On the Extent to which the Presence of Intermediate-stop(s) Air Travel Products Influences the Pricing of Nonstop Air Travel Products

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Abstract

Analysts of air travel markets, which include antitrust authorities, are interested in understanding the extent to which the presence of intermediate stop(s) products influences the pricing of nonstop products. This paper uses a structural econometric model to investigate the potential pricing interdependence between these two product types in domestic air travel markets. Counterfactual experiments using the estimated model suggest that in many (but far from a majority) markets the current prices of nonstop products are at least 5% lower than they would otherwise be owing to the presence of intermediate-stop(s) products.

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1. Introduction

Analysts of air travel markets are interested in understanding the extent to which the presence of intermediate stop(s) products influences the pricing of nonstop products. Among the analysts interested in this issue is the U.S. Department of Justice (DOJ), which published a document stating the following: [1]

"...there are many city pairs that are served by some carriers on a nonstop basis and others on a connecting basis, which poses the following question: is a passenger having the ability to take a nonstop flight likely to regard connecting service as a reasonable alternative, such that he or she would switch from nonstop service offered by one carrier to connecting service offered by another carrier if the first carrier raised its fare?"

A typical air travel origin-destination market contains a menu of nonstop and intermediate-stop(s) products from which potential consumers choose. If consumers are willing to substitute between these two differentiated product types in response to relative changes in price, then the presence of intermediate-stop(s) products can have significant impact on the pricing of nonstop products. This paper intends to shed light on the potential pricing interdependence between these two product types in air travel markets. To the best of our knowledge, there is no formal empirical analysis of this issue in the literature, even though some researchers have separately analyzed competition between nonstop products from competition between intermediate-stop(s) products [e.g. see Brueckner et al. (2013)].

Standard oligopoly theory pricing models suggest that there are primarily two channels through which intermediate-stop(s) products may influence the pricing of nonstop products: (1) a demand-elasticity-driven channel; and (2) a marginal cost channel. The demand-elasticity-driven channel recognizes that the optimal markup an airline charges on a given product depends on the product's own-price elasticity as well as the product's cross-price elasticity with substitute products the airline also offers in the market. The marginal cost channel recognizes that an airline's marginal cost of offering a given product in a market may depend on the other products that are also offered in the market. We first conduct a separate and thorough investigation of the own-price and cross-price demand elasticities between nonstop and intermediate-stop(s)

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[1] U.S. Department of Justice (2000), "Statement of John M. Nannes, Deputy Assistant Attorney General, Antitrust division, Before the Committee on Transportation & Infrastructure, U.S. House of Representatives, Concerning Antitrust analysis of Airline Mergers." http://www.justice.gov/atr/public/testimony/4955.htm.

products, which motivates and facilitates a separate analysis of the demand-elasticity-driven channel. A subsequent investigation of the joint impact of the demand-elasticity-driven and marginal cost channels is then conducted.

In studying air travel demand, Berry and Jia (2010) provide evidence suggesting that in recent time consumers have an increasingly strong preference for nonstop products compared to intermediate-stop(s) products. Gillen et al. (2003) conduct a report of air travel demand elasticities for Canada. They suggest that the demand for air travel should be distinguished by types of consumers (leisure vs. business travelers), length of haul (short-haul vs. long-haul distance), and types of markets (domestic vs. international destinations). So in addition to a general investigation of the pricing interdependence between these product types, it might be useful to see if the result of the investigation depends on length of market haul or types of consumers. The following quote from a DOJ published document further motivates breaking down the analysis by consumer types: [2]

*"...**Chances are** that passengers traveling for leisure -- on vacation perhaps -- are more likely to consider switching; their demand is said to be more elastic. However, passengers making business trips are significantly less likely to regard connecting service as a reasonable alternative..."*

The challenge we face in breaking down the analysis by consumer type is that publicly available data, like the Airline Origin and Destination Survey (DB1B) which we use, do not provide information about consumers' purpose of travel (e.g. business versus leisure). As such, in the spirit of recent literature on differentiated products demand, we use a structural econometric model to capture consumers' heterogeneity in tastes. [3] Modeling consumers' heterogeneity is important for more accurate estimation of demand elasticities, corresponding product markups, and implied marginal costs.

Our econometric estimates suggest that consumers' ideal air travel product is a cheap nonstop flight between their origin and destination. When we decompose consumers' choice behavior according to leisure versus business travelers, the result suggests that these two types of

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[2] U.S. Department of Justice (2000), "Statement of John M. Nannes, Deputy Assistant Attorney General, Antitrust division, Before the Committee on Transportation & Infrastructure, U.S. House of Representatives, Concerning Antitrust analysis of Airline Mergers." http://www.justice.gov/atr/public/testimony/4955.htm.

[3] We follow Berry and Jia (2010) approach, but for more flexible consumer heterogeneity specifications see Nevo (2000) and Petrin (2002).

consumers view a product differently with respect to their marginal utilities of price. Leisure travelers are much more price-sensitive compared to business travelers irrespective of whether the market is short-haul, mid-haul, or long-haul distance travel.

The statistically significant cross-price elasticity of demand estimates suggest that, on average, consumers perceive intermediate-stop(s) products substitutable for nonstop products. Furthermore, when facing an increase in price of nonstop products, we find that leisure travelers are more willing than business travelers to switch to intermediate-stop(s) products, suggesting that leisure travelers are more willing to tolerate intermediate stops compared to business travelers.

We then specify the supply-side of the model, which is based on the assumption that airlines set prices of their differentiated air travel products according to a Nash equilibrium. We use the supply-side of the model to conduct counterfactual exercises to better understand the extent to which the presence of intermediate-stop(s) products influences the pricing of nonstop products. These counterfactual exercises explicitly take into account the two channels through which intermediate-stop(s) products may influence the pricing of nonstop products. The results suggest that if we focus solely on the demand-elasticity-driven part of optimal pricing, then we find that intermediate-stop(s) products typically has a less than 5% impact, and in most cases less than 1%, on the price of nonstop products. However, assuming that the presence of intermediate-stop(s) products causes the marginal costs of nonstop products to be uniformly lower (about 5%) than they would otherwise be, as well as accounting for the demand-elasticity-driven part of optimal pricing, results suggest that in many (but far from a majority) markets the current prices of nonstop products are lower than they would otherwise be owing to the presence of intermediate-stop(s) products such that elimination of these intermediate-stop(s) products would substantially raise prices of nonstop products.

The rest of the paper is organized as follows: Important definitions used throughout the paper are collected in Section 2. Section 3 describes the data used in estimation. Sections 4 and 5 outline the econometric model and the estimation technique respectively. We discuss results in Section 6, and offer concluding remarks in Section 7.

2. Definitions

We now define some key concepts that are used throughout the paper. A market is directional air travel between origin and destination airports, independent of any intermediate stops. Thus, a trip from Kansas City to Atlanta is considered a different market than a trip from Atlanta to Kansas City. This direction-specific approach of defining air travel markets allows our model to better capture the impact that differences in demographic characteristics across origin cities may have on air travel demand. For example, origin cities that differ in population density and proportion of business versus leisure travelers are likely to have different demands for air travel.

A trip itinerary refers to a specific sequence of airport stops in traveling from the origin to destination airport. An air travel product is defined as the combination of a trip itinerary and airline. In a given market, airlines often compete with each other by offering a variety of products. For example, varied products in the Atlanta to Kansas City market are: (1) a nonstop trip operated by American Airlines; (2) a nonstop trip operated by Delta Airlines; and (3) a trip that requires an intermediate stop in Chicago operated by American Airlines. In other words, an air travel carrier can offer several distinct products in a given market, as in the example above in which American Airlines offers both a nonstop product along with a product that requires an intermediate stop in Chicago.

For any given product, the responsibilities of a "ticketing" carrier are different from those of an "operating" carrier. A ticketing carrier is an air travel carrier that markets and sells the flight ticket for a product to consumers, while an operating carrier is the one that actually transports the passengers. For most products, typically labeled in the literature as pure online products, a single carrier is the ticketing and operating carrier, while for other products, some of which are referred to as codeshare products, the ticketing and operating carriers differ.[4] In this research we treat the ticketing carrier as the "owner" of the product since this is the carrier that offers the product for sale to the consumer.[5]

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[4] See Ito and Lee (2007), Gayle (2013, 2008, 2007a and 2007b) and Gayle and Brown (2014) for discussions of the various types of air travel products and their relative popularity in US domestic air travel markets.
[5] In relatively rare occasions products with intermediate stops may have different ticketing carriers for each trip segment, but we do not consider such products in our analysis. The products considered in our analysis have a single ticketing carrier for all trip segments.

3. Data

Data are obtained from the Airline Origin and Destination Survey (DB1B), published by the U.S. Bureau of Transportation Statistics. DB1B is a 10% random sample of airline tickets from reporting carriers in the U.S. The database includes: (i) identifying information for ticketing and operating carriers associated with each ticket; (ii) the ticket fare and the number of passengers that purchase each ticket; (iii) the origin and destination airports as well as the sequence of any intermediate airport stop(s) that each itinerary may use; (iv) total itinerary flight distance; and (v) the nonstop flight distance between the origin and destination airports. The data do not contain any passenger-specific information such as: (i) whether the passenger holds frequent-flyer membership with an airline; (ii) whether the purpose of the trip is for business or leisure; (iii) date of ticket purchase; (iv) how long in advance of travel date ticket was purchased; etc. Data in our study are focused on U.S. domestic flights offered and operated by U.S. carriers in the 1st quarter of year 2010.

Some data restrictions are imposed in our study. Observations are dropped with missing market fares and market fares less than $50 due to the high probability that these may be data entry coding errors or discounted fares that may be related to passengers using accumulated frequent-flyer miles to offset the full cost of travel. Only products between the 48 main land U.S. states are included. In addition, flight itineraries with a change in the ticketing carrier or the operating carrier are eliminated. In order for a product from the original database to remain in our sample we require that at least 5 passengers purchase it during the quarter.[6] In addition, we drop the relatively few products that have 3 or more intermediate stops since in these instances the intermediate stops may themselves be destinations of importance for the passenger rather than a mere route to get the passenger to their final destination. In other words, consumers that purchase products with 3 or more intermediate stops are unlikely to perceive products with fewer, or no, intermediate stop as substitutable with the chosen product since the final destination may not have been the only destination of importance for the passenger. Given that a key part of our analysis is to investigate the extent to which nonstop products are substitutable with intermediate-stop(s) products, including products with 3 or more intermediate stops may unduly bias our results towards finding weak substitutability. Last, to facilitate our main objective, an

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[6] Berry (1992), Aguirregabiria and Ho (2012) among others use similar, and sometimes more stringent, quantity threshold to help eliminate idiosyncratic product offerings that are not part of the normal set of products offered in a market.

origin-destination market remains in our sample only if it has both nonstop and intermediate-stop(s) products.

In order to collapse the data based on our definition of air travel product, we compute the mean price for each distinct itinerary-carrier combination. Thus, a product's *"price"* is the mean ticket fare for its unique itinerary-carrier combination. Also, a *"quantity"* variable is created based on the sum of passengers that purchase the product. This variable is used to construct observed product shares, which is defined as product *"quantity"* divided by the potential market size. As in Berry, Carnall and Spiller (2006) and Berry and Jia (2010), we measure potential market size using the geometric mean across origin city and destination city populations of the market. The final dataset has sample size of 11,425 products spread across 773 origin-destination markets.

We then construct some product characteristics variables. *"Interstop"* is a variable that counts the number of intermediate stops in each product. A measure of product *"Inconvenience"* is created as the ratio of the total itinerary flight distance to the nonstop flight distance between origin and destination. The minimum possible value of the *Inconvenience* variable is 1, indicating the least inconvenient itinerary distance in the market. We also construct an airline *"HUB_Origin"* zero-one dummy variable that equals 1 only if the origin airport is a HUB for the ticketing carrier of the product.

Following Berry and Jia (2010), in order to capture potential product characteristics that are unobservable to us due to the relatively high traffic congestion in Florida and Las Vegas, we create a *"Tour"* zero-one dummy variable that equals 1 if the airport is in Florida or Las Vegas. A *"Slot_control"* variable counts the number of slot-controlled airports on a product's itinerary, which captures possible travel inconveniences for passengers due to airport traffic congestion at slot-controlled airports.[7] In the subsequent sections of the paper we posit that air travel demand is a function of the following variables: *Price* (in thousand dollars), *Interstop*, *Inconvenience*, *HUB_Origin* dummy, *Tour* dummy, *Slot_control*, and ticketing carrier fixed effects.

We posit that air travel supply is a function of the following cost-shifting variables: Itinerary *Distance* (in thousand miles), Itinerary *Distance Squared* (denoted as *Distance²*), *HUB_MC* dummy, *Slot_MC* dummy, and operating carrier dummies. *"HUB_MC"* is a zero-one

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[7] The slot-controlled airports are New Jersey Newark (EWR), New York Kennedy (JFK), New York LaGuardia (LGA), and Washington National (DCA).

dummy variable that equals 1 if the origin, intermediate stop(s), or destination airport is a HUB for the carrier. "*Slot_MC*" is a zero-one dummy variable that equals 1 if the *Slot_control* variable is greater than zero. Descriptive statistics of the sample data are reported in Table 1.

Table 1: Descriptive Statistics

Variable	Description	Mean	Std. Dev.	Min	Max
Price	Mean ticket fare for each product, measured in thousand dollars	0.2151	0.0990	0.068	3.889
Quantity	Number of passengers for each product	214.83	642.44	5	9181
Interstop	Number of intermediate stops for each product	0.7488	0.4586	0	2
Inconvenience	A product's cumulative itinerary distance flown from the origin to destination divided by the nonstop flight distance between the origin and destination	1.1488	0.2246	1	2.875
HUB_Origin	Dummy variable that equals 1 if the origin airport is a HUB for the ticketing carrier, otherwise variable takes the value 0	0.1243	0.3299	0	1
Tour	Dummy variable that equals 1 if the airport is in Florida or Las Vegas, otherwise variable takes the value 0	0.1937	0.3952	0	1
Slot_control	Number of slot-controlled airports on a product's itinerary	0.1477	0.3611	0	2
Distance	A product's cumulative itinerary distance flown from the origin to destination, measured in thousand miles	1.6620	0.6692	0.337	3.843
HUB_MC	Dummy variable that equals 1 if either the origin, the intermediate stop(s), or the destination airport is a HUB for the carrier	0.4712	0.4992	0	1
Slot_MC	Dummy variable that equals 1 if the Slot_control variable is greater than zero	0.1454	0.3525	0	1
No. of observations/ No. of products	11425				

Overall, across the 773 markets in our sample, the average market fare is about $215.10. Figure 1 illustrates average market fare of nonstop products compared to intermediate-stop(s) products based on flight distance of markets. [8] A short-haul market is a market with nonstop

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[8] To arrive at the average market fare by product type reported in Figure 1, we first compute the median fare by product type in each market, then take the average of these median fares across markets within a given distance category.

flying distance shorter than 500 miles. The other two market distance categories are the mid-haul market with nonstop flying distance between 500 miles and 1,500 miles, and the long-haul market with nonstop flying distance longer than 1,500 miles, according to definitions in Gillen et al. (2003).

The average market fare is increasing in distance for both types of products. A comparison of nonstop and intermediate-stop(s) products' prices reveal that the pricing gap between the two product types varies depending on the length of the trip. The average market fare of nonstop products is greater than that of intermediate-stop(s) products in mid-haul and long-haul markets. However, the opposite occurs in short-haul markets. The evidence in Figure 1 perhaps suggests that competition between these differentiated products may depend on the market nonstop flight distance.

Figure 1: Average Market Fares for Nonstop vs. Intermediate-Stop(s) Products in 2010:Q1
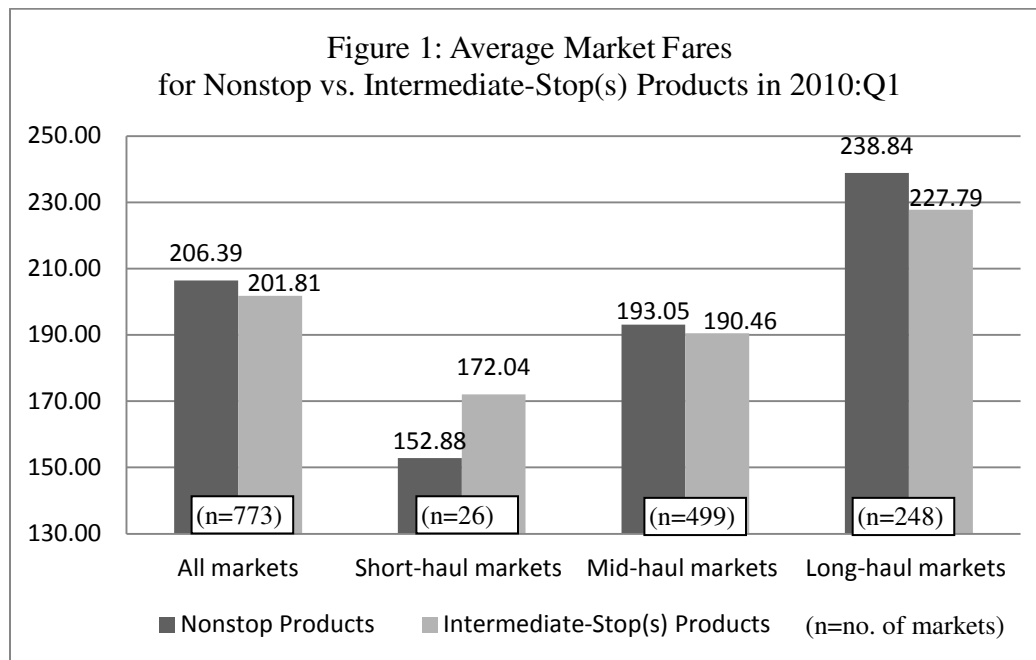
4. The Model

4.1 Demand

Following Berry and Jia (2010) and Berry, Carnal and Spiller (2006),[9] we use a random coefficients discrete choice approach, which allows us to estimate with aggregate market-level data while still being able to identify average choice behavior of different types of consumers. Assume air travel markets are populated with two types of consumers. Type 1 consumers on average are relatively more price-sensitive and have a higher tolerance for less convenient travel itineraries compared to type 2 consumers. Therefore, we may reasonably interpret type 1 consumers to be leisure travelers (subsequently denoted by *L*) and type 2 consumers to be business travelers (subsequently denoted by *B*). But this interpretation of the two consumer types is not "cast in stone".

The indirect utility consumer i, who is type $t \in \{L, B\}$, obtain from purchasing product j in market m is given by:

$$u_{ijm} = x_{jm}\beta_t + \alpha_t p_{jm} + \xi_{jm} + \sigma\zeta_{igm} + (1 - \sigma)\varepsilon_{ijm} , \tag{1}$$

where x_{jm} is a vector of non-price observable product characteristics,[10] β_t is a vector of taste coefficients for consumers of type *t* associated with product characteristics in x_{jm}, p_{jm} is the product price, α_t is the marginal utility for consumers of type *t* associated with a change in price, ξ_{jm} captures components of product characteristics that are observed by consumers but unobserved to researchers, ζ_{igm} is a random component of utility that is common to all products in group *g*, whereas the random term ε_{ijm} is specific to product *j*. Note that $g = 0, 1, 2, ..., G$ index product groups within a market, and one outside alternative (*g=0*). The outside alternative is the option not to purchase one of the air travel products considered in the model.

Some passengers may view the set of products offered by a given airline to be closer substitutes for each other compared to the substitutability of these products with products offered by other airlines, since a given airline's set of products may share a common desirable characteristic. A passenger may therefore choose to have frequent-flyer membership with a given airline, which serves to reinforce the passenger's loyalty to the set of products offered by that airline. Since we do not have passenger-specific information in the data, such as frequent-

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[9] Also see Berry (1990).

[10] Based on our previous discussion in the data section, variables in x_{jm} includes: *Interstop*, *Inconvenience*, *HUB_Origin* dummy, *Tour* dummy, *Slot_control*, and ticketing carrier fixed effects.

flyer membership, one attempt to capture airline brand-loyal choice behavior of consumers is to group products by airline in the demand model. This type of product grouping allows preferences to be correlated across products offered by a given airline. Therefore, product groups that are indexed by g in equation (1) are based on airlines.

The parameter σ, lying between 0 and 1, measures the correlation of the consumers' utility across products belonging to the same group/airline. As σ approaches 1 there is stronger correlation of consumers' preferences across products that belong to the same airline. On the other hand, there is no correlation of preferences if $\sigma = 0$. Consumer choice behavior is consistent with utility maximization when $\sigma \in (0,1)$ and the product share function has the traditional nested logit form.

Let λ_t be the percentage of type t consumers in the population, where $t \in \{L, B\}$. The overall market share of product j in market m is:

$$s_{jm}(\mathbf{x}, \mathbf{p}, \xi, \theta) = \lambda_L \times s^L_{j|g,m} \times s^L_{gm} + \lambda_B \times s^B_{j|g,m} \times s^B_{gm}, \tag{2}$$

where $\lambda_L + \lambda_B = 1$; $s^t_{j|g,m}$ is within group share of product j among type t consumers in market m; and s^t_{gm} is the share of group g among type t consumers in market m.[11] Note that θ is the vector of demand parameters to be estimated, which consists of the taste for product characteristics of both consumer types (β_L and β_B), the marginal utility of price of both consumer types (α_L and α_B), the parameter that captures correlation of consumers' utility across products belonging to the same group (σ), and the probability of type L consumer (λ_L). λ_B is obtained by $\lambda_B = 1 - \lambda_L$.

The demand for product j is given by:

$$d_{jm} = M \times s_{jm}(\mathbf{x}, \mathbf{p}, \xi, \theta), \tag{3}$$

where M is a measure of the market size, which is assumed to be the geometric mean across origin city and destination city populations for a given market.[12]

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[11] The well-know expressions for the within group and group share functions are:
$s^t_{j|g,m} = \frac{\exp\left[(x_{jm}\beta_t + \alpha_t p_{jm} + \xi_{jm})/(1-\sigma)\right]}{D_{gtm}}$ and $s^t_{gm} = \frac{D^{1-\sigma}_{gtm}}{1 + \sum_{g=1}^{G} D^{1-\sigma}_{gtm}}$ respectively, where
$D_{gtm} = \sum_{j \in G_g} exp\left[(x_{jm}\beta_t + \alpha_t p_{jm} + \xi_{jm})/(1-\sigma)\right]$.

[12] For comparative purposes we also estimate two more restrictive discrete choice models of demand: (1) the standard logit model; and (2) the simple nested logit model. Results associated with these more restrictive models are available upon request.

4.2 Markups and Marginal Cost

We assume that carriers simultaneously choose prices as in a static Bertrand-Nash model of differentiated products. Let each carrier f offer for sale a set F_{fm} of products in market m. Firm f's variable profit in market m is given by:

$$\pi_{fm} = \sum_{j \in F_{fm}} (p_{jm} - mc_{jm}) q_{jm} , \qquad (4)$$

where $q_{jm} = d_{jm}(\mathbf{p})$ in equilibrium, q_{jm} is the quantity of travel tickets for product j sold in market m, $d_{jm}(\mathbf{p})$ is the market demand for product j in equation (3), $\mathbf{p}$ is a vector of prices for the J products in market m, and mc_{jm} is the marginal cost of product j in market m.

The corresponding first-order conditions are:

$$\sum_{r \in F_{fm}} (p_{rm} - mc_{rm}) \frac{\partial s_r}{\partial p_j} + s_{jm}(\mathbf{x}, \mathbf{p}, \xi, \theta) = 0 \qquad \text{for all } j = 1, \dots, J \qquad (5)$$

which can be re-written in matrix notation as:

$$s(\mathbf{p}) + (\Omega * \Delta) \times (\mathbf{p} - \mathbf{mc}) = 0 , \qquad (6)$$

where $\mathbf{p}$, $\mathbf{mc}$, and $s(\cdot)$ are $J \times 1$ vectors of product prices, marginal costs, and predicted product shares respectively, while $\Omega * \Delta$ is an element-by-element multiplication of two matrices. Δ is a $J \times J$ matrix of first-order derivatives of model predicted product shares with respect to prices, where element $\Delta_{jr} = \frac{\partial s_r(\cdot)}{\partial p_j}$. Ω is a $J \times J$ matrix of appropriately positioned zeros and ones that describes carriers' ownership structure of the J products, which in effect captures groups of products in the market that are jointly priced. Based on equation (6), the markup equation can be obtained as:

$$Markup = \mathbf{p} - \mathbf{mc} = -(\Omega * \Delta)^{-1} \times s(\mathbf{p}) . \qquad (7)$$

Finally, the marginal cost equation is specified as:

$$ln(\mathbf{mc}) = \mathbf{w}\gamma + \boldsymbol{\eta} , \qquad (8)$$

where $\mathbf{w}$ is a matrix of observed marginal cost-shifting variables, [13] γ is a vector of cost parameters to be estimated, and $\boldsymbol{\eta}$ is a vector of cost shocks that is unobserved by researchers. [14] The supply equation implied by equations (7) and (8) is therefore,

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[13] Based on our previous discussion in the data section, w_{jm} includes: Itinerary distance flown measured in thousand miles (variable is denoted as *Distance*), itinerary distance squared (variable denoted as *Distance²*), *HUB_MC* dummy, *Slot_MC* dummy and operating carrier dummies.

[14] Given certain limitations of our data, we must acknowledge that it is difficult to accurately estimate the true marginal cost of adding one more passenger to a flight. For example, marginal cost may vary substantially

$$ln[\mathbf{p} - Markup(\mathbf{x}, \mathbf{p}, \xi, \theta)] = \mathbf{w}\gamma + \boldsymbol{\eta}. \tag{9}$$

5. Estimation

Generalized Method of Moments (GMM) is used to estimate the demand and marginal cost parameters jointly. First we describe how moment conditions are constructed from the demand-side of the model, and then describe how other moment conditions are constructed from the supply-side of the model.

To construct moment conditions used for identifying demand parameters, we first solve the demand model for the vector of unobserved product characteristics, ξ, as a function of product characteristics measured in the data and demand parameters, i.e., $\xi(\mathbf{x}, \mathbf{p}, \mathbf{S}, \theta)$. We follow the numerical contraction mapping technique outlined in Berry and Jia (2010) to solve the model to obtain ξ_{jm}.[15]

The demand error term, ξ_{jm}, is used to construct the following moment conditions:

$$m_d = \frac{1}{n}Z_d'\xi(\mathbf{x}, \mathbf{p}, \mathbf{S}, \theta) = 0, \tag{10}$$

where n is the number of observations in the sample, and Z_d is a $n \times L_d$ matrix of instruments.

The marginal cost error term $\boldsymbol{\eta}$ is obtained from equation (9) as follows:

$$\boldsymbol{\eta} = ln[\mathbf{p} - Markup(\mathbf{x}, \mathbf{p}, \xi, \theta)] - \mathbf{w}\gamma, \tag{11}$$

which is then used to generate the supply-side moment conditions:

$$m_s = \frac{1}{n}Z_s'\boldsymbol{\eta}(\mathbf{w}, \mathbf{p}, Markup, \gamma) = 0. \tag{12}$$

We combine moment conditions from equations (10) and (12) into a single GMM objective function and jointly estimate parameters in the demand and marginal cost equations. The GMM optimization problem is:

$$Min_{\hat{\theta}, \hat{\gamma}} \left[m(\hat{\theta}, \hat{\gamma})' W m(\hat{\theta}, \hat{\gamma}) \right], \tag{13}$$

where $m(\hat{\theta}, \hat{\gamma}) = \begin{bmatrix} m_d \\ m_s \end{bmatrix}$, and W is the following block diagonal positive definite weight matrix:

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depending on how full a flight is, but or data do not contain volume of passengers on a given flight relative to the seating capacity of the flight.

[15] For the simple nested logit model, the unobservable ξ_{jm} is computed analytically using: $\xi_{jm} = y_{jm} - [x_{jm}\beta_t + \alpha_t p_{jm} + \sigma ln(\mathbf{S}_{j/g})]$, where $y_{jm} = ln(\mathbf{S}_{jm}) - ln(\mathbf{S}_{0m})$, $\mathbf{S}_{0m}$ is the observed share of the outside good (g=0), and $\mathbf{S}_{j/g}$ is the observed within group share of product j. Analogous expressions in case of the standard logit demand model can easily be obtained by setting $\sigma = 0$ in the expressions for the simple nested logit model.

$$W = \begin{pmatrix} \left[\frac{1}{n}Z_d'\boldsymbol{\xi}\boldsymbol{\xi}'Z_d\right]^{-1} & \mathbf{0} \\ \mathbf{0} & \left[\frac{1}{n}Z_s'\boldsymbol{\eta}\boldsymbol{\eta}'Z_s\right]^{-1} \end{pmatrix}.$$

Due to the fact that prices and within group product shares are endogenous, we need instruments that are associated with these endogenous variables but not with the error terms. Following much of the literature on discrete choice models of demand, we make the admittedly strong identifying assumption that observed non-price product characteristics are uncorrelated with unobserved product quality, $\boldsymbol{\xi}$, or unobserved marginal cost, $\boldsymbol{\eta}$.[16] Similar to Gayle (2013, 2007a, 2007b), Gayle and Brown (2014), and Brown (2010), we create the following instruments: (1) the number of substitute products offered by an airline in a market; (2) the number of competitor products in the market; (3) the number of competing products with equivalent number of intermediate stops offered by other carriers; (4) the squared deviation of a product's itinerary distance from the average itinerary distance of competing products offered by other carriers; (5) the sums and averages, by airline, of the *Inconvenience* and *Interstop* variables;[17] and (6) interactions of these instrument variables.

The instruments are motivated by standard supply theory, which predicts that equilibrium price is affected by the size of markup. In other words, the instruments are assumed to influence the size of an airline's markup on each of its products. For example, a product's markup is constrained by the "closeness" of competing products in characteristics space, which is the rationale for instruments (3) and (4). A product's markup is constrained by the number of competing products in the market, which is the rationale for instrument (2). A firm typically can achieve a marginally higher markup on a given product the more substitute products it owns in the market, which is the rationale for instrument (1). Instruments in (5) are based on the idea that the average markup that a firm is able to charge is related to the characteristics of its products. In addition, instruments in (5) are likely associated with passengers' preference for products offered by one airline relative to the products offered by another.

5.1 Identification of λ_L in Demand Model

Since the data do not explicitly provide information on passengers' purpose of travel (e.g. business versus leisure), a reasonable question to ask at this point is: What feature of the data is

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[16] For example, see Berry and Jia (2010) and Peters (2006) for similar identifying assumptions.
[17] See the data section for definition and explanation of the *Inconvenience* and *Interstop* variables.

responsible for identifying parameter λ_L in the demand model, which measures the mean proportion of leisure/price-sensitive type consumers across markets? The answer is that as long as leisure travelers tend to purchase products that, on average, have product characteristics that differ from the characteristics of products typically purchased by business travelers (e.g. products may contrast in their price levels and/or levels of itinerary travel convenience), then this contrasting consumer choice behavior in the data identifies λ_L.

6. Results

6.1 Parameter Estimates

Table 2 reports parameter estimates of the demand and marginal cost equations. We first discuss the demand parameter estimates. [18]

All demand parameter estimates are statistically significant at conventional levels of statistical significance. Recall that the random coefficients logit demand model we specify allows us to disentangle choice behavior for two types of consumers. First, for each type of consumer the negative coefficient estimates for the *Price* and *Interstop* variables suggest that a consumer's utility tends to decrease when the market fare or the number of intermediate stops increase. In other words, irrespective of consumer type, consumers most prefer cheap nonstop flights between their origin and destination. The consumer-type specific coefficient estimates on *Price* suggest that type L consumers (leisure travelers) are much more sensitive to price changes compared to type B consumers (business travelers). Therefore, the evidence suggests that the two types of consumers view a product differently with respect to their marginal utilities of price. Furthermore, the consumer-type specific coefficient estimates on *Interstop* suggest that leisure travelers are less sensitive to intermediate stops compared to business travelers.

An airline may offer several different single-intermediate stop products in a given market that differ based on the location of the intermediate stop and the flying distance required to get to the destination. The negative coefficient estimate on *Inconvenience* suggests that, among

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[18] A Hausman test confirms that price and within group product share variables are indeed endogenous at conventional levels of statistical significance. The computed Hausman test statistic, which is chi-square distributed, has a value of 271.46. When the demand model is estimated without instruments the price coefficient is positive and σ is almost twice as large, which suggest bias due to endogeneity. As such, we believe that our instruments do a reasonable job in mitigating endogeneity problems. To give the reader a sense of the importance of using instruments in estimation of the demand equation, in Table B1 in Appendix B we report single-equation estimation of the nested logit demand model with and without using instruments.

products with the same number of intermediate stops, consumers prefer to choose the product that uses the shortest route to get to their destination.

Table 2: Joint Estimation of Demand and Marginal Cost Equations

Demand Equation		
Variable	Coefficient	(Standard Error)
Type L Consumer		
Price	-18.054[*]	(0.042)
Interstop	-1.3139[*]	(0.057)
Constant	-6.0683[*]	(0.194)
Type B Consumer		
Price	-2.2497[*]	(0.120)
Interstop	-1.3866[*]	(0.478)
Constant	-7.0452[*]	(0.384)
Inconvenience	-1.0171[*]	(0.009)
HUB_Origin	1.0216[*]	(0.007)
Tour	0.7379[*]	(0.008)
Slot-control	-0.5419[*]	(0.007)
σ	0.1787[*]	(0.002)
λ_L	0.4110[*]	(0.055)
Marginal Cost Equation		
Variable	Coefficient	(Standard Error)
Constant	-2.775[*]	(0.053)
Distance	0.297[*]	(0.034)
Distance^2	-0.065[*]	(0.011)
HUB_MC	0.027[*]	(0.008)
Slot_MC	0.026[*]	(0.009)
GMM objective	19428	
Number of obs.	11425	

* represents statistical significance at the 0.05 level. Standard errors are in parentheses. Ticketing (operating) carrier dummy variables are included in the demand (marginal cost) model for estimation even though the associated coefficient estimates are not reported in the table.

Consistent with documented evidence in the existing literature, the *HUB_Origin* coefficient estimate is positive, which indicates that a carrier is more likely to be chosen by consumers if the origin airport is the carrier's hub. Such consumer choice behavior is expected because a carrier is likely to offer convenient gate access and a superior menu of departure options from their hub airport.[19] As suggested in Berry and Jia (2010), the positive *Tour* dummy coefficient estimate captures the relatively high traffic volume in Florida and Las Vegas that cannot be explained by the observed product attributes.

A consumer's utility is likely to be lower if he/she chooses a product that requires travel through a slot-controlled airport, which is consistent with the negative coefficient estimate on the *Slot-control* variable. A reason for lower consumer utility associated with these products is owing to longer wait time due to congestion at slot-controlled airports.

As expected, the parameter estimate σ lies between 0 and 1, which in our demand model specification measures the correlation of consumers' utility across products belonging to the same airline. The point estimate of σ is 0.1787, which suggests that there is correlation of preferences for products belonging to a given airline, but this correlation does not seem to be economically strong since the correlation value is substantially less than 1. The estimate of λ_L is 0.41, indicating that 41 percent of consumers in the sample markets are type L.

We now discuss coefficient estimates in the marginal cost equation. The sign pattern of the coefficient estimates on itinerary distance flown variables (*Distance* and *Distance*^{2}) suggests that marginal cost has an inverted-U relationship with itinerary distance flown, i.e., marginal cost is positively related to itinerary distance up to some distance threshold, then negatively related to itinerary distance at relatively longer distances. This finding is consistent with an argument made by Berry, Carnall, and Spiller (2006), which says that at relatively short distances, the superior cruising efficiency of larger planes may not dominate their larger takeoff and landing costs, and, therefore, the marginal cost is increasing in distance at relatively short distances. However, at relatively long distances, it becomes optimal to use larger planes, since their cruising efficiency may dominate their higher takeoff and landing costs, which eventually causes the marginal cost to decline in distance.

The positive coefficient estimates on *HUB_MC* and *Slot_MC* suggest that marginal cost is higher if an airport on the product itinerary is the carrier's HUB or a slot-controlled airport.

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[19] See discussions in Berry, Carnall and Spiller (2006), Berry (1990), Borenstein (1989) and Borenstein (1991).

Channeling passengers through the airline's hub normally allows the airline to better exploit economies of passenger-traffic density since passengers from different origins and with different destinations can eventually be put on a single large plane for a segment of the trip. This should have a downward pressure on marginal cost.[20] However, as suggested by arguments in Borenstein and Rose (2007) and Mayer and Sinai (2003), often time hub airports are congested, which could cause flight delays and ultimately puts an upward pressure on cost for the airline.[21] Therefore, the coefficient estimate on *HUB_MC* captures the net effect of these opposing forces, and possibly others.

6.2 Own-price Elasticity of Demand

Using the parameter estimates in Table 2, we compute average own- and cross-price elasticities of demand, but first we discuss the own-price elasticity estimates. Own-price elasticity measures the percentage change in demand for an air travel product in response to a percentage change in price of that product. The own-price elasticity for product *j* is computed as, $\epsilon_{jj} = \frac{\partial s_j(\cdot)}{\partial p_j} \times \frac{p_j}{s_j}$, where $s_j(\cdot)$ is the predicted product share function specified in equation (2) and footnote 11. Product *j* is either a nonstop product or an intermediate-stop(s) product, with $s_j(\cdot)$ and ϵ_{jj} being a function of the product's price, p_j, and non-price product characteristics, (x_j, ξ_j). One measured non-price product characteristic, captured by variable "*Interstop*" in vector x_j, is the number of intermediate stops (0, 1 or 2) product *j* has.

Table 3 reports summary statistics on own-price elasticity estimates across all products in the 773 markets, as well as summary statistics on own-price elasticity estimates for nonstop and intermediate-stop(s) products separately. The own-price elasticity estimates are statistically different from zero at conventional levels of significance. The mean own-price elasticity estimate generated by our demand model is -1.92. Oum, Gillen and Noble (1986), and Brander and Zhang (1990) argue that a reasonable range for own-price elasticity in the airline industry is from -1.2 to -2.0. Peters (2006) study of the airline industry produces own-price elasticity estimates ranging from -3.2 to -3.6, while Berry and Jia (2010) find own-price elasticity estimates ranging from -1.89 to -2.10 in their 2006 sample. Therefore, we are comfortable that

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[20] See Berry, Carnall and Spiller (2006) and Brueckner and Spiller (1994).
[21] For a detailed analysis of the theory of congestion and delays, see Brueckner (2002) and Morrison and Winston (2008).

the elasticity estimates generated from our model are reasonable and accord with evidence in the existing literature.

The own-price elasticity estimates indicate that consumers are sensitive to a price change, irrespective of whether the product is nonstop or requires intermediate stop(s). However, the average consumer responds differently when facing a price change of a nonstop product compared to an equivalent percent price change of an intermediate-stop(s) product. Specifically, it is noticeable that consumers are more price-sensitive in the case of intermediate-stop(s) products compared to nonstop products, and the price-sensitivity differences across the two product types are statistically significant at conventional levels of statistical significance as revealed by statistical comparisons in the middle panel of Table 3.

Table 3: Summary Statistics for Own-Price Elasticity Estimates

	No. of markets	Both Types of Consumers		Type L Consumers		Type B Consumers	
		Mean	(se)	Mean	(se)	Mean	(se)
All Products	773	-1.924[*]	(0.005)	-4.274[*]	(0.037)	-0.530[*]	(0.005)
Nonstop Products	773	-1.802[*]	(0.007)	-4.061[*]	(0.043)	-0.501[*]	(0.005)
Intermediate-stop(s) Products	773	-1.981[*]	(0.007)	-4.390[*]	(0.050)	-0.546[*]	(0.006)
		Statistical Comparison of Mean Difference in Own-price Elasticity Estimates across the two Product Types					
Intermediate-stop(s) versus Nonstop Products	773	-0.1796[*]	(0.010)	-0.3297[*]	(0.066)	-0.0444[*]	(0.008)
		Summary Statistics for Own-price Elasticity Estimates Broken Down by Market Nonstop Flight Distance between Origin and Destination					
Short-haul distance markets (less than 500 miles)	26	-1.857[*]	(0.024)	-3.454[*]	(0.183)	-0.429[*]	(0.023)
Mid-haul distance markets (between 500 and 1500 miles)	499	-1.944[*]	(0.007)	-3.988[*]	(0.042)	-0.495[*]	(0.005)
Long-haul distance markets (greater than 1500 miles)	248	-1.893[*]	(0.010)	-4.936[*]	(0.058)	-0.613[*]	(0.007)

[*] represents statistical significance at the 0.05 level. Standard errors are in parentheses.

The consumer-type-specific elasticity estimates indicate that leisure travelers (Type L) are much more price-sensitive compared to business travelers (Type B). Overall, a 1% increase in price causes leisure travelers to decrease their demand for the product by 4.27%, while business travelers would only decrease their demand by 0.53%. Leisure travelers are likely more sensitive to price changes because they have more flexibility in their travel schedule and usually have a more restrictive travel budget. The price-sensitivity gap between leisure and business travelers is wider in the case of intermediate-stop(s) products (-4.39 versus -0.546) compared to the price-sensitivity gap for nonstop products (-4.06 versus -0.50).

In the bottom panel of the table we decompose the own-price elasticity estimates according to market nonstop flight distance categories. Consumers seem to be less price-sensitive in short-haul distance markets relative to long-haul distance markets, which is consistent with findings in Bhadra (2003). It is possible that many of the passengers who choose to use air travel on relatively short distances are business travelers. They likely purchase flight tickets at the last moment and have little or no chance to respond to price changes. [22]

6.3 Cross-price Elasticity of Demand

Cross-price elasticities relevant to our study measure the percentage change in demand for intermediate-stop(s) products in response to a percentage change in price of nonstop products. The cross-price elasticity of demand between products r and j is computed as, $\epsilon_{jr} = \frac{\partial s_r(\cdot)}{\partial p_j} \times \frac{p_j}{s_r}$. For the computed ϵ_{jr}, we focus on cases in which product r is an intermediate-stop(s) product, while product j is a nonstop product. Summary statistics for cross-price elasticity estimates across all markets are reported in Table 4.

Overall, across the 773 markets in our sample, the positive and statistically significant cross-price elasticity of demand estimates indicate that intermediate-stop(s) products and nonstop products are substitutes. The mean cross-price elasticity is 0.01248, and this estimate is statistically different from zero at conventional levels of significance.

Compared to business travelers, leisure travelers perceive intermediate-stop(s) products and nonstop products as closer substitutes. A 1% increase in the price of nonstop products

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[22] The different own-price elasticity for short-haul distance relative to long-haul distance markets may be partly due to differences in product characteristics across markets with contrasting distance haul. We leave it to future research to identify the relative importance of various product characteristics that influence the contrasting own-price elasticity across short-haul distance versus long-haul distance markets.

causes leisure travelers to increase their demand for intermediate-stop(s) products by 0.024%, but only causes business travelers to increase their demand for intermediate-stop(s) products by 0.0034%. [23] In other words, leisure travelers are more willing than business travelers to switch to intermediate-stop(s) products when facing an increase in price of nonstop products, suggesting that leisure travelers are more willing to tolerate intermediate stops compared to business travelers.

Table 4: Summary Statistics for Cross-Price Elasticity Estimates

	No. of markets	Both Types of Consumers		Type L Consumers		Type B Consumers	
		Mean	(se)	Mean	(se)	Mean	(se)
All markets	773	0.01248[*]	(0.0004)	0.02428[*]	(0.0008)	0.00336[*]	(0.0001)
Short-haul distance markets	26	0.00620[*]	(0.0017)	0.00855[*]	(0.0024)	0.00148[*]	(0.0004)
Mid-haul distance markets	499	0.01399[*]	(0.0006)	0.02511[*]	(0.0011)	0.00349[*]	(0.0001)
Long-haul distance markets	248	0.01009[*]	(0.0005)	0.02426[*]	(0.0013)	0.00330[*]	(0.0002)

* represents statistical significance at the 0.05 level. Standard errors are in parentheses.

Table 4 also breaks down the cross-price elasticity estimates by market nonstop flight distance between the origin and destination. Within each distance category, the results show that the mean cross-price elasticities are statistically different from zero at conventional levels of significance. These results suggest that consumers perceive intermediate-stop(s) products and nonstop products as substitutable in all distance categories of air travel markets. Furthermore, irrespective of whether the market distance is short-haul, mid-haul, or long-haul, leisure travelers are more willing to switch to intermediate-stop(s) products compared to business travelers in response to an increase in price of nonstop products. Again, it is evident that leisure travelers are more flexible to change their travel schedule in response to price changes.

It is notable that consumers in short-haul distance markets are less willing to switch to an intermediate-stop(s) product in response to an increase in price of a nonstop product. A possible explanation for this result is that the share of total trip time represented by connecting time grows

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[23] A t-test is used here to confirm that at conventional levels of statistical significance there is a statistically significant difference in mean cross-price elasticity between leisure travelers and business travelers. The difference in mean cross-price elasticities (0.0242-0.0034) is 0.0209 and the standard error of the difference is 0.00083, which implies a t-statistic of 25.21.

as the total trip distance falls. As the time burden of connecting travel increases with shorter trip distances, passengers are less willing to switch to intermediate-stop(s) products for a given increase in the price of a nonstop product. [24] Another notable observation from the data in Table 4 is that the average cross-price elasticity increases from short-haul distance market to mid-haul distance market, but decreases a bit from mid-haul distance market to long-haul distance market.

Table 5 reports statistical comparisons of mean cross-price elasticity estimates across different market distances. Specifically, the table reports the difference in mean cross-price elasticities for markets in two distinct distance-haul categories. For example, the first data entry in the table of 0.00779 is computed by subtracting the mean cross-price elasticity for short-haul distance markets from the mean cross-price elasticity for mid-haul distance markets. The results suggest that there is a statistically significant difference in mean cross-price elasticity between short-haul and mid-haul distance markets. However, when separate consumer types are accounted for, there is not a significant mean difference between mid-haul and long-haul distance markets.

Table 5: Statistical Comparison of Mean Difference in Cross-price Elasticity across Markets in Different Distance Categories

Market Distance Category Comparison	Both Types of Consumers		Type L Consumers		Type B Consumers	
	Mean	(se)	Mean	(se)	Mean	(se)
Mid- vs. Short-haul	0.00779*	(0.0018)	0.01657*	(0.0026)	0.00201*	(0.0004)
Long- vs. Mid-haul	-0.0039*	(0.0008)	-0.0009	(0.0017)	-0.0002	(0.0002)
Long- vs. Short-haul	0.00389*	(0.0018)	0.00182	(0.0027)	0.00182*	(0.0004)

* represents statistical significance at the 0.05 level. Standard errors are in parentheses.

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[24] We are very thankful to an anonymous referee for providing this explanation for why consumers in short-haul markets are less willing to switch to an intermediate-stop(s) product in response to an increase in price of a nonstop product.

It may be argued that the distance categories used in the previous tables are arbitrary. As such, using an approach that is more flexible than the distance categories, we investigate a potential relationship between computed cross-price elasticities and the nonstop market distance. In particular, we estimate the following regression via ordinary least squares (OLS):

$$Y_i = \alpha_0 + \alpha_1 Dist_i + \alpha_2 Dist_i^2 + \varepsilon_i,$$

where Y_i is the cross-price elasticity in market i, which is regressed on the market nonstop flight distance ($Dist$) and distance squared ($Dist^2$). Table 6 shows the results of the OLS regression.

The parameter estimates suggest that cross-price elasticity is increasing with distance between the origin and destination cities up to some threshold distance, but decline in distance thereafter. In other words, the evidence suggests an inverted U-shaped relationship between cross-price elasticity and nonstop flight distance between origin and destination cities. The estimated distance threshold point seems to be approximately 1500 miles. These results are roughly consistent with the arbitrary distance category analysis done previously.

Table 6: Parameter Estimates for the Relationship
between Cross-price Elasticities and Market Nonstop Distance

	Both Types of Consumers	Type L Consumers	Type B Consumers
Dist	5.44E-06	2.01E-05[*]	2.21E-06[*]
	(3.72E-06)	(7.31E-06)	(9.98E-07)
$Dist^2$	-2.65E-09[*]	-6.36E-09[*]	-7.37E-10[*]
	(1.23E-09)	(2.41E-09)	(3.29E-10)
Constant	0.01077[*]	0.011041[*]	0.00198[*]
	(0.00247)	(0.00486)	(0.00066)
R-squared	0.0207	0.0099	0.0065
Distance Threshold	1027	1582	1501

[*] represents statistical significance at the 0.05 level. Standard errors are in parentheses.
The distance threshold is computed by, $Dist\ threshold = -\frac{\alpha_1}{2\alpha_2}$.

6.4 Markup and Marginal Cost Analysis

The parameter estimates in the demand model along with an assumption that airlines set prices according to a Nash equilibrium allow us to compute product-level markups and marginal costs, which are summarized in Table 7.

The estimates suggest that, on average, a nonstop product enjoys larger markup (about 7 dollars more) than an intermediate-stop(s) product, which is consistent with our expectations. Based on our previous results on own-price elasticity of demand, we believe that price-sensitive consumers are more likely to buy intermediate-stop(s) products compared to nonstop products. In addition, standard static oligopoly theory tells us that the more price-sensitive consumers are, the lower the markup firms are able to charge. Thus, the markups reflect the differing choice behavior of dissimilar consumer types across nonstop and intermediate-stop(s) products.

Table 7: Summary Statistics for Markup and Marginal Cost (in Dollars)

	Mean	Std. Dev.
Markup		
All products	129.904	41.536
Nonstop products	135.059	51.285
Intermediate-stop(s) products	127.622	42.239
Marginal Cost		
All products	83.048	22.415
Nonstop products	83.185	35.249
Intermediate-stop(s) products	82.561	14.487

As we previously discussed in the subsection on own-price elasticities, our own-price elasticity estimates are within the range of those obtained by other researchers [see for example Berry and Jia (2010), Brander and Zhang (1990), Oum, Gillen and Noble (1986), and Peters (2006)]. Since standard static oligopoly theory predicts that product markups are determined by price elasticity of demand, then product markups generated by our model will be similar to product markups implied by the elasticity estimates of other researchers.

The mean itinerary distance flown for products in our sample is 1662 miles, while the mean marginal cost estimate is $83.05. Therefore, the implied marginal cost per mile is about 5

cents. Berry and Jia (2010) estimate their econometric model on data in the year 2006 and find a marginal cost per mile estimate of 6 cents, which they argue is plausible based on carriers' reported costs. As such, we believe our marginal cost estimate is within the "ballpark" of what is expected.

6.5 Counterfactual Analyses

The goal of the counterfactual analyses is to assess the extent to which the presence of intermediate-stop(s) products influences the pricing of nonstop products. We implement three counterfactual experiments, which we now discuss in turn.

6.5.1 Counterfactual Experiment 1

Essentially *Counterfactual Experiment 1* is done by removing intermediate-stop(s) products from each sample market, then assuming the previously estimated product marginal costs and preference parameters are unchanged,[25] we use the supply-side of the model to solve for new equilibrium prices for nonstop products. A comparison of the actual nonstop products' prices with their model predicted equilibrium prices when intermediate-stop(s) products are counterfactually removed reveals the extent to which the presence of intermediate-stop(s) products influences the pricing of nonstop products.

A common feature of all three counterfactual experiments is that we artificially remove intermediate-stop(s) products from each sample market. Due to this feature of the experiments it is tempting to dismiss them on the grounds that it is hard to imagine a situation in which policymakers require that intermediate-stop(s) products be removed from a particular market. However, the primary purpose of the counterfactual experiments is not to analyze equilibrium outcomes of market scenarios that could arise from policymakers' actions, but instead these experiments are simply being used as mere tools to assess the extent to which the presence of intermediate-stop(s) products influences the pricing of nonstop products.

Formally, in the spirit of Petrin (2002), Nevo (2000) and others, we first use estimated markups, actual prices and equation (7) to recover product marginal costs as follows:

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[25] We concede that marginal cost and preferences may be different in a world that does not have intermediate-stop(s) products. Such *ceteris paribus* assumptions are typical in the literature when using structural models to perform counterfactual analyses. For example, see Nevo (2000) and Petrin (2002). However, *Counterfactual Experiment 2* and *Counterfactual Experiment 3*, which we subsequently describe, relax the assumption that marginal cost of nonstop products is unchanged when intermediate-stop(s) products are counterfactually removed.

$$\widehat{\mathbf{mc}} = \mathbf{p} + (\Omega * \Delta)^{-1} \times s(\mathbf{p}), \tag{14}$$

where $\widehat{\mathbf{mc}}$ is the estimated marginal cost vector. Second, we eliminate intermediate-stop(s) products, and holding recovered marginal cost constant for the remaining products, we numerically solve for the new nonstop product price vector, $\mathbf{p}_{ns}^*$, that satisfies:

$$\mathbf{p}_{ns}^* = \widehat{\mathbf{mc}}_{ns} - [\Omega_{ns} * \Delta_{ns}(\mathbf{p}_{ns}^*)]^{-1} \times s_{ns}(\mathbf{p}_{ns}^*), \tag{15}$$

where equation (15) is only for nonstop products. Finally, we compare the counterfactual equilibrium price vector $\mathbf{p}_{ns}^*$ to actual nonstop product prices in vector $\mathbf{p}$ to see the influence that intermediate-stop(s) products may have on the equilibrium prices of nonstop products.

Before we examine the results of counterfactual experiment 1, it is useful to discuss what forces are at play in the market equilibrium analysis. In other words, do we expect equilibrium prices of nonstop products to fall, rise, or remain the same when intermediate-stop(s) products are counterfactually removed, and what does the predicted price change depend on? We argue that there are potentially three demand-elasticity-driven effects simultaneously at work that may influence the predicted equilibrium price change of nonstop products: (1) the market power effect; (2) the multi-product firm effect; and (3) the price-sensitivity effect.

The most intuitive of the three effects is the market power effect. This effect simply refers to the increased ability and incentive of carriers to raise the price of the remaining products if competing substitute products are removed from the market. Perhaps this effect is most relevant for the purposes of antitrust analyses.[26]

The multi-product firm effect refers to the situation in which, if the product that is removed from the market is one of several substitute products offered by a firm, then this firm has an incentive to marginally reduce the price on its remaining products. The intuition is the following. A multi-product firm selling substitute products tends to price these products marginal higher than if it were single-product firms selling the same set of products because a marginal increase in the price of one product raises the demand for the substitute products. In other words, each substitute product effectively has a positive demand externality on the others via its pricing. While a multi-product firm can internalize these positive demand externalities across substitute products, single-product firms cannot, resulting in higher prices when the same set of substitute products are offered by a multi-product firm. So if one of the several substitute products offered by a multi-product firm is removed from the market, this also effectively

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[26] We thank an anonymous referee for making this point.

removes the positive demand externality from pricing that this product imposed, and the multi-product firm accounted for, when the firm optimally prices its other substitute product(s). It is the effective removal of the positive demand externality that drives the multi-product firm to price its remaining substitute product(s) at a lower price. In Appendix A we use a linear demand example to illustrate this effect.

The price-sensitivity effect refers to the situation in which there is downward pressure on the price of a product when the price-sensitivity of consumers increases. This effect is likely to exist in our counterfactual exercises since our previous results show that intermediate-stop(s) products tend to be consumed by more price-sensitive consumers compared to the consumers of nonstop products. Therefore, by removing the intermediate-stop(s) products from the market, we in effect force carriers to optimally adjust the price of nonstop products for a more price-sensitive set of consumers that do not have any other air travel product options. This will put a downward pressure on the price of nonstop products.

In summary, by counterfactually removing intermediate-stop(s) products from the market, the market power effect puts an upward pressure on the price of nonstop products, while the multi-product firm and price-sensitivity effects cause downward pressure on price. Thus, what ultimately happens to the price of nonstop products depends on which effects dominate.

Table 8 summarizes one way of examining the results of counterfactual experiment 1. In particular, among the nonstop products in the sample, the table reports the number of these products with positive versus negative predicted percentage change in their equilibrium price. These results are broken down by whether or not the nonstop products were offered by carriers that also offered substitute intermediate-stop(s) products in the same market, i.e., single-product versus multi-product carriers.

Note that for economy of presentation we omit reporting a column in Table 8 for number of nonstop products with zero price change. For example, among the 813 nonstop products offered by single-product carriers, the information reported in Table 8 is saying that the model predicts price increases for 169 of these products, 28 predicted to have a price decrease, and the remaining 616 nonstop products predicted to have zero price change.

First, we see that even in the case of single-product carriers in a market, as many as 28 nonstop products offered by single-product carriers are predicted to experience a decrease in price. Since the multi-product firm effect is not present for these products, we know that the

predicted price decreases are owing to the domination of the price-sensitivity effect over the market power effect. Second, among the 2184 nonstop products offered by multi-product carriers, the model predicts that 463 of them will have price increases, while 236 of them will have price decreases. Therefore, the majority of these nonstop product prices are predicted to either remain the same or fall, suggesting that the market power effect is often dominated by either or both of the other two effects.

Table 8: Number of Nonstop Products with certain Predicted Percentage Change in Equilibrium Price for Single-product and Multi-product carriers in a Market

	No. of Products	No. of Products with Positive % Change	No. of Products with Negative % Change
Single-product carriers	813	169	28
Multi-product carriers	2184	463	236
Total	2997	632	264

We now examine results of counterfactual experiment 1 in terms of actual predicted percent price changes for nonstop products, rather than mere direction of the predicted price changes previously discussed. Results for actual predicted price changes are reported in Table 9. Results reveal that mean prices of nonstop products are predicted to increase in only a few markets (137 out of 773 markets), but these increases seem to be sufficiently large to yield an overall mean price increase of 0.098%. The overall pattern of predicted price changes persists in mid-haul and long-haul distance markets, but not in short-haul distance markets. In short-haul distance markets the model predicts a mean 0.0034% decline in the prices of nonstop products.

Within the context of the ultimate objective of the counterfactual experiments, mean predicted price changes in Table 9 can alternatively be interpreted in the following manner. Accounting for the part of airlines' optimal pricing behavior that is driven by passengers' preferences over the substitutability (demand elasticities) between nonstop and intermediate-stop(s) products, results from counterfactual experiment 1 suggest that the presence of

intermediate-stop(s) products causes the current prices of some nonstop products to be lower than they would otherwise be owing to the market power effect. Furthermore, due to the multi-product firm and price-sensitivity effects the presence of intermediate-stop(s) products causes the current prices of many nonstop products to be marginally higher than would otherwise be the case.

In defining relevant product markets for antitrust purposes, 5% predicted change in price is typically used as an economically important threshold.[27] As such, for the remainder of the analysis we deem price changes that are at least 5% to be economically important changes.

The right-hand-side panel of Table 9 shows that only 2 of the 773 markets have mean predicted percent price increase greater than 5%, and no market has mean predicted percent price decrease less than -5%. In summary, with the exception of 1 mid-haul distance and 1 long-haul distance markets, all markets have mean predicted price changes for nonstop products being less than 5%.

Table 9: Nonstop-products Predicted Percent Price Change
for Different Market Distance Categories

Markets	No. of Markets	Mean	Std. Dev	Min	Max	No. of Markets that lie within the Percent Price Change category			
						> 0%	> 5%	< 0%	< -5%
All markets	773	0.0984	1.3553	-1.6441	30.759	137	2	79	0
Markets by distance-haul Categories									
Short-haul markets	26	-0.0034	0.0176	-0.0885	0.0107	1	0	2	0
Mid-haul markets	499	0.0782	0.9466	-1.6441	20.007	103	1	54	0
Long-haul markets	248	0.1497	1.9824	-1.6104	30.759	33	1	23	0

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[27] For example, see Section 4.1 in U.S. Department of Justice and Federal Trade Commission (2010), "Horizontal Merger Guidelines".

A Caveat of Counterfactual Experiment 1

A caveat of counterfactual experiment 1 is that we assume that marginal costs of nonstop products are unchanged when intermediate-stop(s) products are counterfactually removed from each market. The presence of intermediate-stop(s) products in markets effectively influences the volume of passengers that travel on nonstop products, which in turn implies that the marginal cost of transporting passengers on nonstop products may be different were it not for the presence of intermediate-stop(s) products. Depending on what adjustments airlines choose to make to accommodate passengers solely using nonstop products (e.g. use smaller planes with more flights versus use larger planes with fewer flights), the marginal cost of transporting passengers on nonstop products may either increase or decrease. As such, the presence of intermediate-stop(s) products in markets may indirectly influence the pricing of nonstop products via a marginal cost channel, which is separate from the demand elasticity-driven channel explored in counterfactual experiment 1.

The subsequent counterfactual analyses consider changes in marginal costs of nonstop products in evaluating the extent to which the presence of intermediate-stop(s) products influences the pricing of nonstop products.

6.5.2 Counterfactual Experiment 2

Counterfactual Experiment 2 evaluates predicted changes in the prices of nonstop products when intermediate-stop(s) products are counterfactually removed from each market, and assuming that such product-type removal causes the marginal cost of nonstop products to uniformly increase by 5%. To provide additional sensitivity analysis, Table B2 and Table B3 in Appendix B report results from experiments analogous to counterfactual experiment 2 (*Counterfactual Experiment 2A* and *Counterfactual Experiment 2B*) with the only differences between these experiments compared to counterfactual experiment 2 being that instead of assuming marginal costs of nonstop products uniformly increase by 5%, we assume they uniformly increase by 2.5% in *Counterfactual Experiment 2A,* but uniformly decrease by 2.5% in *Counterfactual Experiment 2B*. Operationally, the key differences between these experiments compared to counterfactual experiment 1, are that $\widehat{mc}_{ns}$ in equation (15) is replaced by $1.05 \times$ $\widehat{mc}_{ns}$, $1.025 \times \widehat{mc}_{ns}$ or $0.975 \times \widehat{mc}_{ns}$ depending on whether we are implementing *Counterfactual Experiment 2*, *Counterfactual Experiment 2A* or *Counterfactual Experiment 2B*,

respectively. Similar to counterfactual experiment 1, these counterfactual experiments capture the demand-elasticity-driven channel through which intermediate-stop(s) products may influence the pricing of nonstop products, but unlike counterfactual experiment 1, these counterfactual experiments additionally capture a marginal cost channel.

Analogous to Table 8 above, in the case of counterfactual experiment 2, Table 10 reports the number of nonstop products with positive or negative predicted percentage change in their equilibrium price. In addition, Table 10 reports the number of nonstop products with greater than 5% or less than -5% predicted percentage change in their equilibrium price. Compared to results in Table 8, Table 10 reveals that substantially more nonstop products will have predicted price increases in the event that the marginal cost of nonstop products uniformly increase by 5% due to removal of intermediate-stop(s) products. Furthermore, counterfactual experiment 2 shows that a substantial number of nonstop products (126 offered by single-product carriers, and 362 offered by multi-product carriers) are predicted to have a price increase greater than 5%. Notwithstanding the assumed 5% increase in marginal cost of nonstop products caused by the removal of intermediate-stop(s) products, the vast majority of nonstop products (85% [$= \left(1 - \frac{126}{813}\right) \times 100$] of the nonstop products offered by single-product carriers, and 83% [$= \left(1 - \frac{362}{2184}\right) \times 100$] of the nonstop products offered by multi-product carriers) are still predicted to have price changes below 5%.

Table 10: Number of Nonstop Products with Positive vs. Negative Predicted
Percentage Change in Equilibrium Price for Single-product and Multi-product carriers
in a Market, Assuming the Counterfactual Elimination of Intermediate-stop(s)
Products Causes Marginal Cost of Nonstop Products to Uniformly Increase by 5%

	No. of Products	No. of Products with Positive % Change	No. of Products with 5 % Change	No. of Products with Negative % Change	No. of Products with -5% Change
Single-product carriers	813	467	126	54	25
Multi-product carriers	2184	1007	362	200	61
Total	2997	1474	488	254	86

Within the context of the ultimate objective of the counterfactual experiments, the results in Table 10 can alternatively be interpreted in the following manner. Assuming that the presence of intermediate-stop(s) products causes the marginal costs of nonstop products to be lower (about 5%) than they would otherwise be, as well as accounting for the part of airlines' optimal pricing behavior that is driven by passengers' preferences over the substitutability (demand elasticities) between nonstop and intermediate-stop(s) products, results from counterfactual experiment 2 suggest that the current prices of many nonstop products are lower than they would otherwise be owing to the presence of intermediate-stop(s) products. However, given the assumptions of counterfactual experiment 2, for the vast majority of nonstop products (approximately 84% $[= \left(1 - \frac{126+362}{813+2184}\right) \times 100]$) that are offered in markets with intermediate-stop(s) products, the presence of intermediate-stop(s) products either does not influence or causes the current prices of nonstop products to be higher than they would otherwise be.

We now examine results of counterfactual experiment 2 in terms of actual predicted percent price changes for nonstop products. Results for actual predicted price changes are reported in Table 11. We see that the counterfactual removal of intermediate-stop(s) products would result in price increases of nonstop products by a mean 2.64%, 3.02% and 1.16% in short-haul, mid-haul and long-haul distance markets respectively, with an overall mean 2.41% increase across all markets. Note that even though counterfactual experiment 2 assumes that the marginal cost of nonstop products increases by 5% due to the removal of intermediate-stop(s) products, the model still predicts that some of these nonstop products will experience a price decrease, perhaps in part due to the demand-elasticity-driven multi-product carrier and price-sensitivity effects.

Compared to counterfactual experiment 1, counterfactual experiment 2 shows that substantially more markets (109 markets) will experience a mean increase in the price of nonstop products greater than 5%. While there exists markets in each distance category that have economically significant predicted price increases, the mean predicted increases are larger in short-haul and mid-haul distance markets. It is useful to re-interpret these results within the context of the ultimate objective of the counterfactual experiments as follows. Assuming that the presence of intermediate-stop(s) products causes the marginal costs of nonstop products to be uniformly lower (about 5%) than they would otherwise be, as well as accounting for the part of

airlines' optimal pricing behavior that is driven by passengers' preferences over the substitutability (demand elasticities) between nonstop and intermediate-stop(s) products, results from counterfactual experiment 2 suggest that in many (but far from a majority) markets the current prices of nonstop products are substantially lower than they would otherwise be owing to the presence of intermediate-stop(s) products.

Table 11: Nonstop products Predicted Percent Price Change, Assuming the Counterfactual Elimination of Intermediate-stop(s) Products Causes Marginal Cost of Nonstop Products to Uniformly Increase by 5%

Markets	No. of Markets	Mean	Std. Dev	Min	Max	No. of Markets that lie within the Percent Price Change category			
						> 0%	> 5%	< 0%	< -5%
All markets	773	2.4145	6.0999	-12.705	103.317	370	109	52	6
Markets by distance-haul Categories									
Short-haul markets	26	2.6421	1.6310	-1.0512	4.6539	21	0	1	0
Mid-haul markets	499	3.0249	5.5051	-12.705	56.066	290	97	29	2
Long-haul markets	248	1.1625	7.2520	-8.215	103.317	59	12	22	4

6.5.3 Counterfactual Experiment 3

We already know from the previously discussed counterfactual experiments that if the presence of intermediate-stop(s) products causes the marginal costs of nonstop products to be uniformly lower by at most 5% than they would otherwise be, as well as accounting for the part of airlines' optimal pricing behavior that is driven by passengers' preferences over the substitutability (demand elasticities) between nonstop and intermediate-stop(s) products, then the presence of intermediate-stop(s) products in markets with nonstop products substantially influences the pricing of many nonstop products, but not a vast majority. We now implement *Counterfactual Experiment 3* to better understand the conditions necessary for the presence of intermediate-stop(s) products in markets with nonstop products to have an economically significant influence on the pricing of all nonstop products in these markets.

Counterfactual Experiment 3 poses a slightly different question than the experiments previously discussed. Specifically, counterfactual experiment 3 asks: Assuming the

counterfactual removal of intermediate-stop(s) products causes the prices of all nonstop products to increase by the economically significant amount of 5%, by how much do marginal costs of these nonstop products need to change in equilibrium to facilitate such a price increase? So instead of predicting equilibrium price changes as the previously discussed counterfactual experiments do, counterfactual experiment 3 predicts changes in marginal costs of nonstop products necessary to sustain a 5% increase in their price given the removal of intermediate-stop(s) products. Put another way, counterfactual experiment 3 tells us the extent to which the presence of intermediate-stop(s) products need to influence the marginal cost of nonstop products such that in equilibrium the presence of intermediate-stop(s) products causes the current prices of nonstop products to be about 5% lower than they would otherwise be. Operationally, we set the prices in vector $\mathbf{p}^*_{ns}$ in equation (15) to be 5% higher than the actual prices of nonstop products, then solve for the vector of marginal costs, $\widehat{\mathbf{mc}}^*_{ns}$, that satisfy equation (15).

The results from counterfactual experiment 3 are reported in Table 12. The results reveal that in order to sustain a 5% increase in the equilibrium prices of nonstop products in short-haul and mid-haul distance markets, the removal of intermediate-stop(s) products will need to cause the marginal costs of nonstop products to increase by a mean 6.26% and 2.92% across these distance-category markets respectively. However, to sustain a 5% increase in the equilibrium prices of nonstop products in long-haul distance markets, the removal of intermediate-stop(s) products will need to cause the marginal costs of nonstop products to decrease by a mean 0.2%.

Why might a decrease in marginal cost of nonstop products be required in some cases to sustain a uniform 5% increase in prices of these products? This result can occur due to the joint reinforcing effects of prices being strategic complements, and the market power effect that results from eliminating intermediate-stop(s) products. Prices are often strategic complements in static models of oligopoly,[28] i.e., an increase in the price of one product causes the price of competing products to rise in equilibrium. The market power effect in these experiments causes upward pressure on the prices of nonstop products, and strategic complementarily between prices of nonstop products also causes upward pressure on the price of a given nonstop product when the prices of competing products increase. Therefore, by removing intermediate-stop(s) products, as well as uniformly increasing the prices of competing nonstop products by 5%, can require that price of a given nonstop product increases by more than 5% to satisfy Nash

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equilibrium conditions. The nonstop products that require a greater than 5% price increase to satisfy Nash equilibrium conditions are the products that will require a reduction in marginal cost in order to limit their price increase to only 5%. The results in Table 12 suggest that this equilibrium outcome is most likely in long-haul distance markets.

Table 12: Nonstop-products Predicted Percent Change in Marginal Cost,
Assuming the Counterfactual Elimination of Intermediate-stop(s) Products
Causes Prices of Nonstop Products to Uniformly Increase by 5%

Markets	No. of Markets	Mean	Std. Dev	Min	Max
All markets	773	2.029	4.930	-13.778	17.461
Markets by distance-haul Categories					
Short-haul markets	26	6.260	4.455	-7.872	12.163
Mid-haul markets	499	2.916	4.608	-13.778	17.461
Long-haul markets	248	-0.200	4.763	-10.382	12.963

7. Conclusion

The key objective of this paper is to investigate the extent to which intermediate-stop(s) products influence the pricing of nonstop products. Standard oligopoly theory pricing models suggest that there are primarily two channels through which intermediate-stop(s) products may influence the pricing of nonstop products: (1) a demand-elasticity-driven channel; and (2) a marginal cost channel. The demand-elasticity-driven channel recognizes that the optimal markup an airline charges on a given product depends on the product's own-price elasticity as well as the product's cross-price elasticity with substitute products the airline also offers in the market. The marginal cost channel recognizes that an airline's marginal cost of offering a given product in a market may depend on the other products that are also offered in the market. We first conduct a separate and thorough investigation of own-price and cross-price elasticities between nonstop and intermediate-stop(s) products, which motivates and facilitates a separate analysis of the demand-elasticity-driven channel. A subsequent investigation of the joint impact of the demand-elasticity-driven and marginal cost channels is then conducted.

Cross-price elasticity of demand estimates suggest that, on average, consumers perceive intermediate-stop(s) products substitutable for nonstop products. In addition, the average cross-price elasticity increases from short-haul distance to mid-haul distance markets, but decreases a bit from mid-haul distance to long-haul distance markets. Consumers in short-haul distance markets are less willing to switch to an intermediate-stop(s) product in response to an increase in price of a nonstop product. The results also suggest that intermediate-stop(s) products may be an attractive alternative to nonstop products for leisure travelers but less so for business travelers, regardless of the length of market distance.

We then conduct counterfactual exercises to better understand the extent to which the presence of intermediate-stop(s) products influences the pricing of nonstop products. These counterfactual exercises explicitly take into account the two channels through which intermediate-stop(s) products may influence the pricing of nonstop products. The results suggest that if we focus solely on the demand-elasticity-driven part of optimal pricing, then we find that intermediate-stop(s) products typically has a less than 5% impact, and in most cases less than 1%, on the price of nonstop products. However, assuming that the presence of intermediate-stop(s) products causes the marginal costs of nonstop products to be uniformly lower (about 5%) than they would otherwise be, as well as accounting for the demand-elasticity-driven part of optimal pricing, results suggest that in many (but far from a majority) markets the current prices of nonstop products are lower by at least 5% than they would otherwise owing to the presence of intermediate-stop(s) products.

The focus of our analysis is on domestic air travel markets. Since consumers may display different choice behavior in international air travel markets than they do in domestic markets, future research may want to investigate if our findings extend to international air travel markets.

Appendix A: A Linear Demand Example Illustrating the Multi-product Firm Effect

The following example is used to illustrate the multi-product firm effect assuming linear demand and constant marginal cost.

Assume an airline is a multi-product monopolist who offers differentiated products 1 and 2 in an origin-destination market, where product 1 is a nonstop product while product 2 is an intermediate-stop(s) product. The products' linear demand equations are:

$$q_1 = 1 + \beta p_2 - p_1 \; ; \; q_2 = 1 + \beta p_1 - p_2$$

where $0 < \beta < 1$. For simplicity, assume each product has the same constant marginal cost, c. The variable profit for the airline is:

$$\pi = (p_1 - c)[1 + \beta p_2 - p_1] + (p_2 - c)[1 + \beta p_1 - p_2]$$

The corresponding first-order conditions are:

$$c(1 - \beta) - 2p_1 + 2\beta p_2 + 1 = 0 \; ;$$
$$c(1 - \beta) - 2p_2 + \beta p_1 + 1 = 0.$$

Thus, the equilibrium prices for products 1 and 2 are:

$$p_1^* = p_2^* = \frac{1}{2(1 - \beta)} + \frac{c}{2}$$

Now suppose we counterfactually eliminate the intermediate-stop(s) product, which is product 2. In other words, the airline becomes a single-product monopolist who only offers nonstop product 1 in the market. The product's linear demand equation is:

$$q_1 = 1 - p_1.$$

With the assumption of constant marginal cost, c, the variable profit is:

$$\pi = (p_1 - c)[1 - p_1]$$

The corresponding first-order condition is:

$$c - 2p_1 + 1 = 0$$

Thus, the monopoly price is:

$$p_1^M = \frac{1}{2} + \frac{c}{2}$$

Comparing the price of product 1 before and after the counterfactual exercise, we can see that $p_1^M < p_1^*$, which indicates that the price of product 1 decreases if product 2 is removed. Therefore, this example illustrates that, *ceteris paribus*, there exists a downward pressure on price for the remaining products of a multi-product firm when one of the firm's substitute products is removed from the market.

Appendix B: Additional Tables

Table B1: Single-equation Estimation of Nested Logit Demand Equations
with and without Instruments

Variable	With Instruments		Without Instruments	
	Coefficient	(se)	Coefficient	(se)
Price	-12.640[*]	(1.206)	0.358[*]	(0.135)
Interstop	-1.539[*]	(0.052)	-1.059[*]	(0.032)
Inconvenience	-0.921[*]	(0.088)	-0.950[*]	(0.060)
HUB_Origin	1.101[*]	(0.071)	0.864[*]	(0.032)
Tour	0.611[*]	(0.048)	-0.592[*]	(0.036)
Slot_control	-0.392[*]	(0.056)	1.131[*]	(0.043)
σ	0.039	(0.025)	0.428[*]	(0.008)
Constant	-6.564[*]	(0.220)	-8.434[*]	(0.115)
R-square	-		0.4662	
N	11425		11425	

* represents statistical significance at the 0.05 level. Standard errors are in parentheses. Ticketing carrier dummy variables are included in the demand model for estimation even though the associated coefficient estimates are not reported in the table.

Table B2: *Counterfactual Experiment 2A* - An Experiment that Assumes the Counterfactual Elimination of Intermediate-stop(s) Products Causes Marginal Cost of Nonstop Products to Uniformly Increase by 2.5%

	No. of Products	No. of Products with Positive % Change	No. of Products with 5 % Change	No. of Products with Negative % Change	No. of Products with -5% Change
Single-product carriers	813	424	26	43	10
Multi-product carriers	2184	890	107	165	24
Total	2997	1314	133	208	34

Markets	Nonstop Products Predicted Percent Price Change					No. of Markets that lie within the Percent Price Change category			
						> 0%	> 5%	< 0%	< -5%
	No. of Markets	Mean	Std. Dev.	Min	Max				
All markets	773	1.0602	2.708	-8.9197	32.655	325	23	45	2
Markets by distance-haul Categories									
Short-haul markets	26	0.9924	0.886	-0.7029	2.1205	17	0	2	0
Mid-haul markets	499	1.3630	2.766	-5.2107	32.655	259	16	27	1
Long-haul markets	248	0.4580	2.620	-8.9197	29.456	49	7	16	1

Table B3: *Counterfactual Experiment 2B* - An Experiment that Assumes the Counterfactual Elimination of Intermediate-stop(s) Products Causes Marginal Cost of Nonstop Products to Uniformly Decrease by 2.5%

	No. of Products	No. of Products with Positive % Change	No. of Products with 5 % Change	No. of Products with Negative % Change	No. of Products with -5% Change
Single-product carriers	813	45	12	404	21
Multi-product carriers	2184	163	54	813	71
Total	2997	208	66	1217	92

Markets	Nonstop Products Predicted Percent Price Change					No. of Markets that lie within the Percent Price Change category			
						> 0%	> 5%	< 0%	< -5%
	No. of Markets	Mean	Std. Dev.	Min	Max				
All markets	773	-0.5574	2.827	-13.262	43.038	57	9	288	6
Markets by distance-haul Categories									
Short-haul markets	26	-1.1064	0.937	-2.7162	0.9426	1	0	18	0
Mid-haul markets	499	-0.7287	3.316	-13.262	43.038	40	6	232	4
Long-haul markets	248	-0.1550	1.568	-9.7856	13.390	16	3	38	2

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