention to price comparison shopping (Degeratu, et al, 2000). This leads to:

- **Hypothesis 2a (The Leisure Segment Opaque OTA Price Elasticity Hypothesis).** *In the leisure segment, demand for opaque OTAs is more price-elastic than offline demand.*
- **Hypothesis 2b (The Business Segment Opaque OTA Price Elasticity Hypothesis).** *In the business segment, demand for opaque OTAs is more price-elastic than offline demand.*

Regarding channel selection, a low percentage of time-sensitive business travelers will book on the opaque channel. Indeed, in our dataset we find that 4% of business travelers that book online purchased through opaque OTAs. The consequent higher share of leisure travelers booking in the opaque channel should lead to a higher price elasticity relative to the offline channel. We hypothesize that:

- **Hypothesis 2c (The Overall Offline vs. Online Opaque OTA Price Elasticity Hypothesis).** *Demand for opaque OTAs is more price-elastic than offline demand, so* $|\eta_{OPAQUE}| > |\eta_{OFFLINE}|$.

Transparent vs. Opaque OTAs. Opaque OTAs provide at most one or two priced offerings, with no information on product characteristics. Hotwire's opaque mechanism typically provides one priced offer with no details of airline name or itinerary. Instead, transparent OTAs typically provide at least 50 priced offers with airline name and itinerary details. An inverse argument of the frictionless markets hypothesis, that less market information is likely to decrease price elasticity, suggests that the lack of information on competitive offerings will lead to a lower price elasticity for opaque OTAs. Therefore, we hypothesize that opaque OTA demand will be less price-elastic.

- **Hypothesis 3a (The Leisure Segment Opaque vs. Transparent OTA Price Elasticity Hypothesis).** *Leisure demand for opaque OTAs is less price-elastic than that of transparent OTAs.*
- **Hypothesis 3b (The Business Segment Opaque vs. Transparent OTA Price Elasticity Hypothesis).** *Business demand for opaque OTAs is less price-elastic than that of transparent OTAs.*

Regarding channel selection, there are few business travelers that buy opaque offers, and it is likely that the more price-sensitive leisure travelers are willing to use the opaque mechanisms. Therefore, price-sensitive travelers who self-select the opaque OTAs increase the price elasticity of the opaque channel.

Based on the above analysis of informational impacts and channel selection, the net effect is not straightforward. The lack of competitive offers in the opaque channel is likely to drive down price elasticity, while the self-selection of price-sensitive online customers into the opaque channel should have the opposite effect. We hypothesize that the inverse of the *frictionless markets hypothesis* will prevail, so the net result is a reduction in price elasticity. This leads to:

- **Hypothesis 3c (The Overall Opaque vs. Transparent OTA Price Elasticity of Demand Hypothesis).** *Air travel demand for opaque OTAs is less price-elastic than that of transparent OTAs, so that* $|\eta_{OPAQUE}| < |\eta_{TRANSPARENT}|$.

D. Data and Model Variables

We analyzed price elasticities in the online and offline channels at the industry level using a database of airline tickets sold by travel agencies through *global distribution systems* (GDSs) for travel between September 2003 and August 2004. The GDSs support electronic sales of airline tickets on the Internet, as well as sales via traditional travel agencies that provide the service through face-to-face or phone interactions. The database contains information for 47 U.S. origin-destination city pairs. We aggregated tickets by *city-pair* (i.e., origin city and destination city), channel, travel purpose, type of OTA, and time of purchase. Tickets were classified as *online* if they were sold by an OTA, and *offline* otherwise. The tickets were also classified by trip purpose, either business or leisure. Within the online channel, an OTA was classified as *transparent* if the search results for the OTA included the airline name and itinerary (e.g., Orbitz, Travelocity, and Expedia), and *opaque* if they did not (e.g., Priceline.com and Hotwire).

Data were available for a booking window of 20 weeks prior to departure. We further classified the tickets based on peak season (June, July, August, and December 15-January 15) or off-peak season. Because the number of peak season tickets sold reflect supply rather than demand patterns due to capacity constraints, we excluded peak season observations from this study. These exclusions reduced the sample to 5,160 records with aggregate information for 1.32 million tickets. (See Table 1.)

Table 1. Descriptive Statistics

VARIABLE	STATISTIC	LEISURE SEGMENT	BUSINESS SEGMENT
Quantity (passenger bookings)	Mean	392.68	121.42
	St. Dev.	1,318.67	679.08
	Range	1 – 35,810	1 – 10,499
Price (one-way, US$)	Mean	142.16	262.34
	St. Dev.	69.90	211.25
	Range	15 – 409	88 – 1,863

Notes: For each segment, this table contains the average of quantity and price for all city-pairs and channels throughout the 20-week booking window. *N* = 5,160.

We consider the demand model *DEMAND = f(Price, Channel, Controls)*, where *DEMAND* is estimated in terms of quantity sold, and price is the average price in dollars of the tickets sold for a given city-pair, channel, segment, and season. (See Table 2.)

Table 2. Air Travel Demand Model Variables

TYPE	VARIABLE	DEFINITION
Dependent	*QUANTITY*	Tickets sold, to represent *DEMAND.*
Main effects	*PRICE*	Average price paid in dollars.
	OFFLINE, TRANSPARENT, OPAQUE	Dummy variables for offline, transparent, and opaque OTAs.
Control	*ADVPURCH*	Time of purchase in weeks before the flight's departure.
	SEGMENT	Business vs. leisure travel dummy.
	CROSSPRICE	Price of the alternative channel.
	ORIGIN	Origin city dummy variables for city-pairs.

Price. The variable *PRICE* captures market prices across channels, segments, and city-pairs. It also captures prices throughout the booking period of a flight, which can fluctuate due to airlines' dynamic pricing practices. The pricing structures in the airline industry are based on fare types that are tied to the time of booking, such that the closer in time to departure, the higher is the price in the market.

Channel Dummy Variables. We include dummy variables *TRANSPARENT* and *OPAQUE* for the transparent and opaque OTAs respectively, to account for their fixed effects relative to *OFFLINE*.

Advance Purchase. The urgency of purchase and its impact on demand is captured in the variable *ADVPURCH*, which measures advanced purchase time in weeks before departure. The closer to departure, the higher is the demand, as the sense of urgency increases. Therefore, we should see a negative relationship between *ADVPURCH* and demand.

Segment. We include a dummy variable for leisure vs. business travel. We expect lower demand for business travel relative to leisure, considering that airlines assign fewer seats to business on flights.

Cross-Channel Prices. The variable *CROSSPRICE* captures the price of the alternative channel. *CROSSPRICE* has an opposite effect on demand than price, so its relationship with demand is positive.

Origin City Dummy Variables. We assigned eight dummy variables for the origin cities in our sample, which control for local demand drivers that are otherwise not included, such as income level effects, local travel preferences, regional competition, hub structure of the local airports, and local economy.

3. EMPIRICAL MODEL SPECIFICATION AND RESULTS

A. Model Specification, Diagnostics, and Basic Model Results

Airline demand models in the transportation literature typically use the linear and log-linear specifications (e.g., Bhadra, 2003; Oum, et al., 1993). The log-linear demand specification for this study is:

$$\ln QUANTITY = \beta_1 + \eta \ln PRICE + \beta_2 \ln TRANSPARENT + \beta_3 \ln OPAQUE + \beta_4 \ln ADVPURCH \quad (1)$$

$$\beta_5 \ln SEGMENT + \beta_6 \ln CROSSPRICE + \sum_j \sigma_j \ln ORIGIN_j + \varepsilon$$

We tested both models and the log-linear specification in Equation 1 had an adjusted R^2 = 74.7%, compared to the linear model OLS regression, which had an adjusted R^2 = 17.2%.

Multicollinearity. There is one correlation of concern between two of the regressors, *PRICE* and *CROSSPRICE,* which is 0.82. This correlation is likely due to the common practice of airlines to price homogeneously across channels through via GDSs (Chellappa and Kumar, 2005). Due to the high variance inflation factor (VIF) of *CROSSPRICE* in the OLS regression (22.03) and the low correlation between *CROSSPRICE* and *QUANTITY* (σ = 0.05, p = 0.07) we excluded *CROSSPRICE* from the regression.

Heteroskedasticity. We performed a Breusch-Pagan Lagrange multiplier test for heteroskedasticity at the level of the model, against the fitted values of ln*QUANTITY*. We rejected the hypothesis of constant variance or homoskedasticity (χ^2 =177.47, d.f. = 1, p < .01). To correct for heteroskedasticity, we estimated the regressions using the Huber-White robust estimators for the standard error.

Endogeneity. In demand models, there is a risk of endogenously-generated prices, which can lead to model misspecification due to a high correlation between prices and the residuals. We performed a generalized Hausman test for the null hypothesis that the OLS estimator is consistent, and the hypothesis was rejected (χ^2 = 162.67, d.f. = 14, p < 0.001). We addressed this endogeneity problem by performing a two-stage least squares (2SLS) regression with the following instrumental variables for *PRICE*.

- *STGLENGTH*: A city-pair's trip distance in air travel miles. This variable has been used in prior studies of airline performance, as noted by Duliba et al. (2001).
- *MKT_CONC*: The *degree of market concentration* in a specific city-pair influences market prices (Borenstein, 1992). We measured this variable using the Herfindahl index.
- *HUB*: Hub operations have been associated with higher prices in the industry, so we incorporate a *HUB* variable to indicate whether the city-pair origins and destinations are hubs of an airline.

The reduced 2SLS model without *CROSSPRICE* has an adjusted R^2 = 72.47%. (See Table 3.) The magnitudes and signs of the coefficients for the control variables are as expected.

Table 3. Air Travel Demand Model: 2SLS and OLS Regressions

VARIABLES	2SLS REDUCED MODEL: COEFFICIENT (Robust SE)	*t*	*p*	OLS REDUCED MODEL: COEFFICIENT (ROBUST SE)	*t*	*p*
• *Main Effects*						
η (*PRICE*)	-1.03***(0.08)	-12.67	0.001	-0.14***(0.04)	-3.40	0.001
β_1 (*CONSTANT*)	14.11***(0.46)	30.91	0.001	9.3***(0.25)	36.96	0.001
β_2 (*TRANSPARENT*)	-1.95***(0.06)	-34.76	0.001	-1.56***(0.05)	-34.35	0.001
β_3 (*OPAQUE*)	-4.41***(0.09)	-48.57	0.001	-3.55***(0.06)	-59.40	0.001
• *Controls*						
β_4 (*ADVPURCH*)	-1.47***(0.03)	-58.46	0.001	-1.36***(0.02)	-59.40	0.001
β_5 (*SEGMENT*)	-2.05***(0.05)	-38.92	0.001	-2.47***(0.04)	-61.47	0.001
R^2 (Adj.-R^2)	72.54% (72.47%)			74.72% (74.66%%)		

Note: N = 5,160. Models: OLS and 2SLS log-linear regressions with robust errors. Reduced model excludes *CROSSPRICE*. Significance: * = p < .10, ** = p < .05, *** = p < .01. Other control variables omitted for brevity.

B. Online and Offline Price Elasticity Comparison: Economy Class

To estimate price elasticity differences across channels econometrically, we used the following econometric specification, which breaks the power of price η into the base elasticity for the transparent OTAs and its difference with respect to the elasticity of the offline travel agencies and opaque OTAs:

$$QUANTITY = e^{\beta_1} \cdot PRICE^{\eta_{TRANSPARENT} + \lambda_1 OFFLINE + \lambda_2 OPAQUE} \cdot ADVPURCH^{\beta_4} \cdot SEGMENT^{\beta_5} \cdot \prod_j ORIGIN_j^{\sigma_j} \cdot e^{\varepsilon} \quad (2)$$

Taking the log transformation of equation 2 leads to:

$$\ln QUANTITY = \beta_1 + \eta_{TRANSPARENT} \ln PRICE + \lambda_1 \ln PRICE \cdot OFFLINE + \lambda_2 \ln PRICE \cdot OPAQUE \quad (3)$$

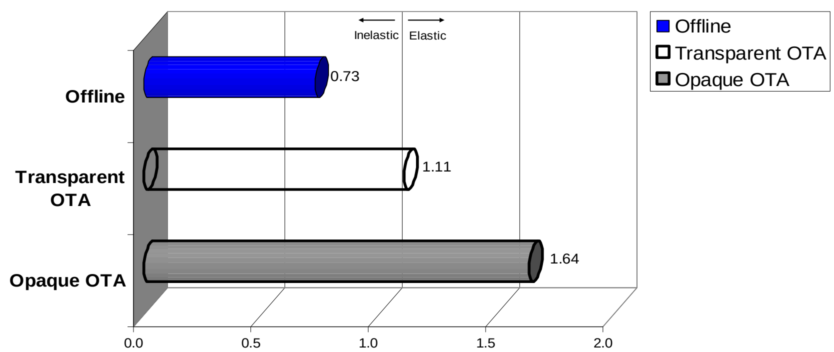
$$+\beta_4 \ln ADVPURCH + \beta_5 \ln SEGMENT + \sum_j \sigma_j \ln ORIGIN_j + \varepsilon$$

In Equation 3, $\eta_{TRANSPARENT}$ is the price elasticity of the transparent OTAs, and it is the *base elasticity*. The parameters λ_1 and λ_2 represent the price elasticity differential of *OFFLINE* and *OPAQUE* with respect to *TRANSPARENT*. See Table 4 and Fig. 1 for the results of the corresponding 2SLS regression.

Table 4. Price Elasticities by Channel: Business and Leisure Combined

VARIABLES	COEFFICIENT (Robust SE)	T	p
$\eta_{TRANSPARENT}$	-1.11***(0.08)	-13.39	0.001
λ_1 $(\eta_{OFFLINE} - \eta_{TRANSPARENT})$	0.38***(0.01)	33.76	0.001
λ_2 $(\eta_{OPAQUE} - \eta_{TRANSPARENT})$	-0.53***(0.01)	-40.92	0.001
β_1 (*CONSTANT*)	12.53***(0.43)	29.27	0.001
R^2 (Adjusted-R^2)	72.76% (72.69%)		
Note: N =5,160. 2SLS model estimation. Significance: * = p < .10, ** = p < .05, *** = p < .01. Main effects reported. Control variables omitted for brevity.			

Figure 1. Price Elasticity Comparison across Channels: Economy Class



Note: This graph depicts the relative price elasticities for the economy class cabin (business and leisure combined).

Transparent-Offline Comparison. The estimate of λ_1 is 0.38 (λ_1 = 0.38, S.E. = 0.01, p<0.01), so the price elasticity estimate of the offline channel is $\eta_{OFFLINE} = \eta_{TRANSPARENT} + \lambda_1$ = -0.73. We find support for the Overall Offline vs. Online Transparent OTA Price Elasticity Hypothesis (H1c). Demand for the transparent OTAs is more price-elastic than that of the offline channel.

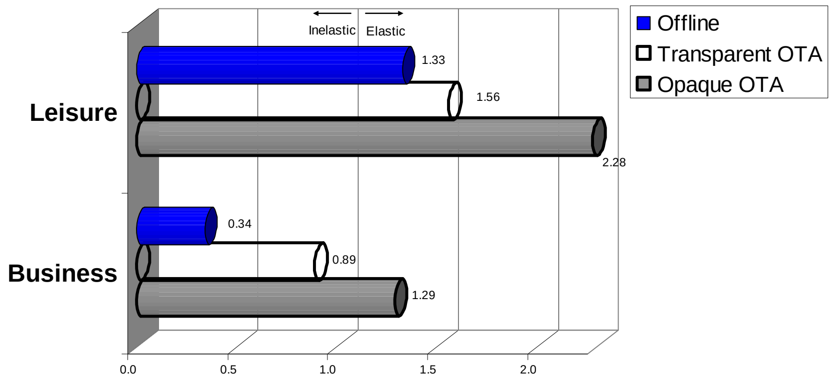
Opaque-Offline Comparison. The estimate of λ_2 or the difference between the price elasticity of the opaque OTAs channel and the transparent OTAs is -0.53 (λ_2 = -0.53, S.E. = 0.01, p < 0.01. The difference between the price elasticity of the opaque OTAs and the offline channel is $\eta_{OPAQUE} - \eta_{OFFLINE} = \lambda_2 - \lambda_1 =$ -0.91. Therefore, we find support for H2c, that the price elasticity of opaque OTAs is higher than that of the offline OTAs.

Transparent-Opaque Comparison. Since λ_2 = -0.53, the price elasticity of the opaque OTAs is higher than that of the transparent OTAs, so we reject the Overall Opaque vs. Transparent OTA Price Elasticity Hypothesis (H3c). We discuss this result further in the conclusions.

C. Price Elasticity Comparison by Segment: Leisure vs. Business

We performed price elasticity comparisons across channels by segment, by estimating price elasticities for the leisure and business segments separately, using the same methodology to break down the power of *PRICE*. (See results in Figure 2.) The directional differences in price elasticity across channels hold in relation to the Economy class cabin as a whole, with some nuances.

Figure 2. Price Elasticities by Channel and Segment



Transparent-Offline Comparison. We find support for the Leisure and Business Segment Transparent OTA Price Elasticity Hypotheses (H1a, H1b). The price elasticity of the transparent OTAs is higher than that of the offline channel in both segments (Leisure $\lambda_1 = 0.23$, S.E. = 0.01, $p < 0.01$, and Business $\lambda_1 = 0.55$, S.E. = 0.01, $p < 0.01$). The magnitude of this difference is found to be higher in the business channel, which is rather counter-intuitive. We discuss this result further in the conclusions.

Opaque-Offline Comparison. The difference between the price elasticity of the opaque OTAs and the offline channel in the leisure segment is $\eta_{OPAQUE} - \eta_{OFFLINE} = \lambda_2 - \lambda_1 = -0.95$. The analogous result for the business segment is $\eta_{OPAQUE} - \eta_{OFFLINE} = -0.95$. Therefore, we find support for the Leisure and Business Segment Opaque OTA Price Elasticity Hypotheses (H2a, H2b). The demand for opaque OTAs is more price-elastic than that of the offline channel in both the leisure and business segments.

Transparent-Opaque Comparison. We find that the price elasticity of the opaque channel is higher than that of the transparent OTAs in both segments (Leisure $\lambda_2 = -0.72$, S.E. = 0.01, $p < 0.01$, and Business $\lambda_2 = -0.40$, S.E. = -10.45, $p < 0.01$), so we reject the Leisure and Business Segment Opaque vs. Transparent OTA Price Elasticity Hypotheses (H3a, H3b).

4. CONCLUSIONS

We found that the price elasticity is higher in the OTA channel than in the offline channel, for both transparent and opaque OTAs. (See summary of results in Table 5.) Online demand is more price-elastic than offline demand for both business and leisure segments. Within the online channel, opaque OTA demand is more price-elastic than that of transparent OTAs.

A. The Frictionless Markets Hypothesis

One of the tenets of perfect competition is that, from the demand side, consumers are more sensitive to price changes due to lower search costs. The finding that transparent OTA demand is more price-elastic than offline demand is consistent with the notion that less friction in the form of lower search costs will lead to higher price elasticity of demand and hence more intense competition. We find support for this hypothesis for both commoditized and differentiated markets, represented by leisure and business travel.

Commodity Markets: The Leisure Segment. In the leisure market, U.S. airlines struggle to stay profitable, one of the signs of the Bertrand-like pricing behavior that leads to marginal cost pricing. Our confirmation of hypotheses H1a and H2a suggest that this higher level of competition is exacerbated in the online channel, where price elasticity of demand is higher for both transparent and opaque OTAs.

Intuitively, if more information about product offers leads to higher price elasticity, less information should lead to lower price elasticity. Yet we found the opposite when comparing opaque and transparent OTAs. We rejected H3a, so opaque OTAs are more price-elastic, despite providing less information about product offers. This results highlights the importance of information about product attributes. When product information is missing, consumers will become particularly sensitive to price changes, and the effect of this missing information will prevail to make demand more elastic.

Table 5. Summary of Results: Relative Price Elasticities across Channels and Segments

SEGMENT	HYPOTHESES ON RELATIVE PRICE ELASTICITIES	THEORETICAL ARGUMENTS	EMPIRICAL RESULTS
Business and Leisure	H1a, H1b: $\lvert\eta_{TRANSPARENT}\rvert > \lvert\eta_{OFFLINE}\rvert$	*Frictionless markets hypothesis*: More information leads to higher elasticity.	Supported for both business and leisure segments. $\lambda_1 = \lvert\eta_{TRANSPARENT}\rvert - \lvert\eta_{OFFLINE}\rvert > 0$
	H2a, H2b: $\lvert\eta_{OPAQUE}\rvert > \lvert\eta_{OFFLINE}\rvert$	*Information integration theory*: Less product information leads to higher elasticity.	Supported for both business and leisure segments. $\lambda_2 - \lambda_1 = \lvert\eta_{OPAQUE}\rvert - \lvert\eta_{OFFLINE}\rvert > 0$
	H3a, H3b: $\lvert\eta_{TRANSPARENT}\rvert > \lvert\eta_{OPAQUE}\rvert$	*Inverse of frictionless markets hypothesis*: Less information leads to a lower elasticity.	Rejected for both business and leisure segments. $\lambda_2 = \eta_{TRANSPARENT} - \eta_{OPAQUE} < 0$
Total – Economy Class	H1c: $\lvert\eta_{TRANSPARENT}\rvert > \lvert\eta_{OFFLINE}\rvert$	*Frictionless market hypothesis. Channel Selection*: More price-sensitive travelers buy online.	Supported. $\lambda_1 = \lvert\eta_{TRANSPARENT}\rvert - \lvert\eta_{OFFLINE}\rvert > 0$
	H2c: $\lvert\eta_{OPAQUE}\rvert > \lvert\eta_{OFFLINE}\rvert$	*Information integration theory. Channel Selection*: More price-sensitive travelers buy opaque.	Supported. $\lambda_2 - \lambda_1 = \lvert\eta_{OPAQUE}\rvert - \lvert\eta_{OFFLINE}\rvert > 0$
	H3c: $\lvert\eta_{TRANSPARENT}\rvert > \lvert\eta_{OPAQUE}\rvert$	*Inverse of frictionless market hypothesis. Channel Selection*: More price-sensitive travelers buy opaque.	Rejected. $\lambda_2 = \lvert\eta_{TRANSPARENT}\rvert - \lvert\eta_{OPAQUE}\rvert < 0$

Differentiated Markets: The Business Segment. In the business segment, we find that transparent OTA demand is more price-elastic than offline demand (found support for H1b and H2b). Therefore, our results are consistent with the frictionless markets hypothesis not just for commodity products like leisure travel, but also for differentiated markets like business travel. The higher price elasticity that we find online for business travel is in contrast with Degeratu, et al. (2000) and Lynch and Ariely (2000), who found that price sensitivity was lower online for groceries and premium wines.

We also found that the elasticity differential of 0.55 between transparent OTAs and the offline channel in the business segment is higher in magnitude than the analogous 0.38 differential for the leisure segment. Yet the impact on price elasticity of the online channel should theoretically be lower in differentiated markets like business travel than in commoditized markets like leisure travel. Because price information is less important to business travelers, an increase in the ability to compare competitive offerings should have a lower impact on price elasticity for the business segment than for the leisure segment. Possible explanations for this counter-intuitive result are: i) the price point for business travel is higher than for leisure, which may make them more sensitive to competitive price information, ii) the search effect of the online channel is higher for business travelers since they do very little search offline, and iii) the dedicated resources of corporate travel agencies better enables the business segment fsto find lower prices.

B. Information Integration Theory

Information integration theory suggests that more product information should decrease the importance that price or brand have on a purchase decision (Anderson, 1968). Likewise, less product information should lead to a higher focus on price comparison, which will increase price elasticity. The main difference between opaque OTAs and offline agencies is the lack of product information, so travelers using opaque mechanisms will be relatively more sensitive to price changes. Our finding that opaque OTA demand is more price-elastic than offline demand is consistent with this theoretical argument.

C. Channel Selection

Our results show that more price-sensitive customers will gravitate to channels with lower search costs and higher price comparison capabilities. Part of the reason why we observe a higher price elasticity online is the disproportionate set of leisure travelers that book online. In contrast, a high proportion of business travelers book offline, because they prefer the convenience of an assisted purchase that satisfies their complex needs and their value of time. This channel self-selection effect partially explains the higher price elasticity in the online channel for the economy class as a whole.

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