PROCEEDINGS OF THE 40TH ANNUAL MEETING OF THE TRANSPORTATION RESEARCH FORUM

Philadelphia, Pennsylvania
October 29-31, 1998

Volume 1

Welcome to the Transportation Research Forum's 1998 Annual Meeting

These proceedings contain those papers presented at the 40th Annual Meeting of the Transportation Research Forum, held in Philadelphia from October 29-31, 1998, that were received by the deadline publishing date. All papers were reviewed by the Program Vice President to assess their suitability for inclusion in these volumes. Additional papers may be made available by some of the presenters at the time of the Conference.

The Transportation Research Forum (TRF) is an independent organization of transportation professionals providing pertinent and timely information to those who conduct research and those who use and benefit from research. It functions as an impartial meeting ground for carriers, shippers, government officials, consultants, university researchers, suppliers, and others seeking an exchange of information and ideas related to both passenger and freight transportation. The Transportation Research Forum started with a small group of transportation researchers in New York in 1958 and the first national meeting was held in St. Louis in 1960. National meetings have been held annually since 1960 at various cities throughout the U.S. and Canada.

Numerous TRF members and supporters aided in the development of this year's Forum, but it is authors of the papers, the organizers and contributors to the various panels, and the session chairs who make TRF annual meetings so worthwhile and enjoyable. The conference program simply reflects the interests, enthusiasm and commitment of those members of the transportation community. Special thanks go to Patrick and Judy Little who graciously agreed to assemble this year's proceedings for me. Without their help, the job of Program Chair would have been much more of a burden.

A number of other TRF members also assisted in the development of this meeting. Randy Resor and Jim Blaze were constant sources of ideas and encouragement. When help was asked for, they came through repeatedly. Other TRF members provided help with the program in their areas of interest. I want to thank Alan Bender, Michael Belzer, Ken Ericksen, Paul Gessner, Harold Kurzman, Scott Ornstein, Clint Oster, and Peter Smith for their help. Claire LaVaye at the University of Texas assisted with promoting the meeting on TRF's website. Finally, Rick Guggolz provided valuable assistance on the businees arrangements for the conference.

We are also grateful to those companies and organizations who have sponsored awards or made other contributions to the success of the Forum. These include: LTK Engineering, The Metropolitan Transit Association, and RailTex. Among our own members, we are especially indebted to the TRF Foundation, the Cost Analysis Chapter and the Aviation Chapter for their assistance and support.

These proceedings are prepared and distributed at the TRF Annual Forum as a means of disseminating information and stimulating an exchange of ideas during the meeting. Every effort has been made to reproduce these papers accurately. TRF, however, assumes no responsibility for the content of the papers contained in these volumes.

Richard Golaszewski
Program Vice President
October, 1998

The Economics of Railroad Safety

Ian Savage
Department of Economics & the Transportation Center
Northwestern University
ipsavage@nwu.edu

Abstract

This paper deals with safety on railroads in the United States. It summaries the research recently published as a book (Savage, 1998). After some brief introductory material on railroad accidents and recent trends, it primarily deals with public policy analysis and prescription for dealing with grade crossing accidents, trespassing, occupational injuries and operational accidents. The primary conclusion is that the government oversight body, the Federal Railroad Administration, should take on the role of teacher and risk analyst rather than that of police officer. By doing so the FRA can target the real causes of the "railroad safety problem" and do so at reduced cost.

Recent Trends in Railroad Safety

To the lay person the popular image of railroad safety is of spectacular train wrecks and burning tank cars, coupled with the suspicion that the frequency of these events has been increasing. However, the reality is much different. In 1996 1,039 people were killed and 12,558 sustained injuries on the railroads. As can be seen in table 1 these casualties are primarily of three types. The first are fatalities sustained in rail-highway grade crossing accidents, the second are trespasser fatalities at places away from highway grade crossings, and the third are employee injuries of which the vast majority do not involve a moving train.

In figure 1 are shown historical trends for the three predominant casualty types since 1960. The numbers of fatalities are shown as a rate relative to exposure. The three measures shown are:

- annual employee fatalities per employee hour (injuries could not be used because of a change in reporting requirements in 1975),
- annual trespasser fatalities away from highway crossings per head of population, and
- annual grade crossing fatalities per highway vehicle registered.

All of the casualty rates are shown as an index with the value for 1960 set equal to 100.

The casualty rates for crossings have recorded the most impressive improvements falling rapidly since 1967, so that the risk is now less than a fifth of what it was in 1960. This improvement has been assisted since 1973 by a federal government program to equip crossings with active warning devices such as flashing lights and gates. The trespasser casualty rates also started to decline rapidly after 1967 but leveled out after 1975 at about forty percent below

Table 1: Number of Fatalities and Injuries by Type of Person 1996

	Fatalities	Injuries
Employees or contractors	42 (4.0%)	9635 (76.7%)
Highway users at grade crossings	487 (46.9%)	1505 (12.0%)
Trespassers not at grade crossings	471 (45.3%)	474 (3.8%)
Non-trespassers (public lawfully on the railroad / adjacent to the railroad)	27 (2.6%)	431 (3.4%)
Passengers on trains	12 (1.2%)	513 (4.1%)
TOTAL	1039	12558

Source: Federal Railroad Administration (1997)

the fatality rate in 1960. If anything, there may be a slight upward trend in recent years. Employee casualty rates increased by thirty percent during the 1960s. They only started to decline in 1973. The subsequent improvement has been substantial such that the fatality rate is now half of what it was in the early 1970s.

Figure 1: Railroad Fatality Rates since 1960

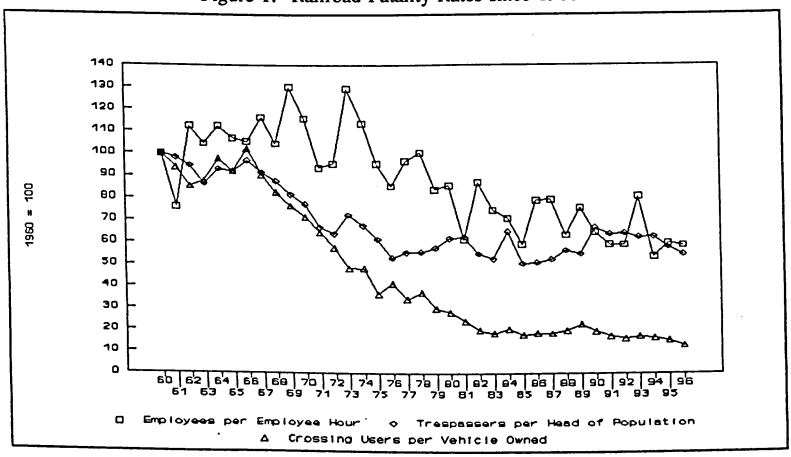
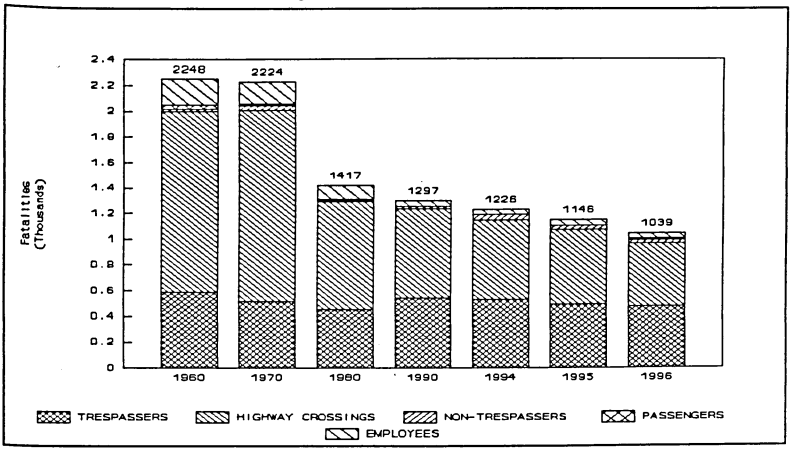


Figure 2: Annual Fatalities

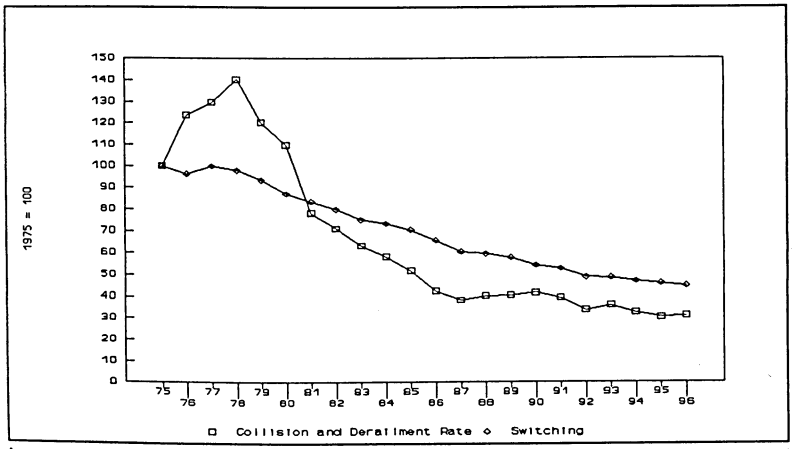


The effect of the improvement in risk is shown in figure 2 which shows the annual number of railroad fatalities for 1960, 1970, 1980, 1990, and then 1994 through 1996. The number of annual fatalities is now less than half what it was in 1960 and 1970. The number of fatalities fell the fastest during the 1970s, but the annual fatality toll has continued to decline since 1980. In 1996 the number of fatalities is twenty-five percent less than in 1980. The major source of the reduced fatalities is the greatly improved safety at highway grade crossings, although employee fatalities have shown a considerable improvement as well. The number of trespasser fatalities has remained reasonably constant and provisional data for 1997 suggests that this is now the leading cause of railroad fatalities.

Recent safety trends are further investigated in figure 3 which covers the period since 1975, and shows data on collisions and derailments (which have only been measured on a consistent basis since 1975) per train mile. Data are shown as an index with 1975 set equal to 100. The rate of collisions and derailments increased until 1979, and then fell substantially, such that it is now only a quarter of the rate in the late 1970s.

In the 1960s the railroads were in considerable financial difficulties and it is widely believed that standards of maintenance were reduced which led to an increase in collisions and derailments and employee injuries. The worsening safety in the 1960s lead to the *Federal Railroad Safety Act* of 1970, the first substantial change in railroad safety regulation in sixty years. Despite the new regulations which dealt primarily with track maintenance, collisions and derailments did not decline until the economic deregulation of the industry in 1980. With the deregulation of the industry by the *Staggers Act* of 1980, the financial health of the industry

Figure 3: Collision and Derailment Rate since 1975



improved and railroads were able to substantially increase their expenditures on track and equipment.

However, much of the improvement in collisions and derailments has also come from a change in the way railroads handle traffic. Traffic is increasingly handled in unit trains and there is much less switching of cars. As can be seen in figure 3, the proportion of train miles that are represented by yard and switching operations has fallen by half, from thirty percent to close to thirteen percent, in the past twenty years. As three-quarters of collisions and three-fifths of derailments occur in yards and sidings, it is therefore not surprising that the rate of collisions and derailments has fallen in recent years.

Highway Grade Crossings

Grade crossing collisions cause almost half of all railroad fatalities. While there have been great improvements in safety at grade crossings subsequent to a government funding initiative in 1974, there are still considerable problems.

The first is that some highway users do not exercise enough care. At crossings with flashing lights or gates, so called active warning devices, more than eighty percent of collisions are caused by the highway user ignoring the lights and/or driving around the gates. At crossings with passive warning devices such as crossbucks signs many drivers do not properly look and listen for a train. Because the conduct of highway users at crossings with passive

warning signs is not explicitly defined in the law, there is some suggestion that courts hold drivers to a lower level of due care than they should.

The root of this problem is that some road users do not fully appreciate the dangers of grade crossings: trains approach a crossing much faster than might be assumed, and cannot stop quickly. The government and the railroads should be commended for their "Operation Lifesaver" campaign that attempts to educate the public of the dangers. There is a growing trend to specify conduct at crossings with passive warning devices by replacing crossbucks signs by stop signs. This is certainly not a panacea. While there may be advantages in encouraging drivers to take care, there are considerable problems including the fact that slow-moving vehicles are more likely to be hit by a train than a vehicle moving quickly across a crossing. There is an increased chance of rear-end collisions between highway vehicles at the stop sign, and the possibility that stopping for nonexistent trains may diminish the regard that drivers have for stop signs. I think that empirical research is necessary before one should support installing more stop signs.

The second problem is that there are a large number of crossings that deserve upgrading from passive to active warning devices. My estimation is that there are at least 8,500, and maybe as many as 20,000, crossings deserving upgrades. At the current rate of progress, a realistic prediction of when all deserving crossings will be upgraded is somewhere between the years 2013 and 2036. One beneficial initiative to speed up deployment of warning devices has been a program to consolidate together little-used crossings into one crossing provided with active warning devices. The consequent delays to road traffic from closing some crossings is minimal. In many locations the large number of adjacent crossings is a legacy of the era of the horse and buggy when nearly every intersecting highway was provided with a crossing.

A proactive systematic program to upgrade crossings has been hampered by the legal system which places the duty to prove safe crossings on the railroad, even though funding of and decisions on upgrades are largely in the hands of state highway authorities. The current legal system encourages railroads to respond to random collisions by pressing for installation of active warning devices at little-used crossings so as to avoid liability in the event that another collision occurs in the coming decades. Because the railroad and not the highway authority is the defendant in suits brought by highway users, evidence that the crossing did not "deserve" upgraded warning devices is not always admissible as a defense.

A 1993 Supreme Court ruling promises to change the system. Some courts have held that the involvement of federal money means that federal standards for when to install active warning devices preempt state common laws that hold railroads liable for this decision. In 1995 the federal government proposed to clarify this preemption by placing the decision to install warning devices entirely in the hands of highway authorities, who would use Federal Highway Administration rules in deciding which crossings to upgrade. The role of railroads would be reduced to just providing information on the level of train traffic, and supplying technical expertise.

Unfortunately, there is a downside in that most States have sovereign immunity against claims for damages from injured highway users. Even if they decide to waive sovereign

immunity, there are often limits on the dollar amounts of claims. There are many crossings that deserve upgrades that will still not be treated in the foreseeable future because of budget limitations. Highway users killed or injured at these crossings will either be unable to seek damages or have the amount of damages severely limited under the proposed rules. Critics of the proposal correctly observed that the principal effect of the 1995 proposal would have been to limit corporate liability at the expense of individual road users.

The proposal was quiet dropped in 1997. Railroad lawyers suspect that it would only be resurrected when the mood of the country again turns toward tort reform and limitations on corporate liability.

I am supportive of the concept that the highway authority and not the railroad should be the legally responsible party. The highway authority is clearly in the best position to judge the most appropriate type of warning device as only it is privy to forecasts of road traffic and land-use changes. However, this authority must be tempered with financial responsibility for the conduct of its crossing improvement program. A waiver of sovereign immunity must be incorporated into any resurrected proposal.

Trespassers

Trespassing fatalities have been increasing in recent years, at a time when safety at grade crossings has been improving considerable. Consequently, preliminary data for 1997 suggest that trespasser fatalities will become the largest category of railroad fatalities. It is common to think that most trespasser fatalities are children and people taking a shortcut by crossing the railroad. However, these fatalities represent less than a fifth of victims. The typical trespasser is a single adult male who is under the influence of considerable amounts of alcohol (Pelletier, 1997). While many are poorly educated, very few are homeless people. Most live reasonably close to the point of trespass. The railroad right of way has become a popular place to socialize, drink and rest. In general one must conclude that most trespassing victims take considerably less care than they should. This is reflected in the courts where trespassers or their relatives are usually not successful in any damage claims against railroads.

In contrast to the essentially rural grade-crossing problem, trespassing is primarily an urban phenomenon. This raises the question of whether the railroad should fence most or all of its urban right of way. Unlike some other countries, the railroads in North America are primarily unfenced. Calculations suggest that fencing the urban rights of way would cost about $3 billion or about $3 million per life saved. This puts fencing on the borderline of desirability based on standard values of life used in the transportation industry. However, the amount required to fence the urban right of way could be used to provide active warning devices at the 20,000 public highway grade crossings that deserve them, and still leave enough money over to provide active warning devices at the 15,000 busiest private crossings. Money spent in this way would save up to twice as many lives than if it was spent on fencing.

The above calculation was based on assumptions that are very favorable to fencing. There is considerable uncertainty about the effectiveness of fencing to reduce trespasser

fatalities. The annual North-American rate of trespasser fatalities at two per million population is the same as it is in Britain where the railway is generally fenced. Closer to home, the rate of trespasser fatalities per train mile for Amtrak who run many of their trains over a fenced right of way in the North-East Corridor is *higher* and not lower than that on neighboring freight railroads with few fences. The general conclusion is that a general requirement to fence the urban right of way would come a long way down the priority list for cost-effectively improving safety on the railroad, and may even be a futile waste of money.

Occupational Injuries

Economic theory, dating back to Adam Smith, indicates that if workers are knowledgeable about job risks, market mechanisms will compensate workers for working in industries that are particularly risky. Workers with a greater tolerance of physical risk will tend to gravitate towards riskier occupations. A market failure will only exist if wages are insufficient to compensate for the risks. Railroad workers are among the highest paid workers in the nation whereas injury and fatality rates are low in comparison to peer industries that involve heavy, moving machinery and work outdoors. Construction, maritime, trucking and warehousing jobs have far higher casualty rates.

There are two reasons why there does not appear to be a market failure for employee safety. The first is that railroad risks are primarily physical injuries about which workers should be well informed. The second is that the high rate of unionization in the railroad industry should provide for higher-than-average levels of safety as unions are typically thought of as representing the inframarginal worker who will be less tolerant of risk than the marginal worker who determines safety in a competitive market.

While the higher wages paid by railroads benefit all workers, the costs fall on the minority of workers who suffer injuries. In the past ninety years, employers have been required to provide insurance schemes whereby injured workers are provided with compensation. The railroad industry has a different form of compensation system than that applicable to the competing trucking industry, and indeed to all other sectors of American industry. The *Federal Employers' Liability Act* (FELA) applicable to the railroads gives a higher level of benefits to injured workers than does the system of workers' compensation applicable to other industries, primarily because workers' compensation does not permit injured workers to claim compensation for non-monetary losses. However, awards to injured railroad workers can be reduced or eliminated if the worker was negligent, whereas awards are guaranteed under workers' compensation. Because of its judicial rather than administrative nature, FELA involves higher transactions costs than does workers compensation.

My analysis indicates that FELA is more likely to ensure that both employees and railroads take care to avoid workplace accidents. If the costs to the railroad of taking care to prevent occupational injuries are more than $2,280 per employee per year, there is the possibility that railroads may take *less* care if FELA was replaced by workers compensation. If this happened society will be worse off. The incentives to employees to take care are similar

under both systems. While negligent employees will receive compensation under workers' compensation, the non-monetary losses which they have to bear themselves act as an incentive for taking care.

However, there is a way in which the adversarial nature of FELA increases workplace risks. Injured employees correctly respond to FELA by not wanting to reveal details of the nature of their cases to railroad managers prior to legal proceedings. Employees also have incentives to claim that the injury resulted from a violation of federal safety laws as this removes the railroad's defense of comparative negligence. This clearly works against informal sharing of information between employees and management on ways to learn from experience in mitigating injuries. Under workers' compensation the employee is guaranteed compensation, and will therefore be able to honestly admit to the circumstances of the injury and ways in which it might be avoided in the future.

There seems to be little prospect of any reform in that both management and labor are firmly entrenched. Management tends to believe that a switch to workers' compensation will save the industry considerable money. I regard that argument as spurious. FELA benefits are highly valued by railroad workers, and railroads should expect that substitution of workers' compensation for FELA will be at the expense of wages or other concessions valued by labor. However, management does have valid concerns about aspects of the *Railroad Retirement Act* which gives longer-serving workers no incentives to rehabilitate themselves following an injury and return to work. Much of the financial concern about the cost of injury compensation could be dealt with by changes to the *Railroad Retirement Act* rather than the replacement of FELA.

Operational Safety

Operational accidents, which are primarily collisions and derailments, result in about twenty-two deaths, 450 injuries and about $250 million in property damage each year. Seventy percent of the collisions and sixty percent of the derailments occur in yards and sidings during switching operations. Half of all derailments are caused by the state of the track, while eighty percent of collisions are caused by incorrect or inappropriate operating practices.

Operational safety is only one of the attributes of service that railroads offer to their customers. Other attributes include price, speed, and reliability. Relatively elementary economic models suggest that there will be a socially-optimal level of each of these attributes. This benchmark level arises because safety, and other attributes, while valued by customers, are also costly to provide. The socially optimal level of safety may not be at the point where all accidents are eliminated. It may not be cost efficient to mitigate all accident risk.

Therefore the fact that we observe over 2,000 collisions and derailments a year is not necessary an indication that there is a "safety problem" on the railroads. There is only a problem if this level of accidents is different from the socially optimal levels. The theoretical causes for such a market failure are fivefold. There will be a market failure if:

(1) railroads do not price in a competitive fashion;
(2) customers cannot accurately perceive the level of safety on offer;

(3) customers do not act rationally;
(4) railroads do not compensate bystanders for damage; and
(5) railroads are myopic in trading off the cost of preventing accidents in the present against accident costs in the future.

Let us review these five possible market failures. There is evidence that railroads do have the necessity and the ability to price above marginal cost. The *necessity* comes from the fact that railroads are characterized by large fixed costs of track and relatively low marginal cost of operating individual trains. This *natural monopoly* characteristic requires pricing above marginal cost so as to recover costs. The *ability* to price above cost results from the high market share they have for certain bulky commodities such as coal, ores and grain. It cannot be denied that certain railroads have become increasingly profitable in recent years. However, economic theory cannot unambiguously conclude that market power leads to lower provision of safety. Even if it did, the safety distortions might be regarded as rather minor compared with the welfare losses associated with restriction of output and higher prices.

For many passenger modes of transportation the major justification for requiring safety regulation is that the customer is not a knowledgeable purchaser. If customers cannot determine the safety of the carrier they select, they will be unable to signal their desires for safety. In the railroad industry most customers are well-informed. This is because they are repeat customers. Commutation passengers and shipping managers are almost daily users of the railroad system. They are able to observe the level of safety on offer. Shipping managers are continually settling claims for minor loss and damage and are well aware of the safety risks. A legacy of the many years of economic regulation is that extensive information is collected on safety, loss, and damage. The Association of American Railroad's (AAR) *Freight Loss and Damage Report* provides a wealth of information on the amount of damage and loss sub-divided by cause, railroad and commodity. Unfortunately this report does not circulate widely outside of a select few in the railroad industry. Wider circulation of this information would certainly reduce calls for safety regulation based on the premise that the customer is not aware of the quality of the service that is being purchased.

Socially-optimal behavior will only occur if fully-informed customers make rational choices consistent with their desires and economic incentives. In general, we can expect freight shippers to make calm and rational decisions based on the prices and safety records of different railroads and available modes of transportation. The situation with regard to passengers is less clear. Psychologists have found evidence that people might ignore safety information in their decision- making so as to avoid thinking about very unpleasant consequences. Whether this is a "market failure" is a matter of semantics, as the failure is within the customer and not in the trade between customers and railroads. It is possible that intervention in the market may be necessary to protect customers from themselves rather than from avaricious railroads.

A traditional cause of market failure in economics is if there are uncompensated externalities on other parties. Bystanders, such as those adjacent to the railroad, can bring suit under the laws of negligence for any losses caused. If the damage is caused by a release of

ultra-hazardous materials the railroad is strictly liable to pay compensation. My investigations suggest that in the vast majority of cases railroads bear the entire cost of damage caused.

However, socially-optimal exposure of third parties to risk only results if shippers are charged prices that incorporate the externality costs that a release of their product may cause. That is to say that shippers of extremely hazardous materials should pay a high price for shipment so as to allow for compensation to bystanders who are affected by a release caused by a collision or derailment. Shippers of commodities which do not cause extensive externalities should be charged lower prices. Unfortunately the railroads have done a very poor job in identifying the costs associated with individual commodities.

In many cases a standard surcharge is collect on all freight movement to cover liability costs to bystanders. As a result too much extremely hazardous materials are shipped, and too little low- or non-hazardous are shipped. Shippers of extremely-hazardous materials are therefore not given the correct incentives to reevaluate where to locate their manufacturing plants or whether to develop safer alternative products. Recent research work has identified that the amount of externalities varies considerably between commodities (Dennis, 1996). Some commodities cause over one hundred and fifty times as much damage per unit shipped than other commodities. While some railroads have made some moves to incorporate these findings into their pricing, there is still a long way to go. A desirable response by the railroads to the public's concern about the transportation of hazardous materials is to ensure that pricing of railroad service fully incorporates the cost of externalities appropriate to that particular commodity.

The market failure that is most threatening and most likely in the railroad industry is that of myopia. The costs of preventing railroad accidents, such as capital expenditures and training, occur in the present whereas the costs of accidents occur at some undefined point in the future. A myopic railroad can save money on prevention in the present while either not appreciating or not caring about the consequent rise in accident costs in the future. Two types of railroads may be susceptible to such myopia. The first are newly-formed railroads who make myopic decisions due to inexperience rather than unscrupulous intent. They simply do not understand that saving on training costs now will result in higher accidents in the future. The proliferation of short-line railroads since the *Staggers Act* of 1980 has given some prominence to this concern. Albeit that there is little evidence that these small railroads pose an unreasonable safety threat. While these railroads do have a higher rate of collisions and derailments than larger railroads, they do not have higher fatality rates. Low speeds of operation mitigate the consequences of many accidents.

The second type of railroad susceptible to myopic behavior are those who intend to "cheat" on their customers. These railroads hope to save money in the short term by reducing expenditures on accident prevention, yet hope that their customers do not notice and react by taking their business elsewhere or demanding lower prices. There is ample evidence that this behavior has occurred in the railroad industry. Indeed, the reason that extensive safety regulation was introduced in the 1970s was due to myopic behavior by certain financially-distressed railroads in the 1960s. These railroads indulged in a particularly insidious form of

cheating in that they reduced their expenditures on track maintenance. It takes some time for a previously well-maintained right of way to deteriorate, and it was therefore some years before shippers could detect that safety was declining.

The market failure caused by myopia does not necessarily imply that safety regulations are necessary. For example, a concern about myopia by inexperienced railroads might suggest that there is a wider role for the insurance industry. Insurance assessors need to make a determination of the precautions taken by a new railroad and charge an appropriate premium to reflect the probability that accident claims will result in the future. Railroad management would be able to trade off the size of the insurance premium against the costs of preventive effort in determining the appropriate level of safety to provide. While there is no requirement for small railroads to hold insurance, most elect to do so. Unfortunately premium schedules are relatively coarse, and insurance companies do not routinely tailor the premium to the specific preventive efforts made by individual railroads.

A concern about myopia by unscrupulous railroads could be mitigated if customers could readily detect the cheating. Customers would immediately express their concern to railroad management and demand a lower price because they are receiving a lower quality of service. There is extensive data already available on railroad accidents. Unfortunately this information is not widely understood or disseminated. The government in the form of the Federal Railroad Administration (FRA) and the National Transportation Safety Board as well as the industry through the AAR or American Short Line and Regional Railroad Association (ASLRRA) would be well advised to make current information more widely available to railroad customers in readily understood formats. Recent advances in electronic dissemination of information have substantially reduced the cost of doing so.

Of course, provision of accident data is not a panacea for removing incentives for cheating. Reductions in maintenance can occur long before they are reflected in accident rates. A purely informational response to a market failure due to myopia would therefore need to provide information on safety inputs such as maintenance activities, training and the age and condition of capital equipment. These are much more difficult metrics to measure and to convey to customers than are accident data. For smaller railroads, information on accidents in a given year is unlikely to provide useful information on whether the safety precautions undertaken by that railroad are deteriorating. Accidents are rare events and it my be difficult to determine from year to year whether the occurrence of an accident is due to myopic behavior or simply due to statistical chance.

While one should support the provision of greater information and encourage insurance companies to be more discriminating in setting premiums, there is probably some role for direct regulation by the government to reduce the chance of myopia. The big question is whether the traditional forms of regulation practiced by the FRA are appropriate for this role, and whether new and improved regulatory strategies could lead to more effective and more cost-efficient ways to prevent myopia.

Some safety regulations date back a long time. These older regulations tend to be supportive of informational and legal response to market failures. The liability of railroads to

employees, shippers, and to bystanders affected by munitions explosions date back to the earliest part of the twentieth century. Railroads have had a requirement to report accidents to the government, and to submit to independent investigation of major accidents, since the same period.

The regulations that have drawn the most criticism are those that date from relatively recent times. This is not to say that railroads have not had their own self-enforced regulations for many years. The very necessity for railroads to exchange cars and locomotives between themselves to provide customers with through service has required standardization. Railroads devised interchange standards for equipment as far back as 1867 and have a recommended code of operating rules dating from 1887. Prior to 1970 these rules were self-administered and not written into federal regulations. The *Federal Railroad Safety Act* of 1970 provided the newly-formed FRA with the powers to "promote safety in all areas of railroad operations." Subsequently regulations were promulgated that wrote freight-car interchange standards into law, devised new standards for railroad track, specified locomotive standards, provided for certification of locomotive engineers and codified certain operating rules into law. Enforcement of these regulations is provided for by the employment of four hundred federal and state inspectors who conduct semi-random inspections of railroads and bring citations and fines for violations found. The FRA also conducts "task force or special assessments" where teams of inspectors undertake comprehensive evaluations of particular railroads. The FRA has the power to issue notifications to require immediate rectification of defects, and in the extreme can forbid operation by a railroad.

The regulations of the 1970s have drawn criticism not only from railroads but also from independent government agencies such as the GAO and the late OTA. The criticisms focus on both how the regulations are written and how they are enforced. The regulations concerning track standards and brakes in particular have been criticized because of a lack of cost-benefit analysis in setting of the standards. It is possible that organized labor has been able to coerce Congress so as to write rules that preserve existing working rules. There is an additional concern that even when appropriate standards are written into law, the rulemaking process necessary to update these standards in the face of technical change or modern requirements is so lengthy and stifling that regulation can impede progress. The main cause of this problem is the penchant of Congress and the FRA to express standards in terms of the design of equipment rather than the performance of it. One would imagine that the FRA is really only interested in how quickly a train can stop or whether there is excessive lateral deviation in track, and not in the specific design of the braking equipment or the number of spikes per section of track.

The enforcement of the regulations has been subject to much criticism. There is considerable feeling, not only in the railroad industry, that semi-random inspections resulting in violation notices and fines are ineffective in improving safety. There is evidence that this is true in the trucking industry (Moses and Savage, 1997), and even the Occupational Safety and Health Administration (OSHA) has recognized that there must be a better way of obtaining a safe workplace. Reports by the GAO suggest that the FRA does not have adequate models

to determine which railroads pose the greatest safety threat and therefore cannot reasonably set priorities for targeted or special assessments of individual railroads. There is also evidence that the tactics of FRA inspectors have antagonized rather than enrolled railroad managements in the cause of safety. Resolution of violations and the payment of fines by large railroads does not normally involve senior officers of the railroads, and there is little evidence that the fines influence corporate policy.

Perhaps the most damning criticism of the 1970s regulations is lack of any strong empirical evidence that these regulations have led to improvements in safety. It is certainly true that railroad safety was declining from the 1960s through the late-1970s, and has improved substantially since. However, other changes have occurred that may explain the decline in accident rates. The railroad industry was deregulated in 1980 and the improved financial viability of individual railroads has allowed increased expenditures on track and equipment. The railroad industry has also changed away from individual-car service towards block trains which reduce the amount of switching and hence the potential for collisions and derailments.

So how can we improve on this rather dismal performance by the legislators who write railroad regulations, and the FRA who enforce them? The answer to this question comes from reflecting on the market failures that the government is hoping to prevent. My analysis suggests that the major role for the FRA is to prevent myopia by inexperienced railroads or unscrupulous railroads. Dealing with these two types of myopic firms calls for two different approaches. An educational system is needed to prevent myopia by inexperienced railroads, while a delinquency system is need to detect and punish unscrupulous myopic railroads who are trying to cheat their customers. The FRA needs to be both a teacher and a police officer.

To a certain extent the FRA already serves as a teacher. Seminars are held jointly with ASLRRA for managers of newly-formed railroads. Press reports suggest that people attending such sessions have found them to be very useful. The objective, of course, is to ensure that managers are made fully aware of the safety consequences of the decisions they are making on training, maintenance, and capital purchases. The FRA should expand its role in cooperation with ASLRRA, the AAR and the insurance companies. All of these organizations have interest in ensuring that new railroads do not pose unreasonable safety risks and also have considerable expertise to pass on. The question arises whether new railroads should be accredited before they are allowed to operate. This accreditation may be based on attendance at these seminars or on other factors.

There are two possible models that the FRA might look to. The first is the system of safety audits undertaken by the Federal Highway Administration (FHWA) of trucking companies. A questionnaire is completed by a federal inspector which is used to rate the firm on the basis of the safety management practices that it has put in place. Perhaps a better educational tool is the "Railway Safety Cases" which had to be completed by private operators who wished to take over the services formerly provided by the state-owned railways in Great Britain. In addition to requiring details of the safety management systems put in place, operators had to complete a risk-assessment exercise in which they had to identify the major safety risks they faced, appraise the probability and severity of these risks, rate the risks and

provide plans for ameliorating those risks that were too high. While data on risk probability and severity may be limited and rating of risks is judgmental, the important role of the risk assessment is to require railroad managers to think deeply about the risk faced and the ways in which the railroad can reduce the risks. It is unlikely that a new railroad that has to undertake a risk-assessment exercise will be myopic due to inexperience.

A delinquency system is not much different in intent from the current activities of the FRA. The objective is to identify those railroads providing sub-standard service or those whose safety record is precipitously declining. The FRA's enforcement role is aided considerably if customers are made aware of declines in the safety offered by an individual railroad. Customers will then pressure railroad managers to restore the previous level of quality or demand a discounted price. The FRA should be encouraged to make the findings of its monitoring and enforcement efforts well known.

These comments should not be taken as an endorsement of the FRA's current methods of monitoring safety performance. Far from it. Semi-random inspections based on finding violations with federal requirements that may or may not be related to safety performance is a bankrupt method of safety control. The system that I am proposing is a four stage process. The first stage requires the FRA to adopt the role of risk analyst. The FRA would analyze data on safety performance for individual railroads to determine which railroads might be delinquent. The second stage involves inspections and evaluations of railroads that the first stage has flagged as potentially delinquent so as to confirm or disprove the FRA's suspicions.

The third stage requires a delinquent railroad to prepare a remediation plan to correct its delinquent behavior. The FRA would also wish to involve the customers of the railroad at this stage so that they can also put pressure on the railroad. The fourth and final stage requires the FRA to monitor whether the railroad is making a good-faith effort to implement its remediation plan. Failure at this stage would trigger traditional methods of inspections, citations and fines. Of course, the FRA retains the powers to issue Special Notices or Emergency Orders to limit operations of specific equipment or stretches of track if it detects extremely dangerous conditions.

Such a system is in use in the trucking industry. The FHWA uses information on the accident rates of carriers, and other information it has, to set priorities for the work of its inspectorate. OSHA conducted an experiment in the state of Maine in 1993 whereby the largest firms where exempted from the traditional OSHA inspections if they made self-assessments of workplace risks, prepared a plan to ameliorate the risks, and made good-faith efforts to implement their plans.

The hardest part of the proposed system is to design an information system that can be used by the FRA to provide an early warning of railroads who may be cheating. An obvious input to such a system is the information that is currently collected on accidents and workplace injuries. While accidents are random events which leads to some natural variation in the number of accidents a firm will have from year-to-year, there are well-understood statistical rules that explain the nature of this variation. Providing the measures of safety that are used occur at least about ten times a year for individual railroads, it is realistic to expect that the

FRA can define statistical rules that effectively identify those railroads whose accident performance is deteriorating or is worse than peer railroads. Candidates for such measures of accident performance are the number of collisions and derailments, and the number of employee fatalities and injuries.

However, this is essentially an *ex-post* identification of myopic railroads. It is clearly preferable if the FRA could identify railroads who are acting myopically before their reductions in preventive efforts are reflected in increased accidents. The FRA might develop a system of warning flags for railroads whose circumstances might suggest myopic behavior, such as financial distress, declines in revenue, financial restructuring, stock offerings or being a takeover target. The FRA might also wish to develop information on safety inputs to alert them to railroads that do not appear to be spending sufficient amounts on track maintenance or who are allowing the average age of their fleets to increase, or who have inordinately high staff turnover. Such warning flags could trigger inspections or a special assessment of the railroad.

Such a statistical risk-analysis approach to analyzing data on safety inputs and outputs is only really applicable to the largest forty or so railroads. The smallest Class II and all of the Class III railroads have accidents so infrequently that any statistical inference would be impossible. The average-sized Class III railroad injures four employees a year, has one grade-crossing accident a year, kills a trespasser once every twenty years and has a collision or derailment once every seven-and-a-half years. It would also be infeasible to collect extensive financial or safety input data on these railroads.

Does this mean that traditional random inspections of track and equipment will have to be retained for smaller railroads? That is certainly a possibility. A more productive method may be an annual audit of each small railroad. This is not an unrealistic suggestion as many small railroads are either owned by larger railroads or are subsidiaries of larger holding companies that own many short-line railroads. There are perhaps only three hundred different corporate entities among the small railroads. During an annual audit the FRA inspector would be able to question management on safety challenges encountered in the past year, the response made by management, future safety plans and possible changes in financial conditions that might suggest myopic cheating. The inspector could also randomly inspect maintenance records, employee qualification files and also track and equipment to ensure that the physical condition of the railroad squares with the report given by management.

In Conclusion

The railroad industry has really only got itself to blame for the current mess it is in with regard to safety regulation. In the 1960s certain managers responded to financial distress by a disregard for safety. Accident rates, which had been improving for many decades, started to increase. Quite appropriately the public demanded that Congress take action. The *Federal Railroad Safety Act* of 1970 is an understandable response to the circumstances. While the

industry had long-standing systems of self regulation, these had failed to exercise discipline over certain railroads.

Unfortunately the new-found public interest in railroad safety was hijacked by two forces. The first was empire building by the FRA which at that time was only three-years old and looking for a mission in life. Albeit, that there is some evidence that the FRA made a preemptive strike so as avoid the railroads failing under the rulemaking powers of the newly-formed OSHA. The second was the labor unions who attempted to prevent certain long-overdue reforms of working practices by trying to write these practices into law under the guise of safety regulation.

Perhaps the biggest mistake was the enforcement strategy adopted by the FRA. The FRA hired existing inspectors from the railroads as its own inspectors. This is not to criticize the professional abilities of the people involved but merely a reflection that the enforcement stance of the FRA became to go out, inspect things and write citations. Never mind the fact that these inspections were somewhat pointless and did not encourage railroads to change their practices. If anything they did the reverse, they antagonized railroad management and did not foster a cooperative spirit of mutually trying to tackle real safety problems.

In this paper I have tried to chart a way forward for the "new" FRA. An FRA that is staffed by people with the outlook of teachers and risk analysts rather than that of police officers. By doing so the FRA can target the real causes of the "railroad safety problem" and do so at reduced cost.

References

Dennis, Scott M., (1996), "Estimating risk costs per unit of exposure for hazardous materials transported by rail," *Logistics and Transportation Review*, 32:351-375.

Department of Commerce, (annual), *Statistical Abstract of the United States*, Washington, D.C.: U.S. Government Printing Office.

Federal Highway Administration, (annual), *Highway Statistics*, Washington, D.C.: U.S. Government Printing Office.

Federal Railroad Administration, (annual), *Accident/Incident Bulletin*, Washington, D.C.: U.S. Government Printing Office.

Moses, Leon N., and Ian Savage, (1997), "A cost-benefit analysis of United States motor carrier safety programs," *Journal of Transport Economics and Policy*, 31:51-67.

Pelletier, Andrew, (1997), "Deaths among railroad trespassers: the role of alcohol in fatal injuries," *Journal of the American Medical Association*, 277:1064-1066.

Savage, Ian, (1998), *The Economics of Railroad Safety*, Boston, Mass: Kluwer Academic Publishers.