RISK CLASSIFICATION
(TEXTBOOK CHAPTER DRAFT)

Chapter 4 - Risk Classification

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I. INTRODUCTION

Risk classification involves similar concepts to both ratemaking (Chapter 1) and individual risk rating (Chapter 2). Risk classification is used primarily in ratemaking when there is not sufficient information to estimate a price for a given individual. In order to derive a price, individuals that are expected to have the same costs are grouped together. The actuary then calculates a price for the group and assumes that the price is applicable to all of the members of the group. This, in simple terms, is the substance of risk classification.[1]

Premiums should vary if the underlying costs vary. Costs may vary among groups for all of the elements of insurance cost and income: losses, expenses, investment income, and risk. For losses, as an example, groups may have varying accident frequency or average

[1] For more detail on the general problem of risk classification, see SRI International (1979) and SRI (1976).

claim costs. Expenses may also differ among groups and in some lines, such as boiler and machinery, inspection expense is a major portion of the premium. Investment income may vary among groups; for example, some insureds may be sued more quickly (emergency physicians versus obstetricians) or claims may be settled more quickly. Finally, risk, defined as variation from the expected, may vary among different types of insureds. For example, more heterogeneous groups are subject to more adverse selection and, hence, more risk. In the remainder of this chapter, the term "costs" will refer to all of the above considerations.

Risk classification is "the formulation of different premiums for the same coverage based on group characteristics". These characteristics are called rating variables. For automobile insurance, examples are geography and driver characteristics. Rating variations due to individual claim experience, as well as those due to limits of coverage and deductibles, are not considered as part of the classification problem.

This chapter first considers the interaction between classifications and other rating mechanisms, such as exposure bases, marketing, underwriting, and individual risk rating. This chapter will then review the various criteria (actuarial, operational, social, and legal) for selecting rating variables. It then turns to historical examples of classification systems. Next, measures of classification efficiency are examined. Finally, the chapter briefly reviews problems in and approaches to estimating class relativities.

II. RELATIONSHIP TO OTHER RATING MECHANISMS

The classification process must be considered within the overall context of marketing, underwriting, and rating. The overall goal is to price an insured properly for a given coverage. This may be accomplished in different ways. Risk classification is one step in a process that makes significant pricing decisions in many ways.

Exposure Base

An important consideration is the exposure base. For automobile insurance, the exposure base is an insured car-year. For workers' compensation, exposure can be total payroll, hours worked, or limited payroll (i.e., payroll up to some limit for a given time period). Manual premiums are calculated as the exposure times a rate. For example, if payroll is $1 million and the rate is $5 per $100 of payroll, manual premium is $50,000.

Exposure bases should be as closely proportional to costs as possible. For example, consider workers' compensation, which has both medical and indemnity benefits. If a worker is injured, the worker's medical costs are paid and the worker receives indemnity payments for time lost from work. Indemnity benefits typically are calculated as two-thirds of wages, subject to a maximum equal to the statewide average wage. For example, assume the maximum benefit is $400 per week. If the worker's wages are $600 or more, the worker receives $400; if the wages are $450, the worker receives $300. The most appropriate exposure base would be hours worked for medical benefits and limited payroll (limited to $600 per week per employee) for indemnity benefits. These exposure bases would be proportional to costs, assuming that all workers have the same accident frequency per hour worked and no differences other than wages in average claim size.[2]

If all employers pay the same wages (or have proportionately the same number of workers at different wage levels), total payroll is an adequate exposure base. If one employer pays higher wages than another, however, total payroll is not as accurate an exposure base as the combination of hours worked and limited payroll. Because accident frequency or severity varies among different insureds, some element of cost variance remains to be rated by a classification system or other means.

Individual Risk Rating

As mentioned above, the goal in all pricing is to properly evaluate the potential costs. When the individual insured is large enough

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[2]It may be argued that accident frequency, the duration of indemnity benefits, or the total amount of medical expense is related to wages. If so, total payroll could be more accurate than hours worked or limited payroll.

to have credible claims experience, that claims data can be used to modify the rate that would have been charged by a classification plan alone.

Schedule rating, based on underwriting judgment, is often part of individual risk rating plans. It is based on items that are not quantifiable or not includable in a classification or experience rating plan. Schedule rating has the potential for predicting costs more accurately, but it is often used to meet competitive prices.

Marketing and Underwriting

Insurers may use different strategies for pricing business. As will be pointed out below, many factors that are related to cost potential cannot be objectively defined and rated. Instead of pricing these factors, insurers may adjust their marketing and underwriting practices to account for them.

Two common strategies are: (1) adjust price according to individual cost potential, and (2) accept an individual only if the existing price structure is adequate.[3] It often happens that commercial lines underwriters follow the first strategy and personal lines underwriters follow the second. Part of the reason may be the size

[3]For more detail see Glendenning & Holtom (1977) and Launie, Lee & Baglini (1976).

of the accounts; with a larger account, more expense dollars, and more meaningful claims history, an underwriter may feel more comfortable in formulating an individual price.

An alternative to the second strategy is to have several different rate structures within the same insurance group. Due to rate laws, this often requires several different insurance companies. For example, one company in a group may charge bureau rates; one charge 20% more; another charges 10% less than bureau rates; and a fourth company charges 25% less than bureau rates. Using all available information, the underwriter makes a subjective judgment about which rate level is the most appropriate. In practice, competitive rate quotes may have an influence on the underwriter's judgment.

In the above case, the underwriter is working with an existing classification plan. Each rate level, presumably, has the level of class detail that can be supported by objective rating variables. The underwriter assesses all other relevant information, including difficult to quantify data, to fix the charged rate.

In practice, a certain number of insureds will be considered to be uninsurable. This can happen when the number of potential insureds with certain characteristics is so small that cost experience will not be credible. Along the same line, the insureds within any given group may be thought to be too heterogeneous. That is, there is a great risk in writing such an insured because the cost may be much higher than the average (or measured) cost of the group. In both cases, the individual insureds are difficult to rate properly because there is not enough experience with analogous types of insureds.

Notwithstanding the above situation, insurers compete on price for larger individual risks and classes of business. An important consideration is the ability and propensity of insureds to shop for the best price. The more insureds shop, the more an insurer must refine its classification plan. Insurers also vary in their ability to select lower-cost insureds within a classification through underwriting. More successful insurers are said to be "skimming the cream".

When an insurer receives a disproportionate number of higher-cost insureds, relative to its classification plan, it is being adversely selected against. If the adverse selection continues, the insurer must increase its premiums. Such premium increases may induce the insurer's lower-cost insureds to move to another insurer, creating more adverse selection and producing a need to further premium increases. The insurer can become insolvent, unless it can adequately price its book of business.

In summary, premiums for the same amount of coverage can vary among insureds due to exposure bases, individual risk rating plans, and marketing or underwriting approaches. Classification plans are one aspect, integrated with these others, of accurately pricing individual insureds.

III. CRITERIA FOR SELECTING RATING VARIABLES

Criteria for selecting variables may be summarized into the following categories: actuarial, operational, social, and legal. Following this discussion, the section describes the ramifications of restricting the use of rating variables.

Actuarial

These criteria may also be denominated "statistical" criteria. They include accuracy, homogeneity, credibility, separation and reliability. Foremost is accuracy. Rating variables should be related to costs. If costs do not differ, the usual methods for estimating rate relativities will produce the same relativity; thus the variable adds to administrative expense, and possibly consumer confusion, but does not affect premiums. As an example, most insurers do not charge different automobile insurance premiums for drivers between the ages of 30 and 64, solely due to age. Presumably costs do not vary much by age, or cost variances are due to other identifiable factors. As a practical matter, insurers may maintain cost information on a more detailed basis than the pricing structure; data is maintained so that premium differences may be introduced if there actually are cost differences.

Accuracy is important for at least two reasons: the market mechanism and fairness. In a market economy, insurers that price their products more accurately can be more successful. Suppose, for example, that the cost (including a reasonable profit) of insuring group A is $100 and the cost of insuring group B is $200. If an insurer charges both groups $150, it is likely to be undersold in group A by another insurer. The first insurer will tend to insure more people in group B and, consequently, to lose money. Thus, to the extent that insurers accurately can identify costs, they can compete more successfully. There is thus an incentive to charge more accurate premiums. For the most part, this incentive also produces more rating variables and a more detailed classification system.

Another reason for the importance of accuracy is fairness. In the example above, it is fair for group A members to pay $100 and group B members to pay $200, because this is the cost of the goods and services provided to them. (Of course, if there are subgroups within group A whose costs are $50, $150, and $250, it would be fairer to charge those costs to those subgroups). This concept is often called "actuarial fairness" and it is based on the workings of a market economy. Of course, other concepts of fairness may appeal to some people. For example, income taxation is supposedly progressive, meaning that people pay for government services based on ability to pay rather than services received.

The second actuarial criterion is homogeneity. This means that all members of a group that receive the same rate or premium should have similar expected costs. As a practical matter, it is difficult to know if all group members do have similar costs. The reason for grouping is the lack of credibility of individual experience. Consequently, for many rating groups, subdivisions of the group may not have sufficiently more credibility than individual insureds.

The third actuarial criterion, alluded to above, is credibility. A rating group should be large enough to measure costs with sufficient accuracy. There will always be the desire to estimate costs for smaller groups or subdivisions, even down to the individual insured level. Random fluctuations in claims experience may make this difficult, however. There is an inherent trade off between theoretical accuracy (i.e., the existence of premiums for smaller and smaller groups) and practical accuracy (i.e., consistent premiums over time).

The fourth actuarial criterion is separation: different groups should have different mean costs. If two different groups have the same mean cost and are charged the same premium, it may not serve any purpose to have separate classifications.

The goals of separation and homogeneity may conflict in practice. Two subgroups with similar mean costs may have different levels of homogeneity. Separate classes may reduce adverse selection. In addition, two heterogeneous subgroups may be combined into one class, even though the mean costs are different, if cost variations within the subgroups significantly exceed differences in mean costs.

The fifth actuarial criterion is reliability or predictive stability. Based on a given set of loss data, the apparent cost of different groups may be different. The differences, however, may be due to random fluctuations (analogous to the problem discussed under credibility, above). In addition, the cost differences may change over time. For example, historical cost differences between genders may diminish or disappear as societal roles change. Technology may change relative cost differences.

In summary, actuarial classification criteria attempt to most accurately group individual insureds into groups that: (1) are relatively homogeneous (all group members have similar costs), (2) are sufficiently large to estimate relative cost differences (credibility), (3) have different mean costs (separation), and (4) maintain different mean costs over time (reliability).

Operational

These actuarial criteria must be tempered by practical or operational considerations. The most important is that the rating variable have an objective definition. There should be little ambiguity; class definitions should be mutually exclusive; and the opportunity for administrative error should be minimized. For example, automobile insurance underwriters often talk of "maturity" and "responsibility" as important criteria for youthful drivers. These are difficult to define objectively and apply consistently. The actual rating variables, age, gender, and marital status, may be seen as proxies for the more "fundamental" sources of cost variation. Maturity might be a more accurate variable, but it is not practical.

Another important practical consideration is administrative expense. The cost of obtaining and verifying information may exceed the value of the incremental accuracy. For example, driving mileage (or even, when and where a person drives) may be a very good indicator of cost. It is probably too expensive to obtain and verify, however. Assume that drivers driving under 7,500 miles per year cost 20% less than those who drive 7,501 to 12,000 miles, who cost 20% less than those who drive more than 12,000 miles. Assume also that the middle group costs $100 per year and that it costs $20 per driver to obtain, process, and verify annual mileage data. In a system utilizing mileage, drivers driving under 7,500 would pay $100 (their previous cost of $80 plus $20 for the additional expense), the middle group would pay $120 and the highest cost group, $145. Nobody would pay less than before! Although this example may be extreme, it demonstrates that added expense to classify may not serve insured (or insurers) any better than not classifying.

Another practical consideration, alluded to above, is verifiability. If insureds know that they can pay lower premiums by lying, some percentage of them will do so. The effect is to cause honest insureds to pay more than they should to make up for the dishonest insureds that pay less than they should. There is a practical tradeoff between verifiability, administrative expense, and accuracy. Few rating variables are free from manipulation by insureds. Indeed most insurance rating information is supplied by insureds and much of it is only verified to a limited extent. At some point, the value (in expense savings) of relying upon unverified information is outweighed by its inaccuracy. In practice, variables are added, at a tolerable cost, as long as they result in improved overall accuracy.

There are several other practical considerations in selecting rating variables. The variables should be intuitively related to costs. Age, in life insurance, is intuitively related (i.e., older people are more likely to die). Age in automobile insurance is less so. Younger operators may tend to be more reckless and older operators may tend to be less observant, but the correlation between age and these factors is less precise than with mortality. Intuitive relationships also improve acceptability, which will be discussed below.

Pertinent to the cost-verifiability issue, it is often better to use measures that are available for another purpose. If the variable is used only for insurance rating, it is more likely to be manipulated and it may be more difficult to verify. Payroll and sales records, for example, are kept for other purposes (such as taxation). These may be manipulated for those purposes, as well as insurance purposes, but there may be other ramifications of manipulation (such as criminal penalties or adverse relations with suppliers or bankers).

Still another practical consideration is the avoidance of extreme discontinuities. If group A's rate is $100 and group B's rate is $300, a group B insured may obtain a significant premium reduction by qualifying for group A rates. Thus the incentive to cheat and the expense to verify will be higher if there are fewer classes, with larger differences in premiums. It may be difficult in practice, however, to construct gradual changes in rates because there may be very small numbers of very high cost insureds. Thus, for credibility purposes, there may be fewer classes, with widely differing rates.

Social

This section has discussed the actuarial goals of classification and some of the operational difficulties. Another limitation on classification is "social acceptability" or social considerations. A number of key terms, such as "causality", "controllability", "discrimination", and "affordability" have been debated in public. This section will briefly describe some of the public concerns.

Privacy is an important concern. People may be reluctant to disclose personal information. This affects accuracy of classification, verifiability, and administrative cost. In automobile insurance, for example, a psychological or behavioral profile might be strongly correlated with claims cost. (It may also be expensive to obtain). Many people might resist this intrusiveness, however. Although insurer A might have a more accurate rating system, using a psychological profile, it might not obtain a sufficient amount of business. Insureds may choose to pay more to avoid disclosing personal information.

Discrimination is an emotionally charged term when used in racial, religious, or gender contexts. In fact, all people discriminate every day, in their choice of food, clothing, friends, etc. Life is a matter of making choices, which involves discrimination. Some types of discrimination may be morally disreputable, but discrimination itself is inevitable. Risk classification is discrimination. Different insureds are charged different amounts of premiums. Furthermore, risk classification is discrimination based on group characteristics. The insured is charged a premium based on the costs of the group, assuming that the insured belongs to that group.

What differentiates risk classification from the opprobrious types of discrimination is that it is (or should be) objective and based on prospective costs. Racial discrimination is condemned because it is not objective. Fair discrimination involves the use of relevant characteristics that have a measurable relationship to costs.

In this connection, the terms "correlation" and "causality" are often invoked. Assume there is some rating variable, X, which divides insureds into groups A, B, C, etc. The rating variable is correlated with costs if the mean costs for the various groups are significantly different. There may be other variables for which there are similar correlations. The "real" reason for the differences in costs may be some entirely different variable or combination of variables. Nevertheless, X is correlated to the cost of providing insurance. X may be a proxy for the "real" cost difference.

"Causality" implies a closer relationship to costs than correlation.[4] Mileage in automobile insurance might be considered

[4]See, for example, Mass. Division of Insurance (1978), p.22.

a causal variable; the more miles a driver drives, the higher the cost of insurance should be (other things being equal). "Causality" is difficult to define in operational terms, but it conveys a direct relationship with costs. Loss costs, for example, can be divided into claim frequency and average claim cost. "Causal" variables then, could be considered to be directly related to claim frequency and average claim cost. Automobile mileage, presumably, is proportional to claim frequency. Proximity to fire protection, in fire insurance, may be proportional to the average claim cost.

Unfortunately, however, the categorization of variables as "causal" or "non-causal" is ambiguous. With automobile mileage, for example, when and where one drives may be more relevant to costs than mileage. Driving in a large city, with more vehicles, more intersections, and more distractions is probably more hazardous than driving in rural areas. Driving at night or when tired or drunk may be more hazardous than driving in daytime or when fully rested or sober.

Clearly, "causality" is a valuable concept. "Causal" variables are probably better at cost prediction than non-causal variables. The issue, as usually put forward by insurance industry critics, is whether mere correlation should justify the use of rating variables. In automobile insurance, for example, it is argued that age, gender, and marital status are not "causal" variables and, therefore, are not "socially acceptable." It is usually not disputed that there are correlations between costs and age, gender and marital status. These variables, by themselves, are not the true cause of the cost variances (according to critics). In the sense that some younger drivers have lower cost potential than some older drivers, this is true. There are reasons, albeit unknown, for the cost differences between younger and older drivers. Are the true reasons: immaturity, inexperience, recklessness, or something else? Some of these possible reasons can be measured and used as rating variables. For example, inexperience could be measured by the number of years licensed. (Of course, the quality of experience, such as total mileage and mileage under various driving conditions, would be difficult to assess). Most of the other plausible reasons tend to fail under the above practical considerations (e.g., objective definitions or cost) or other social considerations (e.g., privacy).

The dilemma can be summarized as follows. Certain variables will be correlated to costs, but (at least in the opinion of certain critics) not causally related. That is, the relationship between the variable is not direct enough; it may be a proxy for other, "real", causes or it may be a spurious or fleeting correlation. If non-causal variables are prohibited, insurers would have an incentive to develop causal variables, which are seen to be better, or other, less opprobrious non-causal variables. The ultimate problem, however, is that no "causal" variables may satisfy all of the other actuarial, practical, and social constraints. Thus there may be a question of using a non-causal variable or using nothing at all. From an actuarial point of view, correlated variables provide more accurate premiums and are thus more desirable in a competitive market place. Eliminating correlated non-causal variables may produce certain market corrections. Those will be discussed later.

Several other concepts of "social acceptability" have been debated by the insurance industry and its critics. These include (1) unfair discrimination, (2) controllability, and (3) affordability.

Most property-casualty rating laws prohibit "unfair discrimination." The number of reported legal decisions that have construed this term are few. From an actuarial point of view, this would normally mean premiums out of line with costs. From a social point of view, this may be analogized to legal cases involving race, ethnic, or religious discrimination. Legal considerations will be discussed below.

"Controllability" is seen as desirable by most insurance industry critics. A controllable variable is one which is under the control of the insured. If the insured moderates behavior in a certain way, premiums will be reduced. For example, by installing burglar alarms, the insured reduces claims cost potential and should receive some discount. Accident prevention can be encouraged by the use of controllable rating variables.

From a practical view point, there may not be very many useful controllable variables. The make and model of automobile in physical damage insurance is controllable. Geographical location is controllable in a broad sense, but not very useful in making day-to-day or short-term decisions. (Moving a warehouse or petroleum refinery is not practical; nevertheless, the decision to locate a structure is controllable and insurance costs may possibly be a factor in the decision). Driver training course credits for automobile insurance are also controllable.

Even though variables are controllable, they may not have much impact on the rating system. Most people take some sort of driver training, for example, so the rate differential will only apply to a small group of drivers. In addition, burglar alarms may reduce the frequency of burglaries, but some thefts will occur anyway and theft costs may be a small proportion of homeowners and commercial property premiums.

Controllable variables may increase administrative costs. If the insured has control over premium costs, the insured can manipulate the rating system and insurers may require verification. As with "causality", "controllability" is a useful concept but there is a shortage of usable rating variables that apply.

Another social consideration is "affordability". In the context of risk classification, it usually arises where classification schemes are more refined, with the attendant spreading of rates. Thus high rates are often seen as causing affordability problems (even if, for example, the high rate is generated by a youthful operator driving a Corvette in New York City). Another example is the correlation of incomes and insurance rates. In automobile insurance, rates are often highest in urban areas, where, allegedly, most poor people live. In reality, wealthy people also live in urban areas; youthful drivers that can afford any car or a high-priced car are not necessarily poor. Thus both high rates, per se, and higher rates for lower-income groups pose an affordability concern.

Another aspect of the affordability issue is the necessity of insurance. Many states require automobile (liability) insurance. Most mortgagors require property insurance. To some insurance industry critics, this implies the necessity of a subsidy for some consumers. (Of course, owning a car or a house is optional. The value of controllable variables, providing an incentive to prevent accidents or reduce costs, is ignored in this context).

Still another aspect of affordability is availability. If rates are arbitrarily leveled or reduced below cost, the market may not voluntarily provide coverage. Thus rates may be "affordable" but insurers may be very reluctant to insure people at those rates.

This section digresses at this point to consider the interaction of the arguments often posed by insurance industry critics. Causality is good and correlation (without causality) is bad. When discussing affordability problems, however, the alleged correlation between incomes and premiums is sufficient to cause concern. Further, a controllable variable, such as geographical location, is an anathema for the affordability issue, while controllability, in general, is much preferred to immutable characteristics (such as age, and gender). This is not to say that insurance industry practices are above criticism or that insurance industry critics do not have valid concerns. The point is that classification criteria are multi-faceted and risk classification is a difficult problem.

A theme that is stressed by insurance industry critics, particularly in the causality-correlation and controllability debates, is that of individual characteristics. Analogizing to racial, ethnic, and religious discrimination cases, critics essentially attack the basing of rates on group characteristics. This is seen to be unfair to individuals whose costs may differ from those of the group. A common rhetorical device is the "overlap theory", which can apply to almost any rating variable. As an example, this section will use gender in automobile insurance. Youthful females generally have lower automobile insurance costs than youthful males. Some youthful females, however, have higher costs than some youthful males, and, in a perfect rating system, should be charged more than some males. The overlap theory conclusion is that it is unfair to charge males more than females.

The overlap theory relies on the concept, however impractical, of a perfect system. The real risk classification issue is whether the male-female rating system is more accurate than a system that does not use that variable. (It could be argued that a value system based on something other than accuracy is being used. That argument is defeated by the dependency of the overlap theory on the "unfairness" of certain individuals being charged more than their costs. Notions of accuracy, as a criterion for risk classification, are central to the overlap theory.)

The overlap theory essentially ignores the nature of insurance and the practical necessity of using group characteristics for rating individuals. Costs in insurance are fortuitous. Individual insureds have a cost potential, but this potential is not directly measurable. Cost potential can be estimated using subjective probability. The actuary can use a wide range of information, including historical cost information, to make a subjective judgment about future costs. Subjective judgments include what rating variables are related to costs and whether certain individuals belong in certain groups that are used for rating purposes. Since the costs of individuals are unknown, and since group characteristics are used, there will be an overlap, by necessity. The overlap reflects the reality of the insurance situation: that costs have a fortuitous element and that group characteristics must be used for rating purposes.

The critics might contend that the use of group characteristics is unjustified; that each individual should be judged on his or her own merits. This may be appropriate in work situations or some other contexts, but it is not feasible in an insurance situation.

What is meant by using individual characteristics? Presumably these are a collection of enough different factors so that almost any two individuals would compute a different "score" or have a different combination. That is, they would be individuals because they would not be exactly alike some one else. For each of these factors, the actuary could subjectively determine the prospective impact on costs. To do this, the actuary will evaluate group experience for each of the different factors. The actuary cannot evaluate individual experience because, from the definition at the beginning of the chapter, that experience is not credible. Thus the only way the actuary can proceed is to project group costs. If costs are projected for enough different factors, the resulting rates may approach individual rates (in the sense that no two individuals have exactly the same combination of factors).

The upshot is that _more_ variables should be used to rate individuals, rather than fewer. More variables and a more detailed rating plan will provide more accurate rates and more individualized rates. The conclusion that the critics draw from the overlap theory (i.e., the abolition of a rating variable) is self-contradictory.

With the exception of the affordability issue, these social issues are based on accuracy arguments. The basic limitations on accuracy are the competitiveness of the insurance industry and the credibility of the cost information. These factors are related in some cases. As long as the insurance industry is competitive, there are incentives (profitability, solvency) to accurately price individual insureds. These incentives may be minimal, however, for small groups of heterogeneous insureds. Restrictions on competition are unlikely to produce a more accurate rating system. The ramifications of restrictions will be discussed after a brief review of legal considerations.

Legal

This section has considered actuarial, practical, and social considerations. It now turns to the legal context of risk classifications. The following discussion is necessarily brief, but it provides an overview. The circumstances of each particular case (e.g., rating variable, line of insurance, state statutes and constitution), will determine its outcome. The following is based on general concepts and principles.

Risk classification may be affected by constitutions (state and federal), statutes, and regulations. Generally, constitutions govern statutes and statutes govern regulations. Constitutions are usually very general, statutes are more specific, and regulations may be the most specific.

Both federal and state constitutions may apply to a risk classification situation. There must, however, be a specific phrase or section that is applicable. The federal constitution is quite broad and vague. The "equal protection clause" ("EPC") might be applicable. Other clauses probably are not. State constitutions are often much more specific. Gender discrimination, for example, may be specifically mentioned.

The federal equal protection clause reads: "No state shall ...deny to any person within its jurisdiction the equal protection of the laws." This points to two requirements; (1) state action and (2) unequal treatment. "State action" generally means that the state has acted, either on its own or by officially sanctioning the conduct of private individuals. Purely private discrimination is usually not actionable under the EPC. With insurance, the requisite state action is probably the promulgation of rates; the mere approval or acquiescence in rates probably is not state action. If rates are not regulated at all, rating classifications are probably exempt from the EPC.

Unequal treatment is also a requirement under the EPC. Arguably, basing premium differences on demonstrable cost differences is not unequal treatment.

Because of the state action requirement, constitutional challenges to insurance rating classifications are unlikely to succeed. Statutes, however, can impose restrictions on insurers. In this case, it is the insurers who will try to invoke constitutional provisions to invalidate the statutes. Several federal clauses, such as "due process," "takings", and "contracts" may be applicable. As a general rule, however, courts have been very solicitous of legislatures in their regulation of businesses. Most likely, any statutory restriction on rating variables would be constitutional.

Finally, regulations issued by state insurance departments may affect classifications. Under a constitutional theory (known as the "delegation doctrine") only the legislature may promulgate substantive law; the executive branch merely carries out the will of the legislature. Although states vary considerably, broad discretionary grants of power to executive agencies may be found unconstitutional.

In summary, constitutional provisions, statutes, and insurance department regulations may all potentially affect the freedom of insurers to select and use rating variables. As this brief discussion indicates, constitutional provisions are probably not applicable; statutes are practically invulnerable; and regulations may or may not be subject to challenge by insurers.

Ramifications Of Restrictions

Legislatures may abolish the use of certain rating variables or relativities may be capped. The consequence will be similar for each, although more extreme for abolition. The discussion below deals with abolition. Insurers can react in three ways: pricing, marketing, and underwriting. In pricing, they can try to find replacement variables. As stated above, there may not be many variables that are suitable, given the above actuarial, operational, and social criteria. Insurers generally do have incentives to create better variables, and the current ones in use are considered to be the best. If no replacement variables are found, rates will be levelled and subsidies created. For example, if Group A's cost is $50 and Group B's cost is $150, but the distinction between them cannot be used in rating, both groups may pay $100. Group A would be overcharged by $50 and Group B would be subsidized by $50.

The effect of abolishing rating variables in a competitive market, is to create availability problems (unless there are suitable replacement variables). Insurers may withdraw from marketing the coverage to certain groups or refuse to insure them. This will produce, most likely, a larger residual market. (Residual markets, such as assigned risk plans in automobile insurance, exist to provide insurance to those not voluntarily insured). Abolition of variables may also affect insurer profitability and solvency. If an insurer, in the above example, has a large percentage of Group B business, it will need to raise its rates or else it will be unprofitable. When it raises its rates, it may drive more of its better business to competitors, who have lower rates; this will further increase its costs and require a further rate increase. In the long run, solvency may be threatened.

Abolition of rating variables has social consequences, as well. To some extent, abolition will create subsidies. Insurers may voluntarily subsidize certain groups. Otherwise, residual markets will expand; since most residual markets are subsidized by the voluntary market, subsidies will be created. Such subsidies, deriving from legislation, are a tax-in-kind. Certain insured pay more for insurance than they otherwise would have, while others pay less. There is a redistribution of income from the disfavored group to the favored group.

In addition to the subsidies, abolition of rating variables can reduce accident prevention incentives. That is, to the extent accurate pricing promotes accident prevention, less accurate pricing reduces it.

Thus the abolition of rating variables probably will reduce the accuracy of the rating system, which either creates subsidies or else produces availability problems. In either case, accident prevention incentives are reduced.

IV. EXAMPLES OF CLASSIFICATION SYSTEMS

So far this chapter has discussed the general principles for developing classification systems. In this section, specific systems, with particular emphasis on automobile insurance, will be discussed. To be concrete, some assumptions will be made that may not be widely accepted within either the actuarial profession or the insurance industry. The objective is not to specify all of the relevant factors and only relevant factors, but to present an approach that a knowledgeable actuary may follow. Risk classification is a difficult subject area. In theory, not enough is known about either the underlying causes of loss or the variations in costs between insureds. In practice, there is never sufficient data for formulating and testing hypotheses.

Forces Affecting Classification Systems

Classification systems vary over time. Automobile liability originally had only one classification. Prior to World War II there were three classes (adult, youthful operator, and business use). These became refined into nine classes by sub-dividing the youthful class and adding more use categories. In 1965, the National Bureau of Casualty Underwriters (a rating bureau predecessor to today's Insurance Services Office) introduced a plan which had 260 classifications. In 1970, the number of classes was reduced to 217. Most of the classifications were for combinations of age-gender-marital status and use, for youthful operators.

Many forces, chiefly those related to competition, influence classification plans. Generally, the more competitive the marketplace, the more classifications there will be. Assume one insurer charges the same rate, $100, to groups A and B, but their costs are different, $50 for A and $150 for B. Another insurer could charge group A $50 and still be profitable. Thus, to the extent insurers can actually identify cost differences, they will tend to make price differentials. Not to do so affects their profitability and, ultimately, their solvency.

Classification systems may also become more refined as coverage becomes more expensive. From the buyer's side, shopping for favorable prices is encouraged when coverage is more expensive. From the insurer's side, more expense dollars may be available to classify and underwrite; in addition, the cost of making mistakes, or of not having as refined a system, is higher when premiums are higher. For example, towing coverage may be priced the same for all automobiles, even though older cars may be more likely to break down and towing costs may be higher in rural areas; at a low premium (e.g. $10 per year), it may not be cost effective to have rate differentials.

Classification systems usually are more refined for larger markets. Considering the credibility of available cost data, more classifications can be supported by larger amounts of insured exposure.

Finally, classification systems probably have become more refined as information technology has progressed. More information can be handled more cost-effectively today than yesterday. This section now turns to automobile liability classifications.

Automobile Insurance Classifications

Automobile liability insurance classifications can be categorized into the following types of variables: (1) age-gender-marital status, (2) use, (3) geography, and (4) others. Classification plans vary significantly among insurers.[5] Certain types of factors are widely used; many factors are used by only one or a few insurers.

Age-gender-marital status primarily distinguishes among youthful operators, although most insurers have a separate class for drivers over 65. Youthful operators generally are those under 25, although most insurers separate single males under 30. Some insurers have separate classes for each age; some group ages, such as 17 to 20

[5] See SRI (1976).

and 21 to 24. Most insurers distinguish between single male principal operators (using the automobile 50% or more) and occasional operators. Many insurers do not distinguish between single and married female operators, or between principal and other operators for females and married males.

Use categories typically are: pleasure, drive to work (sometimes over or under a given number of miles, one-way, such as 10), business, and farm. Added to this may be annual driving mileage over or under a given amount (such as 7500). Use categories may vary between adult and youthful operators.

Geographical territories are commonly used in classification plans. Contiguous areas, often delineated by city or county boundaries, are the most common. Some insurers use zip codes, sometimes combining adjacent areas or using some other criteria (such as population density). Territories are the same for all age-gender-marital status classes and all use classes. Territories sometimes vary by coverage. For example, there may be fewer claims for uninsured motorist coverage, so there are fewer separate rating territories.

Several other rating variables are in common use. These include good student and driver training discounts for youthful operators; multiple-car discounts; accident and violation surcharges, and sports car surcharges.

In addition to the above variables, several other variables are used for automobile physical damage insurance. These generally consider the value of the automobile, its crashworthiness, and its age. Most insurers use the make and model of the car; various makes and models are combined into a series of different rate groups.

Cost Variation in Automobile Insurance

Above are the classification variables that are commonly used in automobile insurance. Some are "causal"-type variables; others are correlated to costs. Below, this section will discuss potential reasons for cost differences. Some of these are incorporated into rating variables, while others are used only in "underwriting" (i.e., risk selection or rejection).

Cost differences can be classified into four broad categories: (1) use of the automobile, (2) driving ability, (3) interaction with the claims mechanism, and (4) the extent of damages. In many of these areas, the available evidence is more subjective than objective. What is presented is thought to be relevant to costs, even though concrete data may be elusive.

Different uses of the automobile contribute to varying cost potential. More driving should produce more exposure to liability and collision claims. Driving conditions (time of day, traffic density, weather) are also important. Automobile theft is a significant factor for comprehensive coverage, therefore location of the car in higher crime neighborhoods is relevant for that coverage.

Mileage may be used directly in rating, although commonly the only distinctions are annual mileage over or under a given amount and mileage to-work. Indirectly, mileage may be correlated with multiple-car discounts and some age-gender-marital status classifications. For example, over 65 drivers may drive less or under more favorable conditions; females may drive less than males; married males may drive less than single males. Driving conditions are taken into account, at least indirectly, in geographical territories. The territory is usually defined by the principal garage, which may differ, of course, from where the car is usually operated. Driving conditions are considered more directly in the use variables.

Cost differences may be due to differences in driving ability, arising from familiarity with the driving conditions, experience and training, reaction time, eyesight and hearing, concentration, condition of the automobile, and driving style. Some classification variables are related indirectly to these cost differences. For example, youthful operators have less familiarity and less experience; over 65 drivers may have poorer eyesight or hearing; discounts for driver training are available. Admittedly, individual performance varies greatly within the given rating classes.

Cost differences may also arise from interactions with the claims mechanism. Some people are more claims conscious than others. This affects the physical damage, personal injury protection, and medical payments coverages for the insured. Geographical differences may be apparent for liability coverages. Some people may be more or less sympathetic to a jury. Some people may press dishonest claims. Some people may be more cooperative in submitting claims or in helping to defend claims. Most of these differences are quite subjective and difficult to quantify in a rating variable. Where cost differences can be discerned, it is more likely that insurers would refuse to insure an individual, rather than try to determine an accurate rate.

Finally, cost differences may result from the extent of damages, given that an accident has occurred. Crashworthiness of the automobile is an obvious rating variable. The same type of accident may produce $100 of damage in one car and $1000 of damage in another. The speed with which a car is driven will also affect damages. The use of safety devices, such as air bags or seat belts, will affect costs. Physical impairments may produce higher loss costs. Some of these differences may only be relevant to certain coverages.

To some extent, existing rating variables consider these differences in costs. Sports cars are often surcharged, presumably because they are driven at higher speeds, are prone to greater damage, cause greater damage, or are more prone to lawsuits.

In summary, a variety of factors have been presented that affect claims costs. Some of these are more objective and lend themselves more readily to becoming rating variables. Many factors, however, are quite subjective, very difficult to measure, and almost infeasible to use as rating variables; these tend to be used by underwriters to decline coverage or assign to a higher-rated company in the group.

To conclude this section, other lines of business are briefly reviewed. Most lines of business use geographical rating. Workers' compensation classes are mostly based on occupations or industries. There are some 600 different classes used by the National Council on Compensation Insurance in one or more states. Medical malpractice classes are based on specialties, paying particular attention to the amount of surgery performed. Boiler and machinery rates vary by type of object, because inspection costs are a significant element of premium. Products liability classes are defined by the type of product. Premises liability is defined by the character of the operation or activity. Homeowners and dwelling fire rating variables include the number of units in the structure and the age and type of the structure. Fire insurance rates are based on the type of construction, type of occupancy, protection features, and special exposure to loss.

V. MEASURES OF EFFICIENCY

The quantitative description of the accuracy of classification systems has concerned actuaries for many years. Recently, however, public debate on risk classification has encouraged new research and analysis. This section will define "efficiency" as a measure of a classification system's accuracy.

The reason for developing classification systems is the variability in costs from one insured to another. The key to measuring efficiency is understanding this variability. Costs vary because claim frequency varies and because claim sizes vary. A perfect classification system would produce the same variability as the insured population. Conversely, a classification system that has less variability than the insured population cannot be perfect, because two insureds may receive the same rate when their costs are actually different.

A complicating factor is the fortuitous nature of insurance. Costs are unknown. When measurements are made of cost variability, it is after certain events have already happened. The same events probably will not happen again. It is uncertain whether the actual events that occurred are representative of what will occur in the future. The future may have more or less variability than the past.

Most existing measures of classification efficiency use the statistical measure of variance. Other measures are possible, include average deviation, and average absolute deviation. Variance has the advantage of being widely used in many types of statistical applications (e.g., regression analysis and analysis of variance). This section will use variance concepts as an operational measure of efficiency, but other measures could be used.

Likewise, there are many possible specific formulas for efficiency. The measure most commonly used compares the variance explained by the classification system to the total variance underlying the insured population.[6] If the classification system were perfect, the efficiency would be 100%. If the classifications had no predictive value (i.e., were random with respect to potential costs), the efficiency would be 0%.

This formula requires the calculation of two items: (1) the variance of the classification system and (2) the variance of the insured population. The former is relatively easy to calculate; the latter is unknowable. Each will be discussed in turn.

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[6] See SRI (1976), Woll (1979).

To determine the variability of the class plan, one needs the class relativities and the percentage of exposures by class. It is assumed that the relativities are the expected values of actual cost differences; if not, the latter should be used instead.

Although formulated in terms of "variance", efficiency can be measured by other numerical calculations. For simplicity, this chapter uses the concept of the coefficient of variation, ("CV") which is the standard deviation divided by the mean. The square of the CV can be used to measure efficiency, as proposed above, in terms of variance. (It is assumed that both the class plan costs and the underlying population costs have the same mean; if not, adjustments can be made).

For a numerical example, see the table below.

Relativity	Percentage of Exposures	Mean (Extension)	Deviation From Mean	Deviation Squared	Variance (Extension)
.5	.10	.05	1.0	1.00	.1000
1.0	.40	.40	0.5	0.25	.1000
1.5	.30	.45	0.0	0.00	.0000
2.0	.10	.20	0.5	0.25	.0250
3.0	.05	.15	1.5	2.25	.1125
5.0	.05	.25	3.5	12.25	.6125
Total	1.00	1.50			.9500

The coefficient of variation is the standard deviation (.975) divided by the mean (1.5), or 0.65. This numerical example points out several truisms. First, high efficiencies necessarily require extreme rates. Almost two-thirds of the variance is due to the highest cost 5% of insureds. Second, the key to designing highly efficient systems is to find variables that can isolate the highest and lowest cost individuals. Many insured populations seem to have a coefficient of variation of about 1.0.[7] If this is true for the numerical example above, the efficiency would be about 42% ($.65^2$).

The basic difficulty in computing efficiency is determining the variability of the insured population. Because costs depend upon fortuitous events, the variability is unknowable. It is possible to apply concepts of risk theory, however, to develop some plausible estimates.

The basic types of variability that should be considered are:

- Inherent variability in expected accident frequency,
- Inherent variability in expected claim size,
- Variability in frequency and claim size for an individual insured over time, and
- Variability in the actual frequency and claim size, given the expected values.

The list could go on, but it already contains enough substance to challenge the mathematically sophisticated. Few practical applications have involved variability in claim sizes. Most published research includes only expected and actual claim frequency. Woll (1979) has mentioned changing individual

[7]See SRI (1976).

frequency over time. (Woll refers to this as the individual's exposure to loss, which he treats as a stochastic process.)

The underlying variability will be measured from actual claim experience. Any such measurement, of course, will only be accurate if the actual data derives from a suitable situation. It is subject to random fluctuations, since the actual data is the result of random processes.

To provide a framework for the measurement, Woll (1979) defines X as the actual number of claims; M, as the distribution of expected frequency for the individual insureds; and P, as the distribution of the individual insured's frequency over time. He derives the following formula:

$$\mathrm{Var}(X) = \mathrm{Var}(M) + E(M) + E(\mathrm{Var}(P))$$

What is required is Var(M), the underlying variability in expected claim frequency. Woll gives four formulas for calculating Var(M). These are illustrated in Exhibit I. In that Exhibit, 1000 drivers are observed over two periods. They are categorized by the number of claims in the first and second periods. The first formula was used by SRI and assumes no variation in loss costs over time. The second uses the difference in frequency between insureds with zero and one prior accidents. The third multiplies the claim-free discount by the variance of the observed frequency. The fourth is due to Woll. $\alpha(j)$ is the claim frequency for insureds with j prior claims. r_j is the percentage of insureds with j claims. Note that $E(M) = E(X)$.

$$
\begin{aligned}
(1)\quad Var(M) &= Var(X) - E(X) \\
&= .1179 - .11 \\
&= .0079 \\
CV(M) &= .808
\end{aligned}
$$

$$
\begin{aligned}
(2)\quad Var(M) &= [E(M)]^2 \ \frac{\alpha(1) - \alpha(0)}{\alpha(0)} \\
&= .11^2 \ \frac{(.1333) - (.1044)}{.1044} \\
&= .00335 \\
CV(M) &= .526
\end{aligned}
$$

$$
\begin{aligned}
(3)\quad Var(M) &= \left[1 - \frac{\alpha(0)}{E(X)}\right] Var(X) \\
&= \left[1 - \frac{.1044}{.11}\right] .1179 \\
&= .0060 \\
CV(M) &= .704
\end{aligned}
$$

$$
\begin{aligned}
(4)\quad Var(M) &= \sum_{j=0} j \ r_j \ \alpha(j) - E(X)^2 \\
&= 1(.09)\ (.1333) + 2(.01)\ (.4000) - .11^2 \\
&= .0079 \\
CV(M) &= .808
\end{aligned}
$$

Other formulas are certainly available. One clear message from this example is that empirical data may not provide a suitable estimate of efficiency.

Measures of efficiency, even if they can be calculated with accuracy and consistency, do not provide a complete answer. The cost of the classification process itself is ignored, for example. The availability of a feasible, more accurate system is unknown. Efficiency may be low in any given case, but no better system may be available at a reasonable cost.

What are the implications of efficiency measures for the design of classification systems? To produce a higher efficiency there must be higher percentage of insureds at more extreme relativities. This is necessary to produce a higher variance or CV. This process, however, runs counter to much of the current criticism. Higher rates mean less affordability. In addition, greater efficiency can be produced by any variable that can accurately refine the classification system. Thus, the preference for causal variables is irrelevant to increased efficiency; correlated variables can be just as efficient if they can distinguish cost potential. Similarly, controllable variables are useless unless they can produce greater efficiency. Indeed, controllability and causality are irrelevant; what is important to efficiency is being correlated with costs.

Risk classification efficiency can be approached from another point of view. Insurers have economic incentives to accurately classify insureds. The classification system should be as good as the market allows. In other words, if a group is too small to have credible experience or poses too great a risk (in that there is too much variability in costs within the group), the group may not be very accurately rated. If the group is large and relatively homogeneous, insurers have an incentive to properly classify and rate it.

In summary, the importance of classification efficiency may be overrated. Existing efficiency measures are a comparison to an abstract ideal, that probably has little relevance to practical situations. They do not provide useful information about what practical, cost-effective variables might be utilized. In addition, the market will probably dictate how refined classification systems will be. The more competitive the market, the more refined the classification system may be.

EXHIBIT I

Number of Drivers with X_i Claims

Second Period Count	First Period Count 0	1	2	Total	Count	Frequency
0	814	79	7	900	93	.1033
1	78	10	2	90	14	.1556
2	8	1	1	10	3	.3000
Total Drivers	900	90	10	1000	110	.1100
Claim Count	94	12	4	110		
(1) Frequency $\alpha(j)$	.1044	.1333	.4000	.1100 = E(X) = E(M)		
(2) Deviation	-.11	.89	1.89			
Deviation Squared	.0121	.7921	3.5721			
(3) Variance (Extension)	.0109	.0713	.0357	.1179 = Var(X)		

Notes:

(1) Count/drivers.
(2) Count - overall frequency (.11).
(3) Sum over first period counts (percentage of drivers times deviatic squared).

VI. ESTIMATING CLASS RELATIVITIES

This final section will discuss several actuarial problems involved in estimating classification relativities. These include: 1) whether relativities should be additive or multiplicative, 2) how to estimate multiple sets of relativities, 3) how to obtain more or more reliable data, and 4) how to select the appropriate credibility complement for groups with less than fully credible data. This topic is also discussed in Chapter 2.

Relativities are usually calculated for classification variables, rather than pure rates for each class, because they are used in different contexts. For example, relativities between classes are likely to be the same from state to state, even though the absolute value of the rate may be quite different. For example, state A may have double the medical malpractice costs of state B. The relativity in costs between general surgeons and general practice (with no surgery), however, may be about 3 to 1 in both states.

The two most common mathematical constructs for relativities are additive and multiplicative factors. For two-dimensional structures, there would be no practical difference in results. For three sets of factors, however, there may be significant differences. For example, in automobile liability the first dimension is combinations of age-gender-marital status. The second dimension is use, such as pleasure-farm and all other. A third dimension could be good student-driver training discounts.

Philosophically, are the third level differentials additive (i.e., a function of the base rates for a given territory) or multiplicative (i.e., a function of the specific age-gender-marital status and use differentials)? For example, is a good student discount worth 20% of the base (i.e., adult) rate (additive) or 10% of the actual rate (multiplicative)? The actual rate may be 360% of the base for a 17 year-old male principal operator (multiplicative good student discount equals 36% of base rate) or 150% for a 20 year-old female (multiplicative good student discount equals 15% of base rate). Does "good student" status reduce costs equally for all insureds (additive) or does it affect costs proportionally (multiplicative)?

Whether a variable should be additive or multiplicative is difficult to determine; the type of variable is important. Most often variables are treated as multiplicative. This makes the relativities somewhat easier to calculate and analyze.

Regardless of which form is chosen for the relativities, estimation is not necessarily straightforward. Certain subdivisions of a rating variable may have a disproportionate share of another rating variable; that is, two rating variables may be highly correlated with each other. For example, assume group A costs twice group B and group X costs twice group Y. Also assume that AX occurs 40% of the time, AY, 10%, BX 10%, and BY, 40%. See Exhibit II.

The empirical cost for X is 3.6, and for Y, 1.2. Thus the empirical relativity is 3.0, when we know the actual cost is only double. This has happened because a disproportionate amount of exposure is concentrated in higher and lower cost groups. In determining the relative cost of X and Y, one may expect half of the exposure to be in group A and half in group B. Instead, 80% of X's exposure is in high-cost group A and 80% of Y's exposure is in low-cost group B. Thus X looks relatively higher in cost than it actually is.

Various methods can be used to adjust for unequal distributions of underlying exposures. Bailey (1963) provides a method for doing this. Premiums at present rates can be calculated for each cell using current rate relativities. The comparable number of base class exposures also be calculated for each cell. For example, if A is priced at three times B, the base class, each class A exposure is multiplied by three.

Another estimation problem concerns the credibility of the data. Since competition encourages insurers to refine their classification systems, refinement will generally continue to the point where the credibility of the data becomes minimal.

In the context of classification, credibility involves the assessment of the relative meaningfulness of a group's cost versus the meaningfulness of the credibility complement's cost. Assume for example, that the task is to estimate the cost of group A. If group A has a large body of data, that experience alone may be sufficient for estimating its cost. As group A becomes smaller, at some point it will be useful to compare group A's empirical costs to the cost of some other group. This other group is the credibility complement. Group A's empirical cost may be twice the cost of the complement. Since group A has less data or less reliable data, the actuary may decide that group A's true cost is only 60% higher than the complement.

Thus two credibility related problems emerge: (1) how to obtain more data or more reliable data, and (2) what is the most appropriate credibility complement? Each of these matters can be discussed at length. The purpose here is to provide an overview.

Obtaining more or more reliable data can be done in several ways. Most obviously, more years of data or, possibly, data from several states (or countrywide) can be used. Of course, the threshold question is whether the broader base actually applies. Has there been a change over time? Do countrywide indications apply in each state?

Another method is to give more weight to more stable phenomena. For example, relativities can be based primarily on frequency (by looking only at claim counts or by limiting the size of claims), instead of pure premiums. Partial pure premiums can be calculated. For example, property damage liability costs may be more stable than bodily injury liability; workers' compensation medical costs may be more stable than deaths or permanent disabilities. In determining relativities, more emphasis (credibility) is given to the more stable phenomena.

The choice of credibility complement may be more difficult than obtaining more or more reliable data. It may not be clear which group is most nearly the same as the group in question. National or regional data may be applicable. Related industry group data may be applicable. In most of these cases, adjustments must be made because the level of costs can be quite different for the complement. Often, the percentage change in the complement is considered, rather then the actual value. As a last resort, the complement may be based on the prior year's analysis; this, in effect, takes more years of data into account.

EXHIBIT II

I. Exposure

	A	B	Total
X	40	10	50
Y	10	40	50
Total	50	50	100

II. Pure Premium

	A	B
X	4	2
Y	2	1

III. Costs

	A	B	Total	Exposures	Relativity
X	160	20	180	50	3.0
Y	20	40	60	50	1.0
Total	180	60	240	100	
Exposures	50	50			
Relativity	3.0	1.0			

Exhibit III illustrates some of the credibility issues. The problem is choosing rate relativities for a group of surgical specialties. At the current time, all specialties shown on Exhibit III are being charged 8.4 times the base. Data is grouped for various combinations of accident years (all groups ending with 1988). Relativities to the base are shown for claim frequency, severity, and pure premium. The severity relativity for all surgery classifications is about 1.25.

The frequencies seem to be different for the different groups, although groups B and C could possibly have the same frequency. The severities are much different for group C, although the number of claims is relatively small (17 for the 10-year period).

Selected relativities were based on judgment rather than a formal credibility formula. Essentially, claim frequency was given high credibility. The overall severity for surgeons (1.25) was used for groups A and B, although actual data is not much different. The severity for group C reflects a small upward adjustment to the overall surgeons' relativity (about 15% credibility). The selected pure premium relativities were rounded.

EXHIBIT III

CLASS RATING EXAMPLE

Current Relativity = 8.4

Rating Group		Years	Exposures	Relativites to Group 1 Frequency	Severity	Pure Prem
I.	Raw Data					
	A	79-88	420	4.2	1.15	4.9
		81-88	340	4.6	1.18	5.4
		84-88	193	4.6	1.10	5.1
		86-88	93	4.7	1.36	6.3
	B	79-88	846	5.1	1.16	5.9
		81-88	635	5.6	1.22	6.9
		84-88	304	5.2	1.07	5.6
		86-88	147	6.0	1.26	7.6
	C	79-88	293	5.9	1.93	11.3
		81-88	233	6.1	1.98	12.1
		84-88	133	4.8	1.72	8.3
		86-88	69	4.5	1.69	7.6
II.	Conclusions					
	A			4.8	1.25	6.0
	B			5.6	1.25	7.0
	C			6.0	1.33	8.0

SUMMARY

Risk classification involves the formulation of different premiums for the same coverage based on group characteristics. That is, the task is to price an individual insured, but the available claim data for that individual is insufficient for the purpose. The recourse is to measure group costs and assume that the individual belongs to a certain group.

Premiums should vary because underlying costs vary. Costs may vary due to different claim frequency or average claim size, different administrative expense requirements, different investment income potential, or differing assessments of risk. Risk classification proceeds by identifying variables that distinguish these costs among different insureds. In addition to classification variables, premiums can also vary due to the choice of different exposure bases, individual risk rating methods, and marketing or underwriting strategies.

Various criteria, actuarial, operational, social, and legal, have been suggested for formulating classification variables. Actuarial criteria attempt to most accurately group individual insureds into groups that, (1) are relatively homogeneous (2) are sufficiently large to estimate relative cost differences (credibility) (3) have

different mean costs (separation) and (4) maintain different mean costs over time (reliability).

Operational criteria include objective definitions, reasonable administrative expense, and verifiability. Social criteria include privacy, causality, controllability, and affordability.

A competitive market tends to produce more refined classifications and accurate premiums. Competition may be limited, however, when the premium volume for a group is small or where there is significant heterogeneity in costs within the group. Most of the social criteria are based on concepts of accuracy. The abolition of certain rating variables, which is seen as desirable by various insurance industry critics, likely will reduce rating accuracy, as well as creating subsidies or availability problems. The inadequacy in the current rating systems is primarily determined by the level of competition and the statistical difficulty of rating small groups of insureds.

The absolute efficiency of current classification systems can be estimated, but the estimates depend upon some measurement of the variability in costs among all insureds (which can never be observed directly). Knowing the absolute efficiency, however, is not particularly useful in determining whether more and better rating variables are available.

Chapter 4
Risk Classification

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