AIR TRAVEL DEMAND ELASTICITIES: CONCEPTS, ISSUES AND MEASUREMENT

FINAL REPORT

David W. Gillen
School of Business & Economics
Wilfrid Laurier University
Waterloo, Canada

William G. Morrison
School of Business & Economics
Wilfrid Laurier University
Waterloo, Canada

Christopher Stewart MBA
School of Business & Economics
Wilfrid Laurier University
Waterloo, Canada

November 6, 2002

Executive Summary

This study has reviewed most all published or reported airline demand studies completed in the last 25 years.[1] The elasticity values examined in this report represent coverage of a range of studies that used different methodologies, on different datasets, for very different markets. As such, one cannot tell whether differences in the elasticities values reflect differences in the models calibrated in the various studies, or underlying differences in the elasticities of different markets. Even if the latter, there is no reason to believe that these markets represent a valid sample of Canadian markets; this issue would have to be investigated. Therefore we argue that the median of the values found in the various studies should not be automatically *assumed* to be a reasonable estimate of the average elasticity in Canadian markets. Rather than selecting one value for elasticity, analysts and forecasters should consider a range of values and should take into account some [gross] market characteristics as delineators, such as length of haul, business-leisure sub markets and market structure (competition) differences.

The range of elasticity values varies widely by market and with market characteristics. The summary of our work is reported in Table 5.1. The elasticity values range from 1.52 for domestic short haul leisure to 1.26 for long haul domestic leisure to 1.15 for long haul domestic business. These are not different estimates of a constant parameter, but rather separate estimates of a parameter value that is unique to each market. Whether any of these values are appropriate for the Canadian situation cannot be determined without considering how similar each market is to the situation in Canada or between Canada and other countries (transborder versus true international). It may well be that Canada happens to fall in the middle of the range, but that would be quite coincidental.

The value of this report lies in demonstrating that fare elasticities appear to vary widely, depending on the circumstances of each market, and in providing a range of values against which the values used by departments in the Federal Government, such as Department of Finance and Transport Canada, can be compared, as a test of reasonableness.

Table of Contents

[1] Published includes studies reported in the academic literature and government sponsored studies.

1. Introduction

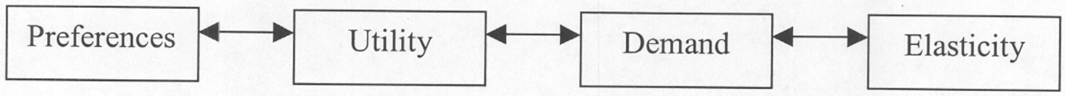
The purpose of this study is to report on all or most of the economics and business literature dealing with empirically estimated demand functions for air travel and to collect a range of fare elasticity measures for air travel and provide some judgment as to which elasticity values would be more representative of the true values to be found in different markets in Canada.

While existing studies may include the leisure – business class split, other important market distinctions are often omitted, likely as a result of data availability and quality.[2] One of the principal value added features of this research and what distinguishes it from other surveys, is that we develop a meta-analysis that not only provides measures of dispersion but also recognizes the quality of demand estimates based on a number of selected study characteristics. In particular, we develop a means of scoring features of the studies such as focus on length of haul; business versus leisure; international versus domestic; the inclusion of income and inter-modal effects; the age of the study; data type (time-series versus cross section) and the statistical quality of estimates (adjusted R-squared values). By scoring the studies in this way, policy makers are provided with a sharper focus to aid in judging the relevance of various estimated elasticity values.[3]

2. Elasticity in the context of air travel demand.

Elasticity values in economic analysis provide a "units free" measure of the sensitivity of one variable to another, given some pre-specified functional relationship. The most commonly utilized elasticity concept is that of "own-price" elasticity of demand. In economics, consumer choice theory starts with axioms of preferences over goods that translate into utility values. These utility functions define choices that generate demand functions from which price elasticity values can be derived.

[2] In some cases separate equations are estimated for these markets; PODM (The Transport Canada air travel forecasting model) for example uses different equations and variables for leisure and business markets.



Therefore elasticities are summary measures of people's preferences reflecting sensitivity to relative price levels and changes in a resource-constrained environment. The ordinary or Marshallian demand function is derived from consumers who are postulated to maximize utility subject to a budget constraint. As a good's price changes, the consumer's real income (which can be used to consume all goods in the choice set) changes. In addition the goods price relative to other goods changes. The changes in consumption brought about by these effects following a price change are called *income* and *substitution* effects respectively. Thus, elasticity values derived from the ordinary demand function include both income and substitution effects.[4]

Own-price elasticity of demand measures the percentage change in the quantity demanded of a good (or service) resulting from a given percentage change in the good's own-price, holding all other independent variables (income, prices of related goods etc.) fixed. The ratio of percentage changes thus allows for comparisons between the price sensitivity of demand for products that might be measured in different units (natural gas and electricity for example). 'Arc' price elasticity of demand calculates the ratio of percentage change in quantity demanded to percentage change in price using two observations on price and quantity demanded. Formally this can be expressed as:

$$\eta_{arc} = \frac{\Delta Q}{\Delta P} \frac{\bar{p}}{\bar{q}} \qquad (1)$$

where:

ΔQ and ΔP represent the observed change in quantity demanded and price

---

[3] Previous surveys (e.g. Oum et al., 1992) provide a listing of the elasticities and their ranges but no basis for choosing from among the values within the range.

[4] Theoretically an alternative to the ordinary demand function is the *compensated* demand function, obtained from a resource expense minimization subject to a given level of utility. Elasticity values from the compensated demand function incorporate only substitution effects, however in practice we can estimate only the ordinary demand function. Nevertheless the distinction is important since large price changes may yield significant income effects.

$\bar{p}$ and $\bar{q}$ represent the average price and quantity demanded. The elasticity is unitless and can be interpreted as an index of demand sensitivity; it is measuring the degree to which a variable of interest will change (passenger traffic in our case) as some policy or strategic variable changes (total fare including any added fees or taxes in our case).

In the limit (when ΔQ and ΔP are very small) we obtain the 'point' own-price elasticity of demand expressed as:

$$\eta_{\text{point}} = \frac{\partial \text{Q(P,S)}}{\partial \text{(p)}} \frac{p}{q} \tag{2}$$

where:

Q(P,S) is the demand function
P = a vector of all relevant prices
p = the good's own-price.
q = equals the quantity demanded of the good
S = a vector of all relevant shift variables other than prices (real income, demographic characteristics etc.)

We expect own-price demand elasticity values to be negative, given the inverse relationship between price and quantity demanded implied by the 'law' of demand, with absolute values less than unity indicating 'inelastic' demand: a less than proportionate response to price changes (relative price insensitivity). Similarly, absolute values exceeding unity indicate elastic or more sensitive demand: a more than proportionate demand response to price changes (relative price sensitivity).

The ratio of change in quantity demanded to change in price [equation (1)] highlights that elasticity measures involve linear approximations of the slope of a demand function. However, since elasticity is measuring proportionate change, elasticity values will change along almost all demand functions, including linear demand curves.[5] Estimation of elasticity values is therefore most useful for predicting demand responses in the vicinity of the observed price changes. As a related issue, analysts need to recognize that in markets where price discrimination is possible aggregate data will not allow for accurate predictions of demand responses in the relevant market segments. In air travel, flights by a carrier are essentially joint products consisting of differentiated service bundles that are identified by fare classes. However the yield management systems employed by full-service carriers (FSCs) also create a complex form of inter-temporal price discrimination, in which some fares (typically economy class) decline and some increase (typically full-fare business class) as the departure date draws closer. This implies that ideally, empirical studies of air travel demand should separate business and leisure travellers or at least be able to include some information on booking times in order to account for this price discrimination, and that price data should be calibrated for inter-temporal price discrimination: for example, the use of full-fare economy class ticket prices as data will underestimate the absolute value of the price elasticity coefficient. Within the set of differentiated service bundles that comprise each (joint product) flight, the relative prices are important in explaining the relative ease of substitution between service classes. Given the nature of inter-temporal price discrimination for flights, the relative price could also change significantly in the time period prior to a departure time.

The partial derivative in (2) indicates that elasticity measures price sensitivity independent of all the other variables in the demand function. However when estimating demand systems over time, one can expect that some important shift variables will not be constant. It is important that these shift variables be explicitly recognized and incorporated into the analysis, as they will affect the value of elasticity estimates. This will also be true with some cross-sectional studies or panels.[6] In particular changes in real income and the prices of substitutes or complements will affect demand. In air travel demand estimations, income and prices of other relevant goods should be included in the estimation equation. Alternative transportation modes (road and rail) are important variables for short-haul flights, while income effects should be measured for both short and long-haul. The absence of an income coefficient in empirical demand studies will result in own-price elasticity estimates that can be biased. With no income coefficient,

---

[5] The exception would obviously be the constant elasticity demand function.
[6] A panel is a data set that contains both time-series and cross-sectional information.

observed price and quantity pairs will not distinguish between movements along the demand curve and shifts of the demand curve.[7]

The slope of a demand function, which affects the own-price elasticity of demand, is generally expected to decrease (become shallower) with:

- The number of available substitutes;
- The degree of competition in the market or industry;
- The ease with which consumers can search and compare prices;
- The homogeneity of the product;
- The duration of the time period analyzed.[8]

Given the implied relationships above, any empirical demand study should carefully define market boundaries to include all relevant substitutes and complements and to exclude products that might be related through income or other more general variables. In air travel, ideally market segment boundaries should be defined by first separating leisure and business passengers and second long-haul and short-haul flights. The reason is that we expect different behaviour in each of these markets. Within each of these categories, distinctions should then be made between the following:

- Business and leisure travel;
- Connecting and origin-destination (O-D) travel;
- Hub and non-hub airports;[9]
- Routes with dominant airlines and routes with low-cost carrier competition.

In addition, for the North American context, long-haul flights should be further divided into international and domestic travel (within continental North America). These market segment boundaries are illustrated in figure 2.1 below, which also highlights the relative importance of intermodal competition for short-haul travel.

---

[7] This will be true for all factors other than own-price.

[8] The exception here is durable goods, for the opposite relationship is expected between long and short run elasticities.

While distinctions in price and income sensitivity of demand between business and leisure or long and short-haul travel are more intuitive, other distinctions are perhaps less obvious. If available, data that distinguishes between routes, airlines and airports would provide important estimates of how price sensitivity is related to the number of competing flights and the willingness to pay of passengers utilizing a hub-and-spoke network, relative to those traveling point-to-point, more commonly associated with low cost carriers. To the extent that existing studies assume that each passenger observation represents O-D travel, they will not be capturing fare premiums usually associated with hub-and-spoke networks and full service carriers, nor will they necessarily capture the complete itinerary of travellers utilizing a number of point-to-point flights with a low cost carrier. For example, a passenger who travels from Moncton to Vancouver with Air Canada, and utilizes the hub at Pearson International airport, is being provided with a number of services that includes baggage checked through to the final destination and frequent flyer points as well as a choice in flights and added flight and ground amenities. The fare for Moncton-Vancouver includes a premium for these services. Now consider a passenger that is travelling with WestJet from Moncton to Hamilton, and then with JetsGo from Toronto Pearson Airport to Vancouver. In this case there are no frequent flyer points to be attained and baggage has to be collected and re-checked after a road transfer between Hamilton and Pearson International. Although the origin and destination is the same for these passengers, the itineraries are significantly different. In many cases data used for demand estimates would not able to account for these differences.

Route-specific data can also capture competition that may exist between airports and the services they offer as well as airlines. This may be especially true for certain short-haul routes where intermodal competition (road and rail) can play an important role in shaping air travel demand.

---

[9] The difference between this point and the previous one is that hub airports will have different service levels and will generally have a hub premium.

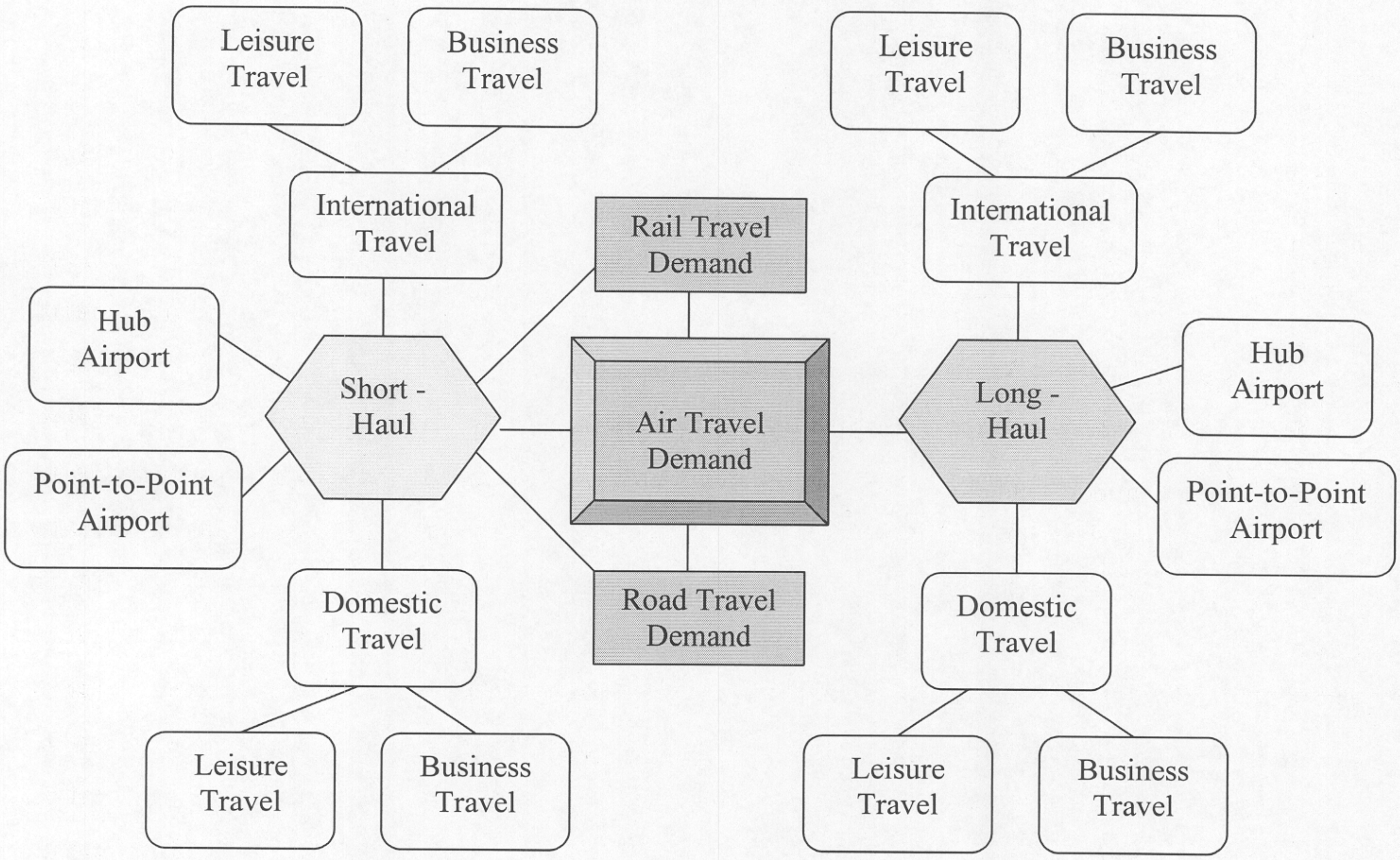


Figure 2.1
Market segments in air travel demand.

3. Measurement issues

Oum et al. (1992) provide a valuable list of pitfalls that occur when demand models are estimated and therefore affect the interpretation of the elasticity estimates from these empirical studies.

1. *Price and Service Attributes of Substitutes*: Air travel demand can be affected by changes in the prices and service quality of other modes. For short-haul routes (markets) the relative price and service attributes of auto and train would need to be included in any model; particularly for short-haul markets. Failure to include the price and service attributes of substitutes will bias the elasticity. For example, if airfares increase and auto costs are also increasing, the airfare elasticity would be underestimated if auto costs were excluded.

2. *Functional Forms:* Most studies of air travel demand use a linear or log-linear functional specification. Elasticity estimates can vary widely depending on the functional form. The choice of functional form should be selected on the basis of statistical testing not ease of interpretation.

3. Cross-Section vs. Time-series Information: In the long run demand elasticities for non-durable goods and services are larger in absolute terms, than in the short run. This follows because in the long run there are many more substitution possibilities that can be used to avoid price increases or service quality decreases. In effect there are more opportunities to avoid these changes with substitution possibilities. Data tends to be cross-sectional or time-series although more recently panels have become available. A panel is a combination of cross-section and time-series – information on several routes for a multi-year period is a panel. Cross-sectional information is generally regarded as indicating short run elasticities while time-series data is interpreted as long run elasticities. In time-series data the information reflects changes in markets, growth in income, changes in competitive circumstances, for example. Policy changes should rely on long run

elasticities since these are long run impacts that are being modelled. Short run elasticities become important when considering the competitive position of firms in a highly dynamic and competitive industry.

4. *Market Aggregation/Segmentation*: As the level of aggregation increases the amount of variation in the elasticity estimates decreases. This occurs because aggregation averages out some of the underlying variation relating to specific contexts. Since air travel market segments may differ significantly in character, competition and dominance of trip purpose, interpreting a reduction in variation through aggregation as a good thing would be erroneous. Such estimates might have relatively low standard deviations but would be also be relatively inaccurate when used to assess the effect of changes in fares in a specific market.

5. *Identification Problem*: In most cases only demand functions are estimated in attempts to measure the demand elasticity of interest. However, it is well known that the demand function is part of a simultaneous equations system consisting of both supply and demand functions. Therefore, a straightforward estimation of only the demand equation will produce biased and inconsistent estimates. The problem of identification can be illustrated by describing the process by which fares and travel, for example, are determined in the origin-destination market simultaneously. To model this process in its entirety, we must develop a quantitative estimate of both the demand and supply functions in a system. If, in the past, the supply curve has been shifting due to changes in production and cost conditions for example, while the demand curve has remained fixed, the resultant intersection points will trace out the demand function. On the contrary, if the demand curve has shifted due to changes in personal income, while the supply curve has remained the same, the intersection points will trace out the supply curve. The most likely outcome, however, is movement of both curves yielding a pattern of fare, quantity intersection points from which it will be difficult, without

further information, to distinguish the demand curve from the supply curve or estimate the parameters of either.[10]

Earlier we identified sources of bias that can arise from problems with aggregation, data quality, implicit assumptions of strong seperability among others. Almost all demand studies have an implied assumption of strong seperability in that they only consider aviation markets in the analysis. Such studies in effect constrain all changes or responses in fares or service to be wholly contained in the aviation component of people's consumption bundle. The paper by Oum and Gillen (1986) is the one exception where consideration of substitution with other parts of consumption was included in the modelling. It would be difficult to extract a conclusion from this one study as to existence, degree and direction of bias in elasticity estimates when other parts of consumption are and are not included in the modelling. However, having said this, an inspection of the elasticity estimates from this study shows they are not significantly different than other time-series estimates.

3.1 Data Issues

Elasticity estimates depend critically on the quality and extent of the data available. Currently, the best data for demand estimation, , is the DB1A 10 percent ticket sample in the US, but even this data has some problems.[11] The DB1A sample represents 10 percent of all tickets sold with full itinerary identified by the coupons attached to the ticket. However with electronic tickets, as more and more tickets are being sold over the Internet, there is a growing portion of overall travel that may not be captured in the sample. This means that the proportion is not 10 percent but something less.[12] Other important considerations are the amount of travel on frequent flyer points, by crew and airline personnel.

---

[10] Fortunately, several techniques have been developed for the estimation of the structural parameters of an *apriori* specified system of simultaneous stochastic equations. These include indirect least squares, two stage least squares, instrumental variables, three stage least squares, full information maximum likelihood, and limited information maximum likelihood.
[11] The term 'best' means researchers observe this data source to be the most geographically comprehensive, detailed and temporally available.
[12] The growth of the Internet in booking tickets is being integrated into the DB1A database, as is the growing use of electronic tickets.

In Canada we have poor quality data because it is incomplete, even if it were accessible. Airports collect traffic statistics but these data make it very difficult to distinguish OD and segment data. Airlines report traffic data to Statistics Canada (or are supposed to) but these data do not include fare information or routing. Knowing the itinerary or routing is important because of differences in service quality and hubbing effects. Fare data is also more useful than yield information since it identifies the proportion of people travelling in different fareclasses. Yet, in many cases yield information is used as a weighted average fare. There is also the problem that carriers of different size may have different reporting requirements. Some researchers and consultants have been cobbling together data sets for analysis by using the PBX clearing house information. These data are limited and apply only to those airlines that are members of IATA.[13] The current public data available in Canada simply does not permit estimation of any demand models.

Besides demand side data it is also important to have supply side information. Elasticity estimates should emerge from a simultaneous equations framework. This data is more accessible through organizations like the OAG[14], which provide information on capacity, airline and aircraft type for each flight in each market.[15] These data measure changes in capacity, flight frequency and timing of flights.

One study, which undertook an extensive survey to collect multimodal data,[16] was the High Speed Rail study sponsored jointly by the Federal, Ontario and Quebec governments. This study, which had three different demand modelling efforts, examined the potential for High Speed Rail demand, and subsequent investment, in the Windsor-Quebec corridor. The analysis included intermodal substitution between air, rail, bus and car. The study was undertaken in the early 1980s. However, it is not possible for public access to any of the technical documents that would allow an assessment of the study. Attempts in the past to obtain access to the data have proven fruitless.

---

[13] IATA is the International Air Transport Association.
[14] OAG is the Official Airline Guide.
[15] These data are sold and can be expensive.
[16] Estimates were that in excess of $1 Million was spent on data collection alone.

3.2 Distinguishing Elasticity Measures

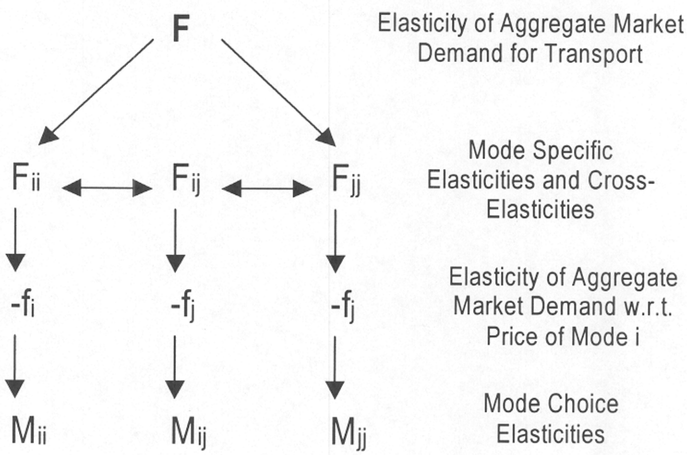
As we have stated, price elasticity measures the degree of responsiveness to a change in own or other prices (fares). However, care must be exercised in interpreting the elasticity since they differ according to how they have been estimated. Many empirical studies of air travel demand estimate a log-linear model. In evaluating such studies, it is important to keep in mind that the empirical specification implies a certain consumer preference structure because of the duality between utility functions and demand functions. It is equally important to remember that empirically estimated demand functions should contain some measures of quality and service differences or quality changes over time. Failure to include metrics for frequent flyer programs, flight frequency, destination choice or service levels in estimating an air demand function can lead to downward bias in the price elasticity estimates.

Price elasticities can be estimated for aggregate travel demand as well as modal demand. Figure 3.1 illustrates the differences between aggregate and modal elasticities.[17] Our interest is in modal elasticities not the aggregate amount of travel but it is important ultimately that any policy analysis take account of the impact of any policy change on aggregate travel as well as modal redistribution. The impact of a change in price on aggregate demand would be measured by the $-f_i$s in Figure 3.1 whereas the F_{ii}s would measure the impact on air travel demand. The F_{ii}s are a composite or combination of the f_is and the M_{ii}s.

The Canadian aviation industry has undergone significant change in the last several years. In 2000 Air Canada completed its takeover of Canadian Airlines, which left it with in excess of 80 percent market share. Market dominance leads to different fare and service quality levels. As a result of higher fares, for example, we should find lower elasticities of demand simply because with higher fares we have moved further up the demand curve. In 1996 Westjet entered the market and has continued to grow each year. Canada 3000 exited the market in 2001, as did Canjet and Royal (as part of Canada 3000). Roots airline has come and gone but Canjet has reemerged in eastern Canada and JetsGo is offering some level of service on longer haul domestic flights as well as in the Montreal-Toronto market.

The entry of low cost carriers leads to lower fares for a subset of traffic and competitors will offer a supply of seats to match these fares. Lower average fares should lead to higher demand elasticity estimates, as will increases in the number of competitors in the market.

Figure 3.1



One should not confuse low cost carriers with a seeming lack of exploiting monopoly power. High prices or fares are not synonymous with monopoly and low fares with competition. Airlines like Westjet where they are the sole airline serving the market may still act as a monopolist but charge low(er) fares. Profit maximizing monopolists price where marginal cost equals marginal revenue, if marginal cost is low, one should expect to see lower fares but still marginal cost and revenue are equalized. Monopolists are generally viewed as being high price because they are high cost and the high costs are attributable to some degree from a lack of competitive discipline in the market. Full

[17] This figure is adapted from Figure 1 in Oum et al. (1992)

service carriers operating with hub-and-spoke systems have a high cost business model while low cost carriers have a low cost business model.

4. Evaluation of elasticity studies

Overall we have collected some 274 demand elasticity estimates from 22 studies. Each of these studies is described, using a standardized summary sheet; illustrated in Appendix A. To aid our understanding of how existing elasticity estimates might inform policy makers in forecasting air travel demand, we provide a descriptive meta-analysis of various distributions of estimated values in section 4.1. We next develop a weighted scoring table with respect to generally desirable data, design and output characteristics of the studies. This allows us to generate a rank ordering of the studies, from which to generate a sub-sample of estimates from studies with a 'passing grade' score. A passing grade is simply defined as 50 percent of the maximum score attainable. From these studies we provide suggested ranges of elasticity values in six key market segments:

1. Short-haul business travel
2. Short-haul leisure travel
3. Long-haul, domestic business travel
4. Long-haul, domestic leisure travel
5. Long-haul, international business travel
6. Long-haul, international leisure travel

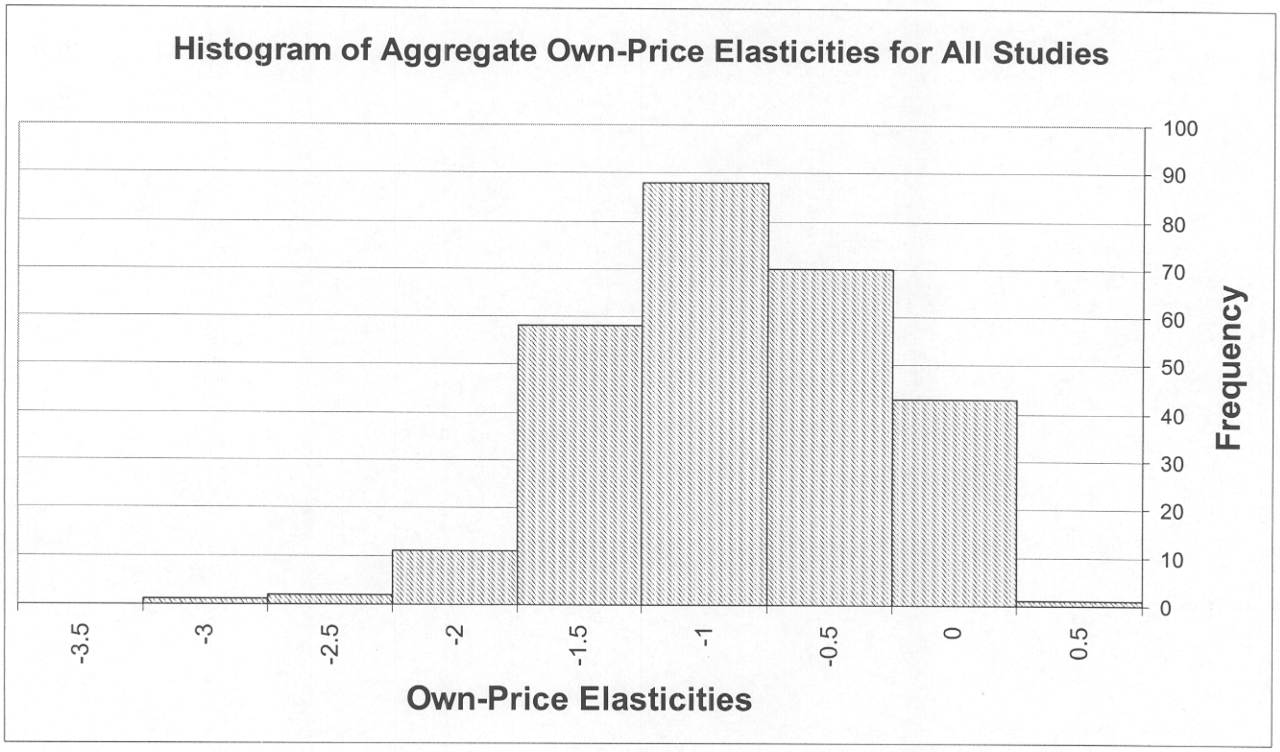
Before we discuss our scoring system for the studies, we first present some more general descriptive information on the distribution of estimated elasticity values in various categories.

4.1 Descriptive Distributions of elasticity estimates

Here, we present for the aggregate and for several important sub-categories, histograms of the estimates in the studies we have researched. We begin with the most general distribution: the set of all the studies containing some 274 estimates of own-price elasticity. We next present sub-categories in increasing detail defined in terms of market characteristics. We also present sub-samples of the estimates based on data type (cross-section versus time-series) and the age of the study (less than five years old, versus between five and ten years old). In each case we report the median value as a measure of central tendency, along with the kurtosis and skewness of the distributions.[18]

4.1.1. All studies

We generate a histogram for all own-price elasticities with 274 estimates taken from 22 studies.[19] The minimum estimated elasticity value is –3.20.[20] The histogram demonstrates a crowd of estimates between zero and –2.5. The median, or midpoint, of all estimates is –1.15. We use the median as the measure of central tendency, as opposed to the mean, in order to remove the effects of outliers in our data set. The skewness of the histogram is (–0.24). This indicates that our data is not normally distributed.



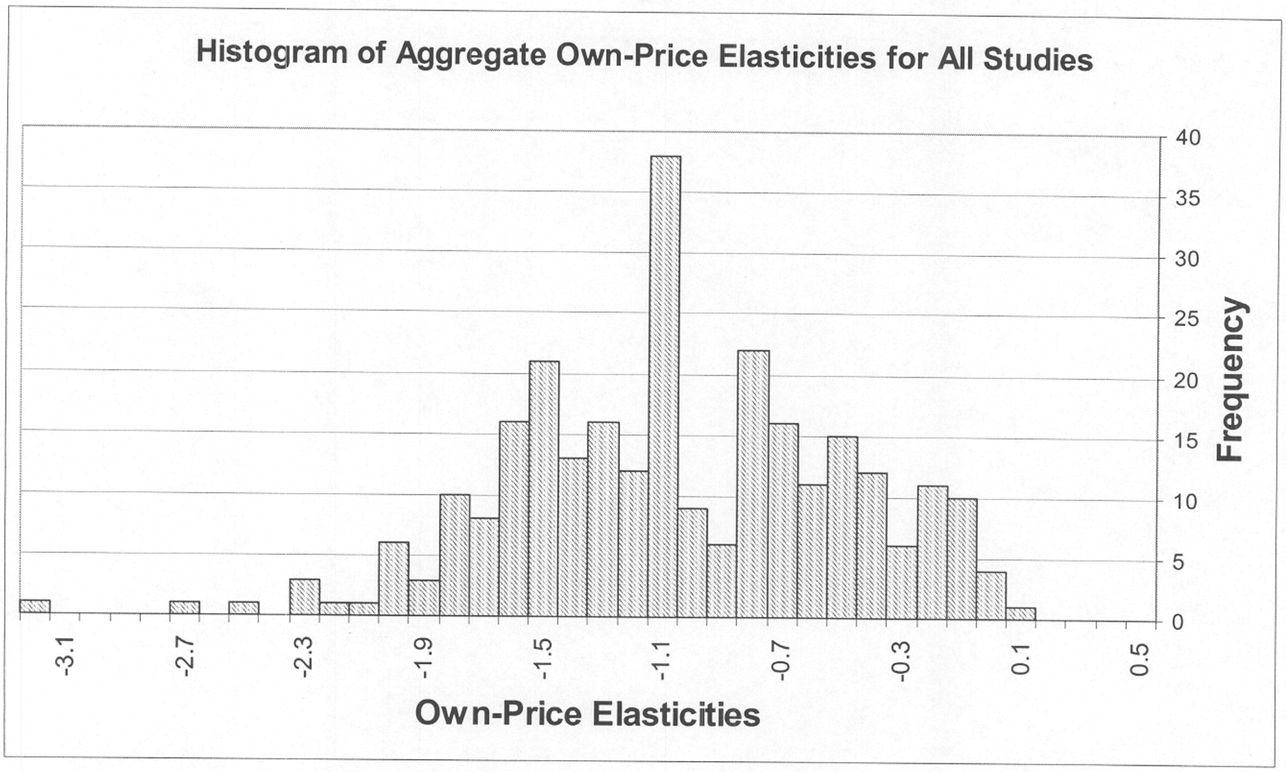
[18] Since in many cases, the distribution of estimated values is skewed, the mean is not a useful measure of central tendency and the standard deviation is not useful in providing a range around the mean.

[19] The study by Anderson and Kraus (1981) is excluded since they do not calculate elasticities per se. Doubt over the quality of estimated positive elasticities in Jung and Fuji (1976) lead us to exclude their estimates also.

[20] It is conventional to present own-price elasticities with a negative sign indicating the general negative relationship between price and quantity demanded. Larger values of the elasticity imply greater price sensitivity while lower values imply less price sensitivity.

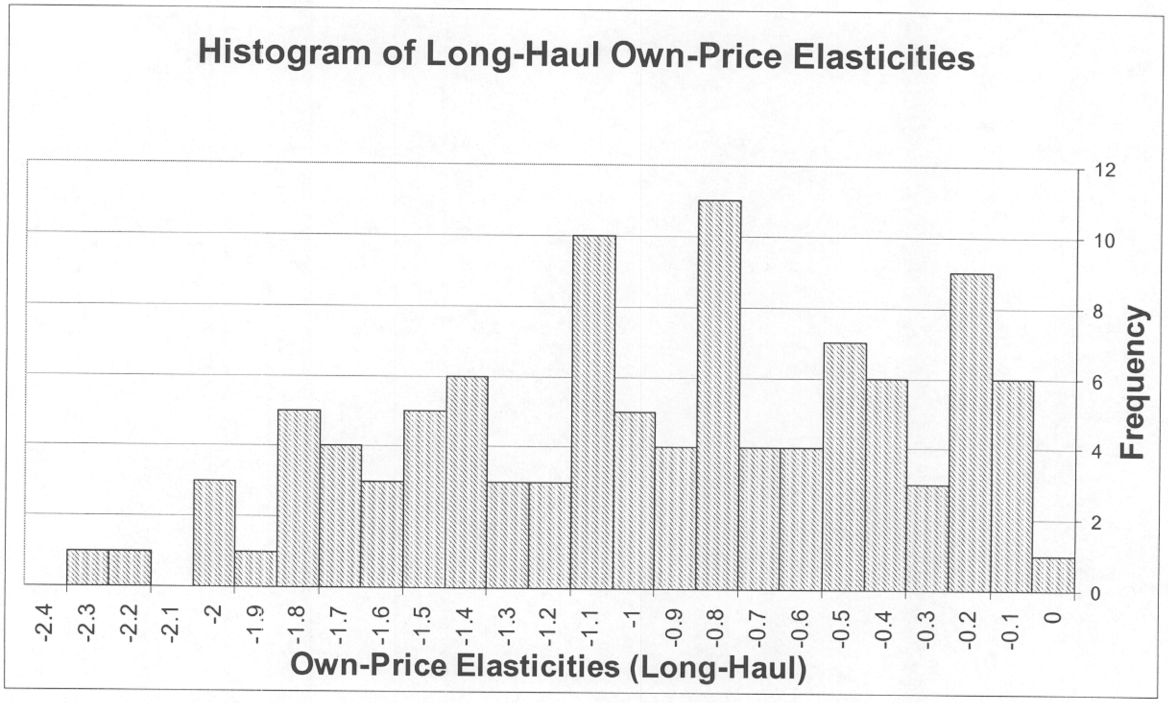
All Studies Own-Price Elasticities	
5th percentile	-1.987
First quartile	-1.519
Median	**-1.150**
Third quartile	-0.682
95th percentile	-0.194
Number of estimates	274.000
Minimum	-3.200
Maximum	0.040
Variance	0.312
Interquartile range	0.837
Skewness	-0.240
Kurtosis	0.022

The histogram below provides a more detailed depiction of the crowd of elasticity estimates with each column representing a one-tenth (0.1) segment.



4.1.2. All long-haul studies

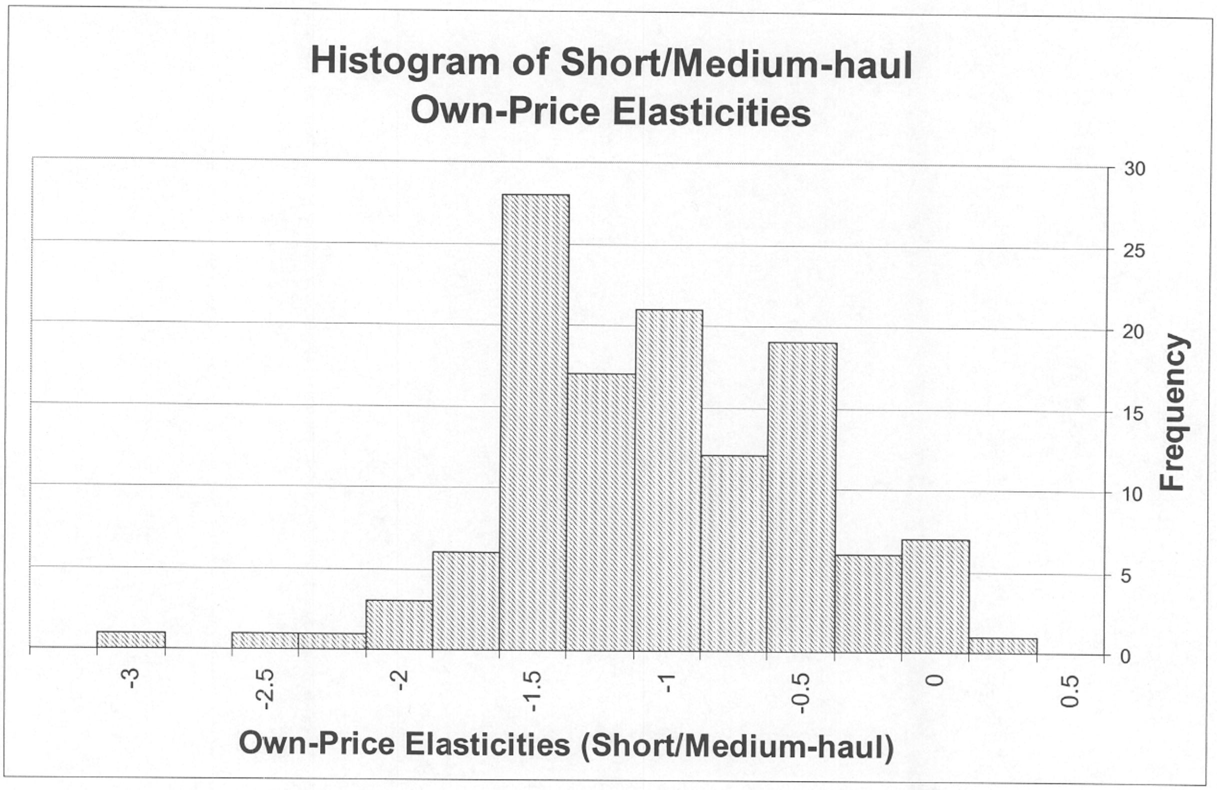
We subdivide the aggregate data into a subset of long-haul own-price elasticity estimates. The data set includes estimates for distances greater than 1500 miles, or estimates that are reported as 'long-haul' or 'international' in their respective study. The subset is comprised of 105 estimates with a median elasticity of –0.95. A majority of the values are bunched up between zero and –2 as indicated by the skewness of the histogram at –0.261.



All Long-haul Own-price Elasticity Estimates	
5th percentile	-1.892
First quartile	-1.430
Median	**-0.950**
Third quartile	-0.500
95th percentile	-0.191
Interquartile range	0.930
Number of estimates	105.000
Minimum	-2.336
Maximum	-0.010
Variance	0.321
Skewness	-0.261
Kurtosis	-0.850

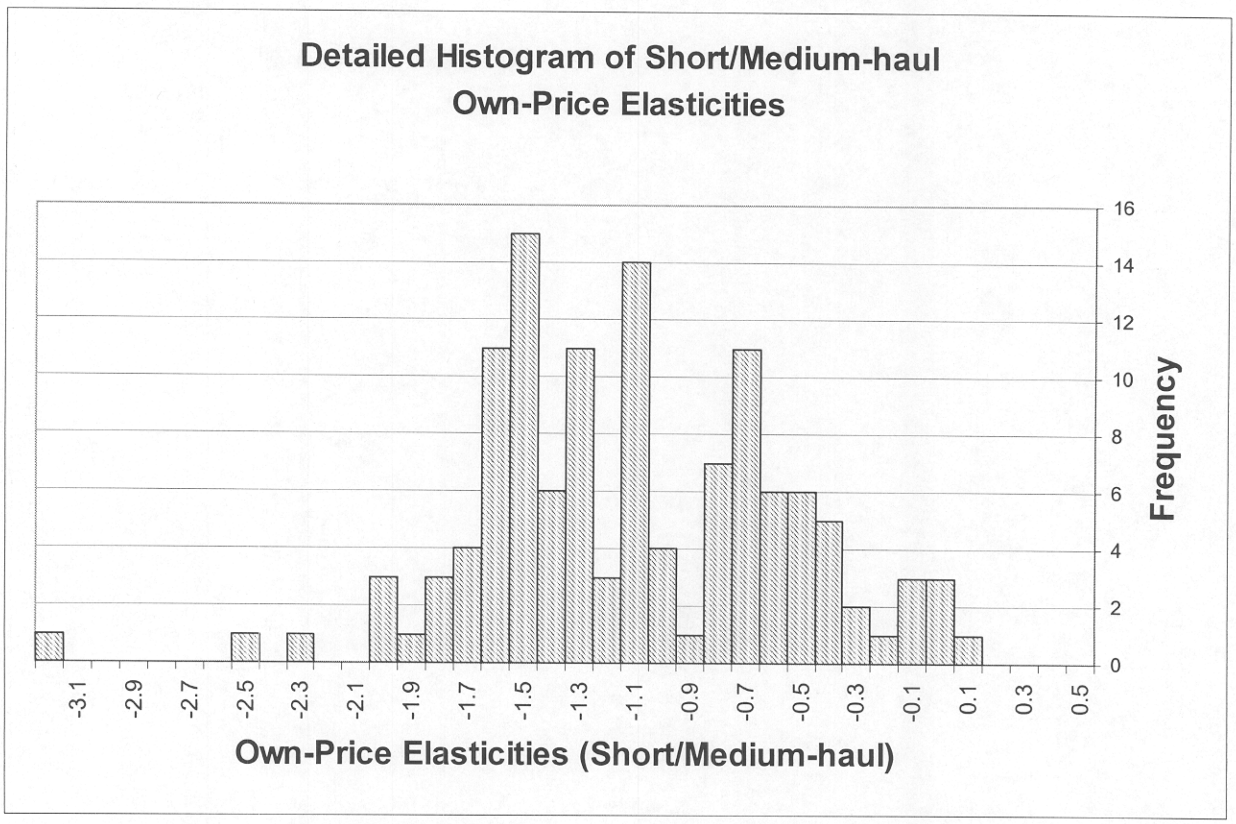
4.1.3. All Short/medium-haul studies

The data set for short/medium-haul own-price elasticity estimates includes estimates for distances less than 1500 miles, or estimates that are reported as 'short-haul', 'medium-haul', or 'regional' in their respective study. The subset is comprised of 124 estimates. Note that the sum of long-haul and short/medium-haul estimates (105+124) does not equal the number of estimates in the aggregate data set. This is a result of the exclusion of elasticity estimates that are not defined by their distance in their respective reports. The median elasticity in this subset is –1.15. A crowd of estimates is located between zero and –1.5. The minimum value (–3.20) represents a Sydney-Brisbane route taken from Milloy et al. (1985). The skewness of the histogram is –0.201.



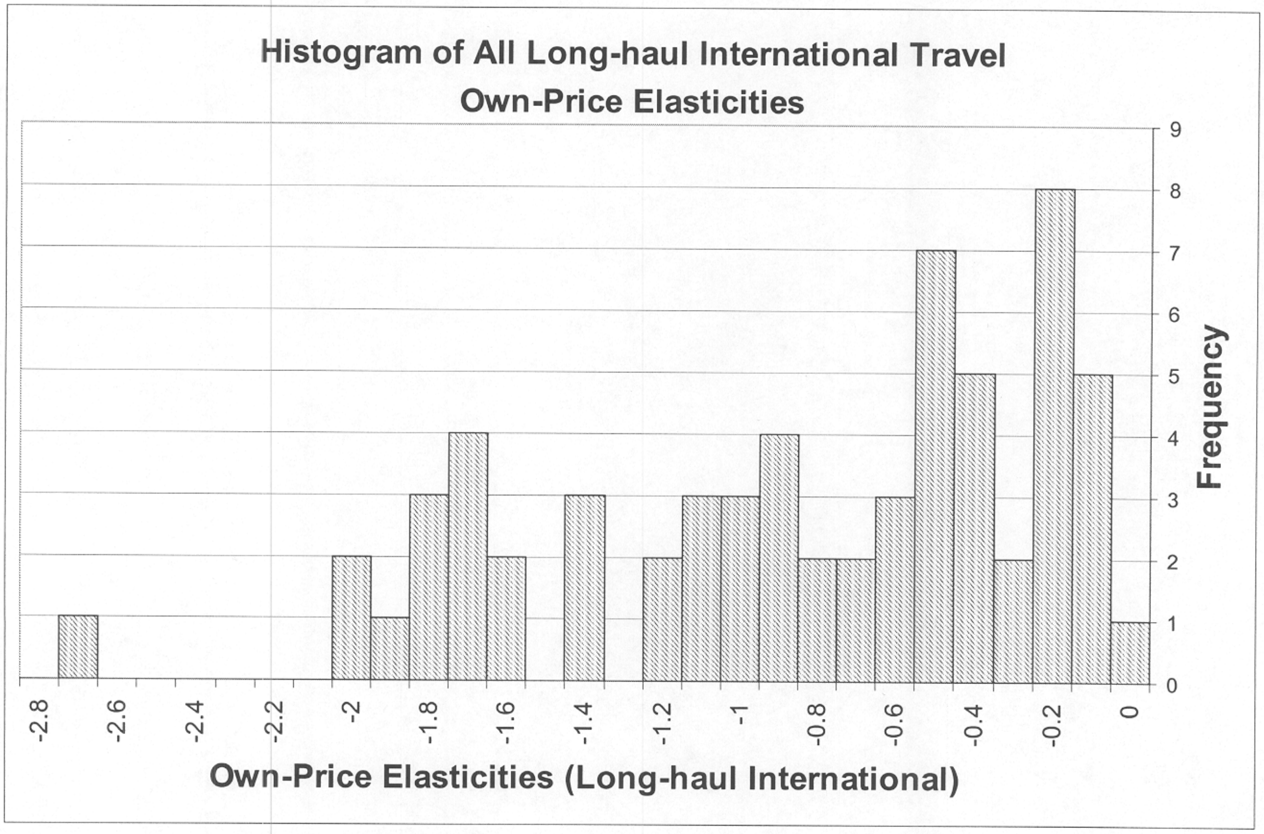
All Short/Medium-haul Own-price Elasticity Estimates	
5th percentile	-1.965
First quartile	-1.542
Median	**-1.150**
Third quartile	-0.730
95th percentile	-0.142
Interquartile range	0.813
Number of estimates	124.000
Minimum	-3.200
Maximum	0.040
Variance	0.309
Skewness	-0.201
Kurtosis	0.605

The histogram below provides a more detailed depiction of the crowd of elasticity estimates with each column representing a one-tenth (0.1) segment.



4.1.4. All long-haul international travel estimates

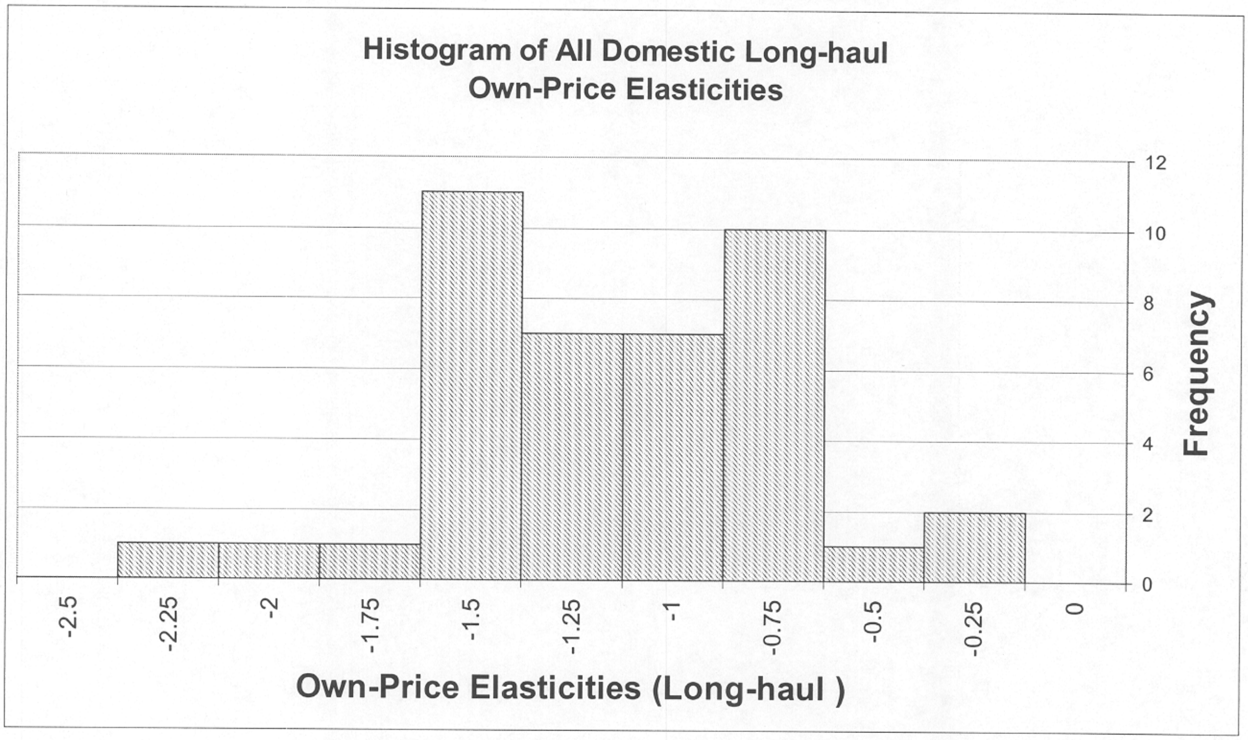
This sub-category of long-haul international travel is comprised of 69 estimates extracted from the aggregate data set. The data set represents estimates for country-to-country international travel taken from seven studies. The estimates are distributed between zero and –2.7, with some crowding below –0.5. The median elasticity is –0.79 and the distribution is somewhat skewed.



Long-haul International Travel Own-price Elasticities	
5th percentile	-1.960
First quartile	-1.400
Median	**-0.790**
Third quartile	-0.349
95th percentile	-0.172
Interquartile range	1.051
Number of estimates	69.000
Minimum	-2.700
Maximum	-0.010
Variance	0.407
Skewness	-0.672
Kurtosis	-0.456

4.1.5. All long-haul domestic studies

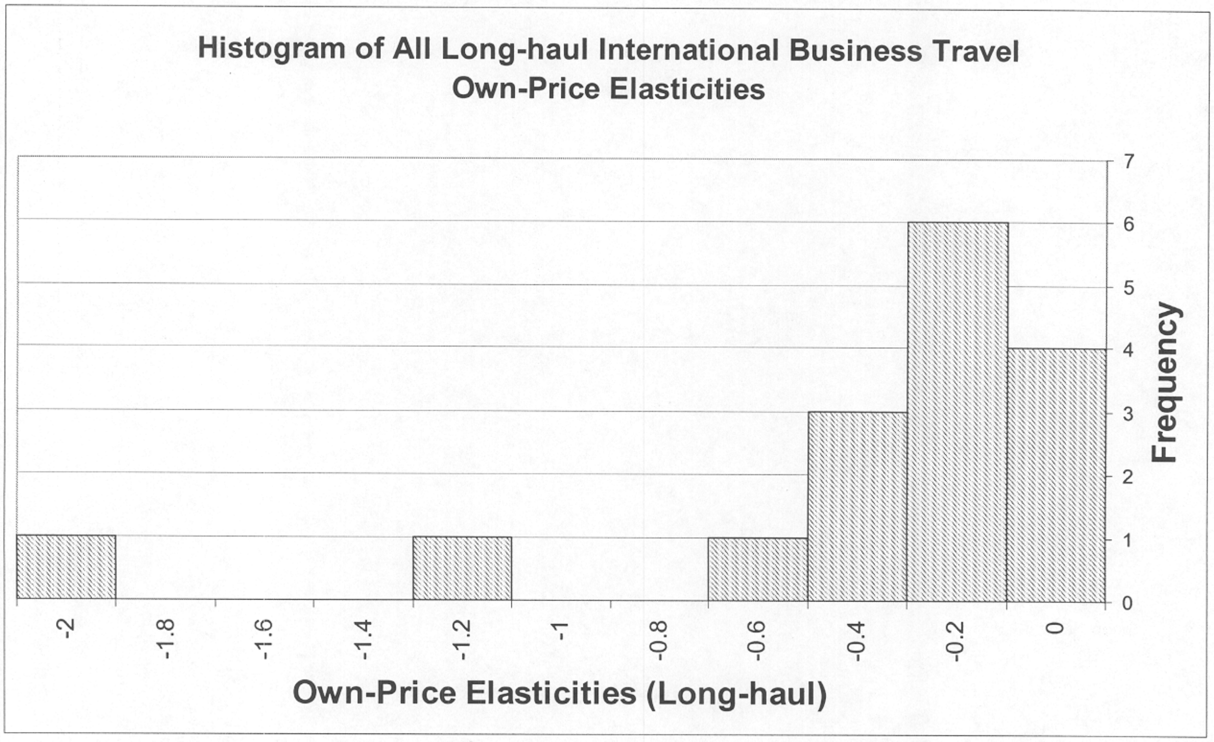
This subset is comprised of 41 estimates extracted from seven studies. The majority of the estimates are bunched between the maximum value (-0.44) and –2.3. The skewness is –0.109.



All Long-haul Domestic Travel Own-price Elasticities	
5th percentile	-1.810
First quartile	-1.550
Median	**-1.340**
Third quartile	-0.849
95th percentile	-0.590
Interquartile range	0.701
Number of estimates	41.000
Minimum	-2.336
Maximum	-0.440
Variance	0.185
Skewness	-0.109
Kurtosis	-0.296

4.1.6. All long-haul, international business travel estimates

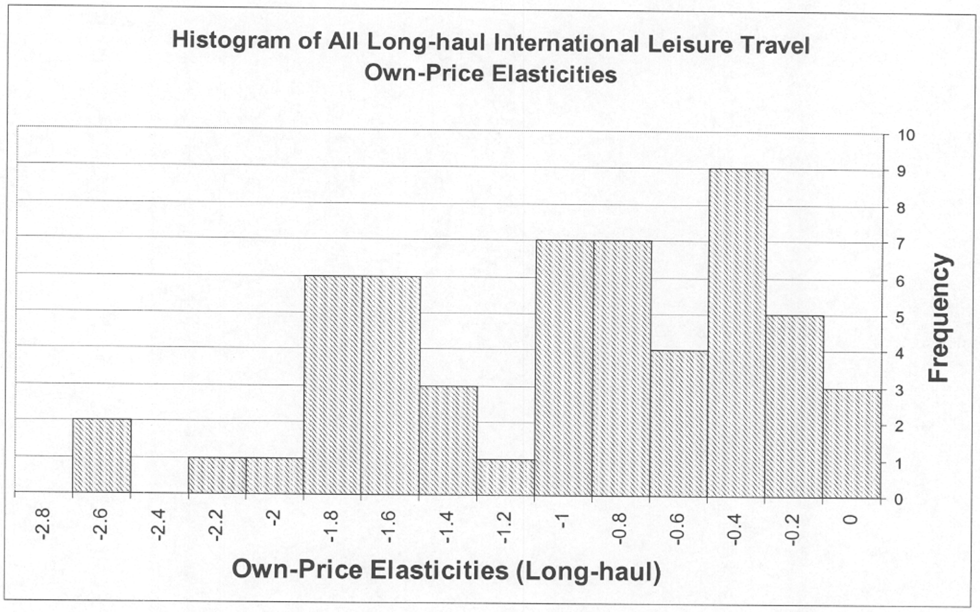
The international business travel subset contains 16 estimates from two studies. A majority of the estimates (15) are calculated by the Bureau of Transport Communications and Economics (1995) for business travellers to and from Australia. The lowest estimate (-2.0) represents Australian business travellers to the U.K. The majority of the estimates are bunched between the maximum value (-0.1) and –0.6. The median elasticity estimate is –0.265. The histogram is negatively skewed (-2.405), which indicates a non-normal distribution.



All long-haul international business travel Own-price Elasticities	
5th percentile	-1.423
First quartile	-0.475
Median	**-0.265**
Third quartile	-0.198
95th percentile	-0.093
Interquartile range	0.278
Number of estimates	16.000
Minimum	-2.000
Maximum	-0.010
Variance	0.251
Skewness	-2.405
Kurtosis	6.095

4.1.7. All long-haul international leisure travel estimates

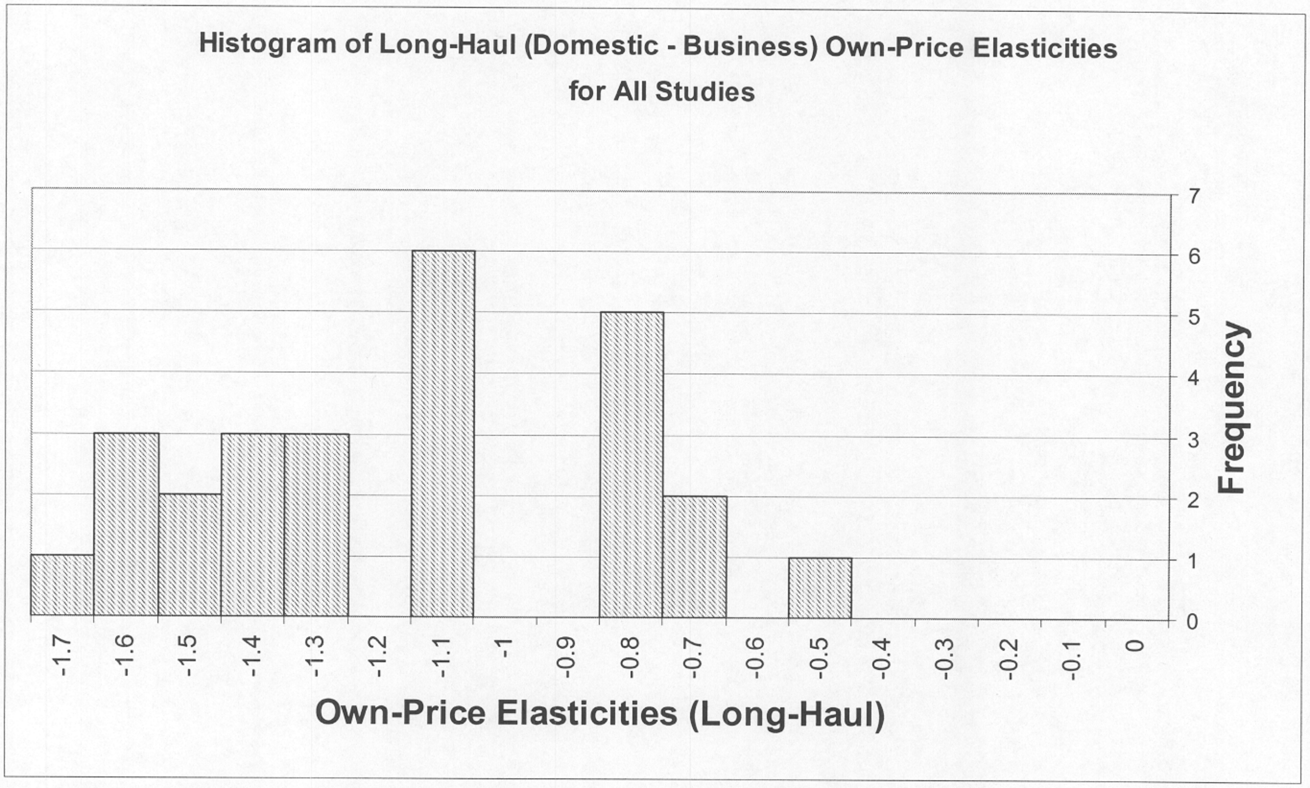
The long-haul leisure travel segment contains a total of 55 estimates, representing seven studies. Nearly 50 percent of the estimates (24) are taken from the Bureau of Transport Communications and Economics (1995) study. The median of the estimates is –0.993 with estimates distributed between –0.14 and –2.7. The minimum values (-2.7) are taken from Taplin (1980) and represent elasticity estimates calculated by Jud and Joseph (1974) (for travel from the U.S. to Latin America), and from Straszheim (1978) (for high discount travel). The skewness of the histogram is –0.555.



All Long-Haul International Leisure Own-price Elasticities	
5th percentile	-2.070
First quartile	-1.650
Median	**-0.993**
Third quartile	-0.535
95th percentile	-0.220
Interquartile range	1.115
Number of estimates	55.000
Minimum	-2.700
Maximum	-0.140
Variance	0.423
Skewness	-0.555
Kurtosis	-0.393

4.1.8 All Long-haul Domestic Business Estimates

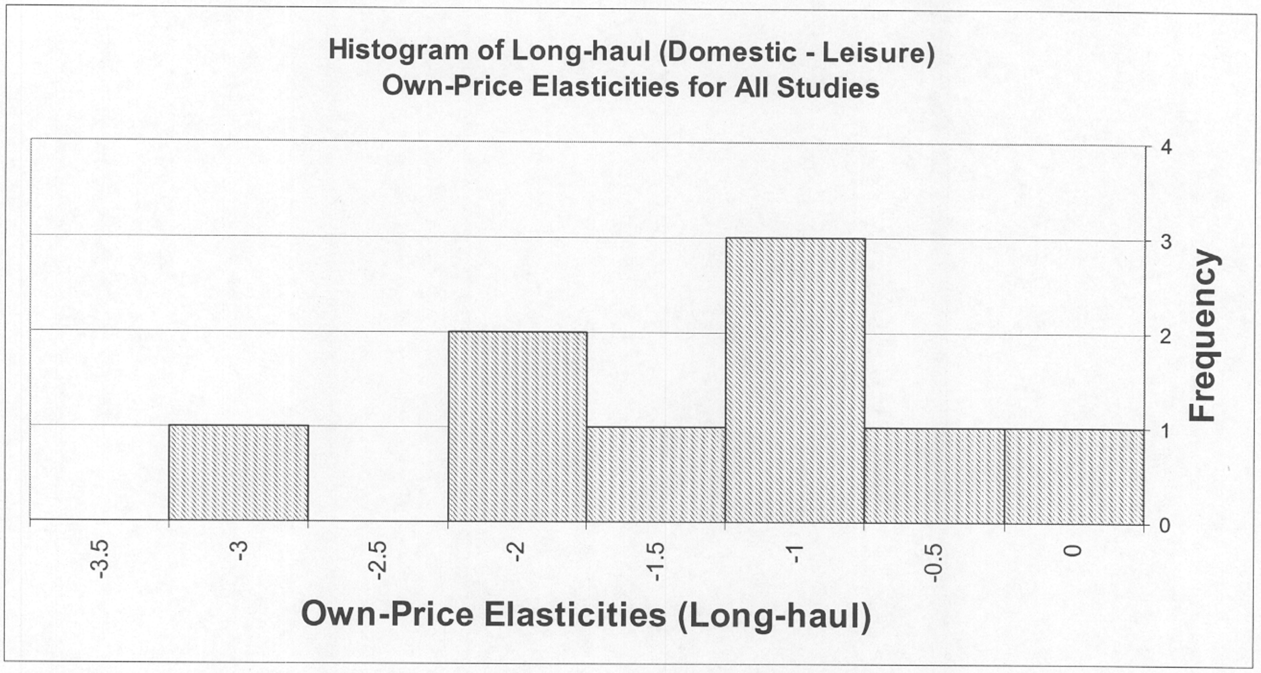
The long-haul domestic business travel subset is comprised of 26 estimates from two studies. The estimates are bunched up between the –0.5 and –1.6. The median of the histogram is –1.15. The skewness (0.270) indicates a non-normal distribution.



All Long-haul Domestic Business Own-price Elasticities	
5th percentile	-1.670
First quartile	-1.428
Median	**-1.150**
Third quartile	-0.836
95th percentile	-0.780
Interquartile range	0.591
Number of estimates	26.000
Minimum	-1.700
Maximum	-0.543
Variance	0.113
Skewness	0.207
Kurtosis	-1.119

4.1.9 Long-haul Domestic Leisure Histogram

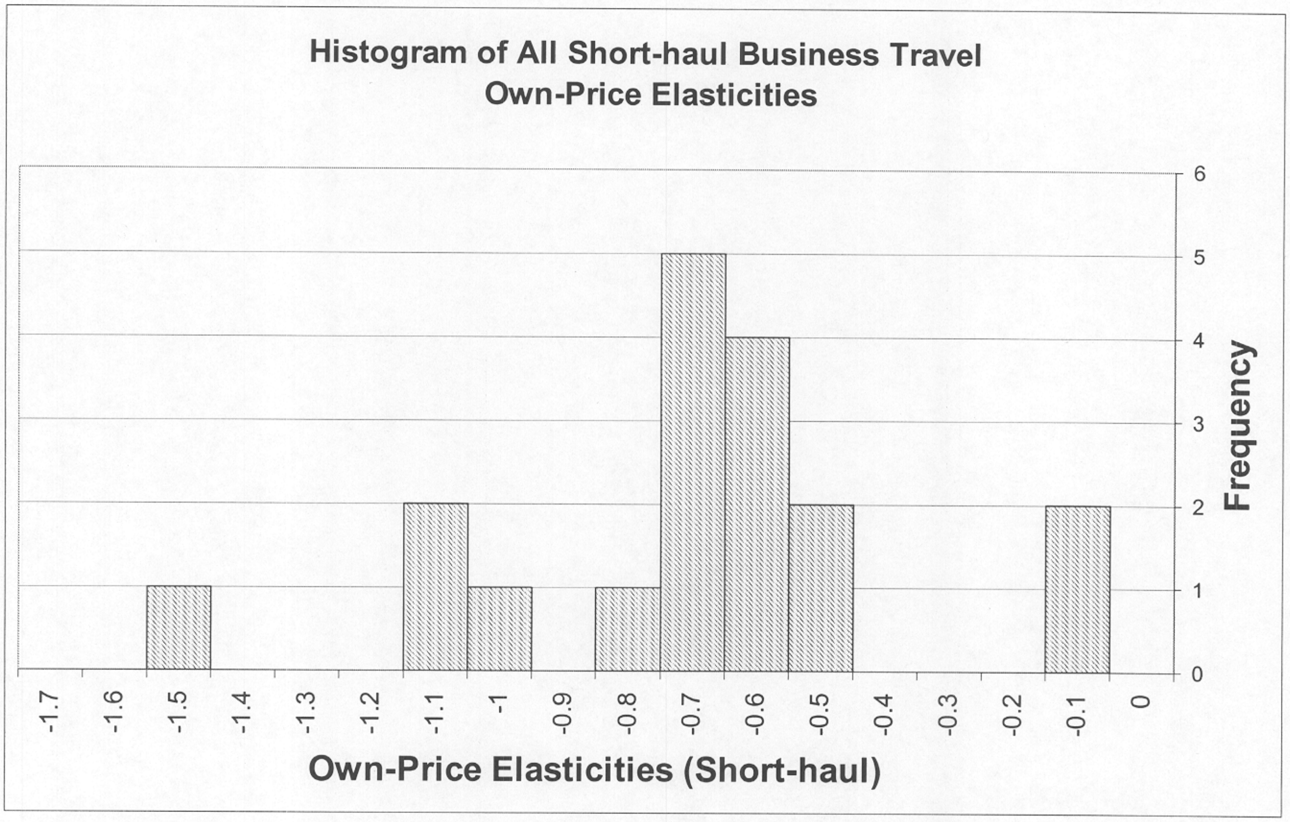
The long-haul domestic leisure travel subset is comprised of nine estimates from two studies. The estimates are distributed between –0.44 and –3.20. The median elasticity is –1.264.



All Long-Haul Domestic Leisure Own-price Elasticities	
5th percentile	-2.854
First quartile	-2.032
Median	**-1.264**
Third quartile	-1.087
95th percentile	-0.539
Interquartile range	0.945
Number of estimates	9.000
Minimum	-3.200
Maximum	-0.440
Variance	0.756
Skewness	-0.756
Kurtosis	0.186

4.1.10. All short-haul business travel estimates

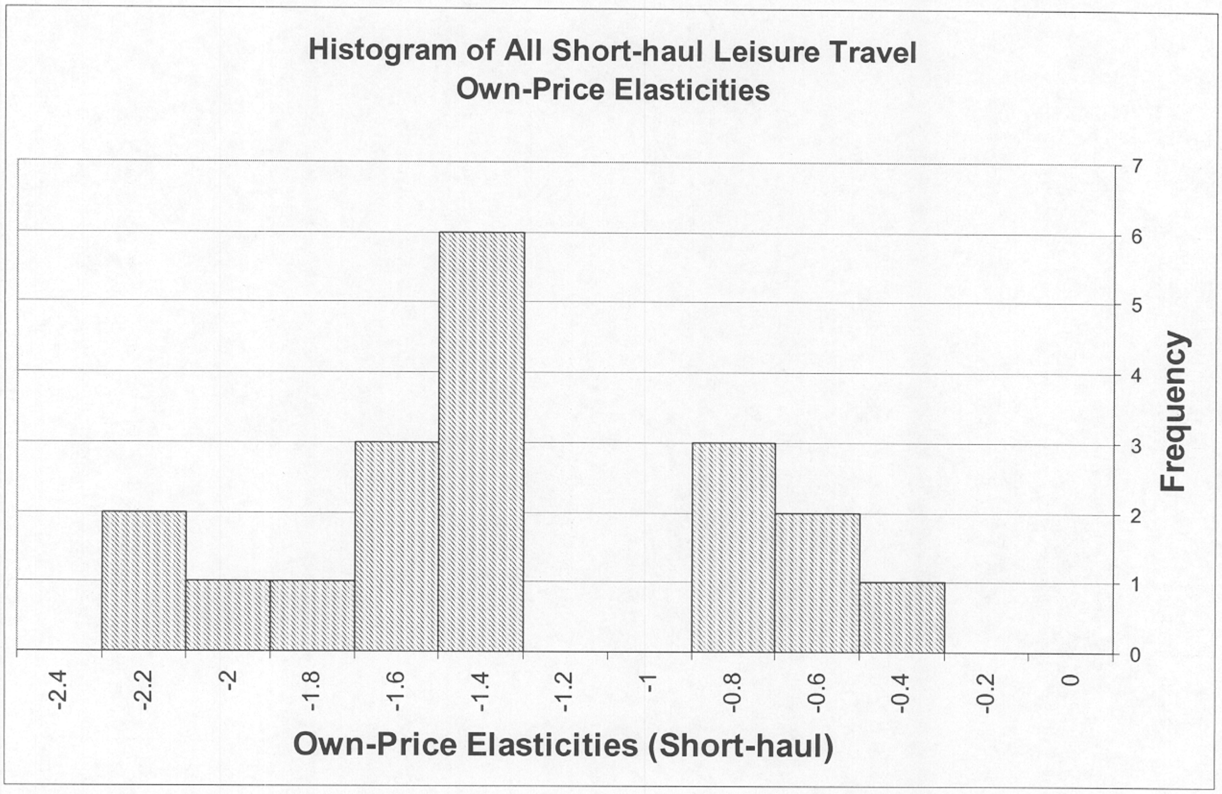
The short-haul business travel subset is comprised of 18 estimates taken from four studies. The median elasticity is –0.73. The histogram demonstrates some crowding of values between –0.5 and –0.8.



All Short-haul Business Travel Own-price Elasticities	
5th percentile	-1.169
First quartile	-0.798
Median	**-0.730**
Third quartile	-0.608
95th percentile	-0.126
Interquartile range	0.190
Number of estimates	18.000
Minimum	-1.500
Maximum	-0.100
Variance	0.106
Skewness	-0.151
Kurtosis	1.509

4.1.11. All short-haul leisure travel estimates

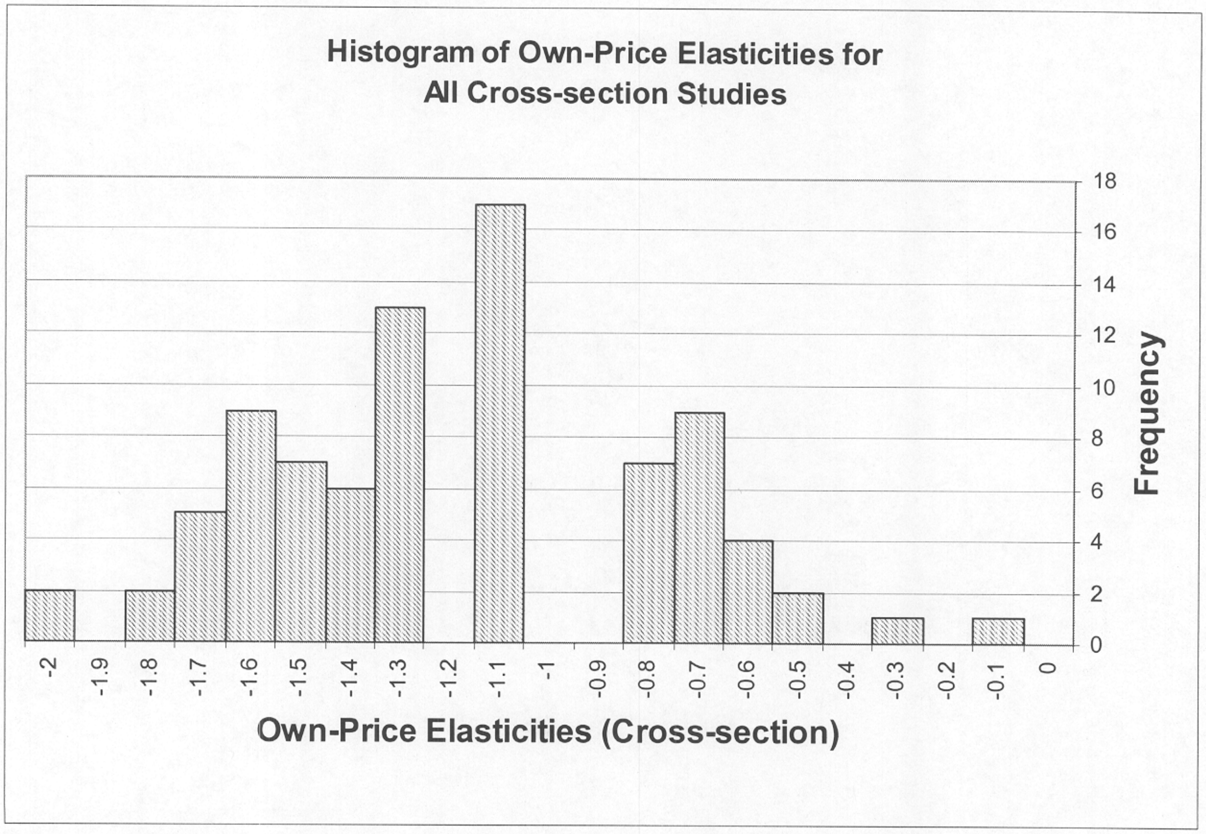
This subset is comprised of 19 estimates from five studies. The median elasticity is –1.52 with estimates distributed across the range of values with little crowding. The histogram is positively skewed (0.158), which indicates that the number of estimates decrease as we approach zero.



All Short-haul Leisure Travel Own-price Elasticities	
5th percentile	-2.307
First quartile	-1.745
Median	**-1.520**
Third quartile	-0.885
95th percentile	-0.688
Interquartile range	0.860
Number of estimates	19.000
Minimum	-2.370
Maximum	-0.400
Variance	0.307
Skewness	0.158
Kurtosis	-0.704

4.1.12 All Cross section study estimates

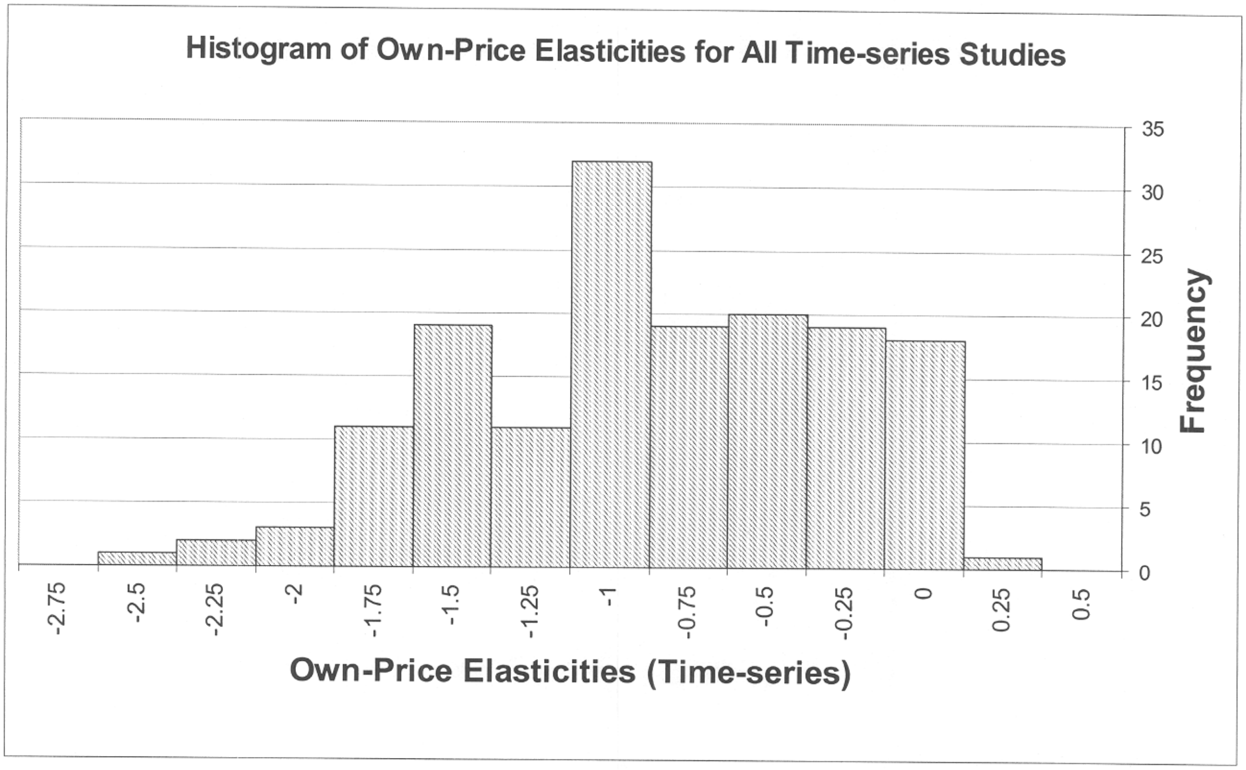
The subset of all cross-sectional studies is comprised of 85 estimates, of which 80 estimates are taken from Oum et al. (1986) and represent U.S. city-pair routes. All of the estimates are taken from studies between 1981 and 1986. The median elasticity is –1.33. The histogram is positively skewed (0.314).



All Cross-section Study Own-price Elasticities	
5th percentile	-1.766
First quartile	-1.520
Median	**-1.330**
Third quartile	-0.810
95th percentile	-0.606
Interquartile range	0.710
Number of estimates	85.000
Minimum	-2.010
Maximum	-0.181
Variance	0.158
Skewness	0.314
Kurtosis	-0.563

4.1.13 All Time-series study estimates

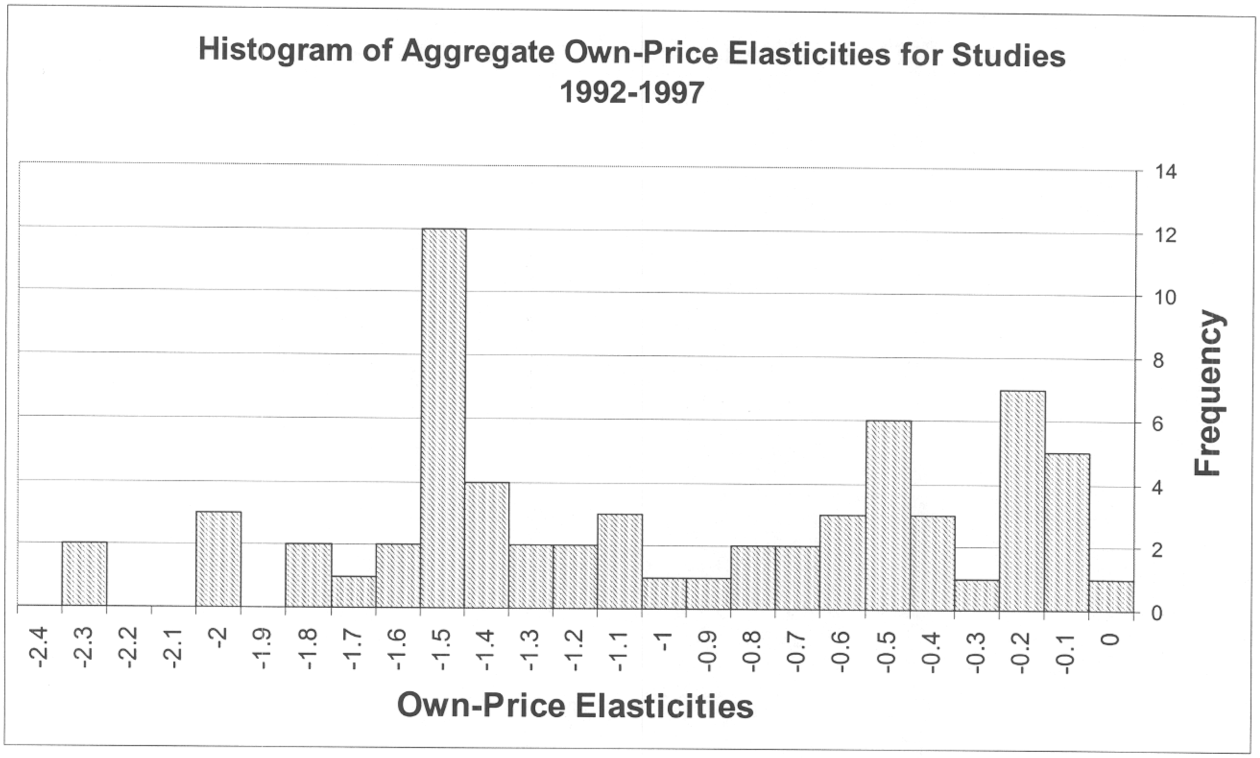
This subset is comprised of 156 estimates, twenty-eight of which are taken from studies published within the last five years. The histogram is negatively skewed with a crowd of estimates between zero and –2. The median elasticity is –1.02.



All Time-series Study Estimates	
5th percentile	-1.915
First quartile	-1.460
Median	**-1.020**
Third quartile	-0.500
95th percentile	-0.155
Interquartile range	0.960
Number of estimates	156.000
Minimum	-2.540
Maximum	0.040
Variance	0.331
Skewness	-0.271
Kurtosis	-0.643

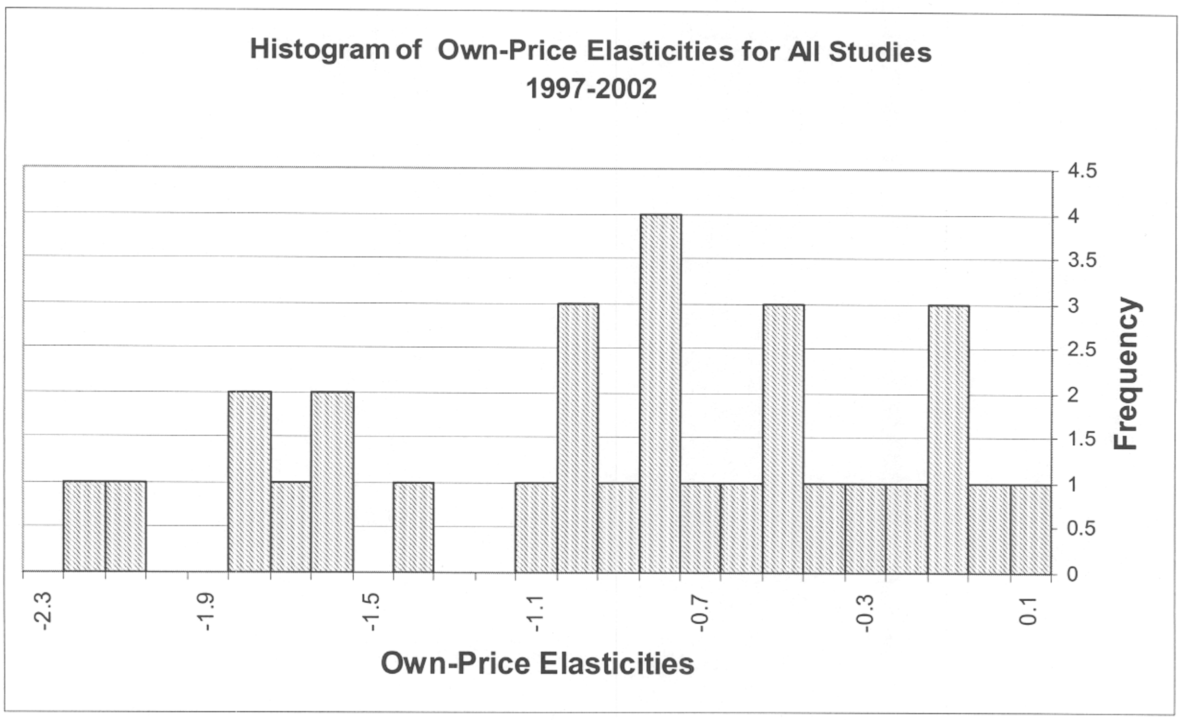
4.1.14 Studies 5-10 years old

Two subsets have been created based on the age of the studies. The first subset is comprised of estimates calculated in studies published between 1992 and 1997. This subset contains 65 estimates from three studies.



Estimates for all studies 1987-1997	
5th percentile	-2.000
First quartile	-1.542
Median	**-1.140**
Third quartile	-0.480
95th percentile	-0.144
Interquartile range	1.062
Number of estimates	65.000
Minimum	-2.336
Maximum	-0.010
Variance	0.410
Skewness	-0.086
Kurtosis	-1.215

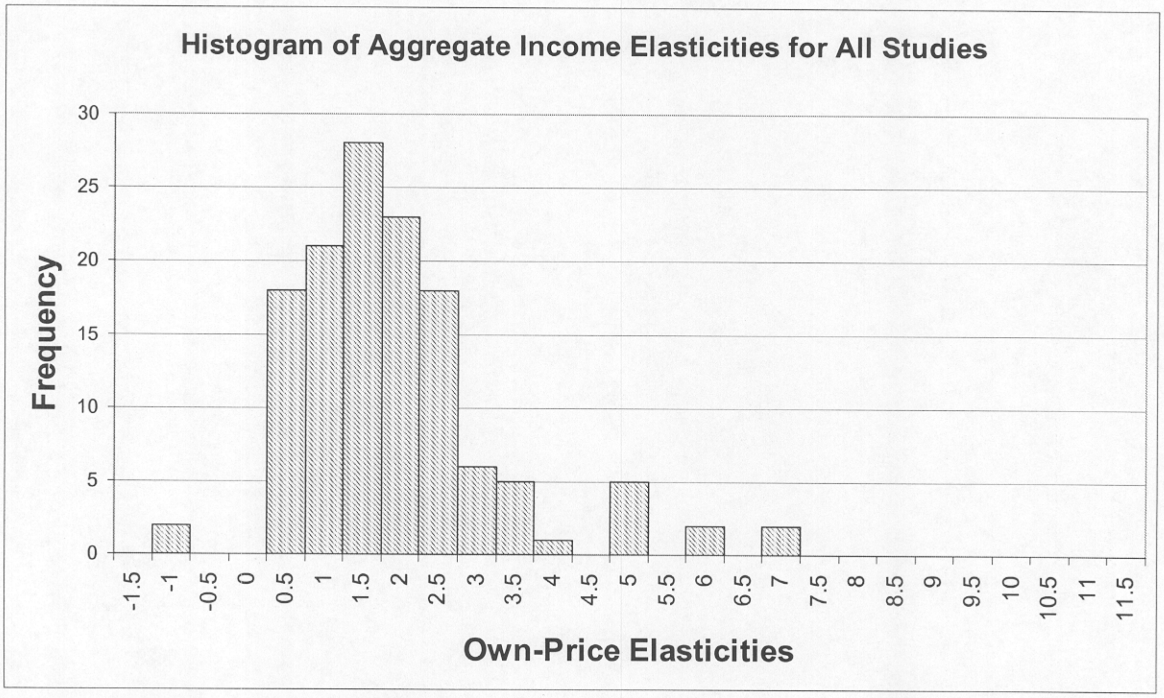
The subset has a balanced proportion of both international and domestic estimates, with 59 estimates taken from the Bureau of Transport Communications and Economics (1995) and Oum et al (1993). The median elasticity is –1.14 with the majority of estimates residing between –0.1 and –2. The histogram is negatively skewed with a skewness of –0.086, which indicates a non-normal distribution. The second subset of estimates based on the age of the study is comprised of estimates calculated in studies published between 1997 and 2002. Four studies qualify for this subset resulting in 30 estimates. The histogram demonstrates no crowding around a small range of values. Instead, there is a wide distribution of values between zero and –2.3. The median elasticity is –0.847.



Own-price Elasticity Estimates for all studies 1997-2002	
5th percentile	-1.978
First quartile	-1.368
Median	**-0.847**
Third quartile	-0.484
95th percentile	-0.084
Interquartile range	0.883
Number of estimates	30.000
Minimum	-2.234
Maximum	0.040
Variance	0.407
Skewness	-0.426
Kurtosis	-0.731

4.1.15 All income elasticities

The subset of all income elasticities contains 132 estimates from 14 studies. The minimum estimated elasticity value is –1.21, which represents inbound pleasure travel to Australia from the United States, as calculated by Hollander (1982). The maximum value is 11.58, which is calculated in the Bureau of Transport Communications and Economics (1995) report for leisure travel by Australian residents to Taiwan. The median estimate is 1.39. There is a crowd of estimates bunched up between 0.5 and 2.5.



All studies Income Elasticities	
5th percentile	0.249
First quartile	0.840
Median	**1.390**
Third quartile	2.169
95th percentile	4.640
Interquartile range	1.329
Number of estimates	132.000
Minimum	-1.210
Maximum	11.580
Variance	2.506
Skewness	2.671

4.1.16 Summary

Table 4.1.16 summarizes the median values of estimated own-price elasticities by market segment and study characteristics (data type and age). The median values indicate that short-haul demand is relatively more price sensitive than long-haul demand, and that business travel demand is relatively less price sensitive than leisure demand. *Moreover, time-series estimates indicate relatively more price sensitivity than those derived from cross-section studies, as expected.* More recent studies have returned relatively inelastic values compared with older studies.

Table 4.1.16

Summary of median elasticity values by type

Category	Median Own-price Elasticity value
All estimates	-1.150
All long haul estimates	-0.950
All long-haul international estimates	-0.790
All long-haul international business estimates	-0.265
All long-haul international leisure estimates	-0.993
All long-haul domestic estimates	-1.340
All long-haul domestic business estimates	-1.150
All long-haul domestic leisure estimates	-1.264
All short/medium haul estimates	-1.150
All short/medium haul business estimates	-0.730
All short/medium haul leisure estimates	-1.520
All cross-section study estimates	-1.330
All time-series study estimates	-1.020
All estimates from studies 1992-1997	-1.140
All estimates from studies 1997-2002	-0.847

4.2 Scoring the studies

To improve the level of confidence regarding the practical use of elasticity values in forecasting air travel demand, we developed a scoring system based on desirable input and output characteristics of empirical demand studies. Following on from our earlier discussion of theoretical and measurement issues, we have identified eleven characteristics that contribute to the quality of elasticity estimates. In each case, the point scores represent our assessment of the relative importance of either the inclusion or exclusion of the characteristic in question. We readily acknowledge that the subjective assignment of point scores cannot provide definitive scientific results. Nevertheless we feel that in the absence of time or resources for more sophisticated analysis (meta regression analysis, risk analysis and bootstrapping techniques for example), the scoring rule provides a useful rule of thumb for comparing the reliability of estimates we feel should be of higher quality with the overall set of estimates from all the studies surveyed. Specifically, we have rated the studies based on the following characteristics:

i.	Separation of business and leisure travel
ii.	Separation of long-haul vs. short-haul travel
iii.	Inclusion of an income coefficient
iv.	Inclusion of intermodal substitution
v.	Data type: panel vs. time-series vs. cross-section
vi.	Country focus
vii.	Route-specific estimates
viii.	Hub vs. non-hub airports
ix.	Connecting vs. O-D passengers
x.	Age of the study
xi.	Adjusted R-squared values

i. *Separation of business and leisure travel*

We expect business travel to be more price insensitive than leisure travel. Consequently studies that do not distinguish between these market segments are likely to provide elasticity estimates that would be biased if applied in any detailed analysis whether applied to specific business or leisure market segments, or to routes, which are predominantly business or leisure oriented.

Scoring rule:

Estimates for both business and leisure = 3 points

Estimates for either business or leisure = 2 points

No separation of business and leisure = 0 points

ii. Separation of Long-haul vs. short-haul travel

We expect less price sensitivity for long-haul flights than for short-haul flights (where more inter-modal substitution is possible). In a similar fashion to the business/leisure distinction, studies that do not distinguish market segments by flight length will provide elasticities that underestimate price sensitivity for short-haul flights and over-estimate it for long-haul flights.

Scoring rule:

Estimates for both long and short-haul = 3 points

Estimates for either long or short-haul = 2 points

No separation of long and short-haul = 0 points

iii. Inclusion of an income coefficient

Without an income coefficient, demand studies will confuse a shift of the demand curve with movements along the demand curve. With a positive income elasticity for air travel, and increasing per-capita real income, demand studies with no income coefficient will overestimate the absolute price elasticity of demand for price decreases and underestimate it for price increases.

Scoring rule:

Income coefficient = 2 points

No income coefficient = 0 points

iv. Inclusion of intermodal substitution (for short-haul flights)

The shorter the distance comprising a trip, the more road and trail transportation become effective substitutes for air travel. Therefore we would expect the price and other characteristics of alternative modes to have a more significant (shift) impact on the demand for short-haul air travel, ceteris paribus. Studies of short-haul flights that do not include intermodal effects are likely to provide bias estimates if the shadow prices of alternative modes change. The scoring rule in this case attempts to award short-haul studies that incorporate intermodal effects, without penalizing studies of longer-haul air travel.

Scoring rule:
Intermodal substitution in short-haul study = 2 points
Not a short-haul study = 1 point
No intermodal substitution in short-haul study = 0 points

v. Data: panel vs. time-series vs. cross-section

Policy analysis should not be guided by immediate or short-term reactions to prices that result from policy changes. Consequently, policies that impact air travel demand should rely more on long-term elasticity measures. While panel studies are ideal as they capture cross-section and time-series effects, studies from time-series data that are sufficiently long in duration will also capture longer-term elasticities.

Scoring rule:
Use of panel data or time-series = 2 points
Use of cross–section data = 0 points

vi. Country focus

There are likely to be many structural details of price sensitivity that relate to the specific national context of the airline industry, including the degree of competition, the size of the market and the regulatory environment. The impact of policies on air travel prices in Canada can be more readily related to some countries more than others. The close geographical proximity of international hubs and agreements within the EU make European studies somewhat less relevant to the Canadian context. US studies are more relevant given the geographic proximity of the US to Canada and the number of US cities to which Canadians travel. Australia on the other hand, provides reasonably comparable demographic, urban, geographical, governmental and regulatory structures.

Scoring rule:
Study relates directly to Canada = 2 points
Study relates to similar foreign country (US or Australia) = 1 point
Study relates to non-similar foreign country = 0 points

vii. Route-specific estimates

Studies that aggregate the effects of price changes on multiple routes will not capture the effects of market competition in which certain airlines enjoy significant market power on some routes but not others. A well-known example of this in the US is the effects of low-cost competition by Southwest Airlines on routes flown by full-service carriers. A related issue is that studies, which focus on multiple short-haul routes run the danger of aggregating effects of routes that are predominantly used by business travellers with routes that are more leisure, oriented. This latter category often constitutes a significant portion of business for low-cost carriers, who offer cheap short-haul flights in competition with alternative leisure activities and entertainment. An example of this is the market for special event parties in Dublin (wedding stags for example) that was created by flights offered by RyanAir from various locations in the UK.

Scoring rule:
Study provides route or airline-specific estimates = 1 point
Study does not provide route or airline-specific estimates = 0 points

viii. Hub vs. non-hub airports

Studies that do not separate out hub from connecting airports will not be able to distinguish "hub premium" effects. Passengers with an itinerary that utilizes a hub airport may be willing to pay a "hub premium" for the integrated service that hubs provide, including sequenced flight segments that minimize waiting time, and baggage that is checked through to the final destination. The existence of a hub premium effect is supported by research in the US.

Scoring rule:
Study identifies hub airports = 1 point
Study does not identify hub airports = 0 points

ix. Connecting vs. O-D passengers

There is a difference between an itinerary and the measurement of traffic volumes between city pairs. If a passenger is travelling from Moncton to Vancouver via Toronto, then their willingness-to-pay and their price sensitivity relates to the trip from Moncton to Vancouver. However, such a passenger could be included in the data that is measuring price sensitivity on the city pair Toronto-Vancouver.

Scoring rule:
Study identifies connecting vs. O-D passengers = 1 point
Study does not distinguish connecting vs. O-D passengers = 0 points

x. Age of the study

The airline industry is a dynamic and changing industry, in the evolution of business models (full-service versus low cost carriers for example), infrastructure (airport business practices) and government regulation. Studies conducted in the US prior to 1978 would not incorporate the effects of deregulation. A similar argument applies to studies that predate 1984 in Canada. Further the National Airport Policy in Canada has led to a gradual devolution of airports from Transport Canada to independent local airport authorities throughout the 1990's. This devolution has led to important infrastructure and pricing decisions. Only the most recent studies would capture system-wide effects of this evolution as some local airport authorities have only come into being in the last year or two.

Scoring rule:
Studies completed during 1997-2002 = 3 points
Studies completed during 1990-1997 = 2 points
Studies completed prior to 1990 = 1 point

xi. Adjusted R-squared coefficient values

This last item addresses the quality of output in the studies rather than the quality of inputs. In regression results, a low R-squared value indicates that only a small portion of variation in the dependent variable (O-D passengers), is explained by the independent variables. The *adjusted* R-squared value is a weighted measure that penalizes the addition of a large number of independent variables with low explanatory power.

Scoring rule:
Adjusted R-squared value over 0.8 = 3 points
Adjusted R-squared value between 0.6 and 0.8 = 1 point
Adjusted R-squared value lower than 0.6 = 0 points

The highest possible score under the criteria we have developed is 23 points. Table 4.2.1 below summarizes the scores of 18 studies, from which we have generated histograms in six sub-categories using only those studies with a 'passing grade' of 12 points or higher. The categories provide separation of long and short-haul, international and domestic travel and business and leisure travel. Note that the column headings in the table refer to the numbered characteristics discussed above.

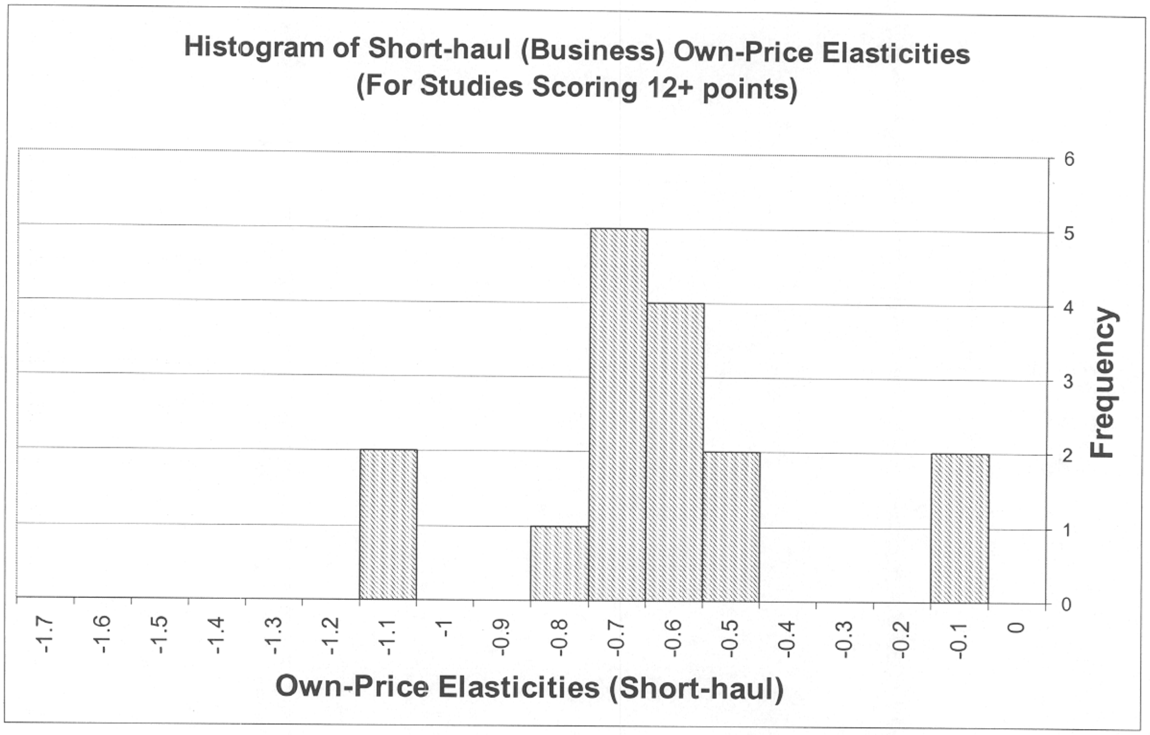
Table 4.2.1 Summary of Study Scores

Study Characteristics		i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	**Score**
Study Title	Author(s)												
An Econometric Air Travel Demand Model For The Entire Conventional Domestic Network: The Case of Norway	Lasse Fridstrom and Harald Thune-Larsen	0	0	2	1	2	0	1	0	0	1	1	8
A Service Quality Model of Air Travel Demand: An Empirical Study	Michael Abrahams	3	3	2	2	2	1	1	0	0	1	1	16
Demands for Fareclasses and Pricing in Airline Markets	Tae H. Oum, David W. Gillen and S.E. Noble	2	3	2	0	0	1	2	1	0	1	0	12
The Structure of Intercity Travel Demands in Canada: Theory Tests and Empirical Results	Tae H. Oum and David W. Gillen	0	0	2	2	2	2	1	0	0	1	1	11
The Demand For International Air Passenger Service Provided by U.S. Air Carriers	Vinod Agarwal and Wayne K. Talley	2	0	0	0	0	1	1	0	0	1	3	8
Estimating Airline Demand With Quality of Service Variables	Richard A. Ippolito	0	0	2	1	0	1	1	0	0	1	0	6
The Demand For Air Services Provided By Air Passenger-Cargo Carriers In A Deregulated Environment	Wayne K. Talley and Ann Schwarz-Miller	0	0	0	0	0	1	1	0	0	1	3	6
An Abstratc Mode Model: A Cross-Section And Times-Series Investigation	Andreas A. Andrikopoulos and Theophilos Terovitis	0	0	2	2	2	0	2	0	0	1	0	9
A Coherence Approach To Estimates of Price Elasticties In The Vacation Travel Market	John H. E. Taplin	2	2	2	1	2	1	1	0	0	1	0	12
Quality of Service and the Demand for Air Travel	James E. Anderson and Marvin Kraus	3	3	2	0	2	1	2	0	0	1	1	15

Study Characteristics		i	ii	iii	iv	v	vi	vii	viii	ix	x	xi	Score
Study Title	Author(s)												
Inter-firm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets	Tae H. Oum, Anmin Zhang and Yimin Zhang	2	3	0	0	2	1	2	0	0	2	0	12
Tourist Expenditure in Australia	Bureau of Industry Economics	2	2	2	1	2	1	2	0	0	1	0	13
Determinants of Demand for Travel to and from Australia	G. Hollander	2	2	2	0	2	1	1	0	0	1	0	11
Tourism Related Movement Study Final Report	Nairn, R.J. and Partners and Hooper, P.	3	2	0	0	0	1	1	0	0	2	0	9
Demand for Australian Domestic Aviation Services Forecasts by Market Segment	Bureau of Transport Economics	2	3	2	2	2	1	1	0	0	1	0	14
Brandow Demand Functions For Australian Long Distance Travel	A.S.G. Lubulwa	3	3	2	2	2	1	2	0	0	1	0	16
Independent review of economic regulation of domestic aviation: Consumer Responsiveness to Changes in Air Fares	T.E. May, E.W.A. Butcher, and G. Mills	2	3	0	0	2	1	1	0	0	1	0	10
Demand Elasticties for Air Travel to and from Australia	Bureau of Transport Communications and Economics	3	2	2	0	2	1	1	0	0	2	3	16
The Price Elasticity of Demand for Air Travel	J.M. Jung and E.T. Fujii	0	0	0	0	2	1	2	0	0	1	0	6
An Econometric Analysis of the Demand for Domestic Air Travel in Australia	B. Battersby and E. Oczkowski	0	0	2	2	2	1	2	0	0	3	1	13
Demand for Air Travel in the United States: Bottom-Up Econometric Estimation and Implications for Forecasts by O&D Pairs	Dipasis Bhadra	0	3	2	0	2	1	1	0	0	3	0	12
An Econometric Analysis of the Demand for Intercity Passenger Transportation	Steven A. Morrison and Clifford Winston	3	0	0	2	0	1	1	0	0	1	0	8
A Generalized Decomposition of Travel-Related Elasticities Into Choice and Generation Components	Taplin, J.H.E	2	3	2	2	0	1	1	0	0	3	0	14
Australian Outbound Holiday Travel Demand: Long-haul Versus Short-haul	K. Hamal	2	3	2	2	2	1	1	0	0	3	0	16

4.2.1 Short-haul business travel

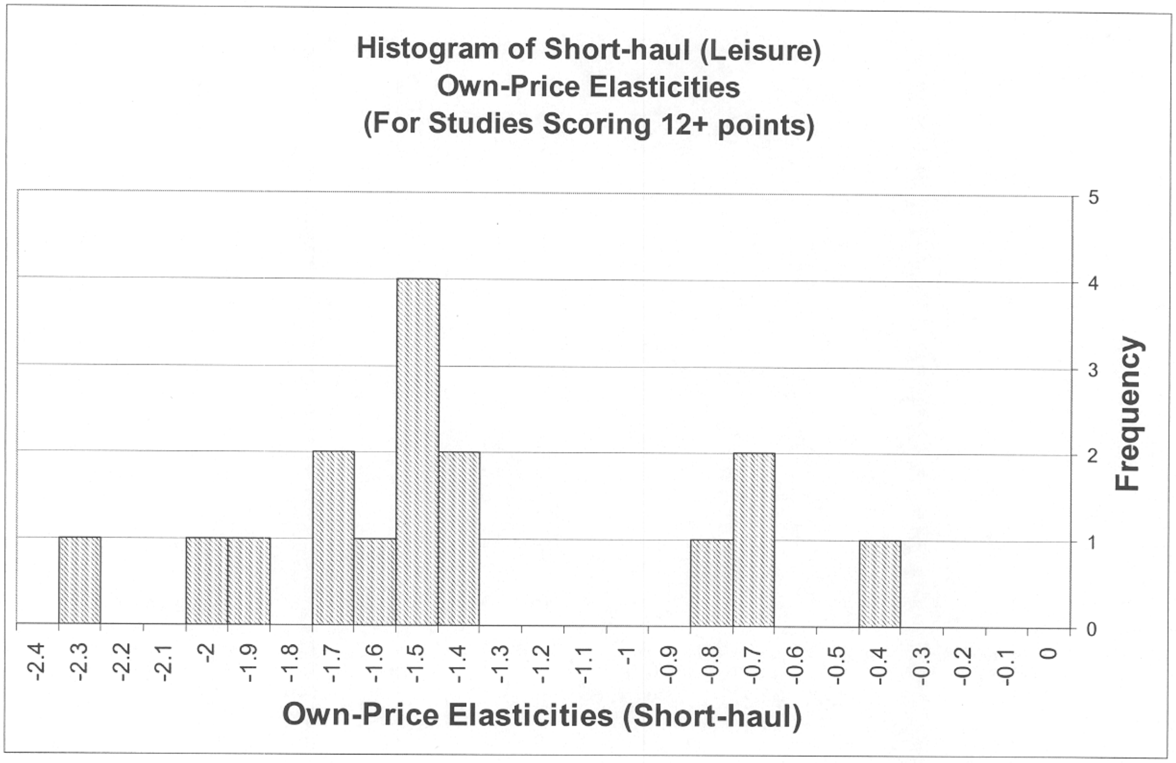
This subset is comprised of 16 estimates taken from three studies, the most recent of which is Battersby-Oczkowski (2001). The median elasticity for the data set is –0.70.



Short-haul Business Travel Own-price Elasticities: Studies Scoring ≥ 12 Points	
5th percentile	-1.103
First quartile	-0.783
Median	**-0.700**
Third quartile	-0.595
95th percentile	-0.123
Interquartile range	0.188
Number of estimates	16.000
Minimum	-1.110
Maximum	-0.100
Variance	0.072
Skewness	0.697
Kurtosis	1.396

4.2.2 Short-haul leisure travel

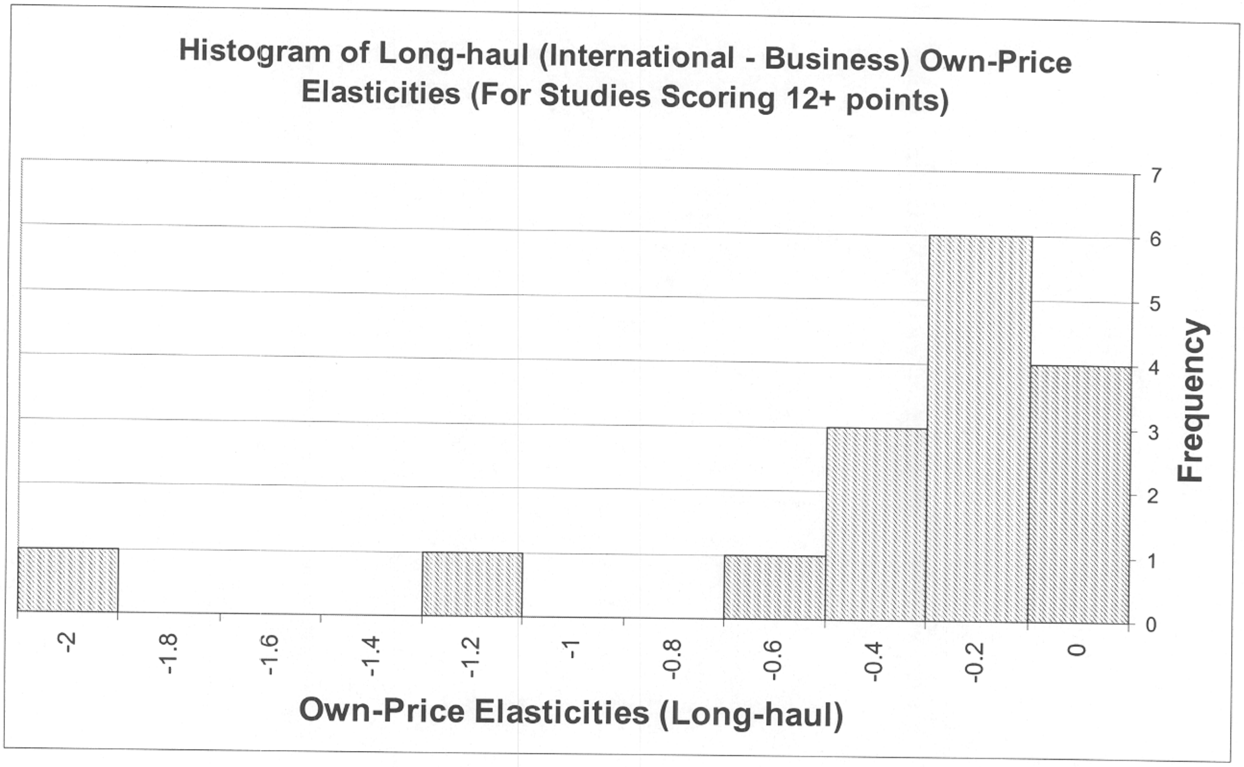
Two studies scoring more than 16 points in our scoring system generate four estimates of short-haul leisure travel. The estimates are distributed between a range of –0.4 and –2.37. The minimum value is taken from the Bureau of Transport Economics (1986) and represents winter vacation travel in Australia. The median estimate for all values is –1.520.



Short-haul Leisure Travel Own-price Elasticities: Studies Scoring ≥ 12 Points	
5th percentile	-2.100
First quartile	-1.743
Median	**-1.520**
Third quartile	-1.288
95th percentile	-0.640
Interquartile range	0.455
Number of estimates	16.000
Minimum	-2.370
Maximum	-0.400
Variance	0.278
Skewness	0.485
Kurtosis	-0.116

4.2.3 Long-haul international business travel

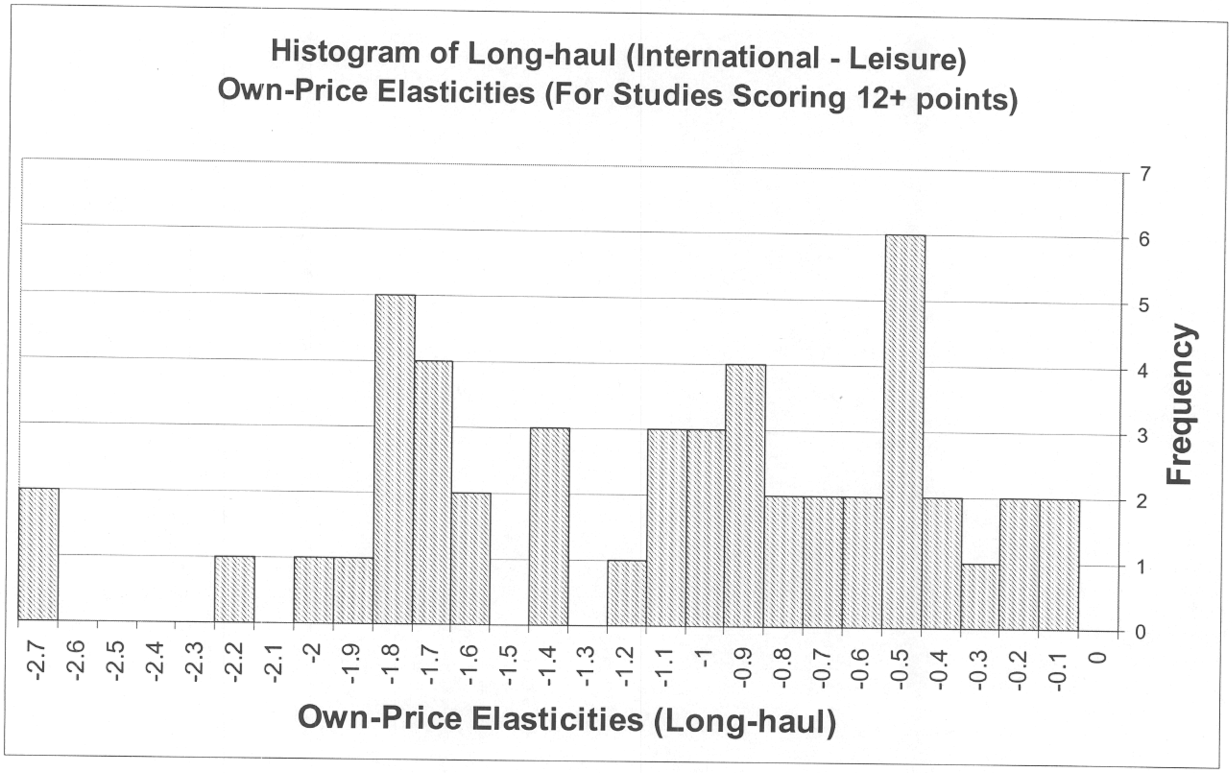
The subset of international business travel estimates provides 16 estimates taken from two studies. The median elasticity is –0.265, which is the same value derived prior to applying the scoring model to the aggregate data set. This occurred because both data sets are comprised of the same estimates.



Long-haul International Business Travel Own-price elasticities Studies scoring ≥ 12 points	
5th percentile	-1.423
First quartile	-0.475
Median	**-0.265**
Third quartile	-0.198
95th percentile	-0.093
Interquartile range	0.278
Number of estimates	16.000
Minimum	-2.000
Maximum	-0.010
Variance	0.251
Skewness	-2.405
Kurtosis	6.095

4.2.4 Long-haul international leisure travel

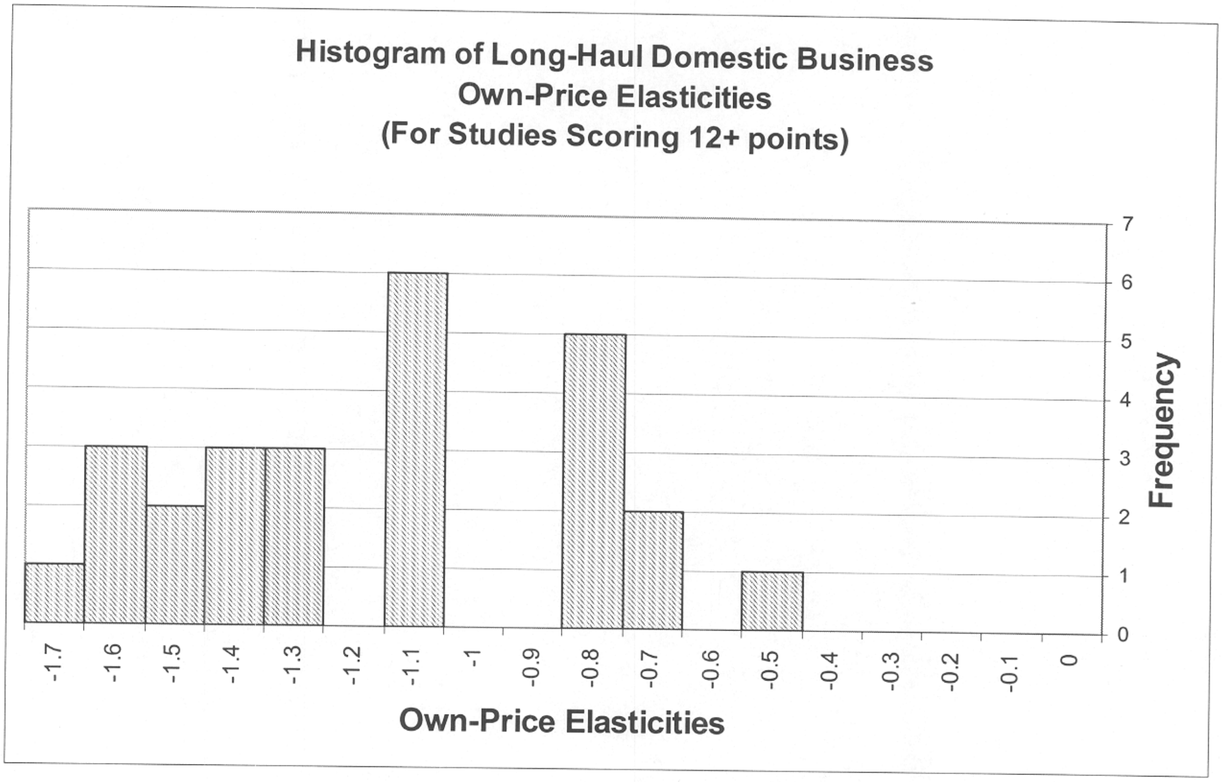
There are 49 international leisure travel price elasticity estimates from six studies with more than 12 points in our scoring system. A majority of the estimates (31) are taken from studies published after 1995. The median elasticity is –1.040 with a large proportion of the estimates bunched up between –0.14 and –1.



Long-haul International Leisure Travel Own-price elasticities Studies scoring ≥ 12 points	
5th percentile	-2.140
First quartile	-1.700
Median	**-1.040**
Third quartile	-0.560
95th percentile	-0.254
Interquartile range	1.140
Number of estimates	49.000
Minimum	-2.700
Maximum	-0.140
Variance	0.420
Skewness	-0.465
Kurtosis	-0.474

4.2.5 Long-haul domestic business travel

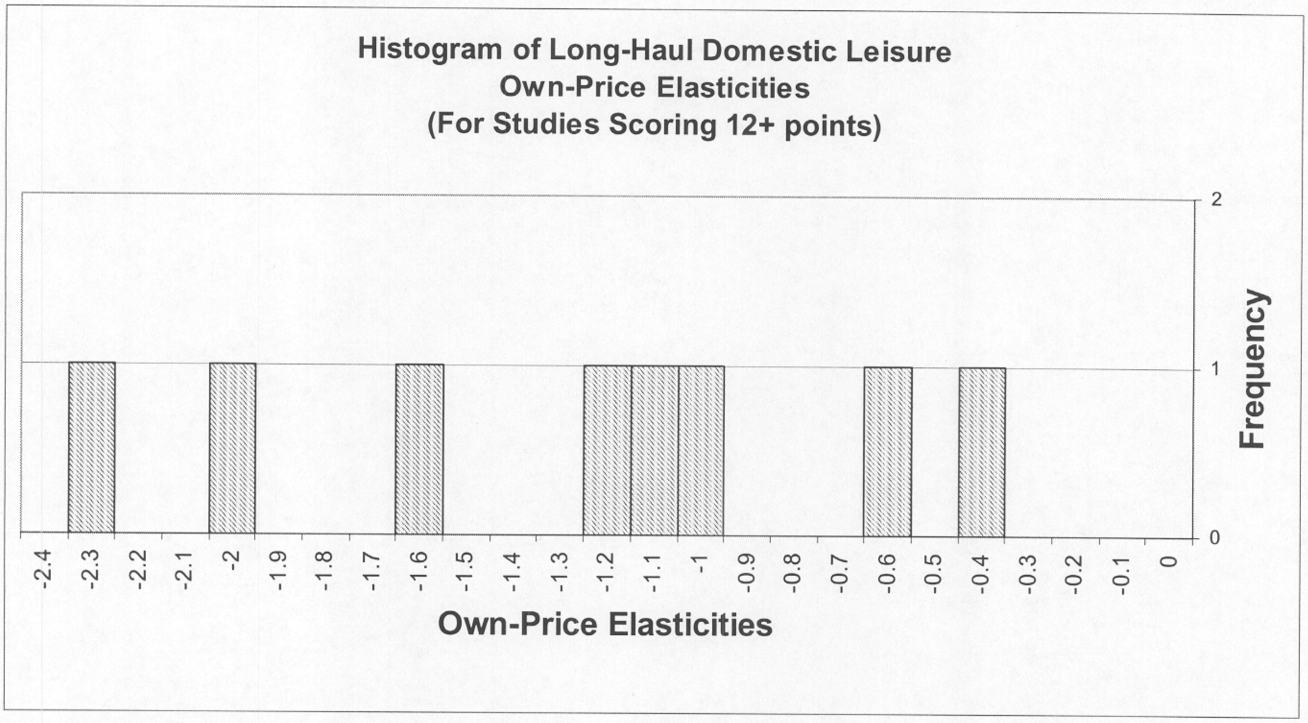
The domestic long-haul business travel subset consists of 26 estimates from two studies. The median elasticity is –1.15. The estimates are taken from Lubulwa (1986) and Oum et al. (1986).



Long-Haul Domestic Business Travel Own-price Elasticities Studies scoring ≥ 12 points	
5th percentile	-1.670
First quartile	-1.428
Median	**-1.150**
Third quartile	-0.836
95th percentile	-0.780
Interquartile range	0.591
Number of estimates	26.000
Minimum	-1.700
Maximum	-0.543
Variance	0.113
Skewness	0.207
Kurtosis	-1.119

4.2.6 Long-haul domestic leisure travel

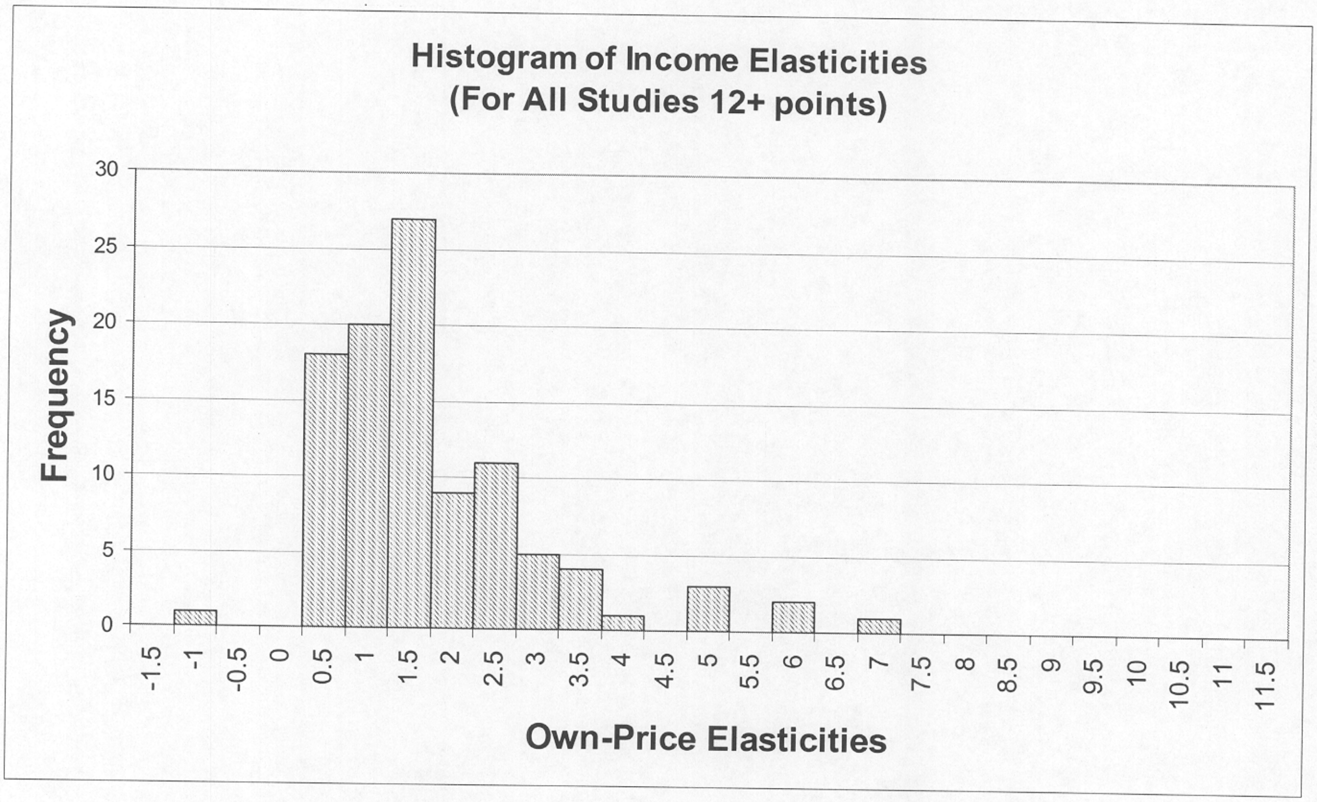
There are eight long-haul domestic leisure travel price elasticity estimates taken from three studies. The median elasticity is –1.192. The histogram demonstrates no crowding around a range of values.



Long-haul Domestic Leisure Travel Own-price Elasticities Studies scoring ≥ 12 points	
5th percentile	-2.230
First quartile	-1.768
Median	**-1.192**
Third quartile	-0.987
95th percentile	-0.526
Interquartile range	0.781
Number of estimates	8.000
Minimum	-2.336
Maximum	-0.440
Variance	0.420
Skewness	-0.284
Kurtosis	-0.849

4.2.7 Income elasticities

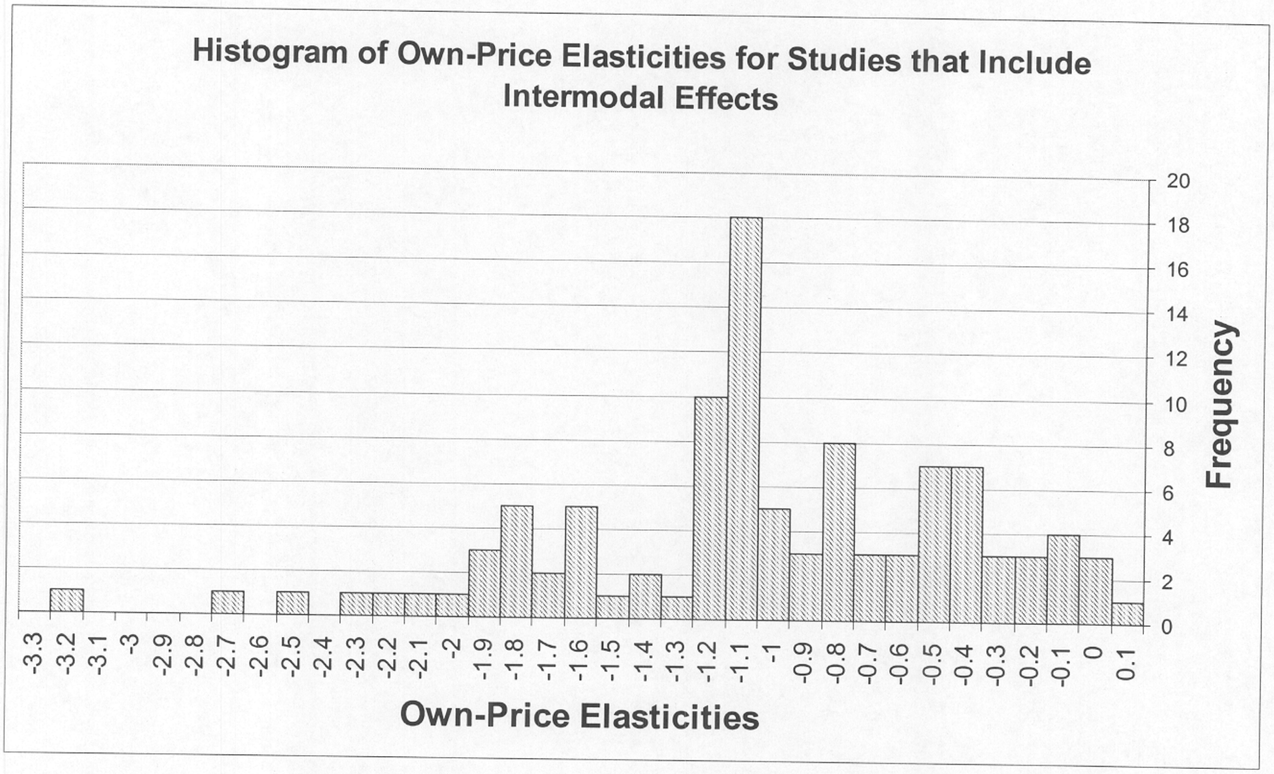
A subset of 103 income elasticity estimates is generated from the 'passing grade' studies. In similar fashion to the histogram for all studies, a crowding of estimates around the values of 0.5 to 2.5. The median value of the subset is 1.14.



Income elasticities for all Studies scoring ≥ 12 points	
5th percentile	0.242
First quartile	0.807
Median	**1.140**
Third quartile	2.089
95th percentile	4.636
Interquartile range	1.282
Number of estimates	103.000
Minimum	-1.039
Maximum	11.580
Variance	2.642
Skewness	3.051
Kurtosis	14.139

4.2.8 Studies that Account for Intermodal Effects

The data set for studies that include the effects of intermodal competition (e.g. auto, rail, bus, ship) is comprised of 104 own-price elasticity estimates taken from thirteen studies (including short, medium and long haul routes). The histogram does not demonstrate any bunching around a set of values as supported by the skewness (-0.641). The median elasticity value is –1.113.



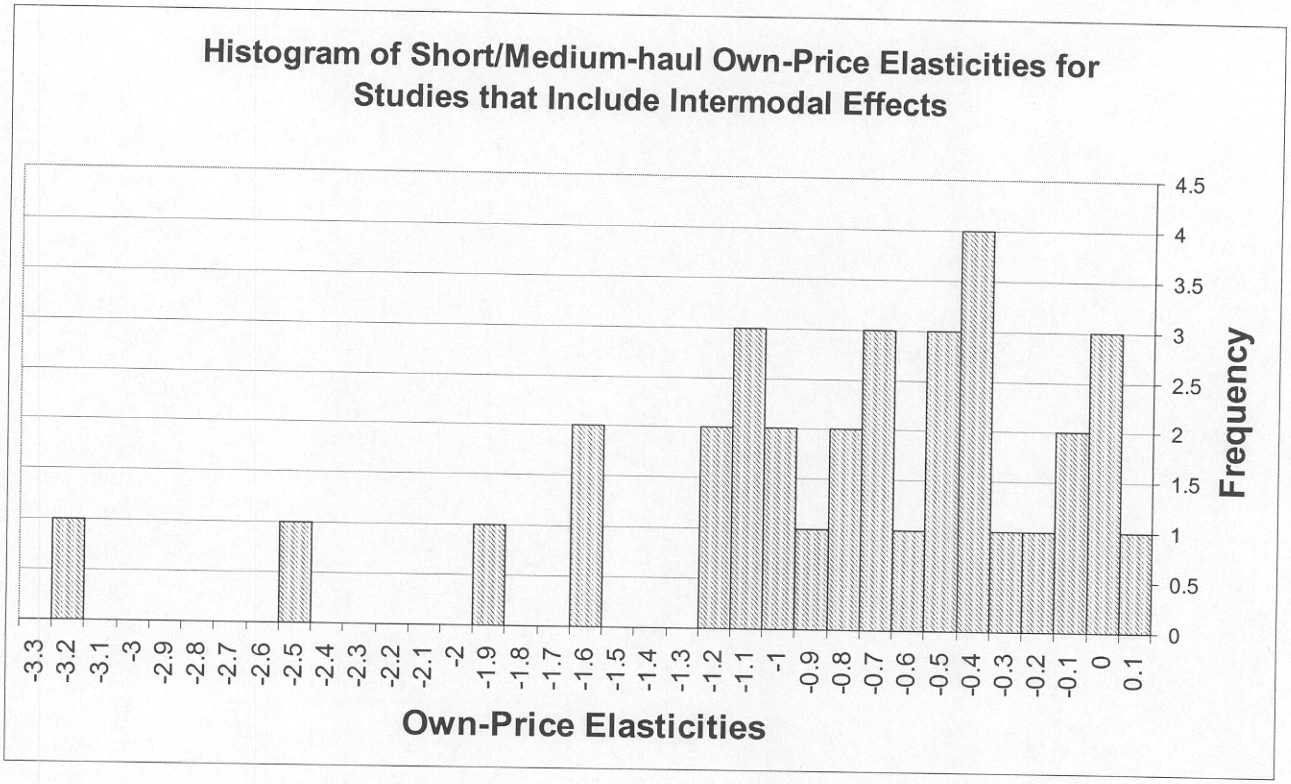
Own-price Elasticities: Studies with Intermodal Effects	
5th percentile	-2.085
First quartile	-1.290
Median	**-1.113**
Third quartile	-0.588
95th percentile	-0.138
Interquartile range	0.703
Number of estimates	104.000
Minimum	-3.200
Maximum	0.040
Variance	0.389
Skewness	-0.641
Kurtosis	0.614

A subset of estimates is extracted that includes estimates for short/medium-haul elasticities. The data set is comprised of 34 estimates taken from four studies including those elasticities calculated by Battersby-Ozckowski (2001). The median estimate (–0.720) is lower than the median elasticity calculated for all intermodal studies (-1.113). However, some details of these studies make the interpretation of this result difficult.

First, the subset includes discount, economy, and business fare-class estimates. The elasticities reflect both the nature of travel on the routes (business or leisure) and the fare class. For example, the Sydney-Melbourne route is a significant business route in Australia with relatively low elasticity estimates (Discount= –0.07, Economy= -0.81, Business = -0.1). The dataset contains several estimates from routes that are historically business travel city-pairs.

Secondly, thirteen of the estimates are from city-pair routes with distances of approximately 870 to 1000 km (the high end of the short-haul distance condition). Only five out of 34 estimates are explicitly defined as short-haul routes of less than 750 km. These elasticity estimates are: Melbourne-Adelaide (-0.46); Australia short-haul <500 km (-0.728); New South Wales, Australia, routes <200km (-2.54); Short-haul Western and Mid-western, U.S., routes <500 miles (-0.08); Short-haul Eastern city-pairs, U.S. <500 miles (-0.36). Two of the estimates (Short-haul Eastern U.S., and Western and Mid-Western U.S.) are likely capturing business travel.

Lastly, 28 of the 34 estimates are taken from studies comprised of Australian city-pair routes. These studies do not provide sufficient information about the city-pair characteristics, such as whether or not a specific route has one or more (or possibly no) competing transportation modes. If the use of a competing mode is infeasible or highly unlikely then the elasticity estimate is not capturing intermodal effects.



Short/Medium haul Own-price Elasticities: Studies with Intermodal Effects	
5th percentile	-2.176
First quartile	-1.108
Median	**-0.720**
Third quartile	-0.415
95th percentile	-0.077
Interquartile range	0.693
Number of estimates	34.000
Minimum	-3.200
Maximum	0.040
Variance	0.508
Skewness	-1.524
Kurtosis	2.925

5. Discussion

In a number of cases, studies that are focused on the impact of price changes or fees on demand use a single elasticity measure to compute the quantity, revenue and profit change for a route, market, airline or entire economy (see for example, PODM (Transport Canada) which uses one elasticity of business and one for leisure; economic impact studies for airports often use this approach as well). Using a single value implicitly assumes that the elasticity measure is transferable across markets and time. There is a rich and extensive literature that explains the conditions under which such estimates are transferable.[21] The properties or characteristics of the data in different markets should meet statistical tests in order to have statistical validity in having a common elasticity. For example, some studies or applications (e.g. PODM)[22] do not distinguish between long-haul and short-haul routes but do differentiate business and leisure markets in selecting representative elasticities.

We have shown that elasticity values can and do differ significantly between travel distance, type of traveller and even domestic and international routes. This is illustrated in Table 5.1 in which we report elasticities for three different route types and two passenger types. We have argued that the usefulness of estimates should be based upon other criteria such as the inclusion of income coefficients and distinctions between types of passengers and airports. We have also argued that route-specific data is especially valuable in capturing competitive, geographic and market differences.

In the body of the report we show that for the entire set of studies as well as for categories of studies the distribution of elasticity estimates is highly skewed. Such a distribution makes the use of the mean or average tenuous at best. The mean may turn out to be a value that was yielded by none of the studies. The variance is also large which makes the level of confidence we can place in a 'mean' value particularly low. Therefore, we have used the 'median' value of the elasticity estimates as an indicator of what elasticity value

[21] This literature grew out of the early demand modeling efforts. See for example, Watson, Peter L. and Richard Westin. *Transferability of Disaggregate Mode Choice Models*, Amsterdam: North-Holland, 1975 and Frank S. Koppelman and Eric I. Pas, Multidimensional Choice Model Transferability,. *Transportation Research. Part B, Methodological*. Vol. 20B, no. 4 (Aug. 1986) p. 321-330

might be used in forecasting changes in revenue, passengers and profit in markets where the elasticity is appropriate – short or long-haul, business or leisure etc. as a result of a policy change.[23] In addition to the reported median values in the various categories, we have also reported quartile information from the distributions of elasticity values; dividing the observations into quartiles simply means we have divided it into quarters, so the 1st quartile would be the first 25 percent of observations. In particular, table 5.1 draws attention to the first and third quartiles (twenty-five percent of the values in a distribution fall below the first quartile and seventy-five percent fall below the third quartile).[24] The first and third quartiles form a useful range around the median that widens (narrows) as the tails of the distribution grow thicker (thinner). This is illustrated in figures 5.1a and 5.1b.

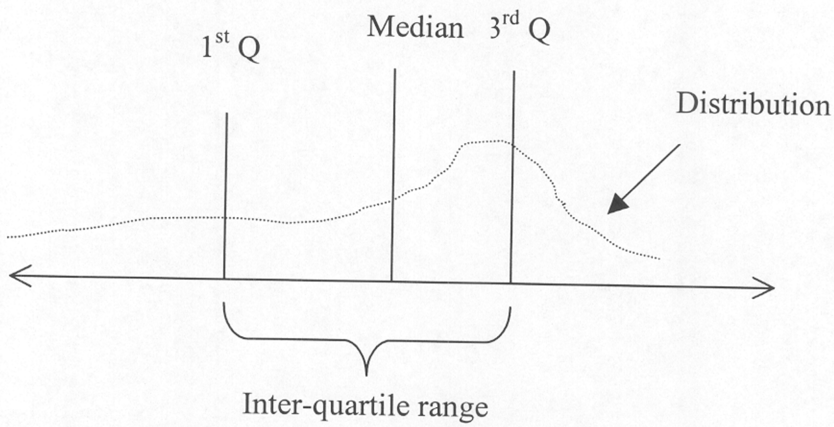


Figure 5.1a: Inter-quartile range with wide tails in the distribution

[22] PODM is the air travel forecasting model used by Transport Canada.
[23] We remind the reader the median is the value that divides the sample in half so 50 percent of observations will lie above the median value and 50 percent will lie below it.
[24] When using mean values as a measure of central tendency, the standard deviation of the distribution can be used to create confidence intervals of plus and minus one standard deviation around the mean. Since we are using the *median* as a measure of central tendency, we cannot use standard deviations (which assume a normal distribution which by definition is not skewed).

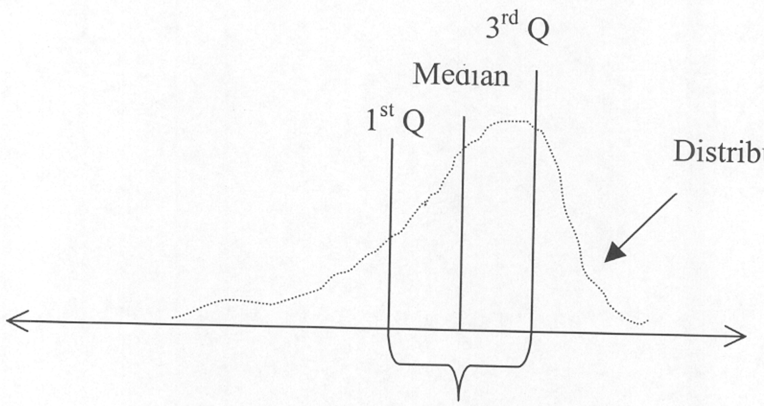


Figure 5.1b: Inter-quartile range with narrow tails in the distribution

Table 5.1 below, shows median *absolute* values (meaning we have dropped the negative sign in front of the elasticity value) of estimated demand elasticities along with the first and third quartiles of the distribution for all studies and for 'passing grade' studies in six categories.[25]

In the long-haul *international* market, there is no apparent difference between the elasticity values from all studies and the group regarded as having a 'passing grade', based on our scoring system.[26] The median values are low (0.265) for business travel and close to unity for leisure travel. This seems reasonable, since long-haul international business travel demand has relatively few close substitutes, making demand insensitive to fare changes. On the other hand, international leisure travellers are more likely to postpone trips to specific locations in response to higher fares, or shop around for those

[25] Absolute values mean we have dropped the negative sign before the elasticity value. We had included the sign in section 4 because price elasticities were negative while income elasticities were positive. In a few cases studies reported positive price elasticities, a clear error. Here we are interested in only the degree of difference in price sensitivity as reported by the magnitude of the elasticity value.
[26] These are not the same set of studies but the superior group is a subset of the total.

Table 5.1

Summary Table of Absolute Elasticity Values

Category	Median (1st quartile) (3rd quartile) Elasticity values All studies		Median (1st quartile) (3rd quartile) Elasticity values Studies scoring ≥ 12 points	
Own-price: Long-haul international business	0.265		0.265	
	0.475	0.198	0.475	0.198
Own-price: Long-haul international leisure	0.993		1.040	
	1.65	0.535	1.700	0.560
Own-price: Long-haul domestic business	1.150		1.150	
	1.428	0.836	1.428	0.836
Own-price: Long-haul domestic leisure	1.264		1.192	
	2.032	1.087	1.768	0.987
Own-price: Short/medium-haul leisure	1.520		1.520	
	1.745	0.885	1.743	1.288
Own-price: Short/medium-haul business	0.730		0.700	
	0.798	0.608	0.783	0.595
Income elasticity	1.390		1.140	
	0.840	2.169	0.807	2.0489

locations offering more affordable fares. In the vacation market, international travel competes more directly with domestic travel for vacation destinations.

The long-haul *domestic* business segment elasticities are the same whether looking at all studies or the sub-set of 'passing grade' studies. The value of 1.15, being close to unity indicates that domestic_business travellers will have higher elasticities (in this case about four times the value) than international business travellers. In domestic markets, alternatives such as telecommunications are more substitutable than in international markets due to common culture, laws, contracts etc. International trips are typically planned well in advance, with the travel spread over more time we would expect the airfare to be a lower proportion of overall trip costs.

The median long-haul domestic leisure elasticity values do not differ significantly between all studies and those rated superior, however the *range* of elasticity values in the passing grade studies (as defined by the first and third quartiles of the distribution) is narrower and slightly lower. The value of 1.192 does not seem unreasonable in comparison to the domestic business travel elasticities.

The median elasticity value from all studies versus 'passing grade' studies for short/medium-haul leisure are identical and characteristically elastic at 1.52. Notice however that the *range* of values around the median is narrower in the passing grade studies, excluding the possibility of inelastic demand at the lower bound of the range. Note also that, the fare elasticity for leisure short-haul traffic may be under valued since more recent competitive effects of low cost carriers have not been captured by any of the studies.

The estimated median fare elasticity for short/medium-haul business travel is moderately inelastic at 0.73 with a very tight range around the median. Once again, accounting for more recent competitive effects of low cost carrier competition on short-haul routes could generate higher (absolute) elasticity values.[27]

Table 5.1 provides ample evidence that using a single elasticity for all market segments is inappropriate just as a single elasticity will not reflect impacts on the aggregate market. Furthermore, simply segmenting markets by business and leisure is insufficient to provide any degree of accuracy to forecast changes in passengers with changes in fares. For example, given the clear differences between short and long-haul market elasticities, using long-haul values to evaluate impacts on short-haul markets would provide an underestimate.

There is some cause to believe that the existing elasticity values in the literature may be somewhat low for both leisure and business travel, particularly in short to medium-haul markets. The reasoning is based on research, which shows that the entry of low cost carriers into markets leads to a reduction in the average fares on those routes (Windle and Dresner, 1999).[28] For example, if a low cost carrier like Southwest enters a market, the effect has been a reduction in fares of almost 50 percent. Table 5.2 compares very recent revenue yields in various US markets that are delineated based on length of flight but also on whether there is competition from Southwest Airlines, and the form of that competition. The table shows, quite dramatically, that the more direct the competition from Southwest, the lower the yields (which translates into lower average fares).

Table 5.2

Revenue yields of other airlines (OA) and Southwest (SW)

Market type	Yields (cents per passenger mile)	
	500 Miles	1000 Miles
OA-no SW presence	51	26
OA-SW connecting competition	31	20
OA- SW Direct competition	26	19
SW-connect	21	14
SW-non-stop	18	12

Sources: US Department of Transportation (2002); D. Gillen "Frills, no frills or Wal-Mart: The future of Canada's Aviation industry" (Forthcoming, Van Horne Institute, University of Calgary)

There are few studies that have included, as a time-series, the growth in markets where low cost carriers have concentrated their activity. In empirical studies, routes are usually aggregated so an average elasticity is estimated across short, medium and long-haul routes. Thus, in studies using detailed US data markets served by Southwest Airlines and more recently by other low cost carriers such as JetBlue and Air Tran are aggregated with

[27] A good example is to look at the Ottawa-Toronto-Montreal triangle and the lack of response to fare increases and average fare levels but low cost carriers are not in two of these markets.

[28] Robert Windle, Martin Dresner (1999) *Competitive Responses to Low Cost Carrier Entry*, *Transportation Research. Part E, Logistics and Transportation Review*. Vol. 35E, no. 1 (Mar. 1999) p. 59-75

those served by other full service carriers even though the growth in traffic in these markets is quite different.

In order to look at the potential underestimation of demand response in markets where low cost carriers participate we used US data from 1999-2000 2nd Quarter. The year-over -year changes in passengers and fares are used to calculate arc-elasticities for routes of different length and for fare increases and fare decreases. We found the calculated arc elasticities did not differ in any significant way from the values we have found from our survey of the literature. This applies to values for long-haul as well as short to medium-haul markets; short/medium-haul markets are more price sensitive than long-haul markets. We therefore feel the values reported in Table 5.1 fairly reflect the sensitivity of markets including those served by low cost and low fare carriers.[29]

As we note in the discussion of Table 5.1, there is no single elasticity value that is representative of air travel demand. There are several distinct markets and several different elasticities should be used when exploring the impact on markets from changes to the aviation environment. Furthermore, even given the elasticity for a market segment, there is a range around this elasticity that should be considered in using the elasticity to forecast the impact of fare changes. The aggregate elasticities for the market segment reflect the combined effect of demand relationships in each component market. Each market will typically exhibit different elasticities than that considered for the aggregate market level.

[29] We have not carried out any analysis on Canadian data since is there is no comparable data set to that available in the US.

Bibliography

Abrahams, M., *A Service Quality Model of Air Travel Demand: An Empirical Study*, Transportation Research, 17A(5), 385-93, 1983.

Agarwal, V. and W. Talley, *The Demand for International Air Passenger Service Provided by U.S. Air Carriers*, Interntaional Journal of Transport Economics, 12 (1), 63-70, 1985.

Anderson, James E., and Marvin Kraus, *Quality of Service and the Demand for Air Travel*, The Review of Economics and Statistics, Volume 63, Issue 4, 533-540, 1981.

Andrikopoulos A.A., and T. Terovitis, *An Abstract Mode Model: A Cross-section and Time-series of Investigation*, International Journal of Transport Economics, 10(3), 563-76, 1983

Battersby, B. and E. Oczkowski, *An Econometric Analysis of the Demand for Domestic Air Travel in Australia*, International Journal of Transport Economics, Vol. 28(2),193-204, 2001.

Bhadra, Dipasis, *Demand for Air Travel in the United States: Bottom-Up Econometric Estimation and Implications for Forecasts by O&D Pairs*, Center for Advanced Aviation System Development – The Mitre Corporation, 2002.

Brons Martijn, Eric Pels, Peter Nijkamp and Piet Rietvela, *Price Elasticities of Demand for Passenger Air Travel: A Meta-Analysis*, Tinbergen Institute, Amsterdam, 2001.

Bureau of Industry Economics, *Research Report 16*, Bureau of Industry Economics, Canberra. BIE, 1984.

Bureau of Transport and Communications Economics, *International Aviation*, Report 86, 19-22.

Bureau of Transport Communications and Economics, *Demand Elasticities for Air Travel to and from Australia*, Working Paper 20, Department of Transport and Communications, 1995.

Bureau of Transport Economics, *Demand for Australian Domestic Aviation Services Forecasts by Market Segment*, AGOS, Canaberra. Occasional Paper 79., 1986.

Fridstroom, L. and H. Thune-Larsen, *An Econometric Air Travel Demand Model for the Entire Conventional Domestic Network: The Case of Norway*, Transportation Research, 23B(3), 213-24, 1989.

Gillen D. W. and Morrison W. G., *Airport Financing, Costing, Pricing and Performance*, Report to the Canadian Transportation Act review Committee, April 2001.

Hamal, K., *Australian Outbound Holiday Travel Demand: Long-haul Versus Short-haul*, Bureau of Tourism Research, Canberra, BTR Conference Paper 98.2, 1998.

Hollander, G., *Determinants of Demand for Travel to and from Australia*, BIE Working Paper no. 26, Bureau of Industry Economics, Canberra., 1982.

Ippolito, R.A., *Estimating Airline Demand With Quality of Service Variables*, Journal of Transport Economics and Policy, 15(1), 457-64, 1981.

Jung, J.M. and E.T. Fujii, *The Price Elasticity of Demand for Air Travel*, Journal of Transport Economics and Policy, Volume 10, 257-262, 1976.

Lubulwa, A.S.G, *Brandow Demand Functions For Australian Long Distance Travel*, Forum Papers, 11th Australian Transport Research Forum, volume (2), 200-218, 1986.

May, T.E., E.W.A. Butcher and G. Mills, *Consumer Responsiveness to Changes in Air Fares, Indpendent Review of Economic Regulation of Domestic Aviation*, vol. 2, Appendix L, 1986.

Morrison, Steven A., and Clifford Winston, *An Econometric Analysis of the Demand for Intercity Passenger Transportation*, Research in Transportation Economics, Volume 2, 213-237, 1985.

Nairn, R.J. and P. Hooper, *Tourism Related Movement Study Final Report*, Roads and Traffic Authority, NSW, Sydney., 1992.

Oum T.H. and D. W. Gillen , *The Structure of Intercity Travel Demands in Canada: Theory tests and Empirical Results*, Transportation Research, 17B(3), 175-91, 1983.

Oum T.H., D. W. Gillen and S.E. Noble, *Demand for Fareclasses and Pricing in Airline Markets, Logistics and Transportation Review*, 22(3), 195-222, 1986.

Oum, T.H., Waters, W.G. and Yong , J.S., *A Survey of Recent Estimates of Price Elasticities of Demand for Transport*, World Bank Working Paper, WPS 359, 1990.

Oum T.H., Waters, W.G. and Yong , J.S., *Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates*, Journal of Transport Economics and Policy, vol.26(2), 139-154, 1992.

Oum T.H., A. Zhang and Y. Zhang, *Inter-Firm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets*, Journal of Transport Economics and Policy, vol. 27(2), 171-92, 1993.

Talley, W.K. and Schwarz-Miller, *The Demand for Air Services Provided by Air Passenger-Cargo Carriers in a Deregulated Environment*, International Journal of Transport Economics, 15(2), 159-68, 1988.

Taplin, J.H.E., *A Coherence Approach to Estimates of Price Elasticities in the Vacation Travel Market*, Journal of Transport Economics and Policy, 14(1), 19-35, 1980.

Taplin, J.H.E., *A Generalized Decomposition of Travel-Related Elasticities Into Choice and Generation Components*, Journal of Transport Economics and Policy, Volume 31 (2), 183-192, 1997.

Appendix A: survey of demand elasticity studies

We have adopted a standard reporting sheet to summarize existing studies in the literature. Each sheet denotes (when possible), the publication or completion date of each study; the country or countries studied; the modes of travel studied and the type and sources of data used. In addition, we note which market segments are identified (business/leisure; long-haul/short-haul) and the types of elasticities estimated (own-price, cross-price or income). Finally, the summary sheet specifies where possible, the type and functional form of the model employed along with any relevant statistical properties.

Many studies in the literature were completed and/or published prior to 1990 – more than twelve years ago. Consequently, actual estimate values in these studies provide less relevance for forecasting air travel demand in Canada. For this reason, we have grouped the summary sheets into older studies (completed prior to 1990), and more recent studies.

A.1 Older Studies (prior to 1990)

A.1.1

Title of study	**The Price Elasticity of Demand for Air Travel**
Authors	J.M. Jung and E.T. Fuji
Date completed/published	September 1976

General Summary information

Country/countries studied	U.S. (3 U.S. cities selected as origins and matched with 42 destinations)
Modes of travel studied	Air (Passenger)
Data Sources	Official Airline Guide (North American Edition); CAB; Data from second quarter of 1972 and 1973

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand		No	
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres	Yes		All city-pairs were U.S. with distance: 50 miles < distance < 500 miles.
Short-haul between small communities	Yes		""
Own-price elasticity values	Yes		
Cross-price elasticity values		No	
Income elasticity values		No	

Technical report

Type of model employed	Arc elasticity equation.
Modes of travel included in study	Air (Passenger)
Functional form of the model	See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	Pre-deregulation in the U.S.
Statistical properties of estimates	Not given.

Other Comments

$$e_p = \left[(\Delta Q / Q) - \sum_{c=1}^{n} (\Delta Q_c / Q_c) / n \right] / (\Delta P / P)$$

Where,

$\Delta Q / Q =$ Relative change in the number of local passengers along a route where prices changed.

$\Delta Q_c / Q_c =$ Relative change in the number of local passengers along a comparable route where price did not change.

$\Delta P / P =$ Relative price change.

$n =$ Number of routes compared.

A.1.2 Title of study — A Coherence Approach To Estimates of Price Elasticities in the Vacation Travel Market

Authors: John H. E. Taplin
Date completed/published: 1980

General Summary information

Country/countries studied	Various
Modes of travel studied	Air (Passenger)
Data Sources	A summary of results of 8 previous studies.

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		
Long-haul between major centres	Yes		Only country-pairs are provided.
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes*		
Income elasticity values	Yes		

Technical report

Type of model employed	Unknown
Modes of travel included in study	
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	

Other Comments

* Taplin calculates cross-elasticity values, which include estimates with respect to car operating costs, price of domestic accommodation, price of overseas accommodation, and the price of other consumer goods and services.

A.1.3 **Title of study** Quality of Service and the Demand for Air Travel

Authors: James E. Anderson and Marvin Kraus

Date completed/published: 1981

General Summary information

Country/countries studied	U.S.
Modes of travel studied	Single mode: Air (Passenger)
Data Sources	Unknown (1973-76 U.S. monthly time-series data)

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes		
Leisure travel demand	Yes		
Long-haul between major centres	Yes		
Long-haul between small communities		No	
Short-haul between major centres	Yes		
Short-haul between small communities	Yes		
Own-price elasticity values	Yes		
Cross-price elasticity values		No	
Income elasticity values	Yes		

Technical report

Type of model employed	Log-linear demand model; Two-stage least squares; Time-series data
Modes of travel included in study	
Functional form of the model	See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	The time chosen is 1973-76, when fares were set according to the CAB formula, and flight-scheduling rivalry dominated carrier competition.
Statistical properties of estimates	

Other Comments

The authors originally planned to estimate the value of time variable but were unable to obtain reliable estimates due to data problems. Instead, they assigned various values to this parameter. Also note, "price" includes value of time hence these are not fare elasticities.

Demand equation:

$$Q_t = (Q_{t-1})^a (Q_{t-12})^b (Q_t^*)^{1-a-b} U_t$$

Where,

t = Time subscript

U_t = Log-normal disturbance for which ln Ut has zero mean

$Q^*_t = \alpha(p_t + wT_t)^{\beta} Y_t^{\Phi}$, Long-run demand, log-linear form

A.1.4

Title of study	Estimating Airline Demand With Quality Of Service Variables
Authors	Richard A. Ippolito
Date completed/published	1981

General Summary information

Country/countries studied	U.S.
Modes of travel studied	Single mode: Air (Passenger)
Data Sources	Data sources unknown.

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		Use dummy variables for segments that served Florida, California, or Las Vegas
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No*	
Income elasticity values		No	

Technical report

Type of model employed	Log-linear demand function, allow for inter-modal competition by dummy; Simultaneous equation model
Modes of travel included in study	
Functional form of the model	
Policy or price change relevant to estimate(s) in the study	Pre-deregulation in the U.S.
Statistical properties of estimates	Only t-stat values

Other Comments

* Ippolito: To account for mode choice, distance (in logs) is added to the demand specification. Moreover, since the preference for the auto mode may be particularly strong for very short trips, zero-one dummy variables were included in the model, which equalled unity when trip distance was 100 miles or less.

A.1.5	**Title of study**	The Structure of Inter-city Travel Demands in Canada: Theory Tests and Empirical Results
	Authors	Tae H. Oum and David W. Gillen
	Date completed/published	July 1982

General Summary information

Country/countries studied	Canada
Modes of travel studied	Three travel modes (Air, Bus, Rail)
Data Sources	Statistics Canada (CANSIM data base); 1961-76.

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand		No	
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		(Includes: bus, rail, goods, and services)
Income elasticity values	Yes		

Technical report

Type of model employed	Structural analysis – demand equations derived from utility maximization. Estimated by Non-linear least squares.
Modes of travel included in study	Air, Bus, Rail
Functional form of the model	
Policy or price change relevant to estimate(s) in the study	
Statistical properties of estimates	Air: D.W. Statistics = 1.645; R-square = 0.9048

A.1.6

Title of study	Determinants of Demand for Travel to and From Australia
Authors	G. Hollander
Date completed/published	1982

General Summary information

Country/countries studied	Australia, New Zealand, UK, US, Japan, Canada, Germany, Italy
Modes of travel studied	Air (Passenger)
Data Sources	Bureau of Industry Economics

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		Country of origin to Australia.
Long-haul between major centres	Yes		Country-pairs are provided.
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No	Unknown if model includes intermodal effects.
Income elasticity values	Yes		

Technical report

Type of model employed	Double-log; pooled time-series, cross-section 1975-1981
Modes of travel included in study	Air (Passenger)
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	Unknown

Other Comments

All data was retrieved from the Bureau of Transport and Regional Economics website at:

http://dynamic.dotars.gov.au/btre/tedb/tablist_detail.cfm?ID=153

A.1.7

Title of study	A Service Quality Model of Air Travel Demand: An Empirical Study
Authors	Michael Abrahams
Date completed/published	April, 1983

General Summary information

Country/countries studied	United States
Modes of travel studied	Air passenger travel (demand equation includes automobile operating costs)
Data Sources	C.A.B. Service Segment Data Base (100 most heavily traveled domestic origin-destination pairs in the U.S.); Measure of price employed is the lowest unrestricted coach fare deflated by the Consumer Price Index (1973-77); Value of schedule delay time are estimates obtained from a procedure developed by Ericson (1977) and Swan (1978)

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		Northeastern U.S. major centres to Florida; West Coast to Hawaii.[30]
Long-haul between major centres	Yes		Transcontinental U.S. (> 1500 miles)
Long-haul between small communities		No	
Short-haul between major centres	Yes		Eastern U.S. (< 500 miles)
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No	Effect of fare on demand through changes in the air: auto model split
Income elasticity values		No	

Technical report

Type of model employed	2 SLS estimation with Cochrane-Orcutt Transformation (used to correct for first order serial correlation); Time-series (20 quarters)
Models of travel included in study	
Functional form of the model	Demand and Elasticity equation: See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	The study was conducted pre-1978 Airline Deregulation Act in the U.S.
Statistical properties of estimates	Durbin-Watson values indicate that the hypothesis that there exists no first order serial correlation cannot be rejected; R-square for all pools were > 0.96 for dummy variable, and > 0.91 for non-dummy variable;

Other Comments

City-pairs were pooled on the basis of common characteristics.

Demand equation:

[30] We infer that the leisure routes from the Northeastern U.S. to Florida are short/medium haul routes.

$$X(i,j) = \alpha_0 + \alpha_1 P(i,j) + \alpha_2 SD(i,j) + \alpha_3 AC(i,j) + \alpha_4 POP(i,j) + \alpha_5 Y(i,j) + \alpha_6 GGNP$$

Where,

$P(i,j)$ = Lowest unrestricted coach (air) fare between city i and j;
$SD(i,j)$ = Expected schedule delay time in hours as estimated using equation;
$AC(i,j)$ = Auto costs as described in equation;
$POP(i,j)$ = Population of Standard Metropolitan Statistical Area (SMSA) containing city i times the population of SMSA containing j;
$Y(i,j)$ = Income per capita of SMSA containing i times income per capita of SMSA containing j;
GGNP = Gross National Product.

Elasticity equation:

$$\varepsilon^D = (\beta^P + \beta_{AC} * (1/ADC))\frac{\overline{P}}{\overline{X}}$$

Where,

ε^D = Average price elasticity of demand;
β^P = Estimated fare coefficient for P;
β_{AC} = Estimated coefficient for AC;
$\overline{P}$ = Average real fare;
$\overline{X}$ = Average passenger traffic;
ADC = average auto driving costs.

A.1.8 **Title of study** An Abstract Mode Model: A Cross-section and Time-series Investigation

Authors: Andreas A. Andrikopoulos and Theophilos Terovitis

Date completed/published: 1983

General Summary information

Country/countries studied	Greece
Modes of travel studied	Air-ship, Air-Bus, Air-bus-rail
Data Sources	Civil Aviation Service, Olympic Airline Time and Fare Tables

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand		No	
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		
Income elasticity values	Yes		

Technical report

Type of model employed	Linear demand; Cross-section (1970-80) and Time-series data (1969-80); Estimated by OLS
Models of travel included in study	
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	

Other Comments

Number of air passengers per unit of time is taken as the dependent variable. Two sets of explanatory variables: 1) the mode's attributes relative to the close substitute, 2) Socio-economic variables including population and tourism.

A.1.9 **Title of study** Unknown

Authors Bureau of Industry Economics (Australia)
Date completed/published 1984

General Summary information

Country/countries studied	Australia, New Zealand, UK, US, Japan, Canada, Germany Italy
Modes of travel studied	Air (Passenger)
Data Sources	Bureau of Industry Economics (Australia)

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		
Long-haul between major centres	Yes		Between countries of origin and Australia.
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		Intermodal, prices in alternative destinations.
Income elasticity values	Yes		

Technical report

Type of model employed	Unknown; Pooled time-series and cross-section; 1970-1980
Modes of travel included in study	Air (Passenger)
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	Unknown

Other Comments

All data was retrieved from the Bureau of Transport and Regional Economics website at:

http://dynamic.dotars.gov.au/btre/tedb/list_detail.cfm?Ref_ID=21

A.1.10

Title of study	The Demand For International Air Passenger Service Provided by U.S. Air Carriers
Authors	Vinod Agarwal and Wayne K. Talley
Date completed/published	1985

General Summary information

Country/countries studied	U.S. and undisclosed foreign-country destinations. (city-pairs)
Modes of travel studied	Single mode: Air (Passenger)
Data Sources	International Civil Aviation Organization (ICAO), Official Airline Guide (World-wide Edition)

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		All elasticities are assumed to be 'excursion' travel.
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No	
Income elasticity values		No	

Technical report

Type of model employed	Log linear demand estimated by OLS. Cross-section data (Dec. 1981), 63 flight segments.
Models of travel included in study	
Functional form of the model	See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	Post-deregulation data after 1978 in the U.S.
Statistical properties of estimates	Only variables P, FF, LF are significant at the .05 level; Adjusted R-square = .8766

Other Comments

Demand equation:

$$Q_{ij} = g(P_{ij}^{U}, MS_{ij}, T_{ij}, FF_{ij}, LF_{ij})$$

Where,

Q_{ij} = Number of passengers transported by U.S. air carriers from the ith U.S. departure point to the jth foreign-country landing point.

P_{ij}^{U} = Average excursion fare for U.S. air carriers on a given flight segment divided by the distance in kilometers of that flight segment.

MS_{ij} = Represents the proportion of all air passengers transported by U.S. air carriers from the ith U.S. departure point to the jth foreign-country landing point.

T_{ij} =Average of the travel times for all U.S. air carriers providing service on a given flight segment.

FF_{ij} = Total number of flights provided by all U.S. air carriers serving ij flight segment.

LF_{ij} = Number of passengers transported by U.S. air carriers (for December 1981) divided by the number of aircraft seats flown by these carriers over a given flight segment.

A.1.11 Title of study

Title of study	An Econometric Analysis of the Demand for Intercity Passenger Transportation
Authors	Steven A. Morrison and Clifford Winston
Date completed/published	1985

General Summary information

Country/countries studied	U.S.
Modes of travel studied	Rail, Air, Bus (Vacation and Business trips)
Data Sources	1977 Census of Transportation National Travel Survey; June 1977 Official Airline Guide

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes		
Leisure travel demand	Yes		
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		Intermodal coefficients are included for rail, car, and bus.
Income elasticity values		No	

Technical report

Type of model employed	Nested logit model.
Modes of travel included in study	Rail, Bus, Air.
Functional form of the model	
Policy or price change relevant to estimate(s) in the study	Data taken from 1977 (Pre-deregulation in the U.S.)
Statistical properties of estimates	

Other Comments

Morrison and Winston note that the elasticity results for vacation travellers (Air) are not too large (less than 1.0). They assert that given the large share of the market that this mode possesses, the results are not too surprising.

Morrison and Winston: More generally, the air destination elasticities indicate that mode choice price elasticities for air may understate the total traveller responsiveness to changes in airfare. Consequently, such elasticities should be viewed with some caution.

A.1.12 **Title of study** Demands for Fare classes and Pricing in Airline Markets

Authors: Tae H. Oum, David W. Gillen and S.E. Noble

Date completed/published: 1986

General Summary information

Country/countries studied	U.S.
Modes of travel studied	Domestic air passenger travel
Data Sources	Official Airline Guides, North American Edition; Domestic Origin-Destination Survey of Airline Passenger Traffic, Air Transport Association of America; Two hundred intra-U.S. routes were selected from 1978 cross-sectional data.

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	Aggregate data includes business and non-business travel.
Leisure travel demand	Yes		Washington D.C. – Miami, Pittsburgh – Miami, N.Y. - Miami
Long-haul between major centres	Yes		
Long-haul between small communities		No	
Short-haul between major centres	Yes		
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes[31]		Between Fare classes: first class, economy, and discount.
Income elasticity values	Yes		Vacation routes

Technical report

Type of model employed	First stage: Partial Elasticities, translog demand system. Second stage: Total Elasticities, Log-linear aggregate demand model; cross-sectional data (1978), intra-U.S. routes
Models of travel included in study	Air (Passenger)
Functional form of the model	Demand equation: see next page.
Statistical properties of estimates	Total Price Elasticities, R-square = 0.6793 Vacation routes (price-elasticity) t-ratio = 2.08 Vacation routes (income-elasticity) t-ratio = 1.43 Non-Vacation routes (price elasticity) t-ratio = 2.52

Other Comments

Demand equation:

$$\log X_r = \alpha_0 + \alpha_1 D_r + \alpha_2 \log P_r + \alpha_3 (\log P_r) * D_r + \alpha_4 \log I_r + \alpha_5 (\log I_r) D_r + \alpha_6 \log PoP_r$$

Where,

X_r = Aggregate traffic volume of route r;

P_r = Weighted average fare of route r using the fitted revenue shares Sj's as the weights;

D_r = Dummy variable (equal to 1 for vacation roués);

[31] No intermodal coefficients are used in the model.

I_r = Weighted average per-capita income of the two cities on route r;

POP_r = Total population of the two cities on route r.

A.1.13 Title of study

Title of study	Demand for Australian Domestic Aviation Services by Market Segment
Authors	Bureau of Transport Economics
Date completed/published	1986

General Summary information

Country/countries studied	Australia
Modes of travel studied	Air (Passenger)
Data Sources	Bureau of Transport Economics

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		Tasmania and Queensland.
Long-haul between major centres	Yes		O-D points not given.
Long-haul between small communities		No	
Short-haul between major centres	Yes		O-D points not given.
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		Transport mode not given.
Income elasticity values	Yes		

Technical report

Type of model employed	Double-log; time-series data; 1977-1983
Modes of travel included in study	Air (Passenger); Alternative mode for cross-elasticity not given.
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	Unknown

Other Comments

All data was retrieved from the Bureau of Transport and Regional Economics website at:

http://dynamic.dotars.gov.au/btre/tedb/list_detail.cfm?Ref_ID=27

A.1.14 **Title of study** Brandow demand functions for Australian long distance travel

Authors A.S.G. Lubulwa

Date completed/published 1986

General Summary information

Country/countries studied	Australia
Modes of travel studied	Air (Passenger)
Data Sources	Compilation of 7 studies.

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes		
Leisure travel demand	Yes		
Long-haul between major centres	Yes[32]		O-D points not specified for all elasticities.
Long-haul between small communities		No	
Short-haul between major centres	Yes[33]		O-D points not specified for all elasticities.
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		Cost of car.
Income elasticity values	Yes		

Technical report

Type of model employed	Unknown; Compilation of seven studies
Modes of travel included in study	Air; (Cost of travel by car is provided as cross-elasticity)
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	Unknown

Other Comments

All data retrieved from the Bureau of Transport & Regional Economics website at:

http://dynamic.dotars.gov.au/btre/tedb/tablist_detail.cfm?ID=42

[32] We calculate distances for city-pair routes provided and distribute the estimates accordingly based on short/medium or long-haul.
[33] Ibid.

A.1.15 **Title of study** Consumer responsiveness to changes in air fares

Authors T.E. May, E.W.A. Butcher, and G. Mills

Date completed/published 1986

General Summary information

Country/countries studied	Australia
Modes of travel studied	Air (Passenger)
Data Sources	Unknown

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		
Long-haul between major centres	Yes		O-D points not given.
Long-haul between small communities		No	Unknown.
Short-haul between major centres	Yes		O-D points not given.
Short-haul between small communities		No	Unknown.
Own-price elasticity values	Yes		
Cross-price elasticity values		No	
Income elasticity values		No	

Technical report

Type of model employed	Unknown; data set from 1977-1984
Modes of travel included in study	Air
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	Unknown

Other Comments

All data retrieved from the Bureau of Transport & Regional Economics web site at:

http://dynamic.dotars.gov.au/btre/tedb/tablist_detail.cfm?ID=43

A.1.16 **Title of study** The Demand for Air Services Provided By Air Passenger-Cargo Carriers In A Deregulated Environment

Authors Wayne K. Talley and Ann Schwarz-Miller

Date completed/published 1981

General Summary information

Country/countries studied	U.S.
Modes of travel studied	Single Mode: Air (Passenger and Cargo)
Data Sources	22 U.S. air-passenger-cargo carriers for the year 1983: Moody's Transportation Manual and the Air Carrier Traffic Statistics

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand		No	
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No	
Income elasticity values		No	

Technical report

Type of model employed	Log-linear two stage least squares demand function; Cross-section data
Models of travel included in study	
Functional form of the model	See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	Post-deregulation in the U.S.
Statistical properties of estimates	R-square: 0.9662, Adjusted R-square: 0.9696; t-stat: -3.453

Other Comments

General form of the demand function:

$$Q_{pti} = Q_p(P_{pti}, DEPART_{ti}, OFS_{ti})$$

Where,

Q_{pti} = Number of passenger miles of service demanded of the ith carrier for the tth time period.

P_{pti} = Passenger fare per mile of the ith carrier for the tth time period.

$DEPART_{ti}$ = Number of departures by the ith carrier for the tth time period.

OFS_{ti} = Overall flight stage length (average distance covered per flight hop) by the i^{th} carrier for the t^{th} period.

A.1.17 Title of study

Title of study	An Econometric Air Travel Demand Model For the Entire Conventional Domestic Network: The Case of Norway
Authors	Lasse Fridstrom and Harald Thune-Larsen
Date completed/published	July 1988

General Summary information

Country/countries studied	Norway
Modes of travel studied	Air (Passenger)
Data Sources	Origin-Destination data set (source unknown).

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand		No	
Long-haul between major centres		No	Travel time including checking, checkout, access and egress times between city center and airport (in minutes) is a variable in the equation.
Long-haul between small communities		No	“”
Short-haul between major centres		No	“”
Short-haul between small communities		No	“”
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		Cross demand elasticity of air travel with respect to surface fares.
Income elasticity values	Yes		

Technical report

Type of model employed	Gravity Model: the model was estimated applying ordinary least squares regression to a logarithmic transformation of the equation. Norway Time-series (1972-83 annual) and Cross-section (95 intercity links) data.
Models of travel included in stud	
Functional form of the model	See ‘Other Comments’.
Policy or price change relevant to estimate(s) in the study	
Statistical properties of estimates	Sample size: 1140 annual observations. R-square: $0.6923 < R < 0.7520$

Other Comments

The model includes a short-term/medium-term and a long-term variable.

$$Y_{ijt} = \Psi(B_{it}B_{jt})^{\beta}(R_{it}R_{jt})^{\rho}\left[\frac{P_{ijt}/Q_{ijt}}{P_{ij0}/Q_{ij0}}\right]^{\pi_1}\left[\frac{P_{ij0}}{Q_{ij0}}\right]^{\pi_2}\left[\frac{Q_{ijt}}{Q_{ij0}}\right]^{\pi_3}\left[Q_{ij0}\right]^{\pi_4}$$

$$\bullet\left[\frac{T_{ijt}/S_{ijt}}{T_{ij0}/S_{ij0}}\right]^{\tau_1}\left[\frac{T_{ij0}}{S_{ij0}}\right]^{\tau_2}\left[\frac{S_{ijt}}{S_{ij0}}\right]^{\tau_3}\bullet\left[S_{ij0}\right]^{\tau_4}$$

$$\bullet\left[R_{it}R_{jt}\right]^{\lambda_1 \ln P_{ijt} + \lambda_2 \ln T_{ijt}}\bullet e^{U_{ijt}}$$

A.2 More Recent Studies (1991 -)

A.2.1	**Title of study**	Tourism Related Movement Study Final Report
	Authors	Nairn, R.J. and Partners and Hooper, P.
	Date completed/published	1992

General Summary information

Country/countries studied	USA, Australia
Modes of travel studied	Air (Passenger)
Data Sources	Pickrell (1984), BTE (1983)

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes		U.S.
Leisure travel demand	Yes		Australia
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres	Yes		U.S. (Centres unknown)
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No	Unknown if intermodal coefficients are used.
Income elasticity values		No	

Technical report

Type of model employed	Unknown
Modes of travel included in study	Air (Passenger)
Functional form of the model	Unknown
Policy or price change relevant to estimate(s) in the study	Unknown
Statistical properties of estimates	Unknown

Other Comments

All data was retrieved from the Bureau of Transport and Regional Economics website at:

http://dynamic.dotars.gov.au/btre/tedb/list_detail.cfm?Ref_ID=111

A.2.2 Title of study

Title of study	Inter-firm Rivalry and Firm-specific Price Elasticities in Deregulated Airline Markets
Authors	Tae Hoon Oum, Anming Zhang and Yimin Zhang
Date completed/published	1993

General Summary information

Country/countries studied	U.S. (Firm-specific: United versus American Airlines)
Modes of travel studied	Single mode: Air (Passenger)
Data Sources	I.P. Sharp Associates data from Databank 1A of the U.S. Department of Transportation

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes[34]		
Leisure travel demand	Yes		Vacation routes between Chicago and Las Vegas/Reno
Long-haul between major centres	Yes		Chicago is the static origin.
Long-haul between small communities		No	
Short-haul between major centres	Yes		Chicago is the static origin.
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No	
Income elasticity values		No	

Technical report

Type of model employed	Log-linear; pooled cross-sectional and time-series data.
Modes of travel included in study	Single mode: Air (Passenger)
Functional form of the model	See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	Post deregulation data was used from 1981-1988.
Statistical properties of estimates	

Other Comments

Market demand equation:

$$\log X_{kt} = A - \eta_k \log p_{kt} + g(Y_{kt}) + \varepsilon_{kt}$$

Where,

A = Unknown parameter associated with the demand intercept;
Y_{kt} = Vector of variables shifting demand;
$g(\bullet)$ = Some function to be determined;

ε_{kt} = Random error term;

η_k = Market demand elasticity (estimated from the data);

Notes:

The paper focuses on origin-destination data between Chicago and various U.S destinations, which meet a set of criteria: twenty routes were selected by taking all Chicago-based city-pair routes for 1985 on which American and United together had market share exceeding 90%, and on which each carrier had at least 100 passengers per quarter in the 10% sample (taken from the O-D Survey); the quantity data for 20 routes were then collected for each quarter from 1981 to 1988

- 20 routes * 30 quarters = 600 data points, after filtering only 359 used
- Traffic volume of the first-class category was considered to be too small and excluded from analysis; standard economy and discount categories are aggregated together
- Airline's (weighted) average fare is used as the product of price for the airline
- 308/359 data points are considered to be duopoly category; 51 data points considered to be monopoly data points

Some conclusions

- Test results indicate that American and United do not apply same pricing strategy on all routes; neither airline applies an identical pricing strategy in all markets
- Higher price elasticities for vacation routes
- Results show that moving from duopoly to monopoly routes would raise prices by about 17%

A.2.3

Title of study	**Demand Elasticities for Air Travel to and from Australia**
Authors	Bureau of Transport Communications and Economics
Date completed/published	1995

General Summary information

Country/countries studied	Australia and numerous destination countries around the world.
Modes of travel studied	Air (Passenger)
Data Sources	ABS, Overseas Arrivals and Departures Australia, Cat. 3402.0; Book1 Worldwide Fares, Air Tariff Publications

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes		
Leisure travel demand	Yes		
Long-haul between major centres	Yes		
Long-haul between small communities		No	
Short-haul between major centres		No	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values		No[35]	
Income elasticity values	Yes		

Technical report

Type of model employed	Double log and linear models are employed; Time-series data
Modes of travel included in study	Air (Passenger)
Functional form of the model	See 'Other Comments'.
Policy or price change relevant to estimate(s) in the study	Unknown.
Statistical properties of estimates	

Other Comments

Leisure travel

A general expression for the dynamic model of leisure travel demand is:

$$LD_{it} = \alpha + \sum_{j=0}^{4} \rho_j LF_{i(t-j)} + \sum_{j=0}^{4} \beta_j REX_{i(t-j)} + \sum_{j=0}^{4} \lambda_j Y_{i(t-j)} + \sum_{j=1}^{4} \phi_j LD_{i(t-j)}$$

for $i = 1, 2, \dots, 24$ and $t = 1, 2, \dots, 32$

where i is the leisure travel market analysed for foreign visitors and Australian travellers between Australia and each of the 12 countries, t is the quarterly time period and j is the number of quarterly lags.

[35] BTCE: For Australia, there is effectively no intermodal competition to international air travel. In 1993, only 0.3% of arrivals and departures were by ship. P.28-29

The variable *LD* is leisure demand for air travel, *LF* is the real leisure airfare, *REX* is the real exchange rate, and *Y* is real income.
The coefficients ρ_o, β_o and λ_0 represent the short–run effect on demand of a change in the airfare, the real exchange rate and income. The sum of the coefficients $\sum_{j=0}^{4}\rho_j, \sum_{j=0}^{4}\beta_j$ and $\sum_{j=0}^{4}\lambda_j$ represents the long–run effect on demand of a change in the airfare, the real exchange rate and income. These coefficients can be used to derive long-run *elasticities* of demand[36].

Business travel

A general expression for the dynamic model of business travel demand is:

$$BD_{it} = \alpha + \sum_{j=0}^{4}\rho_j BF_{i(t-j)} + \sum_{j=0}^{4}\beta_j REX_{i(t-j)} + \sum_{j=0}^{4}\lambda_j AGDP_{i(t-j)} + \sum_{j=0}^{4}\delta_j FGDP_{i(t-j)} + \sum_{j=1}^{4}\phi_j BD_{i(t-j)}$$

for $i = 1, 2, \dots, 24$ and $t = 1, 2, \dots, 32$
where *i* is the business market analysed for foreign visitors and Australian travellers between Australia and each of the 12 countries, *t* is the quarterly time period and *j* is the number of quarterly lags.
The variable *BD* is business demand for air travel, *BF* is the real business airfare, *REX* is the real exchange rate, *AGDP* is real Australian gross domestic product and *FGDP* is real foreign gross domestic product.

A.2.4 **Title of study** Australian Outbound Holiday Travel Demand: Long-haul Versus Short-haul

Authors Hamal, K.

Date completed/published 1998

General Summary information

Country/countries studied	Australia and Foreign Destinations
Modes of travel studied	Air (Passenger)
Data Sources	Bureau of Tourism Research, Canberra

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand	Yes		Australian outbound holiday travel.
Long-haul between major centres	Yes		
Long-haul between small communities		No	
Short-haul between major centres		No[37]	
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		
Income elasticity values	Yes		

Technical report

Type of model employed	Double-log linear, time-series data (1974-1996)
Modes of travel included in study	Air
Functional form of the model	Unknown.
Policy or price change relevant to estimate(s) in the study	N/A
Statistical properties of estimates	Unknown

[37] Hamal differentiates between short-haul and long-haul international travel. Australia-U.K. is determined to be long-haul, Australia-Singapore is determined to be short-haul. We calculate distances between all country-pairs and determined that these country-pairs all satisfied the long-haul condition. We group all estimates into long-haul elasticities, as alternative modes of transportation are improbable.

A.2.5 Title of study

Title of study	An Econometric Analysis of the Demand for Domestic Air Travel in Australia
Authors	B. Battersby and E. Oczkowski
Date completed/published	2001

General Summary information

Country/countries studied	Australia
Modes of travel studied	Air (Passenger): Three distinct segments – discount, full economy, and business.
Data Sources	Quarterly data (1992 – 1998); Bureau of Transport Economics;

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand	Yes		
Leisure travel demand		No	
Long-haul between major centres		No	
Long-haul between small communities		No	
Short-haul between major centres	Yes[38]		
Short-haul between small communities		No	
Own-price elasticity values	Yes		
Cross-price elasticity values	Yes		No specific transport mode is highlighted, just an index.
Income elasticity values	Yes		

Technical report

Type of model employed	Linear
Modes of travel included in study	Air (Passenger)
Functional form of the model	Not provided in detail. Demand determinants included: price, income, substitute prices and seasonality.
Policy or price change relevant to estimate(s) in the study	N/A
Statistical properties of estimates	

Other Comments

The authors note that their own-price elasticity estimates are generally at the lower end of the estimates reported by previous studies. The estimates reported for the Melbourne-Brisbane route are particularly low. This general divergence from previous estimates may in part be due to the explicit modelling of individual market segments, which contrasts to the aggregate route analysis conducted by most other studies.

[38] We calculate city-pair distances for the Australian domestic O-D pairs used. Based on these distances all four (4) of the routes studies are short/medium-haul domestic routes.

A.2.6

Title of study	Demand for Air Travel in the United States: Bottom-Up Econometric Estimation and Implications for Forecasts by O&D Pairs
Authors	Dipasis Bhadra
Date completed/published	2nd Draft (2002)

General Summary information

Country/countries studied	United States
Modes of travel studied	Air (Passenger)
Data Sources	Aviation statistics from Bureau of Transportation Statistics (10% Survey) (50,000 records for eight quarters, 1999 and 2000); and local area data from Bureau of Economic Analysis

Specific focus

Identified elasticities	Yes	No	Comment
Business travel demand		No	
Leisure travel demand		No	
Long-haul between major centres	Yes		Distance (in miles) is used to identify long or short haul.
Long-haul between small communities	Yes		“”
Short-haul between major centres	Yes		“”
Short-haul between small communities	Yes		“”
Own-price elasticity values	Yes		“”
Cross-price elasticity values		No	
Income elasticity values		No	

Technical report

Type of model employed	Semi-logarithmic linear model with Limited Information Maximum-Likelihood (LIML) estimation.
Modes of travel included in study	Air (Passenger)
Functional form of the model	See ‘Other Comments’.
Policy or price change relevant to estimate(s) in the study	N/A
Statistical properties of estimates	

Other Comments

$$\ln(P_{ij}) = \alpha + \beta * \ln(f_{ij}) + \chi_i * \ln(PI_i) + \chi_j * \ln(PI_j) + \delta * \ln(Density_i) + \delta * \ln(Density_j) + \phi_i * \ln(Interactions_i)$$
$$+ \phi_j * \ln(Interactions_{ij}) + \eta * \ln(MarketPower_{ij}^{D}) + \iota * \ln(MarketPower_{ij}^{ND}) + K^D * (Southwest_{ij}) + K^{ND} * (Southwest_{ij})$$
$$+ \gamma_i * (hubstatusOrigin) + \gamma_j * (hubstatusDestination) + \varphi * (\ln(Dis\tan ce_{ij}) + \rho * (season) + \varepsilon_{ij}$$

Where,
P = average daily passengers
D and ND = dominant and non-dominant airlines
f = one-way fare

PI = personal income

Density = population density per sq. miles
Interactions = intensity of economic activities are represented by interactions between population and income
Distance = distance traveled between O&D markets
Market Power = share of passenger demand by airlines in total O&D market
Southwest = presence of Southwest Airlines in O&D market
Season = adverse spring and summer weather

Take log for those independent variables for which interpretations are meaningful. Leave out hub status, Southwest presence and season as dummy variables.