Research in Transportation Economics 43 (2013) 148–164

Contents lists available at SciVerse ScienceDirect

Research in Transportation Economics

journal homepage: www.elsevier.com/locate/retrec

Analyzing aviation safety: Problems, challenges, opportunities

Clinton V. Oster Jr.[a], John S. Strong[b,*], C. Kurt Zorn[c]

[a] School of Public and Environmental Affairs, Indiana University, 361 Redband Road, Troy, MT 59935, USA
[b] Mason School of Business, College of William and Mary, Williamsburg, VA 23187-8795, USA
[c] School of Public and Environmental Affairs, Indiana University, 1315 E. Tenth St., Bloomington, IN 47405, USA

ARTICLE INFO

Article history:
Available online 21 February 2013

JEL classification:
L93
R41

Keywords:
Aviation safety
Aviation security
Aviation terrorism

ABSTRACT

This paper reviews the economic literature relating to aviation safety; analyzes the safety record of commercial passenger aviation in the United States and abroad; examines aviation security as a growing dimension of aviation safety; and identifies emerging issues in airline safety and challenges for aviation safety research. Commercial airline safety has improved dramatically since the industry's birth over a century ago. Fatal accident rates for large scheduled jet airlines have fallen to the level where (along many dimensions) aviation is now the safest mode of commercial transportation. However, safety performance has not been evenly distributed across all segments of commercial aviation, nor among all countries and regions of the world. The finding that developing countries have much poorer safety records has been a persistent conclusion in aviation safety research and continues to be the case. Unfortunately, operations data are not available for many of the airlines that experience fatal accidents, so it is not possible to calculate reliable fatality rates for many segments of the worldwide aviation industry. Without more complete information, it will likely be difficult to make substantial improvements in the safety of these operations. Challenges to improving aviation security include: how much to focus on identifying the terrorists as opposed to identifying the tools they might use; determining how to respond to terrorist threats; and determining the public versus private roles in providing aviation security. The next generation of safety challenges now require development and understanding of new forms of data to improve safety in other segments of commercial aviation, and moving from a reactive, incident-based approach toward a more proactive, predictive and systems-based approach.

This paper reviews aviation safety performance and challenges. It begins with a brief introduction in Section 1, followed by a review of the economic literature relating to aviation safety in Section 2. Section 3 analyzes the safety record of commercial passenger aviation in the United States and abroad. Section 4 discusses aviation security as a growing dimension of aviation safety. Section 5 identifies emerging issues in airline safety, along with the challenges for aviation safety research. Section 6 provides a summary and major conclusions.

1. Introduction

Scheduled passenger airline service has become very safe.[1] With one passenger fatality per 7.1 million air travelers, 2011 was the safest year on record for commercial aviation worldwide[2] (Michaels & Pasztor, 2011). The International Air Transport Association reported that the global airline accident rate was one accident for every 1.6 million flights, a 42 percent improvement since 2000 (Hersman, 2011). The improvement in safety during flight has led to increased attention to on-ground risks in the industry – hazards that occur before take-off and after landing – as the quest for improving commercial aviation continues (Pasztor, 2011).

Improvement in safety has come from many sources over the years. Technological improvements in aircraft, avionics, and

* Corresponding author. Tel.: +1 757 221 2864 (office); fax: +1 757 221 2937.
E-mail addresses: oster@indiana.edu (C.V. Oster), John.strong@mason.wm.edu (J.S. Strong), zorn@indiana.edu (C.K. Zorn).

[1] There are a number of sources for airline safety data and analysis. From the governmental side, these include the FAA (See http://www.faa.gov/data_research/safety/ and http://www.asias.faa.gov/portal/page/portal/ASIAS_PAGES/ASIAS_HOME); the National Transportation Safety Board (http://www.ntsb.gov/); and the International Civil Aviation Organization (http://www.icao.int/Safety/Pages/default.aspx). Nongovernmental sources include the Flight Safety Foundation (www.flightsafety.org and http://aviation-safety.net/index.php), Airline Safety (http://www.airlinesafety.com/), AirSafe.com (http://www.airsafe.com/), and Ascend FlightGlobal (http://www.ascendworldwide.com/what-we-do/ascend-data/accident-and-loss-data/).

[2] In 2004, there was one fatality per 6.4 million passengers on commercial flights worldwide.

0739-8859/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.retrec.2012.12.001

engines have contributed to the betterment of the aviation safety record. Accident investigations have been aided by improved cockpit voice recorders and flight data recorders. The development and use of ground proximity warning devices on aircraft have all but eliminated a certain type of accident known as controlled flight into terrain for aircraft equipped with such devices. Aircraft engines are more reliable and fail less often. Indeed, improvements in aircraft components have resulted in fewer accidents that involve equipment failure. Pilot training has improved through the use and evolution of sophisticated flight simulators in both initial and recurrent pilot training. Pilot training has also benefitted immensely from improved understanding of human factors and the application of that understanding to training and regulations. Navigational aids and air traffic management have also improved, making flight safer. Improved weather forecasting and better understanding of weather phenomena such as downdrafts and wind shear have also helped.

Another major contributor to the improved safety record can be traced to the careful investigation of past accidents to determine what led to the accidents and what needs to be done to prevent such events from occurring again. This reactive approach to improving aviation safety has been enhanced by the thorough analyses of data from numerous accidents, which has aided in the identification of recurring patterns or risk factors that are not always apparent when individual accidents are investigated. More recently, proactive approaches to determining ways to improve safety have become increasingly popular. An example of such a proactive approach is the analysis of incident data to identify areas of increased risk that may lead to an accident.

2. Economic analysis of aviation safety

As might be expected, much of the literature on aviation safety has its roots in engineering and technology (Rodrigues & Cusick, 2012; Stolzer, Halford, & Goglia, 2008). Much of the economic analyses of airline safety in the 1980s and early 1990s focused on the potential safety effects of deregulation and liberalization, and the comparative safety performance of industry segments, especially new entrant carriers. Although the conclusions were mixed, Savage shows that safety records for new entrant airlines in the early 1990s were worse than for established carriers (Savage, 1999). In the past decade though, there has been little variation in safety among the major airlines in the developed world. Efforts to analyze comparative safety performance in the developing world have been hampered by problems of data availability and inconsistency.

2.1. Reactive versus proactive approaches to the analysis of aviation safety

Traditionally the focus of research on aviation safety has been on analyzing accidents, investigating their causes, and recommending corrective action. More recently, in addition to this reactive approach to improving aviation safety, increased emphasis has been placed on taking a proactive approach. This approach involves identifying emerging risk factors, characterizing these risks through modeling exposure and consequences, prioritizing this risk, and making recommendations with regard to necessary improvements and what factors contributed to the accident. This approach places more emphasis on organizational and systematic risk factors (GAO, 2012).

2.2. Economic (reactive) analyses of safety

While the worldwide aviation safety record has improved dramatically over time, these safety advances have not been evenly distributed across all segments of commercial aviation nor among all countries and regions of the world (Barnett, 2010; Barnett & Higgins, 1989; Barnett & Wang, 2000; Oster, Strong, & Zorn, 1992, 2010). A handful of researchers, in addition to those identified above, have tried to identify what causes these variations in accident rates among air carriers.

The effect of profitability on an airline's safety record is one area that has received a fair amount of attention, with mixed results. Research performed in 1986 by Golbe found no significant relationship between airline profitability and safety. Rose (1990) found a significant relationship between profitability and lower accident rates. Upon a closer analysis of the data, it was determined that this correlation between profitability and safety was present for medium and small airlines but was not statistically significant for larger airlines. A 1997 analysis of the Canadian airline industry by Dionne, Gagné, Gagnon, and Vanasse (1997) identified a negative relationship between profitability and safety for the smallest airlines analyzed. While on the surface this result might seem counterintuitive, the investigators discovered that those small airlines that spent more on maintenance, which would negatively impact the bottom line, experienced lower rates of accidents. A recent update to the Rose analysis found a negative relationship between financial performance and accident rates among air carriers, especially among smaller regional carriers (Raghavan & Rhoades, 2005). Specifically it was found that the negative relationship between profitability and safety existed for both major and regional airlines but was statistically significant only for the latter.

Noronha and Singal (2004) use a slightly different methodology to address the question whether an airlines' financial health has an impact on its safety record. They note that previous studies have identified a weak or non-existent relationship between financial health and safety and posit that this may be due in part to airlines enhancing their profitability in the short run by reducing investment in safety. Instead of using profitability as a measure of financial health, they use bond ratings as a proxy for financial performance. It is determined that airlines with stronger bond ratings are safer than those airlines that are financially weak. The authors emphasize that although they found a correlation between financial health and airline safety, they were unable to establish causation.

Savage (2012) employs a different approach to determining if there is a link between an airline's finances and its safety record. In theory, an airline would think about safety as a quality indicator that would reduce the competitive focus on prices. In other words, by establishing a better safety record than its competitors, an airline should be able to increase its profitability. Despite economic theory suggesting that airlines should attempt to differentiate themselves from their competitors in order to augment their bottom line, it appears they do not do this in practice, especially for airlines serving a particular market segment or geographic region. He attributes this phenomenon to the difficulty airlines have effectively communicating safety differentials and the failure of consumers to adequately internalize what information they do receive. This in turn means consumers are unwilling to pay a premium for safety enhancements they fail to perceive.

In a re-examination of the link between an airline's profitability and its safety record, Madsen (2011, p. 3) suggests that the "strikingly inconsistent results" in the existing empirical literature are due to an inflection point in the relationship between profitability and safety. His analysis "…demonstrates that safety fluctuates with profitability relative to aspirations, such that accidents and incidents are most likely to be experienced by organizations performing near their profitability targets" (Madsen, 2011, p. 23). In other words, if an airline is slightly below its profitability target, it has an incentive to increase its risk of accidents by spending less on