A STUDY OF THE REMOTE AREAS AIR SERVICE SUBSIDY POLICY IN TAIWAN

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Abstract: In Taiwan, the economic viability of a domestic flight route is evaluated on the basis of its demographic, geographic, and economic characteristics. This paper explains the methodology used to differentiate the market characteristics of a remote areas air service subsidised community policy from a non-subsidised one. In order to quantify the differences between the market characteristics of these two groups, a discriminant analysis was conducted. The following variables were used to test the forces that affect the subsidy programme: (1) Subsidy Status; (2) Size of Population; (3) Distance; (4) Level of Service; (5) Market Demand; (6) Competitive Pressure; and (7) Unit Fare. The research results indicated a need to regroup the subsidised and non-subsidised remote areas air service. The final discriminant function was seen to be primarily based on passenger demand and seat capacity. Hopefully, as a result of this study's findings, the remote areas air subsidy programme in Taiwan will be carried out more smoothly than before and provide a good subsidy model for other areas in Asia.

Key Words: Air Transport, Subsidy, Discriminant Analysis, Taiwan.

1. INTRODUCTION

In Taiwan, the 1953 Civil Aeronautics Law laid the foundation for the modernisation of the Civil Aeronautics Administration (CAAC). This law did not restrict the entry of new airlines into the passenger aviation market. Later, implementation of the "open sky policy" and promulgation of the Act of **Entry, Increased** service routes, **Purchasing** aircraft Application for the Civil Aeronautics Transportation Industry (EIP Act) in 1987 increased the number of domestic airline companies to nine by 1993. The EIP Act has deregulated airlines and their service routes' entry/withdrawal restrictions and their tariff rate restrictions. Consequently, domestic airlines' passenger traffic continues to soar at an unprecedented rate.

However, miscalculation of government policy to approve the direct domestic flight link between Mainland China and Taiwan led domestic airline companies to purchase far too many middle size (100~200 seats) aeroplanes. These aeroplanes were delivered to the airline companies from 1992 onwards. Due to oversupply of the fleet capacity, fierce competition ensued and from 1994 thereafter many domestic carriers began to report losses. Three domestic airlines merged in 1996: Mandarin Airlines merged with Taiwan Airlines and Yon-Hsin Airlines. Uni-Air took over Makung Airlines in 1993 and later also took over Great China Airlines in 1994. One airline company, U-Land Airlines, was grounded by the CAAC due to the lack of airworthiness of her fleet in 1999. Only 4 domestic scheduled carriers remained operative in the domestic air service

in June 2001[1]. When the total ROI of domestic carriers is in the black, they can maintain non-profitable flights to remote areas because of coaxing from the CAAC. Nowadays, the total ROI of these carriers is in the red, and they cannot afford to maintain flights to remote areas without adequate subsidies from the government sectors.

Within the deregulated environment of Taiwan, air carriers are relatively free to restructure their network configuration in such a way that theoretically profits may be maximised. There are currently more than 22 domestic flight networks in the Taipei Flight Information Region (FIR)[2]. They do not have to compulsorily serve the money losing routes which they had to prior to the deregulation of airlines. As regards other domestic transportation modes, e.g., water and land transportation, the government has subsidised the passenger ferry companies and bus companies that serve the remote areas of Taiwan[3] for a long time. For these remote offshore islands, air is the main form of transportation linking them with the rest of Taiwan in days of severe weather. Moreover, the need to give the inhabitants of remote islands an equal transportation opportunity is becoming an increasingly recognised responsibility of government. To maintain the economic viability of the remote areas air service, the CAAC officially launched a subsidy programme for these small remote islands in July 1999. The subsidy programme has therefore only been in existence for two years. Yet some airlines have already decided to withdraw their flights from these remote islands. The initial subsidised areas were the five small remote islands listed in Table 1. As a result of legislator lobbying, the CAAC has enlarged the subsidised areas to include the other two larger remote Makung and Kinmen islands. These events make it opportune to review the market characteristics of the subsidised communities, and to analyze the factors that affect the subsidy determinations, and the benefits received by these remote areas' airports.

2. SUBSIDY METHODS

The MOTC's (Ministry of Transportation and Communication's) traditional transportation subsidy policy has dual goals: ~~to ensure a reliable and continuous service to the remote areas~~ and ~~to maintain the subsidy payments at reasonable levels~~. Theoretically there are three economic approaches to subsidy methods[4]: (1) the Cost-Plus system: under this approach, a maximum level of losses is established by the government for airlines serving the remote areas; (2) Fixed-Incentive rate: this approach is also based on a target loss but differs from the cost-plus system in that the airlines absorb all losses in excess of the target; and (3) Shared-Incentive rate: the government reimburses the carrier for a portion of the additional losses instead of all of them (as with the cost-plus system) or none of them (as with the fixed-rate system).

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[1] Namely, Uni-Air, Mandarin Air, Trans-Asia Air, and Far East Air were the big four serving the domestic air transport market. China Airlines and EVA Airlines also provided a feeder service from Kaohsiung and CKS international airports to domestic destinations.

[2] CAA Statistics Data, Table 8: ~~Taiwan-Fukein Domestic airlines load factor analysis~~.
http://www.caa.gov.tw/account/1997/indexc.htm

[3] The MOTC subsidised the remote areas passenger ferry companies NT$ 217,230,000 between July 1999 and Dec. 2000.

[4] "U.S. Essential Air Services Study", pp.19-20. Canadian Transport Commission, Research Branch, 1985.

In Taiwan, currently there are three forms of subsidy: (1) Passengers pay 80% of the tariff fares for their flights to and from the remote areas. And the airlines obtain the remaining 20% of the fares from the government subsidy fund; (2) Elimination of the landing fees in these remote areas airports.[5] (3) the remote areas scheduled air service providers receive a privileged majority airport time slots allocation from the CAAC. However, due to deterioration in the government budget, the CAAC prefers to adopt the non-fiscal subsidy approach. The value for the latter type of subsidy can be decided as follows: the preferable time slot value = (The Load Factor of Peak Hour – the load factor in the off peak hour) × Designated Aircraft Passenger Capacity × the Fares of the flight route. In the year 2000, major domestic airlines in Taiwan reported that the average load factor difference between the peak hour and off-peak hour of a weekday was about 30%~40% (mean value 35%) on the main routes. Taking the Boeing737-400 serving the Taipei-Kaohsiung route as an example, this could accommodate around 168 passengers. Thus the value of the peak-hour time slot serving this route could possibly be worth (35% × 168 × NTD $1,700) = NTD $99,960/ per peak hour slot.

Due to the "Grandfather right", the time slots in the peak hours are almost always occupied by the earlier established airlines[6]. Unless the air traffic control facilities are greatly improved, it will be difficult for the CAAC to increase the available airport time slots efficiently[7], and it will be hard for the CAAC to use the time slots as a kind of subsidy/encouragement if the airlines agree to serve the remote areas.

Despite the above mentioned three forms of subsidy from the CAAC, the airlines still lose money on their remote areas air services. Therefore the CAAC is considering making the open-tender approach available to all domestic airlines who want to apply for the subsidy fund and manage the remote areas air service by private contract[8]. Those who bid for the lowest government subsidy fund will win the bidding. However, the CAAC should set the minimum amount of the subsidy fund at a higher value in order to attract more domestic airlines to provide air services to the remote areas[9]. The drawback to the open tender approach is that airlines may reduce or change their service quality on the remote flight routes if these airlines lose more money than the amount to be subsidised by the CAAC.

3. A REVIEW OF RELEVANT LITERATURE

The CAAC's recent internal "Current Situation of Remote Air Service Routes and Problems Analysis Report[10] has identified the major causes of Taiwanese domestic airlines' losses from the cost/revenue/flight route perspectives. It also noted that the USA airlines economic deregulation

[5] The CAAC will consider eliminating the landing fee on remote areas flight routes.
[6] Far Eastern Airlines and China Airlines are the two airlines owning the better time slots.
[7] Shengchen Huang(2001), The Challenges of the Airport System in the 21st Century. Proceedings of the New Millennium Airport Management Conference, CAAC, Taiwan, 1-2, Feb. 2001.
[8] Class lecture given by Ms. Ling Feng-Yi, Business Division chief of the CAAC at NTOU, Dec. 2000.
[9] One of the major domestic airlines is Uni-Air. According to Uni-Air president, Mr. Wu C.M., the airline will not participate in the open-tender for the subsidy unless the CAAC subsidy fund is sufficient to cover its loss from its provision of the remote areas air service.
[10] "CAAC Remote Air Traffics and Services Policy Analysis". CAAC, December, 12, 2000.

policy and launching of the essential air service (EAS) plan is likely to be implemented by the CAAC in the near future. It also reviewed likely outcomes of the government's involvement in the ownership and operation of a newly merged remote-island-dedicated airline in the future. Finally it discussed the aforementioned ways to subsidise remote island air services. However, this report did not clearly indicate the methods to be employed to select the targets to be subsidised. It assumed the subsidised targets would be decided by legislators' political-economics philosophy.

H.S. Lin[11] (1997) analysed the subsidy from the transportation economics perspective, and concluded that the remote-islands transportation subsidy programme should take the air transportation sector into consideration[12]. Lin also stated: *"It is the government's responsibility to equalise the transportation resources across the nation".* She recommended 5 auxiliary airports (Lan Yu, Wan An, Chi Mei, Mat Zu, Green Island) suitable for landing small size (19 seats) aircraft as the subidised targets. However, she only employed one criterion to decide whether the remote areas air service should be subsidised or not.

Reynolds-Feighan (1995) looked at the impact of the European Union's (EU) "Third Package" of Liberalisation measures on small communities and took the Ireland Republic as an example.[13] The liberalisation package came into effect on 1 January 1993 and allows for free entry on intra-European routes and freedom by carriers to set passenger fares and cargo rates. However in the EU, there is no subsidy scheme similar to the U.S.'s "Essential Air Service" subsidy programme. Therefore Feighan concluded that the Irish regional airports are suffering from a reduction or removal of air services because carriers wish to focus on the more lucrative high- density intra-community routes. Feighan suggested a EU-wide Essential Air Service Programme, and put forward the following criteria where the EU-edition of EAS is concerned: (1) the size of the communities, (2) the distance to the nearest hub airport and (3) the influence of alternative transportation modes available. Feighan contested that subsidy payments decided in the above-mentioned ways should be more closely matched to the requirements of each region.

Hooper (1998) has suggested that policy makers in developing countries (India) should draw on the documented experiences of the developed countries (Australia). Some specific circumstances that need to be taken into account are the size of markets in developing countries, airline networks dominated by a small number of dense routes, and "the concern of government to subsidise air services in situations where surface transport links are poor".[14] Thus Hooper(1998) adopted the **"convenience of the surface transport links"** as the air subsidy criterion.

Waters et al. (1996) have mentioned that there are well-recognised circumstances where economic efficiency criteria may call for subsidy[15]. These include "economies of scale" whether

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[11] H.S. Lin (July 1997) "The Study of the remote island airlines' expenses' subsidy". Journal of Tax and Finance Research, P147-156, July, 1997.

[12] At that time, there was no remote areas air transport subsidy fund programme.

[13] Aisling J. Reynolds-Feighan, "European and American Approaches to Air Transport Liberalization: Some implications for small communities", Transportation Research A, Vol 29A, No. 6, pp.467-483.

[14] Hooper, Paula . Journal of Transport Geography, Vol: 6, Issue: 2, pp. 105-116, June, 1998.

[15] WG Waters II, James Evans and Joan Caravan, "Subsidy policy on low volume ferry routes", Transport Policy,

in the production process or in costs of time borne by users, "externalities", and possible "second-best" arguments whereby prices in one sector deviate from marginal cost pricing to offset distortions in prices elsewhere. Waters found three factors influence the cost-recovery across ferry routes: (1) traffic volume, (2) distance travelled, (3) vessel utilisation rate. He concluded two policy directions for the BCFC (British Columbia Ferry Corporation): (1) the appropriate overall level of subsidy from government and (2) the need to restructure fares so they better reflect the relative costs of the different services provided. He also pointed out that the current pricing practices of the BCFC involve substantial implicit cross-subsidisation whereby off-peak and year-round users cross-subsidise peak travellers who are often temporary visitors. The BCFC does receive some direct subsidy payment but without explicit directives. Waters did not mention how to determine the target routes to receive the subsidy.

4. HYPOTHESIS

The Irish Industrial Development Authority supported investment in airports on the grounds that air access to the regions was vital for maintaining and attracting export-oriented firms. However, Feighan (1995) pointed out that these airports are located in predominantly rural areas at surface travel times of generally at least 3 hours from Dublin in regions considered to be peripheral in Irish as well as European terms. **Currently, EU member governments have reached agreement with the EU commission that governments will 'abstain from granting any further aid or other new measures favouring directly or indirectly' the national carriers**[16]. As far as the remote areas air transportation subsidy is concerned, CAAC subsidy policy in Taiwan should not only take the off-shore small islands into evaluation, but also remote areas in the Taiwanese mainland (such as Hualien, Taiching, Taitung), according to the above-mentioned subsidy evaluation standards suggested by Feighan[17]. The three criteria Feighan proposed, which have been highlighted in the literature review, could, in the writer' view, be modified to (1) Demographic, (2) Geographical, and (3) Economic considerations, and applied to the case of Taiwan.

Where the above three criteria indicate a disadvantageous situation in an area, then this area will face the risk of fare hiking, flight reductions, or even the withdrawal of all the airlines flights from the route. It seems that at present legislators and government officers have their own idiosyncratic ways of determining which routes are qualified to receive the subsidy fund. Objective criteria appear to be totally lacking. **Thus the writer hypothesis that current remote areas, flight routes in Taiwan are incorrectly assigned to present subsidised and non-subsidised groups**. Furthermore, due to incorrect subsidy assessment, the government has suffered from insufficient funds to maintain the economic viability of some flight routes which really need the subsidy fund.

Vol. 3, No. 3, pp. 111-121, 1996.

[16] "Politics, subsidies and competition: the new politics of state intervention in the European Union", p. 94 , Kostas A. Lavdas et al., Edward Elgar Publishing Limited, Glos U.K., 1999.

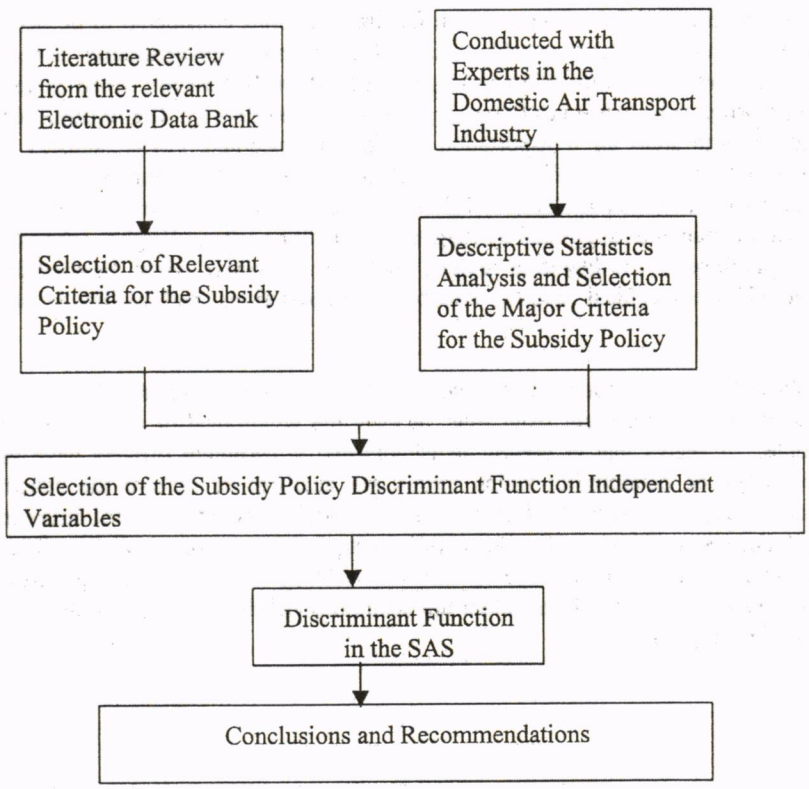
5.RESEARCH DESIGN

In order to quantify the differences in the market characteristics of these two groups, a discriminant analysis is conducted. The purpose of the analysis is to find a discriminant function whereby a subsidised group can be separated from a non-subsidised one based on the value of the discriminant function. The result can hopefully point to a linear function of the observed market characteristics.

5.1 The research objects

The remote areas' airports support those communities with a less favourable market environment. Only these airports are considered to be the potential subsidised targets. However, it is difficult to define the exact meaning of "remote areas", so all domestic airports' connecting flight routes, excluding routes among the three main hub-airports (Taipei and Kaohsiung airports are domestic hub airport and Kaohsiung and CKS airports are international hub-airports)[18], are the research targets for this study.

5.2 Research Structure



[17] Aisling J. Reynolds-Feighan, pp.477.
[18] The annual passenger throughput in the hub-port is not less than 4 million.

5.3 Research Limitation

The research utilised the ELSEVIER Science B.V. electronic science data bank only to find all literatures possessing the keywords airline subsidy, due to time and resources constraints. Therefore criteria related to subsidy-decision were confined to the capacity of this data bank. In order to reduce the impact of this limitation, the writer conducted an interview survey with experts in the domestic air transport industry in Taiwan to further ascertain major criteria. The writer found that most of the criteria selected from the data bank search were also considered important by the experts in Taiwan except for the unit fare criterion (see Table 7). Consequently we can conclude that in general the subsidisation criteria derived from the data bank search and literature review were valid for the case of Taiwan.

5.4 Experts Questionnaire Survey

Since most of the criteria we used in this paper were concluded from former studies conducted by other researchers abroad, the writer of this paper performed 48 face-to-face interviews with experts in the domestic air transport industry concerning domestic air transport subsidy policy in Taiwan in January 2001. Prior to this in a pilot study the writer interviewed 5 well-known experts in this industry and selected the 20 criteria they thought important to subsidy policy. Subsequently, 48 questionnaires were sent out to 48 further experts in the industry and 48 were returned completed. Each questionnaire contained 20 subsidy criteria whose importance interviewees were asked to evaluate on a 5 point Likert Scale. The 48 experts were selected from: ①Senior planning department managers/staff in Taiwan's three major domestic airlines (Far East Air, Fu-Shin Air, and Mandarin Air), ②Relevant officers in the MOTC and CAAC, ③Academic researchers in the university.

By averaging the 48 experts' answers the overall degree of importance of each selection criterion could be ascertained. Table 7 shows the subsidy criteria in rank order of importance to interviewees. The higher the score the more important the selection criterion. By this means, discriminant criteria were selected objectively.

5.5 Data Sources

All the secondary data for this research were derived from relevant literatures published by the government agency (CAAC, MOTC) or the airlines industry association (Taipei AIA) in 1999. Thus the reliability and validity of the data are deemed to be trustworthy. (1). For the Demographic criterion: "The statistics of the city and areas development" by the City and Housing Development Centre of the Executive Yuan Economic Development Council; (2). For the Geographical Separation criterion: **Flight Time** from the CAAC's "Aeronautical Information Publication (AIP)" , **Surface transportation trip time** from the Highway Bureau and Taiwan Railway Company, and **Water transportation trip time** from the Department of Aviation and Navigation, Ministry of Transportation and Communication; (3) For the economic perspective: **Service level in terms of available seats offered** from "Transportation data analysis, 1999/June" published by the Institute of Transportation, MOTC, **Service level in terms of passenger throughput** from "Transportation Data Analysis, 1999/June", and **Competitive pressure** from "Transportation Data Analysis, 1999/June". (6) **Average Unit Fare** were derived from "The CAAC annual report" and reports published by the Taipei AIA.

5.6 Definition of the research variables

As earlier mentioned, the economic viability of a route can be evaluated on the basis of its demographic, geographic, and economic characteristics. Therefore, a community that is disadvantaged according to these characteristics would, in the absence of an effective subsidy programme, probably face substantial increases in fares and/or reductions in the level of service.

The following variables are taken from the previous literature review to test the forces that affect the subsidy programme and the benefits accruing to the subsidised communities: Subsidy Status; Size of Population (Feighan, 1995); Distance (Feighan, 1995); Level of Service(Hooper, 1998); Market Demand(Hooper, 1998); Competitive Pressure(Feighan, 1995); and Unit Fare (Waters et al., 1996).

Dependent Variable: Whether the flight routes serving non-hub airports should receive the government subsidy, i.e. the Subsidy Status.

Independent Variables:

From the previously mentioned three criteria (**demographic, geographic, and economic characteristics**), the writer developed six independent variables as follows: ~~Size of Population~~, this **demographic** characteristic can be represented by the number in the population in the counties/cities that the non-hub airport serves; ~~Distance~~, this **geographic** characteristic can be determined by the degree of isolation which can be measured in terms of the shortest trip time (in terms of minutes) from non-hub airports to the domestic hub airport cities (Kaohsiung, Taipei) by surface transportation. The **economic** factors were determined by ~~passenger demand~~, ~~level of service~~, and ~~the number of airlines operating in the region~~; '~~Level of Service~~' refers to the total available seats offered by all the Airlines on each flight route; '~~Market Demand~~' refers to the total passenger throughput in each non-hub domestic airport; '~~Competitive Pressure~~' refers to the number of airlines serving each non-hub domestic airport route; '~~Unit Fare~~' referring to the average fare per mile was selected as an indicator to differentiate subsidised airports from non-subsidised ones. The average fare per kilometre was selected as an indicator to measure the benefits of "the remote areas air transport subsidy programme". The airlines are free to set their fares within the CAAC's tariff limitations. The airlines' pricing policy is cost-oriented, but on a route-specific, rather than on a system-average basis. As a consequence, fare differences between routes are more likely to be the result of cost differences in these markets. Since the average unit cost of providing an air service decreases as the number of passengers per flight increases, assuming that the most appropriate aircraft is used, it is expected that unit costs and therefore fares will be higher for the communities in remote areas. However, the gap in unit fares between subsidised and non-subsidised routes could be narrowed in the presence of an effective remote areas air transport programme. Therefore, comparisons of unit fare levels between groups of subsidised and non-subsidised domestic airports would afford an overview of the benefits entailed in the Taiwanese edition of the EAS programme within a relatively competitive market environment.

5.7 Research Methodology

This research uses an interview survey administered to experts in the domestic air transport industry and the discriminant analysis of the multivariate methodology[19]. This methodology is suitable for utilising a single dependent variable and multiple independent variables. The dependent variable is known and predetermined before the research begins.

6. THE DISCRIMINANT FUNCTION AND AN EXPLANATION OF THE RESULTS

Table 1 provides comparisons of group means of the descriptive variables. It is apparent from the information that substantial differences between the subsidised and non-subsidised groups existed. Differences were observed in passenger demand, in the number of carriers operating in the community, in the weekly available seat capacity, and in the weekly departures. Similarly, there was a difference in the group means of the unit fares (i.e. $7.60 per kilometre for the subsidised group as opposed to $5.58 per kilometre for the non-subsidised group). It is possible to conclude that within a relatively competitive market environment, the EAS airports in Taiwan have benefited from the subsidy programmeme, but not sufficiently enough to maintain their economic viability. However, after the government subsidising 20% of fares on the remote areas airlines, passengers pay an average $6.08 per kilometre for the fares on remote flight routes, which is approximately 10% higher than the non-subsidised ones ($5.58 per kilometre).

The final discriminant result is a linear function as below:

$$Y = -0.0000005518\,X1 + 0.0103088916\,X2 + 0.0000005370\,X3 - 0.0000004294\,X4 - 0.9190424777\,X5 + 0.2930992152\,X6$$

X1: Population	X2: Trip Time	X3: Seats offered
X4: Passenger Throughput	X5: Competitive Pressure	X6: Unit Fare

X1: Size of Population: The number of inhabitants in the counties/cities that the non-hub airport served. **X2:** Separation: the shortest trip time (in terms of minutes) from non-hub airports to the major hub airport cities (Kaohsiung, CKS/Taipei airports) by surface transportation. **X3:** Level of Service: The weekly aircraft departures and corresponding seat capacity for 1998 were selected to represent the level of service. **X4:** Market Demand: The total passenger throughput in each non-hub domestic airport was chosen to represent passenger demand for each community. **X5:** Competitive Pressure: The numbers of airlines operated in each non-hub flight route in 1999 were selected to measure the degree of competition in providing air services to the community. **X6:** Unit Fare: Despite the fact that it was impossible to obtain data showing the number of passengers traveling on each fare class, a fare variable was developed. This was based on the lowest possible economy fare per kilometre between the community and the largest counterpart airport, as offered in the 1999. The average fare per mile was selected as an indicator to measure the subsidised airports from the non-subsidised ones. (The detailed data of the six variables for each domestic airport are as attached in Table 1.)

In the discriminant function, the Y value is very important for distinguishing the subsidised flight routes from the non-subsidised ones. In canonical discriminant analysis, the eigenvalue is as high

[19] "Multivariate Analysis", pp.161-163, Dr. J.Y. Huang, Hua-Tai Publish Company, Taipei, July 2000.

as 6.0156, the discriminant function is significant. In Table 2, the F-value (= 8.26), and the p-value (= 0.0049) both reveal that differences between the subsidised and non-subsidised group existed.

From Table 3, "Pooled within-class standardised canonical coefficients", we perceive the relative importance of the six variables on the subsidy from their coefficients' values. The coefficient of the X4 variable (passengers' throughput) is –1.519063023, indicating that the "subsidy status" is in a negative relationship with the passengers' throughput. The variable X3 (available seats offered) is in a positive relationship with the "subsidy status".

From Table 4, " The posterior probability of membership in Each Group", we discern that the CAAC and MOTC have differentiated the subsidised and non-subsidised groups very well; there is no misallocation to the subsidised or non-subsidised group. However, when the subsidised Makung flight route is repositioned to the non-subsidised group, the eigenvalue of the discrimination analysis is greatly improved from 6.0156 to 9.3991, and the F-value also increases very steeply from 8.0208 to 12.5321 as shown in Table 5.

The sign of the X6 is positive which means that the government will be more inclined to subside those areas with higher unit fares because higher unit fares indicate areas at a greater disadvantage due to lack of surgace transportation to the metropolitan areas. **However, we can see from the Canonical Discriminant Analysis Tables (Tables 2 and 5), that the Probability (Pr.) value in both tables is smaller than 0.005. This means that whether the X6 variable is included in this discriminant function or not, the discriminant function is still significant. The writer also tried to remove each of the other five independent variables from the discriminant functions, however none of them could pass the 0.005 strict significance test criterion.** We can also see Pooled Within-Class Standarized Canonical Coefficient Table(Table 3), it will have only small influence on the Y value. So we could remove it from the discriminant function and make the discriminant function again. If we delete the X6 (Unit Fare) criterion and execute the discrimination function with the independent variables X1 ~ X5, there is only one remote area misallocated to the subsidised group as shown in Table 6. The procedure reveals that Makung airport is the only remote area wrongly allocated to the subsidised if we use only five independent variables. As a result of this finding we should find reasons to explain why the Makung area should not be subsidised: ① Compared to the other subsidised areas, the passenger throughput in Makung is large, the figures, in fact, are larger than in most of the non-subsidised areas. Thus Makung is a competitive market. ②All the four domestic carriers serve Makung airport, which means this market is in a competitive situation. ③Most of the domestic airlines profit from the provision of an air service to Makung.

7. CONCLUSIONS AND SUGGESTIONS

From the previous paragraphs, it has been found that the current remote areas air transport subsidy programme groupings are, for the most part, correctly assigned, except where flight routes connecting with Makung airport are concerned. Thus, to a certain degree, this paper's hypothesis, namely, some flight routes need to be reassigned groupings, is true in the case of Taiwan.

Most research studies have looked into the subsidy policy from the economics perspective, hopefully to find the best subsidy policy. One of the most important aspects of the subsidy policy is "to distribute the right subsidy funds to the right subsidised areas". Consequently, this paper has tried to analyse the subsidised areas by means of multivariate methodology, in order to examine the current aviation authority subsidy policy in Taiwan. The ultimate purpose of this research is to employ the multivariate discriminant methodology in all the transportation subsidy programme decision-making support systems in Taiwan.

This study only conducted 48 interview surveys. If a larger scale survey among different countries and areas were undertaken, it could generate more universal criteria. Further research could be implemented on a cross-countries basis. In addition, the independent variables could be normalised by 7 scores in the discriminant function and other multivariate analysis techniques could be employed to find a regression equation among variables. For further study, different interviewees' answers could also be used to make a factor analysis and a t-test undertaken on different areas' interviewees' answers.

ACKNOWLEDGEMENTS

Thanks to Mr. Kang-Lin Chiang, Researcher at the National Taiwan Ocean University, Mr. Gordon K.C. Shang at Cardiff University U.K., and Ms. Margaret Foster who provided many valuable comment during the writing of this paper.

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Table 1. Group means of the descriptive variables for domestic airports in 1999

Variables / Airports	X1: Number of innabitants	X2: Trip time (Minutes to the nearest hub airports)	X3: Annual Available seats offered	X4: Enplanement	X5: Number of Airlines in the market	X6: Unit Fares (NT$/KM)	X7: Means of the Unit Fares for subsidised and non-subsidised airports (NT$/KM)
1.Taipei	9,597,081	40	22,752,093	13,809,154	4	5.18	
2.Kaohsiung	2,723,443	0	12,530,910	7,951,764	4	5.18	
3.Taichung	4,867,674	140	2,282,652	1,545,297	2	5.87	
4. ChaYi	1,571,709	70	1,754,217	929,134	3	5.06	
5.Tainan	1,841,258	30	4,024,322	2,256,596	3	4.94	
6.PingTung	907,376	50	248,355	147,971	2	5.17	
7.TaiTung	245,299	165	1,752,002	1,072,248	4	4.81	Non-Subsidised Airports (1~8)
8.HuaLien	353,644	210	2,595,616	1,491,849	4	8.44	@5.58 for means of (airports 1~8)
9.Makung	82,606	270	3,342,835	2,031,214	4	7.58	
10.ChiMei	3,015	390	27,510	21,076	2	8.82	
11.WanAn	3,801	300	1,517	1,116	1	8.05	
12.Matzu	6,687	480	103,397	85,662	1	5.64	
13.Kinmen	53,293	600	1,548,835	1,054,875	3	4.37	
14.LanYu	3,139	345	55,312	41,961	2	4.71	Subsidised Airports (9~15)
15.Green Is.	2,757	215	121,133	93,419	2	14	@7.60 for means of (airports 9~15)

Note :
X1 : Population (the inhabitants of counties and cities near domestic airports).
X2 : Trip time (The travelling time to the nearest hub-airport or major cities by surface transport).
X3 : Annual available airplane seats offered by all the airlines serving each of the airports).
X4 : Annual passengers throughput in each of the airports.
X5 : The number of carriers serving each of the airports.
X6 : Unit Fares(NT$/KM) (The lowest unit fares on flight routes connecting each of the airports.)

Data source: combined government and airline industry association publications.

Table 2. Canonical Discriminant Analysis (When Makung Airport is Subsidised)

Eigenvalues of INV(E)*H = CanRsq/(1-CanRsq)			
Eigenvalue	Difference	Proportion	Cumulative
6.0156	.	1.0000	1.0000

Test of H0: The canonical correlations in the current row and all that follow are zero				
Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
0.14253920	8.0208	6	8	**0.0049**

NOTE: The F statistic is exact.

Table 3. Pooled Within-Class Standardized Canonical Coefficients (When Makung Airport is Subsidised)

	CAN1	
X1	Inhabitants Numbers	-1.271321345
X2	Trip Time to Hub by Surface Transportation	1.083594503
X3	Annual Seats Available	3.094461253
X4	Enplanement (Passengers Throughput)	-1.519063023
X5	Competitive Pressure (Number of Carriers in certain Market)	-0.896030808
X6	Unit Fares (NT$/KM)	0.705419659

Table 4. Posterior Probability of Membership in each GROUP (When Makung Airport is Subsidised)

Number of Observations and Percent Classified into GROUP:			
From GROUP	Non-Subsidised	Subsidised	Total
Non-Subsidised	8 100.00	0 0.00	8 100.00
Subsidised	0 0.00	7 100.00	7 100.00
Total	8	7	15
Percent	53.33	46.67	100.00
Priors	0.5000	0.5000	

Table 5. Canonical Discriminant Analysis (If Makung Airport is Non-Subsidised)

Eigenvalues of INV(E)*H = CanRsq/(1-CanRsq)			
Eigenvalue	Difference	Proportion	Cumulative
9.3991	.	1.0000	1.0000

Test of H0: The canonical correlations in the current row and all that follow are zero				
Likelihood Ratio	Approx F	Num DF	Den DF	Pr > F
0.09616229	12.5321	6	8	**0.0011**

NOTE: The F statistic is exact.

Table 6. Posterior Probability of Membership in each GROUP (When Makung Airport is Subsidised and use X1~X5 variables as the discrimination criteria)

Number of Observations and Percent Classified into GROUP:			
From GROUP	Non-Subsidised	Subsidised	Total
Non-Subsidised	8 100.00	0 0.00	8 100.00
Subsidised	1 (Makung Airport) 14.29	6 85.71	7 100.00
Total	9	6	15
Percent	60.00	40.00	100.00
Priors	0.5000	0.5000	

Table 7. Subsidy Selection Criteria in Rank Order of Importance

Question Numbers	Subsidy Criteria	Average Scores	Rank
1	**Profitability**	**4.5**	**1**
2	**Surface transportation time to the metropolitan areas**	**4.3**	**2**
3	**Passenger throughput**	**4.3**	**3**
4	**Competitive pressure**	**4.2**	**4**
5	**Capacity offered**	**4.2**	**5**
6	Numbers of Local Habitants	4.1	6
7	Flight safety record	4.1	7
8	Adequate medical-care resources	4.0	8
9	Adequate education resources	3.9	9
10	Importance of airlines' income derived from cargo and mails freight	3.8	10
11	Average income of local habitants	3.8	11
12	Willingness to serve the route	3.5	12
13	Flight time between the domestic OD cities	3.3	13
14	Surface transportation to CKS, Kaohsiung hub airports?	3.4	14
15	Numbers of weekly flights	3.3	15
16	*Size and category of airports*	*3.2*	*16*
17	*Local habitants' ability to travel abroad*	*3.2*	*17*
18	*Ticket fares (i.e. Unit Fares)*	*3.1*	*18*
19	*Local economic viability*	*3.0*	*19*
20	*Local employment opportunities*	*3.0*	*20*

Data Source: Interview survey, January 2001.