

VU Research Portal

Price elasticities of demand for passenger air travel: a meta-analysis

Brons, M.R.E.; Pels, E.; Nijkamp, P.; Rietveld, P.

2001

document version

Early version, also known as pre-print

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Brons, M. R. E., Pels, E., Nijkamp, P., & Rietveld, P. (2001). *Price elasticities of demand for passenger air travel: a meta-analysis*. (TI Discussion Paper; No. 01-047/3). Tinbergen Institute.
<http://www.tinbergen.nl/discussionpapers/01047.pdf>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl



TI 2001-047/3

Tinbergen Institute Discussion Paper

Price Elasticities of Demand for Passenger Air Travel: A Meta-Analysis

Martijn Brons

Eric Pels

*Peter Nijkamp**

*Piet Rietveld**

*Department of Spatial Economics, Faculty of Economics and Business Administration, Vrije
Universiteit Amsterdam*

** Tinbergen Institute*

Tinbergen Institute

The Tinbergen Institute is the institute for economic research of the Erasmus Universiteit Rotterdam, Universiteit van Amsterdam and Vrije Universiteit Amsterdam.

Tinbergen Institute Amsterdam

Keizersgracht 482
1017 EG Amsterdam
The Netherlands
Tel.: +31.(0)20.5513500
Fax: +31.(0)20.5513555

Tinbergen Institute Rotterdam

Burg. Oudlaan 50
3062 PA Rotterdam
The Netherlands
Tel.: +31.(0)10.4088900
Fax: +31.(0)10.4089031

Most TI discussion papers can be downloaded at
<http://www.tinbergen.nl>

Price Elasticities of Demand for Passenger Air Travel: a Meta-Analysis

Martijn Brons, Eric Pels, Peter Nijkamp, Piet Rietveld

Free University, department of Spatial Economics

De Boelelaan 1105, 1081 HV Amsterdam, the Netherlands

Abstract

The demand for air transport is largely determined by the spending capacity of customers. This paper aims to offer more insight into the determinants of price elasticities in the aviation sector. It seeks to identify both common and contrasting factors that influence the price elasticities, on the basis of a comparative analysis among a large number of empirical studies in this field. By means of meta-analytical methods the relative importance of several driving forces (e.g., distance, type of ticket, nature of study etc.) is investigated.

1. Introduction

The aviation sector is in constant motion. The continuing growth in the number of passengers and aircraft movements necessitates a rise in investments in airport and aircraft capacity. But even with these new investments, peak congestion and the environmental impact of aviation remain problematic. Air transport is apparently a field fraught with externalities. Another development in the aviation sector is the tendency to form alliances. Although the literature shows that these alliances may be beneficial to passengers, they still need, in one way or another, consent from aviation authorities. In the deregulated aviation sector, aviation authorities therefore play a critical role in protecting the population from excessive noise and in safeguarding the consumer against “excessive” usage of market power.

One potential instrument the government has at its disposal is the price. For example, the government can put a price on the externality to reduce the negative effect, but if the passengers are not very sensitive to price changes, this policy will have little effect; the airlines simply pass the charge on to the passengers. The government needs information on the price sensitivity of passengers in order to be able to estimate the likely policy effects or to justify noise annoyance policy. This information is needed on different levels. A kerosine tax, for example, can only be justified in the context of an international policy arrangement and requires different insights than a local noise charge.

The estimation of price elasticities in aviation can however be rather difficult, given the various problems concerning data availability on prices, number of passengers etc. As an alternative, one can use research synthesis from various empirical studies undertaken elsewhere or in the past. Using existing research, one tries to find common factors explaining potential differences in e.g. estimates of price elasticity. This approach will be followed in the present paper.

In the paper a survey will be carried out of studies on price elasticities in aviation. The purpose of this paper is to test whether these price elasticity estimates encountered in the literature are statistically equal, and if not, to explain the variation in these elasticities. The paper is organised as follows. Section 2 the economic determinants of demand for air transport are discussed. Section 3 contains the empirical results and section 4 concludes.

2. Determinants of demand for passenger air transport

In this section a number of economic, demographic and geographic determinants with respect to the demand for passenger air transport and its related price elasticity of this demand will be discussed. First, the relevance of substitution modes with respect to these determinants will be pointed out. Subsequently, the determinants themselves and the various ways in which they affect price elasticity levels will be described. Finally, a number of moderator variables which may have an influence on the price elasticity will be focused on. The section will be concluded with a concise reflection.

2.1 Choice contexts in air transport demand

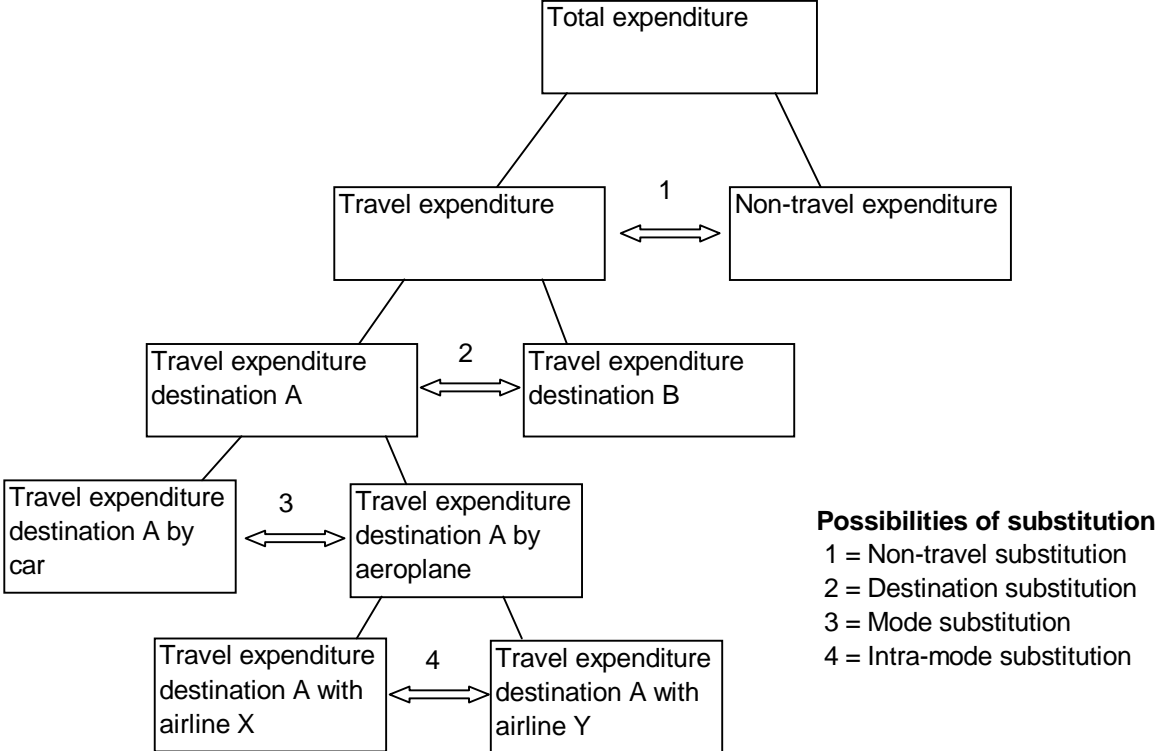
The price elasticity of the demand for a good, whether a consumer good or a production input factor, is directly related to the possibilities of substitution for that good. A relatively large number of substitutes will imply a high price elasticity, whereas a lack of substitutes will likely force demand to become more rigid so that the demand for this commodity may become inelastic. In the specific case of the demand for passenger air transport, the structure and critical factors of the demand are likely not different. Most of the determinants of price elasticity discussed in this paper do not directly influence price elasticity, but rather affect the level of supply of substitutional modes and thus exert their influence in various indirect ways.

An important issue in aviation is that multiple levels of substitution can be distinguished, as Figure 1 shows. First, different carriers may compete with each other on the same route, providing a case of intra-modal substitution. In the case of homogeneous transport services there will be perfect competition implying a very high price elasticity. However, when services of varying quality are offered, the substitutability will be less.

Next, on certain market segments, alternative transport modes may provide sufficiently similar qualities to be regarded as substitutional modes. Numerous factors, primarily of geographic, economic and demographic nature, determine the availability and the potential success of alternative modes as a substitute. It is obvious that geographic components such as seas, impenetrable mountain ranges or even the mere distance of a trip, may complicate the presence or establishment of a given supply of adequate substitutional modes.

On the third place, different destinations with sufficiently similar characteristics may assume the role of substitutes for each other. A useful way to look at this phenomenon is to adopt a hedonic point of view. The specific characteristics of a destination may be regarded

Figure 1. Illustrative case of substitution in the aviation market



as attributes, each of which contributes to some degree to the perceived overall utility of the destination. The rational consumer is, subject to given budget considerations, assumed to try to maximise overall utility, i.e. to choose a destination that yields the highest level of utility. If now the relative fare level for this destination increases, the consumer may reconsider his expenditure choices and may start a search for less expensive destinations with (nearly) the same utility results or for destinations within the same price class but which are providing a higher level of utility. Whether or not the consumer will succeed in finding another, more favourable alternative after a price increase also depends on the degree to which the individual characteristics of the original destination can be substituted for. For instance, an appointment with a business partner in New York cannot as easily be substituted for as a leisure trip to a generic Mediterranean seaside resort, due to several non-replaceable characteristics.

Finally, non-transport goods may be regarded as substitutes for transport goods since again budget constraints (either a person's disposable income or a firm's operational budget) force them into mutual competition. This issue is closely related to the previously mentioned phenomenon. It appears that immobility may be regarded a substitute for transport as long as the utility level derived from alternatively spending the budget savings are at least equal to the utility provided by the default consumption of transport. Note that these trade-off effects are generally subject to mechanisms of diminishing rates of marginal return.

We conclude that prices play a role in various choice contexts. When the choice alternatives are very homogeneous (case 1) we may expect that price elasticities are "large" whereas when the choice alternatives are very different the price elasticities are more moderate.

2.2 Economic determinants of demand and price sensitivity

Various economic, demographic and geographic factors can be identified which, according to their formal theoretical specification, may affect price elasticity estimate values. From the previous section we may argue that price elasticities of demand and substitution possibilities are strongly related concepts from an economic point of view. It is interesting then to observe that for several determinants, the substitutional environment assumes an important role with respect to the ways these factors exert their influence on elasticity estimate values.

If the initial demand for air transport would be weakly related to the income level, the expenditures on air transport would form a smaller share of the disposable income for consumers with a higher disposable income level than for consumers with less money to spend. Assuming decreasing marginal utility returns on income, this would mean that utility loss as a result of a fare increase will be lower for consumers with a higher disposable income. As a result, consumers with a higher disposable income would be less price-sensitive, implying a negative relation between income level and the magnitude of the price elasticity of demand for air transport.

However, higher incomes are generally associated with relatively higher demand for air transport (see Mutti and Murai, 1977). Air travel is often a luxury good with demand elasticities of income greater than unity, so that income level and the *share* of air transport demand of disposable income are expected to be positively correlated (see Crouch, 1991). If indeed the share of air transport demand is higher for consumers with higher income levels, this would suggest that, despite a decreasing marginal utility of income the utility losses

associated with a fare increase are higher for this group of consumers, which would imply that they may be more price sensitive than consumers with lower incomes.

As has been discussed in the previous section, possibilities for transport substitution are likely to be directly related to the distance of a flight. Long-distance flights will generally suffer from a smaller amount of substitutional modes than short-distance flights, particularly when intercontinental ocean crossing flights are concerned. The existence of such cases implies an inverse relationship between distance and price sensitivity. On the other hand, long-distance flights are usually more expensive to begin with than short-distance flights¹, so that an increase in costs will require a larger share of a passenger's budget. This second aspect seems to point towards a positive relationship between distance and price sensitivity. Thus the relationship between flight distance and price elasticity of demand for air travel appears to depend on a number of counteracting forces. It is not clear beforehand which effect will generally prevail.

In addition to mere travel distance, the geographic location or continent in which a price elasticity is estimated may be an important factor in determining the value of these estimates. Cultural differences, relative abundance of ground transport networks or income related factors can all play a role in the extent to which fare price changes affect demand levels for air transport.

A distinction between business passengers and leisure passengers can be based on two criteria resulting in the institutionalised formal distinction between business class travellers and economy class travellers and the actual distinction according to travel motive. These distinctions are generally assumed to be in mutual accordance, although this is not necessarily always true. Moreover, since passenger data on fare classes are generally more easily available than data on travel motives (the latter often being the more relevant construct of demand theory), theory and empirics on the subject of demand sensitivity are not always perfectly in consonance. However, as long as this is accounted for, fare class data may well be used as a reasonable proxy for travel motives.

Leisure travellers, essentially consumers, aim to maximise the utility -or satisfaction - derived from air travel and from the associated consumption of holiday experiences, subject to a given income or budget constraint. Characteristic for leisure travel demand are

¹ In today's complicated aviation market, distance and fare price are not as closely related as one would expect. Landing rights, alliances, tariff classes and other market factors often dominate the cost structure of fares and distort such a close relationship (see for example Marsan and Kostoris, 1993 or Cooper and Maynard, 1971). Ample examples of not only decreasing marginal prices of flight distance but even decreasing average prices of flight distance, suggest that negative relations between distance and fare should not necessarily be considered as anomalies.

determinants such as travel costs, relative price of other goods, income and socioeconomic characteristics. Business travellers, who use business as an input to final production, are in general interested in minimising costs for a given level of output. Business travel demand is determined by such factors as travel costs, relative price of complementary production input factors and a firm's output level. Because of this, leisure and business travellers are likely to respond differently to changes in certain socioeconomic factors influencing the demand, and should therefore be modelled separately (see Hooper, 1993).

In general, demand for business travel tends to be less sensitive to changes in air fare than demand for leisure travel. Leisure travel is generally regarded as discretionary expenditure. Many goods and services compete with leisure travel for obtaining a share of the consumer's discretionary budget. Thus, even while the number of perfect substitutes for air travel may not be overwhelming as has been pointed out in the previous section, leisure travel, compared to business travel, has some additional substitutes inside as well as outside of the transport sector and therefore tends to be more sensitive to changes in airfares, implying a higher absolute price elasticity. Moreover, the absolute elasticity of business demand with respect to airfares is likely to be lower than that for leisure travellers because of two other factors.

First, the total cost of travel includes a value of time component. Since business travellers generally value time higher than leisure travellers, airfares seem to form a smaller part of their total travel costs. This would mean that an increase in airfares leads to a smaller rise in total travel costs for business passengers, compared to leisure travellers, and therefore a lower willingness to substitute monetary for time-saving advantages. It is important, though, to point at the initial difference in fare levels between business class and economy class trips. Because of the fact that business class fares are generally much more expensive, the airfares still form a large part of the total travel costs for business class passengers and the monetary disadvantages of an increase in fares will be higher than those for leisure travellers. The willingness to substitute monetary for time advantages may thus be higher than expected for business class passengers. The difference in price elasticity values between business class and economy class passengers therefore seems to depend on the difference between the ratio of the business class versus the economy class passengers' time valuation and the ratio of business class versus economy class initial fares.

Secondly, business travellers are more likely to be concerned with maximising their productivity while travelling. Therefore, they are most likely willing to pay for a 'higher quality' service that allows last-minute bookings and changes to travel plans, and provides

better check-in and on-board facilities. Additionally, any rises in airfares tend to be absorbed by the firm rather than the individual traveller.

2.3 Study descriptive determinants of price elasticities

In addition to the economic and geographic determinants discussed in the previous section, a number of moderator variables can be distinguished that may exert influence on the precise level of elasticity estimates from a certain study. Also here, plausible relationships between substitution possibilities and some moderator variables do exist, in particular the time horizon that is used in the original case study.

The distinction that exists between short-run and long-run elasticity estimates is an important one. Generally speaking, in the long-run consumers and firms are better able to adjust to price signals than in the short run, implying that the long-run demand tends to be more elastic than the short-run demand (Oum et al., 1992). In the case of demand for transport, decisions with respect to geographic relocation and asset holding as long-run responses to increased transport costs come to mind. However, complex time-dependent behavioural patterns may induce sufficient distortionary effects to prevent us from simply adopting this long-run adjustment rule as a rule of thumb. First of all, sudden cost changes may easily lead to an exaggerated behavioural response in the short term, which may subsequently be perceived erratic and corrected for in the long run. All other things equal, this latter aspect may point to an inverse relationship between time horizon and price sensitivity which is quite the opposite from the prediction of the former aspect. It seems as if the ability and the willingness to adjust the demand show divergent paths. The relation between price elasticity of demand for air transport and time horizon seems to be rather complex and to depend on various partial effects.

An important issue here is the fact that the degree to which either one of these effects prevails under the given circumstances may be directly related to the degree to which substitution is available. For the specific case of the demand for passenger air transport, a number of aspects is relevant in this context. First, there is a lack of sufficient substitution transport modes for the air transport sector. The mere travel speed of the mode is as yet still unmatched, whereas intra-modal substitution can hardly be regarded as a cost-evasive substitution due to differential fare structures and competition-related characteristics inherent in the air transport sector. Secondly, there are factors complicating possible long run adjustment strategies. Relocation costs, both pecuniary and non-pecuniary, as a means to

evade increased transport costs tend to be relatively high due to the average flight distance and the often trans-cultural nature of the flight.

These aspects may imply that as far as possibilities for adjustment strategies are concerned, the use of long-run time horizons may not as obviously result in higher price sensitivity estimates compared to short-run time horizons as expected, while at the same time expressions of short-run price sensitivity will to a large degree be limited to demand changes on an aggregate modal level. The overall relationship between time-horizon and price sensitivity is, among other factors, determined by the ratio of leisure travellers to business travellers, since the former group generally disposes of more possibilities for demand adjustment on an aggregated level of the mode than the latter.

Most empirical research on airline demand has used cross-section data, notably a sample of city-pair data. This offers the advantage of larger samples than are often available in time series analysis, which is essential for studying dimensions of consumers' travel demand such as time valuation and quality of service or for studying the modal choice behaviour of consumers. However, the disadvantage is that it does not always permit accurate estimation of price and income elasticities since cross-section data generally exhibit relatively little variation in air fares per unit of distance within a given fare class (see Straszheim, 1978).

Time series data are more useful in estimating price and income elasticities, primarily since price (and income) changes have been dramatic during the last decades. But price changes, however significant they have been, are also relatively infrequent due to government regulation, whereas changes in service variables such as schedule frequencies, speed of aircraft, and density of seating also occur.

Multicollinearity pervades clearly both cross-section and time series estimates. In cross-section models with gravity variables, fares tend to be strongly correlated with distance variables. This problem is most severe in time series studies. Variables such as price and income tend to be tightly correlated with a time trend. Parameter estimates therefore, are generally sensitive to changes in model specification and sample coverage. Moreover, the multi-collinearity, coupled with data limitations, leads to a persistent tendency to underspecify or oversimplify the model, with consequent biases in regression coefficients (see Jung and Fiji, 1976).

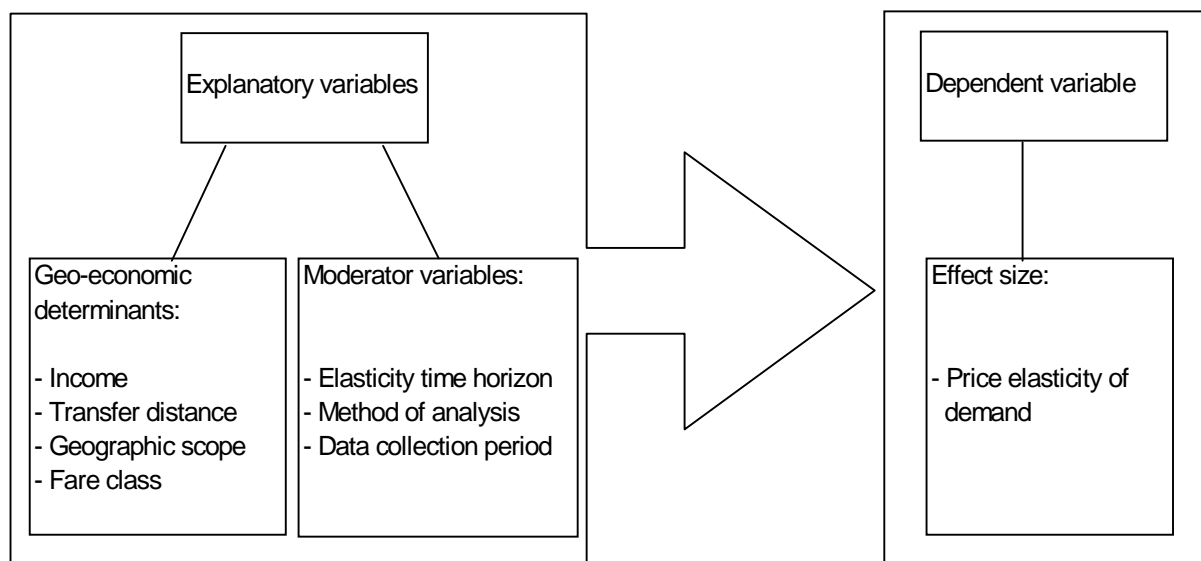
3. Meta-analysis and empirical results

In this section the evidence offered by previous empirical case studies on the price elasticities of demand for passenger air travel will be examined by means of a meta-analysis. The objective of this section is to test whether price elasticity estimates encountered in the literature are statistically more or less equal, and if not, to explain the variation in these elasticities in order to be able to draw some general or transferable conclusions. In Section 4.1 the data collection proces will be described, while in Section 4.2 some descriptive statistics and variation analysis results will be given. Subsequently, in Section 4.3, the results of a meta-regression analyses will be presented. And finally, Section 4.4 will end this chapter with some concluding remarks.

3.1 Data collection and variables used

Since the objective of our meta-analysis basically consists of a comparative re-evaluation of previous research on price elasticities for passenger air transport we collected a number of 37 studies in which one or more price elasticities for passenger air transport were estimated, leading to a total number of 204 observations. From each study the elasticity estimates as well as information on certain geographic, economic and demographic sample variables and moderator variables were gathered and entered into a database.

Figure 2. Dependent and independent variables used



In our analysis we treat the price elasticity estimates as the dependent variable whereas the study descriptors and the other variables are included for their respective explanatory power with respect to the variance among price elasticity estimates. In doing so, possibilities for mutual interdependencies among the explanatory variables will also be considered. For an overview of the variables employed we refer to Figure 2.

The geo-economic variables used for explaining the variance among price elasticity estimates are: transfer distance; fare class; geographic location. Moderator variables employed here are: research method; time horizon used and period of data collection.

The majority of the data are all directly or indirectly gathered from the original studies. Most of the explanatory variables have been subdivided into various subcategories. Each elasticity estimate observation belongs to exactly one of the categories for each explanatory variable.

Some discrete variables such as fare class, method of research used or elasticity time horizon are generally mentioned explicitly in the original studies. Other variables have been calculated and categorised based on information in the original study. In Table 1 the possible categories of each explanatory variable an elasticity estimate observation can belong to are presented.

Table 1. Categorisation of variables

<u>Variable</u>	<u>Categories</u>
Gross Domestic Product	- Continuous variable
Data collection period	- Continuous variable
Distance	- Close distance (< 500 miles) - Medium distance (500 – 1500 miles) - Long distance (>1500 miles)
Geographic scope	- North America - Europe - Australia - Intercontinental
Elasticity time horizon	- Short term elasticity - Long term elasticity
Fare class	- Economy class - Business class
Method of analysis	- Time series analysis - Cross-section analysis - Pooled analysis

GDP values are determined by averaging the values for the origin and destination country of any given flight. These values are calculated by taking the average of the GDP values for every year of the period in which the data used in the original study has been collected. GDP values are corrected for price level.

Values for the period of data collection are determined by calculating the average year of the period in which the data used in the original study has been collected.

The values for the distance variable are calculated as the estimated average distance of every origin-destination combination that enter in the original study's calculation of a given price elasticity estimate and are then categorised.

The geographic scope variable consists of the categories North America; Europe; Australia and intercontinental. The first three categories consist of intra-continental flights within the concerned continent. Flights between different continents are categorised as 'intercontinental'.

The categorisation decision as to whether an observation should be considered a long-run or a short-run estimate is decided upon by following the author's statement about it. In the literature on which this paper is based, sometimes different opinions were encountered as to how a long-run elasticity estimate is defined by the author. Despite these differences a common underlying assumption could be discerned that a long-run estimate, as opposed to a short-run estimate, does not only signal the direct budgetary effects of a fare change on demand, but also takes into account adjustments relating to relocation and asset ownership.

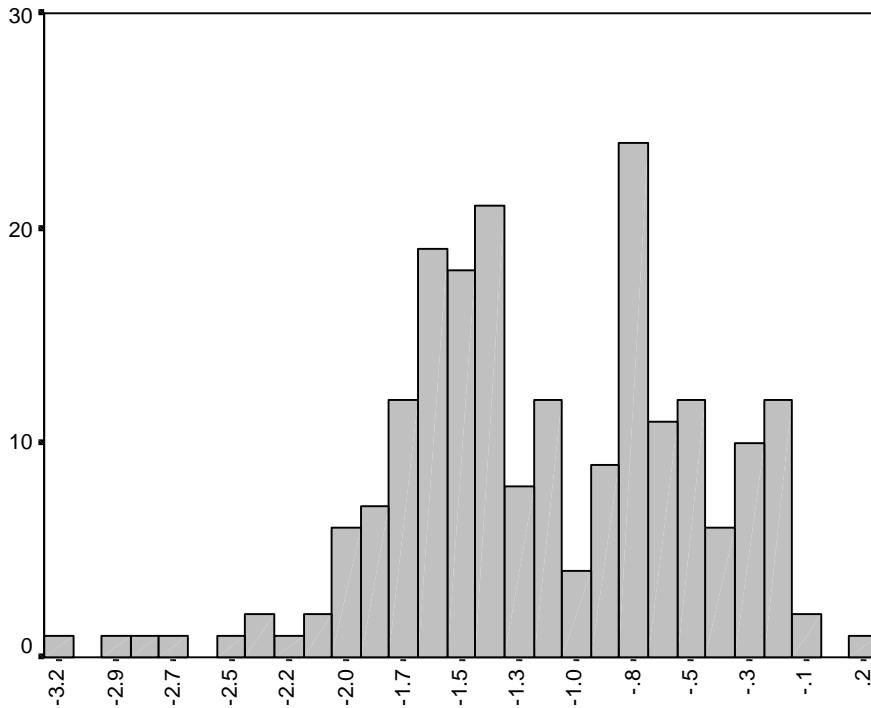
The variables with respect to fare class and method of analysis are categorised based on direct information in the original study.

3.2 Descriptive statistical results

Before we will proceed with the use of meta regression techniques to statistically explain the variations among price elasticity estimates, it may be interesting to look at some descriptive statistics on the set of price elasticity estimates we used and how this relates to several other sample characteristics and moderator variables we employed in our analysis.

Figure 2 visually represents the distribution of the set of elasticity estimates we collected from the case studies. The overall mean price elasticity, based on our set of 204 observations, is below unity at -1.146 , implying that price changes will result in more than a proportional change in demand. The standard deviation of the elasticity distribution is 0.619 .

Fig 2. Distribution of price elasticity estimates



The lowest elasticity we found is -3.20 , while the highest is positive at 0.21 , the latter being the only positive price elasticity we found in the original studies. The curious double top formation in Figure 2 largely stems from the general difference in price elasticity estimates between case studies that focused on business class travellers and other case studies. Figures 3.a and 3.b clearly illustrate that price elasticity among case studies focusing on business class

Fig 3.a. Distribution of price elasticity estimates from studies on business class travellers

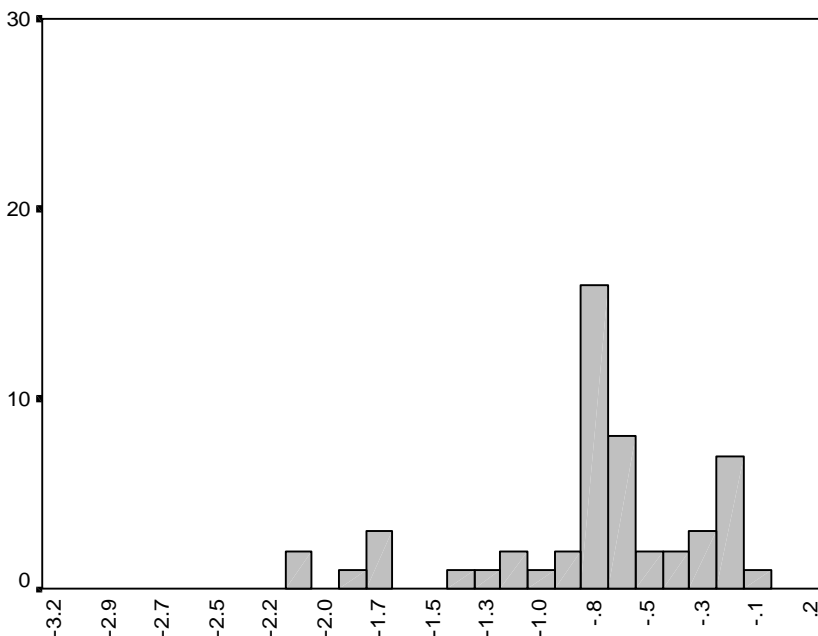
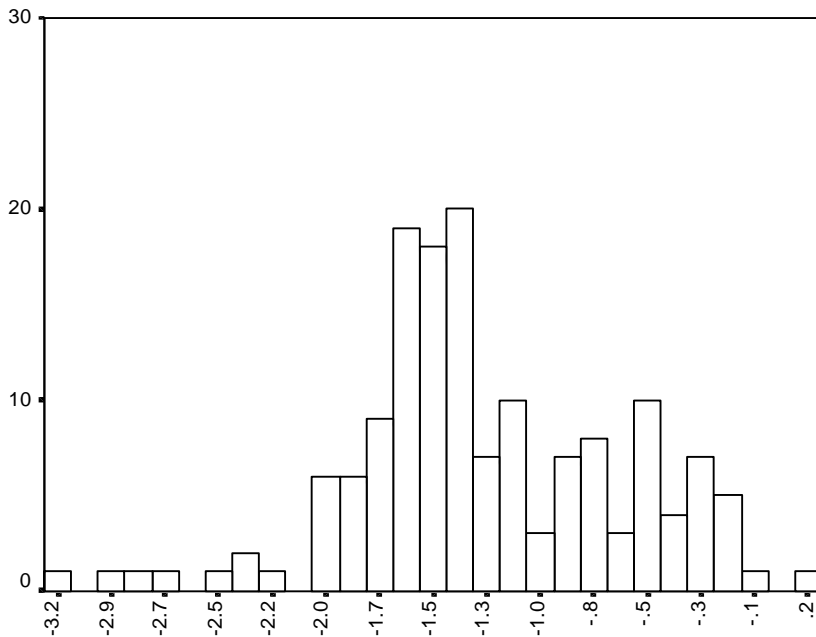


Fig 3.b. Distribution of price elasticity estimates from other studies



passengers generally tend to be lower (closer to zero) than elasticity estimates gathered from other studies.

In Table 2 a number of simple correlation coefficients between the set of elasticity estimates and several (classes of) sample characteristics and study descriptors are given. We will briefly discuss these coefficients, after which the relationships between the dependent and the independent variables and the various, sometimes complex relations within our set of independent variables will be more extensively discussed in the next section.

Table 2. Correlations of determinants with price elasticity

	Coefficient	Standard error
Year of data	0.255	0.000
Distance	0.304	0.000
Intercontinental	0.466	0.000
North America	-0.350	0.000
Europe	-0.062	0.382
Australia	-0.124	0.077
Short term estimates	0.199	0.004
Long term estimates	-0.199	0.004
Economy class	-0.303	0.000
Business class	0.341	0.000
Time Series studies	0.438	0.000
Pooled studies	-0.250	0.000
Cross-section studies	-0.133	0.058
GDP	-0.206	0.006

The price elasticity level appears to be positively correlated with the year data variable. Apparently travellers have become less price sensitive over the years. Travellers are

also less price sensitive, as flight distance increases (according to the next coefficient in the table). This may be due to the relative lack of substitution modes on longer distance flights. From the geographic location variables, the intercontinental variable is positively correlated to price elasticity, while each of the continent variables is negatively correlated with the price elasticity. The flight distance of intercontinental flights is generally longer than intra-continental flights, and therefore this finding may partially be explained by the same arguments as given above with respect to the distance coefficient. The correlation coefficients between price elasticity and short-term estimates is negative, whereas that for long-term estimates is positive. This implies that demand responses to fare price changes are higher when a longer time horizon is used. The negative correlation coefficient between price elasticity and the economy class dummy and the positive coefficient between price elasticities and the business class dummy points at a lower price sensitivity among the latter segment. The dummy for time series studies is positively correlated with price elasticity, while both the cross-section studies dummy and the dummy for pooled studies are negatively correlated with price elasticity. According to the correlation coefficient, gross domestic product is negatively correlated with price elasticity, which means that travellers with a higher income tend to be more price sensitive than travellers with a lower income. The fact that travel, and specifically air travel, may be regarded as a relatively luxury good which would provide for a positive relationship between income level and the share of income share allocated to air transport, may explain this higher price sensitivity among high income travellers.

3.3 Meta-regression analysis results

The meta-regression equation to be estimated was already discussed in subsection 3.1². The positive and significant coefficient of the ‘year of data’ variable (see Table 3) points at a lower price elasticity over time. Apparently, consumers have become less price sensitive in time. The distance variable enters the regression analysis with a negative, but insignificant coefficient. Apparently, there are multiple factors exerting their influences here, thus distorting an unambiguous relationship between the distance of a flight and the price elasticity of demand for a flight. Arguably, the theoretically predicted decreasing effect on price sensitivity due to a relative lack of substitutional modes on long distance flights may prove insufficient to dominate the theoretically predicted increasing effect on price sensitivity due

² Instead of using GDP values in the regression-equation we used a dummy variable for case studies that correct for income while estimating demand. Due to the high number of such studies in our set, the use of GDP value as an explanatory variable would lead to biased results.

Table 3. Meta-regression coefficients

	Estimation 1		Estimation 2	
	Coefficient	T-value	Coefficient	T-value
(Constant)	-21.972	-2.200	-18.793	-1.885
Year of data	0.011	2.146	0.009	1.852
Distance	-0.005	-0.066	-0.023	-0.306
Europe	0.201	0.962	0.112	0.425
North America			0.022	0.130
Australia			-0.493	-2.194
Long run	-0.644	-2.555	-0.906	-3.278
Business class	0.552	5.414	0.622	5.913
Cross-section	0.181	1.594	0.008	0.060
Time-series	0.439	3.022	0.154	0.830
Dummy GDP	0.589	4.151	0.761	4.347
R-Square		0.416		0.435

to the fact that long distance flights demand a larger share of the disposable income than short distance flights. Apparently this seems to hold even if, as has been pointed out in Section 2.2, fare and flight distance are not as perfectly positively correlated as would be expected from a cost perspective.

The Europe dummy shows an insignificant positive sign. This is rather surprising, since one would expect a somewhat higher price elasticity among European travellers due to the fact that the intra-European passenger surface transport network offers better substitutes than its North-American and Australian counterparts. Moreover, the fact that the European income level is low compared to North-American and Australian values would lead one to assume a somewhat higher price sensitivity among European travellers. Yet we find that passengers within Australia are more price sensitive than other passengers. It is also interesting to see that the time series dummy is rendered insignificant by the inclusion of the region-specific dummies. One might expect multicollinearity here, especially when there is a relatively large number of time series studies for a specific region.³ However, the time series dummy has the opposite sign of the Australia dummy, and the same as the (insignificant) U.S. dummy, where one typically would expect a relatively large number of cross-sectional studies. Note that the sign of the time series dummy is positive (and significant), indicating that estimates from time series data yield lower price elasticities (i.e. more price sensitive passengers). This could indicate that, as some authors observe, time series estimates without

³ Correlation results indeed indicate a strong correlation between the time series dummy and intercontinental flights and, to a lesser extent, between the time series dummy and the North America dummy.

extensive lag structures typically yield short term elasticity estimates, although we have already included a long-term dummy⁴.

The dummy coefficient for observations derived exclusively from business class data has a positive sign and is significant. Business class travellers' price elasticities are lower on average than economy class travellers' price elasticities. This may be explained by the lower price sensitivity in the business class segment, which might be primarily due to the higher valuation of time among these travellers. Other explanations may be that business class passengers generally have less substitutes than leisure passengers, that business class travellers are to a higher degree willing to pay more for 'higher quality' services (such as allowance for last-minute bookings and changes in travel plans, better check-in and on-board facilities) and that tickets are usually paid by the firm, rather than the individual traveller. Apparently, these characteristics of demand for business class are important enough to result in a significant coefficient with the expected sign. Again, it is important to note that travellers with a business motive do not necessarily travel business class. An analogous story holds for travellers with a leisure goal, although the discrepancy will be of less importance.

The coefficient of the dummy for observations in which long-run elasticities are estimated is negative, implying that - as has already been discussed in Section 2.3 - a longer response time indeed enables consumers to adjust better to changes in fare prices. Even if such long-run demand adjustment effects are expected to show less severe in air transport than in other modes, the results show that a long-run adjustment time causes the price elasticity to decrease.

Finally, the coefficient for the dummy for observations which are estimated by a demand equation in which an income related explanatory term is entered is positive and significant, meaning that the inclusion of an income-related term in the demand equation draws the absolute (negative) coefficient of the fare price related term - the price elasticity of demand - towards zero. In other words, if the results of the original study are corrected for income level, this yields a lower price sensitivity. In theory, omission of the income variable in the demand equation causes the price parameter to be biased. When only the price and income are arguments in the demand equation and if the income is falsely omitted, the bias is given by the income parameter multiplied by $\text{Cov}(\text{price}, \text{income}) / \text{Var}(\text{price})$ (see Greene, 1992). When this covariance is negative (for example, because in the course of time income

⁴ In a plot of a sufficiently long time series, convergence to equilibrium might be visible. However, a simple regression (of traffic on fare) would weight the data point representing the initial impact of the fare change the same as the data point representing the long run equilibrium. The estimated fare coefficient is therefore biased towards the initial impact. Because the cross-sectional variance is larger, the estimation results from a cross-sectional study are therefore more likely to be indicative of the long-run effect (see Abrahams, 1983).

increases in real terms and fares decrease in real terms as a result of deregulation), the bias has a negative sign and the estimated price sensitivity is too high. Thus, inclusion of the income would yield a lower price sensitivity.

4. Conclusion

When formulating an environmental policy concerning aviation, the authorities (also) need information on the price sensitivity of passengers to predict the effectiveness of the policy. For example, if the airlines or airports can charge all extra costs to the passengers without decreasing demand, the policy has no other effect than increasing the authorities' revenues. In this paper, price elasticities of demand for passenger air transport were analysed. This research synthesis provides valuable information on the "expected" level of price sensitivity in a specific setting. It can also provide information on the design of new research / a questionnaire.

From the meta-regression analysis, the following results are obtained. Long-run price elasticities are higher in absolute value, as was to be expected from a theoretical point of view. Hence, basing long run policy instruments on short run elasticities leads to distortions. Passengers become more price sensitive over time; this also needs to be acknowledged in the design of long run policy instruments. Business passengers are less sensitive to price; this is a common finding in the literature. The difference is about 0.6, *ceteris paribus*. This fact gives the airlines the opportunity to charge extra costs (resulting from a price-based policy instrument) to the passengers, where the business passengers can be charged more than proportional without decreasing demand. If this is not acknowledged by the authority, the (environmental) policy may have little success, although the authority gets the revenues. Surprisingly, it is found that European passengers are not more price sensitive than U.S. passengers and Australian passengers, while one would expect that the availability of more substitutes in Europe would result in a higher price sensitivity within Europe. If in the underlying study the income variable is falsely omitted, the price elasticity is higher in absolute value (i.e. the price sensitivity is higher). When the results of the study are to be used, it is important that one is aware of this bias. This finding also suggests that in setting up a new study, income should not be left out.

The research agenda that follows from this paper is as follows. First, attention should be paid to the question whether research synthesis allows for the determination of confidence intervals for price elasticities in specific cases. In order to do this one needs accurate data on a

wide range of (study) characteristics. For example, the finding on price sensitivity of European passengers necessitates additional analysis, using more and more specific characteristics. Second, methods of analysis other than simple regression analysis should be explored. For example, inclusion of extra explanatory variables in the analysis in this paper (if they were to become available), could cause endogeneity or multicollinearity problems. In general, given the relatively small number of observations and the fact that some observations may be obtained from the same study, one should take notice of the asymptotic properties of the estimator. Finally, research synthesis does not take away the need of specific case studies. As explained above, research synthesis may be necessary because performing new case studies is, for example, too expensive or there is too little time for it. But of course research synthesis can only be carried out on the basis of a sufficient number of similar case studies.

Literature

Case studies

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

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

Alperovich, G. and Machnes, Y.: "The Role of Wealth in the Demand for International Air Travel", *Journal of Transport Economics and Policy*, 1994, vol.28(2), 163-173

Andrikopoulos, A.A. and Teriovitis, T.: "An Abstract Mode Model: A Cross-Section and Time Series Investigation", *International Journal of Transport Economics*", 1983, vol.10 (3), p.547-555

Brown, S.L. and Watkins, W.S.: *The Demand for Air Travel: A Regression Study of Time Series and Cross-Sectional Data in the U.S. Domestic Market*, Civil Aeronautics Board, paper presented at the 47th annual meeting, 1974

Bureau of Transport and Communications Economics: "Demand for Australian Domestic Aviation Services: Forecasts by Market Segment", Occasional paper 79, Canberra: AGPS

Bureau of Transport and Communications Economics: "Trends and Prospects for Australian International Air Transport", Occasional paper 88, Canberra: AGPS

Bureau of Transport and Communications Economics: "Demand Elasticities for Air Travel to and from Australia, working paper 20, 1995

- De Vaney, A.S.: "The Measuremental Cost of Airport Noise", Environmental Quality Program, Texas A. & M. University, 1974
- Fridstrom, L. and Thune-Larsen, H.: "An Econometric Air Travel Demand Model for the Entire Conventional Domestic Network: The Case of Norway", *Transportation Research*, 1989, vol.23B(3), 213-23.
- Furuichi, M. and Koppelman, F.S.: "An Analysis of Air Travelers' Departure Airport and Destination Choice Behavior", *Transportation Research*, 1994, vol.28A(3), 187-195
- Haitovsky, Y., Salomon, I. And Silman, A.: "The Economic Impact of Charter Flights on Tourism to Israel: An Econometric Approach", *Journal of Transport Economics and Policy*, 1987, vol.21 (2), 111-134
- Hartley, P. and Trengrove, C.: "East-West Airlines' Sydney-Melbourne Service: Market Expansion or Market Diversion?", *The Economic Record*, 1991, vol.66(194), 203-220
- Hensher, D.A. and Louviere, J.J.: "Identifying Individual Preferences for International Air Fares", *Journal of Transport Economics and Policy*, 1983, vol.17, 225-245
- Ippolito, R.A.: "Estimating Airline Demand with Quality of Service Variables", *Journal of Transport Economics and Policy*, 1981, vol.15 (1), 7-16.
- Jud, G.D. and Joseph, H.: "International Demand for Latin American Tourism", *Growth and Change*, jan. 1974, 25-31
- Jung, J.M. and Fuji, E.T. "The Price Elasticity of Demand for Air Travel", *Journal of Transport Economics and Policy*, 1976, vol.10, 257-262
- Liew, C.K. and Liew, C.J.: Airline Deregulation and its impact on Intercity Travel Demand, *Transportation Research Record*, 1979, vol.732, 34-39
- Marin, P.L.: "Competition in European Aviation: Pricing Policy and Market Structure", *The Journal of Industrial Economics*, 1995, vol.43 (2), 141-159
- Melville, J.A.: "An Empirical Model of the Demand for International Air Travel for the Caribbean Region", *International Journal of Transport Economics*, 1998, vol 25 (3), 313-336
- Milloy, H.B., Douglas, L. and Sullivan, S.M.: "Market Response to Discount Fares on Selected Domestic Trunk Routes", *Papers of the Tenth Australian Transport Research Forum ATRF: Melbourne*, 1985, 1-18
- Morrison, S. and Winston, C.: "Enhancing the Performance of the Deregulated Air Transportation System", 1989, The Brookings Institution. Washington D.C.
- Morrison, S. and Winston, C.: "The Economic Effects of Airline Deregulation", 1986, The Brookings Institution. Washington D.C.
- Mutti, J and Murai, Y.: "Airline Travel on the North Atlantic", *Journal of Transport Economics and Policy*, 1977, vol.11 (1), 45-53

Okeahialam, C.C.: "An Empirical Study of Cross-Channel Route Choice", Channel Tunnel Research Unit, University of Kent at Canterbury.

Oum, T.H. and Gillen, D.W.: "The Structure of Intercity Travel Demands in Canada: Theory Tests and Empirical Results", *Transportation Research*, 1983, vol.17B (3), 175-191

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

Oum, T.H., Zhang, A. and Zhang, Y.:"Inter-firm Rivalry and Firm-Specific Price Elasticities in the Deregulated Airline Markets", *Journal of Transport Economics and Policy*, 1993, vol.27 (2), 171-192

Saad, M.: "Demand for air passenger travel in Australia", Papers of the Eighth Australasian Transport Research Forum, Perth, 1983, vol. 2, 605-623

Smith, A.B. and Toms, J.N.: "Factors Affecting Demand for International Travel to and from Australia", Bureau of Transport Economics, Canberra, 1987

Straszheim, M.R.: "Airline Demand Functions in the North Atlantic and their Pricing Implications", *Journal of Transport Economics and Policy*, 1978, vol.12, 179-195

Talley, W.K. and Schwarz-Miller, A.: "The Demand for Air Services Provided by Air Passenger-Cargo Carriers in a Deregulated Environment", *International Journal of Transport Economics*, 1988, vol.15 (2), 159-167

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

Taplin, J.H.E.: "A Generalised Decomposition of Travel-Related Demand Elasticities into Choice and Generation Components", *Journal of Transport Economics and Policy*, 1997, 183-191

Thompson, A. and Caves, R.: "The Projected Market Share for a New Small Airport in the North of England", *Regional Studies*, 1992, vol.27 (2), 137-147

Walters, A.A.:"Airports - An Economic Survey", *Journal of Transport Economics and Policy*, 1978, vol.12, 125-160

Wheatcroft, S.: "The Economics of European Air Transport", Manchester University Press, 1956

Other references

Marsan, M.A. and Kostoris, F.P.S.: "Competition through Fares and Fare Accesses on the Air Transport Markets", Discussion Paper Series 776, CEPR, London, 1993

Summers, R. and Heston, Alan.: "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988", *The Quarterly Journal of Economics*, May, 1991, 327-368

Crouch, G.I.: "The Effects of Income & Price on International Tourism Demand", *Management Paper* 38, Monash University, Graduate School of Management, 1991

Cooper, M.H. and Maynard, A.K.: "The Price of Air Travel", Hobart Paper 53, Institute for Economic Affairs, 1971

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*, 1992, vol.26 (2), 139-154

Hooper, P.: "The Elasticity of Demand for Travel: A Review", Research Report, Institute of Transport Studies, Sydney, 1993