An Aggregate Empirical Model of International Airline Traffic for Selected Asia Pacific Countries

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Abstract:

The airline industry frequently stresses the relationship between economic activity and fluctuations in industry activity. This paper used an aggregative model to investigate this proposition for a number developed and developing countries in the Asia Pacific region. Commonsense predicts that economic activity is not the only factor important to airline activity. For example, changes in the cost of air travel would also be expected to effect the aggregate amount of air travel. Accordingly, this paper investigates the statistical significance of the relationship between air passenger traffic, economic activity and the relative cost of air travel for each of the selected developed and developing countries in the Asia Pacific. The findings suggest there is a strong correlation between air passenger activity and economic activity.

The views expressed in this paper are those of the author, and do not necessarily represent those of the bureau of Transport and Communications Economics

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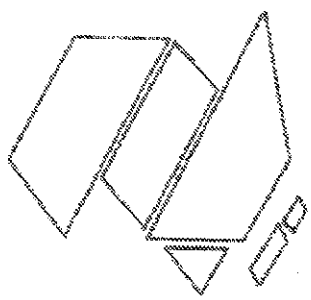


AN AGGREGATE EMPIRICAL MODEL OF INTERNATIONAL AIRLINE TRAFFIC FOR SELECTED ASIA PACIFIC COUNTRIES

1. Introduction

The Asia Pacific region is expected to provide the strongest growth in international air passenger traffic to the year 2000 and beyond. This expected growth in air travel in the region, is mainly because the region is home to a number of newly industrialised countries, that are expected to maintain their strong economic growth. The literature on the airline industry suggests a link between economic activity and the international air passenger traffic. This paper investigates the link between air passenger traffic levels and economic growth with particular reference to the Asia Pacific region and uses historical data to test the statistical significance of any relationship between economic activity and air passenger traffic for selected countries within the Asia Pacific region.

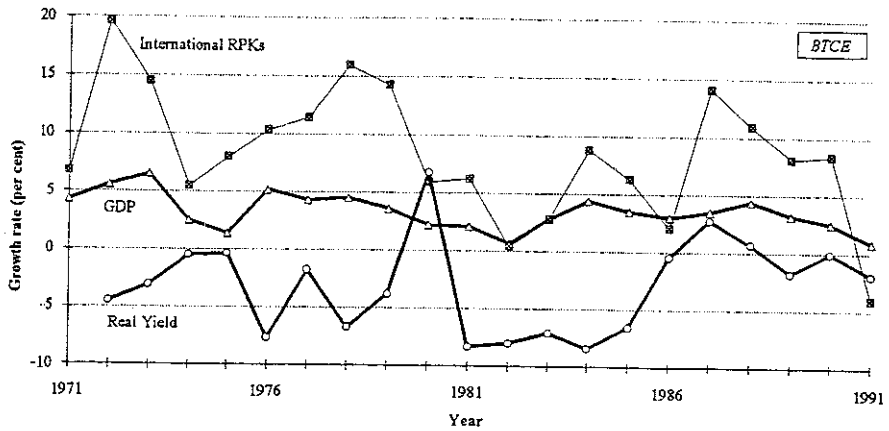
Strong economic growth is not the only factor which can influence international air passenger travel. Other factors which affect air passenger traffic levels include the relative price of air travel and the relative price of goods and services complementary to air travel. The paper estimates the statistical significance of the relative price of air travel on aggregate air passenger travel. The estimates, together with some information on the features of current air passenger travel in the Asia Pacific region, are then used to draw inferences about likely trends in future air passenger travel within the region.

2. The Demand For International Aviation Services

There is a range of empirical evidence that suggests that, at the aggregate level, there is a direct relationship between economic activity and air passenger travel. Tretheway and Oum (1992) and ICAO (1992b) present evidence that there is a significant statistical relationship between aggregate economic activity and air passenger traffic levels. This section first considers the *prima facie* evidence of the relationship between world economic activity and world aviation activity, illustrated in figure 1. The foundations for the empirical investigation of the relationship between economic activity and air passenger traffic is then established by considering the travel decision of a representative air passenger. The decision process of a number of different air passenger travellers can be combined to derive an aggregate relationship between economic activity and air passenger traffic.

Figure 1 shows year on year growth in international revenue passenger kilometres (RPKs) plotted against growth in world gross domestic product (GDP) and average airline (real) yield. (Airline yields are defined as average revenue per passenger kilometre.) The figure does illustrate that air passenger demand has grown in every year over the period 1971-1990, though that growth has not been consistent. It is only in 1991 that growth in air passenger traffic was negative, so that air passenger demand actually declined. Over the period 1971-1990, air passenger traffic experienced growth of approximately 6 per cent per

annum Over the same period world economic growth averaged 3 5 per cent per annum while airline real yields declined by approximately 2 per cent per annum.



Sources ICAO (1992a) and earlier issues
United Nations (1991) and earlier issues

Figure 1 Year on year growth in international RPKs, world GDP and (real) airline yields

The comparison of the growth of international RPKs and world GDP in figure 1 suggests that growth in international RPKs is, in general, positively correlated with world GDP growth. Two examples of this correlation are the oil price rises in 1973 and 1979. As a result of the oil price rise in 1973, international air passenger growth declined because of the rise in airline operating costs and a general decline in economic activity around the world. Air passenger traffic growth declined for the same reasons following the 1979 oil price shock. The subsequent period of 1980-82 was one of slow economic growth which had a deleterious effect on demand for international air travel and the profitability of the airline industry in general.

The evidence on the relationship between real yields and air passenger traffic in figure 1 is less conclusive. Airline yield is a measure of airline revenue per RPK. One would expect that as real airline yield increases, the cost of air travel to the air traveller increases, relative to other goods, and so air passenger traffic will decline. This effect is most noticeable in the periods immediately following the oil price shocks in 1973 and 1979. At this time the cost of air travel for passengers increased, along with general price increases, average airline real yield growth turned up, and air passenger traffic declined. For the rest of the observation period, however, the evidence is not as conclusive. Indeed, since 1987 for some unexplained reason, RPK growth and real yields have declined together.

One would expect then the empirical evidence to show a positive correlation between RPKs and GDP and, if any, a negative correlation between RPKs and real yields The empirical evidence presented in section 3 confirms these expectations, with GDP a significant influence on RPKs and the effect of real yield being negligible. The next section establishes a framework in which to analyse the significance of the relationship between air passenger demand and economic activity

Individual demand for international aviation services

In describing the aviation industry, and transport activity, the literature distinguishes between two different types of consumers: leisure travellers and business travellers. Leisure travellers and business travellers will tend to have different characteristics and different travel preferences In general, leisure travellers are more sensitive to price and income variations while business travellers are less sensitive to price changes and place a greater emphasis on service convenience. This section outlines the factors important in the travel choice of leisure and business travellers

Leisure travel

A leisure traveller, in general, travels because of a desire to consume goods and services in a different spatial location Only a small proportion of leisure travel is undertaken for the intrinsic value of the travel itself Factors important in a leisure traveller's air travel choice include the price of air travel, the price of any alternative modes of travel, the value to the consumer of quality of service aspects associated with the different modes of travel, the price of goods and services at the destination to which the traveller is journeying, and the leisure traveller's disposable income. The demand for air travel of a representative individual leisure traveller can be written as a function of all these factors:

$$d_a = f(y, p_a, p_c, p_m) \qquad (1)$$

where d_a is the leisure traveller's demand for air travel;
y is the leisure traveller's income;
p_a is the price of air travel;
p_c is the prices of complementary goods and services on the 'trip'; and
p_m is the price of any alternative modes of travel

All else being equal, as the price of air travel falls or as the general price of goods and services complementary to air travel falls, the demand for air travel will tend to increase As a leisure traveller's income increases the leisure traveller will have more to spend on all goods and services and the traveller's demand for air travel will tend to increase.

For each individual leisure traveller, the observed relationship between income and air travel is not everywhere continuous. While an increase in disposable income or a reduction in the relative price of air travel may increase an individual leisure traveller's propensity to travel, it may have no observable effect on that consumer's behaviour. This is because a leisure traveller who does travel, must value air travel, and any associated goods and services, more highly than total cost of air travel and associated spending, while a consumer who does not choose to travel must not value air passenger travel as highly as its cost. Increases in a consumer's disposable income will make air travel more affordable for the consumer, but the increase may not be sufficient to place the consumer's valuation of the journey, and associated air travel, above the cost of that journey.

In aggregate, however, this discontinuity in each consumer's air travel demand function is not a problem. By aggregating across a number of different consumers, a continuous relationship can be observed between the demand for air travel and economic variables such as income and price. As aggregate income rises, there will be some consumers who will increase their air travel demand and others who will not.

Business travel

The demand for air travel by business is assumed here as derived from the productive activities of the firm. Consider the production function for a typical firm as a function of its inputs:

$$Y = f(\underline{x}) \qquad (2)$$

where Y is the firm's output; and
$\underline{x}$ is a vector of the firm's inputs

The demand for air travel as an input to business can be written as a function of all input prices, conditional on the level of output:

$$x_a = g(p_a, p_c, p_s, Y) \qquad (3)$$

where x_a is the demand for air travel by business travellers;
p_a is the price of air travel;
p_c is the price of any inputs complementary to air travel;
p_s is the price of any inputs that are substitutable with air travel for the firm; and
Y is the firm's level of output

Other things being equal, as the price of air travel falls relative to other input prices and as the productive activities of the firm increase, demand for air travel by a firm will tend to increase. Again, as in the case of consumers and leisure travel, some firms will be at the

margin for additional air travel and some firms will not Some firms will increase their demand for air travel, while for other firms there will be no observable change in the demand for air travel

In aggregate then, business' demand for air travel will tend to increase as the general level of output increases and it is expected that there is a continuous relationship between aggregate economic activity and the demand for air travel

An aggregate demand relationship

The demand for international air travel by a country's residents is assumed to be the sum of aggregate demand for leisure travel and the aggregate demand for business travel by all residents Factors that influence a country's aggregate demand for air passenger services are home country economic activity, the relative price of air travel to residents and the relative cost of complementary goods and services for residents This is described by the function:

$$D_a^i = f^i\left(Y^i, p_a^i, p_c^i\right) \qquad (4)$$

where D_a^i is the demand for air travel by domestic residents of country *i*;

Y^i is GDP of country *i*;

p_a^i is the relative price of air travel for residents of country *i*; and

p_c^i is the relative price of goods and services complementary to air travel for residents of country *i*

The aggregate relationship described by (4) disregards service characteristics and the price of alternative modes of travel Omitting the price of alternative modes of transport, from the model, is not considered a problem since there are few close substitutes for international air travel, especially in the Asia Pacific region Data on changes in quality of service characteristics, such as travel time, was not obtained and so service quality characteristics are not considered in the empirical investigation

While it is true that the demand for international air travel by domestic residents is related to domestic income, data for air travel distinguishing a passenger's country of origin was not available The air passenger travel data used in the empirical analysis identified only total passenger traffic to and from each country Empirical investigation requires some modification to the demand specification outlined in equation (4)

Obviously, by not differentiating between domestic residents' and foreign visitors' demand for aviation services to and from the home country, the aggregate model, based on a measure of GDP of only the home country, misspecifies the true relationship While the demand for air travel of domestic residents will be influenced by domestic incomes, the

demand for air travel to the home country by foreign residents is influenced by economic activity in the foreign country, not the home country The spending of foreign residents on goods and services produced in the home country will affect the home country's export earnings and thus domestic GDP, but the propensity of foreign residents to travel to the home country will be affected by income in the foreign country

The appropriate empirical specification should be able to capture the influences on both outbound domestic residents and inbound foreign residents The aggregate travel demand of outbound domestic residents will be some function of domestic income, the relative price of air travel for domestic residents, the relative cost of complementary goods and services for domestic residents. The aggregate travel demand of inbound foreign residents will be some function of foreign residents' incomes, the relative price of air travel to foreign residents and the relative cost of complementary goods and services

Dynamic influences on air travel demand

For leisure travellers and business travellers it may not only be changes in current income or production that influences current air travel Past earnings and expected future income, or production, may impact on current travel behaviour These dynamic effects have been found to be important in empirical analysis of general consumption functions and may be important in explaining aggregate air passenger travel activity

The model used in the empirical analysis then, was assumed to have the following general form:

$$D^i_{at} = f^i\left(Y^i_t, Y^i_{t-1}, \ldots, Y^i_{t-r}; Y^j_t, Y^j_{t-1}, \ldots, Y^j_{t-r}; p^i_{at}, p^j_{at}, p^i_{ct}, p^j_{ct}\right), \text{ for all } j \neq i \qquad (5)$$

Equation (5) states formally the ideas presented above The demand for air passenger travel into and out of country *i*, will be some function of current and past domestic income, current and past income of foreign visitors, the relative price of air travel for residents and foreign visitors, and the relative cost of complementary goods and services for residents and foreign visitors. The following section describes the estimation process undertaken

3. Empirical Evidence

For empirical estimation, of the demand functions, this paper assumes a log-linear functional form The full log-linear model specification is given below, the tilde denoting the natural logarithm of the variable:

$$\tilde{D}^i_{at} = \alpha^i + \sum_{k=0}^{r} \beta^i_k \tilde{Y}^i_{t-k} + \sum_{j \neq i}^{J} \sum_{k=0}^{r} \gamma^j_k \tilde{Y}^j_{t-k} + \delta^i \tilde{p}^i_{at} + \sum_{j \neq i}^{J} \delta^j \tilde{p}^j_{at} + \phi^i \tilde{p}^i_{ct} + \sum_{j \neq i}^{J} \phi^j \tilde{p}^j_{ct} \qquad (6)$$

Data

The demand for air travel into and out of a country is measured by total revenue passenger kilometres (RPKs) attributable to that country The measure of RPKs used here is that given by the International Civil Aviation Organization (ICAO) The ICAO measure of international RPKs for each country is the number of international RPKs carried by airlines registered in that country This measure does not, therefore, reflect the number of international RPKs of a country's residents, for it will include foreign resident RPKs travelled on the home country's airline(s), which is why (6) is chosen as the estimable functional form. The problem is not as great as would first appear, however, because bilateral agreements, in general, limit the extent to which airlines can carry traffic between third party states and so most airlines operate on routes in which their home state must be either the port of origin or destination of the service. In general then, a high proportion of passengers on any international airline are residents of that airline's home state. If this is true, and income is a significant determinant of air passenger traffic, then the estimation results would be expected to show significant correlation between RPKs and domestic economic activity

Economic activity is measured as real gross domestic product for each country in question. The price of air travel is defined as the price of air travel (measured by average nominal airline yields) relative to the prices of all other goods in the home country The appropriate instrument to use for the relative price of goods and services complementary to air passenger travel is not as clear One instrument that could be considered is to use country to country exchange rate, however, there are a number of these available for each particular country and because of the small sample size, where included in the empirical models, this term was represented by each country's terms of trade index.

Estimation of the full specification described in (6) would require more information than was available, so the set of variables included in the models had to be restricted In estimating the empirical relationships, therefore, a number of subsets of all possible variables were chosen and a suite of models were estimated for each country. Estimation was by the method of maximum likelihood method of estimation, the data is annual calendar data and the estimation period considered is 1971-1990.

Table 1 presents the estimation results for a simple regression of air passenger traffic against home country income and the relative price of air travel to domestic residents The empirical evidence, in table 1, suggests there is a 'strong' relationship between economic activity and air passenger traffic levels for each country considered. Table 1 also presents elasticity estimates for all world international air passenger traffic In all cases, the correlation between GDP and RPKs is statistically significant. There also appears to be some relationship between the relative price of air travel and air passenger demand, though the relative price of air travel does not appear to be as significant as economic activity

TABLE 1 INTERNATIONAL AIR PASSENGER TRAVEL ELASTICITY ESTIMATES

Country	Intercept	GDP	Relative price of air travel	Summary Statistics
World	**-8.19**	**2.88**	**0.16**	**R^2 = 0.996**
	(-7.7)	**(11.6)**	**(0.8)**	**AIC = -74.18**
Australia	-17.0	2 31	-0 33	R^2 = 0 981
	(-5.4)	(11.9)	(-1.3)	AIC = -42.78
Hong Kong	-9 98	1 92	-0 85	R^2 = 0 994
	(-5.3)	(26.4)	(-1.6)	AIC = -39.18
Japan	-16 0	2 14	-0 16	R^2 = 0 992
	(-6.3)	(12.2)	(-1.49)	AIC = -55.49
Korea	-26 37	2 67	1 15	R^2 = 0 943
	(-2.8)	(4.5)	(1.3)	AIC = 10.64
Malaysia	-28 1	2 28	2.54	R^2 = 0 952
	(-5.6)	(9.8)	(3.5)	AIC = 0.42
New Zealand	-6 68	1 69	-0 55	R^2 = 0 962
	(-0.7)	(2.1)	(-1.8)	AIC = -20.17
Singapore	0 74	1 74	-2 10	R^2 = 0 963
	(0.1)	(4.0)	(-3.8)	AIC = -4.09
Thailand	5 96	1 67	-1 48	R^2 = 0 967
	(1.3)	(7.8)	(-1.8)	AIC = -9.96

Note Figures in parentheses are t-statistics of the estimated parameter
AIC is Akaike's Information Criterion measure
Estimation period: 1971-1990

After estimating the simple model for each of the selected countries, a further round of empirical testing was conducted to account for the significance of lagged domestic income effects, foreign income, and movements in the home country's terms of trade. Two alternative measures of foreign income were considered: world GDP, and GDP of countries which provide a large proportion of the home country's tourists. The preferred empirical model for each country is given in table 2

In choosing the preferred model, the signs and significance of the parameter estimates were considered as well as the general fit of the model. In all cases, except for New Zealand, the parameter estimate for the effect of changes in world GDP on air passenger travel to and from a country was not different from zero. A glance at table 2 shows that for most countries the preferred model includes the terms of trade index. It should be stated that there was little difference in the fit of alternative specifications, however, the parameter estimates, especially for GDP, were sensitive to the variations in the set of parameters. This is because the available set of information is small and this reduces the predictive power of the models.

TABLE 2 PREFERRED MODEL - INTERNATIONAL AIR PASSENGER TRAVEL ELASTICITY ESTIMATES

Country	Variable Name	Elasticity estimate	Parameter t-statistic	Summary statistics
Australia	GDP	2.25	(8 5)	R^2 = 0 981
	Price of air travel	-0 41	(-1.2)	AIC = -40 92
	TOT	-0.09	(-0.3)	
Hong Kong	GDP	1 82	(16 4)	R^2 = 0 993
	Price of air travel	-1 00	(-3 1)	AIC = -35 44
	TOT	-0.36	(-1.1)	
Japan	GDP	1 74	(19 7)	R^2 = 0 996
	Price of air travel	-0 33	(-5.2)	AIC = -65 54
	TOT	-0.22	(-6.4)	
Korea	GDP	0 76	(2.7)	R^2 = 0 952
	Price of air travel	-1 25	(-1 5)	AIC = 7.31
	TOT	-4.97	(-7.3)	
Malaysia	GDP	1 99	(-1 6)	R^2 = 0 953
	World GDP	0 44	(0 1)	AIC = 4 16
	Price of air travel	2 31	(2 1)	
	TOT	-0.30	(-0.5)	
New Zealand	GDP	2 91	(7 3)	R^2 = 0.986
	Price of air travel	-0 92	(-4 2)	AIC = -40 23
	TOT	-0.94	(-6.2)	
Singapore	GDP	1 58	(12.5)	R^2 = 0 964
	Price of air travel	0 79	(1 1)	AIC = -4 13
	TOT	5.21	(6.4)	
Thailand	GDP	1 32	(4 3)	R^2 = 0 973
	Price of air travel	-1 68	(-2 0)	AIC = -11.59
	TOT	-0.81	(-1.8)	

Note Figures in parentheses following parameter estimates are t-statistics
AIC is Akaike's Information Criterion measure.
Estimation period: 1971-1990

Comparing the evidence, the simple model used to produce the results in table 1 appears to capture most of the variation in RPKs to and from a country The results in table 2 suggest that estimating the model, and trying to capture that element of air travel to and from a country that is influenced by foreign factors, delivers little extra explanatory benefits.

Considering the simple empirical relationships in table 1, the evidence, for the set of selected Asia Pacific countries, suggests there is a significant relationship between aggregate domestic economic activity and air passenger travel demand Apart from Korea, with an estimated income elasticity of 2 67, all countries exhibit income elasticities within the range

1 67 to 2 31, and none of the estimated income elasticities are statistically different from 2. This finding accords with other empirical studies, such as Oum and Gillen (1983) who find income elasticities in the range 1 6 to 2 5 for Canadian airline demand, and Gillen, Oum and Noble (1986) who find income elasticities of 1 5 for US business travellers and 2 1 for US leisure travellers.

The estimates of the elasticity of the relative price of air travel are not as conclusive. Only for Singapore and Malaysia is the price elasticity estimate statistically different from zero, but in the case of Malaysia and Korea the estimate is of the wrong sign. For all other countries considered, the price elasticity of air travel is not significantly different from zero. The empirical evidence suggests that the demand for international air travel, to and from the selected countries, is relatively price inelastic. These aggregate empirical results accord with the empirical findings of Oum and Gillen (1983) whose aggregate model of intercity travel demand in Canada finds a very small and statistically insignificant own price elasticity of air travel demand.

The empirical results for all international air travel demand also shows that international air travel demand is positively correlated with income, with an estimated elasticity of approximately 2.9. This estimated income elasticity is, in contrast to the individual country estimates, significantly greater than 2, though it is not clear why this is so. The estimated price elasticity of demand for all international air travel demand if relatively inelastic (and not significantly different from zero) and accords with the individual country results. The quick analysis of figure 1 earlier suggested a relationship between air passenger traffic and economic activity but it was not clear from the figure if the relative price of air travel was a significant explanator of air passenger traffic. These expectations concur with the statistical results presented in this section.

Making assumptions about future economic activity for each country, the empirical relationships, outlined in table 1, can be used to make forecasts about future traffic levels. The Asia Pacific region is expected to provide the greatest air passenger traffic growth up to the year 2001, and for some period beyond. The main reasons for this is that the Asia Pacific region is the home for some of the world's newly industrialising economies which are expected to exhibit high rates of economic growth up until the next decade.

5. Conclusions

This paper has considered the demand for air passenger traffic services in the Asia Pacific region and the main determinants of demand. The empirical results indicate that in a country specific aggregate model, own country economic growth is a significant indicator of air passenger travel demand. The empirical results also indicate that air passenger travel demand is relatively unresponsive to changes in the relative cost of air travel. This indicates that changes in the price of air travel do not have a great influence on the decision to travel. The extent to which international air travel is consumed jointly with other goods, such as

packaged tours and accommodation and the extent to which these prices movement affect the demand for international air passenger services could be an important omission from the model Further work could be done to improve the model by using passenger data on an origin-destination basis and including prices of other modes and complementary goods and services in a disaggregate model of international air passenger demand

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