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## Fatal Encounters: An Economic Theory of Accidental Injury with Application to New Zealand's No-Fault System

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Fatal Encounters: An Economic Theory of Accidental Injury  
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John C. Hause\*

Abstract

This study develops a model of accidental injury that demonstrates plausible conditions where the elimination of tort liability for personal injury increases accident rates. The abolition of liability generates qualitatively offsetting changes in the care taken by injurers and victims. But if there are significant diminishing returns to their care in reducing accidents and if care by injurers and victims are imperfect substitutes, the normalized accident rate increases.

A major effort is made to locate old and develop new data sets enabling comparisons of Australia and the U.S. with New Zealand for evidence on liability effects. Overall fatal accident rates do not appear to be sensitive to the existence of liability. There is no evidence of a discontinuity in accident rates when New Zealand abolished tort liability for injury in 1974. At most, there has been a modest long run trend effect in increasing fatal accident rates over what they would otherwise have been. Data on industrial injury trends and rotary wing aircraft accidents provide some support for believing that the abolition of tort liability for personal injury has led to a net reduction in incentives to reduce accident-generating behavior. There is strong evidence that liability can have a large effect on prices and on the availability of specific products and activities. But it is difficult to demonstrate quantitatively the net effect this has on accidental injury rates.

JEL #: K13, J28

Key words: Accidents, Tort Liability,  
No-Fault, New Zealand

Fatal Encounters: An Economic Theory of Accidental Injury  
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John C. Hause\*

I. Introduction

Accidental injury is usually an unintended by-product of the activities people engage in, the care they exercise in these activities, and the environment in which these activities are undertaken. This by-product does not come cheaply. The National Safety Council reports a \$358 billion loss from accidental injury in 1993.<sup>1</sup> It also finds that accidents in 1990 were responsible for 90000 fatalities in the U. S., and are the leading cause of death in age cohorts from 1 to 37 years.<sup>2</sup>

At the behavioral level, a reduction in accidental injury may be achieved in two primary ways. The first is by a reduction in those activities that are more likely to generate accidents. The second is by carrying out activities more carefully. Both modes of injury reduction entail costs. There is the cost of the foregone utility from engaging less in those activities which have greater risk of injury. And the personal effort, attention, and other resources expended to reduce the frequency or severity of accidental injury by greater care have opportunity costs, and are subject to diminishing returns.

If people are fully informed of the expected value of the consequences their decisions have on accidental injury, and bear the cost of the harm from accidental injury generated by their decisions, they face incentives that appropriately internalize the

accidental injury that may follow. These circumstances should result in efficient behavior that properly takes injury into account.

It is useful to distinguish three types of accidental injury. First, there are exogenous accidents such as being struck down by a meteorite. Such mishaps are independent of any specific activities or defensive care measures undertaken by the injured party. No obvious change in behavior can prevent such uncommon accidents, and they will not be considered further in this study. Second, there are self-inflicted accidental injuries, such as an amateur mycologist unintentionally consuming agaricus fastibilis. The probability and severity of injury from such accidents can be altered by the specific activities undertaken and the care level employed by potential injurees. No other person or agency is involved whose actions or conduct contributes to the accident. Under these conditions, an informed and competent injuree who directly suffers the full consequences of the accident has efficient incentives to determine his exposure to such risks. Finally, there are accidental injuries that involve the conduct of others, such as a motorist accidentally running over a jogger. To the extent that the motorist is liable for the harm experienced by the injured jogger, prospective liability provides an incentive for the motorist to take such harmful outcomes into account.

This study is focused primarily on this third type of accident, and with the effect of a change in liability on the accident rate. We take the Coase Theorem as the point of departure. The Coase Theorem implies that if transaction costs are

negligible and legal entitlements are completely specified, the accident rate and conduct are invariant to the liability rule. However, it is difficult or impossible for those involved in most of these accidents to negotiate their mutual responsibilities in advance. Since ex post negotiations after an accident are costly, one would expect that individual conduct will be affected by the liability rule in accident law. The large law and economics literature on tort liability has emphasized the role played by different doctrines of liability in providing incentives for efficient behavior where accidental harm is a partial consequence of that behavior. An important outcome of that research has been recognition of the offsetting effects liability rules frequently have on the behavior of potential accident "victims" and "injurers." A change in the rules that increases the liability of injurers leads to more accident reducing behavior by injurers and less accident reducing behavior by victims. Similarly, a change decreasing the liability of injurers has the opposite effect. There appears to be little consensus in the literature as to the net effect of a change in liability rules on accident rates.

In part II a theoretical model of accidental injury is developed and analyzed. Most of this analysis assumes perfect information, but the consequences of imperfect and asymmetric information on accidents are discussed briefly. The main theoretical conclusion reported there is that accident rates will be higher if tort liability is abolished, if the care by injurers and victims are imperfect substitutes and if care yields sufficiently strong decreasing returns. The model also yields intermediate level implications about the liability effect on

equilibrium quantities and prices of risky activities and the levels of care that accompany these activities.

Part III considers why major changes in liability rules are likely to alter incentives to extract, analyze, and disseminate information generated by the accident process. The new pattern of incentives may change the industrial organization of risk detection and prevention, and are likely to change the level of resources allocated to these activities. Hence a major change in liability rules may alter the evolution of the accident process itself, and thus the accident rate over time. New Zealand eliminated tort liability for accidental injury in 1974 by adopting a universal Accident Compensation System. Part IV analyzes some time series and other data on accident rates in New Zealand, Australia, and the U.S., to see whether the theoretical predictions of the final effects of tort liability on accident rates are consistent with the data. It is found that overall accidental fatality rates were somewhat higher in New Zealand than in the other countries when tort liability for injury was abolished in 1974. The rate of decline in fatality rates from then until the late 80's was (significantly) greater in Australia and (nonsignificantly) greater in the U.S. It is also found that industrial injury rates were higher in New Zealand than in the U.S. in all major industries except wholesale and retail shortly before 1974. But over the next 19 years, they fell modestly in the manufacturing and the construction industries in the U.S. (-19% and -12%), but appear to have risen in New Zealand (+14% and +7%).



Evidence is considered in Part V on intermediate level effects of liability change on product availability, quantities, and prices. Particular attention is given to the liability component in pricing pharmaceutical products, and to the introduction and withdrawal of potentially risky drugs from the market. Part VI summarizes the main conclusions and suggests directions for future study.

## II. A Theoretical Model of Accident Rates and Tort Liability

The following model of accidents and incentives is in the spirit of Shavell's (1980) insightful theoretical study on accidents and liability rules. The model treats an accident as a low probability mishap between a potential injuree ("victim") and injurer, who play asymmetric roles. It is assumed that accidents are generated by a Poisson process, and that the probability of accidental injury to a potential victim is given by

$$p = yx\lambda(c,d).^3 \tag{1}$$

In this expression,  $x$  and  $y$  are the activity levels of specific activities undertaken by a potential victim (such as jogging along a highway) and a potential injurer (such as driving a car on a highway).  $\lambda(c,d)$  is the Poisson "parameter" of the accident generation process.  $\lambda$  is a strictly positive function of  $c$  and  $d$ , the expenditures on care per unit of their respective activities by the potential victim and injurer. (In other words, the potential victim spends  $cx$  on care if he engages in  $x$  units of the activity, and the potential injurer spends  $dy$ .) To simplify notation, the explicit dependence of  $\lambda$  on  $c$  and  $d$  is usually suppressed.

The qualitative properties of  $\lambda$ , and the tradeoff between victim and injuree expenditures on care,  $c$  and  $d$  respectively, are important in determining the theoretical conclusions that are reached later. The following assumptions seem empirically plausible. (1)  $\lambda$  is a decreasing function of the care levels, i.e.,  $\lambda_c < 0$  and  $\lambda_d < 0$ , where the subscripts on  $\lambda$  indicate partial

derivatives. (2)  $\lambda$  is subject to diminishing returns from care, i.e.,  $\lambda_{cc} > 0$  and  $\lambda_{dd} > 0$ . (3) The care levels  $c$  and  $d$  are technological substitutes for reducing  $\lambda$ , i.e.,  $\lambda_{dc} > 0$ . Equivalently, an increase in either's care level reduces the marginal product of the other's care level in reducing  $\lambda$ . Although some theoretical conclusions follow from these restrictions, the most interesting result requires an additional restriction. (4) The care levels  $c$  and  $d$  are imperfect substitutes. This assumption is introduced formally by the hypothesis that  $c$  and  $d$  can be aggregated into a scalar care level function,  $e(c,d) \equiv \gamma(c) + \delta(d)$ . It is assumed that  $\gamma(c)$  and  $\delta(d)$  are both increasing and strictly concave functions, i.e.,  $\gamma' > 0$ ,  $\delta' > 0$ ,  $\gamma'' < 0$ , and  $\delta'' < 0$ , where ' and '' denote first- and second-order derivatives.  $\gamma(c)$  and  $\delta(d)$  are normalized by assuming  $\gamma(0) = \delta(0) = 0$ . These four assumptions are equivalent to restricting the Poisson parameter  $\lambda(c,d)$  to the following form:

$$\lambda(c,d) \equiv \lambda[\gamma(c) + \delta(d)] \equiv \lambda(e), \quad (1a)$$

where  $\lambda'(e) < 0$  and  $\lambda''(e) > 0$ . This formulation incorporates both imperfect substitution between victim and injurer care in reducing the likelihood of an accident and diminishing returns from care.

The potential (risk neutral) victim's utility function is given by

$$U(x,z,c) \equiv z + f(x) - \pi(H-L).^4 \quad (2)$$

In this expression,  $z$  is a numeraire commodity which generates constant marginal utility.  $f(x)$  is a separable utility function component for  $x$  with the standard properties  $f' > 0$ ,  $f'' < 0$ .  $\pi$  is the probability of accidental injury defined in (1).  $H$  is the

expected loss from injury, conditional on an accident taking place.  $L$  is the expected compensation the victim will receive because of liability of the injurer. (Subsequent discussion of this model shows that  $L = 0$ , because the injurer will choose to act so that he is not negligent if an accident occurs.) A more realistic specification of the accident technology would recognize that greater care effort may reduce  $H$  as well as  $\pi$ . We ignore this complication for analytic convenience.

Maximizing the victim's utility subject to the budget constraint  $I = (p_x + c)x + z$  (where  $I$  is income,  $p_x$  is the market price of  $x$ , and  $c$  is care level expenditure per unit of  $x$ ) yields the first order conditions determining  $x$  and  $c$ ,

$$df/dx = p_x + c + \pi(H-L)/x, \quad (3a)$$

$$-\pi_c(H-L) = x. \quad (3b)$$

Equation (3a) states that the potential victim will engage in that level of activity  $x$  (i.e., "consume"  $x$ ) so that the marginal utility of  $x$  is equal to the full price of  $x$ . The full price of  $x$  exceeds its market price,  $p_x$ , by  $c + \pi(H-L)/x$ . The first term,  $c$ , is cost of care the victim is expending on each unit of  $x$ . The second term,  $\pi(H-L)/x$ , is the expected net accident loss per unit  $x$  that the potential victim consumes. Thus the victim will choose to engage in less of activity  $x$  than would be the case if he faced only the market price of  $x$ . The reduction of consumption induced by the care and accident cost components of full price is greater the higher the victim's price elasticity of demand for  $x$ . If the full price of  $x$  is large enough, some individuals may decide not

to consume any  $x$ , and will thus not be exposed to any potential harm (from engaging in activity  $x$ ).

Equation (3b) is the standard efficiency condition for making expenditures on care level per unit  $x$ ,  $c$ , up to the point where the expected net marginal loss from injury is equal to the marginal cost of the additional care. Given the specification of  $\pi$  in (1), this condition is equivalent to choosing  $c$  to minimize the full price of  $x$  given in equation (3a).<sup>5</sup>

This simple model has several obvious but important implications for reducing accidental injury. Injury from a specific activity may be reduced both by decreasing the activity level  $x$  (reducing exposure) and by carrying out the activity more carefully (increasing  $c$ , which lowers  $\lambda$ ). Much discussion of accident reduction (outside of the economic literature) seems to take exposure levels for granted, and pays exclusive attention to making the activity safer (lowering  $\lambda$ ). The analysis here suggests that such a lowering of the full price of the activity would lead to increased demand for that activity, offsetting to some degree the final effect of a lower  $\lambda$  on the accident rate.<sup>6</sup>

This model is also useful for considering the incentive effects of compensating accidentally injured individuals, whether by liability or by first party insurance. Suppose that an injured victim is completely compensated for the accident by a payment of  $L$  (i.e.,  $L=H$ ). Since the effect of an accident on the person's expected utility is  $\pi(H-L)=0$  in this case, the prospect of an accident makes no difference to the potential victim. Hence the victim would make no care expenditures,  $c$  (since  $c$  generates no direct utility and is spent solely to reduce the expected cost of

injury). Similarly, the full price of consuming activity  $x$  would fall to the market price  $p_x$ , which would lead to an increase in accidents. If the victim receives only partial compensation (so that  $(H-L) > 0$ ), both the incentives for spending on care and reducing activity  $x$  because of the full price of  $x$  are attenuated. It follows that if an individual can only obtain compensation by purchasing first party insurance, the appropriate incentives for efficient levels of  $x$  and  $c$  are blunted if the insurance premium for cover is independent of the choices of  $x$  and  $c$ . If insurance for participation in the activity is made compulsory (and the requirement is enforced) there will be some reduction in accidental injury due to nonparticipation in the activity by those who find the insurance entry price too high.

The accident model is completed by analyzing the behavior of the potential injurer and the net effect of the injurer and injuree responses. The injurer's utility function is

$$V(y, z, d) = z + g(y) - \pi L. \quad (4)$$

$y$  measures the activity level of the injurer.  $g(y)$  is the injurer's utility function component associated with  $y$ , where  $g' > 0$ ,  $g'' < 0$ .  $y$  also influences  $\pi$ , as indicated in (1).  $L$  measures the injurer's liability for damages, measured in numeraire commodity units if the accident occurs, and depends on what liability rule is in effect. The following analysis assumes the most widely used common law liability standard, negligence, and the normal rule for civil damages, which is for the negligent injurer to make the victim "whole."<sup>7</sup> "Making the victim whole" is interpreted as setting the damages  $L=H$ , the harm to the victim.

Following Shavell, it is assumed that the injurer is negligent only if  $d < d^*$ , i.e., the level of injurer's care in carrying out his activity is less than the critical care level  $d^*$  used to define negligence. Finally, it is assumed that  $d^*$  has been determined so that the injurer always sets  $d = d^*$ . Hence the injurer is not negligent if an accident occurs.

The injurer maximizes utility subject to the budget constraint  $I = (p_y + d)y + z$  (where  $I$  is income,  $p_y$  is the market price of  $y$ , and  $d$  is the injurer's expenditure on care per unit of  $y$ ). The first order condition for the injurer's utility maximization with respect to  $y$  is

$$dg/dy = p_y + d^*. \quad (5)$$

As already noted, the injurer sets  $d = d^*$ , so there is no first order condition for this choice. But the full price of  $y$  to a potential injurer who wishes to escape possible liability exceeds the market price of  $y$  by  $d^*$ , the per unit of  $y$  care level defining liability.<sup>8</sup>

The net effect of the victim and injurer responses on the normalized accident rate, i.e., the accident rate per unit  $x$  is now explored.<sup>9</sup> In this model, an increase in the accident rate is equivalent to an increase in the accident probability  $\pi$  for a given victim-injurer pair. Similarly, an increase in the normalized accident rate is equivalent to an increase in  $\pi/x$ .

With liability abolished, the injurer reduces care  $d$  from  $d^*$  to 0, since the only benefit the injurer obtains from care expenditures on  $y$  is the reduction in his expected liability. This reduces the full price of  $y$  to the injurer, and thus leads to an

increase in  $y$  by (5). These two adjustments individually and jointly increase  $\pi$ . The appendix shows that each of these responses leads to qualitatively offsetting changes by the injuree, i.e., the injuree's activity level  $x$  decreases and care level  $c$  increases. More formally,  $x_y < 0$ ,  $x_d > 0$ ,  $c_y > 0$ , and  $c_d < 0$ , where the subscripts indicate partial derivatives. These adjustments are a consequence of the victim adjusting his FOC responses in (3a) and (3b) to the injurer's change in behavior.

This outcome of qualitatively offsetting behavior by the victim is precisely the intuitive result one would expect. The more interesting theoretical issue is to determine whether the net effect of injurer and injuree responses to the elimination of tort liability would increase the accident rate or not. It is useful to distinguish between the normalized and unnormalized accident rate in analyzing this issue.

Let  $\Delta \ln(\pi)$  be the change in the logarithm of  $\pi$  resulting from the abolition of liability. Call  $\Delta \ln(\pi)$  the relative change in the accident probability. Similarly, the corresponding relative change in the normalized probability of an accident is:

$$\Delta \ln(\pi/x) = \Delta \ln(\pi) - \Delta x. \quad (6)$$

Since  $y$  increases and  $d$  decreases when liability is abolished, and since  $x_y < 0$  and  $x_d > 0$ , it follows that  $\Delta x < 0$ . Hence we have the following major conclusion.

PROPOSITION 1. In changing from a tort liability regime to one without tort liability,  $\Delta \ln(\pi/x) > \Delta \ln(\pi)$ , i.e., the relative change in the normalized accident rate is algebraically greater than the relative change in the accident rate.



Proposition 1 implies that if abolishing tort liability increases the accident rate, then it must increase the normalized accident rate by an even larger percentage. But it doesn't assure that either rate change is necessarily positive.

The model unambiguously says that if liability is abolished, the injurer increases activity level  $y$  and decreases care level  $d$  to 0. Hence the normalized accident rate  $(\pi/x)$  necessarily increases if  $\partial(\pi/x)/\partial y > 0$  and  $\partial(\pi/x)/\partial d < 0$ .

The appendix shows that that these two inequalities are satisfied, as well as the four conditions on  $\lambda$  and substitution between  $c$  and  $d$  if one lets

$$\lambda(c,d) \equiv ke^{-(\gamma(c) + \delta(d))}, \quad (7)$$

where  $k > 0$ ; and  $\gamma(c)$  and  $\delta(d)$  are positive increasing concave functions of their arguments. This functional form for  $\lambda(c,d)$  characterizes the strength of diminishing returns from  $c$  sufficient to assure the condition  $\partial(\pi/x)/\partial y > 0$  holds.<sup>10</sup>

This analysis of the model leads to the second main theoretical conclusion.

PROPOSITION II. In changing from a tort liability regime to one without tort liability (negligence), the victim activity level  $x$  declines and the victim care level  $c$  increases.<sup>11</sup> The normalized accident rate  $(\pi/x)$  will increase if diminishing returns from care on the Poisson accident parameter are strong enough (of a magnitude suggested by equation (7)). Suppose this condition is satisfied and the increase in  $y$  activity by the injurer is not more than offset by the decrease in  $x$  activity by the injuree. These conditions are sufficient to assure that abolishing tort liability for accidental injury increases the accident rate,

$\pi \equiv xy\lambda$  as well as the normalized accident rate.<sup>12</sup>

The preceding analysis probably exaggerates the extent to which abolishing liability would induce substitution away from risky goods by potential victims because of the increase in their full price if tort liability for injury were abolished. A partial equilibrium model was used to examine the effect on the quantities and care levels in a pair of specific activities of a potential victim and corresponding injurer if liability was removed. If the full price of most goods and services consumed by potential victims increase because of the changed behavior of the injurers, then there will be less opportunity to substitute lower risk for higher risk activities by the victims. If this general equilibrium response to the change in legal rules is important, it makes it more likely that the overall injury rate from accidents would increase if tort liability is eliminated.<sup>13</sup>

This theoretical model of accidents and tort liability has empirical implications for accident rates and for market price and quantity adjustments to liability. The main implication is that the normalized accident rate (and perhaps the unnormalized accident rate) will tend to increase if tort liability is abolished. The empirical relevance of this prediction model clearly depends on the class of accidents under consideration. (1) Tort liability provides an injured person (and his attorney) with ex post incentives to find an injurer who can be pursued for damages. But for many accidents, no such third party injurer exists. Tort law should have no effect on such accidents. (2) At the other extreme, there are accidents that are unambiguously the

consequence of an injurer's behavior, in which the victim is uninformed of the existence of the risk or is unable to do anything about it. Tort law should have its greatest effect in such situations. (3) Many accidents occur under circumstances lying between these extremes. The effect of abolishing tort liability on the overall accident rate obviously depends on the distribution of different types of accidents.

It is obvious, but important to distinguish these conclusions about accident rates from those conclusions when the abolition of tort liability is accompanied by public compensation of those suffering accidental injury.<sup>14</sup> The earlier brief discussion of the incentive effects of compensating accidentally injured individuals pointed out the unambiguous attenuation of victim incentives to reduce exposure to accidental injury. One therefore expects higher levels of victim activity  $x$  and lower levels of victim care  $c$  in an equilibrium when victim compensation is present, leading to an increase in accident rates.

The accident model also has implications for liability effects on equilibrium prices and quantities of goods and services, and on the care people take when engaging in risky activities. The model shows how liability influences the full price of goods and services faced by injurers and injurees and the full costs of suppliers (who may be liable). This influence of liability is often transmitted by the cost of insurance (or may even determine whether insurance is available). Insurance costs or availability can be a significant determinant of the market price. It may even be decisive in determining whether a market exists for a product.<sup>15</sup> These effects of liability on prices and quantities

are easier to observe than the net effect on accident rates. If a specific activity (product) is not available because of potential liability costs, clearly no accidents can arise from that activity. The net effect of this on the overall accident rate is not obvious, because it depends on the level of risk in all substitute activities.

### III. Tort Liability and the Organization of Risk Detection and Accident Prevention

Part II developed a two-person micromodel of the accident process. But many (and the most serious) accidents leading to tort liability involve more organizational structure in important ways. This section provides a short discussion of incentives that tort liability gives to organizations to gather, process, and act on information about the accident generating process. The accident model implicitly assumes that knowledge of the risk and how care and activity levels determine that risk is known to the potential victim and injurer. But accidents are usually low probability events. Knowledge of what generates them and efficient ways of reducing them must be produced, disseminated, and acted on. The efficient allocation of these tasks within organizations and the development of distinct institutions to deal with them are interesting topics in industrial organization that seem relatively unexplored by economists. These issues are relevant for this study because a major change in tort liability may have significant long run effects on accident rates by altering the organization and financing of risk detection and accident prevention activities.

(1) Organizations are frequently defendants in tort liability actions. The threat of tort liability for negligence creates an incentive to spend resources on internal monitoring, both to control liability and to document nonnegligence when accidental injury occurs. The need to document behavior itself encourages the organization to devote more attention to the detailed circumstances where relatively low probability but severely

injurious accidents occur. There may be other motives for some level of internal monitoring and documentation such as reputation, insistence by insurers (discussed below), or regulatory requirements. But it seems plausible, e.g., that hospitals engage in some of their extensive monitoring, record maintenance, and protocols in response to the prospect of tort liability.

(2) Trade associations in a number of industries finance research to make both their production processes and outputs safer. For example, some of the work by the American National Standards Institute on safety is funded in this way. Here again it seems plausible that potential liability is a significant motive generating these expenditures in addition to the direct motives of reducing disruption of the production process, or loss of reputation with employees or customers.

(3) Large insurance companies selling either first or third party insurance may acquire relevant information through the analysis of their own claims experience. This information may enable them to provide useful advice to their policy holders. They may charge premia that depend on customer compliance, and in some cases even require compliance as a condition for providing cover. The insurers have an incentive to monitor compliance.

(4) As in (2), trade associations of insurance companies may finance accident prevention research within their own institutes, such as the Institute for Highway Safety or for research and development of safety standards by such organizations as the American National Standards Institute. There is a long history of insurance company involvement involved in fire prevention research

and organization of fire prevention. The information generated from these expenditures is then transmitted to their customers as in (3).

(5) There are probably significant interactions between regulatory safety standards and tort liability. The limited resources that regulatory agencies often have to monitor compliance and the limited penalties they can impose for failure to comply before or after an accident occurs reduces incentives to comply. But failure to comply may provide an injured tort plaintiff with strong and obvious evidence on negligence, and perhaps even a threat of punitive damages that substantially increases the settlement offer the defendant (or his insurers) will make. It seems likely that tort liability incentives will speed up compliance with a new safety regulation, as well as the degree of compliance. This Tort-Regulation Interactions hypothesis has been mentioned, but little systematic theoretical or empirical study has determined its importance.

(6) It might be argued that the role of the government could be expanded to develop and disseminate safety information and to engage in safety regulation to offset any increase in accident rates that the abolition of liability might generate. This exogenous view of government policy is unsatisfactory. It doesn't provide any basis for predicting whether such offsetting policies would be likely to occur if liability was abolished.

In summary, in the absence of offsetting mechanisms, the abolition of tort liability for accidents will reduce the market incentives for developing and using this kind of safety information, and for regulatory compliance.

#### IV. Accident Rates in Faultless New Zealand

In April 1974, New Zealand established an Accident Compensation system, which provided universal coverage and abolished tort liability for personal injury. This legal innovation makes the New Zealand experience a natural experiment for a study of the relationship of tort law and accident rates. The overall fatal accident rate is studied first. Motor vehicle accidents and workplace accidents are studied next. These accidents were the two primary areas of tort litigation for personal injury in New Zealand until 1974, as reported by Franklin [1975]. This is followed by a brief examination of civil aviation accidents because of the remarkably detailed data available. In part V, some of the intermediate effects of tort liability on prices, quantities, and product availability are considered. Fragmentary evidence is examined from commercial bungy jumping, pharmaceutical product prices, and the process of approval of pharmaceutical products for the market and withdrawal of those that are defective, to explore a few of the channels through which tort liability incentives may operate.

A brief overview of the tort liability system in New Zealand before 1974 and a few comparisons with the U.S. system provides perspective on the extent of the institutional change occurring when liability was abolished.<sup>16</sup>

Tort law for personal injury in New Zealand was carried out under a comparative negligence standard.<sup>17</sup> This standard made it easier for injured plaintiffs to collect at least partial damages, compared with the primary use of contributory negligence in the



U.S. at that time, which in principle barred any recovery if the plaintiff had himself been negligent. Similar to U.S. experience, most cases were settled by the disputants.<sup>18</sup> And, as in the U.S., a jury was commonly used if the case went to trial. The categories for damages were formally the same in New Zealand and the U.S., but awards for pain and suffering were far smaller in the former. New Zealand also provides free care in its public hospitals. It is unclear how much reimbursement the hospitals received from liability insurance, but the organization of the New Zealand health care system probably made medical compensation a considerably smaller component of damages in New Zealand. One commentator wrote in 1973 that the jury awards reported in the newspapers were probably about a quarter to a third of comparable American awards. As an indicator of the level of tort compensation for personal injury, the ratio of tort compensation to GDP for 1970 accidental injuries in New Zealand is .28%. Estimates of the ratio for the U.S. in 1985 range from .52% to 2.16%.<sup>19</sup>

Another indicator of the historical scale of tort activity for personal injury in New Zealand is the fraction of income lawyers derived from injury tort activity. Although New Zealand lawyers do not use a formal contingent fee arrangement for compensating their services, it has been suggested that fees tend to approximate 7 to 8% of the amount recovered. This leads to an estimate that tort fees for personal injury cases were at least 2.4% of legal practice income.<sup>20</sup> A corresponding estimate for the U.S. has been elusive.

A. The Overall Rate of Fatal Accidents and Tort Liability

In countries where tort liability for injury exists, no attempt to obtain compensation through liability is made for most accidental injuries. This outcome is unsurprising. It is too costly to pursue tort damages unless they are large enough. Furthermore, many accidents occur for which there is no semiplausible target for tort liability. Reliable statistics to document this claim are elusive. A recent American survey study by Hensler et al, p 121 [1991] estimated that only 10% of those experiencing nonfatal accidental injury made a formal or informal attempt to bring liability claims.<sup>21</sup> However, the small fraction of accidents leading to tort action provides no direct evidence on how the accident rate would change if tort liability was removed. Indeed, there would be no accidents at all leading to tort action if the tort system worked perfectly and costlessly. Injurers would take the proper level of care to avoid liability for negligence. The empirical issue is how large the increase in accidents would be if the negligence incentives disappear.

If tort liability has a significant effect on the overall accident rate, and if the accident generating process in New Zealand was in steady state equilibrium before tort liability ended, the theory suggests changes in the level and trend of the accident rate time series. The net effect of the change of incentives on the behavior of victims and injurers would tend to increase the level of accident rates. It is implausible that this change would be instantaneous. A distributed lag in the adjustment of behavior and accident-related institutions is far more likely.

Furthermore, imperfect substitution of care measures by victims and injurers suggests that changes in available safety technologies would lead to fewer adoptions of new and costly care technologies by injurers than would occur with liability. The net effect of these last two factors would tend to make the trend in accidents without liability less negative (or more positive) than with liability. Thus cross country comparisons with New Zealand to see how accident rate trends differ may be informative.

We begin the empirical study of the New Zealand experience by examining the overall fatal accident rate from 1950 through 1987 in New Zealand, Australia, and the U.S. Attention is limited to fatal accidents in this initial analysis. Accidental death is a serious event that requires a death certificate to be issued. Consequently, mortality statistics on accidents are far more accurate and comprehensive than morbidity (injury) statistics, and are more readily compared over time and across countries. In addition, most countries use the same International Classification of Diseases for mortality statistics.<sup>22</sup>

One expects changes in accident rates and their outcomes to occur over time, in response to changes in the activities people engage in, medical technology, and other factors which we cannot measure well and/or which influence the accident generation process in ways not well understood. To the extent that these factors lead to qualitatively similar trends across advanced countries, cross country comparisons may be informative. Australia is a natural "control" for New Zealand, given its geographic proximity and common cultural tradition from Britain. Comparisons of New Zealand and the U.S. over time are also of

interest, given the prominence of U.S. tort litigation.

Figure 1A plots the overall accident fatality per 100,000 population on a logarithmic scale against time (1950 through 1987) for New Zealand, Australia, and the U.S. A striking feature of this Figure is the strong positive trend of the New Zealand fatality rate in the first part of the period, reaching its peak in 1973. This differs substantially from the slightly negative trend in fatalities of the other two countries over the same period. Whereas in 1950 the fatality rate in New Zealand was 31% less than in Australia, by 1973 it was 9% higher. Since 1973, there appears to be a negative trend in the fatality rate of all three countries, although the year-to-year changes are more erratic for New Zealand.

The puzzling growth of the New Zealand fatality rate through the 1950's and 1960's until it exceeded the Australian and U.S. rates is unexplained. This behavior makes it implausible that the accident process in New Zealand was in a steady state equilibrium at the time tort liability for personal injury was abolished in 1974. Lacking an explanation why the time series of the fatal accident rate behaved as it did in the first part of the period, a comparison of the slope and level of accident rates in New Zealand before and after 1974 provides little insight into what effect the legal change had.

Not a ripple, much less, tidal wave of carnage after 1974 can be detected in Figure 1A. There is no support for the hypothesis that abolishing tort liability for injury increased the level of fatal accidents in the Figure. This result is consistent with the

view that changes in victim and injurer behavior, in response to incentive changes were offsetting, leaving no observable net change in the accident rate.

The results of a more careful examination of the data is reported in Table 1, with estimates of a regression specified to test whether trends in fatal accident rates in Australia and the U.S. differ from the trend in New Zealand from 1974 when tort liability disappeared to 1987. The regression equation is  $y_{it} = b_0 + b_1t + b_2a + b_3a*t + b_4u + b_5u*t$ , where  $y$  is the logarithm of the accident fatality rate per 100,000 population in country  $i$  in year  $t$ ,  $t$  is the year,  $a$  and  $u$  are dummy variables taking on the value 1 for Australia (or the U.S.), or 0 otherwise. The parameter estimates show that there is a highly significant negative trend of fatal accident rates ( $b_1$ ) of -2.1% a year for New Zealand. However, the Australian trend ( $b_3$ ) is significantly more negative, -3.7%, and the U.S. trend ( $b_5$ ) is insignificantly more negative (with a difference of -.0004%), than the New Zealand trend. The point estimates of the intercepts of the trend line of fatal accident rates for Australia and the U.S. are about -4% and -7.5% less than the corresponding New Zealand intercept.<sup>23</sup>

Several conclusions follow from this regression of trends. Over the period since tort liability disappeared from New Zealand, the level of all accident rate fatalities has been higher in New Zealand than in Australia and the U.S. The decrease in fatal accident rates is significantly greater in Australia than in New Zealand. One cannot prove, of course, that these results are a consequence of the absence of tort liability in New Zealand. Indeed, the decrease in accident mortality rates in Australia over

this period is significantly greater than in the U.S., despite the greater level of injury litigation and larger tort damages awarded in the U.S. Clearly the overall accidental fatalities trend in New Zealand shows a smaller decline than the trend in Australia.

#### B. Motor Vehicle Accidents and Tort Liability

There is a vast literature on motor vehicle accidents and a large number of theoretical and empirical studies on the interaction of these accidents and the tort liability system.<sup>24</sup> The size of this literature reflects the importance of these accidents as the primary source of fatal accidents. In New Zealand, Australia, and the U.S., they accounted for 41%, 57%, and 48% of the fatal accidents in 1970 and for 56%, 52%, and 50% in 1987.<sup>25</sup> Motor vehicle accidents also account for a large proportion of serious, but nonfatal injury. Consequently, motor vehicle usage is one of the most heavily regulated activities, with mandatory licensing, motor vehicle inspection, and regulation of driving behavior. Motor vehicle accidents are also the major arena of tort liability for personal injury. They are estimated to account for perhaps 85% of 1970 tort compensation for injury in New Zealand and 52% of 1985 tort compensation for injury in the U.S. Furthermore, a substantial proportion of motor vehicle accidents lead to claims. It appears that about 50% of the injured filed claims, both in New Zealand 1970 and in the U.S. in 1988.<sup>26</sup>

Despite the high involvement of personal injury tort liability and motor vehicle accidents in New Zealand prior to 1974, it is implausible that the abolition of personal injury liability altered the incentives for care faced by most drivers.

Since 1962, owners of motor vehicles were required to insure against negligent damage for bodily injury or death to others. The insurance was automatically part of the annual licensing of vehicles, at government determined rates depending solely on type of vehicle. In 1973, the last year of the tort liability system, there were 12 vehicle rate classes, with rates that varied from a minimum of \$1.10 for power cycles to \$11.35 for private cars to a maximum of \$69 for buses. Comprehensive motor vehicle insurance was also purchased by owners, which generated about four times the premiums obtained from the compulsory third party insurance program prior to 1974. It has been estimated that the comprehensive policies paid out less than 1% of their premiums for injury compensation exceeding the coverage limits of the mandatory liability insurance. The comprehensive insurance gave customers a substantial premium bonus of up to 40% from the previous year, depending on age and previous experience, if the customer had filed no claims during the year. The average of these comprehensive mv premiums per registered car in 1970 were \$45, a modest amount unlikely to generate much effect on driver care.<sup>27</sup>

After the ACC system went into effect in 1974, the general insurance-mediated incentives for care in motor vehicle activities appear virtually unchanged. Fees based purely on vehicle class that had financed the compulsory insurance for third party injury continued to be collected. But they were now paid to the ACC to finance compensation for motor vehicle injuries, instead of to private injurers who had managed the compulsory negligence program. The initial vehicle rates imposed a 25% surcharge on the

previous rates, and were unchanged until 1982. From 1982 through 1991, the number of vehicle rate classes were reduced to 2, based primarily on vehicle size. The larger class (cars, trucks, busses) paid \$14.20 in 1982 and increased in fitful spasms to \$136 in 1991. These vehicle rates are clearly so low that they provide no measurable deterrence to motor vehicle ownership or usage.

Motor vehicle comprehensive insurance also continued, with no discontinuity in the level or volume of premiums collected, since the ACC system only abolished tort liability for personal injury and not for property damage. The upshot of this analysis is that the size of the pre-1974 insurance incentives for motor vehicle care provided by mandatory liability insurance and comprehensive motor vehicle insurance were quantitatively unchanged.

Even so, it is still of interest to examine the data on motor vehicle fatalities. Figure 1B shows motor vehicle accident fatalities per 100,000 population from 1950 through 1990 in New Zealand, Australia, and the U.S. A "stacked" regression of the log of motor vehicle fatalities for levels and trends in the 1974-1987 period yields a statistically insignificant and small (-.001) negative trend for New Zealand, and statistically significantly smaller trends for Australia (-.041) and the U.S. (-.014).

The initial level of fatalities in New Zealand in the Figure is much lower partly because of fewer vehicles per capita, and the steep rise in per capita motor vehicle fatalities reflect the relatively faster growth rate of vehicles per capita in New Zealand. Since 1979, the rate of these fatalities have remained the highest of the three countries.

Figure 2 shows the fatality rate per vehicle. The New Zealand



rate overtakes the U.S. rate by 1970. It remains higher than the U.S. after then, despite a modest erratic decline during the 1970's. It has little trend in the first 20 years or in the 1980's.<sup>28</sup>

It appears unlikely that aggregate motor vehicle fatality data will reveal a response to abolished tort liability in New Zealand because of negligible change in incentives. A more detailed examination of firm level behavior by studying responses to liability by those with deep pockets might be informative, but is beyond the scope of the present study.<sup>29</sup>

### C. Workplace Accidents and Tort Liability

Fatal industrial accidents account for 5.3% of all fatal accidents in New Zealand in 1970, and the fatality rate per 100,000 workers was 8, compared with 18 for the U.S.<sup>30</sup> New Zealand had a workers' compensation system prior to the ACC. In contrast with state workers' compensation in the U.S., the New Zealand system did not extinguish common law tort claims for negligence until adoption of the ACC. In 1965, only .9% of workers' compensation claims led to tort recovery. But these tort claims accounted for 32.5% of the total payments for industrial accidents.<sup>31</sup> Insurance premiums for workers' compensation and common law claims were not experienced rated, but were paid to private insurers at a uniform rate by industry risk classification.

If workers and employers were fully informed of workplace risks, one would not expect the disappearance of tort liability for employers to have a measurable effect on accident rates, since

an efficient level of safety provisions is an essential component of the total compensation of labor. If there is imperfect information, employers might reduce marginal safety expenditures not readily observed by workers or regulators, and engage in a lower level of care that would qualify for negligence.

Unfortunately, no data on worker injuries were published between 1973 and 1979 in New Zealand, and subsequent injury statistics published by the ACC are inconsistent with the pre-1973 data.<sup>32</sup>

Table 2 gives some data on work-related accidental fatalities in New Zealand and the U.S. since 1975, omitting motor vehicle accidents in the course of employment. The fatality rate per worker is lower in New Zealand than in the U.S. for all years except 1982. These rates have tended to decline in both countries, although over the 10 year period from 1975 to 1984, the rate of decline was slightly greater in the U.S.<sup>33</sup>

The small numbers of industrial fatalities in New Zealand make it impossible to disaggregate the data to refined classifications of industrial activity. Furthermore, as Franklin [1975] emphasized, nonfatal industrial injuries were considerably greater in New Zealand than the U.S. Thus the behavior of fatal industrial accidents is a seriously misleading indicator of industrial injury. Therefore a major effort was made to obtain nonfatal industrial data that makes injury rate comparisons possible before and after 1974, between New Zealand and the U.S.<sup>34</sup> In these industrial injury rates, workers are included only if they were away from work for a week or more after the injury.

Table 3 compares New Zealand and U.S. injury rates in the 1990's for 7 major industries. In 6 out of 7 cases, the NZ injury rate is substantially higher than the U.S. Of particular note, in manufacturing the NZ rate is over 3 times as high, and in building and construction it is almost twice as high.<sup>35</sup> Even if the U.S. industrial injury rates are somewhat undercounted because of differences in individual state policies for recording them, it is hard to believe that the differences are due entirely to measurement biases.

No direct conclusions can be drawn about the effects of tort liability from the higher industrial injury rates in NZ relative to the U.S. in the 1990's. Columns 3 and 4 of Table 3 provide additional, more suggestive information. These columns show the trend of injury rates in New Zealand and the U.S. by major industry over a 19-year period, ending in the 90's. The trend is measured by the ratio of the 90's injury rate divided by the corresponding injury rate 19 years earlier. In 6 out of 7 major industries, the injury rate fell in the U.S., while it only declined for 3 of the New Zealand major industries. Furthermore, in the large employment and relatively high injury rate industries, manufacturing and building & construction, the injury rate fell in the U.S. (by -19% and -12%), but increased in NZ (by +14% and +7%). The differences of the change in accidents of New Zealand and the U.S. in each of these industries are significant at the .001 level. These changes are consistent with the belief that the loss of tort incentives in New Zealand and the lack of any experience rating incentives in NZ for workers compensation premiums by firms is associated with the relative increase in NZ

workplace injury rates.

Table 3A provides accident rate comparisons between NZ and the U.S. for 3 observable types of accidental injuries: amputations, fractures, and hernias. These rates corroborate the conclusion based on overall injury rates. The NZ rates are in most cases higher than in the U.S. Table 3B disaggregates the industries to determine the extent to which differences in injury rates of major industries might be related to different compositions of minor industries in the two countries. However, it appears that there is a strong tendency for the U.S. minor industries to have lower injury rates than the NZ rates. Some of the differences are large enough to be puzzling. For example, the chemical and the petroleum & coal products industries in New Zealand have injury rates more than 6 times the rates in the U.S., according to the data. Further research is necessary to determine what lies behind these large differences.

#### D. Rotary Wing Aircraft Accident Rates and Tort Liability

The fear of falling has led to the investigation and the collection of detailed official statistics on civil aviation accidents and the attendant circumstances which are far more accurate and comprehensive than motor vehicle statistics. Because of rules for logging aircraft flights, reasonable estimates can be obtained for accident rates per 10000 flying hours.<sup>36</sup> Table 4 reports accident rates for rotary wing aircraft for New Zealand, Australia, and the U.S. from 1970 through 1988.

There are two striking features in this table. The first is the much higher accident rate per flying hour in New Zealand than

in the U.S. or Australia. The average number of accidents per flying hour between 1974 and 1987 was 3 times as high in New Zealand as Australia and 5.3 times higher than in the U.S. 1974

The second is the large growth in the number of registered rotary wing aircraft in New Zealand, just at the time tort for injury was being abolished. The growth was 43% in 1973 and 76% in 1974. These features are compatible with the interpretation that New Zealand helicopter pilots are less deterred from flying under marginal conditions, where a lawsuit for negligence might be initiated if a passenger was injured in an accident. Such behavior is precisely the sort of conduct that tort negligence helps to deter. Judgment is involved in deciding whether conditions are adequate for flying. Regulation cannot usefully prescribe an adequate set of enforceable criteria to substitute for the pilot's judgment. And a typical passenger lacks the knowledge to assess for himself the risk involved and relies on the pilot's experience. If an accident occurs, a negligence suit allows the litigants to reconstruct the details surrounding the flight, and to make an ex post assessment of whether the pilot should have decided to fly or not. The large increase in the stock of aircraft near the time injury liability was abolished can be interpreted as recognition that more flying services would be demanded if the price of flying didn't have to cover the expected negligence cost from lawsuits.<sup>37</sup>

V. Intermediate Price and Quantity Effects of Abolishing Tort Liability for Injury

This section sketches fragmentary evidence on the effects of liability change on prices, availability, and organizational responses to changes in risk. The focus is on markets for goods and services that have a significant risk component. If expected liability costs are sufficiently high to potential suppliers, liability insurance (if available) is sufficiently costly, and contractual waivers of liability are infeasible, no supply of these goods and services will be forthcoming. No accidental injury will arise from these products that are unavailable because of liability. If such liability of suppliers is abolished, accidental injury will increase only to the extent that the substitute products which are now consumed less because of the newly available products, generated less accidental injury than the new ones appearing in the market.

Less dramatically, expected liability costs to suppliers of risky products may be a significant component of the market price. The market price of such products may decline substantially if supplier liability is abolished. Accidental injury associated with the product will increase to the extent that consumption of the product increases. The fall in the market price of the product exaggerates the incentive to consume more of the product. The fall in the expected liability cost of the supplier is offset in part by an increase in the expected accident cost borne by the consumer. Thus the change in the full price of the product to the consumer is smaller than the change in the market price, and the incentive to consume more of the product is less than would be

suggested by the market price change. The full-price elasticity of demand for the product determines the extent to which product consumption (and therefore accidental injury associated with the product) is altered by the full-price change experienced by the consumer from the change in liability.

Because it is difficult to trace empirically the detailed path from liability change to accidental injury change for specific products, this section merely attempts to document a few examples where availability and prices seem to be affected by liability.

#### A. Commercial Bungy Jumping

There is a demand for physical thrills if the price is cheap enough. A. J. Hackett initiated commercial bungy jumping on a bridge near Queenstown, New Zealand in November 1988.<sup>38</sup> The opening of this new market was preceded by a thorough examination of physical standards and procedural safeguards that would leave customers depleted of adrenaline, but otherwise intact. Liability insurance was not a relevant factor in the costs of initiating this enterprise. The current price of a jump is 19 NZ dollars (about \$12 U.S.). Most local governments and landowners insist that operations satisfy safety standards established by the Standard Association of New Zealand (which Hackett helped to develop.) To date, there has been only commercial bungy fatality in New Zealand (by an inexperienced operator not associated with Hackett).<sup>39</sup>

In the U.S., local and state regulation typically impose mandatory insurance for such activities, if they are allowed at

all. It may have been difficult initially to obtain the coverage given the lack of insurer experience with this activity, which probably delayed the start of commercial bungy jumping. Currently, liability insurance is 5% to 7% of gross revenue of each jump, and provides \$1,000,000 in coverage, with \$5000 deductible. Customers are required to sign liability waivers (which would be unenforceable against negligence). The usual price of a jump in the U.S. is \$25.<sup>40</sup>

This brief survey of the new bungy jumping industry suggests several conclusions. The combination of tort liability and regulatory insurance mandates may delay the development of new industries supplying products with unfamiliar risks. In this example, there is a market price difference in New Zealand and the U.S. which is much greater than the insurance required for tort liability cover. This net difference market price presumably reflects other demand and cost differences. Determining these other differences is beyond the scope of this paper.

There are many other cases where product availability, or the timing of its availability, and the market price are significantly influenced by potential liability. Consider the production of small planes for general aviation, or the sponsorship of athletic events and other risky activities by schools and local governments. These are examples where observable differences between New Zealand and the U.S. (and other tort liability countries) could probably be uncovered by a diligent scholar with a surfeit of research funds. It would be much harder to estimate the net effect of these differences on accidental injury rates.



## B. Prices of Pharmaceutical Products

Because of the serious harm that may arise from the use of pharmaceutical products, it seems plausible that drug prices will reflect potential liability of the manufacturers. Recent studies by Garber [1993] and Manning [1994], [1995] provide strong empirical support for this conjecture. This section compares the prices of some pharmaceutical products in New Zealand, the U.S., and Canada to provide some quantitative evidence on the potential size of these liability premiums.

Table 5 shows some time series data of the price per dose of DPT vaccine in the U.S. and New Zealand.<sup>41</sup> The first row gives the catalog price of a dose in the U.S. The second row gives the price paid (converted to U.S. dollars) for a dose of DPT vaccine by the New Zealand government for each year in which there was a change in supplier (and contract price).

Three pieces of evidence strongly support the conclusion that the rapid, 3000% increase in DPT price in the U.S. between 1982 and 1987 reflects the liability costs implied by the rapid increase in lawsuits claiming severe neurological damage to a small number of children from use of the vaccine. (1) The U.S. price of DT vaccine (which has no such neurological effects, but doesn't immunize against pertussis (whooping cough)) was never more than 10% less than DPT price between 1950 and 1982. This suggests that DPT and DT have similar costs over that period. (2) Between 1982 and 1987, the price of DT vaccine in the U.S. only increased by 40%. (3) Table 5, line 2 shows that even by 1991, the U.S. dollar price of DTP vaccine in New Zealand was less than the

U.S. catalog price in 1981. (4) As of 1993, the New Zealand contract price of DT vaccine was about 7% less than DPT vaccine. The last three statements imply that the DT price continues to be a reasonable proxy for estimating costs of DPT, that the costs of manufacturing and marketing DPT have increased very modestly in the U.S. over this period, and that the contract price of DT and DPT vaccine differs only by 7%. The New Zealand price information provides strong auxiliary support for Manning's [1994] empirical evidence that the rise in the U.S. price of DPT reflects liability costs. The data suggest that the absence of tort liability in New Zealand yields much lower pharmaceutical prices for products with substantial perceived risk.

Lines 3 and 4 in Table 5 provide some evidence on the substitution induced by the very large price increase of DPT vaccine.<sup>42</sup> Line 3 is number of doses of DPT sold from 1981 to 1988, while line 4 is the ratio of DT doses to DPT doses sold over the same period. As indicated above, DPT is riskier than DT, because the pertussis vaccine can occasionally cause severe neurological damage. Although the variation of the sales of DPT over time is very small (line 3) the variation of the ratio of DT to DPT sales is much larger. In fact, the sales of DT more than doubled between 1981 and 1984. This strongly suggests substitution away from DPT as its relative price shot up with the lawsuits.<sup>43</sup> But line 3 shows that quantitatively the reduction in exposure to DPT was very small. The modest substitution associated with the extremely large price changes for vaccines is not surprising. The vaccine cost is generally only a modest part of the cost of getting vaccinated, there are large public subsidies of

vaccination programs, preschool vaccination is mandated by law in many places, and parents of children getting vaccinated rely heavily on the doctor's judgment.

A larger sample comparison of pharmaceutical prices in New Zealand, the U.S., and Canada is shown in Figures 4A, 4B and Table 6. The sample of drugs is based on a subset of 54 of the most commonly prescribed in the U.S. in 1991, for which comparable price data could be obtained for the three countries.<sup>44</sup> Figures 4A and 4B show smoothed nonparametric estimates of the cumulative distribution function and density functions of the U.S.-NZ and the Canadian-NZ price ratios. The Figures clearly display the long right-hand tail of the U.S.-NZ ratio, which shows the substantial number of U.S. prices that are much higher than the NZ prices. Table 6 reports the median price ratios of 3.19 for the U.S.-NZ and 2.00 for Canada-NZ.

In the absence of a more complete model of international pharmaceutical price determination, one cannot determine the extent to which the lower New Zealand prices is a consequence of the absence of tort liability. In his comparison of a larger set of U.S. and Canadian drug prices, Manning [1995] finds that about half of the price differential of the U.S. and Canadian pharmaceuticals can be rationalized by the U.S. liability system, based on strict product liability. Since the New Zealand prices also tend to be substantially less than the Canadian prices, the data suggest that there may be a substantial liability component in the Canadian prices which does not appear in the New Zealand prices.

C. Marketing and Withdrawal of New Risky Pharmaceutical Products

Does tort liability have a measurable effect on the way societies deal with specific kinds of risk? This section contains a short, informal empirical exploration of potential differences between New Zealand and the U.S. in dealing with risks associated with new pharmaceutical products. The release of such products on the market and the withdrawal of harmful ones is determined by a complex process influenced by regulation, as well as liability.<sup>45</sup> This process is not well understood, and no attempt is made here to develop a satisfactory model. Even in the absence of tort liability, large pharmaceutical manufacturers presumably have a reputational concern of not decimating their customers by the unanticipated adverse effects of new products. Nevertheless, the threat of potential liability imposes an additional expected cost of marketing a product that may turn out to have sufficiently adverse effects.

Hence more drug manufacturers may seek marketing approval in New Zealand before the U.S. for two reasons. First, if the product turns out to be defective, there is no expected tort liability cost in New Zealand. Second, the marketing of a drug provides additional information about risks that might not be detected by the smaller number of cases in clinical trials. The discovery of serious adverse effects at this stage could then lead to its withdrawal with less potential liability than if it had been marketed first in the U.S. These informal arguments have two observable implications. (1) There may be a greater tendency for pharmaceutical producers to apply to New Zealand for marketing

suggests that New Zealand's marketing approval process is not freeriding on the approval process in these other countries, since the ratio would be close to zero in this sample (because it only includes drugs already accepted in the comparison country.)

To compare the screening provided by the marketing approval process in New Zealand and the U.S., supplementary information was obtained on drugs in the list of 56 that had applied for, but not received, marketing approval in the U.S.<sup>49</sup> Five drugs were found satisfying these criteria. Three of these also applied for New Zealand approval, and are indicated by the "NA" in the U.S. column of Table 7. From the available information, the nonapproval to marketing application ratio is  $8/17 = .471$  in New Zealand, and  $5/16 = .313$  in the U.S. Although the difference in the nonapproval ratio is not statistically significant, it is noteworthy that the actual nonapproval of drugs subsequently withdrawn from a market was higher in New Zealand than the U.S.<sup>50</sup>

In summary, the brief study of new drug approval and withdrawal in this section leads to the following conclusion. Despite the substantial differences in the liability and regulatory systems of the two countries, New Zealanders face no more risk than Americans from the release of new pharmaceutical products that are subsequently withdrawn because of unanticipated side effects.

### E. Private Versus Public Information on Risk

The proponents of the ACC system declared that risk reduction and rehabilitation were as important as compensation for lost income and health costs. It was argued that the centralized administration of the system would give it data that should make it possible to understand much better the accident generation process. In turn, this should reduce accidental injury rates. An analogy was made with the historical role played by insurance companies in supplying fire insurance, information, and incentives to their customers to engage in appropriate risk reduction measures.

Nothing of the sort happened. The ACC did not even continue to collect and publish the high quality industrial accident statistics that had previously been the task of the Workers' Compensation Board. Nor did the ACC develop a serious program of accident research. There was no publication of industrial accident data by the ACC for over five years. The quality of the data published by them was vastly inferior to the earlier data supplied to the Department of Statistics by the WCB. The ACC administrators were primarily concerned with speedy and low-cost claims processing. The annual reports are filled with self-applause for this achievement.

The ACC experience suggests that government agencies are unlikely to carry out efficiently "public good" activities in the absence of a strong constituency supporting the necessary expenditures. It would be quite interesting to determine how much expenditures on risk reduction have been altered because of the

disappearance of liability for injury.

## VI. Conclusions and Potential Extensions

The economic theory of tort liability emphasizes the importance of offsetting behavior by potential injurers and injurees in determining the effect on the accident rate if major modification of the tort system occurs. This paper has argued that abolishing tort liability will increase the accident rate if victim and injurer care are imperfect substitutes and subject to sufficiently strong diminishing returns in reducing accidents.

A large empirical effort was made to collect and analyze data from New Zealand, Australia, and the U.S. before and after 1974, the year in which New Zealand adopted a universal Accident Compensation system, which abolished all tort liability for personal injury. The major objectives of the empirical work are to determine whether the evidence supports the theoretical prediction and to verify what happened after New Zealand abolished tort liability.

In 1970 about 85% of all tort compensation for personal injury in New Zealand was related to motor vehicle accidents. Furthermore, given the previous system of compulsory third party motor vehicle insurance, it appears that getting rid of tort liability left the incentives of those involved in motor vehicle accidents virtually unchanged. Thus it would seem, a priori, that little effect on aggregate accident rates would be observed.

There is indeed no evidence of an increase in the aggregate level of fatal accidents after the change in regime. But a regression shows that over the next 13 years, fatal accidents

declined (significantly) more slowly in New Zealand than in Australia, and (nonsignificantly) more slowly than in the U.S. This result suggests that overall accident rates are not very sensitive to tort liability, but that over longer periods of time, the lack of liability may blunt responses to potential injurers spending resources to reduce accidents.

In contrast with the U.S., New Zealand's system of workers' compensation before 1974 retained the opportunity for an injured worker to sue his employer for negligence instead of collecting workers' compensation. Evidence was found that in New Zealand in 1965, these negligence payments accounted for almost a third of total payments to injured workers. A major effort was made to obtain data that would enable comparisons of levels and trends of industrial injury rates in New Zealand and the U.S. Recorded injury rates in New Zealand in the early 90's are almost twice as high in construction and three times as high in manufacturing as they are in the U.S. It is difficult to interpret these large differences, given the possibility of substantial recording biases. However, there were positive trends of injury rates for these industries over the preceding 19 years in New Zealand, and negative trends in the U.S. This finding is a much more persuasive piece of evidence showing that New Zealand has experienced an increase in industrial accident rates relative to the U.S. since it abolished tort liability. A detailed understanding of what lies behind these different trends requires future study.

Data were also found showing civil aviation rotary wing aircraft accidents per flying hour in New Zealand between 1974 and



1987 have been almost three times more than in Australia, and over five times more than in the U.S. The lack of tort liability is plausibly related to these differences.

New Zealand did not have a strict product liability doctrine in 1974 when it eliminated tort liability, and it is unclear to what extent the doctrine might have evolved. Nevertheless, part V of the study shows that vaccine and other pharmaceutical prices tend to be much lower in New Zealand than in the U.S. or Canada. It seems plausible that a significant amount of these price differences can be explained by the absence of a liability premium in New Zealand. Further research is required to determine more precisely the size of this premium. Because of the heavy use of insurance and the way drugs are prescribed, it seems likely that the demand for prescription drugs will have a relatively low price elasticity. Therefore it appears unlikely that these very large price differences will have much effect on the quantity sold, and therefore on the amount of accidental injury that will arise from use of these drugs.

An exploratory attempt was made to determine the interaction of liability and drug marketing regulation by comparing the market approval and withdrawal of drugs with unexpected harmful side effects in New Zealand and the U.S. No evidence was found to support the conclusion that New Zealand consumers were more at risk from release or withdrawal of such drugs than U.S. consumers. Thus, New Zealand's lack of liability and relatively rapid system of processing marketing requests (normally taking less than two years) seems to generate no more bad outcomes than the U.S., with product liability and a much slower processing of marketing

requests by the FDA.

In summary, this study finds that the removal of tort liability for accidental injury has had at most a modest long run trend effect in increasing aggregate fatal accident rates in New Zealand. But there is strong evidence that it can have a large effect on the availability of highly specific products and activities, and on their prices, if they are available.

An important direction for future research lies in a thorough exploration of the Tort-Regulation Interactions hypothesis. There are extensive safety regulations in both the U.S. and in New Zealand. In both countries, some administrative apparatus exists to inspect for compliance, which has the nominal power to impose penalties for failure to comply. Does the threat of tort liability substantially increase the level of compliance? This outcome seems plausible if failure to comply with the regulation would be considered strong prima facie evidence of negligence if an accident occurred. It is usually difficult, and often impossible, to provide a convincing demonstration of the effect of one or more safety regulations on accident rates. Even so, we would understand the potential costs and consequences of regulation better if we knew the extent to which tort incentives increase regulatory compliance.

## Appendix A

This appendix derives the effects of the abolition of tort liability for negligence on the normalized accident rate. The first order conditions for utility maximization by the accident victim's choice of hazardous activity  $x$  and care expenditures  $c$ , (3a) and (3b) are rewritten as implicit functions:

$$h(x,c,y,d) \equiv f'(x) - y\lambda H - p_x - c = 0 \quad (1a')$$

$$i(x,c,y,d) \equiv -x(y\lambda_c H + 1) = 0 \quad (1b')$$

The partial derivatives of these implicit functions are:

$$h_x = f''; \quad h_c = -(y\lambda_c H + 1) = 0; \quad h_y = -\lambda H; \quad h_d = -y\lambda_d H; \quad i_x = (y\lambda_c H + 1) = 0; \\ i_c = -xy\lambda_{cc} H; \quad i_y = -x\lambda_c H; \quad \text{and} \quad i_d = -xy\lambda_{cd} H.$$

The response of an injuree's activity and care levels to the change in the injurer's activity and care variables when tort liability vanishes is determined next. By implicit differentiation, the partial derivative of  $x_y$  is:

$$x_y = \frac{-\begin{bmatrix} h_y & h_c \\ i_y & i_c \end{bmatrix}}{\begin{bmatrix} h_x & h_c \\ i_x & i_c \end{bmatrix}} = \lambda H / f'' < 0. \quad (2a')$$

Similarly, the other partial derivatives of interest are:

$$c_y = -\lambda_c / (y\lambda_{cc}) > 0; \quad (2b')$$

$$x_d = y\lambda_d H / f' > 0; \quad \text{and} \quad (2c')$$

$$c_d = -\lambda_{cd} / \lambda_{cc} < 0. \quad (2d')$$

The signs of the derivatives were obtained from the first three assumptions made about the signs of the first and second order partial derivatives of  $\lambda(c,d)$ . The main text showed that abolishing tort liability leads the potential injurer to increase his accident generating activity  $y$  and to decrease his care level

d. Thus the signs of the derivatives in equations (2a'), (2b'), (2c'), and (2d') prove that the potential victim responds qualitatively in an offsetting way to the injurer's behavior. The victim decreases  $x$  and increases  $c$  in response to the injurer's increase in  $y$ . And the victim decreases  $x$  and increases  $c$  in response to the injurer's decrease in  $d$ .

Sufficient conditions that assure an increase in the normalized accident rate  $\pi/x$  ( $\equiv y\lambda$ ) if tort liability for accidental injury is abolished are  $\partial(y\lambda)/\partial y > 0$  and  $\partial(y\lambda)/\partial d < 0$ .

$\partial(y\lambda)/\partial y = \lambda + y\lambda_c c_y$ . Substituting for  $c_y$  from (2b'), the first sufficient condition implies

$$(\lambda_c)^2 < \lambda \lambda_{cc}. \quad (3a')$$

This differential inequality is satisfied by

$$\lambda[\gamma(c) + \delta(d)] = ke^{-[\gamma(c) + \delta(d)]}, \quad (3b')$$

where  $\gamma(c)$  and  $\delta(d)$  are increasing, strictly concave functions of their arguments, as defined in (1a) of the main text, and  $k > 0$ . (Concavity of  $\delta(d)$  is unnecessary here, but is required in the next paragraph.) Since  $ke^{-[ac + bd]}$  (with  $a > 0$ ,  $b > 0$ ) satisfies the differential equation (3a') as an equality, these results suggest the strength of diminishing returns of safety expenditures  $c$  that are sufficient to assure that an increase in  $y$  by the injurer induces an increase in the normalized accident rate.

The condition  $\partial(y\lambda)/\partial d < 0$  implies  $y(\lambda_d + \lambda_c c_d) < 0$ . Substituting for  $c_d$  from (2d') gives the differential inequality

$$\lambda_d \lambda_{cc} < \lambda_c \lambda_{cd}. \quad (4')$$

Restriction (1a) in the main text,  $\lambda(c,d) \equiv \lambda[\gamma(c) + \delta(d)]$ , satisfies (4'), since it leads to the condition  $\lambda''\gamma'' > 0$  because of

the assumptions  $\lambda' < 0$  and  $\gamma'' < 0$ . Thus restriction (1a) is sufficient to assure that a decrease in care level  $d$  by an injurer increases the normalized accident rate. Since the specific  $\lambda$  in (3b') belongs to this class, it follows that this  $\lambda$  satisfies the sufficient conditions for an increase in the normalized accident rate.

## Appendix B

### The Accident Compensation Corporation System in New Zealand<sup>51</sup>

The ACC system compensates individuals for personal injury by accident, but not for losses due to disease, a distinction that is often murky. Compensation covers wage loss (a totally disabled worker can collect 80% of lost income with a ceiling of approximately NZ\$70000 a year) up to age 65. The ACC pays no wage benefits for the first week, but if the worker is employed (i.e., not self-employed), the employer pays at this rate for the first week. If the worker dies from the injury, surviving dependents receive (collectively) up to the full amount of lost wages the worker was entitled to receive.<sup>52</sup> All New Zealanders receive a high level of medical benefits, but those injured are treated even more generously than those suffering from illness.<sup>53</sup> Medical benefits include doctor's, dentist's, and psychiatrist's services. Rehabilitation (including physiotherapist) services are also covered.<sup>54</sup> A scheduled lump sum payment for permanent loss or impairment of bodily function (up to a maximum of NZ \$17000, as adopted in 1982) can be awarded. Finally, a lump sum payment of NZ\$10000 can be awarded for loss of enjoyment of life.<sup>55</sup>

The ACC system is financed from three funds. The earners' fund covers all work and nonwork injuries except for automobile accidents. It is paid from a payroll tax on employers for employees (up to the maximum earnings covered). Until 1992, a flat rate was paid for nonwork injuries to employees in all industries, varying from \$.32 in 1985 to \$1.05 in 1988 per \$100 payroll.<sup>56</sup> Employers were classified in decreasing numbers of broad

industrial classes, declining from 160 in 1984 to 27 in 1995, which pay different payroll rates for work-related injuries. Since 1984, the average rates paid for work injuries (net of the flat rate for nonwork coverage) per \$100 payroll varied from \$.40 in 1984 to \$1.69 in 1995. The specific industry rates per \$100 payroll ranged from \$.25 (accounting) to \$5.00 (aerial crop dusting) in 1974 and from \$1.30 (accounting) to \$18.70 (crop dusting) in 1988.<sup>57</sup>

The variations in these rates are largely a consequence of changes in the pay-as-you-go system for financing the payments. There is no experience rating of individual employers. Self-employed earners pay a levy on their own earnings.

The motor vehicle fund, which pays for all powered vehicle-related (automobile, truck, bus, motorcycle) injuries is financed by annual flat-rate vehicle tax unrelated to driver, usage, or vehicle vulnerability in accidents.

The supplementary fund for injuries to nonworkers is financed by general tax receipts.

This brief description of the ACC system indicates that the finance of coverage for injury is only weakly related to type of activity, exposure to risk from the activity, or personal care in engaging in the activity.

## Footnotes

\*This study would not have been undertaken without George Stigler's support for initiating the project at the CSES in 1992 and his lifelong insistence on linking economic theory and evidence. Yoram Barzel, Gary Becker, Roger Kerr, and Sam Peltzman provided exceptional comments or assistance in pursuing the study. Lisa Orman was an exemplary research assistant. Qun Shi supplied rapid and efficient computational assistance. An extraordinary number of people have provided me with institutional information, data, and feedback, some of whom are acknowledged in the appropriate places. I am strictly liable for conclusions, lapses, and errors.

<sup>1</sup>National Safety Council [1994], page 2 (after subtracting motor-vehicle damage and fire loss).

<sup>2</sup>National Safety Council [1994], pages 1-6.

<sup>3</sup>The probability for one accident with the Poisson assumption is  $\pi = yx\lambda(c,d)\exp[-yx\lambda(c,d)]$ . But since  $0 < yx\lambda < 1$  in our application, the approximation given by (1) is satisfactory.

<sup>4</sup>The stochastic net harm to the victim,  $(H-L)$ , is written directly into the utility function and not the budget constraint. If the accidental injury occurs, the victim loses the utility equivalent  $H$ , measured in terms of equal loss of consumption of the numeraire commodity  $z$ . But the victim is then compensated by an income transfer  $L$ , which would be spent in this model on the numeraire commodity  $z$ . One could write the harm loss in the utility part and the liability compensation in the budget constraint, a formally equivalent specification. The same issue arises in writing the expected liability of the injurer as part of the injurer's utility function, and not as part of the injurer's income constraint. Sherwin Rosen kindly suggested clarification of this point.

<sup>5</sup>This result is a consequence of specifying  $\pi$  as a linear function of  $x$ . More generally, let  $\pi = w(x)v(y)\lambda(c,d)$ , where  $w(x)$  is a monotonically increasing function of  $x$  and  $w(0) = 0$ . If  $w$  is concave, the care level  $c$  satisfying the first order condition (3b) is smaller than the  $c$  that minimizes the full price of  $x$  in (3a). And if  $w$  is convex, the  $c$  satisfying (3b) is greater than the  $c$  that minimizes the full price of  $x$ .

<sup>6</sup>This quasi-Peltzman effect is a pervasive issue in the analysis of the net consequences of a policy change. Peltzman (1975) argues that mandatory safety standards for automobiles that (in our terminology) initially reduce  $\lambda$  would be offset (in part and perhaps totally) by changed behavior, such as more rapid driving. The induced change in activity level was not explored. Although this response would offset in part the lower  $\lambda$  in the specific activity, the net effect on the overall number of accidents would depend on the probabilities of accidents in substitute activities.



<sup>7</sup>With minor expository changes, the subsequent analysis leads to the same conclusions for a strict liability standard.

<sup>8</sup>The model assumes that liability for negligence would never occur because the injuree would always act carefully enough (choose a large enough  $d^*$ ) to avoid negligence. Thus the liability term  $L = 0$  in the victim's first order conditions (3a) and (3b). This assumption is clearly counterfactual, because substantial transfer payments are made under the negligence system. However, the purpose of the model is to help determine what would happen to the accident rate if legal liability is abolished. It is much easier to carry out this analysis with a model that is not constrained to explain the positive liability payments we observe.

<sup>9</sup>Yoram Barzel notes that the following discussion ignores why the liability rule might be abolished, if one regards such rules as an endogenous outcome of a more comprehensive economic model. The empirical part of this study is motivated by an interest in understanding New Zealand's experience before tort liability for personal injury was abolished in 1974. The New Zealand legislation grew out of a commission set up to deal with dissatisfaction with the Workers Compensation system. Geoffrey Palmer's [1979] fascinating account of the history of this legislation leaves one baffled about the forces leading to the radical change that was enacted in the Accident Compensation Commission legislation.

<sup>10</sup>If  $v(c)$  is an increasing linear function, and not a strictly concave increasing function, Appendix A shows that  $\partial(\pi/x)/\partial y=0$ .

<sup>11</sup>This analysis assumes that transactions costs are high enough to prevent victims from bribing injurers to be more careful. For accidents between strangers the assumption is very plausible. For accidents between parties with regular transactions (such as employers and employees) it is less plausible. Yoram Barzel suggested making this assumption explicit.

<sup>12</sup>I am unaware of any theoretical or empirical presumption why in general there should be a systematic difference in activity level responses by the victim and injurer. This contrasts with the plausibility of diminishing returns from care and imperfect substitution of victim and injurer care.

<sup>13</sup>If accident victims are overcompensated in the initial equilibrium with tort liability, elimination of tort liability would induce a larger increase in victim care and/or reduction of accident generating activities than if the initial compensation level was efficient. John Lott pointed out the possibility of this offsetting effect on the predicted increase in accidents. In the context of the New Zealand system before the liability change, no evidence I am aware of suggests initial overcompensation.

<sup>14</sup>This is precisely the policy change adopted in New Zealand in 1974 with the adoption of the Accident Compensation Commission.

<sup>15</sup>Insurance may also play an important and more active role in dealing with risk. Economies of scale in claims transactions may provide insurance companies with superior knowledge about accident generation and accident reduction technology than their clients possess. Thus they may provide their clients with useful information on loss reduction as well as coverage for risk. And they have an incentive to monitor their clients care level efficiently.

<sup>16</sup>The ACC system is described in Appendix B.

<sup>17</sup>This brief description draws heavily on Mark Franklin's [1975] study of New Zealand's accident system in 1970. Geoffrey Palmer's [1979] detailed study of the adoption of the ACC legislation also provides useful information on New Zealand's legal system.

<sup>18</sup>Franklin [1975], p. 99 reports that only 2% of a 2/3 sample of successful claimants in motor vehicle accidents went to trial.

<sup>19</sup>The estimate of total tort liability payments for 1970, \$15,606,000, adjusts Franklin's [1975] estimate of \$13,475,000 for the actual claims finally paid out for motor vehicle accidents in 1970 according to the Department of Statistics Insurance Statistics, 1983-84 and for estimated unsettled claims for worker accident tort claims. The lower 1985 estimate for the U.S. is based on the lower figure of Kakalik and Pace's [1986] estimated range of \$21-\$25 billion for tort compensation. The higher figure is based on Sturgis' [1992] estimate.

<sup>20</sup>According to unpublished NZ census data, average income (not salary) of all self-employed solicitors was \$18,700 in 1970. There were 2776 practicing certificates in 1970. Assuming each of these had an average practice income equal to the average income of the solicitors (a substantial overestimate) yields \$51,981,000 in total salaries. Using 8% of \$15,606,000 of estimated tort payments in footnote 17 yields \$1,248,000, 2.4% of total estimated practice income. Using the same method to estimate total practice income in 1973 and 1974, there was a decline in practice income of \$4,683,000. If the personal injury tort actions had been in steady state, and had increased in nominal value as rapidly as the CPI, we can interpret the decline in injury tort income in 1974 as accounting for 38% of the estimated nominal decline, to a first order approximation.

<sup>21</sup>Households in the survey were classified having such an injury only if they satisfied at least one of the following criteria. (1) The injury lead to one or more nights in a hospital. (2) The injury required at least one day of restricted activity. (3) The injury led to a visit to a health professional. (4) The injury led to initiating or resolving a liability claim. (Hensler et al [1991], pp. 9-10.)

Hensler et al. state the 3 important categories of accidents causing injuries which generate tort claims in the U.S. are those associated with motor vehicles, those in which some product is involved, and those involving slips and falls. Narrowing down the

injuries in these categories for which a third-party target might be available leads to the conclusion that about 67% of the accident-incidents in the sample might potentially have led to liability. (Hensler et al, p. 50.) In fact, given the costs of pursuing liability, and the fact that most injuries are relatively minor, only 10% of the accident-incidents led to any effort to legal action (p. 110). In discussing how severity of injury is related to tort action, the authors report that the distribution of accident-incidents is 7% very serious, 21% moderately serious, and 72% relatively minor (p. 41). The corresponding percentages of those within each of these injury categories taking some legal action is 35%, 21%, and 8%, respectively (p. 127).

I have been unable to find corresponding estimates of the fraction of fatal accidental injuries that result in liability claims or recovery.

<sup>22</sup>One disadvantage in focussing on accidental fatalities is the relatively small sample size for New Zealand. In 1970, there were 1586 accidental deaths according to the New Zealand National Health Statistics Centre. One cannot disaggregate this information across many activities before one runs into sampling variation problems due to small numbers.

It is not necessarily true that a higher fatality rate in a particular activity implies a higher injury rate. Franklin's (1975) careful study compares New Zealand and the U.S. for both accident fatalities and injuries in 1970. For industrial accidents, Franklin reports the New Zealand injury rate appears to be more than twice the U.S. rate, but the New Zealand mortality rate is less than half the U.S. rate.

<sup>23</sup>Lung Fei Lee, Stefan Mittnik, and George Tauchen were very helpful in implementing and discussing the stacked regressions. This "stacked regression" was specified to facilitate testing the hypothesis that the Australian and U.S. parameters are the same as those of New Zealand. Standard hypothesis testing assumes that the residuals are identically, independently and normally distributed. Running separate regressions for each country yielded Durbin-Watson D statistics of 1.666, 1.936, and .592 for New Zealand, Australia, and the U.S., indicating serial correlation is a problem only for the U.S. Running first, second, and third order autoregressions on the U.S. data led to acceptance of the second order specification, with  $AR(1)=1.19$  and  $AR(2) = -.74$  on the grounds that BIC initially decreased, then increased in going from the second to third order specifications. The residual variances from the individual regressions for the 3 countries differ, with New Zealand having the largest variance.

The point estimates of the differences between the NZ trend and the Australian and U.S. trends are  $-.0158$  and  $-.0013$ , respectively. The corresponding differences between the intercepts are  $-.0240$  and  $-.0666$ , respectively. In comparison with the stacked regression results in Table 1, the Australian trend coefficient is still significantly less than New Zealand's. But the U.S. intercept is no longer significantly less than the New Zealand intercept.

<sup>24</sup>See Zlatoper [1989] for a survey of empirical models to explain motor vehicle death rates in the U.S. and their results. Brown [1985] discusses New Zealand from 1966 through 1980 of New Zealand motor vehicle accidents, registered vehicles, registered motor vehicles, estimated kilometers traveled, and enforcement variables, and concludes there is little support for believing that the loss of tort incentives affected the accident rates. Frith and Toomath [1982]. See McEwin [1989] for evidence that liability rules affect motor vehicle accidents in Australia, and Scott, Pittams, and Derby [1987].

<sup>25</sup>Data obtained from World Health Organization, World Health Statistics Annual, with accidental deaths classified by the ICD (International Statistical Classification of Diseases, Injuries, and Causes of Death).

<sup>26</sup>The New Zealand figure is obtained by updating information in Franklin [1975], pp. 668-672. The Department of Statistics, Insurance Statistics 1983-1984 reports the third party risks payments for 1970 claims was ultimately \$1,291,000 more than the \$11,000,000 estimated in Franklin. Adding this to Franklin's other figures yields \$12,621,000 and \$14,766,000 for motor vehicle and for all tort insurance injury payments, respectively. One insurance executive suggested to me in a 1992 interview that the estimate of total medical malpractice payments for \$185,000 was probably too high.

The American figures for nonfatal injury tort payments are derived from Hensler et al [1991], p. 198. The 52% figure comes from upper estimates of \$13 billion for motor vehicle tort payments by the National Association of Independent Insurers and \$25 billion tort compensation paid in 1985 by Kakalik and Pace [1986].

Estimates of the portion of motor vehicle injury leading to tort action are from Franklin [1975], p. 669 and Hensler et al [1991], p. 124.

<sup>27</sup>See Franklin [1975], p. 669, for the estimate of comprehensive insurance payments for injury. See Brown [1985], pp. 981-982, for information on comprehensive premiums. Darrin Goulding of the ACC kindly furnished me with the complete data from 1975 through 1994.

<sup>28</sup>The apparent jump in the fatality rate is a statistical fluke related to a changed procedure for recording motor vehicle fatalities, in which a delay for the final coroners report was eliminated. A new highway speed limit, lowering open road maximum speeds from 55 to 50 mph was also imposed in 1974, as an energy saving response to the OPEC oil crisis. Frith and Toomath [1982] report there was a popular patriotic response to this policy. Both the mean and standard deviation of highway speeds (both factors positively correlated with motor vehicle accidents and fatalities) declined significantly in rural areas for several years and then slowly increased. The relative number of rural area highway fatalities fell during this period, providing highly persuasive documentation of the policy and behavioral change. Land Transport's Motor Accidents in New Zealand, 1990 document a number of other changes in motor vehicle regulation and enforcement since 1974.

<sup>29</sup>An unsuccessful effort was made to locate data that would permit the comparison of motor vehicle accident rates involving rental cars and driver-owned cars, in which a car defect was a factor that appeared to contribute to the accident. The issue is whether potential liability for negligent maintenance of a car induces rental fleet owners to a more vigilant program of vehicle maintenance, to avoid potential high liability from such accidents. If the maintenance is superior for rental cars, that should show up in a lower accident rate from vehicle defects for rental cars. A similar difference might show up in truck accident rates associated with defective vehicles in a comparison of large trucking companies which own their own vehicles with one-man trucking businesses.

<sup>30</sup>Franklin [1975], p. 661.

<sup>31</sup>The Workers' Compensation Report states that \$2,266,264 common law claims were paid out, and total payout in 1965 was \$6,979,082. Adjusting Franklin [1975], pp. 670-672, by \$840,000 for claims from 1970, still unresolved in 1974, at the average 1965 tort compensation and allowing for the CPI change yields estimated tort claim payments of \$2,500,000 out of total payments of \$10,240,000.

<sup>32</sup>See Langley and McLoughlin [1987], p. 66-67. Industrial accident statistics in the pre-ACC era were collected by the Workers Compensation Board published in their annual reports at a fairly aggregated level. The Department of Statistics published detailed accident rate statistics based on this and other information. The ACC took over this function, but took very little interest in spending any resources on it, and did not publish accident statistics until 1980. The criteria for inclusion injury or mortality in their data is administrative, related to their compensation function. They contain fatalities only if a compensation claim was filed. They generally omit injuries for which the worker is absent for work less than a week, since they pay no compensation for the first week. Hence the statistics they have published annually since 1982 are not consistent with the pre-ACC data.

33 A stacked regression of the log of the fatality rates on level and trend gave a significant trend coefficient of  $-.07$  for New Zealand and difference in U.S. trend (nonsignificantly) more negative for the U.S.

One possible source of higher fatality rates in U.S. industrial injury is acts of homicide. The Occupational Safety and Health Reporter, (August 17, 1994), 20% of nonhighway, work-related fatalities are a consequence of homicide. And homicides are less common in New Zealand than in the U.S. Walter Oi brought this information on workplace homicides to my attention.

34 The 1992 injury rates for the U.S. are based on a BLS data tape which made it possible to include in the injury counts only injuries leading to the injured worker missing at least 5 days of work. This restriction was an important criterion for making the U.S. injury rates comparable with the New Zealand rates. The 1990 New Zealand injury rates are based on an ACC data tape for industrial injuries for which the worker received compensation from the ACC (which requires the injurer to be away from work for a week). I am indebted to John Ruser at the BLS for the U.S. calculations, Leanne Robertson at the ACC for arranging for the New Zealand data tape, and Qun Shi for carrying out the New Zealand accident rate calculations.

The 1973 data on U.S. injuries is from BLS Bulletin 1874. Since this source reported injury rates based on workers losing at least one work day (but not on workers losing at least 5 days), a second 1992 U.S. injury rate was calculated, based on the one-or-more lost days criterion. This made possible the construction of a meaningful U.S. injury rate trend from 1973 to 1992. The 1971 data injury data from New Zealand was obtained from the Department of Statistics' Industrial Injuries 1971, Part B, Table 30, which made it possible to include only injuries for which the worker was away from work for a week or more after the injury. Industrial employment data were obtained from the New Zealand Official Yearbook.

35 The differences between the levels and trends of industrial injury rates in New Zealand and the U.S. are an important issue that merit further research. It seems unlikely that the different trends are solely a consequence of eliminating tort liability in New Zealand.

36 I am indebted to Ron Chippendale for making available the New Zealand civil aviation accident statistics and for very useful supplementary information and advice on them. Unfortunately, New Zealand ceased publishing flight time accident rates after 1987.

37 This discussion doesn't imply that the drop in expected liability cost was the only factor affecting this market. The high rate of crashes peaking in 1973 was partly a consequence of a bizarre activity of commercial culling of deer from the air by shooting or netting them from helicopters. Property damage from destruction of the rotary craft led to insurance rates of about 25% of the cost of the craft. Nevertheless there is a strong ring of plausibility to the suggested role played by liability change.

<sup>38</sup>Bungy jumping involves leaping headfirst from a high place with elastic bands firmly attached around the ankles, which terminates the plunge before one's head or body reaches the ground. Neil Waugh, David Standing, and Geoffrey Wilson, (all with A. J. Hackett) and K&K Insurance provided helpful information. Any errors in the facts or conclusions are mine.

<sup>39</sup>By now, a total of 28 bungy jumping fatalities have been recorded. I was unable to determine how many were from commercial operations. AJ Bungy worldwide has had about 700,000 jumps, with no fatalities. The most common injury is apparently black/bloody eyes from water impact at sites where the jumper descends into water. Some industry representatives believe that commercial rafting and skiing are more risky activities for serious injury.

<sup>40</sup>High tower jumps in Las Vegas sell for \$59.

<sup>41</sup>Helen Heffernan's help has been indispensable in the following discussion of New Zealand vaccine prices.

<sup>42</sup>Richard Manning generously provided the U.S. time series data on DPT and DT sales that he has assembled from the Center for Disease Control, Biologics Surveillance.

<sup>43</sup>A regression of the log ratio of the quantities of DT to DPT sales on the log ratio of the DT to DPT prices for the 10 year period from 1979 through 1988 yields a statistically highly significant negative regression coefficient. This is consistent with the hypothesis that the liability induced price increase of DPT led to some substitution of DT vaccine for DPT. The fact that DT to DPT sales had been declining from 1966 until 1980, when it reversed, and that there was no significant trend in the price ratio of DT to DPT vaccine over the same period, increases the plausibility of this interpretation.

<sup>44</sup>Michael Parzen introduced me to the recently developed logspline density estimation methodology and kindly executed Figures 4A and 4B. See Kooperberg and Stone [1991].

I am indebted to Mark Rowland, team leader of evaluation at the Therapeutics Section of the NZ Ministry of Health for making the Pharmac Pharmaceutical Schedule available and to Richard Manning for the U.S. and Canadian data.

The price data are from 1991 for the U.S. and Canada. The U.S. prices are May 1, 1991 Wholesale Acquisition Cost from the Medi-Span Master Drug Data Base-Select. The Canadian prices are the Best Available Price listed in the February 1991 ODB formulary, converted to U.S. dollars using the May 1 1991 exchange rate C\$1.15 = US\$1.00. These data are in the GAO/HRD [1992] study. The New Zealand prices are the manufacturer's price from Pharmac [1995], effective from April 1, 1995. The U.S. prices were updated from 1991 to 1994 by multiplying them by the ratio of the 1994 to 1991 wholesale acquisition cost in the Drug Topics Red Book. The New Zealand prices were converted to U.S. dollars using the March 1995 exchange rate NZ\$1.00 = US\$.646.

<sup>45</sup>New Zealand is a small player in the world pharmaceutical market, and its policies have little influence on that market, outside of its own boundaries. The regulatory process in New Zealand for marketing approval proceeds more rapidly than the FTC process in the U.S., and usually takes no more than two years from the initial application to completion.

<sup>46</sup>Unfortunately, the data do not include the dates of approval for marketing, nor do they identify the countries in which the producers initiated the process to obtain marketing approval from the regulatory authority if approval was not obtained.

<sup>47</sup>I am grateful to Dr. Robert Boyd of the New Zealand Ministry of Health and to Mark Rowland for the comprehensive search made to document the details of the fate of each of the drugs in the list for which a marketing application was made for New Zealand. Rosemary Beresford of the IPRU also provided valuable guidance to data sources.

<sup>48</sup>Consent to market was declined by the Ministry of Health in 3 out of 8 cases for which marketing consent was not obtained. In the other 5 cases, the application for marketing approval was voluntarily withdrawn by the manufacturer. Some of the voluntary withdrawals may have occurred after discussions with the Health Ministry.

Both NZ and the U.S. continue to market two drugs they had approved despite withdrawal from at least one of the four countries. Triazolam (Halcyon) is still marketed in both countries. Indomethacin-R continues to be sold in New Zealand and Etretinate in the U.S. In New Zealand, the Health Ministry did not consider the risks of the drugs justified withdrawal.

<sup>49</sup>The application for FDA approval in the U.S. is treated as confidential information by the FDA. This policy makes it difficult for outsiders to assess how effective the screening process for new drugs is. Ken Kaiten, of the Center for Drug Development, School of Pharmacy, Tufts, was very helpful in providing useful information and the list of 5 companies which had applied to the FDA, and subsequently withdrew their application. Information is voluntarily supplied by American producers to the Center, but foreign manufacturers are not included in the Center's records. So there may be a downward bias in the U.S. ratio. The data from the NZ Ministry of Health for computing the ratio is quite complete.

<sup>50</sup>The standard large sample test for the difference between the the New Zealand and U.S. nonapproval ratios yields a normally distributed  $(N(0,1))$  test statistic with a value of .929.

<sup>51</sup>See ACC (1987) for a useful account of the main features of the system at that date. Danzon (1990), pp. 6-12 provides a convenient description.

<sup>52</sup>A dependent spouse receives 60% and children 20% apiece, up to a family total of 100%.



<sup>53</sup>This differential treatment has apparently led general practitioners, who are the gatekeepers to the system in terms of classifying a patient's condition as due to injury or illness to lean heavily to the former. The consequence is higher ACC costs and exaggerated statistics on the level of accidental injury in New Zealand.

<sup>54</sup>This has apparently led to a substantially increase in the number of physiotherapists, who receive the bulk of their income from ACC payments.

<sup>55</sup>These lump sum awards became part of the ACC system largely as a political compromise as a tradeoff for abolishing common law tort rights to damages for injury. These awards are the main form of compensation for nonworkers, although they are not restricted to them.

These lump sums were not indexed for inflation, (although the bodily injury maximum was raised from the original 1974 level of NZ\$7000 to NZ\$17000 in 1982. The ratio of the CPI in June 1974 to December 1991 is .15 and the December 1982 to December 1991 ratio is (.50). Despite their diminishing real purchasing power of these lump sum awards, there has been a substantial increase in them over time.

<sup>56</sup>The system is being changed so that employers will withhold the payments for the employee's nonwork injuries rather than paying it directly. There is no reason why this change should alter either incentives or incidence of the costs of financing the system.

<sup>57</sup>Darrin Goulding of the ACC made these data available. The differences in these industrial injury rates do not fully reflect differences in incidence of injury costs. There is no differentiation for occupational mix of an employer.

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TABLE 1  
INTERCEPT AND TREND OF FATAL ACCIDENTS IN NEW ZEALAND, AUSTRALIA, AND U.S.

Parameter:	New Zealand		Australia		United States	
	Constant	Trend	Constant	Trend	Constant	Trend
	3.994	-.0211	-.0398	-.0158	-.0748	-.00038
	(.0264)	(.00345)	(.0374)	(.00489)	(.374)	(.00489)

Dependent Variable: Log of fatal accident rate per 100,000 population,  
annual data, 1974-1987

TABLE 2  
WORK-RELATED FATAL INJURIES AND RATES PER 100000 WORKERS

Year	New Zealand	U. S.
1975	8.1	10.7
1976	6.6	9.5
1977	8.0	9.4
1978	9.8	9.0
1979	7.2	8.6
1980	7.3	8.8
1981	6.8	8.0
1982	7.0	7.9
1983	5.0	7.6
1984	6.3	7.0
1985		7.0
1986		6.6
1987		6.4
1988		6.2
1989		6.0
1990		5.9

Source: New Zealand data from P. Colin Cryer and Cara Fleming, Table 1 (1987); U.S. data from National Safety Council, Accident Facts, 1991 Edition, from table on "Work Accidental Deaths and Death Rates, All Industries, 1933-1990," page 37. Work deaths in motor vehicle accidents were subtracted from total work deaths to make the U.S. rates comparable with the New Zealand rates. The U. S. estimates are those by the National Safety Council. There is a discussion of alternative fatality estimates on page 39. The BLS estimate is only 33% of the NSC estimate in 1989.

TABLE 3  
INJURY RATES BY INDUSTRY PER 1000 WORKERS

Major Industry:	All Injuries		Injury Trend	
	NZ 90	US 92	NZ 90/71	US* 92/73
Forestry & Logging	72.2 (3.5)	56.6 (NA)	.47	.54
Mining & Quarrying	67.7 (3.9)	26.7 (0.5)	.55	.63
Manufacturing	63.3 (0.5)	19.9 (0.2)	1.14	.81
Utilities	49.4 (1.9)	9.5 (0.4)	.76	.47
Building & Construction	58.1 (0.8)	31.4 (0.3)	1.07	.88
Wholesale & Retail	15.1 (0.2)	16.7 (0.3)	1.12	1.11
Transport	48.3 (0.9)	29.6 (NA)	1.09	.79

New Zealand injuries for workers away from work at least a week, 1990.  
(Data from ACC special data tape for employees injured at work)

Standard errors in column 1 are nominal, based on count of number  
of injuries, and does not allow for error in employment denominator

1971 data from New Zealand, Industrial Injuries 1971 Part B, Table 30, and  
New Zealand Official Yearbook for industrial employment data

U.S. injuries for workers missing at least 5 days of work, 1992.  
(Data from special tabulation at BLS)

U.S. 1973 Data from Bureau of Labor Statistics Bulletin

\*U.S. trend based on accident rates for workers losing at least  
one day of work

TABLE 3A  
INJURY RATES BY INDUSTRY PER 1000 WORKERS

Major Industry:	All Injuries		Amputation		Fracture		Hernia	
	<u>NZ</u>	<u>US</u>	<u>NZ</u>	<u>US</u>	<u>NZ</u>	<u>US</u>	<u>NZ</u>	<u>US</u>
Forestry & Logging	72.2 (3.5)	56.6 (NA)	*	.60 (NA)	9.78 (1.3)	11.31 (NA)	*	.38 (NA)
Mining & Quarrying	67.7 (3.9)	26.7 (0.5)	*	.24	5.66	3.50	*	.49
Manufacturing	63.3 (0.5)	19.9 (0.2)	.85 (0.1)	.29 (NA)	5.35 (0.1)	1.57 (NA)	.86 (0.1)	.60 (NA)
Utilities	49.4 (1.9)	9.5 (0.4)	*	**	4.03 (0.5)	.59 (NA)	*	.14 (NA)
Building & Construction	58.1 (3.5)	31.4 (0.3)	.52 (0.1)	.22 (NA)	7.15 (0.3)	4.39 (NA)	1.25 (0.4)	.83 (NA)
Wholesale & Retail	15.1 (3.5)	16.7 (0.3)	.17 (0.1)	.08 (NA)	1.50 (0.1)	1.20 (NA)	.39 (NA)	.37 (NA)
Transport	48.3 (3.5)	29.6 (NA)	.27 (0.1)	.08 (NA)	5.87 (0.3)	2.58 (NA)	.96 (0.1)	.57 (NA)

New Zealand injuries for workers away from work at least a week, 1990.

(Data from ACC special data tape for employees injured at work)

U.S.injuries for workers missing at least 5 days of work, 1990.

(Data from special tabulation at BLS)

\*Less than 10 injuries

\*\*Less than 20 injuries

TABLE 3B  
INJURY RATES BY INDUSTRY PER 1000 WORKERS

Minor Industry:	All Injuries		Amputation		Fracture		Hernia	
	<u>NZ</u>	<u>US</u>	<u>NZ</u>	<u>US</u>	<u>NZ</u>	<u>US</u>	<u>NZ</u>	<u>US</u>
Logging	86.0	60.2			15.79	12.30		
Coal Mining	92.7	57.0						
Building Construction	65.0	28.7	.74	.89	7.96	3.98	1.58	.91
Other Construction	69.8	29.9	.71	.25	8.01	4.53	.86	.78
Food & Beverages	108.9	32.1	.85	.41	6.33	2.26	.88	.89
Tobacco	24.7	9.7						
Textile Mill Products	41.2	12.2			2.91	.98		
Apparel	18.7	16.6			1.09	.62		
Lumber & Wood Products	91.3	22.6	3.03	.75	10.92	3.33	1.42	.96
Furniture	30.5	22.6			2.45	1.59		
Paper Products	57.3	19.8			4.66	1.83		
Printing & Publishing	23.4	14.2			2.95	1.15		
Chemical Products	56.6	9.2			6.55	.85		
Petroleum & Coal Products	60.0	9.3						
Rubber & Misc. Plastics	32.2	24.7			2.76	1.95	1.18	.69
Leather Products	44.0	22.2			3.21	1.40		
Stone, Clay, & Glass	72.5	26.3			8.22	2.50	1.59	.84
Primary Metal Industries	73.2	28.6			6.64	2.82		
Fabricated Metal Products	75.8	26.2	1.49	.51	8.49	2.41	1.72	.80
Industrial Mach, Equipment	43.5	15.9	.97	.33	6.18	1.51		
Electronic, Electric Equip	46.6	12.1			4.45	.71	1.00	.27
Transportation Equipment	41.0	24.9			3.75	1.61	.82	.78
Instruments, Related Prod	34.7	9.1						
Misc. Manufacturing	14.2	18.6						
Electric Light & Power	54.4	7.3			4.35	.48		
Railroad Transportation	120.3	35.3			10.09	2.81		
Taxi Services	18.8	20.0						
Trucking	25.5	45.8			4.24	4.96	.56	1.08
Meat Processing	168.6	40.5	1.00	.53	8.86	2.24	1.14	1.22
Poultry slaughter	97.9	23.7						
Beverages	57.6							
Sawmills & Planing Mls	133.3	34.4	3.96	.89	16.00	4.77	1.68	1.02
Wood Furn., Upholstry	33.9	19.0			2.37	1.52		



TABLE 4  
 ROTARY WING AIRCRAFT ACCIDENTS

Year	New Zealand		#	Accidents Per 10000 Hours		
	Total	Fatal		NZ*	Australia	U.S.
70	9	0	48	5.98	5.01	3.05
71	8	2	53	4.39	1.39	2.75
72	10	0	53	4.10	2.35	2.35
73	34	1	76	11.59	1.48	2.40
74	29	4	134	8.44	3.74	2.01
75	35	3	142	9.79	1.86	1.61
76	32	0	133	8.91	1.22	1.77
77	34	3	170	7.52	2.95	1.44
78	48	0	192	7.96	4.65	1.43
79	49	4	228	9.44	3.79	1.13
80	46	3	271	9.41	3.41	1.39
81	30	3	254	6.95	2.10	2.04
82	36	7	259	10.28	2.06	1.57
83	28	2	253	5.98	2.26	1.39
84	30	3	305	6.55	2.00	1.40
85	30	3	348	4.59	2.28	1.21
86	28	3	355	6.64	2.29	1.13
87	39	6	396	8.02	2.09	1.23
88	23	1	383		2.35	2.04
89	29	7	336			

Source: New Zealand Civil Aircraft Accidents, 1970-1989 editions;  
 Australian Air Authorities; U.S. from National Transportation Safety  
 Board and FAA

\*Accidents per 10000 hours for New Zealand only available for rotary  
 wing aircraft engaged in aerial work.

TABLE 5  
PRICE PER DOSE AND QUANTITY SOLD, DPT VACCINE

Year	81	82	83	84	85	86	87	88	89	90	91
U.S. Price <sup>1</sup>	.33	.37	.45	.99	2.80	11.40	8.92	11.03	10.65	10.65	9.97
N.Z. Price <sup>2</sup>						.12	.21		.23		.29
U.S. Quantity <sup>3</sup>	18.8	18.3	18.8	15.6	19.8	19.0	20.5				
U.S. DPT/DT <sup>4</sup>	.043	.054	.055	.088	.076	.071	.073				

<sup>1</sup>U.S. dollars. Catalogue price. Source: Centers for Disease Control, Division of Immunization

<sup>2</sup>Converted to U.S. dollars at prevailing exchange rate when a new supplier contract was made with New Zealand. Source: Communicable Disease Centre, Institute of Environmental Science & Research Limited, New Zealand

<sup>3</sup>DPT, millions of doses. Source: CDC, Biologics Surveillance

<sup>4</sup>Ratio of doses of DPT/DT Source: CDC, Biologics Surveillance

TABLE 6  
PRICE RATIOS OF U.S., CANADIAN, AND U.S. PHARMACEUTICALS<sup>1</sup>

	Minimum	Median <sup>2</sup>	Maximum
U.S./NZ	.50	3.19	9.30
Canada/NZ	.65	2.00	5.96
U.S./Canada	.56	1.36	5.34

<sup>1</sup>54 drugs of the most widely prescribed drugs in U.S. in 1991. Equivalent 1995 to 1994 prices for rows 1 and 2. See footnote 44 for sources and procedures.

<sup>2</sup>Midpoint of 27th and 28th ordered observations.

TABLE 7  
 DRUGS APPLYING FOR NZ MARKETING, SUBSEQUENTLY WITHDRAWN FROM SOME MARKET\*

Drug	Year Approved	Year Withdrawn	Year Withdrawn				Reason	Withdrawn NZ
			US	UK	FR	GER		
Practolol	71	91		90	75	75	DV	
Benozapofen	NA	82	82	82		82	DV	
Indomethacin-R	77	NW		83		83	NW	
Zimeldine	82	83	NA	83		83	DV	
Fenclofenac	NA	83	NA	84			CD	
Isoxicam	NA	89	NA		85	85	DV	
Guanethidine	80	87		86			DV	
Hydrochlorothiazide + sotalol	NA	81			86		CD	
Nomifensine	NA	86	86	86	86	86	DV	
Cyclofenil	73	78			87		MCL	
Suprofen	NA	83	87	87			CD	
Etretinate	82	89	NW		89		DV	
Pirprofen	NA	89			90	90	DV	
Terodiline	89	91		91		91	DV	
Triazolam	79	NW	NW	91			NW	
Mumps vaccine (Urabe AM 9)	86	92	92	92			DV	
Temafloxacin	NA	92	92	92		92	DV	

\*Drugs first marketed in 1970 or later

NA: Never approved for marketing

NW: Not withdrawn from market

CD: Consent to market declined

DV: Withdrew application or or discontinued marketing voluntarily

MCL: Product never marketed despite approval, and consent lapsed

TABLE 8

## NEW ZEALAND APPROVAL AND NONAPPROVAL OF DRUGS FOR MARKETING

	U.S.	UK	France	Germany	# Products
NZ Approves	3	7	3	4	9
NZ Does not Approve	4	5	4	5	8

# Overall Fatality Rate (Per 100,000 Population)

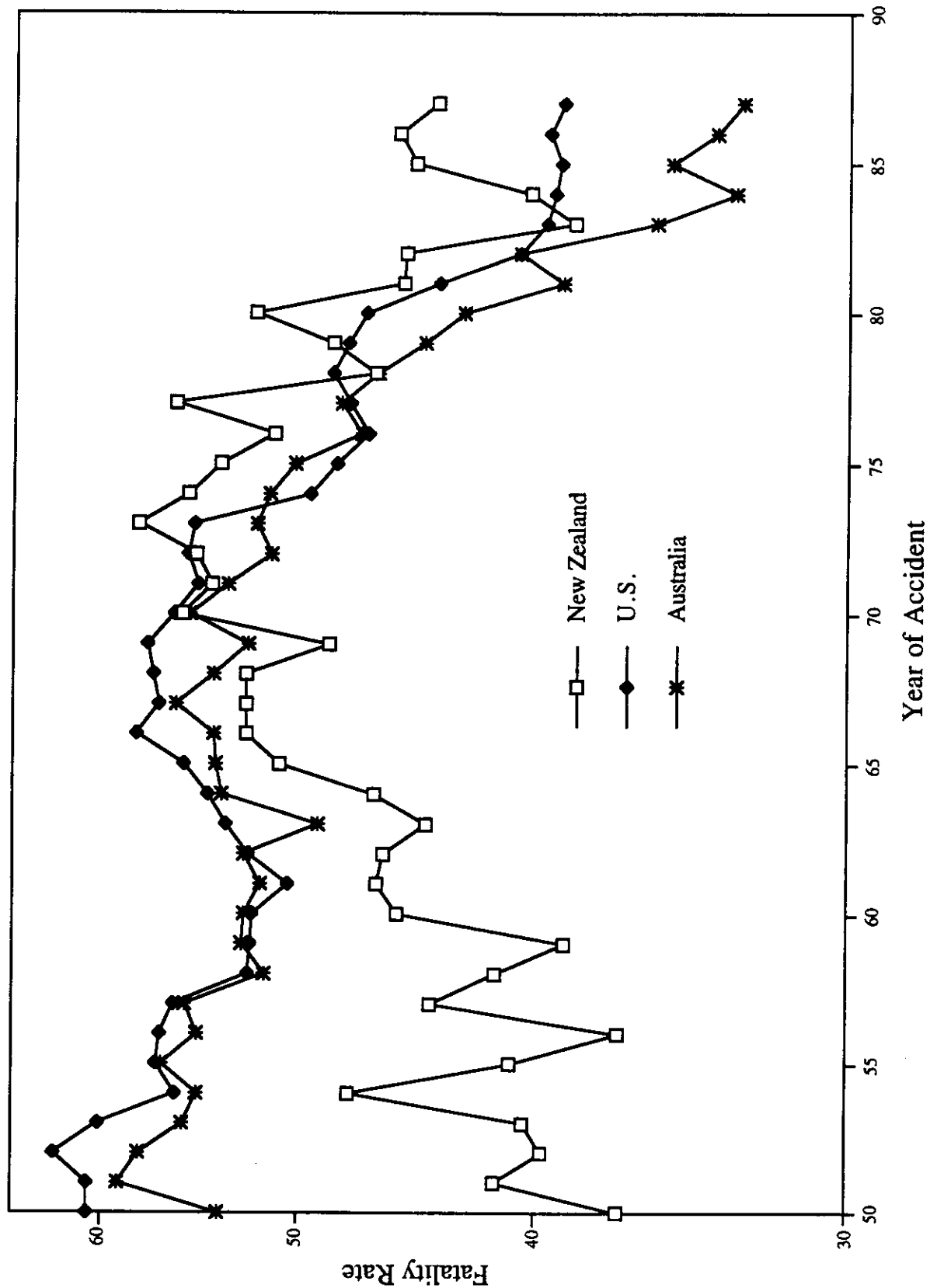


FIG 1A

# Motor Vehicle Fatality Rate (Per 100,000 Population)

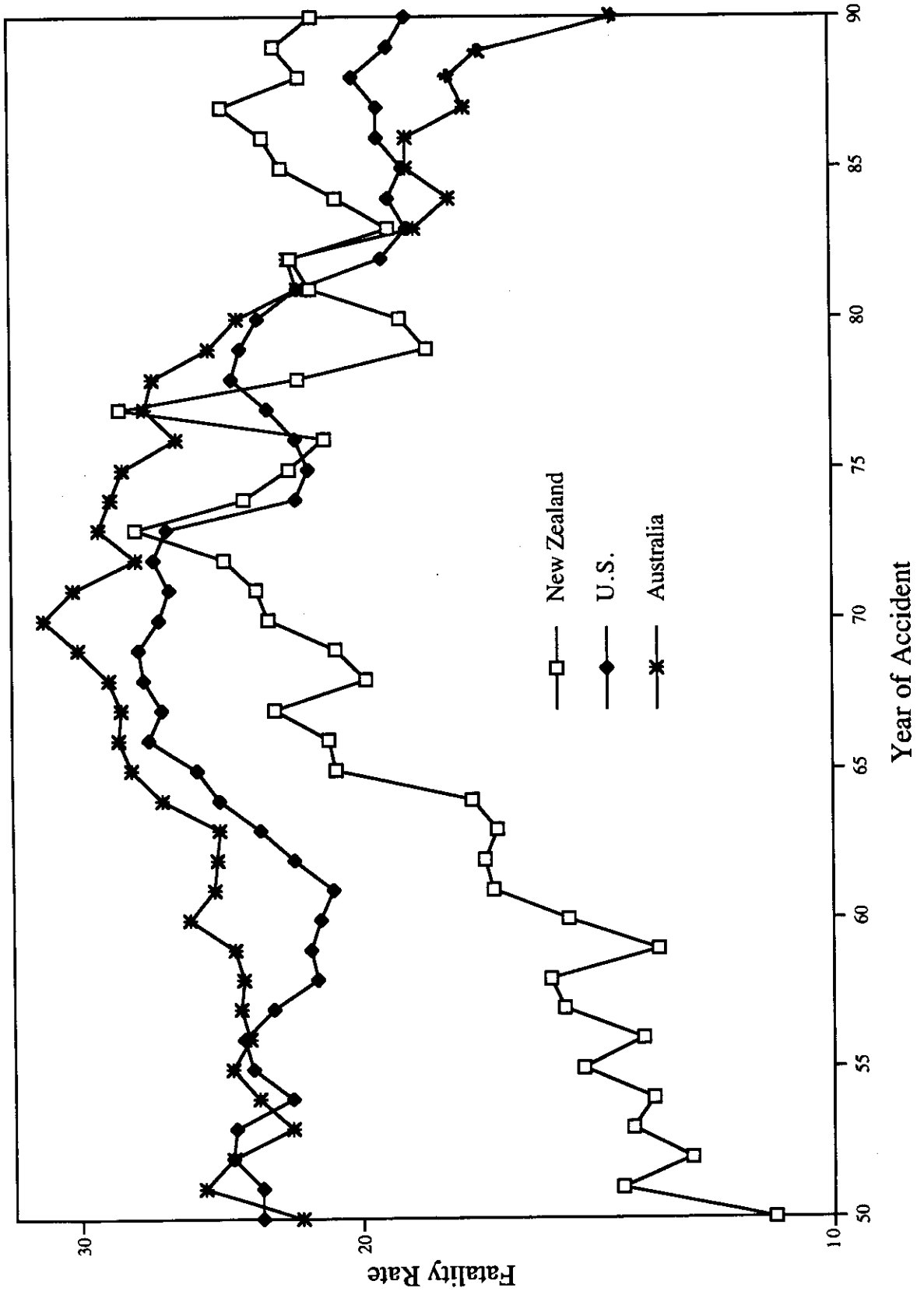


FIG 1B

# Nonmotor Vehicle Fatality Rate (Per 100,000 Population)

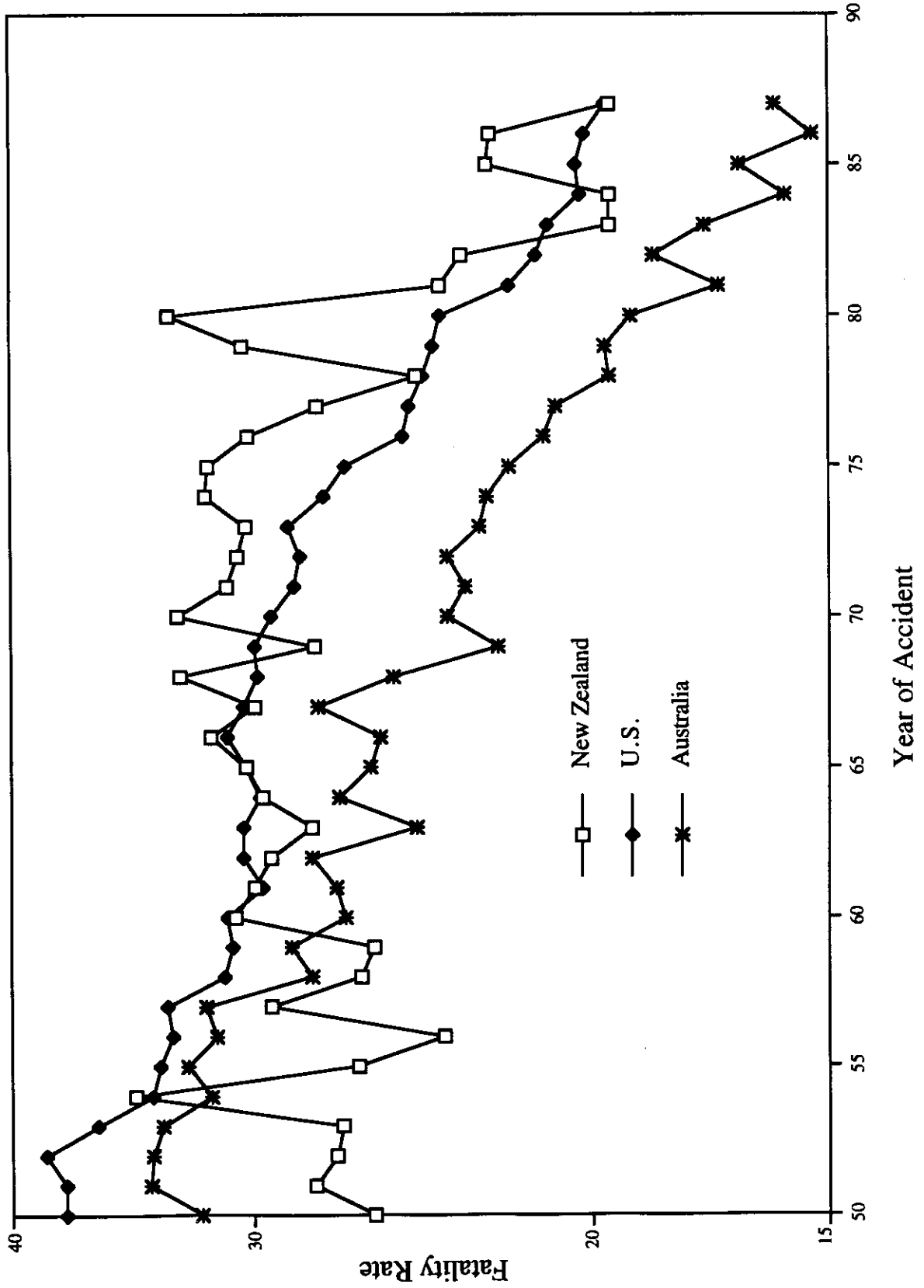


FIG 1C



# Motor Vehicle Fatality Rate (Per 10,000 Registered Vehicles)

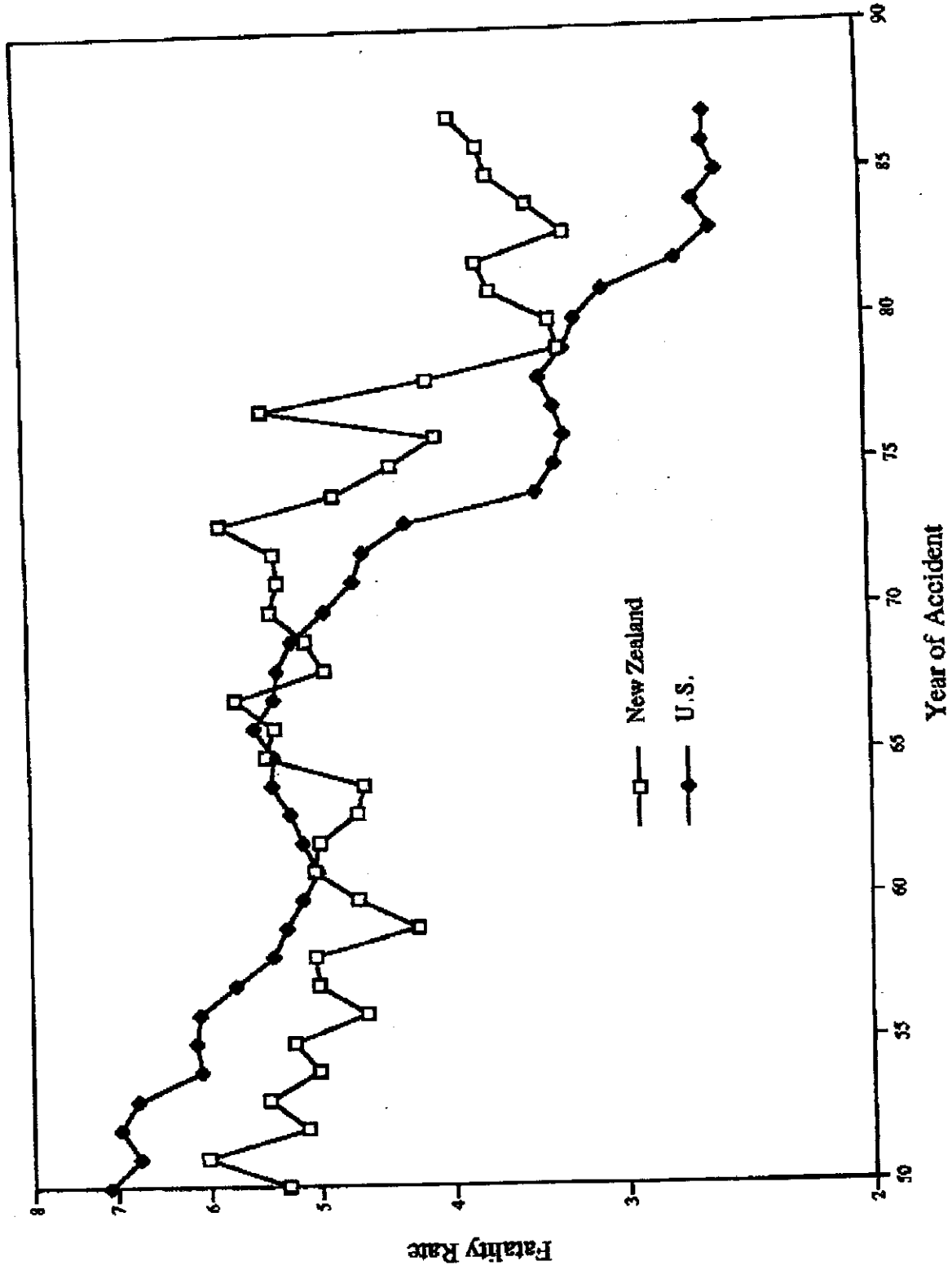
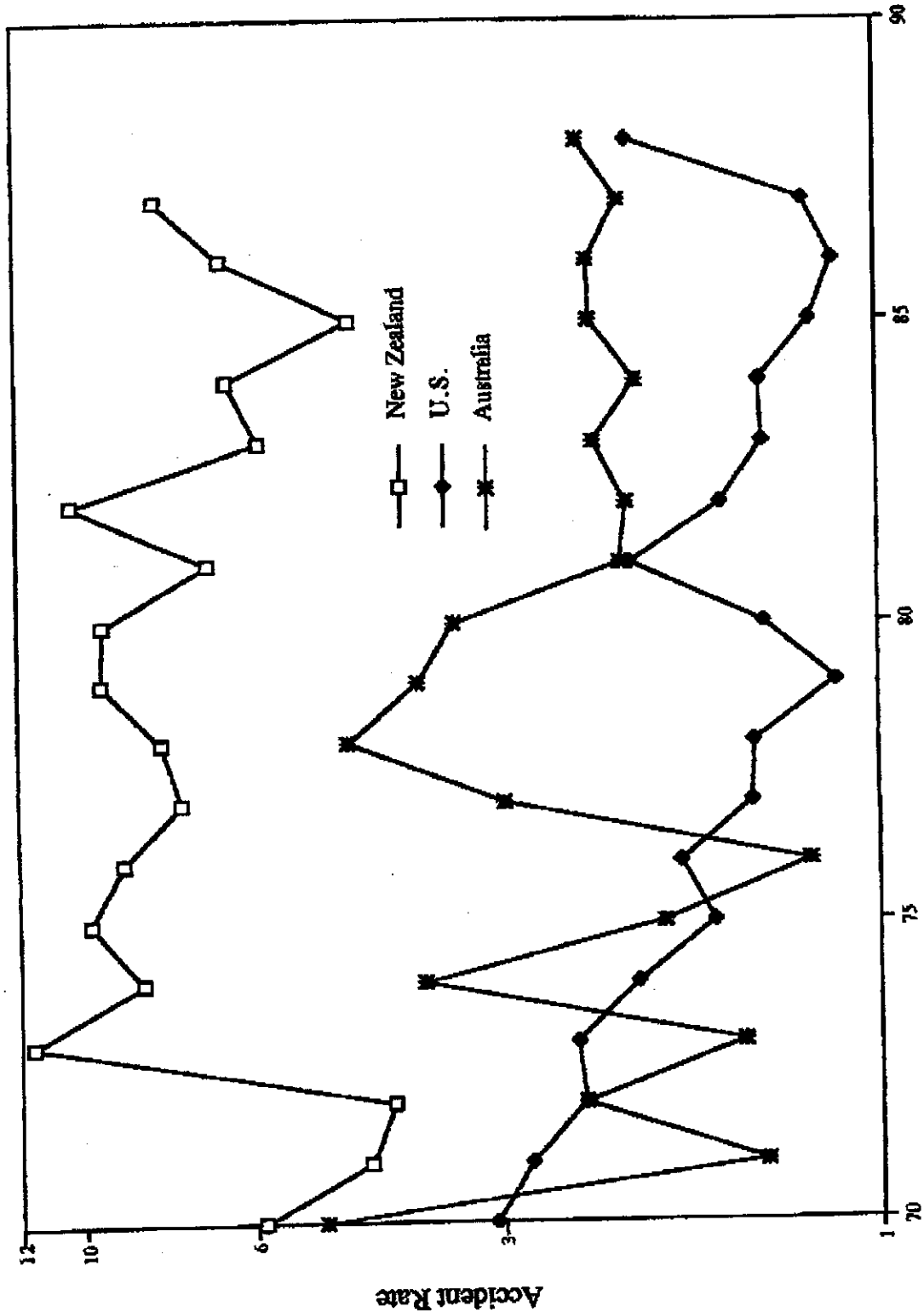


FIG 2

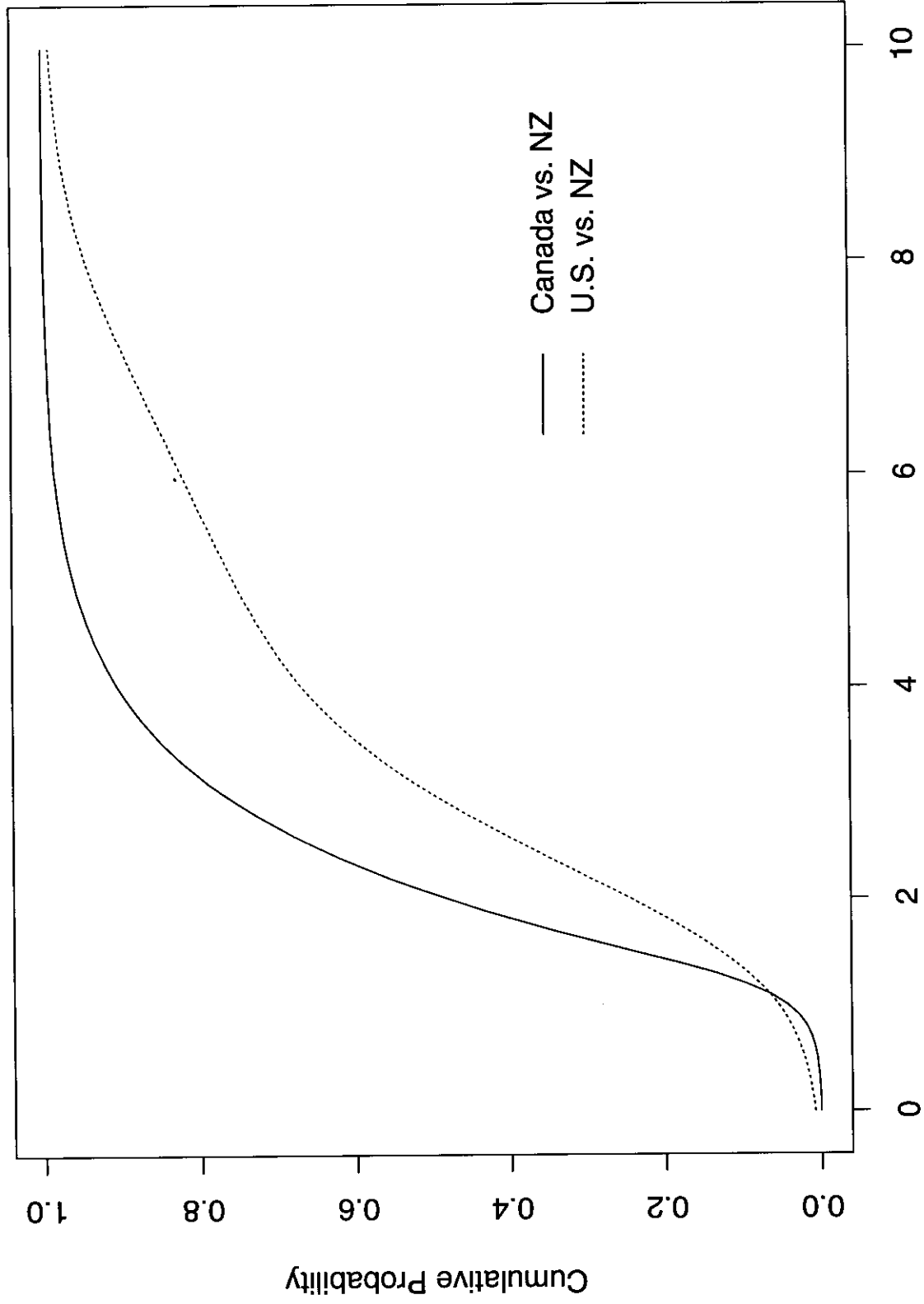
# Rotary Wing Aircraft Accident Rate (Per 10,000 Flying Hours)



Year of Accident

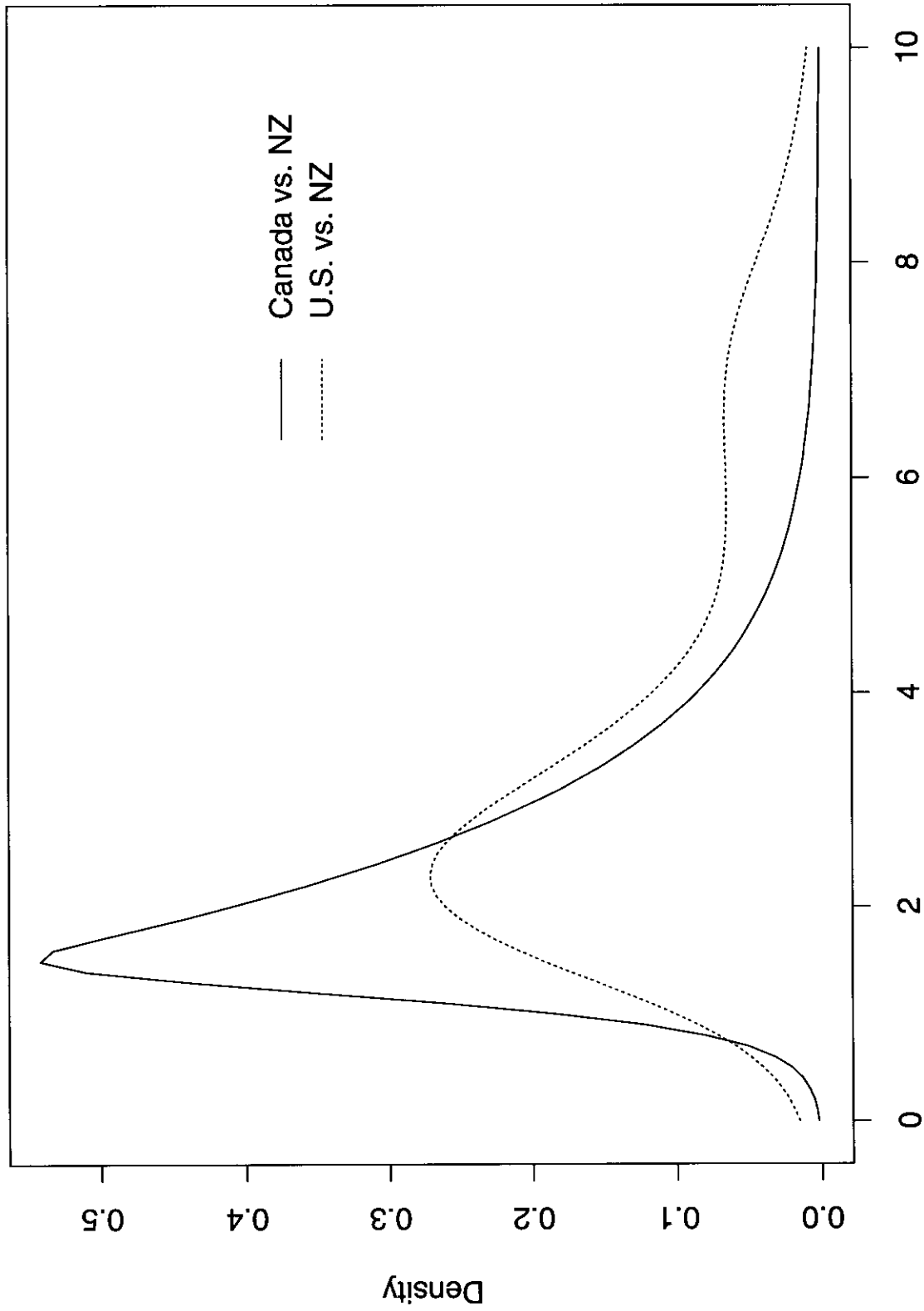
FIG 3

# Cumulative Distribution Functions of Drug Price Ratios



Price Ratio  
FIG 4A

# Density Functions of Drug Price Ratios



Price Ratio  
FIG 4B