PRICING AUTO NO-FAULT AND BODILY INJURY LIABILITY COVERAGES USING MICRO-DATA AND STATISTICAL MODELS

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Abstract

Private Passenger Automobile Bodily Injury (BI) Liability Insurance, the largest subline of property-casualty insurance in the United States, has experienced during the 1980's rapidly increasing claim costs well in excess of the rate of overall inflation. The re-emergence of BI as a problem area has spotlighted traditional tort, no-fault and choice systems as competing vehicles for cost containment. Our purpose is to describe the current BI systems and to provide new methods based on micro-data and statistical models for pricing those systems. We build on the results of a major industrywide data gathering and research effort in Massachusetts. We observe that data on claimants, rather than on insureds, are critical for understanding BI systems and for supporting the least-squares, logistic and Tobit regression models for pricing alternative BI systems. The paper concludes with three applications: changing a monetary threshold, supplementing a trend factor and coordinating benefits with health insurance.

Disclaimer

The opinions expressed by the authors are solely their own and are not attributable to the Automobile Insurers Bureau of Massachusetts or its member companies.

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1.0 INTRODUCTION

Private passenger automobile liability insurance, with earned premiums of $47 billion in 1990, is the largest line of property-casualty insurance in the United States.[1] Workers compensation with $31 billion ranks a distant second. Bodily injury (BI) coverage for injury to people rather than damage to vehicles accounts for about 75% of the total liability premium, still somewhat larger than workers compensation premium.[2]

By the 1960's, dissatisfaction with the cost and efficiency of the traditional tort system had led to significant reforms in many states. Variations of the no-fault concept were implemented widely between 1970 and 1976. Most BI systems have remained quite stable since that time. Recently, however, the bodily injury coverage has re-emerged as a serious problem area. Calls for cost containment and reform are increasingly being echoed (Cummins and Tennyson, 1992; Feldblum, 1990; Foppert, 1992, Maatman, 1989; Weisberg and Derrig, 1992c).

While questions about relative costs of alternative proposals will inevitably be asked of actuaries, the available analytic tools may be of limited utility. Our purpose here is to describe the current BI systems and to offer some new approaches to pricing those systems. We begin with some background on current BI reform proposals and traditional actuarial methods. We then turn to the need for data to support adequate models of the BI process. Section 2 provides

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[1]Best's Aggregates and Averages, 1991 Property-Casualty Edition, p.156.

[2]Countrywide liability incurred losses for 1986-88 show about 77% BI, 23% PDL for voluntary markets (NAIC database, 1991). Earned premium can be assumed to be in approximately the same proportions.

an explanation of various BI claim processes. In Section 3 we outline a pricing methodology based upon micro-data and statistical models. We build on the results of a major industrywide data collection and research effort by the Automobile Insurers Bureau (AIB) and Correlation Research Inc. (CRI) in Massachusetts (Weisberg and Derrig (1991a, 1992a); Feldblum, 1991). The important issue of incorporating behavioral assumptions in the pricing of BI changes is described in Section 4. The methodology is illustrated with three examples from current Massachusetts experience in Section 5. Concluding remarks in Section 6 unify the perspectives addressed in the paper.

1.1 Background for Current BI System Reforms

Cummins and Tennyson (1992) point out that between 1984 and 1989 BI losses grew at an annual rate of nearly nine percent in no-fault states and eleven percent in tort states, despite annual declines of about two percent in property damage liability claims. This phenomenon, particularly pronounced in urban areas, is attributed to changes in "claiming behavior" rather than to real trends in accident frequency or severity. It appears that in some areas of the country slightly injured (or even uninjured) claimants have become increasingly willing to file claims.

The specific nature of the problem is influenced by the kind of tort system in place. Kimball (1985) provides a brief history of the legal principles underlying modern automobile accident law, starting with the Roman law of obligations. Until 1970, the automobile injury compensation system was exclusively concerned with "righting wrongs" through the tort system.[3] It was necessary for an injured plaintiff to show that a defendant was at fault, careless or negligent before compensation could be compelled. Automobile liability insurance provided a

[3]According to Kimball, the law of torts is concerned with straightening out twisted ("tortum") relationships.

reasonably efficient mechanism to *allocate* the costs of this tort system among drivers. However, concerns with the overall high costs of the tort system, especially transaction costs in terms of legal fees and delayed payments, led to experiments that modified the tort system by relaxing the fault requirement. Of course, the tort system had been completely eliminated fifty years earlier for workplace accidents by the workers compensation insurance system.

So-called "no-fault" systems that limit the right to sue in exchange for some form of guaranteed first-party reimbursement are often justified in part as a cost-saving measure. By restricting the eligibility to file a tort claim to those whose injuries cross a specified "threshold" of severity, these systems are intended to eliminate payment of general damages (pain and suffering) for minor injuries and to reduce transaction costs. At the present time, there are fourteen states in which all drivers are covered by some form of no-fault insurance (IRC, 1990). In eight of these states, the tort threshold is defined as a monetary amount of medical expenses. In three (Florida, Michigan, and New York) the threshold is a verbal specification of what constitutes a serious injury. In addition, three states (Kentucky, New Jersey, and Pennsylvania) have adopted "choice" systems in which drivers can choose between the traditional tort system and a variant of no-fault.[4] Choice systems have been the focus of much attention since first proposed by O'Connell and Joost (1986).

Witt and Urritia (1983) have analyzed the advantages and disadvantages of various no-fault systems adopted by 24 states between 1971 (Massachusetts) and 1976 (North Dakota). Using *Best's* loss ratio data by state, 1975-1980, these researchers found that no-fault systems produced higher relative benefits per dollar of premium. Underwriting risk to the insurer, as

[4]Since the IRC publication, Georgia has returned to a full tort system while Pennsylvania changed to a choice state (Powers, 1992).

measured by the standard deviation of state loss ratios, was higher in no-fault states but generally reflected state-specific factors other than the no-fault system of compensation.

The record of no-fault systems in *controlling*, as opposed to allocating, total costs has been mixed. Michigan and New York, with their strong (i.e., stringent) verbal thresholds, have achieved significant savings in BI costs. However, Florida's weak verbal threshold has proved relatively easy to circumvent (Maroney, Hill, and Norman, 1991), and premiums in monetary-threshold states are generally higher than in pure tort states (Cummins and Weiss, 1991).

O'Connell and Joost were motivated to suggest the choice approach primarily because of the failure of weak no-fault laws to control claim costs and the political difficulties of imposing strong verbal thresholds. In their view, the politically more palatable compromises reflected in most existing no-fault systems merely exacerbate the cost problems by creating perverse economic incentives:

> ....no-fault thresholds arguably encourage victims to inflate their claims to exceed the threshold for bringing a lawsuit. Moreover, the more medical expenses and wage losses victims accumulate, within limits, the more they can recover in tort for both economic and noneconomic losses...Permitting victims to profit from additional trips to the doctor or from staying away from work increases both no-fault and tort liability insurance rates.

From this perspective, raising the monetary threshold can lead to additional padding and further claim cost increases.

Cummins and Tennyson attribute much of the problem in both tort and low monetary threshold states to the fact that "it is simply too easy and too profitable to file bodily injury liability claims on auto insurance." Consequently, they argue, many potential claimants regard the liability system as a lottery with a high probability of payoff and a relatively low cost. Increased awareness of these potential rewards, particularly in certain urban areas, has played a major role in the cost increases that precipitate current calls for reform.

1.2 Available Tools for Pricing of BI Systems

Automobile insurance and its pricing problems were hot topics in the 1960s and 1970s. Prior to the first-in-the-nation introduction of no-fault in Massachusetts in 1970, several authors addressed the anticipated automobile liability ratemaking problems in PCAS publications.

Wittick (1963) reported on the early deliberations in Ontario regarding a proposed "compromise between the ordinary negligence system and a full workers compensation type plan". The actuarial conundrum addressed by Wittick was how to merge the available data on per-person accident and health insurance costs with per-car third party liability losses in order to price the additional costs of the hybrid no-fault/fault system.

Stern (1964) provided a comprehensive exposition of automobile liability insurance ratemaking procedures using accident year loss data gathered under a statistical plan. The reported data was, however, only the aggregate exposure, claim and loss information arising from individual claims. A particular feature of this aggregate data was that breakdowns were reported by rating classes rather than by claim characteristics. The underlying loss distribution was assumed for ratemaking purposes to remain the same for future periods except for inflation. Any changes in coverage were priced by "actuarial judgment." This classic paper survives to this day on the CAS Part 6 Syllabus.

Harwayne (1966) applied techniques similar to Wittick's to price a Basic Protection Plan for New York drivers patterned after the original no-fault plan proposed by Keeton and O'Connell (1965). Statistical plan data for bodily injury liability claims were combined with workers compensation claim data (with automobile accident proximate causes) and New York State accident statistics in order to derive estimates of frequency and severity. Interestingly, the key New York variables pertained to *claim characteristics*, such as fractures, lacerations and visible injuries, rather than to characteristics of insured drivers.

Weber (1970) called for the explicit introduction of stochastic process models for accident involvement of drivers into the pricing of auto liability insurance. The exposure unit would be a driver, not an insured vehicle. Accident rate potential would be gleaned from driver histories. Homogeneous subclasses would be established by rating territories. Research on rating based upon individual records continues to this day (Venezian, 1990).

The CAS publications have in recent years fallen silent on the subject of auto liability.[5] While the PCAS has concentrated on such standard problems as credibility and loss distributions, and such emerging concepts as rate of return methodology, solvency and financial analysis, the "500 pound gorilla" of auto insurance has continued to generate interest outside the CAS. Most notably, the Insurance Research Council (IRC) collected extensive data on a sample of automobile claims closed in 1977.[6] After their initial publication (AIRAC, 1979) the data were subsequently analyzed by researchers at the RAND Corporation (see Hammitt, 1985).

The usefulness of the data to insurers and researchers prompted the IRC to follow up with the collection of comparable data from 1987. These closed-claim studies provided an early warning about the deterioration of BI systems that had begun by the mid-1980's. For example, the percentage of Personal Injury Protection (PIP) claimants eligible for a tort claim rose dramatically from 24% in 1977 to 40% in 1987 countrywide and from 26% to 54% in Massachusetts. On a per-car basis, BI liability costs rose by a factor of 2.5 during the decade.

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[5]Venezian (1990) is one of few examples of later CAS papers treating auto insurance (see PCAS index 1964-1988, p.6-7, 46-47.)

[6]Formerly the All Industry Research Advisory Council (AIRAC).

RAND researchers used the rich countrywide data to infer the relative costs of prototypical tort and no-fault systems through specialized analyses and statistical models (Carroll et al, 1991). The IRC further alerted the industry to the nature of the evolving crisis by documenting an apparent trend in claiming behavior between 1980 to 1989 (IRC, 1990). Based on ISO fast-track data, the IRC found rising BI claim frequencies despite stable or falling accident rates.

1.3 The Need for Data and Models

A common theme in the early no-fault pricing literature was the need for insurance claim data to price major coverage changes. Richard J. Wolfrum, in a discussion of Harwayne's paper, bemoaned the lack of "proper data to evaluate a compensation system for automobile bodily injuries" He specifically cited the lack of data on the types and lengths of disability, the medical costs of each type of injury, and the economic status of the claimants. Wolfrum called for "automobile bodily injury accident tables" similar to those applied in evaluating workers compensation benefit changes and for data on the relationship between the insureds and the claimants (driver, passenger, etc.) for rating purposes. Ernest T. Berkeley, another Harwayne discussant, observed that "actuarial judgement" was exercised to a very unusual extent because of the unavailability of "studies based on individual company records."

Our brief review of the original no fault pricing dilemma highlights the essential limitation of available auto BI data. Statistical plans are designed primarily to permit efficient allocation of claim costs to classes of *insureds*. Consequently, certain relevant attributes of insured drivers and their vehicles are carefully recorded. These variables contribute valuable information about the insured's propensity to generate losses *relative to other insureds*. However, these variables tell us very little about the insured's propensity to generate losses relative to *what it would be under a different BI system*. When the system changes, especially through coverage changes such as no-fault plans, the pressing need is for data on the *characteristics of the claimant as she or he relates to the insured.* The types of injuries sustained in accidents are no less important in automobile insurance than in workers compensation.[7]

The IRC data on characteristics of BI claimants represent an important step toward Wolfrum's automobile accident injury table. Moreover, the wealth of information in those studies underscores the usefulness of this type of data. State and company specific micro-data on claim characteristics would be even better for the pricing of system alternatives. The value of detailed claim data has been demonstrated many times over by the use of workers compensation detailed claim data to evaluate reactions to changes in benefits (Butler and Worrell, 1985).

Our research efforts, described more fully below, have led us to two additional conclusions. First, a comprehensive understanding of the BI system, and its alternatives, requires data that reflect certain behavioral aspects of the system.[8] Second, once relevant data have been gathered, appropriate analytic tools are needed to distill the essential information from the mass of raw numbers. Statistical models that summarize the data and that allow for "what-if" analyses are critical if we are to gain understanding and quantification.

Policy limits, tort thresholds, legal representation, subrogation, collateral sources, and coordination of benefits are but a few of the factors that interact and are exogenous to the

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[7]Perhaps one quick meaningful innovation in current auto statistical plans would be to classify BI and PIP claims by a primary type of injury, especially strains and sprains.

[8]The accident process model of Weber foreshadows the use of behavioral variables, such as the decision to file a tort claim, and the effects of changing economic incentives that give rise to fraudulent and inflated claims.

claimant's accident and injury yet exert profound effects on insurance loss costs. The essential value of using detail claimant data comes from the fact that complexities and non-linearity of the interactions impounded in the data may not be amenable to simple aggregate data modelling. The RAND analyses (Hammitt, 1985; Carroll, 1991) used statistical models to summarize the IRC claim data, taking those claim data variables into account. Our purpose here is to elaborate further on the types of micro-data, statistical models and behavioral variables that can be used and that truly inform the pricing actuaries' judgement. We begin at the beginning, with the claiming process itself.

2.0 THE BODILY INJURY CLAIM PAYMENT PROCESS

To understand the usefulness of detailed claim data it is necessary to begin with a description of the claim payment process. The specific aspects of the process will depend upon the kind of tort system in operation. We begin with the traditional tort system. We then consider the additional components introduced by a no-fault system. Finally, we factor in the effects of subrogation between the PIP and BI coverages.

2.1 Traditional Tort System

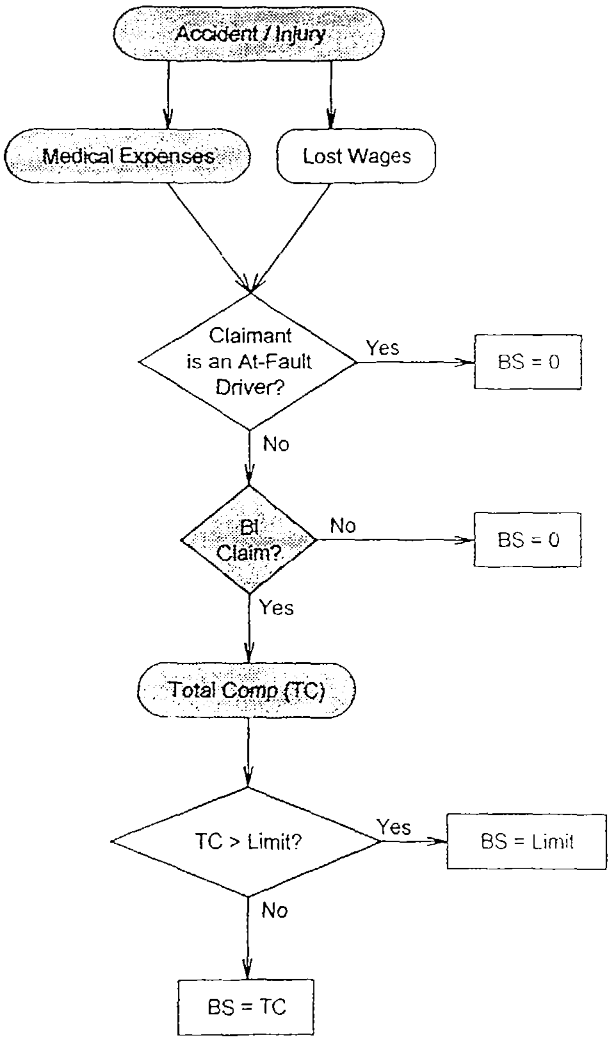
Figure 1 portrays the "case-flow" for a pure tort system in somewhat simplified form. The accident and resulting injury give rise to medical expenses and possibly lost wages. In the traditional tort environment, the victim must first establish his/her eligibility for a tort claim before proceeding further.[9] The specific negligence law of each state determines the conditions under which an accident victim is sufficiently "at-fault" to bar a potential tort recovery. For example, in Massachusetts an individual who is deemed more than 50 percent liable for the

[9]If no actual third-party can be identified, then the victim's own uninsured motorist coverage may substitute for the unavailable BI target.

FIGURE 1

Bodily Injury Liability Claim Payment Process

Tort System



LEGEND

BS = BI Settlement Value
TC = Total compensation value
(BI + PIP unconstrained by limits)

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accident cannot pursue a tort action.

An accident victim who is not at-fault must decide whether to file a BI claim. If a claim is filed, a process of negotiation with the insurer ensues, usually resulting in a settlement (but occasionally winding up in court). In some cases, the insurer might attempt to deny payment on such grounds as alleged claimant liability, lack of BI coverage, or suspected fraud. For the vast majority of claims, a payment, frequently less than the original claim, is eventually made. Theoretically, the amount of compensation received by the claimant is meant to cover the full value of both objective economic losses (also termed special damages) and of subjective pain and suffering (general damages).

The actual payment made under BI liability is constrained by the available policy limits. If the total compensation "deserved" by a claimant exceeds the available policy limit, then only the limit is paid. Moreover, if the compensation due all claimants from a single accident exceeds the aggregate accident limit, then each claimant receives a *pro rata* share of the accident limit.[10]

Note that four elements of this process have been highlighted for emphasis. Each of these represents a point at which factors exogenous to the insurance system itself can play a critical role in determining how the system operates in practice.

The *accident* and resulting *injury* to a vehicle occupant or pedestrian are the events that precipitate a potential claim under the BI liability coverage. In a majority of accidents where injuries are likely to occur, a report is filed by or with the local police and the incident becomes known to the insurance company. Under a traditional tort system, claims against the at-fault

[10]In some cases of multiple claimants whose total damages exceed the accident limit, the shares may not be exactly pro rata due to severity or timing differences among claimants.

driver's policy can be made at any point until the time specified in the statute of limitations, usually 3 years or more from the date of the accident. Details about the accident, and any possible injuries to third parties, accumulate as potential liability claims are assessed and actual claims are investigated. While serious injuries are usually the result of easily observable serious accidents, claims for minor and non-existent injuries can arise from small "fender benders" or even staged accidents. Thus, claimant behavior prior to notification of the insurer determines the character of the claim as it moves through the system. The *amount of medical expenses* generated by the injury is the second key step and depends on the nature of the injury and the treatment (Marter and Weisberg, 1991, 1992). Treatment decisions can in turn be governed by a variety of considerations, possibly including the claimant's desire to obtain a substantial BI settlement (Weisberg and Derrig, 1992a). Patterns of medical treatment can obviously have an important bearing on the ultimate claim costs for BI liability claims.

The third critical juncture is the *decision* by the accident victim regarding *whether to file a tort claim*. What proportion of eligible individuals file claims? What systemic or individual characteristics influence the probability that a claim will be filed? In general, very little is known about claim-filing behavior, except that it varies widely by state and over time (IRC, 1990). Clearly, changes in these patterns could have a dramatic impact on BI claim costs.

The fourth highlighted element is the *valuation of total compensation deserved* by the claimant. In theory, the adjuster attempts to approximate the jury award that would result if the case went to trial. However, because so few cases actually reach the courts, there is little empirical evidence to inform this assessment. In practice, the adjuster tends to rely on guidelines that have become established over many years and have the force of strong tradition. For example, according to traditional claims adjustment lore, the amount of medical expenses is the single most important indicator of injury severity. A common rule-of-thumb is to set an initial settlement value at some multiple of total medical charges (or possibly of total economic loss). However, it is also recognized that these general rules must be modified to take account of other salient characteristics of the injury. Moreover, the effectiveness of legal representation may also affect the outcome of the settlement negotiations.

In each of the four highlighted elements, there are behavioral factors that may change as the rules and incentives of the tort system change. The "propensity to sue" in a given region or state may depend upon economic conditions, the access to specialized accident victim medical treatment, and the aggressiveness of the local plaintiff bar. Economic incentives may exist for the claimant to maximize medical treatment charges and periods of disability in order to obtain the largest settlements possible. Statutes and regulations designed to protect the consumer can also supply the opportunity for fraudulent or excessive ("built-up") claims. As a particular tort system changes in meaningful ways, these behavioral factors will change claim payments, sometimes by substantial amounts (see Section 4 below).

2.2 *Basic No-Fault System*

Figure 2 portrays the case-flow for a generic no-fault system.[11] As noted above, the specific features of the various systems in place vary significantly (PIP benefits, definition of tort threshold, etc.). However, the basic structure of all no-fault systems follows the general pattern shown in Figure 2.

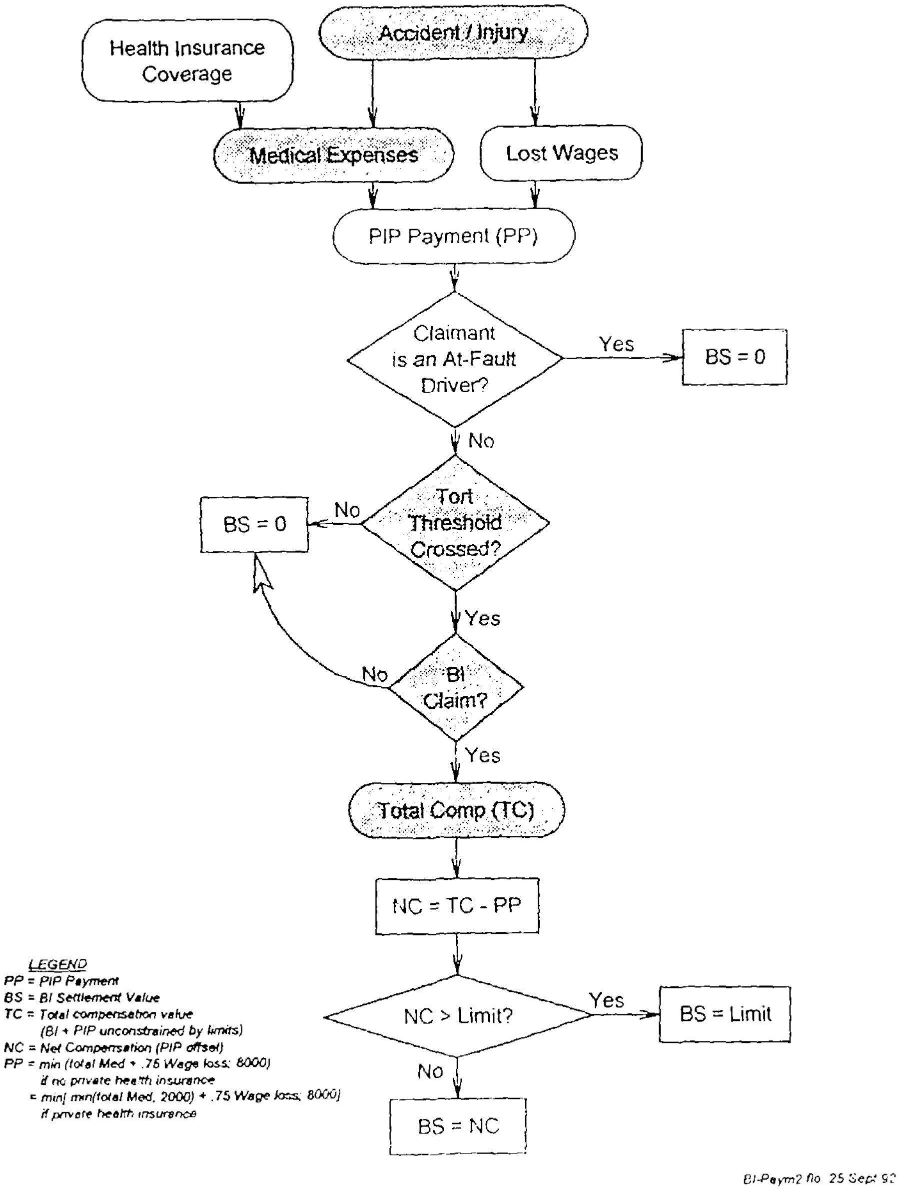
Once an accident has been alleged, real or potentially compensable injuries are assessed by company adjusters. If a claim is likely to arise, a case file and a reserve will be set up.

[11]Although a pure first party no-fault bodily injury compensation system remains a possibility, none has been implemented to date.

FIGURE 2

Bodily Injury Liability Claim Payment Process

No-Fault System



Under no-fault, at least part of the medical expenses and lost wages are reimbursed under the first-party (PIP) coverage. In Massachusetts, full medicals plus 75 percent of wages are reimbursed up to the policy limit of $8,000.[12] Note, however, that for states with coordination of benefits (COB) provisions, some or all of the medical expenses may be paid under other first-party coverage (primarily private health insurance). Thus, the effective amount of expenses for which PIP is responsible may be much smaller than the total expenses incurred. For example, in Massachusetts private health insurance is primary for all medical expenses in excess of $2,000.

The hallmark of a no-fault system is the existence of a tort threshold. The accident victim must not only qualify on the basis of liability in order to pursue a tort claim, but also must cross the tort threshold. In Massachusetts, the threshold is defined in terms of a verbal component (disfigurement, dismemberment, fracture, death, loss of sight or hearing) and a monetary component (at least $2,000 in medical expenses). Of the approximately 45% of Massachusetts PIP claimants who do cross the threshold, only 10% satisfy the verbal component.

Finally, many no-fault systems include a mechanism to preclude double payment of economic losses under the PIP and BI coverages. Typically, the amount of the PIP payment is "set off" against the BI award. That is, the claimant receives a net amount that is equal to the total compensation *reduced by the PIP amount*. In some states without such an offset provision, "double-dipping" is avoided by allowing the PIP insurer to receive reimbursement from their insured out of any BI recovery obtained. Setoffs are generally allowed when a subrogation process is in place.

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[12]Optional Medical Payments coverage can be purchased to extend in effect the PIP limit.

2.3 PIP Subrogation

In Massachusetts and several other states, there exists a further wrinkle. Under some conditions, the first-party insurer is considered to be "subrogated" to the victim's tort rights. That is, the insurer stands in the insured's place with respect to a right of action against the tortfeasor, and may seek reimbursement directly from the third-party carrier. The specific rules governing the operation of PIP subrogation in different states vary considerably. Figure 3 reflects the Massachusetts system, in which subrogation has a major effect.

If the claimant is a passenger in an at-fault vehicle or a pedestrian, then the potential BI carrier is the same as the first-party insurer of the at-fault vehicle. Therefore, subrogation is not possible. In most other situations, a potential BI target will be contacted and a request for subrogation made. Subrogation is allowed in Massachusetts regardless of whether the victim crosses the tort threshold or files a BI claim.

For a situation in which the at-fault insured driver, the "tortfeasor", is 100 percent at-fault, the amount of the subrogation request is ten percent over the PIP payment. The additional ten percent is meant to reimburse the PIP carrier for loss adjustment expenses associated with the claim. In a situation of shared liability, the amount is reduced by the claimant's proportion of fault.[13] If the claimant has filed a BI claim, then an actual subrogation payment cannot be made until after the claim has been settled, since the amount of money that remains available will depend on the BI policy limits. In Massachusetts, the entire policy limit remains available to the BI claimant, regardless of the subrogation amounts.

One can begin to get a flavor for the complexity and potential volatility of the claiming

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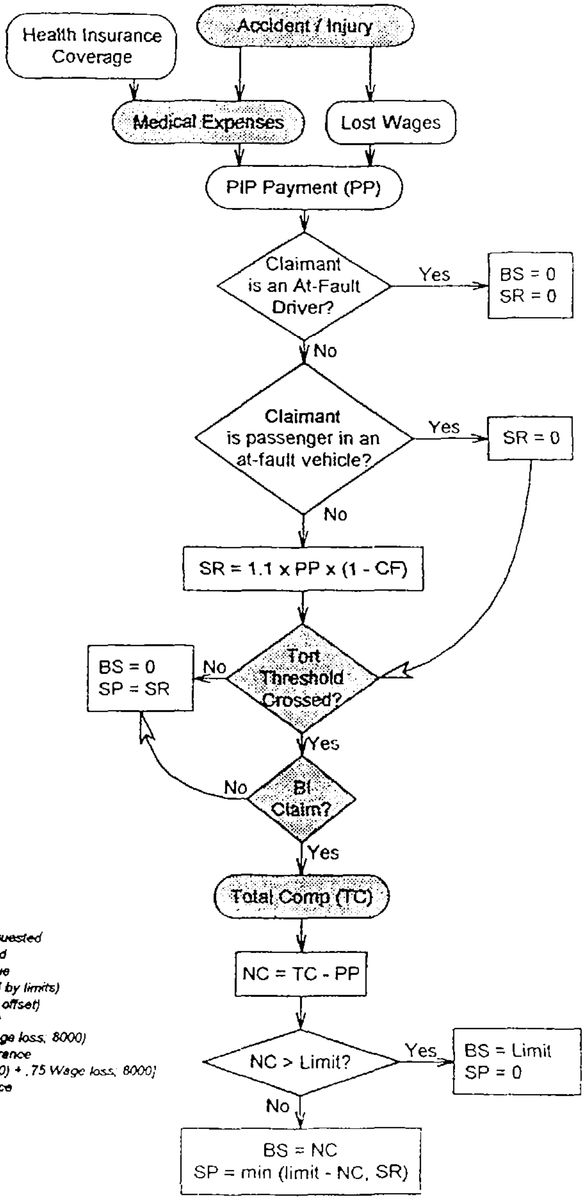
[13]Of course an exact determination of fault percentage may be disputed and arbitration needed to resolve the differences.

FIGURE 3

Bodily Injury Liability Claim Payment Process

Massachusetts No-Fault



LEGEND

PP = PIP Payment
BS = BI Settlement Value
SR = Subrogation amount requested
SP = Subrogation amount paid
TC = Total compensation value
(BI + PIP unconstrained by limits)
NC = Net Compensation (PIP offset)
CF = Claimant's share of fault
PP = min (total Med + .75 Wage loss, 8000)
if no private health insurance
= min[min(total Med, 2000) + .75 Wage loss, 8000]
if private health insurance

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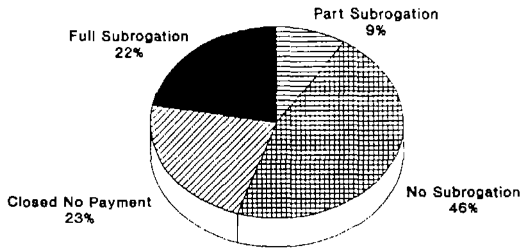
process by noting the final disposition of potential PIP claims in Figure 4. The process of subrogation creates subtle interactions which become important to recognize when alternative BI systems are considered.

Figure 4
Disposition of a PIP Claim



Source: AIB Statistical Plan Data

With a universe of all claims[14] that had positive PIP reserves set up at some time, 23% eventually were closed without any payment, 22% had PIP payments that were fully subrogated to the BI carriers, 9% were only partially subrogated[15], and 46% were pure PIP payments without any subrogation.

Table 1 provides some more detail on the extent and overlap of PIP and BI claim counts and amounts. The data are derived from a random sample of 839 PIP claims from 1989. In

[14]These percentages were derived by scanning the entire 1989 accident year statistical plan data at 42 months (June, 1992).

[15]Partial subrogations occur when the adverse party's coverage limits are exhausted or comparative negligence applies.

particular, only 28% of PIP claimants also received BI settlements; another 26% had their PIP payments fully subrogated to the BI carrier, fairly close to the 29% indicated in the statistical plan paid claim data above, while the remainder had PIP benefits fully paid by their first party PIP carrier.

Table 1
BI and PIP Claim Counts and Amounts

	(1) Number of Claims	(2) Percent of PIP	(3) Amount per Claim	(4) Amount per PIP Claim (1)x(3)/839
I. Total BI Claims*	454	54.1	7,485.70	4,051
A. Total BI Tort	237	28.2	12,569.84	3,551
B. Total PIP Subrogation	307	36.6	1,366.31	500
PIP Subro w/BI	90	10.7	2,780.96	298
II. Total PIP claims	839	100.0	1,663.63	1,664
III. BI Plus PIP Claims (IA & II)	839	100.0	5,214.34	5,214

* Includes 17 Uninsured Motorists Claims.
Source: AIB Study of 1989 PIP Claims.

3.0 A PRICING METHODOLOGY BASED UPON MICRO-DATA

In the Introduction we discussed in a general way the limitations imposed by typical statistical plan data. We now show how detailed "micro-data" can be helpful to address these problems.[16] We use the Massachusetts model (Figure 3) for illustration, but the potential for extrapolation of the basic ideas to other systems should be evident.

3.1 Changing Bodily Injury Claim Systems

Projecting future claim frequency and severity, even under a fixed tort system, is often extremely difficult. If the underlying forces driving the process (e.g., patterns of claim-filing and medical treatment) are in flux, then extrapolations of past trends based on routinely collected

[16]The term micro-data is suggested by the idea that claims are being examined as if under a microscope to reveal the fine detail that is invisible at the grosser level of ordinary statistical plan data.

statistical plan data become unreliable. Moreover, if the parameters of the system (e.g., negligence standards, tort threshold) are substantially *modified* by legislative action or judicial interpretation, then the relevance of the available data may be further attenuated.

Suppose that a monetary no-fault state like Massachusetts decided to change next year to either a verbal threshold or pure tort system (both are currently under active consideration in Massachusetts). We know qualitatively that a verbal threshold should entail a major reduction in the frequency of BI claims and an increase in severity of those claims that remain tort-eligible. A pure tort system should (in theory) generate a substantial increase in claim frequency and decrease in severity. But how could we develop a credible quantification of what will happen under the new system?

The problem faced by actuaries in either case would be to estimate the frequency and severity of an event (BI claim under new system) that is essentially different from the event about which historical data have been accumulated (BI claim under old system). Is there a way to bridge the gap between the old data and the new (anticipated) reality? The answer depends on the extent to which we can measure for the population of accidents/injuries those characteristics that determine whether a PIP or BI claim will be filed and how much compensation will be paid.

Suppose first that both the underlying distribution of accidents/injuries and the nature of individual claim-filing behavior are stable and will not be influenced significantly by the change of tort system. Assume further that we have collected detailed information for the population of accidents/injuries, or a representative sample, on the accident and injury, medical treatment and the extent of disability. In addition, we have data on whether a BI claim was filed and the amount of any BI settlement. Then it would be straightforward to calculate the expected loss distribution under various alternative scenarios.

For example. to evaluate a change from a monetary to a verbal threshold we could first calculate the loss distribution under the current system, after adjusting for any changes in claim characteristics expected to occur (e.g., economic inflation). Then, if we have measured the characteristics that define the verbal threshold (e.g., disfigurement, fracture, length of disability), we will be able to simulate the entire loss distribution that would be expected under this alternative. That is, for each accident/injury, we determine whether a BI claim will be filed and the expected BI payment. Comparing the resulting pure premiums under the two systems would provide an estimate of the rate impact of the proposed changeover. An example of this methodology for a changing monetary threshold is given below in Section 5.1.

So far, we have assumed the availability of micro-data on a sample representative of the entire population of accidents/injuries. However, the prime sources of potential data (statistical plan and claim files) pertain only to accidents/injuries that actually resulted in claims under the existing system. Thus, we may lack data on some new claims that could arise under a different system.

For a traditional tort state, virtually all potential tort claims under any contemplated system are already represented in the population of BI claims.[17] Thus, estimates of the BI loss distribution under alternative systems should be straightforward. However, estimating the number of *additional claims payable under a no-fault coverage* would require external information or theoretical assumptions.

Under an existing no-fault system, the problem is somewhat different. In theory, all potential BI claimants already file PIP claims and will thus be included in the available claim

[17]However, the proposed system may stimulate the fabrication of new fraudulent claims.

population. However, in reality there are some victims who for various reasons choose not to pursue the injury with their auto insurer. Their potential claims close without payment (Figure 4). Because some of these individuals *could* choose to file claims under an alternative system, their exclusion from the claim population might lead to an underestimation of losses.

3.2 Massachusetts BI and PIP Studies

In Massachusetts we have recently completed a series of three studies that can be used to support the kind of simulations described above. The first study was based on a representative sample of 474 BI liability claims based on accidents that occurred in 1985 and 1986. For each claim, extensive data were coded pertaining to the accident, injury, treatment, claim handling, and payment. In addition to objective information contained in the claim file, the coder's judgements regarding fraud and build-up were elicited (Weisberg and Derrig, 1991a).

The second study was a follow-up study of BI claims from accident year 1989. Claim files for a representative sample of 1154 claims were examined using a slightly revised version of the data collection instrument from the earlier baseline study. The primary purpose of the follow-up study was to assess the impact of a reform law implemented in 1989 that increased the monetary tort threshold from $500 to $2,000 (Weisberg and Derrig, 1992a)

The third study was based on a representative sample of 839 PIP claims from accident-year 1989. The primary purpose of the study was to clarify the reasons why PIP pure premiums were increasing at a much faster rate than expected, but an important secondary goal was to estimate the effects of coordination of benefits on both PIP and BI losses. We had originally hoped to obtain information on all the BI claims that arose out of the PIP claims in our sample, thus crafting a database close to the ideal described above. However, the available information on related third-party claims was not adequate. We supplemented the PIP data by searching the statistical plan data for any matches with our PIP claims. This search effort added a number of BI claims that were not evident in the PIP files. (Weisberg and Derrig, 1992b)

Finally, the PIP study also included a special sample of 387 PIP claims that could be linked with corresponding BI claims in our previous 1989 BI study. It was thought that having comprehensive data on both the PIP and BI claims would be useful for several purposes. In particular, we wished to refine the total compensation models developed on the basis of the 1989 BI data by incorporating information about health insurance. Without such information, we could not determine how much of a PIP offset had been incorporated in the BI settlement amount.

4.0 INCORPORATING ASSUMPTIONS ABOUT BEHAVIORAL FACTORS

The basic methodological approach described above assumed that the underlying dynamics of claim generation were stable and independent of the particular type of tort system. Specifically, the underlying distribution of accidents/injuries, patterns of medical treatment, claim-filing propensities, and BI claim valuation were assumed fixed. Consequently, the simulation of alternative scenarios became a mechanical exercise, providing that we could obtain detailed data on a representative sample of accidents/injuries.

The model considered so far might be termed "naive" because it ignores behavioral responses of accident victims, lawyers, and heath care providers. A more realistic model must reflect assumptions about the main behavioral factors that can influence claim losses. Even if we can only speculate about these factors, it is useful to conduct "what-if" analyses under alternative assumptions. We now consider these behavioral factors in more detail and demonstrate how statistical models based on micro-data can sometimes help to provide an empirical basis for improving upon the stable system assumption.

4.1 Profile of Accidents and Injuries

As suggested above, the profile of accidents and injuries might not be stable. For example, improvements in vehicle design or lowered speed limits might tend to decrease injury severity, while increased advertising by attorneys might engender more soft-tissue (strain and sprain) injury claims. Such factors can affect the overall frequency of claims, the distribution of claim types, or both. Pricing the PIP and BI coverages under alternative plausible scenarios regarding the impact of these factors would pose great difficulties for traditional actuarial methodology.

To account for such effects in a pricing model, we must first have some basis for hypotheses about which specific types of claims will be increasing or decreasing and how much. Then we need a way to identify the claims of these types among our sample claims. Finally, we re-weight the observations in our database to reflect the expected distribution of claims under alternative scenarios.

For example, suppose that a campaign to crack down on speeding and drunk driving is expected to reduce the frequency and severity of very serious injuries by 20 percent. If we can define a "very serious injury" in terms of claim characteristics captured in the database, then we can specify which particular claims would be subject to possible elimination. Removing a fifth of these claims from the database for purposes of analysis would then reflect the expected impact of the intervention.

4.2 Medical Expenses

The amount of total medical expenses incurred by the claimant plays a central role in the claim payment process. Under a monetary no-fault system, medical expenses can determine whether a BI claim is possible. Under all systems, the total compensation value is determined largely by total medical expenses. The decision to file a BI claim may also be influenced by the amount of medical expenses.

Suppose we have constructed a database containing micro-data on a representative sample of current accidents/injuries. We wish to simulate the distribution of outcomes (PIP and BI claim payments) that will occur under an alternative system. In theory, the treatment received for a specific type of injury should not be affected by the particular tort system in place. Thus, our simulation might assume that for each accident/injury in the population, the incurred medical expenses will remain the same (except for the effect of medical cost inflation).

It is possible, however, that patterns of medical treatment may be changing over time for a variety of reasons, including the modified tort system. We cannot necessarily assume that medical expenses incurred by future claimants, similar to those represented in the sample, will be identical to the expenses observed. For example, changing economic incentives could result in an increase in utilization of sophisticated diagnostic techniques or in the number of visits to chiropractors.

The null hypothesis of stable treatment patterns is particularly dubious when the profile of reported injuries is changing over time. For example, if increased advertising by attorneys is causing more claims of soft-tissue injuries, then simply re-weighting the observations in our database to reflect the expected increases in strains/sprains may not be adequate. We must also consider how the handling of such claims by claimants, lawyers, and health care providers might affect medical expenses. For example, marginal or fabricated injuries might tend to involve more visits to health care providers than apparently similar legitimate injuries.

Predicting changes in treatment patterns must necessarily be somewhat speculative. However, statistical models based on claim data can provide valuable insight. Our research in

Massachusetts has revealed that provider discretion appears to play a major role in determining the medical charges for injuries that involve strains or sprains, but a very minor role for injuries without a strain/sprain component. Therefore, our success in pricing any statutory modifications of Massachusetts no-fault depends in large measure on correctly anticipating the way soft-tissue injuries will be treated in the future.

A set of multiple regression models has proved particularly informative. We divided the claims in our PIP sample into three categories: pure strain/sprain, mixed, and non-strain/sprain. For each category, we found those claim characteristics that best predicted the total medical expenses. Our first set of analyses included possible predictors which were measures of accident or injury seriousness, but excluded measures of treatment utilization or lawyer involvement. Our second set of analyses included any variable that significantly improved our ability to predict medical expenses.

The results are summarized in Tables 2 and 3 respectively. For claims that involved strains or sprains, variables that reflected the seriousness of the injury explained little of the variation in medical expenses. For pure strains/sprains our model R^2 was only .04 and for mixed claims with strains/sprains and "hard" injuries, the R^2 was .21. Only for the non-strain/sprain injuries was a large proportion of the variation explained by measures of injury severity (R^2 = .62). However, when variables related to treatment utilization and claimant behavior were added in, the value of R^2 for strain/sprain claims jumped to .78 and that for mixed claims to .79, while the R^2 for non-strains/sprains increased only slightly to .68.

TABLE 2 DETERMINANTS OF MEDICAL CHARGES*									
VARIABLE	*STRAIN/SPRAIN*			*MIXED*			*NON-STRAIN/SPRAIN*		
	Coeff	*p-value*	*F*	*Coeff*	*p-value*	*F*	*Coeff*	*p-value*	*F*
Intercept	6.42			7.10			5.27		
Severe Collision	.58	.0004	12.9	-	-	-	.40	.02	6.1
Perm. Partial Disab.	-	-	-	1.28	.02	5.7	2.08	.003	9.3
Hospital Admission	-	-	-	1.59	<.0001	32.2	1.48	<.0001	19.3
Very Serious Injury	-	-	-	-	-	-	1.36	.0004	12.9
Serious Laceration or Fracture	-	-	-	-	-	-	.89	<.0001	20.0
Serious Trauma	-	-	-	-	-	-	.87	.0005	12.6
R^2	.04			.21			.62		

* Dependent variable = Log (Total Charges)
Independent variables all pertain to seriousness of injury only.

TABLE 3 DETERMINANTS OF MEDICAL CHARGES*									
VARIABLE	*STRAIN/SPRAIN*			*MIXED*			*NON-STRAIN/SPRAIN*		
	Coeff	*p-value*	*F*	*Coeff*	*p-value*	*F*	*Coeff*	*p-value*	*F*
Intercept	5.18			5.72			5.04		
Log Outpatient Visits	.60	<.0001	216.9	.59	<.0001	300.5	.61	<.0001	49.5
Lawyer Involved	.46	.001	13.2	-	-	-	-	-	-
Severe Collision	.27	.001	11.2	-	-	-	.47	.003	9.6
MRI Used	.54	.003	9.3	.38	.02	5.8	-	-	-
CT Scan Used	-	-	-	.43	.001	12.0	.59	.02	6.2
Serious Visible Injury	-	-	-	-	-	-	.71	.001	13.4
At-Fault Driver	-.37	.007	7.6	-	-	-	-	-	-
Log of Hospital Days	-	-	-	.83	<.0001	76.8	1.08	<.0001	79.8
Treated by MD Only	-.42	<.0001	16.3		-	-	-	-	—
R^2	.78			.79			.68		

* Dependent variable = Log (Total Charges)

The number of outpatient visits was by far the most powerful predictor of expenses for mixed and strain/sprain claims, after adjusting for available measures of accident and injury seriousness. Therefore, assumptions regarding this aspect of treatment must be the focus of particular attention for pricing analyses, at least in Massachusetts. The statistical significance of legal representation for pure soft tissue injuries in determining medical expenses along with the indicator of whether the claimant was an at-fault driver underline the importance of behavioral factors.

4.3 Decision to File a BI Claim

It seems plausible that the propensity to file a claim will vary across victims and will depend on both individual characteristics and on the nature of the injury. Ideally, our database would contain information for each accident/injury on whether a BI claim was filed. Then to the extent that the underlying distribution of accidents and injuries remained roughly stable, our simulations of alternative scenarios could assume that the claim-filing decisions would also be the same as those observed. However, we noted above that the profile of accidents and injuries might be shifting, possibly in direct response to the tort system modifications. In such a situation, patterns of claim-filing behavior might also change.

In general, it may be difficult to obtain empirical evidence on claim-filing propensity. In traditional tort states, insurance data exist only for accident victims who filed BI claims. We do not know how many other victims could have filed but elected not to do so. In no-fault states, we can determine whether a PIP claimant was eligible to file a BI claim, but may not know whether a claim was filed. So we may have little but intuition to help frame the hypotheses about claim-filing to consider.

In Massachusetts, we were able to obtain valuable insight by developing a two-part model of the claim-filing process. First, we used logistic regression analysis of the data on PIP claims to identify factors related to crossing the monetary tort threshold. Second, we used logistic regression based on the supplementary BI data described above to identify factors related to filing a tort claim, once the threshold had been breached.

The results of the models to predict crossing the monetary threshold are summarized in Table 4. This analysis was restricted to claims that were not by at-fault drivers and did not satisfy the verbal component of the tort threshold. A stepwise regression procedure was used to select independent variables. The pool of potential variables was identical to that used in the total medical charge regression modelling with one exception. In our previous regression analyses of total charges, we found that the number of outpatient visits was a very powerful predictor. It is obvious that a large number of visits would also be correlated with exceeding the $2,000 threshold. However, our interest here was on the more subtle claim characteristics that might explain such a pattern of utilization and the resulting medical expenses. Therefore, we excluded outpatient visits as a potential predictor in this analysis.

TABLE 4
Logistic Model Describing Who Crossed the $2,000 Tort Threshold
(Excludes at-fault drivers and claims satisfying verbal component of threshold)

VARIABLE	COEFFICIENT	WALD CHI-SQUARE	P-VALUE
Intercept	-7.48		
Hospital Admission	4.72	17.8	<.0001
Lawyer Involved	2.66	30.7	<.0001
Log (Total Disability Weeks +1)	.75	11.6	.0007
Log (Partial Disability Weeks +1)	.65	12.2	.0005
Treated by MD and Chiropractor	1.90	11.3	.0008
Treated by Chiropractor Only	2.89	23.5	<.0001
Log (No. OP Provider + 1)	3.56	22.9	<.0001

Dependent Variable = Log (P / 1-P) where P = Probability of crossing threshold

Overall, the monetary threshold was crossed by 41.5 percent of these claims. The factors that exerted the greatest impact on likelihood of crossing the threshold were admission to a hospital, presence of a lawyer, treatment by a chiropractor, and the number of outpatient providers. Other significant factors were treatment by an MD and chiropractor in combination and a lengthy period of temporary disability.

As an example, suppose that a claimant had an attorney, was treated by a chiropractor only, and was partially disabled for five weeks. Then, inserting the appropriate values in the equation, we calculate the probability (p) of filing a BI claim by:

$$\log (p/1\text{-}p) = -7.48 + 2.66 + \ln(6)x.65 + 2.89 + \ln(2)x3.56 = 1.703$$

and therefore:

$$p = .85$$

However, if the same claimant saw an MD only and did not have an attorney, we obtain:

$$\log (p/1\text{-}p) = -7.48 + \ln(6)x.65 + \ln(2)x3.56 = -3.847$$

and therefore:

$$p = .02$$

This equation supports the view that the presence of an attorney and the pattern of treatment, much more than the injury itself, determined whether the monetary tort threshold was attained. Even after accounting for possible effects of several other more direct measures of accident and injury severity, the predictive power of these variables remained strong.

The model of the decision to file a BI claim, once a claimant was tort-eligible, was much simpler. Most potential claimants (79.3 percent) chose to file a BI claim. Table 5 shows that legal representation was by far the strongest predictor, with total medical expenses also significant.

TABLE 5 *LOGISTIC MODEL DESCRIBING WHO FILED A BI CLAIM* *(Includes only drivers who crossed the tort threshold)*			
VARIABLE	*COEFFICIENT*	*WALD CHI-SQUARE*	*P-VALUE*
Intercept	-6.08		
Log of Total Medical Charges	.72	5.6	.02
Lawyer Involved	1.98	12.5	.0004
Dependent Variable = Log (P/1-P) where P = Probability of filing a BI claim			

An important implication of these two equations is that the presence of an attorney greatly increases the probability that a PIP claim will a) involve the necessary $2,000 to cross the threshold and b) result in the filing of a BI claim. While a direct causal interpretation may be speculative, it would seem prudent to reflect patterns of legal representation explicitly in our simulation modelling. For example, a dramatic increase in advertising by attorneys might be assumed to produce an increase in claimants, a higher percentage of represented claimants, or both.

4.4 Total Compensation Value

Ideally, our database would contain information on the amount of any BI award for each accident/injury. In our simulations of alternative systems, we could simply assume that the award would remain the same except for economic inflation. However, we noted above that the total compensation value was typically a multiple of medical expenses, modified by a variety of other considerations. If the process that determines medical expenses is changing, as discussed above, then we would expect the BI settlement to reflect these changes. For example, sharply higher medical expenses would translate into larger BI payments.[18]

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[18]All of our total compensation model runs resulted in claimed medical charge elasticities of 0.50 to 0.60, significantly less than 1.0.

To incorporate such effects in our pricing analyses, we must make assumptions about the relationship between claim characteristics and total compensation value. To serve as a basis for such assumptions in Massachusetts, we have developed a regression model, with the observed total payment (PIP plus BI) as the dependent variable. In principle, we could simply have treated the sum of PIP and BI payments as a dependent variable in a regression modelling framework. However, the BI payment could have been cut off, or *censored*, by the policy limits. We have utilized a variant of regression analysis called Tobit regression (Tobin, 1958) to take into account the censoring. The final model has been summarized in Table 6.

TABLE 6
TOBIT REGRESSION MODEL FOR TOTAL BI COMPENSATION

VARIABLE	*COEFFICIENT*	*CHI-SQUARE*	*P-VALUE*
Intercept	4.74		
Log of Total Medical Charges	.52	79.0	<.0001
Log of Wages	.043	26.7	<.0001
Log of Fault Proportion	.49	17.1	<.0001
Lawyer Involved	.40	11.1	.001
Fracture Involved	.31	8.3	.004
Apparent Build-up	-.25	11.5	.001
Log of Disability Weeks	.075	7.6	.006
Serious Visible Injury	.25	5.3	.03

* Dependent variable = BI Payment + PIP Payment

As expected, the most powerful predictor of the total BI compensation was the amount of medical charges incurred. Although amount of lost wages was also highly significant, the relatively low value of the coefficient (.043) for the wage variable compared to that for medical charges (.520) suggests that the total compensation provides only for wage replacement. General damages may be unaffected by lost work time unless disability is also claimed. Other important determinants of the BI compensation were the at-fault driver's degree of fault, involvement of an attorney, and presence of a fracture injury. The number of weeks on disability also influenced the magnitude of the BI settlement, as did the fact that a serious injury was visible at the accident scene.

We hypothesized that an adjuster who suspects that medical expenses may reflect build-up will try to "compromise" the claim. To test this hypothesis we have included the perception of build-up as one of the independent variables. The highly significant negative impact on the BI award (-22%) suggests that claimants whose medical expenses appeared artificially inflated received a discounted evaluation of pain and suffering. Thus the negotiation process, and hence the final claim settlement value, is affected by the claim adjuster's perception of build-up and fraud.

5.0 SPECIFIC EXAMPLES

The considerable detail captured on each claim in the AIB Studies allowed us to "simulate" how the claim would be treated under various alternative claim environments and at different points in time. We have developed SAS computer models, where needed, to implement these simulations. For each different system and accident year of interest, we can compare the average values and other aggregate statistics of the simulated payments generated by alternative models. In this section, we summarize three examples that. although drawn from Massachusetts experience, represent a range of possible applications.

5.1 Changing a Monetary Tort Threshold

Using the Baseline Study data on 1985-86 accidents we created two models to predict the pattern of claims expected under a change in the monetary threshold from $500 to $2,000 beginning in 1989. The *naive* model embodied the assumption that treatment patterns for injuries would be unaffected by the different financial incentives implicit in the new tort system.

We assumed simply that medical costs would rise at roughly the 8.5 percent rate indicated by the Boston Medical Care Index. Moreover, the model assumed that the underlying frequency of automobile-related injuries would remain constant.[19] Under these assumptions, the model evaluated each Baseline Study claim in terms of its qualification as a potential tort claim under the new criteria. The subset of claims which remained tort-eligible formed the basis of our projections for accident-year 1989.

The fact that traditional tort settlements (or verdicts) as well as PIP subrogations are both BI payments causes a certain awkwardness of terminology. For convenience, we will refer to the BI settlement (or verdict) paid to the claimant as the (true) BI payment, although the PIP subrogation (if any) is really part of the total paid under the BI policy. The subrogation payment to the claimant's first-party insurer will be termed the PIP subrogated payment (see Table 1).

The logic of our simulation program is displayed in Figure 5. The flowchart reflects the decision-making process for each claim in the study sample. The variable denoted PIPPAY is the amount of any PIP subrogation payment generated by the model. BIPAY is the amount of any BI tort payment. VALUE represents the potential PIP payment according to the rules for the payment of PIP benefits.[20] PDPIPSUB is the amount of the actual PIP subrogation recorded in our Baseline Study data base, and CURRVAL is the BI payment for closed claims, or the ultimate estimate for open claims.[21] LIMITS represents the amount of the individual policy

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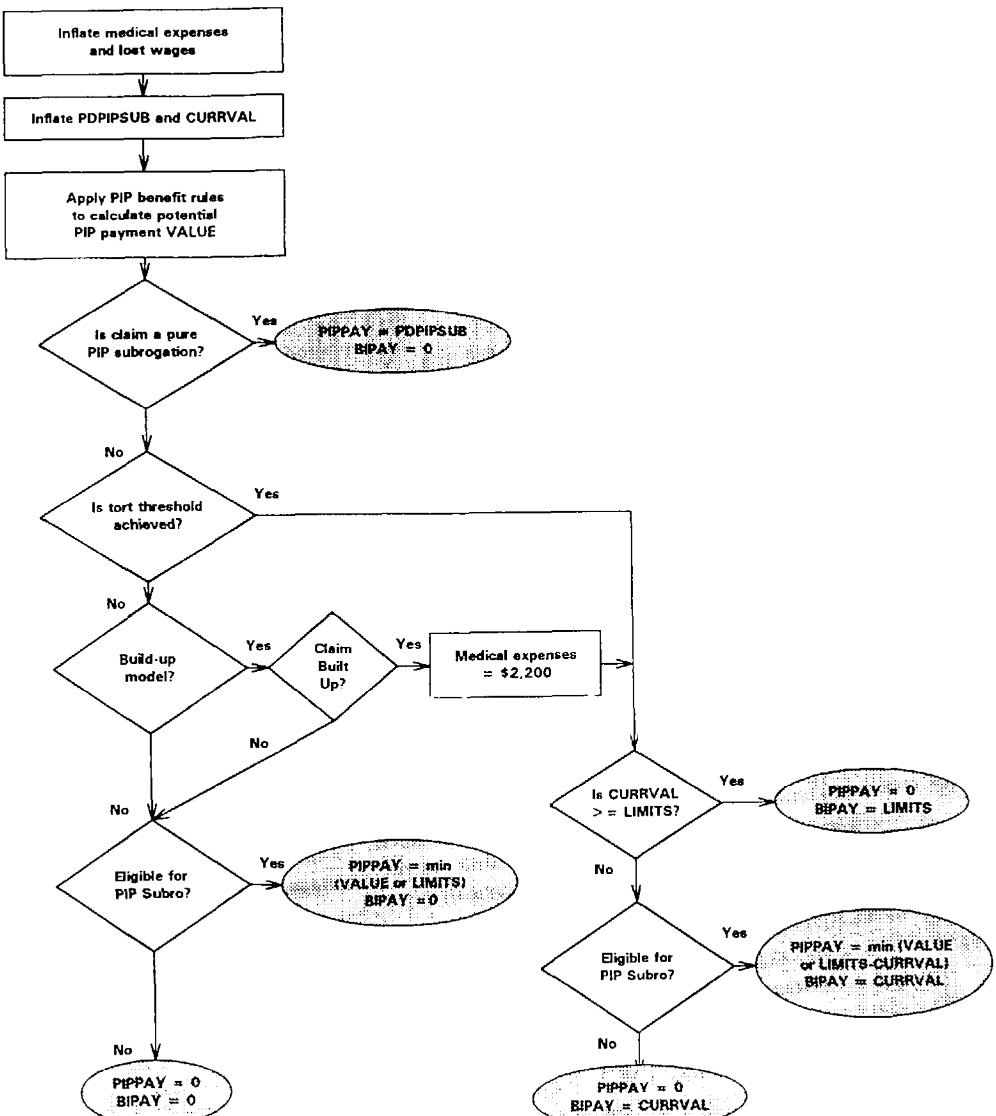
[19]For a complete description of the simulation model and the assumptions underlying its operation, see AIB Filing on Fraudulent Claims Payments for 1991 Rates (Docket G90-15), pp. 339-346.

[20]VALUE can be interpreted as the estimated total PIP payment regardless of which carrier actually ends up paying.

[21]The ultimate estimate of the BI payment was based on the last reserve maintained as of the time of coding (July, 1989).

FIGURE 5

Logic of the Simulation Model



limit.

A principal focus of the Baseline Study was suspicious claims. The coders identified cases of apparent fraud and/or build-up. Under our basic simulation model, a claim that failed to breach the threshold under any particular system was assumed to be paid under PIP. This naive model made no provision for any *more* build-up of medical expenses than that which was already reflected in the 1985-86 claims. To be more realistic, we also developed a model that reflected the hypothesis that claims similar to those that displayed apparent build-up in our Baseline Study would be further inflated (if necessary) to achieve the threshold. Our *conservative build-up* model incorporated the assumption that such claims would reach $2,200 on average in claimed medical charges.[22] The medical charges simulated under this alternative model were those expected to result from behavioral changes of claimants, physicians and lawyers.

Finally, we note that our build-up model was conservative in the sense that it reflected only build-up intended to reach the tort threshold. Build-up of claims already exceeding the threshold in order to "leverage" the general damages was not incorporated. Moreover, for claims built up over the tort threshold, we did not attempt to estimate the increased general damages that might result from the higher medical expenses claimed.[23] Furthermore, we did not

[22]Another purpose of the Baseline Study was to test the implications of alternative types of tort systems that might be considered for use in Massachusetts. For example, alternative no-fault and tort system rules were used to produce verbal threshold simulations that approximated the New York and Michigan systems.

[23]To estimate the increased general damages resulting from build-up would require a statistical model relating general damages to medical expenses. Since modelling efforts shown in Section 4 were preliminary at that time (Weisberg and Derrig, 1991b), we chose to adopt a simple inflation approach to the claim cost. The total compensation model of Section 4.4 could now be easily added.

allow for the possibility of build-up among claims that did not involve build-up under the former Massachusetts system.

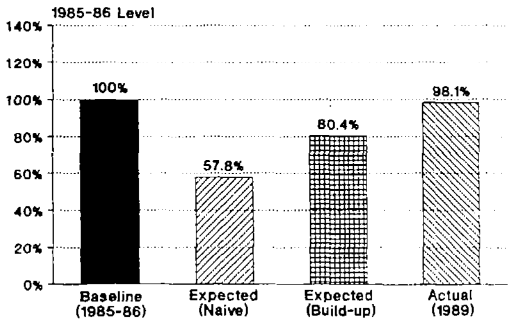
The naive model predicted that the post-reform frequency of true BI liability claims would be about half (50.8 percent) of the corresponding 1985-86 frequency. The conservative build-up model predicted that the frequency would be 70.7 percent of the 1985-86 level. Thus, both predictions were for substantial frequency changes based primarily on the claimed medical-payment data.

In order to gauge how well these two models predicted the effect of the monetary threshold change, we examined the 1989 BI results. After adjusting for the actual 13.7 percent increase in PIP frequencies, the expected frequency relative to 1985-86 would be 57.8 percent for the naive model.[24] Similarly, the conservative build-up model forecasted an adjusted relative frequency of 80.4 percent.

Figure 6 displays the predictions from the two alternative models as well as the actual results. It is evident that the theoretically expected decline in claim frequency simply failed to materialize in practice and that the build-up model was indeed conservative. Note, however that the use of behavior-modified values, based upon the expected consequences of the increased economic incentive (general damages for medical charges over $2,000), produced a predicted change with half the error of the naive model.

[24] 1.137 x .508 = .578, 1.137 x .707 = .804.

Figure 6
Effect of Tort Reform
Frequency of True BI Claims Relative to Baseline



5.2 Supplementing a Trend Factor

The naive/build-up model example demonstrates the use of models to predict single year aggregate losses. Analyses of trends in annual losses can also be improved by using a simulation model, like that developed in Section 5.1, to refine the calculation of trend factors. Suppose that instead of estimating the one-time (marginal) change in a BI system, the actuary's problem is to estimate how the loss costs of a new system will continue to change over time. One simple answer would be to run the model several times, increasing medical costs and total compensation by an additional year of inflation each time.

Suppose, however, that three years of actual data are available under one system and three more years under a second system. Fitting a linear trend with a dummy variable at the system changeover point would yield a reasonable estimate for future values if the rates of change under the two BI systems were similar (equivalently, the second derivative of the time series is approximately zero). What are the chances that a BI system that involves the interaction of policy limits, subrogation, and build-up with a fixed monetary threshold will have a constant rate of change in loss costs? Probably very small. Our next example demonstrates how the micro-data and the model from Section 5.1 can help test the adequacy of simple trend models and adjust the estimated trend when those models prove inadequate.[25]

Briefly, Table 7 shows the 1986-1991 sequences of actual pure premiums and simulated BI losses at basic limits, the latter using our micro-data and the build-up model. A six-year linear trend with a dummy variable for the 1989 change in the threshold provides a projected 1993 value of $143.30 for the pure premium series.[26] Under this linear trend model, pure premiums are expected to increase 6.0% from 1991 to 1993. In other words, a linear trend factor of 1.060 is indicated by the pure premium data.

Table 7
1986-1991 BI Data

Year	*Pure Premiums*	*Simulated Losses (000's)*	*Tort Threshold*
1986	$85.73	$2,884	$ 500
1987	95.58	2,987	500
1988	102.88	3,092	500
1989	100.24	2,533	2,000
1990	112.46	2,645	2,000
1991	135.19	2,786	2,000

Our simulation model can also produce a single estimated value for the 1993 accident year. That value will take into account all the process interactions of interest (limits, inflation,

[25]The authors thank Ruy A. Cardoso for providing this example of the application of the simulation models.

[26]In this case, the use of a dummy variable effectively adjusts the old system data to the new system levels.

tort threshold, etc.). By comparing the 1993 simulation model value of $3,141 to the same type of linear trend model with a dummy variable for the 1989 change projection of $3,045 we see that the linear 1991/93 trend factor for the simulated losses must be supplemented by an additional 3.2% (3141/3045) in order to produce a correct (simulated) 1993 loss level. Thus, the sequence of simulated values is indicating that losses will accelerate (non-linearly) over time rendering linear trends inadequate. A more reasonable total pure premium trend factor might be the linear pure premium trend factor of 1.060 multiplied by the simulation model non-linear supplemental trend of 3.2% for a total trend factor of 1.094 (1.060 x 1.032).

Testing the adequacy of an exponential trend would proceed similarly. The point here is that the use of the micro-data simulation model projections can assist the actuary in choosing adequate trend factors that are based not only on a simple choice of data-fitting model (linear, exponential, etc.) but also on the expected movement in the micro-data aggregate. Moreover, the latter can be analyzed to provide the *reasons* for the changing values; the former cannot.

5.3 Coordinating with Health Insurance

One method that has been proposed to contain the rise of first-party PIP or Medical Payments claim costs is the coordination of benefits with health insurance. Total insurance system cost savings, as opposed to simple cost shifting from one insurance system to the other, can result from the elimination of double coverage and double benefit payments. Mehr and Shumate (1975) find, however, that insureds *prefer* double coverage when given a choice and will generally shun optional deductible plans designed to eliminate the double cover on the automobile side.[27] Of course, from the consumer point of view it is more economical to

[27]Less than 10% of the Massachusetts insureds have chosen PIP deductibles in the 22 years of no-fault coverage existence.

purchase the medical coverage with a pre-tax employee benefit than with after-tax disposable income. Mehr and Shumate conclude that "the strongest and only argument for making health insurance primary is the tax argument."

As mentioned above, in Massachusetts PIP is the primary coverage for the first $2,000 of medical expense. Medicals in excess of $2,000 must be covered by private health insurance, if available, up to the $8,000 PIP limit. Just how much is "saved" by the automobile insurance system using this COB provision? Could more be saved if health insurance became primary? How would increased PIP limits affect the results? The micro-data on PIP claims allowed us to estimate the savings to the PIP coverage of COB with health insurance "triggers" at zero (health primary), $2000 (current system) and $5,000.

The basic approach was to calculate for each claim the amount that would be saved by the PIP insurer under each of the six systems. When the claimant was covered by private health insurance, we first computed the expected amount that PIP would have paid in the absence of the COB provision. This expected payment was the sum of actual lost wages and medical expenses up to the PIP policy limit. We then subtracted the expected payment under COB. This payment was calculated in the same way, except that actual medical expenses were capped by the COB trigger amount (e.g. $2,000 for the current Massachusetts system). The difference between the two payment values represented the savings attributable to COB.

Table 8 shows what were at first considered surprisingly low COB savings for six alternative COB/PIP systems. Further reflection revealed that these results are quite plausible. The explanation can be found within the interactions of the claim characteristics. First, federal insurance plans like Medicare and Medicaid are by statute never primary (their costs are being contained as well). Second, a large segment of the claimant population is not currently covered by health insurance.[28]

TABLE 8 *COORDINATION OF BENEFITS:* *SIMULATED EFFECTS OF COB WITH ALTERNATIVE SYSTEMS**				
PIP LIMIT	*HEALTH INSURANCE TRIGGER*	*PERCENT WITH COB SAVINGS*	*PIP PAYMENT (NO COB)*	*% SAVINGS*
8,000	0	44.6	1,996	38.7
25,000	0	44.9	2,304	41.0
8,000	2,000	17.8	1,996	14.2
25,000	2,000	18.5	2,304	19.4
8,000	5,000	2.9	1,996	2.2
25,000	5,000	3.6	2,304	8.1

* Assumes no medical inflation. Ignores denials and disallowances by health insurer or PIP carrier.

Finally, it is worth reporting with this example that these COB savings are not fully removed from the auto insurance system let alone the total insurance system. Typically, to avoid duplicate *automobile* insurance payments, PIP payments can be offset from total estimated BI damages to produce a lower BI payment. However, unless specifically allowed as a collateral source offset, health insurance COB payments *cannot* be similarly offset from BI damages. Thus, in the case of PIP claims that also involve a BI liability component, the BI plus PIP total auto payment is the same with or without health insurance COB. Indeed, this fact was confirmed by the lack of statistical significance of the health insurance variable in the total compensation model in Section 4.4 (Table 6).[29] Since our micro-data shows that about 68% of the current PIP savings comes from claims with a tort component, auto insurance COB savings

[28]An additional factor, the failure of some private health insurance plans (generally HMO's) to cover chiropractic treatment, was not considered in this model. A more sophisticated model could in theory be developed to account for this factor as well.

[29]The dummy variable for private health had an insignificant coefficient of -.00055 with a p-value of .9579.

are currently at the meager 5% level.

6.0 CONCLUSION

When the forces that determine no-fault and bodily injury liability losses are changing, the accurate pricing of these coverages can become a formidable challenge for actuaries. In particular, when the tort system itself undergoes a major reform, the usual statistical plan data may no longer be directly relevant. Since the impact of the change is primarily in terms of the nature of claims flowing from accidents, which may be only tangentially related to characteristics of insured drivers, detailed claim data can be extremely helpful to supplement statistical plan data.

The importance of detailed claim data for pricing the original no-fault proposals was recognized by actuaries twenty-five years ago. However, these pioneers lacked the technical and data resources necessary to exploit this insight very productively. Today, we are somewhat more fortunate. Thanks to the Insurance Research Council, we have a large national database of claims closed in 1977 and 1987, soon to be supplemented by a 1992 sample. Modern computer capabilities, coupled with sophisticated statistical modelling approaches, can enable us to identify important patterns, trends, and relationships. The kind of statistical modelling efforts undertaken by RAND researchers and our own studies in Massachusetts can serve as examples of what can be accomplished with the currently available data.

In this paper, we have demonstrated that combining the available micro-data on BI and PIP claimants with such techniques as ordinary least-squares, logistic and Tobit regression procedures can produce useful models of the BI/PIP claim payment system. The models, applied to the detailed claim data, can provide explanations for the variability in medical charges, the likelihood of crossing a monetary threshold, and the expected size of the total compensation to a claimant. Our examples show that important actuarial exercises such as estimating new aggregate loss values when the monetary threshold changes, determining the most appropriate loss trend factors under changing BI systems, and estimating the effects of coordinating claim payments with other insurance lines are all amenable to methods using micro-data and statistical models.

To extract full value from this approach, however, will require an investment in the creation of claim databases that are specific to states or companies and that address their unique circumstances. Massachusetts data and findings can be generally informative to California or New York insurers and regulators, or serve as broad guidelines, but they are obviously unacceptable for ratemaking purposes in those states.

There are two obvious approaches to obtaining the necessary data. One possibility is to amend statistical plan specifications to require the reporting of additional claim characteristics. This option may be very costly and cumbersome, but might be worth considering for a few very critical pieces of information (e.g., type of injury). An alternative would be to perform special studies based on representative samples of claim files. As in so many areas of research, a carefully designed sample will usually prove to be more cost-effective.

Finally, it has become clear that behavioral responses to the economic incentives built into a BI system cannot be ignored. Claiming behavior is no longer a "philosophical imponderable" that falls outside the scope of actuarial analysis (Harwayne/Wolfrum, 1966). Fraud and build-up are harsh realities of the present day, and attempts must be made to collect data that will allow their effects to be quantified.

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