Deregulation and Safety: Experiences from the United States

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This paper initially describes the theoretical intuition as to the possible linkages between economic regulatory reform and transportation safety. It then empirically assesses the strength of these possible linkages based on the experience of the United States. The United States provides a useful case study in that economic liberalization occurred more than a generation ago in the late 1970s. Consequently, one can take a more long term view given the passage of time. The primary focus is on the railroad industry, but the paper also discusses the experiences in trucking and commercial aviation.

Why Deregulation Might Effect Safety

Why might one expect that deregulation would change safety? Economic models explain that a firm's choice of safety is not made in isolation. A profit-maximizing firm has to simultaneously choose product price, product safety, and other quality attributes of its product. Market changes that affect one of these variables will usually have a knock-on effect on all of the other variables. Deregulation was expected to have a major influence on the price and quality of transportation services. Consequently, it would not be surprising if safety was also affected.

For example, if regulation had limited the supply of low-quality services, then there would be a proliferation of such services after deregulation and a consequent decline in average safety. There was a school of thought that the airlines had over provided quality during the period of regulation when they were constrained from competing on price. Instead, they competed by providing high service frequencies, new equipment, and in-flight frills. After deregulation, average load factors increased and in-flight amenities declined. It would not have been surprising if this decline in quality, either implicitly or explicitly, extended to safety.

Regulation of the trucking industry was marked by restrictions on entry. Moreover, a large proportion of trucking firms had unionized labor. The labor economics literature recognizes that unionization tends to increase workplace safety. Unions represent the infra-marginal worker rather than the tastes of the marginal worker who determines safety in a competitive marketplace. Infra-marginal workers tend to be older and have a lower tolerance for risk. To the extent that safety in the workplace is related to the safety of the final product, one

might expect trucking deregulation to lead to the entry of non-union firms, and a consequent diminishing of average safety.

Safety, unlike price, is difficult for consumers to observe. Customers have to form opinions regarding the safety performance of the firms that they use. Firms build up a reputation for providing a certain quality of service. In trucking, aviation and the railroads, regulation limited entry and ensured the continuance of existing firms. These firms had ongoing relationships with their customers and had incentives to consider the effect on their reputation if they shaded on safety. The same is not true in a deregulated environment. Industrial organization economists describe how it is profitable for some firms to "cheat" by posing as high-quality firms and charging a premium price, whereas in reality they are low-quality firms. By the time the consumers become aware of the deception the firms have earned a profit, and can exit the industry before there is a consumer backlash. These types of firms do not worry about their long term reputation. The emergence of such "fly-by-night" firms was feared in both the trucking and airline industries.

Deregulation lowers the barriers to entry, and in all modes it was feared that some of the new entrants would offer lower levels of safety than the market desires. Some firms would be motivated by avarice, as described in the previous paragraph, but others would suffer from pure inexperience. Safety has the characteristic that the costs, in the form of equipment and training, are incurred up front, yet the "benefits" in the form of a reduced number of crashes occur in a probabilistic fashion over the course of many years. Many new entrants may be very aware of the costs of providing safety, yet are genuinely unaware of the financial implications of crashes. To the extent that their customers cannot observe, at least in the short run, the true level of safety on offer, these firms may provide unjustifiably low safety in their initial period of operation.

Deregulation was expected to shake up the existing market structure, and remove poorly-managed firms. There is a theoretical literature that indicates that firms close to bankruptcy may also be motivated to cheat their customers by reducing safety. These firms can reduce expenses by cutting maintenance and training, yet can declare bankruptcy to protect against claims in the event that a major crash occurs.

All in all, every indication was that deregulation would be expected to reduce safety, especially in trucking and aviation. The symptoms were expected to be entry of firms who deliberately and openly provide low safety service, "fly-by-night" cheaters, inexperienced new entrants, and financial distress among some existing firms who are unable to adapt to the new market realities.

Structure and History of the United States Railroad Industry

Did these fears prove to be correct? Before we present the evidence from the United States, it is important to present some factual information on the nature of the United States railroad industry, and the forces that led to regulatory reform. In both of these regards, the situation is very different from that in Europe. Understanding the differences will aid an understanding as to whether the United States experience may carry over to Europe.

In terms of structure, the railroad industry in the United States is very different from that in Europe. With a few exceptions, some of which are discussed below, the industry has always been in the private sector. The industry primarily serves freight customers with the exception of long-distance passenger trains in the Northeast, and commuter operations around the largest cities. The freight business is growing in terms of ton miles, and represents about 40% of domestic intercity freight ton miles. Almost half of the railroads' traffic is coal. All of the railroads are vertically integrated. While it is common for one railroad to have negotiated "trackage rights" to operate trains over the lines of neighboring companies, there is no legal requirement to provide "open access" to competitive train operators. Albeit that Congress occasionally makes threatening noises that it might mandate "open access" as a result of mergers reducing competitive service.

The origins of the regulatory reform movement for United States railroads are also quite different from those in Europe. The railroads had been regulated since the *1887 Interstate Commerce Act*. Railroads were required to publish a list of prices (known as a "tariff"), and could not make private agreements with individual shippers to carry traffic at a discounted rate or offer volume discounts or kickbacks. Railroads could not collude in setting prices. Also, railroads were required to serve any shippers who demanded transportation at the published price (known as the "common carrier" obligation). This effectively prevented railroads by exercising discrimination by refusing service to some customers. The Interstate Commerce Commission (ICC) was set up to determine if prices were "just and reasonable." The implication was that standard prices were developed for each commodity, often as a rate per mile, which were applied to all movements of that commodity and to all shippers. In addition it became standard practice that the ICC had to be consulted and approval obtained before any prices could change.

The effect was that railroads could not negotiate individually with shippers to compete against the new modes of transportation that developed in the early twentieth century: pipelines, trucks and the revitalized river barges. ICC regulation forced railroads to continue to provide service on many rural branch lines even though most of the traffic had disappeared to rival modes years before. The rise of the automobile and the jet-age airline industry led to a decline in passenger service. The private railroad companies reduced the amount of passenger service, but they were often restrained from eliminating them entirely by the need to obtain regulatory approval from the ICC.

The inability to price competitively coupled with the constraints on abandoning loss making services and lines led to financial problems. As a result there were many bankruptcies of middle-sized railroads such as the Rock Island and the Milwaukee Road. Mergers took place to keep some other railroads financially viable. A crisis developed by the late 1960s when the Penn Central Railroad, which had been formed from the merger of the Pennsylvania Railroad and the New York Central Railroad, declared bankruptcy. This railroad represented a fifth of the industry and was the dominant railroad in the Northeast of the United States with a service area bounded by Boston, Washington, D.C., St Louis and Chicago.

The financial crisis was the primary motivation for regulatory reform. The first piece of legislation, the *1970 Rail Passenger Service Act* formed the publicly-owned National Railroad Passenger Corporation ("Amtrak") to take over almost all of the remaining long-distance

passenger services. Amtrak continues to receive significant government subsidies and has survived many attempts over the years to remove its funding from the federal budget. Outside of the Northeast Corridor (Boston-New York-Washington) and a few other routes, such as Los Angeles-San Diego, most observers believe that it is difficult to justify Amtrak service even on a social rather than a commercial basis. At about the same time, commuter rail services started to receive public subsidies, and responsibility for their planning moved to regional transportation authorities. Albeit, in many cases the railroads still provide the actual service under contract.

The second piece of legislation was in direct response to the bankruptcy of the Penn Central. The *1973 Regional Rail Reorganization Act* nationalized the Penn Central system to form the publicly-owned Consolidated Rail Corporation ("Conrail"). Conrail was initially heavily loss making, but started to turn a profit in 1981. In 1987 the government returned Conrail to the private sector by offering its shares to the public and raising $1.65 billion in the process. In 1999, Norfolk Southern and CSX paid $115 a share (compared with the 1987 price of $28 a share) to purchase and subdivide Conrail. This indicates the turnaround in the fortunes of the railroad industry that occurred following the deregulation of the industry later in the 1970s.

The first moves to liberalize regulations occurred with the *1976 Railroad Revitalization and Regulatory Reform Act ("the 4R Act")* which allowed the ICC to exempt some commodities from regulation, and made the abandonment of uneconomic branch lines easier. In 1980 the *Staggers Act* strengthened the "4R Act" in exempting more commodities from regulation and loosening price regulation. Private contracts between railroads and shippers were permitted. The Act encouraged the shedding of loss-making secondary and branch lines to newly-formed small companies. The ICC retained powers to review prices for commodities such as coal where rail is the dominant form of transportation. (While the ICC was disbanded on December 31, 1995, powers concerning approval of abandonment or mergers, and review of bulk shipment rate cases were transferred to a newly-formed agency, the Surface Transportation Board, within the Department of Transportation.)

The industry has flourished since deregulation. It has been able to start renewing its infrastructure, which had been suffering from neglect for many years. Costs have been reduced, and many secondary and branch lines have been sold off to short-line and regional railroads. Pricing freedom has allowed the railroads to enter into contracts with major shippers that led to increased traffic. Prices have fallen. The trend toward mergers, evident since the 1960s, has continued. Currently there are only seven major railroads in North America compared with more than 40 in 1980. It is speculated that the industry is rapidly approaching a point where only two or three major railroads may exist. This has caused government concern and has raised the specter of revived regulation. In 2000-01, the Surface Transportation Board imposed a temporary moratorium on any new merger proposals due to concerns about concentration in the industry and poorly executed recent mergers

Railroad Safety

Unlike in Europe where there has been popular concern that deregulation has caused safety problems, in the United States the safety problems were *before* deregulation. Starting in the mid-1960s, the industry reversed its previous longstanding trend of safety improvements. The causes are not difficult to understand. The financial difficulties described above led to railroads disinvesting in their track and capital stock. The situation was made worse because new and heavier freight cars were being introduced. This led to a sharp rise in derailments that were caused by broken rails. These derailments become more of a public concern because of the expanded carriage of hazardous materials. While the railroads had always carried explosives and munitions, they now carried flammable liquids, pressurized liquefied gases, and corrosive liquids. In 1969 there were a series of accidents where tank cars ruptured with disastrous consequences for people who lived next to the railroad.

There was consequently agitation for some government intervention, not least from the labor unions whose members' jobs were under threat as railroads attempted to improve their financial situation. The result was the *1970 Federal Railroad Safety Act* which gave the Federal Railroad Administration (FRA) rulemaking authority to "promote safety in all areas of railroad operations." The FRA's first order of business was to set up a committee to decide on recommended track standards. Six categories of track were established each with a maximum allowable speed. Detailed engineering specifications were written to define each category of track. The FRA was given powers to hire track inspectors to enforce these standards, and assess penalties for noncompliance.

The FRA then dealt with defective rolling stock by taking the existing industry rules on interchange of freight cars and writing those parts dealing with safety-related equipment into federal law. The regulations deal with defining defects in wheels, axles, bearings, trucks, bodywork, couplers and cushioning. Again, the FRA hired inspectors to randomly inspect cars, write citations and assess penalties. Subsequently, rules were also introduced on various aspects of diesel locomotive design, and the frequency with which certain components should be inspected. The *1988 Rail Safety Improvement Act* introduced qualification requirements for railroad engineers. Previously qualifications had been decided by collective bargaining between railroads and unions.

The problem of fatalities at highway grade crossing, which in 1970 were four times as numerous as they are now, was addressed by the *Highway Safety Acts* of 1973 and 1976, and the *Surface Transportation Acts* of 1978 and 1982. These Acts authorized ninety-percent federal funding to states for public grade-crossing improvements such as the installation of flashing lights and gates. This is commonly referred to as the *Section 130* program. Previously the railroads had a common law duty to install gates and lights, but did not have the financial resources to do so in an era when the amount of highway traffic was increasing rapidly. While the federal government has a substantial funding role, decisions on which crossings to improve and what types of warning devices to install are left with individual state highway authorities. The government and the railroads instituted a public information effort under the *Operation Lifesaver* banner to educate the public on the dangers of highway-rail crossings.

Trends in railroad fatality rates since 1960 are shown in figure 1 for the three major types of fatalities. Employee fatalities are expressed relative to employee hours, trespassers relative to the United States' population, and crossing fatalities relative to the number of motor vehicles registered. All of the casualty rates are shown as an index with the value in 1960 set equal to 100. The casualty rate for crossings has recorded the most impressive improvement, falling rapidly since 1967. The risk is now less than a tenth of what it was in 1960. The trespasser rates also stated to decline rapidly after 1967 but leveled out in 1975 at about 40% below the fatality rate in 1960. If anything, there may be a slight upward trend in recent years. Contrary to the popular view that trespasser victims are small children or people innocently taking a shortcut across the tracks, the reality is that most are single adult males who have consumed substantial amounts of alcohol and are using the right-of-way as a place to socialize.

The employee casualty rates show a different picture. After many decades of improvement, the rates started to increase in the 1960s, only resuming the previous downward trend in 1973. Figures on the rate of collisions and derailments are more difficult to analyze because the definition of property-damage-only crashes was not adjusted for inflation prior to 1975. However, every indication is that these also increased significantly in the 1960s and early 1970s, and only started to decline after 1978. As shown in Figure 2 the improvement in safety since the mid-1970s has been dramatic. The fatality rate for employees, repeated from Figure 1, is now only half of what it was in 1973, and the rate of collisions and derailments is only a quarter of what it was in the peak year of 1978. In part, the improvement can be explained by a change in the way that railroads handle traffic. Starting in the late 1970s, traffic has been increasingly handled in unit trains and there is much less switching of cars. The proportion of train miles that are represented by yard and switching miles has fallen by more than half, from 30% in the mid-1970s to close to 11% percent today. As 70% of collisions and 60% of derailments occur in yards and sidings, it is not surprising that the rate of collisions and derailments has fallen. Albeit that the improvement is greater than that explained solely by the reduction in the amount of switching.

The causes of the improvement are open to some controversy. Figure 3 shows a time-series analysis of the rate of collisions and derailments due to track defects and of variables that might affect this rate. These data series are shown in the form of an index with the value in 1975 set equal to 100. The accident rate per track mile increased by two-thirds between 1975 and 1978 and then began to decline and is now only a quarter of the level in the peak year. As explained earlier some of the reduction in track-caused collisions and derailments can be explained by the reducing in switching. Given that the decline in railroad finances in the 1960s is credited with causing the increase in track-related accidents, it is logical that the improvement in railroad finances may have led to the solution to the problem. Capital expenditures per mile of track, in constant 2001 dollars for the largest ("class I") railroads, are shown as the line with the stars. With the deregulation of the industry, capital expenditures increased considerably starting in 1982. Clearly, this was the proximate cause of the decline in track-caused accidents in the 1980s. But what caused this increase in expenditures? The railroads argued that the increased track expenditures were due to their improved financial health subsequent to deregulation. The safety regulators, on the other hand, argued in a hearing in the House of Representatives in 1995 that the "railroads simply had the money [after deregulation] to respond more effectively to FRA's promptings." This latter argument has some statistical merits in that the index of miles

inspected per track mile, shown as the line with the squares, started to increase dramatically in the period after 1978, which is the same time that the accident rate started to fall. From the early 1980s until the mid-1990s, track capital expenditures and government inspections tracked each other closely, making any econometric untangling of their relative contribution to the decline in accident rates difficult.

Experiences in Other Modes

Trucking

The trucking industry has also seen a substantial improvement in safety in the years since interstate deregulation with the *1980 Motor Carrier Act*. As shown in figure 4, the rate of fatal crashes involving large trucks, those with a gross vehicle weight greater than 10,000 lbs. (4,536 kg), has declined substantially. The number of fatal crashes has remained fairly constant, while truck miles have doubled. Much of the improvement has occurred because the roads in general are safer. Improved automotive technology, better occupant protection, better emergency medical response and changing attitudes to the use of seat belts and drunk-driving have contributed to safer highways. This can be seen in the dotted line in figure 4 which shows the fatal crash rate for all types of vehicles. As can be seen, there is evidence that the fatal crash rate for large trucks has declined at a faster rate than the average for all vehicles on the road.

This outcome was not expected at the time of deregulation, when there was a great fear that safety would diminish. There was considerable new entry, especially involving small firms with poorer than average safety records (Corsi and Fanara, 1989). Many middle-sized firms suffered from severe price competition and had to exit the market. The government responded by introducing explicit safety regulations and enhanced enforcement in the *1982 Surface Transportation Assistance Act*, the *1984 Motor Carrier Safety Act*, and the *1986 Commercial Motor Vehicle Safety Act*. These Acts tightened vehicle standards, and introduced a coordinated national Commercial Drivers License. The new license requirements imposed uniform testing across states, and prevented drivers from holding multiple licenses as a way of avoiding the consequences of revocation in one jurisdiction. Many states had to raise driver-testing standards considerably. In addition, federal funding allowed increased enforcement through safety audits of carriers and semi-random inspections at the roadside. Enforcement was further enhanced by the *1999 Motor Carrier Safety Improvement Act* which increased funding and established a separate administration for motor carrier safety within the federal Department of Transportation.

Commercial Aviation

The fatal accident rates per million aircraft departures for commercial aviation since 1950 are shown in figure 5. The annual rate is shown as the symbols with a five-year moving average plotted as the solid lines. The graph differentiates between mainline carriers, regulated under Part 121 of the federal regulations (shown as the squares), and commuter airlines regulated under Part 135 (shown as the diamonds). The risks of flying a mainline airline have declined by more than 90% in the past fifty years. At first glance, there would seem to be evidence that the rate of improvement in the 1960s and early 1970s did not continue after the *1978 Airline Deregulation Act*. One might argue that the past quarter century has not witnessed the same technological

breakthroughs as occurred in the previous quarter century when air traffic control was deployed and second generation jets displaced turboprop aircraft.

Prior to 1997, Part 135 regulations applied to airlines that operated aircraft with thirty or fewer seats. This segment of the industry is, to some extent, a child of deregulation. After deregulation, the mainline airlines moved away from point-to-point service to hub-and-spoke operating strategies. Operations on some of the more lightly-used spokes were provided by "commuter airlines" operating smaller aircraft. Over time demand on these routes expanded rapidly. This led to the deployment of larger and safer aircraft, with the dramatic technology-driven safety improvement seen in figure 5. Piston-engine aircraft with less than twenty seats were replaced with larger turboprop aircraft, which were subsequently superseded by 50-seat or larger "regional jets." In 1997, most of this segment of the industry was brought under the same safety regulations as the mainline jet carriers. This has produced the discontinuity in the Part 135 data series after 1997. Part 135 now only applies to firms that provide service using aircraft with fewer than 10 seats. Nowadays these operations represent less than half of one percent of commercial aircraft miles, and are generally confined to the most remote and challenging parts of the country.

A deeper analysis of whether deregulation has slowed the downward trend in accident rates for mainline carriers is provided in figure 6. In this figure the symbols represent five-year moving average fatal accident rates for midpoint years 1960 through 2002. The five-year average has been used to smooth out year-to-year variations. A logarithmic time trend is fitted to the pre-deregulation data for 1960 through 1978, and is shown as the smooth solid curve. This trend is extrapolated forward beyond deregulation as the dashed line. As one can see the actual post-deregulation fatal accident rates, indicated by the squares, continued to follow the decline from the previous decades with the exception of a period around 1989 and 1990.

Despite the implication from figure 6 that deregulation has not altered the long-term safety trends, some critics have identified safety problems associated with deregulation. In the mid-1980s, there was concern that competitive pressures had led some airlines to cut safety expenditures, with the finger being pointed at some long-established airlines that had to file for bankruptcy. Academic research, based primarily on *pre*-deregulation data, indicated that there was a positive relationship between financial performance and safety performance for medium and smaller sized carriers (Rose, 1990). The problem with this hypothesis is that, excluding 1985, the early 1980s was also the safest period (in terms of passenger fatalities) in the history of aviation. There was also concern that new entrant carriers might be less safe than those already in the industry. Research concluded that the entrants of the early period of deregulation had similar safety records to established firms (Kanafani and Keeler, 1989). However, the same was not true for the entrants in the early to mid-1990s. The closure of the rapidly-expanding ValuJet in 1996, following a crash near Miami, garnered much publicity. This was due to revelations of significant operating and maintenance problems.

Some Concluding Observations

Are there some lessons that can be learned from the United States experience that can be useful for policymakers in Europe? I have eight observations drawn from my years of studying transportation safety.

The first observation is that economists have a hard time in defining "how safe is safe enough?" This is particularly the case in industries where different groups of consumers desire differing levels of safety. The shipper of delicate goods may desire safer transportation than a shipper of durable bulk materials. As a result, it should be recognized that it is not necessarily clear whether pre-deregulation level(s) of safety may have been optimal. In the event that regulation deliberately excluded provision of low-quality service that is valued by some consumers, then witnessing a decline in safety after deregulation may not necessarily be a bad thing!

The second observation is that the fears of some commentators that deregulation would produce inexperienced new entrants and "fly by night" carriers has generally been justified. The same is true for the fears that some incumbent firms will suffer financial distress and may exit the market, and in doing so provide low quality service in their last months of operation. All of these consequences of deregulation have posed safety challenges in almost all modes.

The third observation is deregulation may produce mode shift effects whose safety consequences may be larger than safety effects within a mode. Boyer (1989) investigated whether deregulation of both modes had led to the transfer of some types of freight from railroads to the less-safe truck mode. He found that at least 30 extra annual deaths, and perhaps as many as 230 extra deaths, were caused by this shift. Bylow and Savage (1991) estimated that for each year between 1978 and 1988 between 200 and 300 road deaths were averted due to the deregulation of the airlines, which had encouraged people to fly rather than drive. The magnitude of these effects is huge compared with the safety effects within the mode.

The fourth observation is that after deregulation, explicit safety regulations have had to replace previously implicit ones. This is certainly true in the trucking industry where previously entry controls served to control safety. The early 1980s were marked by a series of Acts which formalized safety regulations. The same was true in the preceding decade for the railroads.

Fifthly, there is evidence in all three modes that the amount of safety monitoring and enforcement by government had to be enhanced. In part this is caused by the increase in the number of firms after deregulation. In addition there have been challenges in all modes from entry of inexperienced firms, bankruptcy of established firms, and a constant turnover of firms that has taxed the government inspectorate and led to an increase in the inspection budgets.

Sixthly, the changing role of the government safety regulator has led to a discussion of the most effective and efficient enforcement strategies. How likely is the probability that an unsatisfactory firm will be detected? How large should the penalties for noncompliance be? Should the safety regulations be set in terms of "specification standards" for equipment and staff, or in terms of "performance standards" based on the number of crashes and other incidents?

These are not trivial questions and the safety regulators in all modes have struggled with them in the years since deregulation.

Seventh, if deregulation is successful then demand should increase. If the quantity of the infrastructure does not increase, then there will be an increase in congestion. Certainly, traffic in major truck routes increased, and airports and airways became very congested. There was ongoing concern that the increased congestion would lead to more crashes. In aviation, critics pointed to an escalation in the number of near misses in the air and runway incursions on the ground. This points to the need to ensure that infrastructure provision keeps pace with any post-deregulation growth.

The final observation is that stepped up oversight can prevent a decline in safety, despite the very real safety problems that deregulation might cause. In all three modes, crash rates have fallen by half in the years since deregulation.

Selected Further Reading (* = available from or linked to at my website)

General

Moses, Leon N. & Ian Savage (eds.) (1989). *Transportation Safety in an Age of Deregulation*. New York: Oxford University Press. *Papers by many authors from a 1987 conference on whether economic deregulation had reduced safety in commercial aviation and trucking.*

* Savage, Ian (1999a). The economics of commercial transportation safety. In Gómez-Ibáñez, José A., William B. Tye and Clifford Winston (eds.) *Essays in Transportation Economics and Policy: A Handbook in Honor of John R. Meyer*. Washington D.C.: Brookings Institution. *Includes an updated review of the deregulation and safety experience in aviation, trucking and railroads.*

* Savage, Ian (forthcoming). Trends in transportation employee injuries since economic deregulation. In People, James, and Wayne Talley (eds.) *Research in Transportation Economics: Transportation Labor Issues and Regulatory Reform*. Amsterdam: Elsevier Science. *Looks at trends in employee injuries in aviation, trucking and railroads before and after deregulation.*

Railroads

Savage, Ian (1998). *The Economics of Railroad Safety*. Boston: Kluwer Academic Publishers. *Book dealing with all aspects of railroad safety. A summary of the conclusions is found in:*

* Savage, Ian (1999). Railroad safety and public policy. *Journal of the Transportation Research Forum*, vol. 38(1), pp. 56-63.

Trucking

* Moses, Leon N. & Ian Savage (1997). A cost-benefit analysis of United States motor carrier safety programs. *Journal of Transport Economics and Policy,* vol. 31(1), pp. 51-67. *Benefit-cost analysis of safety compliance programs that were introduced after deregulation.*

Commercial Aviation

* Savage, Ian (1999b). Aviation deregulation and safety in the United States: evidence after twenty years. In Gaudry, Marc and Robert Mayes (eds.) *Taking Stock of Air Liberalization*. Boston: Kluwer Academic Publishers. *Updates findings from the 1987 conference.*

Bylow, Lance F. & Ian Savage (1991). The effect of airline deregulation on automobile fatalities. *Accident Analysis and Prevention,* vol. 23(5), pp.443-452.

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Corsi, Thomas M, and Philip Fanara (1989). Effects of new entrants on motor carrier safety. In Leon N. Moses and Ian Savage (eds.) *Transportation Safety in an Age of Deregulation,* New York: Oxford University Press.

Kanafani, Adib, and Theodore E. Keeler (1989). New entrants and safety. In Leon N. Moses and Ian Savage (eds.) *Transportation Safety in an Age of Deregulation,* New York: Oxford University Press.

Rose, Nancy L. (1990). Profitability and product quality: economic determinants of airline safety performance. *Journal of Political Economy,* vol. 98(5), pp. 944-964.

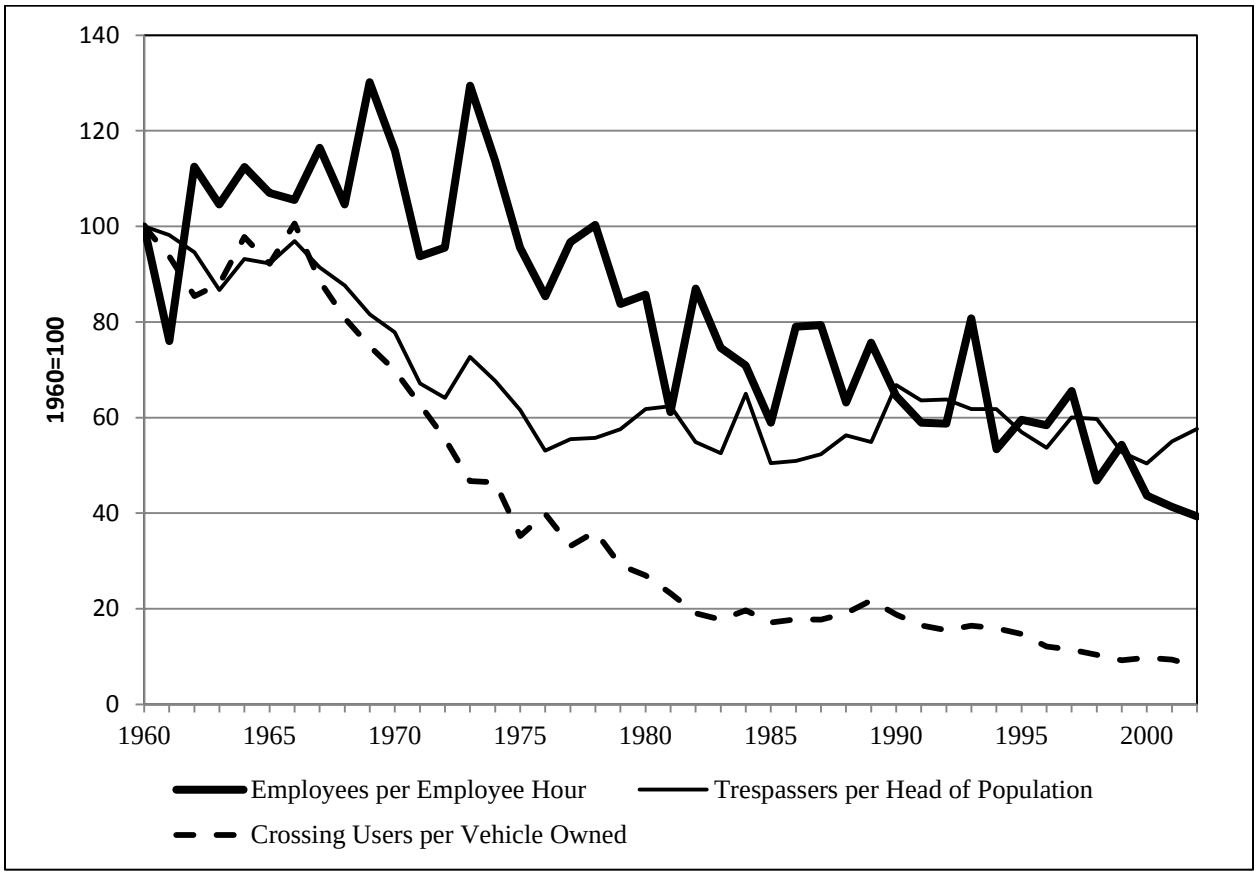

Figure 1: Railroad: Index of Fatality Rates by Type of Person with 1960=100

Figure 2: Railroad: Index of Collisions and Derailments with 1975=100

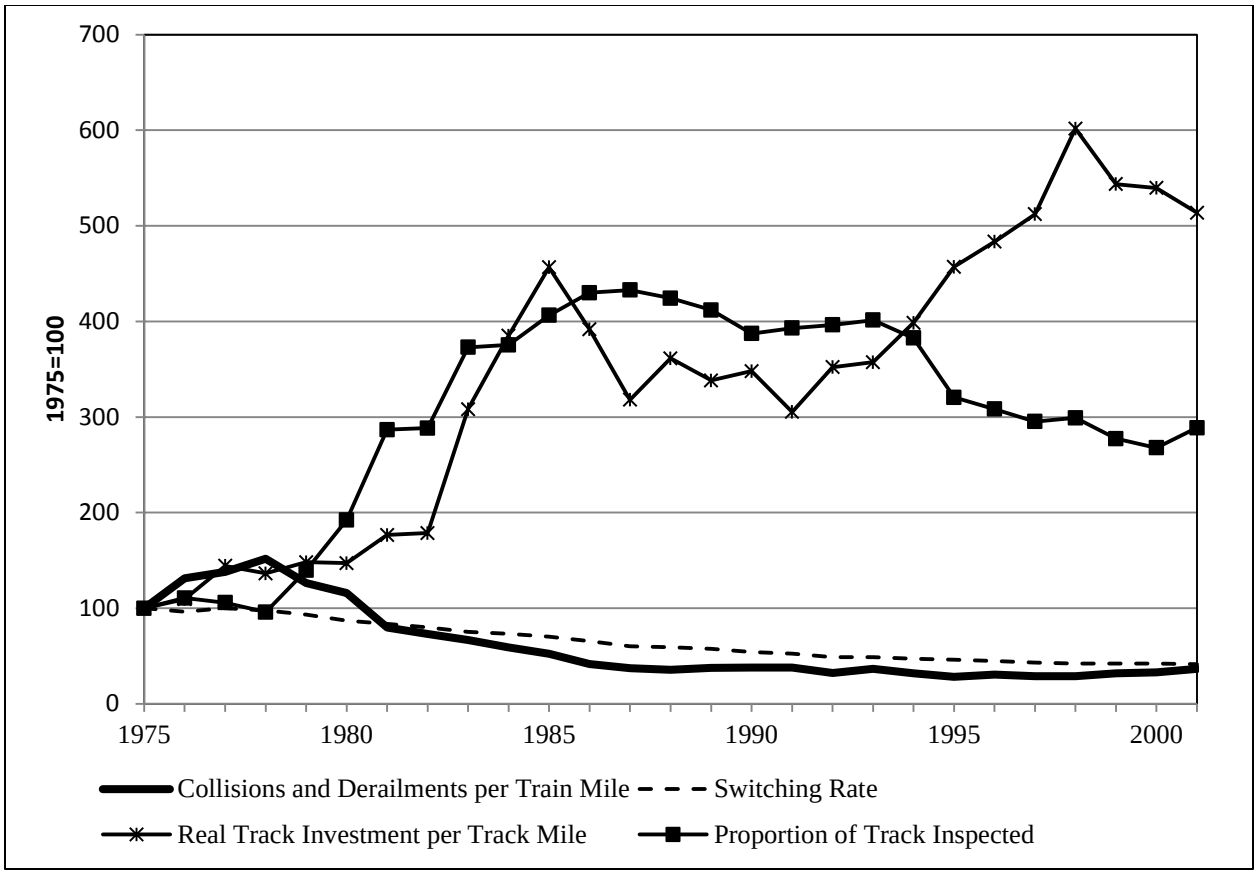

Figure 3: Railroad: Analysis of Track-Caused Collisions and Derailments – Indices with 1975=100

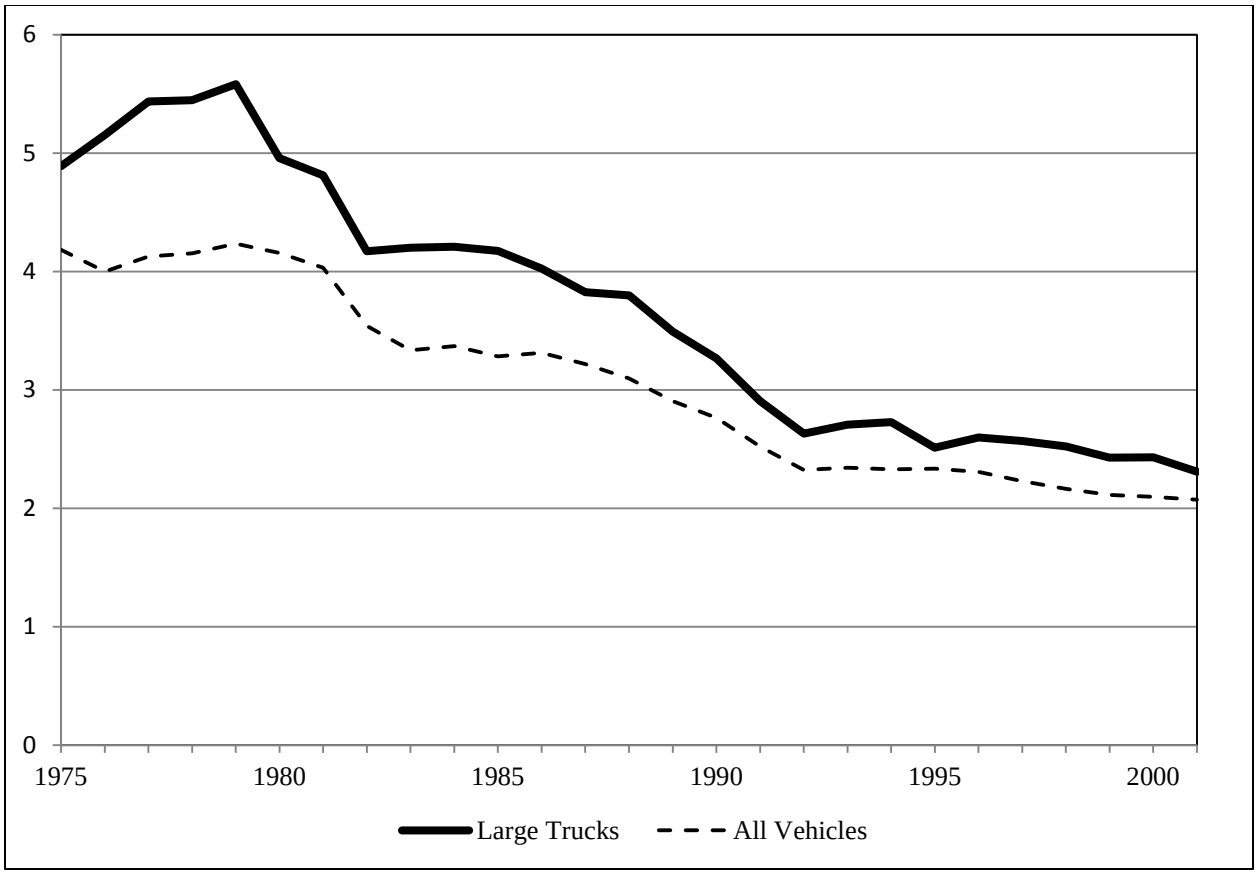

Figure 4: Trucking: Involvement rate in Fatal Crashes per 100 Million Vehicle Miles Traveled. Large Trucks are defined as more than 10,000 lbs (4,536 kg) Gross Vehicle Weight

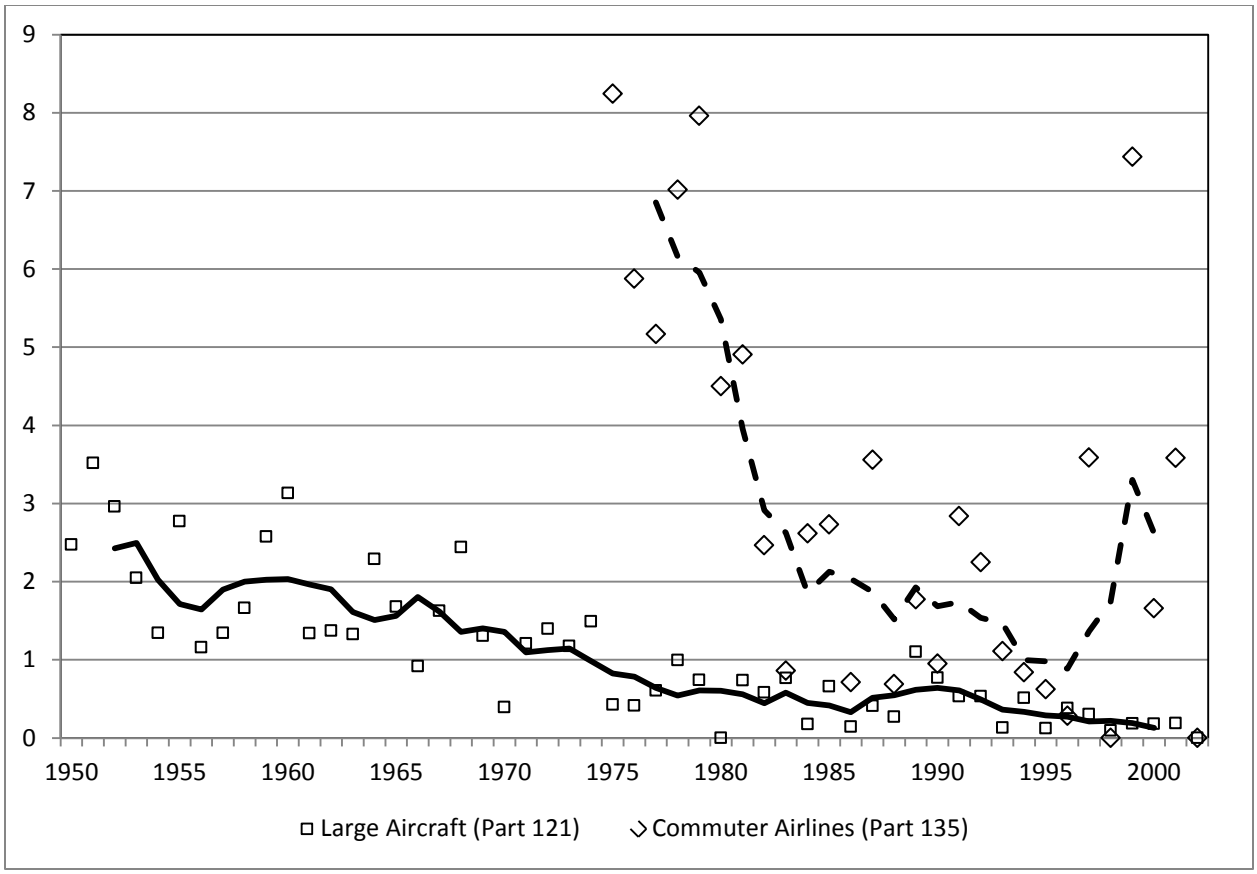

Figure 5: Commercial Aviation: Fatal Accidents per Million Departures with Five-Year Moving Average

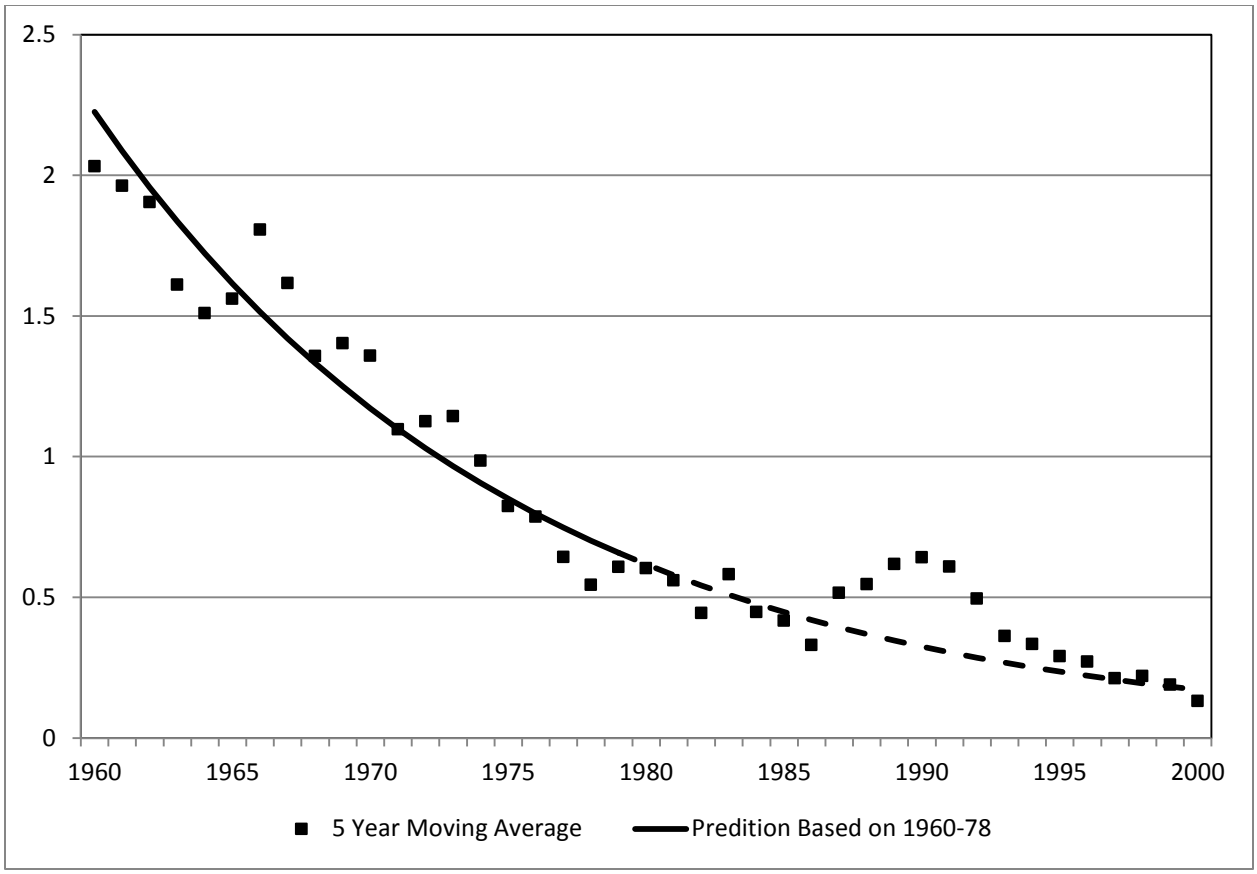

Figure 6: Commercial Aviation: Large Aircraft (Part 121) Actual versus Predicted Five-Year Moving Average Fatal Accidents per Million Departures