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NON-STOP APPEAL: VIABILITY OF LONG-RANGE LOW-DENSITY AIR ROUTES

Abstract

This paper explores consumers' preference for direct, intercontinental service and the technical feasibility of developing the niche of international long-thin routes. By modifying a route choice and market share model derived from US domestic data, insights can be gained as to how the preference for price, service frequency and convenience of travel interact to influence the market appeal of a direct intercontinental service. Meanwhile, improvements in technical capabilities and operational economics of the latest generation of long-range jets render this niche an attractive strategic option in an increasingly globalized airline industry. The success of Air New Zealand in so doing is evidence of the viability and strategic importance of this niche.

Acknowledgements

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Overview

Much research has been conducted on the supply and demand of air services in the United States, especially on the hub-and-spoke route networks (Oum and Tretheway, 1990) developed since the deregulation of the industry. The primary appeal of hub-and-spoke systems is their efficiency in geographical coverage through traffic consolidation. The consolidation of traffic allows higher frequency of service between the hub and non-hub cities, which in turn can stimulate demand primarily by reducing the amount of schedule delay. The inconvenience caused, however, is usually considered to be more than compensated for by the increase in flight frequency in short-haul domestic travels. However, as the travel distance increases, the amount of trip circuitry also tends to increase. At some point, there exists a trade-off between the preference

toward flight frequency and the preference toward trip convenience.

Meanwhile, improved technical capabilities and operational economics of the latest generation of long-range jets allow airlines to offer more long-haul, intercontinental flights with lower break-even demand. This favours the development of direct, point-to-point intercontinental services rather than routing through hubs and represents a viable strategy for smaller carriers to enhance their international competitiveness in niche markets despite the monolithic strengths of global mega-carriers.

In this paper, estimates from a route choice and market share model will first be examined. Then, with reference to the latest generation of long-range jets, the technical viability of direct, non-stop service will be explored. Finally the success by Air New Zealand in developing the niche of long-thin intercontinental routes will be used as a case study.

Market Appeal of Direct Intercontinental Services

Ideally, industry data can be used to quantitatively estimate consumer's preference on travel choice selection. However, by the very nature of long, thin intercontinental routes, difficulties arise in collecting samples of statistically significant sizes on those who have opted to travel on direct flights versus others on connecting services. This is exacerbated by the lack of published international origin-destination data.[1]

Instead of resorting to primary data, insights on the market appeal of direct intercontinental services can be gained through analyzing key research findings on travel preference in the US domestic market (where the data is most complete), and then by extrapolating consumers' preferences on longer-haul travel. Industry surveys are a good starting place for this discussion.

The result of two surveys on important factors affecting an airline passenger's travel decision is shown in Table 1. Airline's reputation was shown to be a significant factor. Schwieterman (1995) estimated the effect of an airline's reputation on ticket price, but the study was limited to US carriers only, therefore precluding further inclusion of this variable in a route choice decision model. The affiliation with a frequent flyer program is also an important factor in a travel decision, but there is simply not sufficient comprehensive, disaggregate data for analysis here.

Table 1. Factors Affecting Travel Decisions

Factor in Order	Frequent Travellers*	OAG Users^
1st (most important)	Schedule	Departure/Arrival Times
2nd	Frequent-flyer program	Air Fare
3rd	Price	Frequent-flyer incentives
4th	Non-stop flight	Route

Sources:

* Annual Reader Poll, *Frequent Flyer*, December, 1995

^ *Pocket Flight Guide Usership Survey – The Harris Poll*, Official Airline Guides, 1995

As evident from the survey, the notion of schedule convenience has two components: frequency of flight (schedule) and ease of travel (the convenience of an itinerary). The former is obviously an important decision. From a firm's perspective, Kahn (1993) showed in detail how United Airlines' dominance in frequency (over American Airlines') from Chicago O'Hare contributed to its disproportionate number of passengers carried and revenues earned. As well, Morrison and Winston (1986) reported that a doubling of frequency of air service would lead to a 21% increase in the demand for air service by business travellers.

The second aspect of schedule convenience, the ease of travel, is also an important attribute in an individual's travel decision. This refers to the number of en-route stops, or whether or not a connection is necessary at a hub airport. This will be explored in more details later.

Certainly, price is an important factor, although its relative importance varies from frequent flyers to leisure travellers. Oum, Gillen and Noble (1986) found that in the United States, the price elasticity for business travellers was -1.15 and that for leisure travellers was -1.5. Agarwal and Talley (1985) reported an elasticity of -0.8425 for international air travel to/from the United States. De Vany (1974) explicitly derived price elasticity values for US domestic travel as an increasing function (absolute value) of trip distance. At the same time, a similar relationship for time elasticity (as a function of trip distance) was derived.

Insights from a Market Share Model

Significant research has been conducted in the travel behaviour in the US. A mathematical model derived from these findings will be adapted to approximate the appeal of direct intercontinental services. Certainly, the results of this technique have to be viewed with caution, since there is an implied assumption that the preferences for some intrinsic trip qualities for both long-haul and short-to-medium-haul travels are similar and do not vary significantly with time. But in the absence of primary data, the insights gained can act as reasonably useful guideposts.

Kanafani, Ghobrial and Hansen have modelled the decision-making process in flight route selection in the US. All of them have used a logit model for the route choice probability (P, manifested in market shares) of traffic on a given flight route (i) between a given city pair (r):

$$P_r = \frac{e^{V_r}}{\sum_i e^{V_r}}$$

where V is a deterministic utility of a given itinerary. Since it is the difference in the deterministic utilities of competing flights that define their respective market share, the absolute value of utilities is not important.

Kanafani and Ghobrial (1985) modelled the utilities based on short-haul domestic travel. Their attributes included travel time, daily frequency, fares, aircraft size and connectivity. Summarized in the connectivity term were the differences among non-stop service, on-line service with stops and indirect connecting service. However, the deterministic effects of these attributes were all simply additive, thereby limiting the model's use to only short-haul domestic traffic.

Ghobrial (1989) examined the competition between US and foreign air carriers on 27 international routes. The use of the logarithm of weekly frequency and the definition of convenience of service as the ratio of non-stop flights to total flights in a specific market were instrumental in modelling travel behaviour, but the omission of price effect precludes its full adoption for intercontinental modeling.

Hansen (1990) estimated the deterministic utility from passenger itinerary and airline flight schedule data (in 1985), based on the US

Department of Transportation 10% flight coupon data. He estimated the functional form of the deterministic utility of a direct service[2] as:

$$Vd = aF + q_o \ln(f) + Vdct$$

where F is the fare in dollars, f is the daily frequency, Vdct is a constant reflecting consumer preference for non-stop service, and a and q_o are also constants as shown in Table 2. Similarly, the utility for on-line connecting service was estimated as:

$$Vc = aF + s\,CIRC + q_1 \ln(fmax) + q_2 \ln(fmin)$$

where CIRC is the trip circuitry in miles, fmax and fmin are the maximum and minimum frequencies of the connecting "spoke segments", and s, q_1, and q_2, are constants as shown in Table 2.

Table 2 Market Share Model Estimates from Hansen's Study (1990)

Coefficients of Attributes	Estimated Value	Standard Error
ln (direct freq), q_o	1.29	0.17
ln (max direct freq), q_1	0.33	0.14
ln (min direct freq), q_2	0.78	0.10
Direct service utility, Vdct	2.72	0.81
Fare in US $, a	-0.0045	0.0010
Circuitry in miles, s	-0.0029	0.00026

271 observations were made, with an R-squared value of 0.74

In intercontinental travels, the effect of higher trip circuitry can be approximated by the CIRC term. The use of the natural logarithm of frequency and the differentiation of direct versus connecting frequencies are generally applicable to long-haul flights. The effect of price has also been incorporated. These make Hansen's model generally applicable to approximate intercontinental travel behaviour.[3]

To do so, these estimates can be applied to a sample routing, say, from Vancouver to Osaka, assuming a symmetry of demand and the offering of only one fare (full economy) per airline. At this writing, according to the *Official Airline Guide*, three airlines: Air Canada, Japan Airlines and United Airlines (AC, JL and UA respectively), offer convenient on-line service on this route (without much backtracking),

and are likely to attract the majority of traffic in this market. Their itineraries are shown in Table 3, and for the purpose of illustration, only these three will be considered.

Table 3. Sample Itineraries from Vancouver to Osaka

Carrier	Stop	Flight time, hr	Transfer time, hr	Daily freq.	Circuitry miles
AC	No	10:50	0	5/7	0
JL	NRT[4]	12:10	1:45	1	671.7
UA	SFO	13:25	3:30	1	1307.4

Airports: NRT-Tokyo Narita, SFO-San Francisco International

If all three airlines offer the same fare of US$1,200 (with other attributes being equal), and if the travel choice selection pattern on the intercontinental market of Vancouver-Osaka is the same as would be expected in US domestic flights, then according to Hansen's model, the market share that would be gained by these three airlines can be expressed as a function of the frequency of non-stop service offered by Air Canada. However, using his original model, even as both UA and JL drop their fares to 75% of that of AC's, the non-stop flight would still be very popular, capturing more than 60% market share with the offering of only 1 weekly flight. This certainly appears to be too favourable for direct intercontinental service, and more stringent conditions need to be applied.

As alluded to previously, De Vany (1974) estimated that as the trip distance increases, the absolute values of price elasticities increase while those of time elasticities decrease. Halving the circuitry coefficient would likely give a more stringent estimate in Hansen's model, with the lower bound of it being zero. A simultaneous doubling of the fare coefficient would reflect a significantly higher sensitivity to fare. The exact magnitude of these adjustments required to model intercontinental air transport demand is not known. However, based on the standard errors associated with these attributes, as reported by Hansen, these two modifications do represent rather stringent conditions to model intercontinental traffic.

Figure 1 shows the effect of lowering fares by UA and JL if AC continues to charge $1,200 and flies 3 non-stop flights a week, based on

these modified conditions. As evident from the figure, even if Air Canada operates only 3 non-stop weekly flights, it would still attract a higher proportion of origin-destination traffic than either JL or UA, given a fare difference of $200. This is consistent with Hansen's original prediction in the domestic setting that even when no extra distance is involved, 15 flights per day on each of two flight segments would be required for a hubbed service to gain a 50% market share if the only other competitor is a direct service of one flight per day.

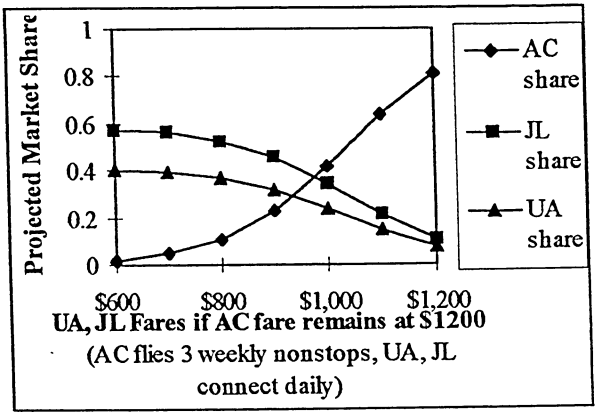

Figure 1. Effect of Price on Market Share, Modified Hansen's Method

The effect of connecting time has not been segregated from the direct service utility in Hansen's estimate. Alternatively, Kanafani and Ghobrial (1985) estimated that the amount of travel time has a linear effect on deterministic utility, with an associated coefficient of -0.897, which, when converted to trip circuitry at 800 km/h, presents a more favourable condition to non-stop service than Hansen's estimate. The inclusion of additional time delay, with Hansen's estimate, does seem to have a significant impact on the predicted market shares (see Figure 2).

Figure 2 shows the effect of non-stop service frequency on the market shares of the Vancouver-Osaka market, assuming that AC charges $1,200 and both UA and JL $200 less, based on modified Hansen's estimates. Even under various stringent conditions as discussed above, the market appeal of a direct intercontinental flight[5] is certainly respectable compared to that of connecting services.

Given the attractiveness of direct intercontinental service, what then,

if any, has prevented airlines from fully exploiting this niche? The availability of aircraft technology has been a major factor, and will be discussed next.

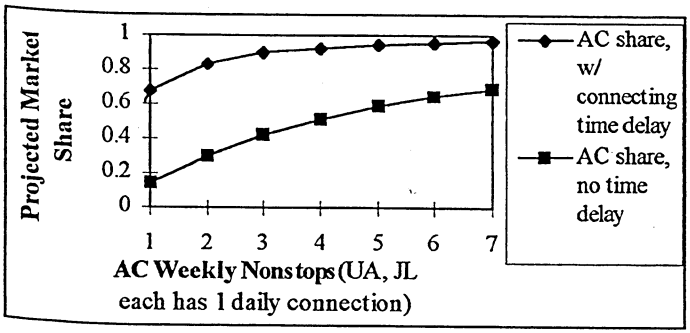

Figure 2. Effect of Non-stop Frequency on Projected Market Shares

Latest Long-Thin Intercontinental Jets

Ideally, the costs of providing these non-stop services can be compared with those of connecting service, thus arriving analytically at a precise measure of benefit in developing one type of service over the other. In reality, however, the effect of hub transfers and scale of economies accomplished through consolidated maintenance and operation bases, the distribution of stochastic delays, and the difference in management structures can add significant uncertainty to such analysis.

Meanwhile, from a global perspective, if the "right" aircraft technology is available, and if an airline can demonstrate success in using these aircraft types to develop the intercontinental long-thin niche to gain international competitiveness, then it is reasonable to conclude that such markets are both viable and of strategic importance.

Technological capabilities had, until the past decade, been a major impediment in the full development of thin, direct intercontinental markets. The 747 had the most impressive payload-range capability, but its sheer size also translated to a larger number of break-even load factor. The smaller 747SP was relatively costly to operate. Some versions of the DC-10 and L1011, notably the DC-10-30 and L1011-500, have been designed to carry fewer passengers over shorter distances than the 747, and were moderately instrumental in developing intercontinental

linkages, albeit often with intermediate stops.

The latest generation of "long-thin" intercontinental jets has certainly changed the scene. The range and typical mixed-class seating capabilities of these and other older aircraft types are shown in Figure 3.

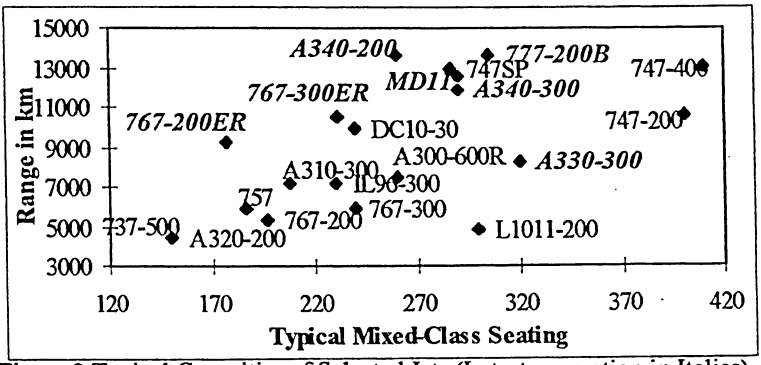

Figure 3.Typical Capacities of Selected Jets (Latest generation in Italics)
Sources: Airbus Industrie, Boeing Commercial Airplanes,
Green & Swanborough (1988), *Flight International* (1993) and
McDonnell Douglas Aircraft.

The latest generation of intercontinental long-thin jets includes the Boeing 767's and 777's, Airbus A330's and A340's, as well as McDonnell Douglas MD-11. In some occasions, the 757-200ER, A310-300 and A300-600R are also used to perform intercontinental flights, particularly across the Atlantic and between Europe and the Middle East. As evident from Figure 3, these aircraft types provide impressive range capability but relatively low seating capacity. Figure 4 reveals that these aircraft types have significantly lower long-range fuel consumption than their predecessors.[6]

Apart from fuel economy alone, the latest generation of long-range, low-density jets generally has relatively low operating costs.[7] Despite the economics of these latest intercontinental long-thin jets, since many of these have just entered scheduled service in the past 2 years or so, the benefits from their deployment and the market niches developed may have yet to mature. Nevertheless, the 767's have been used in the transoceanic flights since the late 1980's, and the success in their intensive use in long-thin routes will be particularly insightful.

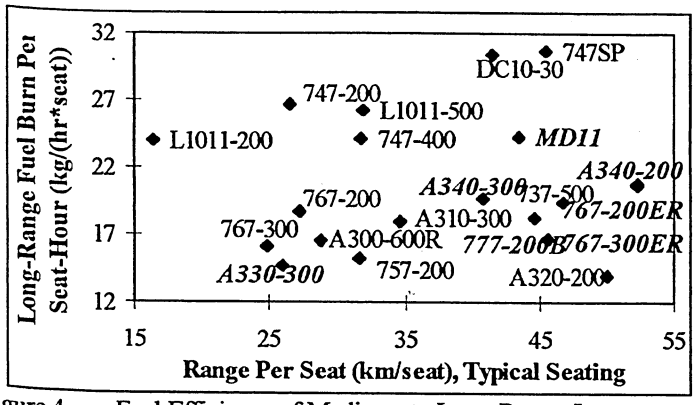

Figure 4. Fuel Efficiency of Medium- to Long-Range Jets
Sources: Green and Swanborough (1988), *Flight International* (1993),

Air New Zealand's Case

Since the late 1980's, the use of 767's over transoceanic services became more popular. However, for the purpose of this paper, the use of such aircraft in developing the intercontinental long-thin niche has to be shown in attracting and possibly stimulating origin-destination traffic between the cities served, rather than merely collecting traffic from a particular region. In this case, Air New Zealand's success serves as an excellent example.

The geographical location of New Zealand offers little opportunity for an airline to develop a comprehensive network for connecting traffic. In 1986, Air New Zealand only flew to 2 destinations in Asia, using the 747-200: Tokyo and Singapore (twice weekly to each from Auckland, airline timetable, 1986). Reciprocal services from the region originated from these two countries only. Across the Pacific, it connected Fiji and Tahiti directly with Los Angeles, again with the 747-200.

In contrast, Qantas of Australia, backed by the enormous size of its home market, flew daily to Hong Kong and Singapore, near-daily to Bangkok and Tokyo, and regular service to Kuala Lumpur, Beijing, Manila and Indonesia. Further, passengers travelling from these places to New Zealand, can often find convenient on-line connections via Qantas. For Air New Zealand to continue operating successfully as an independent, international carrier, it had to find a way to bypass Qantas'

hubs and fly direct to other growing regions of the world.

Since 1987, Air New Zealand has embarked on an expansion plan in the Pacific region, making use of both the underlying consumer preference for direct service and the economics of the 767's. Today,[8] the airline flies to 10 destinations in the region (36 flights a week in total), but the 747-200 is used only to fly to three high-density markets: Tokyo, Taipei and Hong Kong (8 weekly flights total). Meanwhile, the 767 has also been used to connect the South Pacific islands of Western Samoa, Tonga and the Cook Islands directly to the US. Figure 5 compares the growth in Air New Zealand's long-range fleet from the end of 1986 to 1995, providing proof to the airline's increased emphasis in the intercontinental long-thin niche.[9]

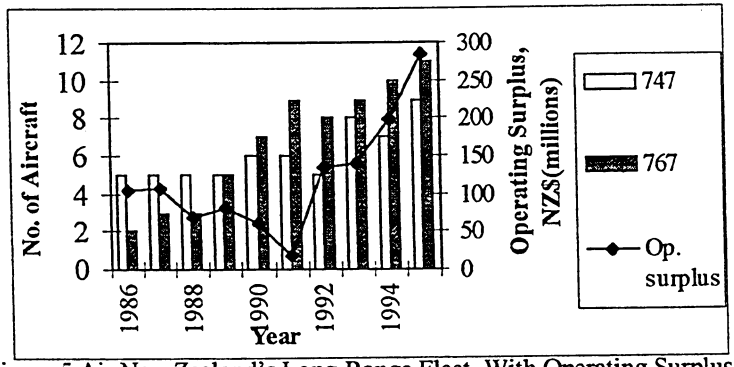

Figure 5.Air New Zealand's Long-Range Fleet, With Operating Surplus
Source: Air New Zealand Annual Report (1996)

Some operational statistics of Air New Zealand from 1986 to 1994 is shown alongside that the world's total in Table 4. It is evident from the table that during this period, the growth in revenue-passenger-kilometres (RPK) for the airline has almost doubled that of the world total, while its growth in the number of passengers carried has been in line with the world's average. The relatively low growth in freight-tonne-kilometres (FTK) carried compared with the world's figure is indicative of the slower-than-average growth of New Zealand's home market.[10] These, combined with the much faster growth of its 767 fleet compared with that of the 747, are clear evidence of the impact of the airline's newly developed intercontinental long-thin markets.

Table 4. Operational Statistics of Air New Zealand in 1986 and 1994

Category	Air New Zealand 1986*	1994*	% change
Pax No.	4.2 mil	5.8 mil	+38
RPKs	8.0 bil	15.6 bil	+94
FTK	329 mil	493 mil	+50

Category	World Statistics 1986*	1994*	% change
Pax No.	960 mil	1.3 bil	+37
RPKs	1,452 bil	2.3 tril	+56
FTK	43.2 bil	97.2 bil	+125

Sources: (*-includes domestic operations) Air New Zealand (1996); *Air Transport World* (1986, 1994)

Strategic Importance and Implications

The successful development of the niche of intercontinental long-thin service through the use of advanced aircraft technology by Air New Zealand can be considered as a practical confirmation of the market share modelling and the operational economics of the latest generation of intercontinental aircraft. Certainly, sound management strategies are important in the success of implementing such strategies. Nevertheless, there is clear evidence of the economic viability, technical feasibility and strategic importance of the direct, intercontinental long-thin markets. This, in particular, has some serious implications for airline strategy planning elsewhere in the world.

Similar to New Zealand, the geographical location of Canada limits the opportunities for Canadian carriers to build effective global hub-and-spoke networks. As well, carriers in the neighbouring United States have comparative advantages on traffic feed owing to their much larger home market and coverage. Passengers to and from Canada, for instance, often observe that a higher frequency of service to an international destination can be provided by an American carrier, albeit with the penalty of added trip circuitry, travel time and inconvenience. Reflecting on Air New Zealand's experience, the recent introductions of non-stop services like Vancouver-Beijing by Canadian Airlines International and Toronto-Tel Aviv by Air Canada appear to be in the right direction.

On the transborder front, the recent near-"Open-Skies" air transport agreement between Canada and the US opened up new opportunities for carriers on both sides of the border. Together with the introduction of the Canadair Regional Jet (CL-65), the Airbus 319 and the latest generation of the Boeing 737's, the transcontinental version of the "long-thin" niche may be of strategic importance in increasing transborder market shares.

Conclusions

To an individual traveller, the higher frequency offered by a hub-and-spoke network between non-hub cities often demands additional time and inconvenience. On intercontinental flights, this inconvenience could be more significant, and beyond a certain point, the comfort of a non-stop flight may be more important to a passenger than frequency and price.

By modifying results from Hansen's study on US domestic travel behaviour, some insights into how the frequency of a non-stop intercontinental service can affect a carrier's market share in face of competition from hub-based connecting service. These findings, however, should be interpreted with caution, as a number of important factors, including frequent flyer programs and airline reputation, still have not been incorporated.

In any case, given the underlying demand for direct, non-stop service, the availability of a host of new aircraft types appear to have rendered the niche of intercontinental long-thin routes a viable strategic option for airlines around the world.

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Endnotes

[1]The International Civil Aviation Organization (ICAO) collects data on

each flight segment as well as same-flight traffic, but not connecting traffic. The U.S. Department of Transportation collects 10% of industry ticket samples, but this is limited to passengers on U.S. airlines. Both the U.S. Immigration and Naturalization Services (INS) and Transport Canada have limited origin-destination data, but with no account on itineraries.

[2]In Hansen's model, direct, on-line, same-plane service is not differentiated from non-stop service. It is reasonable to assume that for an intercontinental flight, as long as the longer sector is sufficiently close to the total stage length, the difference between a true non-stop and a direct flight is negligible. Otherwise, the utility of the flight would be somewhere between a true non-stop flight and an on-line connection.

[3]In fact, the changes in the total route-specific market size as a result of carriers' competition may also be significant. In any case, a carrier's market share should be a reasonably good indicator of its competitiveness.

[4]Passengers travelling on Japan Airlines actually have a choice of airports in Osaka. But only the connection to Kansai Airport will be considered here.

[5]In fact, the model does not measure the appeal of direct flights in general, but only non-stop ones. However, if the two flight segments of an intercontinental flight are far from equal, the difference in utility between the two longer-haul markets can be assumed to be more or less equal.

[6]Also, fuel consumption per passenger-kilometre decreases as the trip distance increases. This decrease can be as much as 20% for a London-Istanbul flight compared with a London-Paris flight by a 767. See Force (1990)

[7]See TravelScan (1995).

[8]Air New Zealand also uses fifth freedom rights between Australia and other Asian countries, but to a limited extent.

[9] In a similar vein, with the 747-400, Air New Zealand launched Auckland-Los Angeles non-stop and same-plane one-stop service to London, forcing its direct competitors to either drop the route (Continental) or adopt the same itinerary (United, British Airways).

[10]This observation is also consistent with the fact that Air New Zealand's domestic revenue-passenger-kilometres figure fluctuated between 1.365 million and 1.637 million only from 1986 to 1995 (Annual Report 1995).