Inter-Firm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets

By Tae Hoon Oum, Anming Zhang and Yimin Zhang*

1. Introduction

Since deregulation in 1978 the US airline industry has undergone major structural changes. A series of mergers and hub-and-spoke network development have increased market concentration at major airports as well as at industry level. The industry is still being consolidated. Analysts express concern regarding the increasing market power of a few airlines, especially in route markets connected to major hub airports. There is clear evidence that major US airlines attempt to solidify their market power by intensifying hub-and-spoke networks, offering commission overrides to travel agents (a system that rewards agents for directing a high proportion of their business to an airline), using skilful dynamic pricing and seat allocation techniques (scientific yield management) and frequent-flyer bonus programmes for rewarding brand-loyal customers.

A large number of routes are served by three or fewer airlines, indicating that a small-numbers oligopoly is the dominant market structure in the industry, particularly on the routes directly connected to major hubs. Furthermore, recent evidence shows that dominant airlines at hub airports have sustained higher average fares for the local traffic than their competitors (see Borestein, 1989, 1990; and Berry, 1992). This suggests the importance of understanding competitive interaction among airlines in order to explain their pricing behaviour and price differentials between airlines serving the same route markets.

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This paper examines the pattern of firm conduct in different market (route) circumstances and estimates price elasticities of the firm-specific demand (the demand an individual firm faces) and aggregate market demand, taking into account explicitly the form of inter-firm rivalry being practised. This is accomplished by estimating the market demand jointly with the firm-specific first-order conditions for profit maximisation. The estimation is carried out using firm-specific panel data for a set of monopoly and duopoly airline routes connected to American Airlines' and United Airlines' Chicago hub. Our first objective is to calculate the price elasticity of the firm-specific demand by estimating airline "conduct parameters" (often called "conjectural variations"). The estimated conduct parameters will also allow us to test how close each airline's pricing behaviour has been to the Bertrand, Cournot and cartel (collusion) strategies in each route market, in addition to computing price elasticity of the demand faced by each airline in each market.

Our second objective is to examine the pattern of an individual airline's conduct in various market situations. Is there a major difference in pricing behaviour between American Airlines and United Airlines in a similar market situation? Are there systematic differences in pricing behaviour between short and long-distance routes? Is the duopolist pricing behaviour related to its current market share? Is the duopolist pricing behaviour on leisure-oriented routes different from that of other routes? What role does the intensity of activity of fringe airlines and charter services play in shaping the pricing behaviour of the duopolists? These are the questions to be examined using the estimated conduct parameters for the two airlines. The results of these examinations may allow us to make some generalisations about the pricing behaviour in other airline duopoly cases, including the situation in Canada between Air Canada and Canadian Airlines International.

Airline demand and pricing have been the subject of considerable empirical study. Significant effort has been expended in the estimation of airline demand (see Verlegher, 1972; De Vany, 1974; Ippolito, 1981; Mutti and Murai, 1977; Strazheim, 1978; Anderson and Kraus, 1981; Abraham, 1983; Hensher and Louvière, 1983; Oum and Gillen, 1983; Morrison and Winston, 1985; Agarwal and Talley, 1985; Oum, Gillen and Noble, 1986; Haitovsky, Salomon and Silman, 1987; Talley and Schwartz-Miller, 1988; and Fridströö and Thune-Larsen, 1989). All these studies, however, focused on aggregate market demand, fare class demands, or consumer choice of modes, not firm-specific demand. What distinguishes this paper is the explicit estimation of price elasticities of the demand an individual airline faces on each route, taking into account the nature of the inter-firm rivalry being practised.


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1 A survey of airline demand and mode choice studies is included in Oum, Waters and Yong (1992).
2 Abraham and Keeler (1981) are probably the first writers who predicted correctly that there would be consolidation of the US airline industry into five or six airlines as a consequence of deregulation.
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and Berry (1990) investigated the relationship between hub-and-spoke route structure and market power. Berry (1990) concludes that both cost advantage and market power lead to airport dominance; McShane and Windle (1989) quantify the effect of hubbing on cost efficiency. Levine (1987) gives comprehensive discussion on various issues of imperfect competition in deregulated airline markets. Several authors, including Bailey and Baumol (1984), Call and Keeler (1985), Morrison and Winston (1989), Whinston and Collins (1992), and Berry (1992) investigate whether airline markets are “contestable”. These price and contestability studies are concerned with market conduct, at least implicitly. Our paper, distinctly, deals with the explicit estimation of conduct parameters and associated firm-specific price elasticities and attempts to isolate a single strategic setting by focusing only on monopoly and duopoly routes.

Recently Brander and Zhang (1990, 1993) investigated airline conduct in a duopoly airline market, taking into account the inter-firm rivalry explicitly. The latter paper focused on the dynamic aspects of airline pricing behaviour. However, in both papers the authors calculate conduct parameters using the price elasticity of market demand estimated by previous researchers rather than estimating conduct parameters econometrically. What distinguishes the current paper is that we estimate the firm-specific first-order conditions for profit maximisation jointly with the route demand function. This allows us to identify a firm’s conduct parameters separately for each route, and compute price elasticities of the firm-specific demand directly from the estimated equations. In our model, the conduct parameters and demand elasticities vary across routes. In addition, the current paper focuses on examining the pattern of pricing behaviour with respect to route characteristics and the competitive situation under which firms operate.

Section 2 describes the theoretical structure of our investigation. The econometric model is derived in Section 3, while Section 4 describes the data. Empirical results are described in Section 5. A summary, and concluding remarks, are given in Section 6.

2. The Theoretical Structure

Consider an industry which consists of two firms producing a homogeneous product. Let \( x^i \) be the \( i \)th firm’s output, \( i = 1, 2 \). Total output, denoted as \( X \), is the sum of \( x^1 \) and \( x^2 \), and the inverse demand is written as:

\[
p = p(X)
\]

(1)

Using \( C'(x^i) \) to denote total cost, firm \( i \)’s profit function can be written as:

\[
\pi^i = x^i p(X) - C'(x^i)
\]

(2)

If we regard output as the choice variable, then the Nash equilibrium is represented by the following first-order conditions:

\[
p + x^i p' = c^i
\]

(3)

where \( c^i \) denotes marginal cost and \( p' \) the derivative of market price with respect to output. This Nash quantity (or “Cournot”) solution yields, by equation (3), a positive price-cost
margin. Furthermore, when there is only one firm in the industry, the term on the left hand side of equation (3) reduces to monopoly marginal revenue.

In this Cournot model, equilibrium arises when each firm optimally selects its output, given the output of the other firm. The alternative conjectural variation framework arises by assuming that each firm views the other firm’s output as a function of its own output, yielding first-order conditions:

\[ p + x^j p' (1 + v^j) = c^j \]  \hspace{1cm} (4)

where \( v^j = \frac{dx^j}{dx^i} (j \neq i) \) is often called the “conjectural variation”. From equation (4), parameter \( v^j \) may be used to index the degree of competitiveness (or collusiveness) of firm conduct. The higher the level of \( v^j \), the greater the price-cost margin and hence the more collusive the firm conduct. The Cournot solution corresponds to zero conjectural variations, so that if a firm behaves more competitively (collusively) than Cournot, \( v^j < (> ) 0 \). In particular, if price rather than quantity is the choice variable, the Nash price (or “Bertrand”) solution will yield marginal cost pricing. If the two firms have the same marginal costs, this implies that \( v^j = -1 \) in equation (4). In other words, the Bertrand model yields the same outcome as under the perfectly competitive strategy, which leads a firm to believe that it can sell as much output as it likes at the current market price. At the other extreme, if firms manage to collude tacitly and maximise their joint profits, the resulting “cartel” solution will imply, under identical costs, that \( v^j = 1 \). In general, we would have \(-1 < v^j < 1 \). Following Brander and Zhang (1990) we refer to \( v^j \) as a “conduct parameter”.

The knowledge of firm conduct is, thus, essential in discussing and predicting prices in oligopolistic markets. Notice that equation (4) can be rewritten as:

\[ (p - c^j)p = s^j (1 + v^j) \eta \]  \hspace{1cm} (5)

where \( \eta = -\frac{dX/dp}{p/X} \) is the (positive) price elasticity of market demand and \( s^j \) is firm \( i \)'s market share. Further, we can define the (positive) reciprocal of firm \( i \)'s perceived elasticity of demand as \( 1/\eta^i = -\frac{d(p/x^j)}{dx^j} (x^j/p) \). Simple manipulation of this expression yields:

\[ \eta^i = \eta^i s^i (1 + v^j) \]  \hspace{1cm} (6)

Combining equations (5) and (6) shows that each firm’s price-cost margin ratio is given by the reciprocal of its perceived elasticity of demand. Under the monopoly market structure, firm-specific elasticity \( \eta^i \) reduces to the market elasticity and equation (5) becomes:

\[ (p^M - c^M)/p^M = 1/\eta \]  \hspace{1cm} (7)

where \( M \) denotes monopoly. In oligopoly, however, \( \eta^i \) may or may not equal market elasticity \( \eta \), depending on conduct parameters. \( \eta^i = \eta \) if firms manage to achieve the cartel solution. Otherwise, \( \eta^i > \eta \). Thus, even if we observe price-inelastic demand in a market, each oligopolist may face an elastic demand; this makes it difficult to raise prices. Here the extreme case is the Bertrand solution in which \( \eta^i \) approaches infinity. In general, the price elasticity perceived by each firm is positively related to the aggregate price elasticity and inversely related to its market share and conduct parameter. In the Cournot solution, each firm’s elasticity is the market elasticity divided by its output share.
3. The Econometric Model

Our principal objectives in this paper are to calculate firm-specific price elasticities by estimating market-specific and firm-specific conduct parameters for a set of Chicago-based airline routes involving American Airlines and United Airlines, and to relate the estimated conduct parameters to market characteristics (such as route distance). The data points, described more fully later, are characterised by duopoly and monopoly only, with a large majority of them being duopoly.

In Section 2 we considered the case of single, homogeneous products. In fact, airlines produce “product lines” consisting of numerous fare classes (first-class, standard economy, various levels of shallow discounts and deep discounts). This makes it difficult, if not impossible, to carry out complete investigations on airline pricing behaviour, particularly in the context of an oligopoly model. It is impossible to fathom an airline’s pricing strategy by examining all fare levels and their volumes because they are so numerous. All airlines use sophisticated “yield management” programmes, which allow them to allocate seats of a flight dynamically over time as they watch the progress of the actual booking for a given flight (see Brumelle et al., 1990). Since the seat allocation for a flight among numerous fare levels changes daily, if not hourly, the prices an airline charges are not transparent even to expert travel agents (let alone consumers). This makes it easier for an airline to charge a high average fare for essentially the same packages of fare classes in a given route market, which is embedded in its scientifically designed yield management programme. Therefore, it is our opinion that the only feasible way to investigate a firm’s pricing conduct is to look at the overall result of the firm’s yield management practices on a route. The weighted average price charged per passenger on a given route is the single most important indicator for the firm’s pricing strategy in that market. This is the reason we chose to use average yields per passenger on each route.

Since traffic volume of the first-class category is very small, we exclude it from our analysis. Standard economy and discount categories are aggregated together and treated as a single output. It is possible to treat them separately, but the distinction between them is unreliable and not consistent across airlines, as they now practise a sophisticated form of seat allocation across numerous fare classes (yield management). This suggests that aggregating the two categories is a better practice, especially when the purpose of the research is to study the strategic pricing behaviour of the firm and the price elasticities perceived by the firms. An airline’s (weighted) average fare is used as the product price for the airline.

We use “local traffic” as our measure of output. Our local traffic, or trips with single plane service, for a city-pair consists of passengers who originate in one city and terminate in the other without changing planes (but allowing stops). Total origination-destination (O-D) traffic would, however, also include “connecting” passengers who change planes, especially on long-distance routes. We assume that connecting traffic, if any, is exogenous to the major firms in the local market.

We treat the outputs of American Airlines and United Airlines as homogeneous, noting that the two carriers are reasonably symmetric in factors which might affect non-price
product attributes including network.\footnote{In fact, airlines compete both in terms of price and quality of service (mainly frequency). Although it is possible to extend our model to include competitive choice of frequency, it is difficult to implement such a model empirically as it requires not only extensive data on frequency but also the information about how costs vary with frequencies. For a given route competing airlines tend to use aircraft of similar size. As a result, the frequency variables would be highly correlated with market shares. This would pose a problem in estimating the system.} Chicago is a major hub for both airlines while the connecting cities in our data set are not significant for either airline.

Our approach to econometric specification is within the general framework discussed in a survey paper by Bresnahan (1989). Consider market \( k \) at the \( n \)th observation. We convert first-order conditions in equation (5) to the stochastic specification,

\[
p_{k} = \frac{c_{k} \eta_{k}}{\eta_{k} - (1 + v_{k})e_{k}} + e_{k}^{*}
\]

(8)

where \( i = 1 \) for American Airlines (AA) and 2 for United Airlines (UA), and \( e_{k}^{*} \) is a random error term. It is worth noting that the error terms in equation (8) allow observed prices to be different between competing airlines even though the first-order condition (equation (5)) implies the same price. Suppose quantity and price data are available. Then conduct parameters \( v_{k} \) can be estimated, using equation (8), if we know marginal cost \( c_{k} \) and the price elasticity of route demand \( \eta_{k} \). Consider first the determination of route demand elasticities. One approach is simply to use the results from existing airline demand studies, as in Brander and Zhang (1990, 1993). However, this approach has two potential drawbacks. First, all the existing airline demand studies we could find (for example, Oum, Gillen and Noble, 1986; Anderson and Kraus, 1981; Straszheim, 1978; and Mutti and Murai, 1977) used pre-deregulation data. As our analysis focuses on firm rivalry in the post-deregulation era, demand elasticities might have changed over the time period. Second, the airline routes considered by these studies do not nest ours, so the best we can do is use an average estimate of elasticity for all our routes. To the extent that elasticities differ systematically across the routes under investigation, this approximation would introduce a source of error in estimating conduct parameters for each route.

Our approach here is to estimate demand elasticities by using the current data set. We approximate market demand (the inverse of equation (1)) with a log-linear functional form as follows:

\[
\log X_{k} = A - \eta_{k} \log p_{k} + g(Y_{k}) + \epsilon_{k}
\]

(9)

where \( A \) is an (unknown) parameter associated with the demand intercept, \( Y_{k} \) is a vector of variables shifting demand, \( g(*) \) is some function to be determined, and \( \epsilon_{k} \) is a random error term. Note that the market demand elasticity, \( \eta_{k} \), enters demand equation (9) as route-specific. Thus, we impose no restrictions on the way \( \eta_{k} \) may vary across routes as well as on their levels: \( \eta_{k} \) are estimated from the data.

As indicated above, estimation of conduct parameters requires marginal cost information for each carrier on each route. Brander and Zhang (1990) have proposed a method in which the route-specific marginal cost is calculated as follows:

\[
c_{k} = \text{cpr}_{i} \times (D_{k} / AFL_{i})^{\theta} D_{k}
\]

(10)
where \( c_{pm_i} \) is each carrier’s cost per passenger-mile for an “average” route in the US domestic market, \( A\ell F_i \) is each carrier’s average flight length for the US market as a whole, and \( D_k \) is the distance of route \( k \). From equation (10), calculation of route-specific marginal costs requires knowledge of \( \theta \). If \( \theta = 0 \), then the cost per passenger is simply equal to the cost per passenger-mile multiplied by flight length, indicating a linear relationship between cost and distance. However, it is well known in airline economics that costs are strictly concave in distance rather than linear, implying \( 0 < \theta < 1 \). This phenomenon is called the “cost taper”, and \( \theta \) may be used to capture the “tapering effect”. The higher the value of \( \theta \), the stronger the tapering effect. Several studies in the airline literature suggest a value of about 0.5 for \( \theta \), and Brander and Zhang (1990) use \( \theta = 0.5 \) in their “base case” analysis.

We use equation (10) as our marginal cost formula, but treat \( \theta \) as an unknown parameter of the cost function. Substituting (10) into (8) yields:

\[
p^*_k = \frac{[c_{pm_i} \cdot (D_k / A\ell F_i)^\theta \cdot D_k]}{\eta_k - (1 + \eta_j) \cdot sl_k} + \epsilon^*_k
\]

(11)

When firm \( i \) is a monopoly on route \( k \) at observation \( t \), use of equation (10) gives:

\[
p^M_k = \frac{[c_{pm_i}^M \cdot (D_k / A\ell F_i^M)^\theta \cdot D_k]}{\eta_k - s^M_l} + \epsilon^M_k
\]

(12)

where \( s^M_l \) is the firm’s market share in the route market. Note that the monopoly pricing behaviour implied by equation (12) generalises that given in (7): if the firm is a “pure” monopolist, then \( s^M = 1 \) and the former reduces to the latter. We use equation (12) because although a single firm may have a substantial market presence, it is empirically rare for the firm to have 100 per cent market share. Given that all the other output is exogenous to the major firm, monopoly pricing (7) can be shown to extend to (12). Although our main concern is firm conduct in oligopolistic markets, data on monopoly routes contain valuable information in determining econometrically the cost and demand functions noting that, given the market share, monopoly conduct, unlike oligopoly conduct, is well specified.

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4 One obvious reason for this lies in the fact that airline costs can be separated into line-haul costs and terminal costs, where terminal costs are those related to the amount of traffic carried but independent of the mileage travelled. A less apparent reason may have something to do with passenger load factor (an indicator of aircraft seat utilisation). The optimal load factor is shown to be higher on long-distance routes than on short-distance routes (see Douglas and Miller, 1974), but a high load factor tends to reduce the cost per passenger, suggesting that long-distance routes tend to have lower costs per passenger-mile than short-distance routes.

5 The profit function for the major firm (“monopolist”) is:

\[
\pi^M = p^M (x^M + x_p) - c^M
\]

(13)

where \( x_p \) denotes the output other than the major firm. The first-order condition for the monopolist, assuming \( x_p \) is exogenous, requires that

\[
p^M + x^M p' - c^M = 0
\]

(14)

where \( p^M = p(x^M + x_p) \). This can be rewritten as:

\[
(p^M - c^M)p^M = s^M \eta
\]

(15)

Substitution of (10) into (15) gives (12).
The first-order conditions of equation (11) ((12) in the case of monopoly) and demand equation (9) are jointly estimated by a maximum likelihood method using a pooled cross-sectional and time-series data set of the Chicago-based airline routes.  

4. The Data

We obtained price and quantity data from I. P. Sharp Associates. The I. P. Sharp data are derived from Databank 1A of the US Department of Transportation (DOT) Origin and Destination Survey. This data set, OD1A, is a 10 per cent sample of all tickets that originate in the US on significant domestic carriers. The basic unit of our price data is the directional fare, which is taken to be half of the excursion (or round-trip) fare. Our volume information contains the number of directional local passengers in the 10 per cent sample for each airline on each route.

We used the following procedure to obtain airline routes in our data set. Twenty routes were selected by taking all Chicago-based city-pair routes for 1985 on which American and United together had a market share exceeding 90 per cent, and on which each carrier had at least 100 passengers per quarter in the 10 per cent sample. The quantity data for the 20 routes were then collected for each quarter from 1981 to 1988. The data for the first and third quarters of 1988 contained errors and were not usable. This left us with thirty quarters and a total of 20 x 30 = 600 potential data points.

Useful data points for our purpose are those that are characterised as duopoly (between AA and UA) or monopoly (AA or UA). We classified an observation (a quarterly data point) as duopoly if the combined market share of AA and UA exceeded 75 per cent, each "duopolist" had at least 30 per cent of the combined share, and the quarterly traffic volume for each airline in the 10 per cent sample was at least 100 passengers. An observation is classified as monopoly if AA (or UA) alone had at least 90 per cent market share and its quarterly traffic volume in the 10 per cent sample was at least 100 passengers. All other observations were excluded from our econometric estimation.

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6 Note that, theoretically, there are three equations (two price equations and one demand equation) for a duopoly route but only two equations (one price equation and one demand equation) for a monopoly route. Our econometric model is a three-equation system. In particular, a third equation will be created when the estimation switches to a monopoly route, and this equation is essentially an identity.

7 Many studies (including Call and Keefer, 1985; Levine, 1987; Morrison and Winston, 1990; Borenstein, 1989, 1990; Berry, 1990; and US DOT, 1990) conclude that the degree of airport dominance affects airline pricing behaviour as a result of such factors as market power, consumer's valuation of higher departure frequency, and cost advantage, all of which come with high presence in a major airport. For this reason, we also excluded major hub airports (such as Denver and Dallas/Fort Worth) from the data.

8 OD1A data are quarterly, beginning on 1 January 1981, and are updated and revised regularly but with a substantial lag.

9 Defining duopoly as having jointly at least 75 per cent market share and monopoly as having at least 90 per cent market share is somewhat arbitrary. US DOT (1990) used 90 per cent market share to define a monopoly route, whereas Brander and Zhang (1990) used 75 per cent market share to define a duopoly route. We have conducted sensitivity analysis using slightly different market share criteria (80 or 70 per cent for oligopoly, 95 or 85 per cent for monopoly) and found that, at least for this data set, the results reported below are not sensitive to these small changes.
After applying the above filtering rule, the total number of observations used for econometric implementation is 359 quarterly data points spanning 20 routes for the 1981-88 period. Of the 359 data points, 308 (about 86 per cent) are in the duopoly category, while the remaining 51 are in the monopoly category. Therefore, duopoly is the primary feature of this data set. The eight-year quantity data set also reveals structural changes on several routes over time, especially between the earlier and later years. All 51 monopoly observations were in the first half of the sample period (that is, before the fourth quarter of 1984) while the duopoly data points spanned the entire period, with about two-thirds of them in the second half of the sample period. Table 1 lists the names of each connecting city and the distance of each route, in ascending order of distance. It also shows, using data on duopoly routes only, the mean prices for American Airlines and United Airlines on each route. The mean passenger volumes in each market are given in column 5 while the last column contains the combined mean market share of the two carriers.

As discussed in Section 3, estimation of marginal costs needs data on a carrier’s overall cost per passenger-mile, $cpmi$, and on a carrier’s average flight length for the US market, $AFL$. Following Brander and Zhang (1990) we used operating expenses as a proxy for variable cost. US DOT reports operating expenses for each carrier based on its Form 41 (see Air Carrier Financial Statistics). The DOT also reports revenue passenger-miles, which is equal to available seat miles multiplied by load factor (see Air Carrier Traffic Statistics). We obtained $cpmi$ by dividing operating costs by passenger miles for each year. $AFL$ was obtained by dividing aircraft revenue miles by aircraft revenue departures performed in each year (Air Carrier Traffic Statistics). Our calculation shows that the average cost per passenger-mile and the average stage length are very similar between the two airlines, with an overall average cost of 12.56 cents for American and 11.93 cents for United, and an overall average distance of 778 miles for American and 773 miles for United.

In equation (9) we specified the route aggregate demand as a function of the average market price and the demand-shifting factors, $g(Y)$.

In order to incorporate the market demand function into the system of estimating equations, we need to choose the variables $Y$ and the functional form $g(*)$. Typically, aggregate airline demand models using route data include the three usual components of gravity-type of transport interaction model between cities: population, income of the origin and destination cities, and one or more measure of impedance between the two cities. Since an average air fare variable is already included in (9) and Chicago is one end of all the routes included in our sample, we only considered population and income of the cities on the other end of the route. Since both population and per-capita income were not statistically significant at any reasonable level on the basis of a likelihood ratio test, it was decided to include the airport catchment area’s total income (that is, the product of population and per-capita income). In addition, we incorporated two dummy variables: a dummy variable indicating high demand seasons (second and third quarters) and a dummy variable indicating vacation-oriented routes (Las Vegas and Reno routes).

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10 Operating expenses are costs incurred in the performance of air transport and air transport related services. This includes direct aircraft operating expenses, ground expenses and indirect operating expenses.
### Table 1
*Route, Distance, Mean Price and Volume on Duopoly Routes*

<table>
<thead>
<tr>
<th>Route</th>
<th>Distance (miles)</th>
<th>AA Fare</th>
<th>UA Fare</th>
<th>Local Passenger</th>
<th>AA and UA Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Rapids</td>
<td>134</td>
<td>112</td>
<td>117</td>
<td>1452</td>
<td>0.970</td>
</tr>
<tr>
<td>Des Moines</td>
<td>306</td>
<td>131</td>
<td>138</td>
<td>2539</td>
<td>0.995</td>
</tr>
<tr>
<td>Omaha</td>
<td>423</td>
<td>127</td>
<td>128</td>
<td>2539</td>
<td>0.946</td>
</tr>
<tr>
<td>Buffalo</td>
<td>467</td>
<td>150</td>
<td>144</td>
<td>2071</td>
<td>0.980</td>
</tr>
<tr>
<td>Rochester</td>
<td>522</td>
<td>159</td>
<td>157</td>
<td>1639</td>
<td>0.994</td>
</tr>
<tr>
<td>Tulsa</td>
<td>587</td>
<td>134</td>
<td>133</td>
<td>1500</td>
<td>0.972</td>
</tr>
<tr>
<td>Wichita</td>
<td>591</td>
<td>173</td>
<td>171</td>
<td>964</td>
<td>0.985</td>
</tr>
<tr>
<td>Syracuse</td>
<td>601</td>
<td>164</td>
<td>163</td>
<td>1371</td>
<td>0.996</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>692</td>
<td>159</td>
<td>160</td>
<td>1627</td>
<td>0.963</td>
</tr>
<tr>
<td>Albany</td>
<td>717</td>
<td>176</td>
<td>177</td>
<td>1352</td>
<td>0.996</td>
</tr>
<tr>
<td>Hartford</td>
<td>778</td>
<td>180</td>
<td>185</td>
<td>3745</td>
<td>0.980</td>
</tr>
<tr>
<td>Providence</td>
<td>842</td>
<td>165</td>
<td>171</td>
<td>1549</td>
<td>0.988</td>
</tr>
<tr>
<td>Austin</td>
<td>972</td>
<td>150</td>
<td>156</td>
<td>1141</td>
<td>0.850</td>
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<tr>
<td>Phoenix</td>
<td>1440</td>
<td>176</td>
<td>156</td>
<td>7061</td>
<td>0.871</td>
</tr>
<tr>
<td>Tucson</td>
<td>1441</td>
<td>160</td>
<td>154</td>
<td>1400</td>
<td>0.966</td>
</tr>
<tr>
<td>Las Vegas</td>
<td>1521</td>
<td>148</td>
<td>116</td>
<td>4982</td>
<td>0.874</td>
</tr>
<tr>
<td>Reno</td>
<td>1680</td>
<td>166</td>
<td>151</td>
<td>769</td>
<td>0.945</td>
</tr>
<tr>
<td>Ontario, CA</td>
<td>1707</td>
<td>199</td>
<td>194</td>
<td>1432</td>
<td>0.955</td>
</tr>
<tr>
<td>Sacramento</td>
<td>1790</td>
<td>195</td>
<td>195</td>
<td>846</td>
<td>0.980</td>
</tr>
<tr>
<td>San Jose</td>
<td>1837</td>
<td>222</td>
<td>218</td>
<td>1418</td>
<td>0.991</td>
</tr>
</tbody>
</table>

A statistical test using Box-Cox transformation of the total income variable in $g(Y_{kt})$ indicated superiority of the logarithmic transformation of that variable over the linear form. Therefore, the log of total income variable and the two dummy variables indicated above enter in the route aggregate demand function (9).

Measurement of population and per-capita income raises a difficulty of defining the “proper” catchment area of each airport. For most airports, we collected the data from *Local Area Personal Income* published by the US Department of Commerce, Bureau of Economic Analysis. This source reports population figures for the metropolitan statistical area (MSA). However, for some airports MSA may not be a good indicator for the airport catchment area.\(^\text{11}\) For these airports (San Jose and Ontario, California) it was necessary to adjust the population figures.

\(^{11}\) For example, multiple airports exist near San Jose and Ontario, CA. Many passengers who travel to and from San Jose use other airports in the San Francisco area (see Harvey, 1987); and many who travel to and from Ontario use Los Angeles area airports.
5. Empirical Results

Two hypotheses were tested concerning conduct parameters of the two airlines. The first hypothesis was to test whether or not American and United adopted identical pricing strategy on all routes in the sample. This can be tested by constraining the equality of conduct parameters on each route, that is, \( v_{ik}^1 = v_{ik}^2 \) for all routes \( k = 1, \ldots, 20 \) (20 degrees of freedom). The second hypothesis concerns whether or not a given airline adopted identical pricing strategy on all routes. This is tested by constraining equality of each airline’s conduct parameters across all 20 routes (38 degrees of freedom), that is, \( v_{ik}^1 = v_{ik}^1 \) for \( k = 2, \ldots, 20 \) and \( i = 1, 2 \). The asymptotic likelihood ratio test was employed to test these hypotheses. Both hypotheses are rejected overwhelmingly.\(^{12}\) These test results indicate that American and United do not apply the same pricing strategy on all the routes, and neither airline applies an identical pricing strategy in all markets. Therefore, in the remainder of this paper, our discussion will be based on the unconstrained econometric model.

Table 2 reports the maximum likelihood parameter estimates for the (unconstrained) econometric model with the standard errors of the estimates in parentheses. The nonlinear estimation converged to these estimates from several different sets of starting values, indicating that the global maximum was (probably) located. Below we discuss the key empirical findings.

Route demand functions
The price elasticity estimate for the route aggregated demand ranges between 1.24 and 2.34 with the vacation routes (Las Vegas and Reno) assuming the highest values. (For routes other than Las Vegas and Reno, the price elasticity ranges between 1.24 and 1.67.) The average price elasticity for the 20 sample routes is 1.58. These elasticity estimates are very close to the estimates reported in previous studies (see, for example, Oum, Gillen and Noble, 1986\(^{13}\)), which used pre-deregulation data. The higher price elasticities for vacation routes are expected because a higher proportion of the users of those routes are leisure travellers, who tend to be more price-sensitive than non-leisure (business) travellers. We also note that for the majority of the routes the elasticity estimates are fairly uniform. All the demand-shifting variables (total income, seasonal and vacational dummies) have expected signs and are statistically significant for the two dummy variables.

---

\(^{12}\) The likelihood ratio test statistics are as follows. The test statistic for the hypothesis of equality of conduct parameters between the two airlines is \(-2(L_0 - L_1) = 2(3472 - 3425) = 94\), where \( L_0 \) is the value of the log-likelihood function under the null hypothesis and \( L_1 \) the value of the log-likelihood function for the unconstrained model. Since the critical value of \( \chi^2_{20} \) at \( \alpha = 0.01 \) is 38, we reject the null hypothesis of equal conduct parameters overwhelmingly. The test statistic for the hypothesis of equal conduct parameters across 20 routes for both airlines is \(-2(L_0 - L_1) = 2(3504 - 3425) = 158\). Since the critical value of \( \chi^2_{38} \) at \( \alpha = 0.01 \) is 63, we reject the null hypothesis overwhelmingly.

\(^{13}\) They estimated a two-stage consumer demand system for US domestic air travel routes, using a cross-sectional sample of 200 routes in 1978. Fare classes were sub-divided into first-class, standard economy and discount. Their estimated elasticities for the discount fare class range from 1.5 to 2.0, and the range for regular economy is 1.2 to 1.4.
Table 2
Parameter Estimates of the Econometric Model
(Standard Errors in Parentheses)

<table>
<thead>
<tr>
<th>Route</th>
<th>Elasticity</th>
<th>AA Conduct Parameter</th>
<th>UA Conduct Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Rapids</td>
<td>1.671 (0.070)</td>
<td>0.636 (0.140)</td>
<td>0.829 (0.156)</td>
</tr>
<tr>
<td>Des Moines</td>
<td>1.475 (0.070)</td>
<td>0.730 (0.239)</td>
<td>0.094 (0.156)</td>
</tr>
<tr>
<td>Omaha</td>
<td>1.492 (0.068)</td>
<td>0.668 (0.374)</td>
<td>0.038 (0.209)</td>
</tr>
<tr>
<td>Buffalo</td>
<td>1.515 (0.067)</td>
<td>0.061 (0.122)</td>
<td>0.148 (0.159)</td>
</tr>
<tr>
<td>Rochester</td>
<td>1.542 (0.065)</td>
<td>0.023 (0.103)</td>
<td>0.329 (0.131)</td>
</tr>
<tr>
<td>Tulsa</td>
<td>1.564 (0.067)</td>
<td>-0.203 (0.172)</td>
<td>0.494 (0.296)</td>
</tr>
<tr>
<td>Wichita</td>
<td>1.623 (0.068)</td>
<td>0.029 (0.164)</td>
<td>-0.072 (0.154)</td>
</tr>
<tr>
<td>Syracuse</td>
<td>1.553 (0.065)</td>
<td>-0.042 (0.103)</td>
<td>0.437 (0.139)</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>1.523 (0.064)</td>
<td>-0.182 (0.118)</td>
<td>0.423 (0.170)</td>
</tr>
<tr>
<td>Albany</td>
<td>1.543 (0.064)</td>
<td>-0.049 (0.102)</td>
<td>0.460 (0.135)</td>
</tr>
<tr>
<td>Hartford</td>
<td>1.356 (0.067)</td>
<td>0.131 (0.149)</td>
<td>-0.135 (0.102)</td>
</tr>
<tr>
<td>Providence</td>
<td>1.581 (0.065)</td>
<td>-0.437 (0.207)</td>
<td>-0.307 (0.179)</td>
</tr>
<tr>
<td>Austin</td>
<td>1.589 (0.068)</td>
<td>-0.440 (0.253)</td>
<td>-0.019 (0.298)</td>
</tr>
<tr>
<td>Phoenix</td>
<td>1.241 (0.067)</td>
<td>-0.853 (0.163)</td>
<td>-1.014 (0.263)</td>
</tr>
<tr>
<td>Tucson</td>
<td>1.523 (0.064)</td>
<td>-0.813 (0.134)</td>
<td>-0.661 (0.206)</td>
</tr>
<tr>
<td>Las Vegas</td>
<td>2.032 (0.251)</td>
<td>-0.693 (0.604)</td>
<td>-1.493 (0.572)</td>
</tr>
<tr>
<td>Reno</td>
<td>2.336 (0.240)</td>
<td>-0.509 (0.325)</td>
<td>-0.893 (0.272)</td>
</tr>
<tr>
<td>Ontario, CA</td>
<td>1.500 (0.062)</td>
<td>-0.412 (0.126)</td>
<td>-0.476 (0.117)</td>
</tr>
<tr>
<td>Sacramento</td>
<td>1.589 (0.062)</td>
<td>-0.538 (0.168)</td>
<td>-0.548 (0.109)</td>
</tr>
<tr>
<td>San Jose</td>
<td>1.461 (0.061)</td>
<td>-0.283 (0.106)</td>
<td>-0.363 (0.087)</td>
</tr>
</tbody>
</table>

Intercept (A) 13.375 (1.189)
Total income \( (g_1) \) 0.163 (0.125)
Seasonal dummy \( (g_2) \) 0.080 (0.026)
Vacational dummy \( (g_3) \) 3.634 (1.194)
Tapering factor \( (\theta) \) 0.432 (0.029)

Log-likelihood \(-3425.062\)
Cost function
The estimate for $\theta$ (distance tapering factor for the cost) is 0.43, with a standard error of 0.03. As expected, a hypothesis test would strongly reject both $\theta = 0$ (linear relationship between cost and distance) and $\theta = 1$ (cost per passenger being unrelated to distance). Furthermore, $\theta = 0.5$, which was used by previous researchers, would also be rejected at the 5 per cent level of significance.\textsuperscript{14} Our estimate, 0.43, lies between 0.15 estimated by Caves et al. (1984) and the value 0.67 estimated by Borenstein (1989). Our costing model in equation (10) gave very similar predicted costs for American and United on most of our sample routes. This justifies using the firm conduct value of $-1$ and $1$ to indicate the Bertrand and cartel behaviour, respectively.\textsuperscript{15} The Cournot conduct parameter (which equals 0) is not affected by marginal cost differences.

Conduct parameter estimates
All 40 route-specific conduct parameters are in the “reasonable range” of $-1$ (Bertrand) and $1$ (cartel) as predicted by our theoretical structure. There are two possible exceptions involving United’s conduct parameters for Phoenix ($-1.01$) and Las Vegas ($-1.49$). Statistically, both are not different from $-1$. As discussed earlier, a conduct parameter close to $-1$ would indicate marginal cost pricing, while a conduct parameter less than $-1$ would suggest pricing below marginal cost. The actual record shows that United’s average yield on the Las Vegas route was $116, as compared to $148 charged by American (see Table 1). The estimated marginal cost figures, on the other hand, were $134 for United and $137 for American. One possible explanation is that United was reacting to the active competition from charter carriers and fringe scheduled carriers as well as trying to maintain its dominant position over American.\textsuperscript{16}

Table 3 reports 95 per cent confidence intervals for the conduct parameters. It may be worth noting that almost one half (19 out of 40) of the conduct parameters include the Cournot value of 0 in their 95 per cent confidence intervals. Eight conduct parameters (involving four routes — Phoenix, Tucson, Las Vegas and Reno — which may be referred to as “sunspot” destinations) include the Bertrand value of $-1$. Thus oligopolistic conduct may be described as being Bertrand behaviour in leisure-oriented (sunspot) markets. Only three out of 40 conduct parameters (involving Grand Rapids, Des Moines, and Omaha, the three shortest routes in the sample) include the cartel value of 1 in the 95 per cent confidence intervals. However, the 95 per cent confidence interval for American in the Omaha route also includes the Cournot value of 0. In sum, the competitive behaviour for American and United may be described as being between Bertrand and Cournot behav-

\textsuperscript{14} The likelihood ratio test rejects the null hypothesis of $\theta = 0.50$ at $\alpha = 0.05$ level: $-2(L_0 - L_1) = 2(3428.27 - 3425.06) = 6.42 > $ critical value of $\chi^2 (0.05) = 3.84$, where $L_0$ is the value of the log-likelihood function under the null hypothesis. But the hypothesis of $\theta = 0.50$ is not rejected at $\alpha = 0.01$ level ($\chi^2 (0.01) = 6.63$).

\textsuperscript{15} Different marginal costs for duopolists could affect the values of firm-specific conduct parameters under the Bertrand solution and the cartel solution.

\textsuperscript{16} There was active competition from charter carriers in the Chicago-Las Vegas market. Furthermore, as the data in Table 1 show, this route has an unusually high presence of fringe scheduled carriers as compared to other duopoly routes.
Table 3
95 Per Cent Confidence Intervals for Conduct Parameters

<table>
<thead>
<tr>
<th>Route</th>
<th>AA Conduct Parameters</th>
<th>UA Conduct Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Rapids</td>
<td>0.362, 0.910</td>
<td>0.524, 1.078</td>
</tr>
<tr>
<td>Des Moines</td>
<td>0.262, 1.198</td>
<td>-0.211, 0.343</td>
</tr>
<tr>
<td>Omaha</td>
<td>-0.064, 1.400</td>
<td>-0.371, 0.372</td>
</tr>
<tr>
<td>Buffalo</td>
<td>-0.178, 0.300</td>
<td>-0.163, 0.402</td>
</tr>
<tr>
<td>Rochester</td>
<td>-0.179, 0.225</td>
<td>0.073, 0.538</td>
</tr>
<tr>
<td>Tulsa</td>
<td>-0.540, 0.134</td>
<td>-0.086, 0.967</td>
</tr>
<tr>
<td>Wichita</td>
<td>-0.292, 0.350</td>
<td>-0.374, 0.174</td>
</tr>
<tr>
<td>Syracuse</td>
<td>-0.244, 0.160</td>
<td>0.165, 0.659</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>-0.413, 0.049</td>
<td>0.090, 0.695</td>
</tr>
<tr>
<td>Albany</td>
<td>-0.249, 0.151</td>
<td>0.196, 0.676</td>
</tr>
<tr>
<td>Hartford</td>
<td>-0.161, 0.423</td>
<td>-0.335, 0.028</td>
</tr>
<tr>
<td>Providence</td>
<td>-0.842, -0.032</td>
<td>-0.657, -0.021</td>
</tr>
<tr>
<td>Austin</td>
<td>-0.935, 0.055</td>
<td>-0.602, 0.457</td>
</tr>
<tr>
<td>Phoenix</td>
<td>-1.182, -0.544</td>
<td>-1.529, -0.594</td>
</tr>
<tr>
<td>Tucson</td>
<td>-1.075, -0.551</td>
<td>-1.064, -0.332</td>
</tr>
<tr>
<td>Las Vegas</td>
<td>-1.876, 0.490</td>
<td>-2.613, -0.579</td>
</tr>
<tr>
<td>Reno</td>
<td>-1.145, 0.127</td>
<td>-1.426, -0.458</td>
</tr>
<tr>
<td>Ontario, CA</td>
<td>-0.659, -0.165</td>
<td>-0.705, -0.289</td>
</tr>
<tr>
<td>Sacramento</td>
<td>-0.867, -0.209</td>
<td>-0.761, -0.374</td>
</tr>
<tr>
<td>San Jose</td>
<td>-0.491, -0.075</td>
<td>-0.533, -0.224</td>
</tr>
</tbody>
</table>

...jor, but closer to Cournot, on most of the sample routes we investigated. This result is not inconsistent with the result of Brander and Zhang (1990), who obtained Cournot behaviour by using a different methodology and a single period data set.

The average values of the conduct parameters of all routes are -0.16 for American and -0.14 for United. These are more competitive than the Cournot conduct while being very close to it. If we assume that costs are roughly the same between monopoly and duopoly routes for the same airlines, then our results can show that moving from duopoly to monopoly routes would raise prices by about 17 per cent. This result is consistent with the estimates obtained in the literature.\(^{17}\) Also, since the number of actual competitors does affect prices, it is another endorsement of the almost unanimous findings of the recent

\(^{17}\) For example, Hurdle et al. (1989) find, using 850 non-stop city-pair routes in the US, that a reduction from two to one firms raised prices on average by 20 per cent. Borenstein (1992) reports that in 1990, prices on routes with two active competitors averaged about 8 per cent lower than on monopoly routes. Our estimate of 17 per cent is between the estimates of the above two studies.
Inter-Firm Rivalry in Deregulated Airline Markets

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![Graph showing Differential Conduct Parameters vs. Differential Market Shares]

**Figure 1**

*Differential Conduct Parameters vs. Differential Market Shares*

studies which conclude that deregulated airline markets are not perfectly contestable (see, for example, Call and Keeler, 1985; Morrison and Winston, 1989; Levine, 1987; and Hurdle et al., 1989).

It can be seen from Table 2 that, although being close to each other overall, conduct parameters of the two airlines (at least their point estimates) are quite different in some route markets. This may imply that, in these markets, the two airlines perceive competition differently and thus employ different pricing strategies. A careful examination of the correlation between conduct parameters and market share distribution led us to make the following inferences.

- The conduct parameters tend to be different between American and United in markets with unequal division of market shares, while they are similar in markets with similar market share divisions (see Figure 1). In fact, the correlation between the difference in the conduct parameters and the differential market shares of the two carriers is 0.90 ($t$-ratio of $-8.6$).

- The observed relationship between conduct parameters and the firm's market shares (see Figure 2) suggests that, in these essentially duopoly markets, the carrier with the higher market share tends to have lower conduct parameters. This negative correlation (the correlation coefficient is $-0.27$ for American and 0.44 for United) may be interpreted in two alternative ways: (a) the airline with the higher market share behaves more competitively than its opponent; (b) the firm that prices more aggressively succeeds in securing a higher market share.
Figure 2
*Estimated Conduct Parameters vs. AA's Market Share*

Figure 3
*Estimated Conduct Parameters vs. AA and UA's Market Shares*
An examination of the conduct parameters and route characteristics led us to make the following observations.

- There is fairly strong evidence that conduct parameters are inversely related to distance, implying that firms price more competitively in longer distance routes. (Similar findings are obtained by, among others, US DOT, 1990). This may result from the additional competition posed by other carriers serving the same route markets, using connecting flights through their respective hubs. For example, Western Airlines (now a part of Delta) served Chicago and Las Vegas out of its Salt Lake City hub. Chicago-Las Vegas passengers could have taken a connecting flight at Salt Lake City.

- The conduct parameters tend to be negative in the markets with a significant presence of fringe airlines (for example, Phoenix and Las Vegas). Figure 3 demonstrates graphically that the conduct parameters of both American and United increase (become less competitive) as their combined market share increases.

A regression of the conduct parameters on the combined market share of American and United and distance variables confirms the above results, that is, a positive and significant coefficient for the combined market share (t-ratio of 2.70), and a negative and highly significant coefficient for distance (t-ratio of –7.28).

Firm-specific price elasticities
The price elasticities of demand each firm faces are computed using the estimated conduct parameters, the market shares of the two firms, and the price elasticities of market demand (see equation (6)). Table 4 reports these firm-specific elasticity results in the last two columns, and the market demand elasticity (from Table 2) in the first column. It is possible to make the following observations from the firm-specific price elasticity results.

- The firm-specific elasticities are similar between American and United. This is a striking result in view of the quite different conduct parameters observed in some of our sample routes. A closer examination reveals that the similarity in elasticities between the two carriers is caused by similar performance in price-cost margin ratios by the two airlines in most routes. Equations (5) and (6) show that the firm-specific elasticity is equal to the inverse of the margin ratio of the airline. This indicates that the duopolists appear to use pricing strategy which equalises the ratio of margin to price. This is indeed a surprising discovery.

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18 This is expected because fringe airlines disciplined the duopolists by offering cheaper fares or by acting as a spoiler in the market. This happened in Canada where Wardair, a minor player in the trans-Canada market, disciplined the duopolists (Air Canada and Canadian Airlines) before being acquired by Canadian. This result is also consistent with the findings of Graham, Kaplan and Sibley (1983) and Borenstein (1990) who conclude that airlines find it more difficult to collude tacitly in markets with three carriers than in markets with two carriers.
### Table 4

*Estimated Firm-Specific Elasticities*

<table>
<thead>
<tr>
<th>Route</th>
<th>Market</th>
<th>AA</th>
<th>UA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Rapids</td>
<td>1.671</td>
<td>2.015</td>
<td>1.853</td>
</tr>
<tr>
<td>Des Moines</td>
<td>1.475</td>
<td>2.355</td>
<td>2.113</td>
</tr>
<tr>
<td>Omaha</td>
<td>1.492</td>
<td>2.398</td>
<td>2.292</td>
</tr>
<tr>
<td>Buffalo</td>
<td>1.515</td>
<td>2.735</td>
<td>2.761</td>
</tr>
<tr>
<td>Rochester</td>
<td>1.542</td>
<td>2.721</td>
<td>2.602</td>
</tr>
<tr>
<td>Tulsa</td>
<td>1.564</td>
<td>2.076</td>
<td>2.892</td>
</tr>
<tr>
<td>Wichita</td>
<td>1.623</td>
<td>3.372</td>
<td>3.286</td>
</tr>
<tr>
<td>Syracuse</td>
<td>1.553</td>
<td>2.743</td>
<td>2.642</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>1.523</td>
<td>3.054</td>
<td>2.741</td>
</tr>
<tr>
<td>Albany</td>
<td>1.543</td>
<td>2.764</td>
<td>2.559</td>
</tr>
<tr>
<td>Hartford</td>
<td>1.356</td>
<td>2.935</td>
<td>2.650</td>
</tr>
<tr>
<td>Providence</td>
<td>1.581</td>
<td>5.806</td>
<td>4.419</td>
</tr>
<tr>
<td>Austin</td>
<td>1.589</td>
<td>4.943</td>
<td>3.802</td>
</tr>
<tr>
<td>Phoenix</td>
<td>1.241</td>
<td>16.000</td>
<td>∞</td>
</tr>
<tr>
<td>Tucson</td>
<td>1.523</td>
<td>13.723</td>
<td>11.052</td>
</tr>
<tr>
<td>Las Vegas</td>
<td>2.032</td>
<td>17.603</td>
<td>∞</td>
</tr>
<tr>
<td>Reno</td>
<td>2.336</td>
<td>11.134</td>
<td>38.121</td>
</tr>
<tr>
<td>Ontario, CA</td>
<td>1.500</td>
<td>5.510</td>
<td>5.331</td>
</tr>
<tr>
<td>Sacramento</td>
<td>1.589</td>
<td>8.389</td>
<td>5.958</td>
</tr>
<tr>
<td>San Jose</td>
<td>1.461</td>
<td>4.722</td>
<td>4.034</td>
</tr>
</tbody>
</table>

- The price elasticity faced by each carrier is very high in sunspot markets (Phoenix, Tucson, Las Vegas and Reno). For the cases of Phoenix and Las Vegas, United’s elasticities reach infinity because the point estimates of the conduct parameters were smaller than −1 (see equation (6)).

- The firm-specific elasticities increase with distance. This is primarily because the conduct parameters decrease with distance. The effect remains even after we control for both the sunspot market effect and the fringe-firm effect.

A regression of the firm-specific price elasticities (excluding the two infinity cases) on distance, the combined share of American and United, and sunspot market dummy shows that the distance coefficient has the expected positive sign and is statistically significant (t-ratio of 1.99).
6. Summary and Concluding Remarks

We have examined the pattern of firm conduct and associated price elasticities perceived by each firm in a sample of 20 routes to and from Chicago which were dominated by American Airlines and United Airlines. The conduct parameters and the aggregate market demand parameters were estimated through an econometric model which takes into account explicitly the form of inter-firm rivalry being practised. The estimation was carried out using firm-specific quarterly data for a set of monopoly and duopoly airline routes for the 1981-88 data.

Statistical tests rejected two hypotheses: (a) identical conduct between American and United, and (b) identical conduct for a given airline in all routes. This led us to believe that the airlines adjust their pricing strategies to the competitive conditions on each route. The overall results indicate that the duopolists’ conduct may be described as somewhere between Bertrand and Cournot behaviour, but much closer to Cournot, in the majority of our sample observations. This has an important policy implication in that rigorous competition is not being practised on some of the duopoly routes. The main results for the pattern of conduct parameters are summarised below.

- Conduct parameters tend to be different between American and United in the markets with unequal division of market shares.
- The carrier with a higher market share tends to have a lower conduct parameter, or alternatively, the carrier exercising aggressive pricing tends to secure a higher market share.
- Conduct parameters are inversely related to route distance, implying that firms price more competitively on longer distance routes.
- Conduct parameters tend to be negative in markets with a significant presence of fringe airlines and/or charter services.

The price elasticity for the route aggregate demand ranges between 1.24 and 2.34 with an average value of 1.58. (The price elasticity ranges between 1.24 and 1.67 for routes other than Las Vegas and Reno, the two vacation routes.) The firm-specific elasticities are very similar between American and United, increase with route distance and are very high for leisure-oriented routes.

Our econometric model represents a small improvement over the airline demand models estimated in the past in two respects. First, this paper estimates the market demand model jointly with the individual firm’s first-order conditions for profit maximisation. Second, inter-firm rivalry is explicitly incorporated in the model.

It could be argued that in order to understand inter-firm pricing rivalry in the airline industry it is necessary to look at the time-series behaviour of the conduct parameters. This paper focused on the effects of route characteristics on the pattern of inter-firm pricing rivalry and the associated firm-specific price elasticities. To accomplish this main objective, it was necessary to formulate the econometric model in such a way as to allow
for variation of the price elasticity of the route aggregate demand and the conduct parameters across routes. This made it impossible econometrically to investigate the dynamic pricing behaviour over time. In contrast, Brander and Zhang (1993) were able to investigate the pattern of dynamic pricing behaviour over time because they computed the conduct parameters by using price elasticities estimated by others (Oum, Gillen and Noble, 1986), rather than estimating them econometrically. Since we found that airline pricing behaviour is different from route to route, future work will be necessary to develop an econometric method that will allow the estimation of conduct parameters which vary over time and across routes.

References


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I. P. Sharp Associates Ltd. (1988-89): Department of Transportation Origin and Destination Survey, Data Bank 1A.


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