IMPACT OF FLIGHT ACCIDENT ON PASSENGER TRAFFIC VOLUME OF THE AIRLINES IN TAIWAN

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Abstract: When a flight accident occurs, the airline must compensate the fatalities, accept financial loss resulting from damage to aircraft, and bear the negative influence of market incentives. The lower stock price and higher insurance premium are obvious, but the impact of an accident on passenger traffic is less clear. Therefore, in order to clarify the impact of accidents on airlines, this research focuses on the shift of passenger traffic following a flight accident exploring the market incentives against the flight accidents. The results reveal that the impact duration of an accident is about 2.5 months on average. Besides, this impact would cause not only the passenger traffic of involved airline to decline significantly, but also would affect the whole market.

Key Words: aviation safety, flight accident, accident impact, travel demand

1. INTRODUCTION

A flight accident often causes the deaths of a great number of people and the loss of billions of dollars, so it gives people a great concern despite the fact that an airplane is the safest mode of transportation. Safety is the key element of an airline service, but it is not easy for customers to feel completely safe. The flight accident rate is declining and tending to become stable with routes expanding and flights increasing. This indicates that if the accident rate cannot be decreased effectively, the number of accidents and fatalities will increase (Rose, 1990; Hasson, 1997; and Berendsen, 2000).

After the Airline Deregulation Act of the United States in 1978, many countries freed their air transportation market of government control. As a result, the market became more competitive. Prices decreased, flights increased, and routes expanded. The result was that many airlines experienced financial difficulties. Even the health operated airlines had deficits because of the recession of the air transportation market in the early 90s. Such a phenomenon gave rise to concerns of the public and scholars about the possible deterioration of safety performance due to the possible decrease of safety related-inputs of airlines.

Advocates of deregulation put more emphasis on the market incentives against the flight accidents. They believe that aviation safety is the key successful factor of airlines because the better the safety performance is, the more passengers there will be. Meanwhile, when there is a flight accident, the airline incurs losses because of compensation to the passengers and damage to aircraft. Since the goodwill also suffers, customers may transfer to other airlines or alternative modes of travel. As a result, the airline revenue and stock price will be greatly affected. Therefore, airlines can not disregard the improvement and enhancement of their safety performance, especially in a competitive market.

An accident to an airline is like a product defect to a manufacturer, which results in lower product demand, sales revenue and stock price. These negative impacts demonstrate the importance of market incentives on product quality. Crafton et al (1981), and Reilly and Hoffer (1983) examined the effect of product recalls on the demand for automobiles. Their research indicated that in the month after a product recall, the demand for the model type subject to recall was reduced. The demand for similar-sized models of other manufacturers was affected adversely as well. Jarrell and Peltzman (1985) showed that the recalls of defective drug products cause substantial value losses for both the recalled manufacturer and its competitors. They found that the total loss sustained due to the recalls far exceeds the estimates of direct costs of the recall.

In the airline industry, Chance and Ferris (1987), Borenstein and Zimmerman (1988), Mitchell and Maloney (1989), Bosch, Eckard and Singal (1998) examined the equity value of airlines' response to flight accidents. Each study found significant impact of accidents on the equity of involved airline. Mitchell and Maloney (1989) showed that if the accidents were proved to be the airline fault, the equity value significantly dropped by 2.2%. If not, there was a 1.2 % decline. Further, Borenstein and Zimmerman (1988) pointed out that the cost imposed by the stock market on the involved airline was less than the social cost of the accident. For other non-involved airlines, Chance and Ferris (1987) found no significant impact of accidents on them, but Bosch, Eckard and Singal (1998) indicated that the close rivals gain from a consumer-switching effect while the distant rivals lose from a general fear-of-flying effect.

Mitchell and Maloney (1989) also looked at the impact of accidents on insurance premiums and concluded that changes in insurance rates explain about 34% of the loss in equity value. Besides, Borenstein and Zimmerman (1988) examined the accident effects on airline passenger demand and indicated that the average impact of involved airlines within 4 months following the accident was 15.3% of monthly traffic in the post-deregulation period and less than 4.3% in the pre-deregulation period, but neither estimate is significantly different from zero. There was very little evidence of impact on other non-involved airlines within 2 months following the accident in both the pre- and post-deregulation periods.

Airlines are insured against most direct costs of an accident including the compensation of the fatalities and the loss of the damaged aircraft. However, they still have to bear the negative influences of market incentives such as declined equity value, higher insurance premium and switch in customer demand; moreover, the influences will probably affect other airlines as well. The declined equity value and raised insurance premium are transparent. However, the impact of an accident on passenger demand is dubious. Therefore, in order to clarify the impact of accidents on airlines and explore the market incentives after the flight accidents, this research focuses on the shift of passenger traffic following a flight accident.

2. THE ANALYSIS FRAMEWORK

There are four probable changes on the passenger traffic volume of airlines after a flight accident: 1. fewer passengers at involved airline due to the loss of goodwill; 2. more passengers at rival airlines due to the passenger shift; 3. fewer passengers at all airlines due to the fear of flying of the general public; and 4. no significant change of the number of passengers at all airlines. Factors which could contribute to these changes include:

- Accident Occurrences

The customers' sense of safety to the involved airlines or the airline market following an accident would change their travel behavior. The severer the fatalities and extent of damage of an accident, the greater the magnitude of the negative effect. Besides, the accident would distribute its effect over time, so the longer the time after the accident is, the less the magnitude of the effect would be. In addition, the involved airline would respond to the occurrence of the accident, usually, by lowering prices to attract passengers to increase the load factor.

- Airlines Attributes

The attributes of airlines are the important factors that would affect the travel behavior of the customers. There are two main aspects, service quality and route character, which must be examined carefully. Service quality refers to the type of aircraft, the arrangement of flight schedule, and the record of safety performance. The better the service quality the airline offers, the more passengers it would attract. As a result, the airline would suffer less from the impact of an accident. Route character refers to the structure of routes, the existent competitive airlines and the alternative modes of travel available. The more competitive the route is, the greater loss the airline would suffer from an accident.

- Demand Fluctuations

Travel demand varies according to weekdays, holidays, seasons and trend cycle, and thus the peak and off-peak periods of demand are formed. When the accident occurs during or just before a peak period, the traffic of involved airline would decline less than if it occurred during a regular period. In some cases, the passenger traffic even increases. However, when the accident occurs during or just before a off-peak period, the situation would be the other way round. Therefore, the fluctuations over time are crucial and must be taken into account.

For the examination of demand changes after an accident, Borenstein and Zimmerman (1988) modeled the demand as a function of price, income, time trend, and seasonal variables. The month in which an airline experiences an accident and the three following months are excluded from the estimation of these parameters. The deviation of actual demand from predicted demand in these four monthly periods is the measure of demand response to accident, and is estimated directly using dummy variables for each of the months. Consequently, the demand change was estimated for each airline separately by Zellner seemingly unrelated regressions (SUR), and the average of the accident impact is calculated from the estimated parameters of the dummy variables for the four post-crash months. However, accidents, even the most catastrophic ones, appeared to have on average a very slight effect on airline demand.

Mitchell and Maloney (1989) took issue with the conclusions of Borenstein and Zimmerman (1988), arguing that one would not expect to see changes in quantity. Rather, they assert, one would see airlines respond to a decline in demand by lowering price (the most important factor for customer demand), or by improving their service quality in terms of greater flight frequency or other criteria. Borenstein and Zimmerman (1988) thought that the prices were set exogenously by the civil aviation authority and changed infrequently under regulation, and flight frequency for an airline cannot be changed substantially in the short run because of fleet size constraint. However, demand changes, even during pre-deregulation period, were insignificant.

Importantly, there are several issues which Borenstein and Zimmerman (1988) didn take into consideration in their research. Firstly, a vector of four months was used to measure the impact on demand for each accident, but, in fact, the duration of each accident was not of the same length. Some impacts were severer or longer, and some were slighter or shorter. Further, the traffic in these four months did not indeed always decline. If the crash date were close to the end of the month, the effect of traffic decline in this month was not significant. The traffic would be greatly affected at first but then only slightly over time, thus rising to normal traffic in the second or third month following accident. Secondly, the number of the month within the sample period and 11 seasonal dummy variables were used to represent the cyclical and seasonal fluctuations of passenger demand, respectively. However, the cycle trend of demand did not progressively increase or decrease over subsequent months, and the relationship between demand and month number did not conform to the basic assumption of the regression. Besides, the significance of traffic decline in the four post-crash months was reduced because of many seasonal dummy variables.

Borenstein and Zimmerman (1988) first estimated accident impact and then explained the variation in demand response by the regression with explanatory variables which were: the number of fatalities, the size of the airline, the primary responsibility for the accident, the crash date, the recent accident records of the airline and the industry, and the extent of newspaper coverage of the crash. However, none of the explanatory variables significantly correlated with the demand effect of crashes. The primary cause may be that the estimated parameters of the dummy variables for the four post-crash months are not accurate at first. Futher, the attributes of one airline are different from those of other airlines, so it is not proper to lump all airlines together to estimate the impact on demand after an accident.

In order to examine and clarify the impact on passenger traffic of airlines after an accident, the factors discussed above should be adequately dealt with as well as, accident occurrences, airlines attributes and demand fluctuations,. Firstly, the crucial time factors to passenger demand will be eliminated for each airline, because the seasonal variation and cyclical trend of different airlines are not identical. Secondly, since the impact duration of each accident is not of the same length, the duration and the associated traffic decline following each accident will be measured according to time-adjusted passenger demand. Thirdly, the airlines will be grouped based on the types of their main operating route and the regression will be used to deeper explore the relationship among traffic changes, accident occurrences, and airlines attributes for involved airlines. Importantly, ticket price— the crucial factor dominating passenger demand— is not taken into consideration. That is because it has seldom changed in the Taiwan domestic market, even following "Entrance Relaxation" policy promulgated in 1987. Finally, in order to grasp the externality effects of accidents, the accident impact on other airlines in the market will be assessed. The analysis framework of this study is shown as in Figure 1.

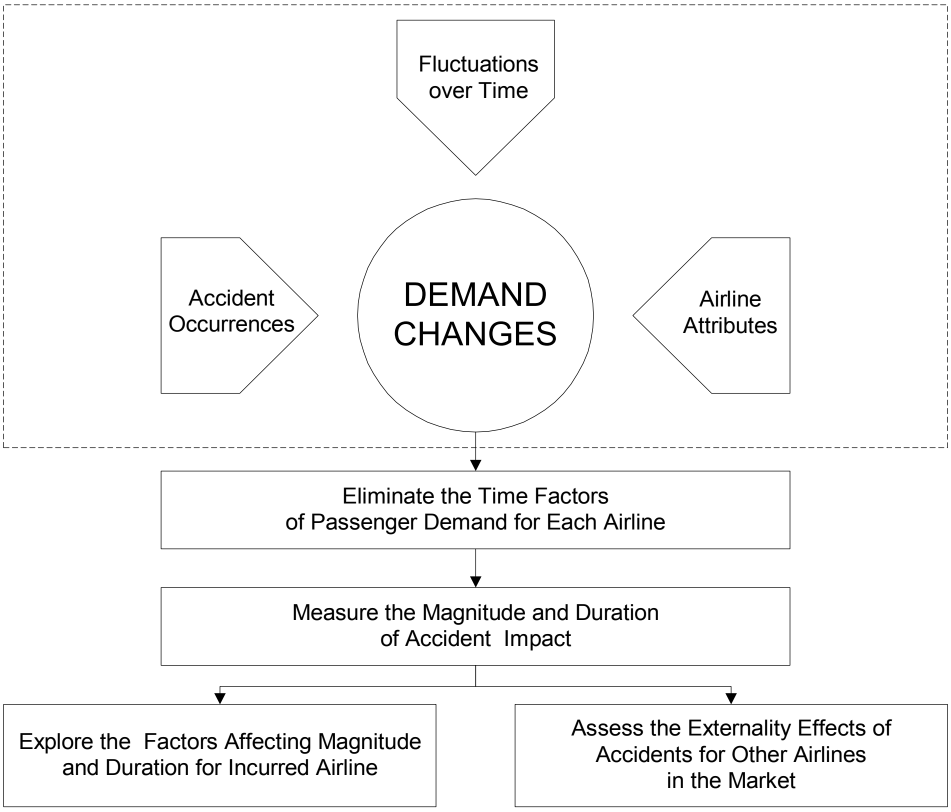

Figure 1. The Analysis Framework

3. THE DATA

The responses of the public to a flight accident are related to the extent of severity and media exposure, according to Borenstein and Zimmerman (1988), and Bosch, Eckard and Singal (1998). Considering the conditions of the information acquired and the public perceptions, samples from which the analysis is drawn are aircraft accidents aboard certificated airlines of Taiwan from 1981 to 1999. By definition of Civil Aviation Law in Taiwan, an aircraft accident means "an occurrence associated with the operation of aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which a person, either within or without the aircraft, is fatally or seriously injured or the aircraft sustains substantial damage or structural failure, is missing or completely inaccessible."

The scope of this study refers only to the domestic airline market in Taiwan, excludes the international airline market. Nine airlines— the China Airlines (CA), EVA Airways (EVA), Far Eastern Air Transport (FE), Mandarin Airlines (MA), Taiwan Airlines (TA), Transasia Airways (TAA), UNI Air (UNI), Great China Airlines (GCA) and U-Land Airlines (ULA)— are included and their most salient characteristics are shown as in Table 1. The period of data collection for airlines founded before "Entrance Relaxation" (CA, FE, MA and TA) is since January 1981. As for the rest, the data was collected from their first day of operation.

Importantly, there are two mergers that must be noted. One airline is the result of the merger of UNI, GCA and TA in July 1997, and the new airline, under the name UNI, continues to operate. In addition to operating previous routes, UNI also flies the domestic routes that EVA formerly operated. The other merger took place when CA began phasing out of the domestic business since November 1989, and handed over its remaining domestic route, Taipei-Kaohsiung, to MA in November 1999. In the meantime, MA merged with Formosa Airlines (FA) under the name, MA.

Table 1. The Background of Airlines

Carrier	Data Period	Main Operating Route	Remarks
CA	1981.01 ∣ 1999.10	Primary	1959.12 CA started operation 1989.11 CA faded out of domestic market, and operated only the Taipei- Kaohsiung route. 1999.11 MA took over the domestic business
EVA	1994.10 ∣ 1998.06	Primary	1994.10 EVA started operation 1998.06 UNI took over the domestic business
FE	1981.01 ∣ 1999.12	Primary	1957.06 FE started operation
TAA	1988.09 ∣ 1999.12	Primary	1988.09 TAA started operation
UNI	1989.01 ∣ 1999.12	Secondary	1989.01 Makung Airlines started operation 1996.01 UNI took over 1998.07 Merged with TA、GCA and EVA
GCA	1989.01 ∣ 1998.06	Secondary	1989.01GCA started operation 1998.07 Merged with UNI
TA	1981.01 ∣ 1998.06	Off-shore	1966.04 TA started operation 1998.07 Merged with UNI
MA	1981.01 ∣ 1999.12	Secondary Off-shore	1966.05 FA started operation 1999.11 MA took over domestic business of CA&FA
ULA	1996.01 ∣ 1999.12	Secondary	1995.12 ULA started operation

According to the accident record of Civil Aeronautics Administration and Aviation Safety Council in Taiwan, 26 accidents took place during the 19-year period. The details of the accidents such as crash date, involved airline, aircraft type, severity and accident record of involved airline at the time, are listed as in Table 2. Importantly, the severity is calculated by multiplying fatalities by three plus serious injuries. Therefore, ero’ means that the aircraft only sustained substantial damage or structural failure. The accident rate shown in Table 2 is the number of accidents divided by cumulative flights. During the initial period of data collection, the accident rate was biased and not representative of what the accident rate was really like. For example, if there was an accident of an airline occurring close to the beginning month of the data period, the associated accident rate of the involved airline skyrocketed. To avoid such abnormal data, the ratios of the airlines founded before 1981 have been adjusted by the lowest rate of each airline during the sample period. As to the rest, rates have been adjusted by the lowest record of domestic market.

Table 2. Accident List

Date	Carrier	Aircraft	Severity	Accident rate
1981.06.13	TA	BN-2A	6	1.38E-04
1981.08.22	FE	B-737	330	7.49E-05
1982.08.17	CA	B-747	3	2.61E-05
1983.03.31	MA	CESSNA-404	0	3.69E-05
1983.09.09	TA	BN-2A	30	4.71E-05
1984.09.28	TA	BN-2A	30	5.19E-05
1986.02.16	CA	B-737	39	1.55E-05
1987.01.06	TA	BN-2MK	0	4.00E-05
1987.04.15	TA	BN-2	0	4.77E-05
1988.01.19	TA	BN-2A	31	5.07E-05
1989.04.20	MA	BN-2A	0	1.20E-05
1989.06.27	MA	CESSNA-404	37	1.73E-05
1989.10.26	CA	B-737	162	1.26E-05
1991.12.29	CA	B-747	15	1.28E-05
1992.04.10	TA	BN-2A	24	3.67E-05
1993.02.28	MA	DO-228	18	1.39E-05
1993.10.25	FE	MD-82	9	7.43E-06
1993.11.04	CA	B-747	0	1.32E-05
1994.04.26	CA	A300	799	1.52E-05
1995.01.30	TAA	ATR-72	12	5.59E-06
1996.04.05	MA	DO-228	18	1.14E-05
1997.08.10	MA	DO-228	48	1.17E-05
1998.02.16	CA	A300	609	1.28E-05
1998.03.18	MA	SAAB-340	39	1.28E-05
1999.08.22	CA	MD-11	219	1.30E-05
1999.08.24	UNI	MD-90	30	4.04E-06

4. ELIMINATION OF THE TIME FACTORS

In order to accurately examine the impact of an accident on demand, the demand fluctuations of passenger traffic due to time factor must be eliminated. Borenstein and Zimmerman (1988) used the month number variable and 11 seasonal dummy variables to represent the cyclical and seasonal factors of demand. However, when applying these, a great number of independent variables in the model are increased and this ruins the significance of other key independent variables. This study employs X11 procedure of SAS/ETS software to adjust such time fluctuation effects in demand.

The X11 procedure, an adaptation of the U.S. Bureau of the Census X-11 Seasonal Adjustment program, can be used to seasonally adjust monthly or quarterly time series. Seasonal adjustment of a time series of passenger demand in this study is based on the assumption that seasonal fluctuations can be measured in the original demand series, OD, and separated from cyclical and irregular fluctuations. The seasonal component of a demand series, S, is defined as intra-year variation that is repeated constantly or in an evolving fashion from year to year. The trend cycle component, C, includes variation due to the long-term trend, the business cycle, and other cyclical factors. The irregular component, I, is the residual variation due to non-time fluctuation factors such as accident occurrences, airline attributes and others.

Experience indicates that many economic time series are related in a multiplicative fashion, thus the relationship among OD, S, C and I is represented in the following formula:

$$OD = S \times C \times I \qquad (1)$$

The primary concept of X11 procedure applies moving averages to the original series to provide the estimates of the cyclical and seasonal adjustment factors. It obtains an estimate of the irregular series by dividing the original series by those adjustment factors, as

$$I = \frac{OD}{S \times C} \qquad (2)$$

After the cyclical and seasonal components of the OD are removed, the irregular series of the demand (ID) can be used to detect the variation due to accident occurrences or airlines attributes and the demand changes can then be examined. It should be noted that the value in the ID refers to the ratio of the observations to the expectations without time fluctuation factors.

The ID of China Airlines is shown as in Table 3, and it shows that the traffic volume declined in the month of crash or the succeeding month. In the case of the two serious accidents in 1994 (Nagoya) and 1998 (Dayuan), the impacts on demand were significant and lasted several months. Thus, the outcome of X11 procedure is credible, and it could facilitate the observation of accident impacts on demand.

Table 3. The Irregular Demand Series of China Airlines

(%)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1981	97.46	101.30	101.72	100.96	98.21	84.35	98.07	97.35	104.31	108.50	99.41	99.51
1982	109.52	89.34	99.43	101.06	101.58	100.19	98.54	99.87	97.73	101.88	99.88	100.90
1983	100.19	99.45	99.28	100.36	100.81	98.96	98.57	103.14	99.31	100.15	99.69	98.97
1984	97.79	104.27	98.77	98.74	99.72	101.85	101.15	96.52	103.70	98.29	101.70	98.20
1985	99.02	97.19	102.12	101.53	102.89	92.44	104.03	100.23	98.19	98.46	97.83	107.34
1986	105.08	108.82	76.31	92.84	93.70	106.11	107.00	102.25	76.70	99.09	99.14	96.61
1987	114.01	97.62	99.09	104.83	101.65	103.58	96.29	97.69	96.60	100.77	107.05	101.01
1988	86.75	99.17	97.99	103.38	100.73	96.47	94.45	105.84	102.52	99.40	97.92	100.94
1989	98.97	102.27	102.08	90.00	97.72	101.23	102.14	98.58	111.08	105.48	85.58	89.70
1990	99.91	99.86	100.82	100.36	103.35	96.97	103.61	96.54	97.40	99.37	103.41	100.52
1991	102.23	96.81	99.30	100.32	101.48	100.65	95.40	102.69	104.59	85.61	96.49	100.05
1992	98.54	100.74	101.79	97.95	100.30	101.46	102.12	100.40	95.13	99.31	102.31	101.99
1993	115.08	96.00	101.29	86.72	111.66	101.68	99.48	102.79	88.84	98.29	96.87	102.17
1994	97.21	105.52	99.96	105.16	78.53	93.25	101.82	94.91	104.76	100.49	103.19	98.19
1995	100.98	99.99	96.57	102.40	97.23	100.02	103.76	99.17	99.26	103.57	97.01	98.62
1996	93.31	126.09	119.54	95.36	96.38	103.43	95.65	103.63	102.48	100.36	97.55	97.07
1997	103.96	99.85	95.93	100.78	113.00	95.91	104.44	90.25	101.53	99.69	101.56	104.18
1998	104.04	72.16	57.96	99.58	128.73	107.06	92.81	107.59	95.15	96.15	103.04	101.09
1999	99.18	98.92	102.67	102.17	96.66	98.94	102.78	100.36	97.42	98.44	.	.

(shaded): Accident Occurrence

As a result of the two mergers during the period, additional treatments are needed for the irregular series estimations of UNI and MA. For UNI, the series before the merger is estimated with the traffic series like other non-merged airlines. The series after the merger, from July 1998 to December 1999, is estimated with the 1993 to 1999 aggregate traffic series of UNI, TA, GCA and EVA. For MA, the merging period covers only two months, which is from November to December in 1999. Its irregular series is estimated with the traffic series in which the proportion of CA has been gotten rid of.

5. MEASUREMENT OF THE MAGNITUDE AND DURATION OF TRAFFIC DECLINE

Measuring the impact of flight accidents is the aim of this study. However, because the impact magnitude and duration of each accident is not the same, they should be measured individually. The value of the ID in month t is represented by ID_t, thus the traffic decline ratio in month t (TD_t) is

$$TD_t = (100 - ID_t)/100 \tag{3}$$

where $TD_t > 0$ implies that the traffic in month t is less than the normal traffic without the demand fluctuations over time.

Generally, once the flight accident happens, the passenger traffic of the involved airline usually decreases, and this can last for several months; nevertheless, the traffic in the month of crash occurrence might not immediately decline. This is because if the crash date is close to the end of the month, the effect of the accident on traffic in this month will be insignificant. Thus, the exact period in which the involved airline suffers from the accident need to be identified.

This study assumes that the beginning month of the affected period will be the month in which the crash occurs if the TD value in this month is greater than zero; otherwise, it will be the following month. Further, the ending month will be the succeeding month in which the traffic rises to the normal level ($TD_t \le 0$). Therefore, the magnitude (MAG) and duration (DUR) of the traffic decline on involved airline will be assessed by

$$MAG = \sum_{i}^{j-1} TD_t \tag{4}$$

$$DUR = j - i \tag{5}$$

where i indexes the beginning month of effect period, and j indexes the ending month.

Table 4 shows the impact magnitude and duration of each accident. It indicates that the monthly traffic of the involved airlines would on average decline by 22.11%. Compared with Borenstein and Zimmerman research (1988), this result of impact magnitude is more serious. Furthermore, the duration of negative impact on traffic is, on average, 2.54 months. The shortest duration is one month and the longest is five months.

6. EXPLORATION OF THE FACTORS AFFECTING THE MAGNITUDE AND DURATION OF AN ACCIDENT

After the demand fluctuations over time are removed and the impacts of accidents are assessed, the relationship between traffic decline and the factors of accident occurrences and airline attributes can be explored to clarify the public response following an accident. Let the severity of an accident (SE) and the accident rate of the involved airline (RA) stand for the accident occurrence factor and airline attribute factor, respectively. The MAG and DUR of the traffic decline on the involved airline attributable to SE and RA can then be estimated by

$$MAG_k = \alpha_0 + \alpha_1 SE_k + \alpha_2 RA_k + \varepsilon_k \tag{6}$$

$$DUR_k = \beta_0 + \beta_1 SE_k + \beta_2 RA_k + \varepsilon_k \tag{7}$$

where k indexes accidents. Furthermore, in order to distinguish the impact on different operating routes, the six airlines which incurred accidents are separated into two groups according to their main operating routes, which are listed in Table 1. The "In-Land" group includes CA, FE, TAA and UNI, and the "Off-Shore" group includes TA and MA.

Table 4. The Magnitude and Duration of Traffic Decline

Date	Carrier	Month					MAG	DUR
		1	2	3	4	5		
1981.06.13	TA	0.1420					0.1420	1
1981.08.22	FE		0.3561	0.3296	0.0401	0.0063	0.7322	4
1982.08.17	CA	0.0013	0.0227				0.0240	2
1983.03.31	MA	0.0071	0.0259				0.0330	2
1983.09.09	TA		0.1987	0.2097	0.0441		0.2182	3
1984.09.28	TA		0.3249				0.3249	1
1986.02.16	CA		0.2369	0.0716	0.0630		0.3715	3
1987.01.06	TA		0.0268				0.0268	1
1987.04.15	TA	0.2295	0.0867	0.0215	0.0300		0.3677	4
1988.01.19	TA	0.0093	0.0001	0.0332	0.0119	0.0424	0.0546	5
1989.04.20	MA		0.0534				0.0534	1
1989.06.27	MA		0.0497	0.0235	0.0190		0.0922	3
1989.10.26	CA		0.1442	0.1031	0.0010	0.0014	0.2496	4
1991.12.29	CA		0.0146				0.0146	1
1992.04.10	TA	0.0971	0.0050				0.1021	2
1993.02.28	MA	0.1598	0.1814	0.0708	0.0060	0.0220	0.4400	5
1993.10.25	FE		0.0292	0.0228			0.0520	2
1993.11.04	CA	0.0313					0.0313	1
1994.04.26	CA		0.2147	0.0675			0.2822	2
1995.01.30	TAA		0.0691	0.0990			0.1681	2
1996.04.05	MA	0.0755	0.0047				0.0802	2
1997.08.10	MA	0.2340	0.0330	0.0224			0.2890	3
1998.02.16	CA	0.2784	0.4204	0.0042			0.7029	3
1998.03.18	MA	0.3264	0.4187	0.0392	0.0001	0.0433	0.8277	5
1999.08.22	CA		0.0258	0.0156			0.0414	2
1999.08.24	UNI	0.0150	0.0121				0.0271	2
Average		0.0618	0.1136	0.0436	0.0083	0.0044	0.2211	2.54

Note: Month 1 is the month in which the crash occurred.

6.1 The Factors Affecting the Magnitude

The results of the magnitude impact on different groups are summarized in Table 5. For In-Land group, the parameters of SE and RA are statistically significant and the signs conform to expectations. The magnitude of the traffic impact increases as SE and RA rise. However, for Off-Shore group, the parameters are not statistically significant and the estimate of RA is of the “wrong” sign. Could it be said that the worse the accident rate is, the less the magnitude is? Actually, this group includes only TA and MA. Although their numbers of accidents are the same, the accident rate of TA is always worse than that of MA. Besides, TA operates only the off-shore routes which have no practical alternative modes available. Therefore, the sign shows that the effect of RA on MAG is negative.

Table 5. The Factors Affect the Magnitude

	All	In-Land	Off-Shore
Intercept	0.1448*	0.0112	0.1392
SE	0.0005*	0.0002*	0.0045
RA	918.36	6867.20*	-554.208
R^2	0.1925	0.6092	0.1639
adj-R^2	0.1223	0.5223	0.0119

*Significantly different from zero at the 5 percent level

Despite the fact that R^2values are not high enough, the In-Land model is much better than the Off-Shore model. This might suggest that the more rival airlines and alternative modes there are on the route, the more the competition and the accident impact will be. The average magnitude of impact on each airline is shown in Table 6. This indicates that the impact magnitude of the In-Land group is numerically greater than that of the Off-Shore group; and further, in the Off-Shore group, the magnitude of MA, which operates the secondary and off-shore routes, is greater than that of TA, which only operates the off-shore routes. However, neither conclusion is statistically significant at the 5 percent level.

Table 6. The Averages of Impact Magnitude

	In-Land Group				Off-Shore Group	
Carrier	CA	FE	TAA	UNI	MA	TA
Accident #	8	2	1	1	7	7
Average Impact	0.2147	0.3921	0.1681	0.0271	0.2594	0.1766
Group Average	0.2247				0.2180	

Note: The p-value of the test of the difference between groups is 0.9446
The p-value of the test of the difference between MA and TA is 0.5120

6.2 The Factors Affecting the Duration

The results of impact duration of different groups are summarized in Table 7. The estimated parameters of SE and RA in these models are not statistically different from zero, but the estimates of intercept are significant. This might refer to the fact that the duration of an accident for each airline or each group is similar, and the conclusion could be tested from the average duration of airlines listed in Table 8. The reason might be that the impact duration is short and the period is only 1 to 5 months; additionally, the sample size of accidents is limited.

Table 7. The Factors Affecting the Duration

	All	In-Land	Off-Shore
Intercept	2.5530*	1.7474*	2.4100*
SE	0.0006	0.0008	0.0337
RA	-253.99	25019.2	-9903.19
R^2	0.0122	0.3120	0.2247
adj-R^2	0.0001	0.1591	0.0837

* Significantly different from zero at the 5 percent level

Table 8. The Averages of Impact Duration for Airlines

	In-Land Group				Off-Shore Group	
Carrier	CA	FE	TAA	UNI	MA	TA
Accident #	8	2	1	1	7	7
Average Impact	2.25	3	2	2	3	2.43
Group Average	2.33				2.71	

Note: The p-value of the test of the difference between groups is 0.4544
The p-value of the test of the difference between MA and TA is 0.5098

7. ASSESSMENT OF THE EXTERNALITY EFFECTS OF ACCIDENTS

One flight accident affects not only the specific airline involved but also the others. The public could transfer to rival airlines by view as firm-specific fault, switch to alternative modes due to their fear of flying, or have no specific reaction, regarding accidents as occurring randomly. In order to clarify the probable impacts on other airlines, the externality effect is studied.

The process to assess the externality effects on other airlines is according to the following steps: Firstly, the impact magnitude of each accident on all airlines in the domestic market is obtained through the irregular series of passenger demand aggregated by all airlines' traffic, according to the process which was used to assess the accident impact on involved airlines in section 5. Secondly, the impact magnitude proportion of the involved airline to the whole market is calculated by the impact magnitude of each accident listed in Table 4 multiplied by the market share of the involved airline in the year which the accident occurs. Finally, the externality effects on other airlines can be obtained from the impact magnitude of each accident on all airlines minus the impact magnitude proportion of the involved airline. Importantly, crash dates of some accidents are close, even in the same month. Considering the fact that the impact of an accident is distributed over several months, the magnitude of the accidents whose impact durations overlap will be counted together. All the results are listed in Table 9.

Table 9 indicates that when a flight accident occurs, not only the involved airline is affected, but the other airlines in the market also suffer a 5.62% monthly traffic loss. For the impact magnitude of all airlines, ten of twenty-three data are not calculated from the month of crash occurrence, but the crash dates of the majority are close to the end of the month. This implies that although the rivals may gain traffic from a switching effect, the traffic they lose due to the public fear of flying is much greater than that which they gain. Generally, the total externality effect is negative in Taiwan domestic market.

8. CONCLUSION

The public reaction following a flight accident causes the traffic changes of airlines. Passengers can transfer to rival airlines, switch to alternative modes, or make no change in their travel patterns. Their reaction depends on the factors of accident occurrences, airline attributes and time fluctuations. In order to clarify the demand changes after accidents, these factors should be carefully examined. Specifically, this study applies the X11 procedure of SAS/ET software to adjust the cyclical and seasonal factors which cause the fluctuation in the demand. The result indicates that X11 procedure is creditable, and therefore it could facilitate the observation of accident impacts on demand.

The focus of this study is mainly on emphasizing the impact magnitude and duration of flight accidents on involved airlines or on the domestic market. Further, the distinction between the close and distant rivals is made according to their main operating routes. On average, accidents are associated with a 2.54 month effect and a 22.11% monthly traffic decline for the involved airline. Furthermore, the more rival airlines and alternative modes there are on the route, the more competition and impact there will be. For involved airlines, the impact of accidents is neither serious nor long, and the effect on the stock price and insurance premium are limited. The market power against the flight accidents works but does not seem enough.

However, if the potential demand switch in the long term and the huge expense for saving the damage of goodwill are included, the market power will be much stronger.

Table 9. The Magnitude of the Accident Impact on Other Airlines

Date	Carrier	(A)	(B)	(C)=(A)-(B)
1981.06.13	TA	0.0382	0.0046	0.0336
1981.08.22	FE	0.3256*	0.0947	0.2309
1982.08.17	CA	0.0152	0.0050	0.0102
1983.03.31	MA	0.0334	0.0007	0.0327
1983.09.09	TA	0.0567*	0.0048	0.0519
1984.09.28	TA	0.0410*	0.0108	0.0302
1986.02.16	CA	0.1865*	0.0408	0.1457
1987.01.06	TA	0.0418	0.0014	0.0404
1987.04.15	TA	0.0746	0.0040	0.0706
1988.01.19	TA	0.0711	0.0004	0.0707
1989.04.20	MA	0.0262	0.0063	0.0199
1989.06.27	MA	0.0598*	0.0036	0.0562
1989.10.26	CA	0.1087*	0.0151	0.0936
1991.12.29	CA	0.0164	0.0019	0.0145
1992.04.10	TA	0.0357	0.0009	0.0348
1993.02.28	MA	0.1044	0.0309	0.0735
1993.10.25 1993.11.04	FE CA	0.0495*	0.0114 0.0025	0.0356
1994.04.26	CA	0.0343*	0.0089	0.0254
1995.01.30	TAA	0.0740*	0.0215	0.0525
1996.04.05	MA	0.0585	0.0044	0.0541
1997.08.10	MA	0.1262	0.0125	0.1137
1998.02.16 1998.03.18	CA MA	0.1649*	0.0123 0.0133	0.1393
1999.08.22 1999.08.24	CA UNI	0.0347	0.0009 0.0040	0.0298
Average		0.0684	0.0122	0.0562

Note: (A)= The impact magnitude of all airlines.
(B)= The impact magnitude of the involved airline.
(C)= The impact magnitude of other airlines.
*The beginning month of the affected period is the month following that in which the crash occurred.

In addition, accidents impact not only the involved airline, but the others as well, which suffer a 5.62% monthly traffic loss. As for the rivals, although they may gain from a switching effect, they may lose some passengers as well due to the public fear of flying. Generally, the total externality effect is negative. This result is important and useful for airlines or public organizations in considering the measures against the demand decline following a flight accident. For example, all airlines should draw up a comprehensive crisis management plan against the impact of flight accident by offering fare discount or incentive programs to stimulate air traffic during the impact period. The government, to pacify the public fear of flying and reduce the negative externality effect following an accident, may proclaim the public that a flight accident is unusually occurred and the airlines' safety is under strict surveillance, so as to strengthen the public confidence in air travel. Besides, it may be to link the research to the complicated issue of compensation through the government's slot allocation policy. Actually, this disputable policy has already been implemented in Taiwan. Therefore, the way of taking the externality into policy consideration should be further elaborately studied.

In the industry, it is usual for an airline to run both domestic and international operations, or for the parent and subsidiary airlines to operate in different markets. Also, when an aircraft of a foreign airline crashes within domestic territory, such as the crash of SQ006 at CKS airport of Taiwan, the effects on both domestic and international airlines of the country would be different. Exploring the cross effects of accidents on such different markets will be interesting and worthy further study.

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