AVIATION DEREGULATION AND SAFETY

Theory and Evidence

By Leon N. Moses and Ian Savage*

The popular press paints a bleak picture of contemporary aviation safety in the United States. The cover stories of *Time* (12 January 1987), *Newsweek* (27 July 1987), and *Insight* (26 October 1987) are of crashes and escalating numbers of near midair collisions, with allegations of improper maintenance. In the minds of the public, these allegations are confirmed by the recent record fines for irregularities imposed on airlines with household names. The popular belief, expressed for example by Nance (1986), is that the root cause is the economic deregulation of the industry in 1978. Deregulation, it is argued, has led to competitive pressures on air carriers to reduce expenditure on safety-related items, and allowed entry into the market by inexperienced new carriers. In addition many believe that the congestion caused by the greater number of airline flights, occasioned by the substantial rise in demand since deregulation, has led to an increased probability of collision.

This paper considers the evidence to date on the validity of these contentions. However, initially we will present a theoretical framework that links economic conditions and the safety performance of firms. This framework allows inferences to be drawn more easily from the various strands of evidence.

THE THEORY

A definition of "safety"

Before we present the theory of safety provision an important semantic issue arises. Throughout the discussion we will speak of "safety" as if it were some unambiguously defined unidimensional concept. It is no such thing. Even if we were to define safety as the "probability that a trip would end in an accident", there would still be the problem that accidents vary in severity from minor damage-only incidents to major tragedies with loss of life. It is not unreasonable

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to assume, as shown in Figure 1, that the minor accidents occur with greater frequency than fatal ones. If one wishes, for purposes of simple exposition, to have a well defined scalar for safety, then a measure inversely related to the mean of the distribution in Figure 1 is, while theoretically flawed,[1] intuitively appealing.

A model of safety determination

Safety is an *economic* attribute of transport service, because it is a characteristic of service that is highly valued by consumers yet costly to provide. Thus, without wishing to trivialise the problem, we can view safety provision in the same way as the determination of other transport attributes, such as speed or service frequency. The precise relationship between consumers' willingness-to-pay for safety, the cost of provision, and the resultant equilibrium safety level will, of course, depend on the economic regime. The literature has long recognised that market structure influences the equilibrium levels of product quality (Spence, 1975; Dixit and Stiglitz, 1977; Dixit, 1979). We note that if these models are to be applicable people really must be willing to trade off less safe transport for a cheaper fare or other benefits. The simple observation that people frequently choose auto travel when statistically safer public transport is available would seem to confirm that they do.

The determination of the equilibrium level of safety is made more complex for a couple of reasons. First, unlike service attributes such as fares and frequencies, on which the consumer can obtain information relatively easily in order to choose between modes and between carriers, safety cannot easily be observed and interpreted by the consumer. The only definitive information consumers have about carriers is the reporting of crashes. These occur so rarely and with such perceived randomness across carriers that research has shown that crashes have little long-term effect on consumer choices (Borenstein and Zimmerman, 1989).[2] This perceived randomness may not be a true reflection of the degree of risk of different airlines, routes and types of aircraft. The consumer just does not know. The apparent assumption that all segments of the aviation industry are broadly equally safe leads to problems of imperfect or asymmetric information. The distortions to markets caused in such circumstances were first examined by Akerlof (1970), and a more formal statement was provided by Leland (1979). In recent years an extensive literature has developed on producers' product quality choice when there is imperfect information: for example, Shapiro (1982, 1983a, 1983b). One should not infer from this paragraph that firms will unambiguously *under*provide safety. Empirically we are unsure whether, in general, consumers under- or over-estimate the probability of airline accidents. In addition some model formulations, such as Shapiro (1982), have firms deliberately choosing higher safety levels to improve their reputations.

1 One would ideally also wish to know the variance of the distribution.

2 Borenstein and Zimmerman also investigated losses in firms' stock values after accidents and found them to average $4.5 million; this compares with the value of the (temporary) lost demand of approximately 15 per cent of one month's revenue, or about $40 million, for an average sized jet airline (see also Chance and Ferris, 1987).

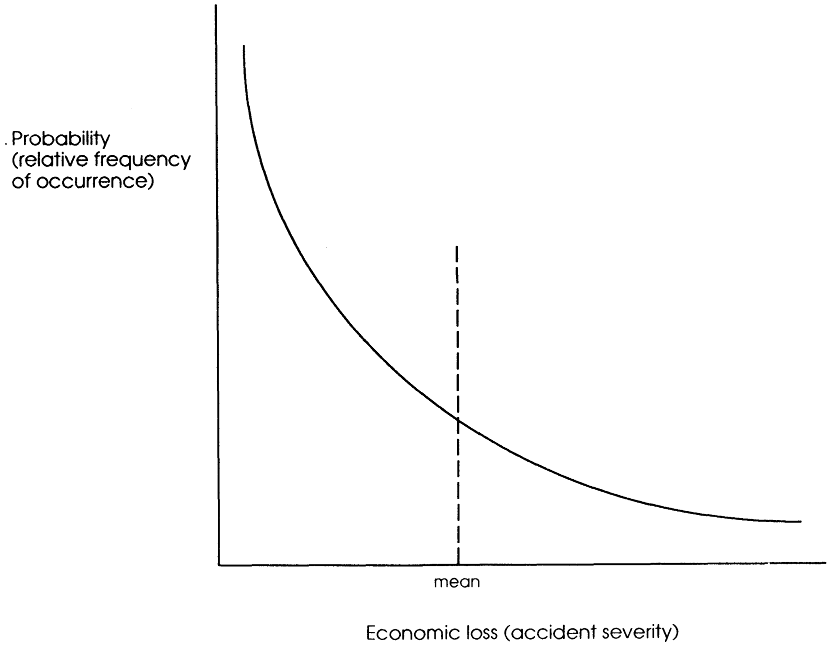

FIGURE 1

Accident Severity and Probability

A second unusual feature of safety is the externalities caused when aviation accidents affect innocent bystanders, such as people who live under aircraft flight paths. Both externalities and imperfect information have been extensively studied by writers on economics. Typically the models have airline passengers and innocent bystanders purchasing insurance or making legal claims against airlines, which can themselves purchase insurance to protect against claims. Coase (1960) and Spence (1977) are seminal works on how insurance and legal recourse can mitigate the problems of externalities and imperfect information, respectively. Therefore we include such items as insurance premiums and deductibles along with consumer willingness-to-pay, the physical costs of providing safety, and the economic regime in a variable, E, representing the economic incentives for firms to provide safety.

Unfortunately, both in theory and in practice these economic forces are not enough to ensure optimal safety provision. The setting of insurance premiums is not usually tied to the safety record of individual carriers, but rather to the performance of the industry as a whole. Additionally there are the well recognised theoretical problems of moral hazard and adverse selection. It is difficult for consumers to perceive actual safety levels, and there is imperfect signalling of consumers' safety preferences back to carriers. Thus there is the opportunity for some firms to engage in antisocial cheating and to provide unacceptably low safety levels, at least in the short run (Klein and Leffler, 1981).

In these circumstances of market failure there is a role for surveillance and oversight, typically by the government, to augment the insurance and legal mechanisms. Shavell (1984a, 1984b) and Kolstad *et al.* (1987) suggest that *ex ante* safety regulation should be deployed in conjunction with *ex post* tort liability settlements for the best possible correction of the apparent market failure. We shall denote by the letter B the system of standards, inspection strategies and penalties which we will collectively call "surveillance". One recognises that, as Becker (1968) pointed out in his seminal work, the practical design of such a surveillance system is not a trivial exercise.

Finally, unlike the safety of other goods (lawn mowers and snow blowers come to mind), safety in the aviation industry cannot be determined entirely by an interaction between producers, consumers and surveillance agencies. The industry makes use of jointly provided airports, runways and controlled airspace. Therefore the providers of these facilities, which we will call the "infrastructure", are also involved. An infrastructure that becomes poorly maintained or overcrowded may result in less safe operations. Adding the variable C to represent infrastructure, we derive the model of safety determination, where S is the resultant safety level:[3]

$$S = f(E, B, C).$$

We should recognise that the amounts of surveillance and infrastructure are themselves dependent on the economic conditions prevailing. A change in the economics of the industry leading to more firms may require more safety inspectors, and more flights may require more infrastructure. We will use the superscript * on the B and C variables to show that they are an optimal response to the economic safety incentives that influence firms in time period i. If the S variable also has a * superscript it denotes that safety is optimised, given the economic conditions.[4]

A theoretical representation of the effects of deregulation

We are now in a position to investigate the possible ways in which economic deregulation may influence the level of safety. Before deregulation (in period 1) the economic conditions E_1 prevail and the safety level is S_1. We cannot tell if the safety level is optimal, given the economic conditions, without knowing whether the levels of surveillance and infrastructure are optimally set:

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[3] S will be a vector, as different firms may adopt differential safety levels as a competitive device.

[4] The '*' on the safety level variable does not, therefore, necessarily imply that the social welfare maximising level of safety prevails. That will only occur if E, B and C reflect perfect competition.

$$S_1 = f(E_1, B_1, C_1).$$

Deregulating the industry alters the variable E. It is our contention in this paper that the levels of B and C did not change sufficiently, in the US deregulation experience, to respond optimally to the new economic conditions. We have an actual safety level after deregulation (in period 2) of S_2.

$$S_2 = f(E_2, B_2, C_2).$$

This, if B and C have not adjusted to the new economic environment, is different from our "benchmark" safety level after deregulation, denoted by S_2^*, the optimal level of safety, given the economic environment:

$$S_2^* = f(E_2, B_2^*, C_2^*).$$

A diagrammatic representation

Figure 2 is a diagrammatic representation of what we have just described. On the vertical axis is the level of safety, which can be thought of as something like the inverse of the expected economic loss per trip, and on the horizontal axis the combined expenditures on surveillance and infrastructure.

On this hypothetical diagram we have plotted S_1, the safety level before deregulation; S_2^*, the benchmark after deregulation, which here represents a greater requirement for surveillance and infrastructure; and the actual level of safety we now observe, S_2, which is lower (that is, less safe) than S_2^* because B and C have not increased enough. The relative positions of these points is, of course, speculative. Indeed, the purpose of the next part of the paper is to determine their relative positions empirically. One can but posit that, if S_2 were to be found by careful scrutiny of the available evidence to exceed S_1, the public debate would soon be over.

Investigation of "safety", measured perhaps by accident rates, over time would be based on observation of S_1 and S_2. We can see from Figure 2 that the observed change in safety is composed of two parts, which we will term type I and type II. Type II is inherently a reduction in safety resulting from governmental failure to set B and C high enough. One would hope that this is a short term phenomenon. The existence of a type II reduction is not a criticism of deregulation, but rather an indication that the government should set its own house in order. Type I is the real effect on safety of the change in aviation economics brought about by deregulation.

The observation of a type I reduction is not necessarily a bad thing. Economic theory suggests that monopolistic power produces a socially incorrect product quality. Evidence in other areas of airline travel, for example service frequency, suggests that the pre-1978 form of regulation promulgated excessive quality (Kahn, 1988). If this was the case with safety, then, if deregulation shifted the level of safety downward towards that associated with the maximisation of social welfare, that is (though it is perhaps unpleasant to say) beneficial. Looking at this in a slightly different way, suppose there were a group of consumers who preferred slightly less safe air travel but at a substantial price discount. The regulation that existed before 1978 in effect outlawed such service, and perhaps constrained the mobility of our hypothetical group of consumers. If the recent regulatory freedom allowed these consumers to be provided with a lower-quality but lower-price service, they would be better off.

It should be said that the empirical existence of a type I safety reduction is a disbenefit to other groups of consumers. However, that by itself cannot support a conclusion that regulatory reform is a failure. Safety changes are just part of the cost-benefit evaluation, and Morrison and Winston (1986) have already identified $16 billion of benefits, at current prices, arising from competitive fares and frequencies.[5]

THE EVIDENCE

Overall data

The second half of this paper considers how the evidence accords with the above theoretical description. A starting point is to look at the overall safety figures for the industry over time. In our previous terminology, we are looking at the relative positions of S_1 and S_2. The question arises how we measure safety. At the beginning of the paper we proposed a measure: namely, the expected economic loss per trip, reflecting varying severities of accidents and their associated probabilities. Unfortunately, commonly available data reflect only the most serious "accidents", those involving at least one of the following: serious injury, death, or severe structural damage to the aircraft. Data on other lapses of safety are available, but either unreliable or not easily amenable to statistical analysis. Less serious "incidents", such as a collision between an aircraft and a baggage cart, are self-reported. Comparison between operators may therefore be unreliable, because different reporting procedures have been adopted by individual carriers. There are similar concerns with data on near midair collisions. The rich database on safety-related occurrences, such as engine shutdowns in flight, reported as "service difficulty statistics" has yet to be analysed.

Suppose that the safety impacts of deregulation were to increase the number of engine shutdowns, minor incidents, and near collisions, yet not to influence the number of catastrophes. There may not be any increased loss of life, but safety has surely been denigrated. The federal safety investigating agency, the National Transportation Safety Board (NTSB), takes the view that the frequency of accidents is not by itself a complete measure of the safety performance of the industry, and is even less trustworthy as a basis for making predictions into the future (Lauber, 1988). This position has been recognised by the government, which has recently announced a lengthy research project aimed at developing a set of "leading indicators" for aviation safety.

Bearing in mind that we are only looking at the frequency of the most severe lapses of safety, we can proceed to review the accident rate statistics. The denominator for the accident rate is the number of aircraft departures; this is used

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[5] The magnitude of these savings has been questioned (see Evans, 1987), but that there have been net positive benefits appears beyond doubt.

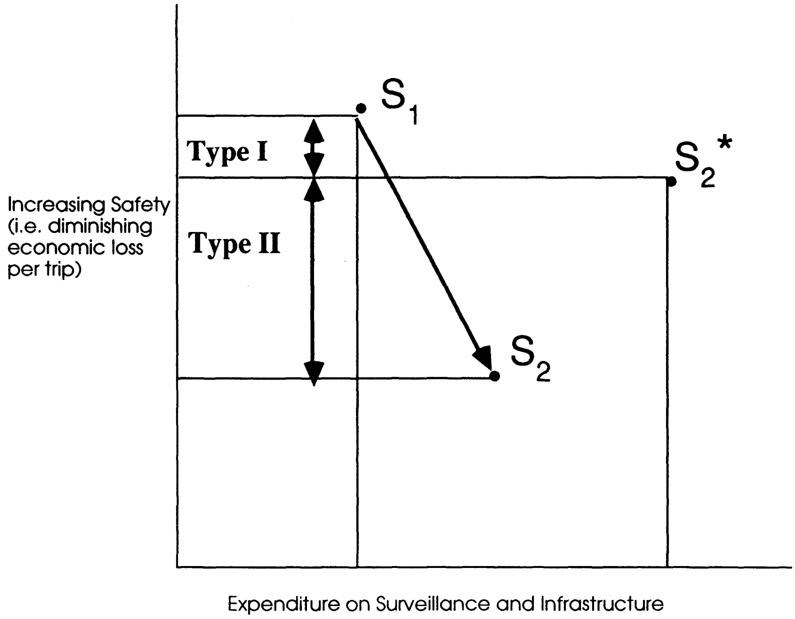

FIGURE 2

A Possible Analytical Interpretation of the Effects of Deregulation on Transport Safety

because the majority of accidents occur during the take-off and landing stages of flight. Figure 3 shows the accident rate for large jet carriers[6] since the widespread adoption of jet aircraft (NTSB, annual). The rate has fallen substantially over the past twenty years: comparison of the post-deregulation period 1979–87 with 1970–78 shows a statistically highly significant decline of 36 per cent. Rose (1989) has gone further by fitting a time trend to the data to see whether deregulation slowed down the rate of improvement in airline accident rates. Her conclusion is that, if anything, the rate of improvement has accelerated in recent years. A similar story pertains to the smaller commuter airlines.[7] The data in

[6] Airlines operating aircraft with more than 30 seats, which are covered by section 121 of the Federal Air Regulations.

[7] Airlines operating aircraft, typically turbo-props, with less than 30 seats, in accordance with section 135 of the Federal Air Regulations.

Figure 4 show a dramatic improvement over the past decade, following a major recasting and strengthening of safety rules and regulations. An exception occurred in 1987, when the accident rate was almost double the average for the preceding four years.

The conclusion that safety appears to have improved is supported by authors who have used alternative approaches. Viscusi (1989) looked at the occupational injury rates of airline workers, and Morrison and Winston (1988) looked at insurance premiums paid by the industry. Neither study was able to isolate any negative safety impacts associated with deregulation.

In stark contrast to the data on the "output" of safety (that is, accidents) is data on the inputs such as training and maintenance. The Flight Safety Foundation, an international safety organisation with no vested interest in a return to regulation, reports that the surge in demand for airline pilots occasioned by deregulation has meant that on average pilots have considerably less experience, particularly in commuter airlines and smaller jet airlines (Lederer and Enders, 1988). Numerous recent reports of the NTSB and the US General Accounting Office (GAO) make similar statements on degradation of safety inputs. In these circumstances one should not dismiss lightly evidence such as the survey of members by the pilots' union (Fingerhut, 1986) showing increasing numbers of deferred maintenance items on aircraft, more inexperienced new hires in the cockpit, and pressure on the captains of some lines to accept aircraft with inoperative systems.

Economists would not necessarily be perplexed by this apparent paradox of inputs and outputs. The latest designs of twin engine jets require much less maintenance input than earlier models. Also if one believes Kahn's (1988) hypothesis that quality was overprovided, or provided inefficiently, in the era of regulation, then an efficient market solution may entail reductions in over-large stocks of safety investments (such as maintenance bases) and in the excessive use of current safety inputs (such as mechanics). Such reductions can lead to increases in accident rates. Nevertheless, the solution achieved can represent an increase in social welfare.

Given the overall accident statistics, one might be forgiven for deciding to end the debate at this point. However, one should look a bit deeper to see if there are areas of concern which these global figures may be disguising. Our research methodology for doing so is to concentrate on the possible areas of concern identified earlier in the paper. To recap, the effect on safety, if any, of economic deregulation will occur in any of these three ways:

(1) A change in the underlying economic incentives to firms, changes in the willingness of consumers to pay for safety, and changes in the cost of safety provision;

(2) Increased opportunity for firms to act "antisocially" in providing less than desired levels of safety; this arises from inadequate surveillance; and

(3) Failure to provide infrastructure in response to changes in demand, resulting in overwhelmed capacity and increased probability of mistakes and collisions.

Note that on the next page, the graphics for Figures 3 and 4 were reversed by the printer (i.e., the graph appropriate to the title to Figure 3 is shown as the graphic in Figure 4 and vice versa).

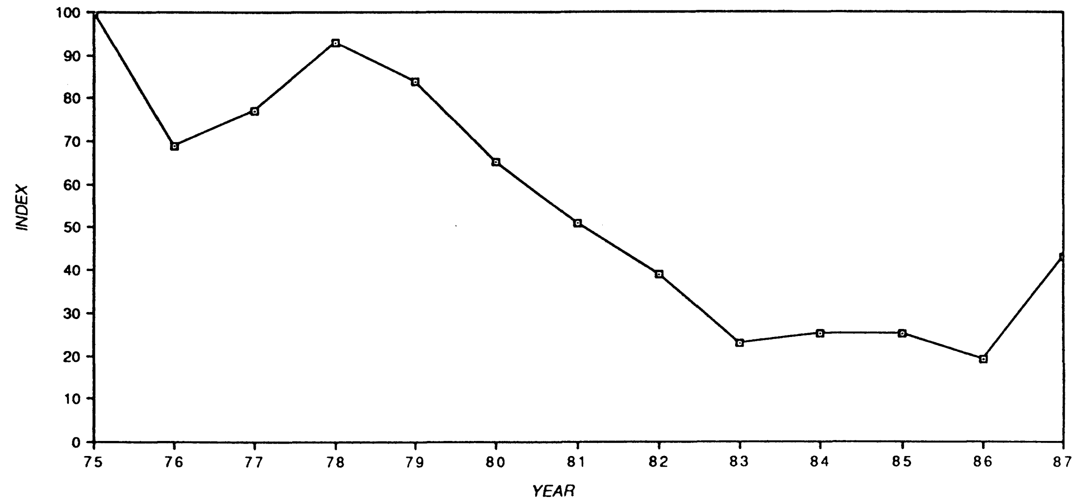

FIGURE 3

Scheduled Major Airlines
Accidents per Departure

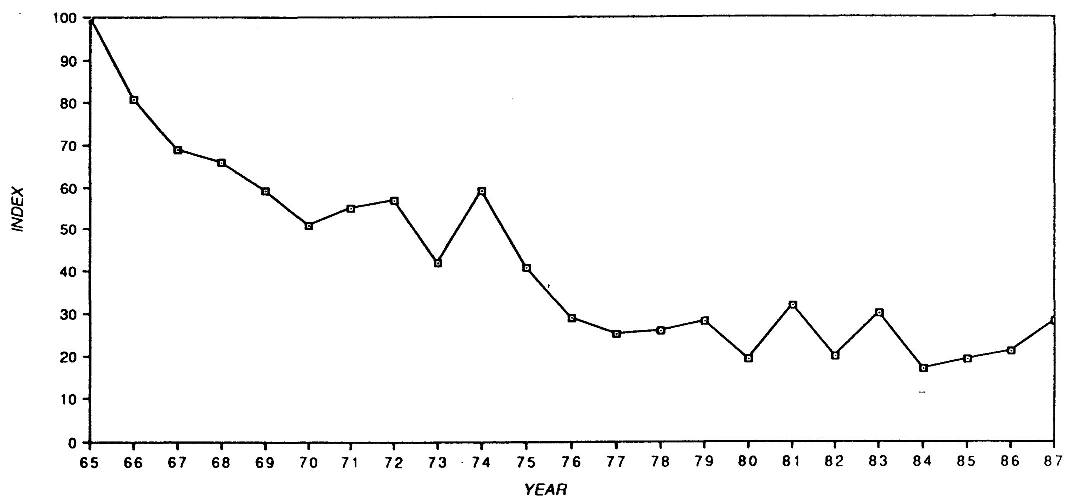

FIGURE 4

Scheduled Commuter Airlines
Accidents per Departure

The first of these is a type I safety reduction, and (2) and (3) are type IIs. We will now review the evidence to date on each of these.

Evidence of a type I safety change

A type I change will occur as a result of any of the following:

(i) a change in the consumers' willingness to pay for safety;

(ii) a change in the underlying production function of safety;

(iii) a change in the economic technology of the safety market (that is, competitive models versus monopolistic models).

On the first of these, we have no basis for supposing that consumer willingness-to-pay has altered in the past ten years. On the third, the contemporary academic knowledge of market mechanisms for safety is so rudimentary that we can gain little insight into the empirical size of any change. For these reasons we make no apology for concentrating on changes in the production function for safety, and in particular on the replacement of large jet airlines by smaller commuter carriers on some less trafficked routes as a result of the ending of compulsory cross-subsidy (Meyer and Oster, 1984).

It is a well documented fact that the safety record of smaller aircraft is inferior to that of jet aircraft. Oster and Zorn (1989) found that, on the basis of fatalities per million enplanements, passengers on commuter airlines were exposed to more than three times the risk of jet passengers. But, as Table 1 indicates, there is a good deal of variation in safety performance within the commuter airline industry. The top 20 commuter carriers, ranked by size, have a far better safety record than the rest of the industry, even though their accident record is almost twice that of jet airlines. It is this subsection of the industry that operates most of the scheduled service in secondary markets. There would appear to be *prima facie* evidence that those passengers (just under 10 per cent of total air trips) who now have to fly with commuter airlines have witnessed a type I safety reduction as a result of deregulation. Whatever losses there are need to be set against benefits to passengers from improved fares and frequencies.

Oster and Zorn (1989) have two reasons for urging caution in accepting the conclusion of a large type I reduction in safety for commuter passengers. The first is that now there is usually direct service from the smaller communities to the regional centre, whereas previously the jet aircraft made several stops on the way. Research by Oster and Zorn, based on a survey of 60 secondary city pairs where commuter airlines had replaced jets, indicates that the average number of intermediate stops has been halved. Since most accident risk occurs in the take-off and landing stages of flight, this reduces the magnitude of the type I effect. Second, some of the additional traffic on commuter routes represents a shift from auto to air, induced primarily by enhanced service levels (Meyer and Oster, 1981). Travel by air is much safer than travel on roads, especially on rural undivided highways.

McKenzie has undertaken research in the latter area. In initial work with Shughart (1986) regressions were carried out on the level of automobile travel

TABLE 1

Fatalities per Million Enplanements, 1979–85

Commuter Airlines		1.27
Top 20 largest carriers	0.67	
Carriers ranked 21–50	1.21	
Other carriers	4.08	
Large jet airlines		0.38

Sources: National Transportation Safety Board, Civil Aeronautics Board, Regional Airline Association.

at the aggregate national level, with a dummy variable to represent airline deregulation. A relationship was found, but it was not large and not statistically significant. In later work with Warner (1987), a more sophisticated model of automobile demand was fitted to the same data. The new model used data on mode prices, incomes, population, and average speed, and a dummy variable structure for the post-deregulation years. Their analysis suggests that, without deregulation, automobile usage per year would have been greater by 46 million miles, or about 4 per cent. On the basis of this reduction in miles per year, they estimate that about 1,700 lives have been saved every year by airline deregulation.

There is undoubted logic in McKenzie and Warner's basic proposition; but conclusions based solely on interpretation of dummy variables are questionable. The unprecedented oil price shocks of the mid and late 1970s may have had structural effects on the pattern of use of automobiles and drivers' behaviour. How much of McKenzie and Warner's 4 per cent decline in auto use is due to these factors is open to debate. One way round this problem is to investigate data on previous mode choice of "new" airline passengers. Without data of this sort the truth of the logically appealing "cheaper skies mean safer streets" proposition remains untested.

Evidence of a type II safety change due to inadequate surveillance

We are here looking for evidence that surveillance activities did not respond to the changes in aviation economics brought about by deregulation, and so did not constrain antisocial safety choices of carriers. Significant economic changes have been witnessed; these include the entry of many new carriers in the early years of deregulation[8], and severe financial difficulties for a number of the larger carriers. To our knowledge there is no theoretical literature to back up the intuitive observation that new entrants may have inexperienced managements and staff, and may therefore offer less safe service. Indeed, the literature might suggest the opposite. New firms without an established reputation may choose to over-provide safety in order to build one up. Conversely, there is some theoretical base for analysing safety choices of firms when profit levels change. Golbe (1981) and Bulow and Shoven (1978) demonstrate that firms close to bankruptcy might choose low safety levels because the downside risk of accidents would not be borne by stockholders if bankruptcy were declared. This ignores the fact that financially troubled airlines are usually acquired by another carrier, and accidents lower the purchase price of the firm. The ambiguity of these models is emphasised by Golbe (1986), who points out that the direction of the influence on safety of a change in profitability is theoretically indeterminate. In other words, the safety-profitability issue is an empirical and not a theoretical one.

The lack of clear-cut theoretical conclusions on these issues is reflected in the relevant empirical analyses. Kanafani and Keeler (1989) have made comparisons between established and new airline firms by looking at maintenance expenditures, the results of inspections by the Federal Aviation Aministration (FAA – the governmental agency overseeing the industry), near midair collisions and accidents. They were unable to establish that new entrants had an inferior safety record. Indeed, there was weak statistical evidence that new entrants spent relatively more on aircraft maintenance and were involved in fewer near midair collisions.

Rose (1988, 1989) has conducted statistical investigations involving data for 30 years, relating financial condition and accident experience.[9] Her work suggests that the evidence for such a relationship is very slim and confined to the smaller carriers. For the smaller jet carriers a change of 10 per cent in operating margin implied a change in accident rates of 30 per cent or more. Rose gives a warning that the precision of her estimates is quite poor, and there are aberrations in certain model forms.

Despite the seeming lack of measurable anti-social behaviour, there is reason to suspect that the level of surveillance did not respond to the changes caused by deregulation. The workload of the FAA has increased dramatically from that needed to oversee the stable and predictable industry that existed in the days of entry control. As already reported, the number of air carriers operating large aircraft rose by 150 per cent. FAA resources were needed to provide initial certification of these carriers. In addition, approximately 4000 existing operators of small aircraft had to be recertified as commuter airlines or air taxis as a result of revisions in safety regulations adopted in 1978. Moreover, since there was a high turnover rate of these types of firms, the resources the FAA required for

[8] The number of large jet airlines increased from 60 in 1978 to 148 in 1985. Since 1985 there has been considerable merger activity in the industry.

[9] This work updates and expands the analysis of Golbe (1986), who found an insignificant yet positive relationship (more profits equals more accidents) based on pre-deregulation data.

certification were even higher than the 4000 number would suggest. Certification of operators entails large expenditure of FAA time to ensure that firms have the ability, fiscal resources, and organisational structure to train crew members adequately and to programme the maintenance of aircraft effectively.

Despite the increase in workload, the decline in FAA staff numbers initiated in the early 1970s continued unchecked through January of 1984. O'Brien (1988) calculates that the net result was a fall in the number of inspectors per airline from 4 in 1978 to 1.5 in 1985. The FAA has admitted that in order to carry out certification duties "routine operations and maintenance compliance (that is, inspection and surveillance) were mostly left undone" (Kern, 1988). The year 1984 saw a reversal of the trend. The FAA conducted a number of major safety audits of the aviation industry. The audits resulted in the large fines against household-name firms mentioned in the preamble to this paper. The FAA also conducted an internal evaluation, Project SAFE, which recommended increased staffing, an evaluation procedure for safety standards, an update of the Federal Air Regulations, a unification of inspection procedures, increased data bases for inspectors, and revisions in FAA internal organisation.

The findings reported in the preceding two paragraphs would seem to be *prima facie* evidence of the *potential* for a type II safety reduction in the years before the implementation of the recommendations of Project SAFE, when surveillance activity was clearly out of line with the needs of the market. The broadly reported crash of an Air Florida Boeing 737 jet at Washington D.C. in 1982, and a series of commuter airline accidents in 1985[10], have been partly attributed, in the published official investigations, to inadequate FAA surveillance of pilot certification procedures of the carriers involved. Yet analysis of overall accident data indicates nothing untoward during these years. How close, if at all, America came to an increased accident rate due to inadequate surveillance is a question we can probably never answer.

Evidence of a type II safety change due to inadequate infrastructure

There is evidence that the infrastructure of the industry has been severely strained since deregulation. Passengers have increased by over 50 per cent and flights by 28 per cent, and flights have become concentrated at specific airports at certain times because of the adoption of hub-and-spoke operating practices. However, capacity has not increased. The last major airport to be opened was Dallas-Fort Worth in 1973, and only Denver has a new airport on the drawing board. The number of air traffic controllers is still below what it was when most controllers were fired because of illegal strike action in 1981. Air traffic control reequipment programmes are, on the evidence of the GAO, running years late. The system has in many ways been the victim of its own success.

Air space has become congested in the vicinity of major airports, with the resultant well publicised delays. To a great extent the delays actually reflect increased rather than diminished levels of safety. Aircraft are now delayed on the

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[10] Bar Harbor Airlines at Lewiston, Maine; Henson Airlines near Grottoes, Virginia; and Simmons Airlines at Alpena, Michigan (see Lauber, 1988).

ground at the point of origin when congestion is expected at the destination, rather than allowed to "circle" the destination airport. Yet it is not unreasonable to assume that the relationship between the number of aircraft movements at a given airport and the probability of collision is positive, despite the lack of literature to confirm or deny this. Indeed, the rate of near collisions in the air ("near midair collisions") and on the ground ("runway incursions") has increased in recent years, as illustrated in Table 2. It should be noted that the statstics on near midair collisions have been criticised because the voluntary self-reporting of incidents can be influenced by media coverage and industrial disputes.

A number of remedies for the increasing inadequacy of the infrastructure are in the process of being implemented. The FAA has won authority for additional air traffic controllers. Airlines have been forced to reveal to the customer, at the time of booking, the extent of expected delays to individual flights. There is a debate on providing additional runways. Technological improvements are also being adopted: to increase the capacity of existing runways (microwave landing systems); to give warning of risk of collisions by fitting detection equipment to jetliners; and to ensure that small private aircraft are adequately monitored by air traffic control (mode "c" transponders).

Pricing solutions are absent. Peak load pricing is not used, and aircraft are charged a landing fee on the basis of weight. This means that a small private aircraft pays very low fees, even though it occupies air and runway space for a comparable, if not longer, time than a jetliner. It is not that the theoretical basis for rational fees is undeveloped. On the contrary, there is a large literature. Morrison (1982) presents a model of Ramsey prices for different forms of aircraft traffic at an uncongested airport. Arnott and Stiglitz (1989) update the classic congestion pricing model of Strotz (1965) to include explicitly the safety effects of congestion. Boston's Logan Airport has proposed introducing such rational fees. Initially it was proposed that fees for small aircraft should be brought closer to those for jets. The Boston airport authority also feels that ultimately peak time pricing will have to be adopted. Unfortunately objections, including those by the politically influential Aircraft Owners and Pilots Association who represent private pilots, resulted in a ruling by an administrative law judge of the US Department of Transportation that the proposed fees were unconstitutional and illegal[11] (see the *Journal of Commerce* for 15 September and 14 November 1988).

There would appear to be *prima facie* evidence that the increase in air travel since deregulation has been imposed on an infrastructure system that is near technological capacity, becoming increasingly technologically outdated, and seriously impaired by the dismissing of air traffic controllers in 1981. Additionally, the use of the existing facilities is not allocated optimally because of an absence of cost-related pricing. Evidence on whether this has reduced safety levels is speculative; to the extent that one believes the data on near collisions it appears to have done so.

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[11] As an aside, it is a sad reflection on our profession's effectiveness in communicating the case for peak load and Ramsey pricing that Law Judge Burton S. Kolko in delivering his judgment described the proposed fees as "lacking in economic justification".

TABLE 2

Near Midair Collisions and Runway Incursions per Departure

	Near Midair Collisions per Departure (1980 = 100)	*Runway Incursions per Departure (1983 = 100)*
1980	100	n/a
1981	70	n/a
1982	56	n/a
1983	81	100
1984	91	79
1985	115	104
1986	119	486
1987	141	n/a

n/a: data not available.
Source: Federal Aviation Administration.

CONCLUDING REMARKS

The good news from the American experience is that, so far, safety performance does not appear overall to have been impaired by deregulation. By this we mean that, except for passengers who now have to fly commuter rather than jet aircraft, the extent of the type I safety reduction is not great.

Yet there is strong evidence that deregulation does pose challenges in the safety area. There is evidence that infrastructure and surveillance need to adjust in a non-negligible way to deregulation. If there had been increases in accident rates caused by inadequate oversight of airlines, or if some of the recent near midair collisions had resulted in a major catastrophe, then the Congress as well as the US Department of Transportation would have had to bear a heavy measure of blame because they adopted a set of contradictory policies.

That is, they adopted a programme of economic deregulation because it promised to bring benefits to travellers. The programme was a success: fares were held down and the amount of travel increased substantially. On the other hand, government, which has much of the responsibility for the character, quality, and capacity of the system's staffing and infrastructure, failed to increase the capacity of the system, to adopt programmes that would use the existing capacity more efficiently, to provide the FAA with sufficient inspectors, and to take other needed actions to ensure safety. Indeed, when we take the number of air traffic controllers into account, the effective maximum capacity of the system is probably smaller than it was in the past. In other words, governmental failure produced the potential for type II reductions in safety.

Why was this allowed to occur? One can but observe that governments that are ideologically in favour of deregulation often favour restraint on public expenditure. In this particular case these are clearly contradictory objectives. Support for this observation can be found in the recent campaign by the airline companies through their trade association, the Air Transport Association of America, to have the FAA removed from the aegis and budgetary control of the US Department of Transportation and made financially independent, its funds provided entirely by user fees.

The important lesson learned from the United States' experience is that changes in the environment of economic regulation that achieve their economic goals also require that there be a careful and timely re-evaluation of the role of government in overseeing safety and providing infrastructure.

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REFERENCES

Akerlof, G. A. (1970): "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism". *Quarterly Journal of Economics,* vol. 84(3), pp. 488–500.

Arnott, R. J., and J. E. Stiglitz (1989): "Congestion Pricing to Improve Air Travel Safety". In: Moses, L. N., and I. Savage: *Transportation Safety in an Age of Deregulation.* New York: Oxford University Press.

Becker, G. S. (1968): "Crime and Punishment: An Economic Approach". *Journal of Political Economy,* vol. 76(2), pp. 168–217.

Borenstein, S., and M. B. Zimmerman (1989): "Losses in Airline Demand and Value following Accidents". In: Moses, L. N., and I. Savage: *Transportation Safety in an Age of Deregulation.* New York: Oxford University Press.

Bulow, J., and J. Shoven (1978): "The Bankruptcy Decision". *Bell Journal of Economics,* vol. 9(2), pp. 437–456.

Chance, D. M., and S. P. Ferris (1987): "The Effect of Aviation Disasters on the Air Transport Industry". *Journal of Transport Economics and Policy,* vol. 21(2), pp. 151–165.

Coase, R. H. (1960): "The Problem of Social Cost". *Journal of Law and Economics,* vol. 3(2), pp. 1–44..

Dixit, A. (1979): "Quantity and Quality Competition". *Review of Economic Studies,* vol. 46(4), pp. 587–599.

Dixit, A., and J. E. Stiglitz (1977): "Monopolistic Competition and Optimum Product Diversity". *American Economic Review,* vol. 67(3), pp. 297–308.

Evans, M. K. (1987): "Has Deregulation Helped or Harmed the Transportation Sector?" *Allied Social Sciences Annual Meeting,* Chicago, Ill., December.

Fingerhut, V. (1986): "The Pilot's View of Air Safety". *Air Line Pilot,* vol. 55(10), pp. 17–22.

Golbe, D. L. (1981): "The Effects of Imminent Bankruptcy on Stockholder Risk Preferences and Behaviour". *Bell Journal of Economics,* vol. 12(1), pp. 321–328.

Golbe, D. L. (1986): "Safety and Profits in the Airline Industry". *Journal of Industrial Economics,* vol. 34(3), pp. 305–318.

Kahn, A. E. (1988): "Surprises of Airline Deregulation". *American Economic Review Papers and Proceedings,* vol. 78(2), pp. 316–322.

Kanafani, A., and T. E. Keeler (1989): "New Entrants and Safety". In: Moses, L. N., and I. Savage: *Transportation Safety in an Age of Deregulation.* New York: Oxford University Press.

Kern, J. S. (1988): "Effect of Deregulation on the Federal Aviation Administration's Inspection and Surveillance Efforts". *Proceedings of the Transportation Deregulation and Safety Conference.* Evanston, Ill.: Northwestern University Transportation Center.

Klein, B., and K. E. Leffler (1981): "The Role of Market Forces in Assuring Contractual Performance". *Journal of Political Economy,* vol. 89(4), pp. 615–641.

Kolstad, C. D., G. V. Johnson and T. S. Ulen (1987): *Ex post Liability for Harm vs. ex ante Safety Regulation: Substitutes or Complements?* Working paper 4. College of Commerce and Business Administration, University of Illinois at Urbana-Champaign.

Lauber, J. K. (1988): "Assessing the Impacts of Deregulation: The Benchmarks of Airline Safety". *Proceedings of the Transportation Deregulation and Safety Conference.* Evanston, Ill.: Northwestern University Transportation Center.

Lederer, J. F., and J. H. Enders (1988): "Aviation Safety: The Global Conditions and Prospects". *Proceedings of the Transportation Deregulation and Safety Conference.* Evanston, Ill.: Northwestern University Transportation Center.

Leland, H. E. (1979): "Quacks, Lemons and Licensing: A Theory of Minimum Quality Standards". *Journal of Political Economy,* vol. 86(6), pp. 1328–1346.

McKenzie, R. B., and W. F. Shughart III (1986): *Has Deregulation of Air Travel Affected Air Safety?* Working paper 101. Center for the Study of American Business, Washington University, St. Louis, Missouri.

McKenzie, R. B., and J. T. Warner (1987): *The Impact of Airline Deregulation on Highway Safety.* Working paper (unnumbered). Center for the Study of American Business, Washington University, St. Louis, Missouri.

Meyer, J. R., and C. V. Oster Jr., eds. (1981): *Airline Deregulation: The Early Experience.* Boston, Mass.: Auburn House.

Meyer, J. R., and C. V. Oster, Jr. (1984): *Deregulation and the New Airline Entrepreneurs.* Cambridge, Mass.: The MIT Press.

Morrison, S. A. (1982): "The Structure of Landing Fees at Uncongested Airports: An Application of Ramsey Pricing". *Journal of Transport Economics and Policy,* vol. 16(2), pp. 151–159.

Morrison, S. A., and C. Winston (1986): *The Economic Effects of Airline Deregulation.* Washington, D.C.: Brookings Institution.

Morrison, S. A., and C. Winston (1988): "Air Safety, Deregulation, and Public Policy". *The Brookings Review,* vol. 6(1), pp. 10–15.

Nance, J. J. (1986): *Blind Trust.* New York: William Morrow.

National Transportation Safety Board (annual): *Annual Report.* Washington, D.C.: U.S. Government Printing Office.

O'Brien, J. E. (1988): "Deregulation and Safety: An Airline Pilot's View". *Proceedings of the Transportation Deregulation and Safety Conference.* Evanston, Ill.: Northwestern University Transportation Center.

Oster, C. V. Jr., and C. K. Zorn (1989): "Is it still Safe to Fly?" In: Moses, L. N., and I. Savage: *Transportation Safety in an Age of Deregulation.* New York: Oxford University Press.

Rose, N. L. (1988): *Profitability and Product Quality: Economic Determinants of Airline Performance.* Working Paper 2032–88, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, Mass.

Rose, N. L. (1989): "Financial Influences on Airline Safety". In: Moses, L. N., and I. Savage: *Transportation Safety in an Age of Deregulation.* New York: Oxford University Press.

Shapiro, C. (1982): "Consumer Information, Product Quality, and Seller Reputation". *Bell Journal of Economics,* vol. 13(1), pp. 20–35.

Shapiro, C. (1983a): "Optimal Pricing of Experience Goods". *Bell Journal of Economics,* vol. 14(2), pp. 497–508.

Shapiro, C. (1983b): "Premiums for High Quality Products as Returns to Reputation". *Quarterly Journal of Economics,* vol. 98(4), pp. 659–680.

Shavell, S. (1984a): "Liability for Harm versus Regulation of Safety". *Journal of Legal Studies,* vol. 13(2), pp. 357–374.

Shavell, S. (1984b): "A model of the Optimal Use of Liability and Safety Regulation". *Rand Journal of Economics,* vol. 15(2), pp. 271–280.

Spence, A. M. (1975): "Monopoly, Quality and Regulation". *Bell Journal of Economics,* vol. 6(2), pp. 417–429.

Spence, A. M. (1977): "Consumer Misperceptions, Product Failure and Producer Liability". *Review of Economic Studies,* vol. 44(3), pp. 561–572.

Strotz, R. (1965): "Urban Transportation Parables". In: Margolis, J.: *The Public Economy of Urban Communities.* Baltimore, Md.: Johns Hopkins University Press.

Viscusi, W. K. (1989): "The Effect of Transportation Deregulation on Worker Safety". In: Moses, L. N., and I. Savage: *Transportation Safety in an Age of Deregulation.* New York: Oxford University Press.