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The Effects of the Occurrence of Aviation Accidents on Air Passengers

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Abstract

This paper examines the impact of aviation accidents and incidents on the number of passengers carried by air transport. A fixed-effect panel regression model is used to analyze a dataset of 169 countries from 1970 to 2020. The study finds that aviation incidents positively and significantly affect passenger numbers. However, aviation accidents hurt the number of air passengers. In addition, fatalities in commercial and all flights hurt passenger numbers. These findings have important implications for policymakers and aviation industry professionals seeking to understand and mitigate the impact of aviation accidents and incidents on passengers, such as prompt and transparent communication, enhanced safety standards as well and compensation and support.

Keywords: Aviation Accidents, Aviation Incidents, Aviation Fatalities

Introduction

In every aviation accident, a lesson is taught, and flying is made safer. Despite better aeronautical technology and weather forecasting equipment, air accidents still occur. Although aircraft are proven to be the safest among all modes of transport, they still tend to cause significant social panic and influence consumer behavior. Based on a study conducted by Renn (1998) on the role of risk perception in risk management, he concluded that a risk that kills a few people at a time is preferred over a risk that kills many people at once. Although air crashes are rare, passengers are still more likely to avoid air travel after an accident since every crash event is nearly always catastrophic.

From a global perspective, a fatal air accident significantly impacts the passenger capacity or the number of passengers. One of the fatal accidents in recent years is China Eastern Airlines Flight 5735, which happened on March 21, 2022. The passenger capacity of civil aviation in March was 15.37 million people, based on Figure 1. The passenger capacity in April was 7.87 million people, a 7.5 million decrease after the accident

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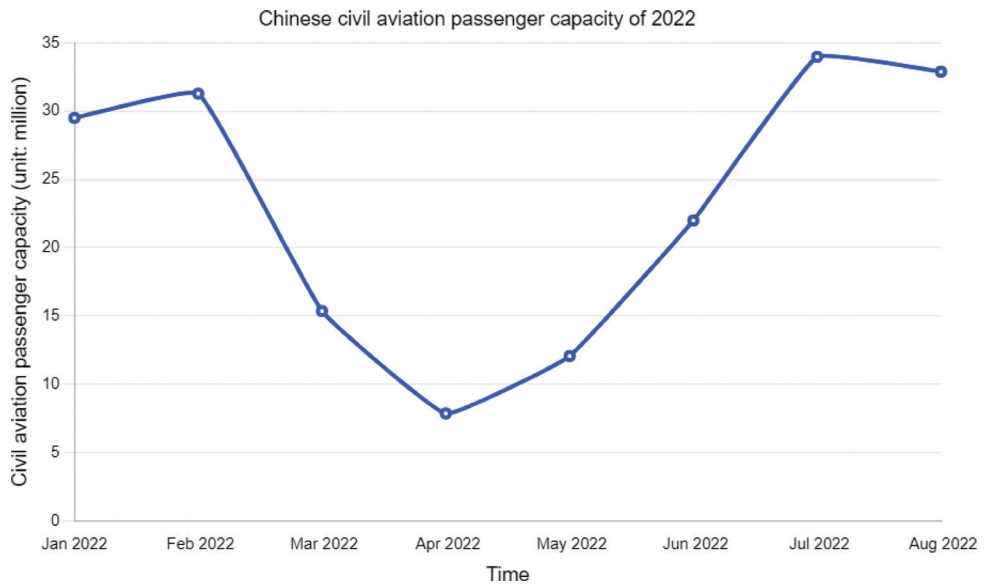

Figure 1 Chinese Civil Aviation Passenger Capacity of 2022

This study focuses on the number of air passengers in 169 countries, including countries with frequent air accidents, such as the United States, the Russian Federation, the United Kingdom, Germany, France, and China. Based on the data provided by the ASN Aviation Safety Database, since 1919, 507 aviation accidents have occurred in China, of which 128 were fatal. In the United Kingdom, 268 out of 836 accidents were fatal. In Germany, 166 out of 513 accidents were fatal. France has 197 fatal accidents out of 548. The country with the most aviation accidents was the United States, with 4,330 accidents, 1,669 of which were fatal.

An indirect relationship between aviation accidents and the number of air passengers has been indicated by previous research. Many papers found that passengers' risk perception or public perception was significantly impacted by aviation accidents (Lirn & Sheu, 2009); Fan et al., (2019); Blangé (2016); Li et al., (2015); Li et al., (2018)). These perceptions indirectly affect the travel mode choice, attitude towards an airline, or attitude towards traveling to a country. The change in consumer behavior eventually affects the number of passengers carried by air.

Based on a study conducted by İnan and Gökmen (2021) on the factors affecting air transportation passenger numbers, GDP per capita was chosen as the control variable in this research. Since people are still in a worldwide COVID-19 pandemic, and most governments have implemented travel restrictions in 2020, government COVID-19 restrictions were included as another control variable.

This research uses regression models to analyze the effects of aviation incidents and accidents on the number of passengers carried by air transport. Specifically, the fixed effect panel data regression model is used to analyze the effects of the intensive margin variables "number of aviation incidents" and "number of aviation accidents" and two control variables, "government COVID-19 restrictions" and "GDP per capita", on the number of air passengers. Furthermore, a fixed effect panel regression model is conducted to examine the impact of accidents to analyze the relationship between fatalities and air passenger numbers. The data were obtained from The World Bank, ASN Aviation Safety Database, and Our World in Data Website.

Since most news media focus on commercial flight accidents, not all general or military aviation accidents can make headlines due to limited public interest, access, and national security concerns. Therefore, this research separates the data on aviation incidents and accidents into "commercial" and "general and military aviation" categories.

Given that airline accidents cause a certain amount of social panic when there have been some casualties among passengers and that many studies have proven that airline accidents have an impact on passengers' risk perceptions, which in turn affects their behavior, it is expected that the number of air incidents, air accidents and fatalities from commercial flights will have a negative impact on the number of air passengers. No impact is expected for air incidents, air accidents, and fatalities from "general and military aviation" flights due to the lack of media exposure.

Since the study focuses on country-level data, the results will be more beneficial for the government rather than the airline companies. Based on the findings, the aviation regulations can be modified, or the government can implement more regulations to help the country's aviation industry recover from the impact of a recent air accident and restore people's faith in the aviation industry.

Literature Review

Many different pieces of research have been conducted on the impact of aviation accidents. In this part, the impact of aviation accidents on the number of air passengers will be shown with real examples. Passenger behavior and travel mode choice directly impact the number of air passengers. Previous research on how aviation accidents affect passenger behavior and their travel mode choice will also be presented, more specifically, how passenger behavior and travel mode choice are affected by aviation accidents.

Background

Fatal aviation accidents have occurred worldwide, and each time after the accident, there has always been a decrease in the number of passengers traveling by air. On July 23, 2014, TransAsia Airways Flight 222 crashed into buildings while approaching land in bad weather at Magong Airport. Among the 58 people on board, only ten survived. The number of passengers carried and the load factor in August 2014 decreased following the accident, based on the passenger number and the load factor (passenger/seat) provided by the Civil Aeronautics Administration and MOTC (Li et al., 2015) in Figure 2.

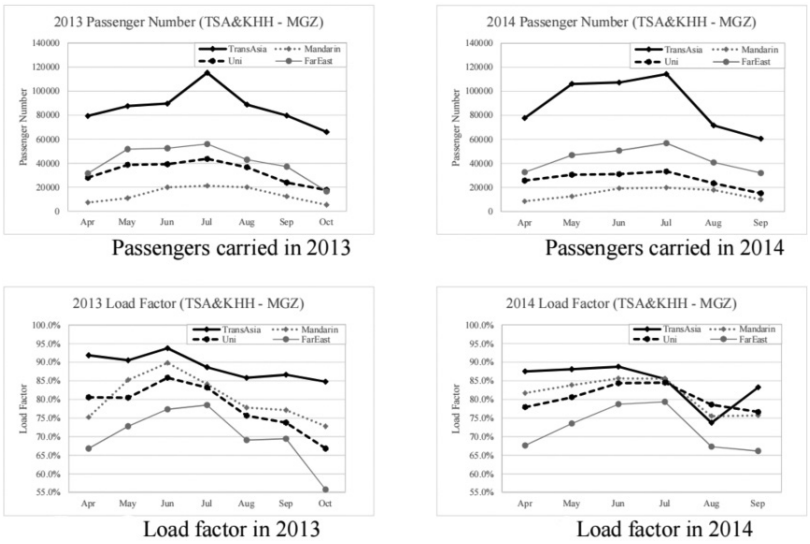

Figure 2 The Passenger Number and the Load Factor of TransAsia in 2013 and 2014

On March 8, 2014, Malaysia Airlines Flight 370 disappeared while flying from Kuala Lumpur International Airport in Malaysia to its planned destination, Beijing Capital International Airport. After the three-month disappearance of MH370, Malaysia Airlines said the dramatic impact of MH370 resulted in its worst quarterly earnings in more than two years. Passenger traffic fell sharply. The disappearance of MH370 caused high cancellations and a decline in long-haul travel. Bookings from China declined by 50-60% (most passengers on MH370 were Chinese). This can be shown by the apparent drop in the passenger load factor of Malaysian Airlines in 2014 (Figure 3).

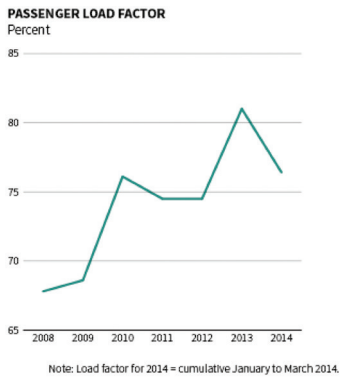

Figure 3 The Passenger Load Factor of Malaysian Airlines: 2008-2014

Previous Research

Previous research has studied the impact of aviation accidents on passenger behavior. Most researchers find that air accidents impact passenger risk perception, and the change in passenger behavior can affect the airline company and the country's tourist industry. A study led by Lirn and Sheu (2009) found that trip time, house, household income, and worry about flight safety significantly influenced passengers' preferred transportation mode choice between surface and air transport mode. Another study by Fan et al. (2019) showed that the perceived

risk of flying the airline negatively affects the attitude toward flying the airline. Furthermore, the perceived risk of flying the airline could indirectly affect the attitude toward visiting the country (Fan et al., 2019). Research conducted by Blangé (2016) showed that safety perception impacts passengers' choice of flight and willingness to pay. Two studies led by Li et al. (2015) and Li et al. (2018) showed that airline safety perception contributes largely to behavioral intention, and air accidents also strongly impact public perception. Both studies indicated that the impact of aviation accidents would decrease over time, but if another accident occurs within a short period, the impact will deteriorate again.

Related research on this subject suggests that other factors may influence the number of air passengers. A study by İnan and Gökmen (2021) found a significant relationship between air transport passenger numbers and GDP and HDI. However, the relationships between air transport passenger numbers with the total population and geographic location are only significant in some countries.

Literature Review Conclusion

The literature review revealed that most of the existing research focused on the influence of a single air accident, air accidents on a type of airplane, air accidents of an airline, or air accidents in a certain region. However, there needs to be more research on the influence of aviation accidents on air transportation for the overall countries. In particular, there needs to be more research on the effect of aviation accidents on the number of air passengers. In this study, the data on the number of incidents, accidents, and fatalities were classified into two groups based on the nature of the flight: "commercial flights" and "general and military aviation flights" (Douglas, 2021). The different effects of aviation accidents on the number of air passengers in these two flight groups were explored through regression model analysis for panel data, making this study innovative.

Methodology

A fixed effect panel regression analysis was conducted on the number of air passengers in 169 countries from 1970 to 2020 to investigate the impact of aviation incidents and accidents on air passengers.

Conceptual Framework

Figures 4 and 5 depict the frameworks of the current study based on the literature review. The framework in 3.1 illustrates the hypothesized relationships between the number of aviation incidents and accidents, government COVID restrictions, GDP per capita, and air transport passengers.

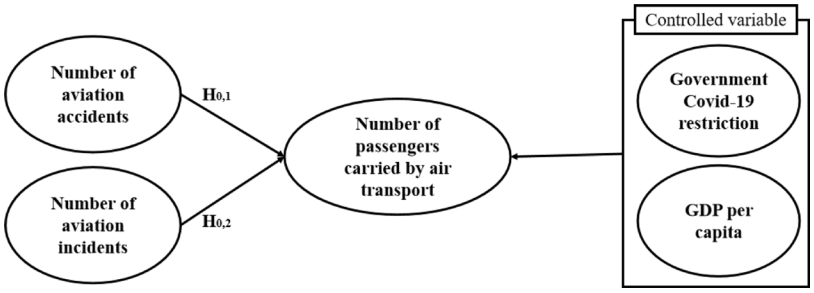

Figure 4 Conceptual Framework 1

On the other hand, the framework in 5 outlines the hypothesized relationships between the number of fatalities in air accidents, government COVID restrictions, GDP per capita, and the number of passengers carried by air transport.

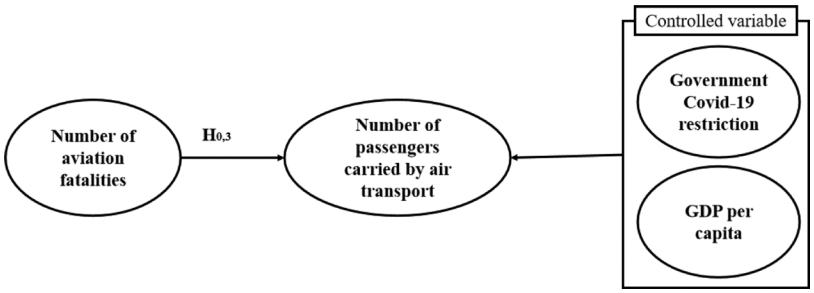

Figure 5 Conceptual Framework 2

The three main null hypotheses in frameworks 1 and 2 aim to estimate the effects of aviation accidents on the number of air passengers:

H0, 1: The number of aviation accidents does not positively influence the number of air passengers.

H0, 2: The number of aviation incidences does not positively influence the number of air passengers.

H0, 3: The number of fatalities does not positively influence the number of air passengers. These will be tested against the alternative hypotheses H1, 1; H1, 2; and H1, 3.

H1, 1: The number of aviation accidents does have a positive influence on the number of air passengers.

H1, 2: The number of aviation incidents does have a positive influence on the number of air passengers.

H1, 3: The number of fatalities does have a positive influence on the number of air passengers.

The Data

This research divided the factor of interest, "aviation incidents and accidents", into two cases. Case 1 is a frequency variable, the number of aviation accidents, where accidents are defined as occurrences in which a passenger, crew member, or person on the ground is fatally injured. Case 2 is a frequency variable, which is the number of aviation incidents, where incidents are defined as any occurrence, other than an accident, that is related to the operation of an aircraft and affects the safety of the operation. The data for both cases was provided by the ASN Aviation

Safety Database (Ranter, n.d.). The dependent variable, "Air passenger number", and the control variable, "GDP per Capita (Current US$)", were provided by The World Bank (World Bank Open Data, n.d.-a).

Since the worldwide COVID-19 pandemic has led to different travel restrictions in different countries, we believe that the last control variable, «government COVID-19 restriction», should be a dummy variable to quantify the restrictions. If the country's government implements the COVID-19 travel restriction, the value will be 1; if there is no implementation, the value will be 0. All the COVID-19 travel restrictions information will be obtained from the Our World in Data Website (Mathieu, 2020).

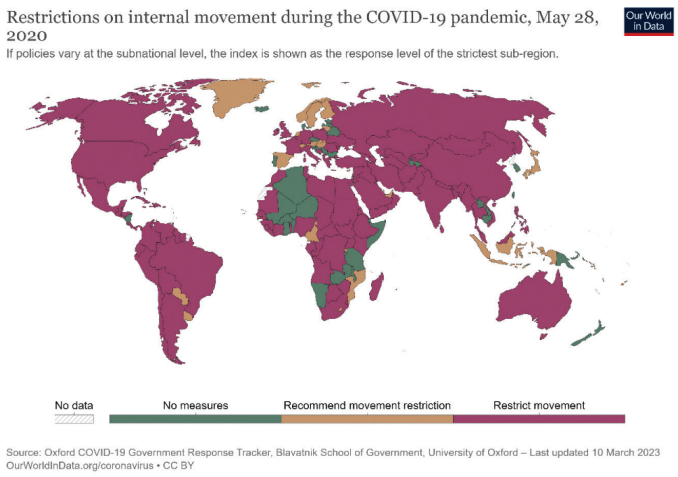

Figure 6 Restrictions on Internal Movement (May 28, 2020)

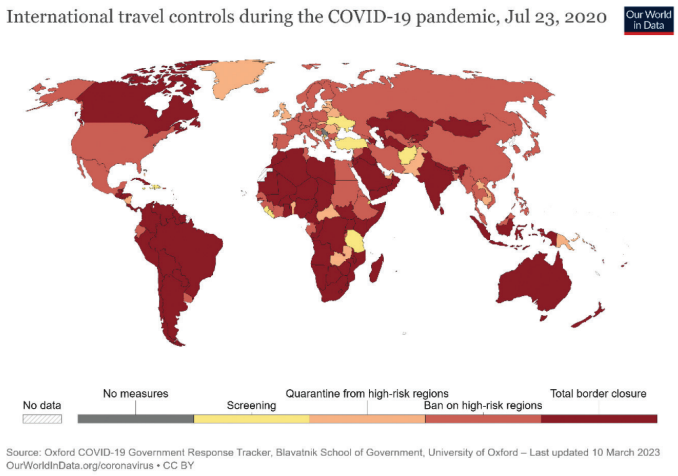

Figure 7 International Travel Controls (July 23, 2020)

All the data used in this study are annual data from the 169 selected countries from 1970 to 2020. The data on the number of incidents, accidents, and fatalities were classified into two groups based on the nature of the flight "commercial flights and general and military aviation flights" (Douglas, 2021). Commercial flights include domestic or international scheduled passenger flights, domestic or international non-scheduled passenger flights, cargo flights, private flights,

and executive and illegal flights. General and military aviation flights include military, ferry/positioning, test, training, official state, survey/research, parachuting, agricultural, demonstration, firefighting, aerial work (calibration, photo), and ambulance.

The selected 169 countries were classified into four groups based on their income level. According to The World Bank, countries with an income of $1,085 or less are considered "Low-income economies". An income level from $1,086 to $4,255 is considered in the group of "Lower-middle-income economies". When a country has an income level from $4,256 to $13,205, it is considered an "Upper-middle-income economy". When the income level reaches $13,205 or more, the countries are considered "High-income economies" (World Bank Country and Lending Groups, n.d.). These groupings are shown in the Summary statistics in Tables 1 to Table 4 below.

Table 1 Summary Statistics

Groups	Average Air Passengers	Average GDP Per capita (Current US$)
Low-Income Economies	354,551.71	556.21
Lower Middle-Income Economies	3,244,240.94	1,249.20
Upper Middle-Income Economies	9,698,986.29	3,741.45
High-Income Economies	24,278,517.82	21,271.06

Table 2 Summary Aviation Statistics (Commercial Flights)

Groups	Average Aviation Incidents	Average Aviation accidents	Average fatalities
Low-Income Economies	0.29	0.13	2.13
Lower Middle-Income Economies	0.45	0.25	6.59
Upper Middle-Income Economies	0.70	0.39	8.44
High-Income Economies	1.03	0.34	7.60

Table 3 Summary Aviation Statistics (General and Military Aviation Flights)

Groups	Average Aviation Incidents	Average Aviation Accidents	Average Fatalities
Low-Income Economies	0.08	0.09	1.50
Lower-Middle-Income economies	0.11	0.13	2.36
Upper-Middle Income Economies	0.20	0.21	1.84
High-Income Economies	0.27	0.24	1.36

Table 4 Summary Statistics (All Flights)

Groups	Average aviation incidents	Average aviation accidents	Average fatalities
Low-Income Economies	0.37	0.22	3.63
Lower-Middle-Income Economies	0.56	0.38	8.95
Upper-Middle Income Economies	0.90	0.60	10.28
High-Income Economies	1.30	0.58	8.96

The Model

The fixed effect panel data regression model used to examine or estimate the effects of the number of incidents and accidents for commercial flights data, general and military aviation flights data, and all flight data is shown below:

$$Passenger_{it} = \beta_0 + \beta_1 Incidents_{it} + \beta_2 Accidents_{it} + \gamma X_{it} + CountryFE + TimeFE + \varepsilon_{it}$$

i: country, i=1, 2, 3, …169 t: time, t=1970, 1971, 1972, …,2020

Where:

Passenger is the air passenger number in a million.

Incidents are the number of aviation incidents.

Accidents are the number of aviation accidents.

X_{it} are the control variables, which include:

1) GDP per capita in thousand for unit (country) i at time t.

2) Government COVID restriction for unit (country) i at time t.

The fixed effect panel data regression is also used to estimate the impact of the number of fatalities in air accidents for commercial flights data, general and military aviation flights data, and all flight data is shown below:

$$Passenger_{it} = \beta_0 + \beta_1 Incidents_{it} + \gamma X_{it} + CountryFE + TimeFE + \varepsilon_{it}$$

i: country, i=1, 2, 3, …169 t: time, t=1970, 1971, 1972, …,2020

Where:

Passenger is the air passenger number in a million.

Fatalities are the number of fatalities in aviation accidents.

X_{it} are the control variables, which include:

1) GDP per capita in thousand for unit (country) i at time t.

2) Government COVID restriction for the unit (country) i at time t.

Results and Discussion

In this study, a fixed effect panel regression analysis was conducted to examine the relationship between aviation incidents, aviation accidents, and fatalities with air passengers using a dataset of 169 countries over a thirty-one-year period. The fixed effects were used to control for unobserved heterogeneity across countries and time. Since the FE model already controls for the impact of COVID restrictions, the dummy variable COVID restriction' is omitted in the FE analysis.

Results of the Impact of Aviation Incidents and Accidents

Table 5 Aviation Incidents and Aviation Accidents

List	Commercial (OLS)	Commercial (FE)	General and Military Aviation (OLS)	General and Military Aviation (FE)	All (OLS)	All (FE)
Incidents	14.79*	4.35*	35.32*	7.29	12.46*	3.98*
	(3.23)	(1.83)	(14.22)	(4.66)	(2.73)	(1.43)
Accidents	1.80	-9.49*	13.34*	-12.11*	0.51	-8.63*
	(1.61)	(4.23)	(2.63)	(5.84)	(1.68)	(3.15)
GDP Per Capita (Thousand)	0.67*	0.72*	0.83*	0.75*	0.64*	0.67*
	(0.18)	(0.32)	(0.25)	(0.34)	(0.17)	(0.28)
COVID Restriction	-4.89	-	-3.39	-	-4.47	-
	(5.32)	-	(3.94)	-	(5.12)	-
Country FE	NO	YES	NO	YES	NO	YES
Time FE	NO	YES	NO	YES	NO	YES
Adjusted R Square	0.61	0.81	0.51	0.80	0.64	0.82

Dependent variable: Air passenger number (million)

Robust standard errors clustered by country in parentheses.

* Significant at 5%

The OLS results show that aviation incidents and GDP per capita significantly impact the number of air passengers for both commercial and all flights. For general and military flights, the air passenger number is affected by incidents, accidents, and GDP per capita. The FE regression results in Table 5 revealed that for both commercial and all flights, the passenger numbers were significantly affected by aviation incidents, accidents, and GDP per capita. However, for general and military aviation flights, the passenger numbers were significantly affected by only aviation accidents and GDP per capita.

For commercial flights, the coefficients from the FE regression revealed that when the number of incidents increases by 1, the number of passengers increases by 4.34 million. When the number of accidents increases by 1, the number of passengers decreases by 9.49 million, and when GDP per capita increases by one thousand US dollars, the number of passengers increases by 0.72 million.

For general and military flights, the coefficients from the FE results indicate that an increase in the number of accidents by one leads to a decrease in the number of passengers by 12.11 million. An increase in GDP per capita by one thousand US dollars increases the number of passengers by 0.75 million.

For all flights, the coefficients obtained from the FE regression show that an increase of one incident increases to 3.98 million passengers. In contrast, the coefficients for accidents suggest that when the number of accidents increases by 1, the air passenger number decreases by 8.63 million. The coefficients for GDP per capita demonstrate that an increase of one thousand US dollars in GDP per capita leads to an increase of 0.67 million passengers.

Overall, a lower passenger number over time is associated with more accidents, as indicated by the negative coefficient in Table 5. This finding is consistent with previous research on the relationship between accidents and passenger numbers. However, the positive relationship between incidents and passenger numbers is unexpected.

Discussion of the Positive Impact of Aviation Incidents on Passenger Number

The positive coefficient of aviation incidents for all three fixed effect regression results might be due to the characteristics of aviation incidents. Aviation incidents in this report refer to any events during a flight that may pose a safety risk but do not harm passengers. For example, an incident could include turbulence, a bird strike, or a minor technical issue. These incidents do not typically receive widespread media coverage and are often seen as routine aspects of air travel. However, in some cases, incidents can sometimes generate media coverage that portrays the airline's response to the incident in a positive light. Suppose the airline is seen as handling the incident competently and professionally. In that case, it can increase confidence in the airline's safety and reliability, leading to an increase in passenger numbers.

Since the actual frequency of incidents that occurred in a given year and the country were used instead of the percentage of incidents that occurred out of the total number of flights, it is also possible that the positive effect of incidents is due to the limitation of data. The data used needs to be more adequate in addressing the indigeneity problem, leading to overestimating the incident's outcome. Moreover, it is widely observed that countries with higher income levels tend to have more flights, and not only do more flights mean more passengers and a higher chance for incidents to occur.

Discussion of the More Significant Impact of Aviation Accidents from General and Military Aviation

Table 5 shows the coefficient for general and military aviation accidents as 12.11, while the coefficient for accidents from commercial flights is -9.49. It can be inferred that accidents from general and military aviation have a more significant impact on the number of air passengers. This result is unexpected since commercial flights are the preferred mode of travel for most people. However, the higher coefficient for general and military aviation accidents can be attributed to several reasons.

First, aviation accidents involving high-profile people tend to receive more media attention, which can lead to increased public fear and uncertainty about air travel as a whole. This fear can discourage potential passengers from choosing air travel, even if they plan to fly on a commercial airline. One example of a devastating aviation accident is the Smolensk air disaster that occurred on April 10, 2010. The crash involved Polish Air Force Flight 101 near the Russian city of Smolensk, resulting in the loss of all 96 individuals on board. Notably, among the victims were prominent Polish figures such as President Lech Kaczyński, former President Ryszard Kaczorowski, senior military officials, government officials, members of Parliament, religious leaders, and family members of victims of the Katyn massacre.

Second, general and military aviation accidents may lead to changes in regulations or safety procedures that affect the entire aviation industry. For example, suppose an investigation into a military aircraft crash reveals a particular engine or instrument flaw. In that case, all aircraft using that equipment may be subject to new safety measures or restrictions. This could result in delays or cancellations for commercial flights using the same equipment, reducing the number of passengers carried.

Third, general and military aviation crashes are more likely to occur at smaller airports, which may not have the same resources and infrastructure as larger commercial airports. This can lead to disruptions in airport operations, including closures of runways and terminals, flight delays, and cancellations. These disruptions can cause a ripple effect throughout the aviation system, with passengers being rerouted or forced to cancel their travel plans altogether.

Results of the Impact of Fatalities

Table 6 Fatalities in Aviation Accidents

List	Commercial (OLS)	Commercial (FE)	General and Military Aviation (OLS)	General and Military Aviation (FE)	All (OLS)	All (FE)
Fatalities	0.24* (0.05)	-0.03* (0.01)	0.78 (0.61)	-0.22 (0.20)	0.25* (0.06)	-0.04* (0.01)
GDP Per Capita (Thousand)	1.18 (0.60)	0.84 (0.45)	1.21 (0.64)	0.83 (0.44)	1.19 (0.60)	0.84 (0.45)
Country FE	NO	YES	NO	YES	NO	YES
Time FE	NO	YES	NO	YES	NO	YES
Adjusted R Square	0.14	0.78	0.11	0.79	0.15	0.79

Dependent variable: Air passenger number (million)
Robust standard errors clustered by country in parentheses.
* Significant at 5%

In Table 6, it was shown by both OLS results and FE results that the number of passengers was significantly affected by the number of fatalities, but only for commercial flights and all flights. In all three data groups, GDP per capita was found to be an insignificant variable that affects air passenger numbers.

The coefficient from the FE regression demonstrated that for commercial flights when the number of fatalities increased by one, the number of passengers decreased by 0.03 million. For all flights, the coefficient of fatalities obtained from the FE regression suggested that an increase of one in fatalities resulted in a decrease of 0.04 million air passengers.

Overall, a lower passenger number over time is associated with more fatalities in commercial and all accidents, as indicated by the negative coefficient in Table 6.

Conclusions

The study conducted a fixed-effect panel regression analysis to examine the relationship between aviation incidents, accidents, and fatalities with air passenger numbers, using a dataset of 169 countries over 31 years. The fixed effects were used to control for unobserved heterogeneity across countries and time. The results revealed that passenger numbers were significantly affected by aviation incidents, accidents, and GDP per capita for commercial and all flights. Both aviation incidents and GDP per capita have a positive impact on air passenger numbers. Aviation accidents are the only significant variable that affects passenger numbers negatively. For general and military flights, only aviation accidents and GDP per capita are significant variables that affect air passenger numbers.

The study also found that fatalities in commercial and all flights significantly affected air passenger numbers. Lower passenger number over time is associated with higher fatalities in aviation accidents.

Overall, the study found that aviation incidents and GDP per capita positively impact air passenger numbers in commercial and all flights. Meanwhile, aviation accidents have a negative impact on all three flight groups. Additionally, fatalities in commercial and all flights have a negative impact on passenger numbers.

Policy Recommendation

Since the results suggest that only aviation accidents have a negative impact on passenger numbers, the recommended policies in this section will solely benefit the government and airlines in the event of an air accident.

Prompt and Transparent Communication

Prompt and transparent communication is critical after an aviation accident. Airlines and government officials should communicate with passengers and the public as soon as possible about the accident's cause, the extent of the damage, and what measures they are taking to ensure passenger safety in the future. The communication should be honest and transparent to build trust and confidence.

Enhance Safety Standards

The airline industry and the government should work together to enhance safety standards and regulations to prevent future accidents. Airline companies should ensure that their planes are appropriately maintained and their pilots adequately trained. They should also conduct regular safety inspections and implement safety measures to ensure the safety of passengers.

Offer Compensation and Support

In an aviation accident, the airline industry and government should compensate and support the affected passengers and their families. This can include financial compensation, medical support, and emotional support. This gesture shows empathy and concern towards the victims and their families, and it can help to rebuild trust and confidence in the airline industry.

Implement Changes

After an aviation accident, the airline industry and government should evaluate their safety protocols and procedures to determine what changes must be made to prevent future accidents. These changes may include updates to safety equipment, changes in pilot training, or modifications to aircraft design. Implementing changes demonstrates a commitment to passenger safety and can help regain passengers' trust and confidence.

Acknowledgments

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