ESTIMATING THE WORKERS COMPENSATION TAIL

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Abstract

The workers compensation tail largely consists of the medical component of permanent disability claims (MPD). Yet the nature of MPD payments is not widely understood and is counter to that presumed in common actuarial methods.

This paper presents an analysis of medical payments based on 160,000 permanently disabled claimants over 77 accident years. It introduces a method for utilizing incremental payment data prior to the standard triangle to extend development factors beyond the end of the triangle (for any casualty line).

A model is presented that explicitly reflects the opposing effects of medical cost escalation and the force of mortality. It demonstrates that

- *paid loss development factors (PLDFs) tend to increase over many successive, "mature" years of development,*
- *PLDFs and tails will trend upward over time due to expected future improvement in mortality—that is, people will be living longer, and*
- *average medical costs for elderly claimants are substantially higher than for younger claimants.*

The paper also demonstrates that case reserves based on inflating payments until the expected year of death are significantly less than the expected value of such reserves. A method is introduced for realistically simulating the high expected value and variability of MPD reserves. It is based on a Markov chain model of annual payments on individual claims.

1. SUMMARY AND INTRODUCTION

Historically, the ability of workers compensation insurers to reasonably estimate tail factors has been hampered by a dearth of available development experience at maturities beyond 10 to 20 years. Substantive advances in workers compensation tail estimation depend on the availability of a substantial database extending to 50 or more years of development.

This paper presents the results of a thorough analysis of the extensive paid loss development database of the SAIF Corporation, Oregon's state fund. This database extends out to 77 years of development separately for medical and indemnity, and separately *by injury type* (i.e., permanent total, permanent partial, fatal, temporary total, temporary partial, and medical only).

This paper predominantly focuses on the behavior of *medical payments for permanently disabled claimants* (MPD) on an unlimited basis. Some of the key findings from this analysis of MPD payments include the following:

1. MPD tail factors calculated empirically are significantly greater than those derived from extrapolation techniques. This occurs because MPD paid loss development factors (PLDFs) do not decrease monotonically for many later development years (DYs).

2. There is an effective, systematic way (the Mueller Incremental Tail method) to utilize incremental payment data prior to the standard triangle to extend PLDFs beyond the end of the triangle for any casualty line.

3. Medical cost escalation rates have generally been much higher than annual changes in the medical component of the Consumer Price Index (CPI). Medical cost escalation rates include increases in utilization rates of different services and the effects of shifts in the mix of services toward more expensive care alternatives.

4. Medical cost escalation rates and the force of mortality are the key drivers of MPD tail factors. Unfortunately, the paid loss development method is not designed to treat these two influences separately. A method (incremental paid to prior open claim) is presented that provides for the separate, explicit treatment of the effects of these two drivers.

5. In the early stages of the MPD tail, medical cost escalation overpowers the force of mortality, leading to increases in incremental paid losses and PLDFs.

6. Assuming recent mortality rates, the incremental paid to prior open claim method fits the empirical data very well out to DY 40, but then tends to understate losses for the next 15 DYs. This understatement is due to the added costs of caring for the elderly, who make up a rapidly increasing percentage of surviving claimants.

7. The common actuarial assumption that the incremental medical severities for each claimant (at current cost level) during each future DY will remain constant is not valid. Such current level severities tend to increase noticeably as each surviving claimant becomes elderly.

8. Declining mortality rates have a substantial effect on medical tail factors. Mortality improvement will also cause individual PLDFs to trend upward slowly for any given DY.

9. The common method of estimating the tail by applying the ratio of incurred to paid for the most mature accident years will underestimate reserves, unless case reserves adequately reflect the implications of points 3, 7, and 8. This is rarely the case.

10. The most significant factor affecting the indications in this paper is the applicable retention. Tail factors and PLDFs at more mature years of development should

be expected to be significantly less at relatively low retentions.

11. The expected value of an MPD case reserve is much greater than cumulative inflated payments through the expected year of death. This is similar to the situation that occurs when reinsurance contracts are commuted, where using the life expectancy of the claimant produces an estimate well below the weighted average of outcomes based on a mortality table [2].

12. The variability of total MPD reserves can be gauged realistically by a Markov chain simulation model that separately estimates payments for each future DY by claimant.

13. The potential for common actuarial methods to understate the MPD reserve, and consequently the entire workers compensation reserve, is significant. This is also true regarding common methods for estimating the degree of variability in the workers compensation reserve.

14. The MPD loss reserve is a high percentage of the total workers compensation loss reserve for maturities of 10 years or more. And that percentage increases noticeably at higher maturities.

It is important to note that the applicability of the above findings depends not only on the retention level, but also the presence (or absence) of permanent disability (PD) claimants with ongoing medical costs and on the specific provisions of state workers compensation laws.

Statutory indemnity benefits differ by state. For example, some states allow for escalation of PD benefits while others do not. Medical benefit structures are much more uniform across states. This paper focuses on MPD payments, which generally do not vary significantly between states.

Organization of Paper

This paper is divided into 10 sections:

1. Summary and Introduction
2. Using Prior Incremental Paid Data to Extend the PLDF Triangle
3. Incorporating the Static Mortality Model into the Incremental Paid to Prior Open Claim Method
4. Mortality Improvement
5. The Trended Mortality Model
6. A Comparison of Indicated Tail Factors
7. Sensitivity Considerations
8. Estimating the Expected Value of MPD Reserves
9. Estimating the Variability of the MPD Reserve with a Markov Chain Simulation
10. Concluding Remarks

The paper also includes five appendices:

A. The Mueller Incremental Tail Method

B. Historical PLDFs for All Other Workers Compensation

C. Incorporating the Static Mortality Model into the Incremental Paid to Prior Open Claim Method

D. Incorporating the Trended Mortality Model into the Incremental Paid to Prior Open Claim Method

E. Quantifying the Elder Care Cost Bulge

Introduction

The workers compensation tail behaves quite differently from that of any other casualty line. For other lines, it is virtually axiomatic that PLDFs will decrease monotonically to 1.0 for later DYs. In sharp contrast, PLDFs for MPD payments quite often increase for later DYs.

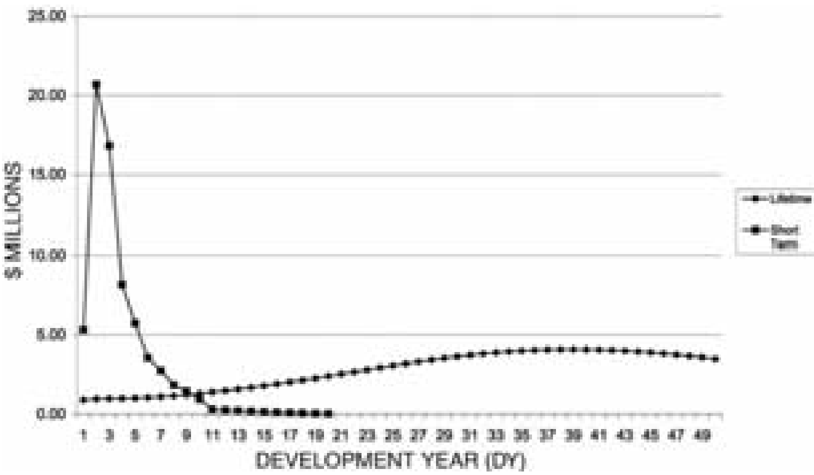
The payout pattern for MPD losses is a composite of two radically different types of payments: short-term and lifetime. What separates these two types is how long work-related medical payments continue. Short-term payments cease well before the claimant dies, either because the need for periodic medical treatments ceases or because the claimant returns to work. Lifetime payments, on the other hand, persist until the claimant dies. Figure 1.1 contrasts these payout patterns. These two categories are conceptual, to help in understanding the behavior of workers compensation payments over time, rather than practical, since MPD payments cannot be precisely separated into these two categories until all claimants die. As such, precise categorization requires hindsight on an ultimate basis.

From Figure 1.1, we see that short-term payments overshadow lifetime payments during the first 10 or so DYs, and lifetime payments dominate soon after that. PLDFs for successive DYs during DYs 3 through 15 tend to drop, largely because of the cessation of short-term payments for a significant percentage of claimants during each DY. For later DYs, the predominant influence affecting whether PLDFs increase or decrease is the relative magnitude of the force of medical cost escalation versus that of claimant mortality, since death is virtually the sole reason for the closure of claims.

An MPD payment history is the result of the sum of the above two payout patterns. As is evident, this will be a bimodal pattern, peaking during DY 2 and around DY 40. If total medical or total workers compensation paid experience is all that is available, the second peak will be much less evident, to the point where the

FIGURE 1.1

PAYOUT PATTERNS—LIFETIME VERSUS SHORT-TERM MPD PAYMENTS FOR A SINGLE ACCIDENT YEAR



tendency of later PLDFs to refuse to decline could easily be seen as an anomaly, when in reality it is to be expected.

The payout pattern for lifetime payments does not end at DY 50. A severely injured worker in his or her late teens or early 20s could require work-related medical payments for up to 90 years after the accident. As a result, the total area under the lifetime payout pattern (i.e., ultimate payments) can easily be three to four times that under the short-term payout pattern.

Often the reserving actuary will have paid losses only for the first 15 (or fewer) DYs. Consequently, the only paid loss experience available consists primarily of short-term payments, and yet the bulk of the loss reserve will be due to lifetime payments. Since the two types of payments are radically different, the risk of underestimating the loss reserve is significant. Frequently the actuary will rely to some degree on the ratio of incurred loss to paid loss for the most mature accident years (AYs) as a guide in selecting a tail factor. Since this typically indicates a larger tail (when there are open permanent disability claims), the actuary may feel that reliance on this latter method will produce a safely conservative reserve estimate. However, such an estimate is only as unbiased as the MPD case reserves are. As will be shown later, MPD case reserves are particularly susceptible to underestimation.

Table 1.1 illustrates the hazards of attempting to extrapolate medical paid loss development factors beyond DY 15 using a common method (exponential decay), as applied to historical PLDFs for DYs 10–15 (highlighted by a box) in Oregon, Washington and California.

In Table 1.1, as well as throughout this paper, a PLDF for a given DY is denoted by the maturity at the end of that year. For example, the factors in the row headed by "2" are for development from 1 to 2 years of age, since this is the second year of development.

In the lower portion of Table 1.1 these extrapolated factors are directly compared with known historical factors. In each state, the extrapolated factors increasingly fall below the historical ones for later DYs. These persistent shortfalls are compounded when tail factors are calculated, such as those shown in the bottom row of the table.

Table 1.1 provides these comparisons for SAIF, the Washington Department of Labor and Industries (WA LNI) and the California Workers Compensation Insurance Rating Bureau (WCIRB), respectively. The SAIF factors are for MPD only, while for the other two states, the factors are for total medical. So, everything else being equal, SAIF's PLDFs will tend to be greater for later DYs.

The problem of persistent shortfalls in the extrapolated factors can be reduced, but not eliminated, by applying inverse power [5] fits to the PLDFs for DYs 10–15. Such fits also assume that PLDFs will decrease monotonically for increasing DYs. The

TABLE 1.1

A Comparison of PLDFs Extrapolated from Historical Factors for DYs 10–15 with Known Historical PLDFs for Later DYs [MPD Losses (SAIF) and Medical Losses (WA LNI and WCIRB)]

	(1)	(2)	(3)	(4)	(5)	(6)
Development Year (DY)	Historical SAIF MPD PLDFs	Fitted/ Extrapolated SAIF MPD PLDFs	Historical WA LNI Medical PLDFs	Fitted/ Extrapolated WA LNI Medical PLDFs	Historical WCIRB Medical PLDFs	Fitted/ Extrapolated WCIRB Medical PLDFs
2	6.624		1.914		1.740	
3	1.525		1.175		1.296	
4	1.140		1.090		1.152	
5	1.072		1.060		1.104	
6	1.041		1.045		1.069	
7	1.027		1.036		1.058	
8	1.019		1.027		1.030	
9	1.020		1.023		1.022	
10	1.015	1.015	1.020	1.019	1.015	1.015
11	1.013	1.014	1.017	1.018	1.012	1.012
12	1.012	1.013	1.016	1.016	1.009	1.009
13	1.013	1.012	1.015	1.015	1.007	1.007
14	1.012	1.011	1.013	1.014	1.006	1.006
15	1.010	1.011	1.013	1.012	1.005	1.005

TABLE 1.1

Continued

16	1.011	*1.010*	1.012	*1.011*	1.006	*1.004*
17	1.013	*1.009*	1.010	*1.010*	1.005	*1.003*
18	1.011	*1.009*	1.010	*1.010*	1.005	*1.002*
19	1.011	*1.008*	1.009	*1.009*	1.005	*1.002*
20	1.012	*1.008*	1.009	*1.008*	1.008	*1.002*
21	1.012	*1.007*	1.008	*1.007*	1.006	*1.001*
22	1.014	*1.007*	1.009	*1.007*	1.007	*1.001*
23	1.012	*1.006*	1.009	*1.006*	1.007	*1.001*
24	1.015	*1.006*	1.009	*1.006*	1.007	*1.001*
25	1.015	*1.006*	1.009	*1.005*	1.009	*1.001*
26	1.016	*1.005*	1.008	*1.005*	1.010	*1.000*
27	1.020	*1.005*	1.009	*1.004*	1.008	*1.000*
28	1.023	*1.005*	1.009	*1.004*	1.009	*1.000*
29	1.027	*1.004*	1.011	*1.004*		
30	1.026	*1.004*	1.009	*1.003*		
31	1.022	*1.004*	1.010	*1.003*		
32	1.018	*1.004*	1.013	*1.003*		
33	1.015	*1.003*	1.013	*1.003*		
34	1.017	*1.003*	1.015	*1.002*		
35	1.018	*1.003*	1.010	*1.002*		
36	1.029	*1.003*				
37	1.033	*1.003*				
Tail @ 15	1.471	1.130	1.221	1.120	1.096	1.018

Notes: (1) The italicized factors in columns (2), (4) and (6) were extrapolated on the basis of an exponential curve fit to the boxed historical factors (less 1.0) for DYs 10–15 for each respective state's experience.
(2) The DYs shown for the WCIRB are off by half a year (e.g., DY 10.5 is shown as DY 10).

reality is that the historical PLDFs in all three Western states *often increase* for later DYs. The shortfalls produced by inverse power fits are smaller because the ratios of the projected factors (less 1.0) rise asymptotically to 1.0, while the decay ratios for the exponential curve fits remain constant at a value well below 1.0.

In addressing the problem of extrapolating paid development when the most mature PLDFs are increasing, some insurers or self-insureds may have data for longer periods of time than the latest 20 years. However, because of system changes or acquisitions, *cumulative* loss development data for old accident years are frequently lacking. In these cases *incremental* calendar year data for old accident years may be available because payments are still being made on the old open claims. Section 2 and Appendix A present the Mueller Incremental Tail method for making full use of the incremental data to calculate empirical tail factors. We have used this method to derive empirically based PLDFs out to 65 years of development based on SAIF's actual MPD loss experience.

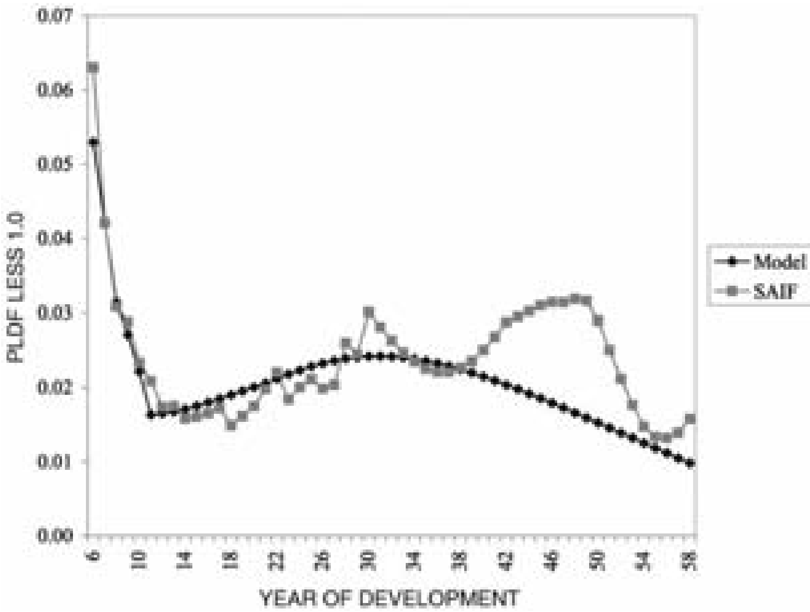
The PLDF model is not designed to reasonably predict the behavior of lifetime payments during later DYs. An alternative approach using the incremental paid to prior open claim method is well suited to this purpose. It separately treats changes in incremental severities (due to annual rates of medical cost escalation) and the slow decline in the number of open claims (due to mortality). A version of it using a recent mortality is presented in Section 3. It will be referred to as the *static mortality model*.

When the rate of medical cost escalation clearly exceeds the percentage of remaining claimants who die during a given DY, then incremental MPD payments will increase from one DY to the next. Such increases should be quite common during DYs 15 through 40.

In Figure 1.2, the PLDFs indicated by the static mortality model are compared with SAIF's empirical PLDFs. The static

FIGURE 1.2

STATIC MORTALITY MODEL AND ACTUAL SAIF PLDFS LESS 1.0



mortality model PLDFs are shown in the last column of Table 3.2. The empirical PLDFs for the first 29 DYs are the averages of the latest 15 historical factors. For DYs 30–58, the PLDFs appear in Tables A.1, A.2 and A.3, where the Mueller Incremental Tail method is applied.

As Figure 1.2 shows, SAIF's actual development experience for DYs 40 through 54 is consistently worse than the model predicts. The bulge in adverse paid development evident for DYs 40 through 54 is attributable to the rapidly increasing percentage of surviving claimants who are elderly. Not uncommonly, elderly PD claimants simply require more extensive and expensive medical care than younger claimants. And as PD claimants

TABLE 1.2

TWO INDICATORS OF AN INCREASING PROPORTION OF THE ELDERLY AMONG SURVIVING CLAIMANTS

DY	Portion 80 Years of Age or Older	Portion Who Will Die Within Five Years
0	0.0%	4.4%
10	0.9%	9.4%
20	10.9%	18.3%
30	36.5%	30.1%
40	51.2%	39.0%
50	64.7%	47.2%
60	100.0%	60.3%

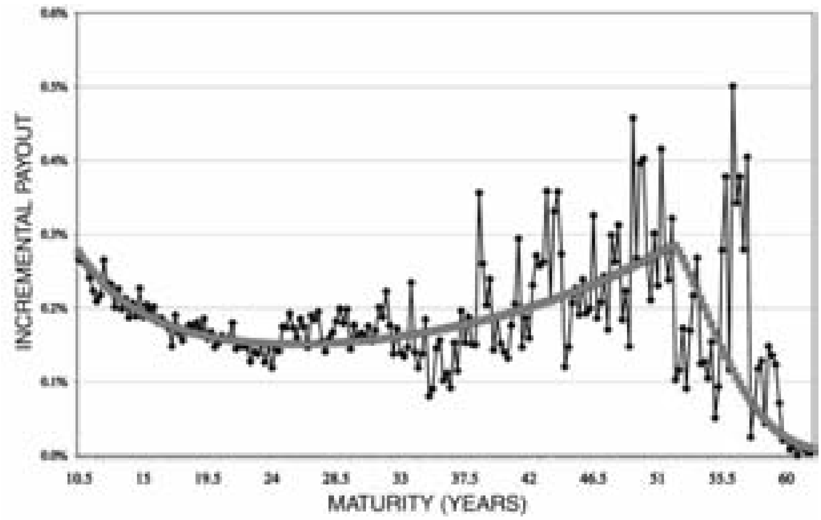
The percentages in Table 1.2 are based on 2000 mortality tables published by the Social Security Administration (SSA), assuming 75% of the claimants are male, and a census of SAIF's permanent total disability claimants by age-at-injury.

age, so do their spouses. Often spouses reach an age where they can no longer provide as much care as previously, and insurers then pay for the increased cost of hiring outside assistants. Table 1.2 indicates the percentage of surviving claimants who will be 80 or older at the beginning of various years of development. It also shows the percentage of surviving claimants expected to die within the succeeding five years. It has also been observed that incremental severities tend to undergo an increase during the last years before a claimant's death that exceeds normal rates of medical cost escalation.

Table 1.2 indicates that for DYs 40 and higher, over half of the surviving claimants will be 80 or more years old. Clearly, this fact could have been anticipated on an a priori basis. After all, if the average claimant were age 40 when injured, it should be expected that 40 years after the injury year the average surviving claimant would be about 80 years old. However, the above table underscores a reality that casualty actuaries may not have heretofore given much consideration. The behavior of loss development for later DYs may well be more adverse than what

FIGURE 1.3

WASHINGTON STATE FUND
MEDICAL TAIL



Solid points = actual data; shaded = fitted data.

would be expected on the basis of earlier DYs, because of the increasing infirmities of surviving claimants and their spouses.

The adverse pattern evident in Figure 1.2 is also quite pronounced in the medical PLDFs for the Washington State Fund, as shown in Figure 1.3. This graph was provided by William Vasek, FCAS.

Table 1.3 provides a direct comparison of the tail factors (to ultimate) at 15 years produced by various extrapolation techniques with that based on SAIF's historical experience.

Clearly, the extrapolated MPD loss reserves at 15 years of maturity are only a small fraction of the MPD reserve indicated by SAIF's development history.

TABLE 1.3

A COMPARISON OF SAIF'S EMPIRICAL TAIL FACTOR WITH EXTRAPOLATED TAIL FACTORS AT 15 YEARS (BASED ON A FIT TO HISTORICAL PLDFS FOR DYS 10–15)

Extrapolation Method	Indicated Tail Factor at 15 Years	Extrapolated Reserve as a Portion of the Reserve Indicated by SAIF's History
Linear Decay	1.046	3.5%
Exponential Decay	1.175	13.4%
Inverse Power Curve	1.234	17.9%
SAIF's Historical Factors	2.309	100.0%

As high as SAIF's paid tail factor at 15 years is (2.309), it is understated because it implicitly assumes that past mortality rates will continue indefinitely into the future. As noted in Section 4, mortality rates have been declining steadily for at least the past four decades, and the Social Security Administration (SSA) reasonably expects such declines to continue throughout the next century.

A second reserving model that explicitly accounts for the compounding effects of *downward trends in future mortality rates* and persistently high rates of future medical cost escalation will be referred to as the *trended mortality model*. It will be described in Section 5.

The indications of the trended mortality model for MPD are significant and troubling:

- Paid tail factors at the end of any selected year of development should be expected to increase slowly but steadily over successive accident years.
- Incremental PLDFs for any selected year of development will also trend upward slowly but inexorably for successive AYs.

- The above effects on MPD will cause corresponding upward trends in paid tails and incremental PLDFs *for all workers compensation losses in the aggregate.*

Unless the effects of downward trends in mortality rates are incorporated into a workers compensation reserve analysis, the resulting reserve estimates will be low when numerous AYs are involved and the retention is very high.

We believe that the most appropriate approach to estimating gross workers compensation loss reserves is to separately evaluate MPD loss reserves by one or more of the methods presented in this paper. Lacking separate MPD loss experience, the static mortality and trended mortality models and the Mueller Incremental Tail method can be applied satisfactorily to total medical loss experience for DYs 20 and higher, since virtually all medical payments are MPD payments at such maturities.

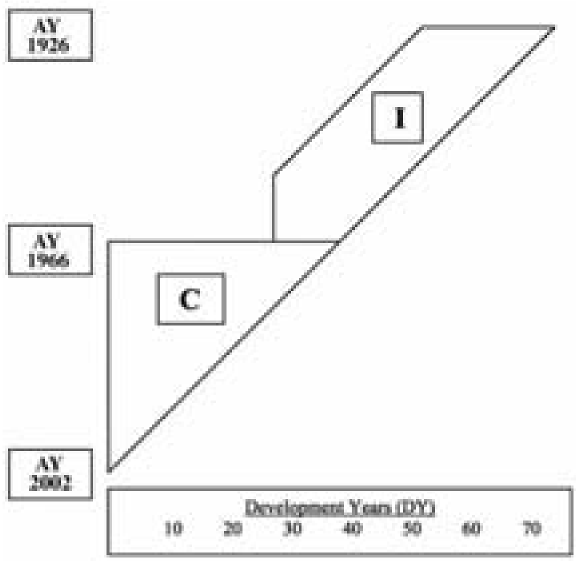
There is an additional reason to utilize the methods presented in this paper instead of the standard PLDF method. In general, legislated benefit changes tend to have a much greater impact on the magnitude and duration of short-term payments than on lifetime payments. When a PLDF method is used, it assumes that the relative magnitude of short-term and lifetime payments for each AY is relatively constant. Benefit changes can significantly change this mix, causing distortions in projections of remaining lifetime payments based on PLDFs. In contrast, projections of future lifetime payments based on the incremental paid to prior open claim method should be comparatively independent of shifts in the relative magnitude of short-term payments.

2. USING PRIOR INCREMENTAL PAID DATA TO EXTEND THE PLDF TRIANGLE

Figure 2.1 provides a graphic summary of the available portions of the incremental MPD payments experience of the SAIF Corporation. A complete triangle of MPD payments exists for

FIGURE 2.1

CONFIGURATION OF SAIF'S MPD PAID LOSS DATA



AYs 1966 through 2002. This region is the triangle labeled "C" to designate that *cumulative* paid losses are available for all of these AYs. In addition, since calendar year 1985, incremental MPD payments have been captured for AYs 1926 through 1965 for DYs 29 and higher. This region is the diagonally shaped area labeled "I" to designate that only incremental payments are available.

2.1. The Mueller Incremental Tail Method

Given the availability of the incremental paid data for DYs well beyond the standard triangle of cumulative paid losses, and the value of such information in more accurately estimating the tail, a method was devised to utilize this data. It was designed by Conrad Mueller, ACAS, and is based on decay ratios of incremental payments. We will use SAIF experience as an example. This section describes the Mueller Incremental Tail (MIT) method and provides the formulas and key results. The actual calculations are included in Appendix A.

The MIT method was used to calculate empirical 37 to ultimate tail factors using the incremental data on old accident years. The empirical data ended at 65 years of development, which for purposes of this section will be considered to be ultimate. We describe the method in three stages:

1. Incremental age-to-age decay ratios.
2. Anchored decay factors.
3. Tail factors.

Notation:

Let S_n = Cumulative payments through n years of development

p_n = Incremental payments made in year n; and

$S_n = \sum p_i$ (i = 1 to n).

Let PLDF_n = Age $n-1$ to n paid loss development factor.

$\mathrm{PLDF}_n = S_n/S_{n-1} = (S_{n-1} + p_n)/S_{n-1} = 1 + p_n/S_{n-1}$.

Let $f_n = p_n/S_{n-1}$, then

$\mathrm{PLDF}_n = 1 + f_n$.

1. *Incremental age-to-age decay ratios.* The first step is to calculate incremental age-to-age decay ratios: p_{n+1}/p_n, p_{n+2}/p_{n+1}, p_{n+3}/p_{n+2}, and so on. With the SAIF data, we are able to calculate ratios of incremental paid loss at age $(n+1)$ to incremental paid at age (n), for n ranging from 29 to 65, using 20-year weighted averages. Because of the sparseness of claims of this age, the empirical decay ratios needed to be smoothed before they could be used. The smoothing was done using five-year centered

TABLE 2.1

INDICATED DECAY FACTORS RELATIVE TO ANCHOR YEAR 37 INCREMENTAL PAYMENTS

Year of Development	Decay Factor
55	.962
50	1.880
45	1.724
40	1.211
Anchor Year 37	1.000

moving averages. These calculations are shown in Appendix A, Tables A.1 through A.4.

2. *Anchored decay factors.* After calculating incremental age-to-age decay ratios, we then anchor them to a base year. We illustrate this using development year n as our anchor year. These anchored decay factors are calculated as the cumulative product from the last column on Table A.4.

   We call the anchored age-to-age factor d_n, where $d_n = p_n/p_n = 1$, $d_{n+1} = p_{n+1}/p_n$, $d_{n+2} = p_{n+2}/p_n \ldots$, all relative to p_n.

   In general,

$$p_{n+r}/p_n = p_{n+1}/p_n * p_{n+2}/p_{n+1} * \cdots p_{n+r}/p_{n+r-1}.$$

   The anchored decay factors are cumulative products of the age-to-age decay ratios and represent payments made in year $n+r$ relative to payments made in the anchor year n.

   Table 2.1 shows the anchored decay factors for payments made in accident years of age 40, 45, 50, and 55 relative to payments made in an accident year of age 37 (our anchor year).

TABLE 2.2

CUMULATIVE DECAY FACTORS RELATIVE TO INCREMENTAL PAYMENTS DURING DIFFERENT ANCHOR YEARS

Anchor Year	Cumulative Decay Factor
37	30.071
36	30.115
35	29.508
34	28.280
33	26.961

For example, payments made in DY 50 are, on average, almost double (88.0% greater) the payments made in DY 37.

By summing the anchored decay factors from 38 to ultimate, we get the payments made in ages 38 to 65 relative to payments made in year 37. We will refer to each of these as anchored cumulative decay factors D_n, where

$$D_{n+1} = p_{n+1}/p_n + p_{n+2}/p_n + \cdots = \sum d_i.$$

The sums of the decay factors are similar to tail factors, but instead of being relative to cumulative payments they are relative to the incremental payments made in the anchor year.

The process can be repeated using a different anchor year. In addition to anchor year 37, the calculations were also performed using anchor years 36, 35, 34, and 33. In each case, the payments from 38 to ultimate were compared to the payments made in the selected anchor year. Table 2.2 shows the cumulative decay factors for each of these anchor years.

The cumulative decay factors can be interpreted as follows: Payments made from ages 38 to ultimate are 30.071 times the payments made in age 37. Similarly, payments made in ages 38 to ultimate are 30.115 times the payments made in age 36, and so on.

3. *Tail factors.* To convert these cumulative decay factors into tail factors, we make use of the selected cumulative loss development factors from the customary cumulative paid loss development triangle.

The tail factor from n to ultimate

$$\begin{aligned}
&= S_8/S_n \\
&= (S_n + \textstyle\sum p_i)/S_n \\
&= 1 + \textstyle\sum p_i/S_n \\
&= 1 + p_{n+1}/S_n + p_{n+2}/S_n + \cdots \\
&= 1 + p_n/S_n(p_{n+1}/p_n + p_{n+2}/p_n + \cdots).
\end{aligned}$$

But $p_n/S_n = (p_n/S_{n-1})/(S_n/S_{n-1}) = f_n/(1+f_n)$, so the tail factor is $1 + [f_n/(1+f_n)] \times D_{n+1}$.

The general formula for the tail factor at age n is

$$\text{Tail factor}_n = f_n D_{n+1}/[1 + f_n],$$

where f_n is the PLDF, less one, for the nth year of development, and D_{n+1} is the cumulative decay factor for payments made during years $n+1$ to ultimate relative to payments made in anchor year n.

In a similar way, an age-to-age loss development factor (less 1.0) extending beyond the cumulative triangle is

$$f_{n+1} = f_n d_{n+1}/[1 + f_n],$$

where d_{n+1} is the decay factor for payments made in year $n+1$ relative to payments made in anchor year n.

This method is sensitive to f_n, the 37:36 PLDF less 1. For this reason the analysis can be repeated using the 36, 35, 34, or 33 anchor years. Table 2.3 shows the 37 to ultimate tail factor calculated using each of these anchor years.

TABLE 2.3

37 TO ULTIMATE MPD TAIL FACTORS BASED ON DIFFERENT ANCHOR YEARS

Anchor Year	37 to Ultimate MPD Tail Factor
37	1.964
36	1.808
35	1.496
34	1.439
33	1.369
Selected	1.581*

*Average excluding the high and low.

The empirically calculated 37 to ultimate MPD tail factors range from a low of 1.369 to a high of 1.964. The value is sensitive to relatively small changes either in incremental age-to-age factors in the tail or in the cumulative age-to-age factors at the end of the cumulative triangle.

Another approach for reducing the high level of volatility of the tail factors shown in Table 2.3 is presented in Table A.6 of Appendix A. Each of the average PLDFs for ages 30 through 36 is adjusted to what it would be for age 37 using the appropriate products of incremental decay factors from AYs 1965 and prior. A weighted average of all of these adjusted PLDFs (1.022) is then used to replace the actual PLDF for DY 37 (1.033). The final selected tail factor from age 37 to ultimate is then 1.0 plus the product of the cumulative decay factor of 30.071 and .022/1.022 (1.647).

2.2. *SAIF's Indicated Paid Tail Factors*

When the indications from SAIF's incremental paid estimation of the tail from 37 years to ultimate are combined with those of a standard paid loss development approach up to 37 years of maturity, the MPD tails shown in the left column of Table 2.4 at different maturities were derived. Some readers may be interested in the Total Workers Compensation tail factor (medical and

TABLE 2.4

SAIF'S INDICATED PAID TAIL FACTORS

Maturity (Years)	MPD	Other Workers Compensation	Total Workers Compensation
10	2.469	1.263	1.671
15	2.328	1.234	1.613
25	2.054	1.129	1.457
35	1.680	1.052	1.294

indemnity combined). These are shown in Table 2.4 assuming an ultimate mix of MPD and Other Workers Compensation of 50% for each. We selected 50% for ease of presentation because in practice the mix would vary by state and over time.

In addition to MPD tail factors, Table 2.4 also displays indicated paid tail factors for all other types of workers compensation losses as well as for workers compensation in total. Most of the Other Workers Compensation tail factors reflect paid development for indemnity losses of permanently disabled claimants. A small portion is also due to paid development on fatal cases. The above table puts the impact of MPD paid tails in perspective relative to the indicated paid tail for all WC losses (i.e., for all injury types and for medical and indemnity combined).

Appendix B provides a comparison of SAIF's historical PLDFs for MPD, all other workers compensation and total workers compensation by DY. MPD is the primary reason why PLDFs for total workers compensation decline much more slowly than generally expected.

To gain an appreciation for the relative contribution to the total loss reserves for a given AY of MPD versus all other workers compensation at each of the above years of maturities, Table 2.5 provides a comparison of what the reserve would be, assuming that total ultimate losses for that AY were $100 million and assuming that 50% of ultimate losses are MPD.

TABLE 2.5

INDICATED LOSS RESERVE AT DIFFERENT MATURITIES (DOLLARS IN MILLIONS)

Maturity (Years)	MPD Reserve	Other Workers Compensation Reserve	MPD Reserve as a Percentage of Total Workers Compensation Reserve
10	$29.8	$10.4	74
15	28.5	9.5	75
25	25.7	5.7	82
35	20.2	2.5	89

TABLE 2.6

WCIRB'S INDICATED CALIFORNIA PAID TAIL FACTORS

Maturity (Years)	Medical Tail	Indemnity Tail	Total Workers Compensation Loss Tail
10	1.276	1.064	1.168
15	1.217	1.041	1.129
25	1.143	1.025	1.086

Source: WCIRB Bulletin No. 2003-24, pp. 8–9 [7].

The MPD reserve makes up an increasing percentage of the total WC loss reserve at later maturities.

It should be borne in mind that Tables 2.4 and 2.5 provide MPD and other workers compensation indications specific to SAIF's loss experience in the state of Oregon, and not that of workers compensation insurers in general.

Table 2.6 provides a comparison of indicated tails at different maturities for California workers compensation experience, as projected by the Workers Compensation Insurance Rating Bureau (WCIRB).

Although the California tails are consistently smaller than SAIF's, it is again true that the medical tails are decidedly greater

TABLE 2.7

WCIRB INDICATED LOSS RESERVE BY LOSS TYPE AT DIFFERENT MATURITIES (DOLLARS IN MILLIONS)

Maturity (Years)	Medical Loss Reserve	Indemnity Loss Reserve	Medical Reserve as a Percentage of Total Reserve
10	$11.7	$2.7	81%
15	9.6	1.8	84%
25	6.8	1.1	86%

than the indemnity tails. Table 2.7 provides a comparison of the size of the medical and indemnity loss reserves at different maturities, again assuming an AY with $100 million of ultimate losses.

In California, medical loss reserves make up an increasing percentage of the total workers compensation loss reserve at later maturities.

3. INCORPORATING THE STATIC MORTALITY MODEL INTO THE INCREMENTAL PAID TO PRIOR OPEN CLAIM METHOD

This section presents the incremental paid to prior open claim method of reserve estimation. The basics of this method bear much resemblance to the structural methods developed by Fisher and Lange [3] and Adler and Kline [1]. In essence, incremental payments for every development year are estimated by taking the product of the number of open claims at the end of the prior development year and an estimated claim severity.

While this method is of limited value for less mature DYs, its merit relative to other reserving methods is substantial in estimating reserves for future MPD payments for more mature DYs. For such mature DYs, future incremental payments are essentially a function of how many claims are still open and the average size of incremental payments per open claim. In contrast, future incremental MPD payments have almost no causal link to payments for rapidly settled claims during early DYs.

Table 3.1 provides a specific example of how this method is applied. The specific steps to be taken in applying the incremental paid to prior open claim method are as follows:

1. Incremental paid losses (A) and open counts (B) are compiled by AY and DY.
2. Historical averages of incremental paid to prior open claim (C) are computed as to (A) divided by claim (B).
3. Each historical average is trended to the expected severity level for the first calendar year (CY) (2003) after the evaluation date (12/31/2002), and a representative average is selected for each DY [last row of (D)]. A trend factor of 9% per year was assumed in this example.
4. Ratios of open counts at successive year-ends are computed (E).
5. The selected ratios from (E) by DY are used to project the number of open claims for each future DY of each AY, thereby completing (B).
6. Future values of incremental paid to prior open claim (C) are projected on the basis of the representative averages in the last row of (D).
7. Projections of incremental paid losses for future DYs for each AY (A) are determined as the product of the projected open counts from the lower right portion of (B) and the projected values of incremental paid to prior open claim from (C).

The descriptions in the lower right portion of sections (A), (B) and (C) of Table 3.1 also detail how the estimates in each portion are derived.

TABLE 3.1

Sample Application of the Incremental Paid to Prior Open Claim Method

(A) Incremental Paid Losses ($000s)

AY	12	24	36	48	60	72
1997	2,822.8	15,936.1	9,182.3	4,281.6	2,063.8	1,411.4
1998	2,638.0	14,249.9	9,096.4	2,935.8	3,214.7	
1999	3,331.3	15,805.8	9,734.9	4,308.9		
2000	3,170.4	18,602.1	12,462.0			
2001	3,143.1	20,305.9		*Product of Projected (B)*		
2002	4,263.1			*and Projected (C)*		

(B) Open Counts

AY	12	24	36	48	60	72
1997	362	1,112	793	490	375	324
1998	338	888	628	431	352	
1999	343	840	664	492		
2000	268	867	731			
2001	276	897		*Use Ratios from (D) to*		
2002	333			*Project Future Open Counts*		

(C) Incremental Paid to Prior Open Claim

AY	24	36	48	60	72
1997	44,022	8,257	5,399	4,212	3,764
1998	42,159	10,244	4,675	7,459	
1999	46,081	11,589	6,489		
2000	69,411	14,374			
2001	73,572			*Selected Average at CY 2003*	
2002				*Level (E) Adjusted for 9% Inflation*	

(D) Incremental Paid to Prior Open Claim Trended to CY 2003 at 9%/Yr.

AY	24	36	48	60	72
1997	67,734	11,656	6,992	5,004	4,102
1998	59,511	13,266	5,554	8,130	
1999	59,676	13,769	7,073		
2000	82,467	15,667			
2001	80,194				
Avg. Latest 3	74,112	14,234	6,540	6,567	4,102

(E) Ratio of Open Counts at Successive Year-Ends

AY	24	36	48	60	72
1997	3.072	0.713	0.618	0.765	0.864
1998	2.627	0.707	0.686	0.817	
1999	2.449	0.790	0.741		
2000	3.235	0.843			
2001	3.250				
Avg. Latest 3	2.978	0.780	0.682	0.791	0.864

Table 3.2 presents a sample application of this method in estimating incremental payments for accident year 2002, assuming 5,000 ultimate PD claims and a series of additional assumptions derived from SAIF's historical loss experience (as described in Appendix B).

The following observations can be made about the phenomena exhibited in Table 3.2:

- Incremental payments consistently increase for every DY from the 11th through the 40th, a counterintuitive pattern.
- The PLDFs consistently increase for every DY from the 11th through the 31st.
- This method produces projected PLDFs out to 85 years of development. Such development is possible because a worker could be injured at age 16 and live to be over 100.
- Incremental payments do not decrease below the local minimum of $1.7 million during the 11th year of development until the 65th year of development.

To understand why incremental payments, as well as PLDFs, tend to increase during many "mature" years of development, it is helpful to examine how the two key components of the incremental paid to prior open claim method change over successive development years.

This section illustrates how a static mortality model has been incorporated into the incremental paid to prior open claim method. It describes the main framework of the method, while Appendix C covers the derivation of various assumptions that involve a complex analysis.

As is evident from Column (4) in Table 3.3, it was assumed that incremental payments per prior open claim would increase by 9% per year for every DY beyond the seventh, except for the 11th DY. This was based on an analysis of SAIF's historical

TABLE 3.2

Estimation of Incremental MPD Payments for AY 2002 by Static Mortality Model

Development Year	# Prior Open	Paid to Prior Open ($000s)	Incremental Paid Loss ($000,000s)	Cumulative Paid Loss ($000,000s)	PLDF	Paid Factor to Ultimate
1	460*	13.5	6.2	6.2		44.579
2	460	78.4	36.1	42.3	6.8187	6.538
3	1,531	16.6	25.4	67.7	1.6014	4.082
4	1,366	8.4	11.5	79.2	1.1692	3.492
5	949	7.9	7.5	86.7	1.0948	3.189
6	677	6.8	4.6	91.2	1.0530	3.029
7	554	6.9	3.8	95.1	1.0420	2.907
8	396	7.5	3.0	98.1	1.0314	2.818
9	323	8.2	2.7	100.7	1.0271	2.744
10	249	9.0	2.2	103.0	1.0222	2.684
11	209	8.0	1.7	104.6	1.0163	2.641
12	197	8.8	1.7	106.4	1.0165	2.598
13	187	9.5	1.8	108.1	1.0167	2.556
14	178	10.4	1.8	110.0	1.0171	2.513
15	170	11.3	1.9	111.9	1.0175	2.469
16	163	12.4	2.0	113.9	1.0180	2.426
17	156	13.5	2.1	116.0	1.0185	2.382
18	150	14.7	2.2	118.2	1.0190	2.337
19	144	16.0	2.3	120.6	1.0195	2.293
20	139	17.5	2.4	123.0	1.0201	2.248
21	133	19.0	2.5	125.5	1.0205	2.202
22	128	20.7	2.7	128.2	1.0212	2.157
23	124	22.6	2.8	130.9	1.0218	2.111
24	119	24.6	2.9	133.9	1.0223	2.065
25	114	26.9	3.1	136.9	1.0228	2.018
26	109	29.3	3.2	140.1	1.0232	1.973
27	104	31.9	3.3	143.4	1.0236	1.927
28	98	34.8	3.4	146.8	1.0239	1.882
29	93	37.9	3.5	150.4	1.0241	1.838
30	88	41.3	3.6	154.0	1.0242	1.795
31	83	45.0	3.7	157.7	1.0242	1.752
32	78	49.1	3.8	161.5	1.0242	1.711
33	73	53.5	3.9	165.4	1.0240	1.671
34	68	58.3	3.9	169.4	1.0238	1.632
35	63	63.6	4.0	173.4	1.0236	1.594

40	*42*	*97.8*	*4.1*	*193.7*	*1.0215*	*1.427*
45	*26*	*150.5*	*3.9*	*213.6*	*1.0185*	*1.294*
50	*15*	*231.6*	*3.5*	*231.8*	*1.0152*	*1.192*
55	*8.1*	*356.3*	*2.9*	*247.6*	*1.0118*	*1.116*
60	*4.0*	*548.2*	*2.2*	*260.0*	*1.0085*	*1.063*
65	*1.7*	*843.5*	*1.4*	*268.6*	*1.0053*	*1.029*
70	*0.56*	*1,297.8*	*0.73*	*273.5*	*1.0027*	*1.010*
75	*0.13*	*1,996.8*	*0.26*	*275.7*	*1.0009*	*1.003*
80	*0.019*	*3,072.3*	*0.06*	*276.3*	*1.0002*	*1.0004*
85	*0.002*	*4,727.2*	*0.01*	*276.4*	*1.0000*	*1.0000*

For the first DY only, the number of claims open at the end of the year is shown.
After DY 35, the italicized amounts are shown only for each fifth DY.
The PLDFs in this table closely fit SAIF's 10-year historical average factors.

TABLE 3.3

Estimation of Incremental Payments by Static Mortality Model

Development Year (DY)	(1) # Open at End of Prior DY	(2) % Decline in Prior Open Counts	(3) Increm. Pd. to Prior Open ($000s)	(4) % Severity Change
1	0.0		13.478	
2	460.0		78.425	481.9
3	1,531.0		16.607	−78.8
4	1,366.0	10.8	8.388	−49.5
5	949.0	30.5	7.903	−5.8
6	677.0	28.7	6.781	−14.2
7	554.0	18.2	6.924	2.1
8	396.0	28.5	7.547	9.0
9	323.0	18.4	8.226	9.0
10	249.0	22.9	8.967	9.0
11	209.0	16.1	8.036	−10.4
12	196.9	5.8	8.759	9.0
13	186.5	5.3	9.548	9.0
14	177.5	4.8	10.407	9.0
15	169.7	4.4	11.343	9.0
20	138.5	3.8	17.453	9.0
25	113.8	4.2	26.854	9.0
30	88.0	5.6	41.318	9.0
35	62.8	7.1	63.574	9.0
40	41.6	8.4	97.816	9.0
45	25.8	9.6	150.502	9.0

incremental severities for these DYs (see Section C.3 of Appendix C). The fact that SAIF's historical PLDFs for DYs 40–54 are noticeably higher than those predicted by this model (see Figure 1.1) is evidence that there are additional costs associated with caring for elderly claimants, who comprise the majority of claimants during these DYs.

The basis for our selection of 9% as the long-term rate of medical cost escalation is presented in Section C.3 of Appendix C. This assumed annual rate of change in the total cost per claim should be expected to be noticeably greater than the change in the medical component of the CPI. Key reasons for this are

1. *Larger increases in unit costs.* The types of services provided to permanently disabled claimants will likely inflate at a greater rate than that of overall medical services. Examples of these include prosthetic devices, new drugs, surgeries and so on.
2. *Increasing utilization.* The rate at which claimants utilize given services has tended to increase over time.
3. *Shifting mix of services.* There has been a trend toward the greater utilization of more expensive alternatives of care.

Because of these three factors, SAIF's historical rate of medical cost escalation for PD claims has consistently exceeded the change in the medical CPI by a discernable margin. As shown in Table C.4.1, the average rate of MPD cost escalation from 1966 to 2003 was 9.2%, while the average annual change in the medical CPI was 6.8%. Therefore, the average annual change in utilization and mix for 1966–2003 was 2.4%. For 1998–2003, the average utilization and mix change was much larger (i.e., 7.4%, per Table C.4.3).

In Table 3.2 incremental payments continue to increase until age 40 because the impact of claims inflation is greater than the force of mortality in closing existing claims.

The percentage declines in prior open counts reflect the composite effects of three factors affecting the number of open claims: (1) increases due to newly reported claims; (2) decreases due to the death of a few claimants; and (3) net changes due to other reasons (including increases due to reopened claims). After 20 years of development newly reported claims become negligible, as do net claim closures. Thus, after 20 years of development, virtually all claim closures are attributable to the death of claimants. Consequently, changes in the number of open claims at the end of each development year beyond 20 years can be predicted entirely on the basis of mortality rates. And changes in the number of open claims can be estimated beyond 15 years via mortality rates and inclusion of the small number of newly reported claims and net closures for other reasons. This is subject to fine-tuning due to the possibility that the mortality rates of disabled claimants might be higher than those of the general populace, although recent improvements in medical technology have reduced the influence of medical impairment on mortality rates.

Table 3.4 presents an accounting of how each of the above factors affects the number of open MPD claims during the development of a typical accident year. Derivation of these assumptions is disclosed in Appendix C.

SAIF's historical database includes the total number of closed claims. The number of claimant deaths was estimated based on SSA mortality tables and any additional claim closures are presumed to be for other reasons. The breakdown was derived by estimating the number of claim closures due to death from the SSA mortality tables for 2000.

The SSA tables were not modified by a disabled lives scale factor because key values predicted by the model either (1) closely fit SAIF's actual experience; or (2) underestimated actual development (e.g., DYs 40–54). Furthermore, prior actuarial inquiries into this question have been mixed regarding whether such a factor is justified. This is discussed in two papers in the Winter 1991 edition of the CAS *Forum* ("Injured Worker Mortal-

TABLE 3.4

FACTORS AFFECTING THE NUMBER OF OPEN MPD CLAIMS FOR A SINGLE ACCIDENT YEAR

Development Year (DY)	(1) # Open at End of Prior DY [(5) of Prior DY End]	(2) Newly Reported Claims	(3) Estimated # of Claimant Deaths	(4) Estimated Claims Closed for Other Reasons	(5) # Open at End of Current DY [(1) + (2)– (3) – (4)]
1		926	3.5	462.5	460.0
2	460.0	2,790	15.0	1,704.0	1531.0
3	1,531.0	866	17.3	1,013.7	1366.0
4	1,366.0	215	14.1	617.9	949.0
5	949.0	91	10.3	352.7	677.0
6	677.0	47	7.9	162.1	554.0
7	554.0	19	6.9	170.1	396.0
8	396.0	11	5.3	78.7	323.0
9	323.0	8	4.7	77.3	249.0
10	249.0	5	3.9	41.1	209.0
11	209.0	4	3.5	12.5	196.9
12	196.9	3	3.6	9.8	186.5
13	186.5	3	3.6	8.4	177.5
14	177.5	3	3.7	7.1	169.7
15	169.7	3	3.8	5.9	162.9
16	162.9	2	3.9	4.9	156.1
17	156.1	2	4.0	3.9	150.2
18	150.2	1	4.2	3.0	144.0
19	144.0	1	4.3	2.2	138.5
20	138.5	0	4.4	1.4	132.8
21	132.8	0	4.5	0.0	128.2
22	128.2	0	4.7	0.0	123.6
23	123.6	0	4.8	0.0	118.7
24	118.7	0	4.9	0.0	113.8
25	113.8	0	5.1	0.0	108.8

ity" by William R. Gillam [6] and "Review of Report of Committee on Mortality for Disabled Lives" by Gary G. Venter, Barbara Schill, and Jack Barnett [7]). It is quite possible that permanently disabled workers receive better medical care, on average, than nondisabled people, helping to close a gap in mortality rates that would otherwise exist.

TABLE 3.5

INDICATED PAID FACTORS TO ULTIMATE

End of Year of Development	With 9% Inflation	Without Inflation	Ratio of 9% Inflation Reserve to Zero Inflation Reserve
10	2.684	1.152	11.1
15	2.469	1.110	13.4
25	2.019	1.054	18.9
35	1.594	1.022	27.0
50	1.192	1.003	64.0

The paid factors to ultimate in the last column of Table 3.2 above are exceptionally sensitive to future rates of claim inflation. Table 3.5 provides a comparison of the indicated tail factors with and without inflation at various representative ages of development.

An example will put the implications of Table 3.5 into practical terms. Suppose a claims adjuster reviews all PD claims open at the end of 25 years of development. For each PD claim, he estimates the medical portion by multiplying current medical payments by an annuity factor that is the life expectancy of the claimant at his or her current age. The ratio of 18.9 in the right column of Table 3.5 is saying is that future medical payments will be 18.9 times the case reserve derived by this method. One might think that the error would decrease the more mature the accident year became, but in actuality the percentage of error dramatically increases at high maturities. In addition, the mortality table used by the claims adjuster may be out of date.

Just as we have modeled the expected PLDF patterns for MPD losses, analogous incurred loss development factor (ILDF) patterns can be estimated if we define total case reserves as the product of the latest year's incremental payments times the average annuity factor for all living PD claimants. This is presented in Table 3.6.

TABLE 3.6

EXPECTED ILDFS IF CASE RESERVES ARE BASED ON ZERO INFLATION ANNUITY FACTORS

DY	# Prior Open	Upward Sum of # Prior Open	Zero Inflation Annuity Factor	Increm. Pd. to Prior Open	Zero Inflation Case Reserve	Cum. Paid	Zero Inflation Case Incurred	ILDF	Incurred Tail
5	949	6,912.6	6.28	7.9	47.1	86.7	133.8	0.9756	2.066
6	677	5,963.6	7.81	6.8	35.8	91.2	127.1	0.9500	2.175
7	554	5,286.6	8.54	6.9	32.8	95.1	127.9	1.0059	2.162
8	396	4,732.6	10.95	7.5	32.7	98.1	130.8	1.0231	2.113
9	323	4,336.6	12.43	8.2	33.0	100.7	133.7	1.0225	2.066
10	249	4,013.6	15.12	9.0	33.8	103.0	136.7	1.0222	2.022
11	209	3,764.6	17.01	8.0	28.6	104.6	133.2	0.9744	2.075
12	196.9	3,555.6	17.05	8.8	29.4	106.4	135.8	1.0193	2.035
13	186.5	3,358.7	17.01	9.5	30.3	108.1	138.4	1.0195	1.996
14	177.5	3,172.1	16.87	10.4	31.2	110.0	141.2	1.0197	1.958
15	169.7	2,994.6	16.65	11.3	32.0	111.9	144.0	1.0199	1.920
16	162.9	2,824.9	16.34	12.4	32.9	113.9	146.8	1.0200	1.882
17	156.1	2,662.0	16.05	13.5	33.8	116.0	149.8	1.0202	1.845
18	150.2	2,505.9	15.69	14.7	34.6	118.2	152.9	1.0203	1.808
19	144.0	2,355.8	15.36	16.0	35.4	120.6	156.0	1.0204	1.772
20	138.5	2,211.8	14.96	17.5	36.2	123.0	159.2	1.0204	1.737
21	132.8	2,073.2	14.62	19.0	36.9	125.5	162.4	1.0205	1.702
22	128.2	1,940.5	14.13	20.7	37.6	128.2	165.7	1.0205	1.668
23	123.6	1,812.2	13.67	22.6	38.2	130.9	169.1	1.0204	1.634
24	118.7	1,688.7	13.22	24.6	38.7	133.9	172.6	1.0203	1.602
25	113.8	1,569.9	12.80	26.9	39.1	136.9	176.0	1.0202	1.570
26	108.8	1,456.1	12.39	29.3	39.4	140.1	179.6	1.0200	1.539
27	103.6	1,347.4	12.00	31.9	39.7	143.4	183.1	1.0198	1.509
28	98.4	1,243.8	11.64	34.8	39.8	146.8	186.7	1.0195	1.481
29	93.2	1,145.4	11.29	37.9	39.9	150.4	190.3	1.0192	1.453
30	88.0	1,052.2	10.96	41.3	39.8	154.0	193.8	1.0189	1.426
31	82.8	964.2	10.65	45.0	39.7	157.7	197.4	1.0185	1.400
32	77.6	881.5	10.36	49.1	39.5	161.5	201.0	1.0181	1.375
33	72.5	803.9	10.08	53.5	39.1	165.4	204.6	1.0177	1.351
34	67.6	731.3	9.82	58.3	38.7	169.4	208.1	1.0172	1.328
35	62.8	663.7	9.57	63.6	38.2	173.4	211.6	1.0167	1.306
36	58.2	600.9	9.33	69.3	37.6	177.4	215.0	1.0163	1.286
37	53.7	542.8	9.11	75.5	36.9	181.4	218.4	1.0157	1.266
38	49.5	489.0	8.89	82.3	36.2	185.5	221.7	1.0152	1.247
39	45.4	439.6	8.68	89.7	35.4	189.6	225.0	1.0147	1.229
40	41.6	394.2	8.48	97.8	34.5	193.7	228.1	1.0142	1.211

41	38.0	352.6	8.28	106.6	33.5	197.7	231.3	1.0136	1.195
42	34.6	314.6	8.08	116.2	32.5	201.7	234.3	1.0131	1.180
43	31.5	279.9	7.89	126.7	31.5	205.7	237.2	1.0125	1.165
44	28.5	248.5	7.71	138.1	30.4	209.7	240.0	1.0119	1.151
45	25.8	219.9	7.52	150.5	29.2	213.6	242.8	1.0114	1.138
46	23.3	194.1	7.33	164.0	28.0	217.4	245.4	1.0108	1.126
47	21.0	170.8	7.15	178.8	26.8	221.1	247.9	1.0103	1.115
48	18.8	149.9	6.97	194.9	25.5	224.8	250.3	1.0097	1.104
49	16.8	131.0	6.78	212.4	24.3	228.4	252.6	1.0092	1.094
50	15.0	114.2	6.60	231.6	23.0	231.8	254.8	1.0086	1.085

A review of this table reveals the following:

- Although there are ILDFs less than 1.0 for the fifth, sixth, and 11th development years, subsequent factors become noticeably greater than 1.0, even up through the 50th year of development, and beyond.
- Incurred loss development factors are expected to increase during each development year from the 12th through the 21st years.
- The rate of decrease in ILDFs after the 21st development year is surprisingly small, resulting in very large incurred tails for nearly all ages.

This example raises major concerns about the practice of estimating the paid tail by taking the ratio of incurred (perhaps with some modest upward adjustment) to paid at the most mature development year. If case reserves do not include any provision for future medical inflation, then reported incurred at each given DY should be multiplied by the corresponding incurred tail factor shown in the last column of Table 3.6 before the ratio of incurred to paid is applied to paid losses for the most mature years. At DY 10, the incurred tail factor is 2.022. Even at DY 30, an incurred factor of 1.426 is needed. Obviously, to the extent that case reserves include a realistic provision for escalation of future medical costs, the above indicated incurred tail factors would be reduced.

TABLE 4.1

LIFE EXPECTANCIES AT DIFFERENT AGES FOR MALES BASED ON SOCIAL SECURITY ADMINISTRATION MORTALITY TABLES

Current Age	1960	1980	2000	*2020*	*2040*	*2060*	*2080*
20	49.7	51.7	54.7	*56.8*	*58.7*	*60.3*	*61.8*
40	31.3	33.5	36.2	*38.1*	*39.8*	*41.4*	*42.7*
60	15.9	17.3	19.3	*20.8*	*22.2*	*23.4*	*24.6*
80	6.0	6.8	7.2	*7.8*	*8.6*	*9.4*	*10.1*

Note: Projections are in italics.

TABLE 4.2

PERCENTAGE INCREASE IN MALE LIFE EXPECTANCIES BASED ON SOCIAL SECURITY ADMINISTRATION MORTALITY TABLES

Current Age	1980 1960	2000 1980	*2020* *2000*	*2040* *2020*	*2060* *2040*	*2080* *2060*
20	4.2	5.8	*3.7*	*3.3*	*2.8*	*2.5*
40	7.0	8.2	*5.2*	*4.5*	*3.8*	*3.3*
60	9.1	11.7	*7.6*	*6.6*	*5.6*	*4.9*
80	11.9	6.5	*8.7*	*10.0*	*8.6*	*7.6*

4. MORTALITY IMPROVEMENT

Life expectancies have been increasing steadily and noticeably for at least the past several decades and are expected to continue to increase throughout the next century, if not beyond.

Consider these trends in life expectancies that have occurred over past decades, and those projected by the SSA. Table 4.1 presents male life expectancies, since a high percentage of permanently disabled claimants are male. Table 4.2 displays the percentage increases in life expectancy corresponding to the estimates in Table 4.1.

Typically, PD claimants receive a percentage of replacement wages until their retirement age, and coverage for their medical expenses related to their work injuries is paid until they die. Since medical expenses are expected to continue rising at high rates of inflation, coverage of such expenses significantly compounds the effects of expected increases in life expectancies.

Consequently, the difference between MPD reserves calculated using constant recent mortality rates and those calculated with trended mortality rates is substantial. The latter calculations are unusually complex. They can best be measured and understood with the aid of a heuristic model.

While the effects of declining mortality rates on gross MPD reserves are almost undetectable over the short run, their magnitude over future decades is quite substantial. However, the extent of these effects is negligible on net MPD when retentions are relatively low. The effect is also fairly small for indemnity loss reserves for permanently disabled claimants.

5. THE TRENDED MORTALITY MODEL

This method is similar to the static mortality model adaptation of the incremental paid to prior open claim method described in Section 3 and Appendix C. The key difference is that the change in the number of open claims for every future development year of every AY is determined by applying mortality tables forecasted by the SSA for the appropriate future development year. The rest of the method is essentially unchanged. A sample of these differences is provided in Table 5.1 for every fifth DY of AY 2002.

As is evident in Table 5.1, small improvements in the annual survival rate of remaining claimants result in major differences in the number of claims still open at higher development years. Given that the greatest differences occur during development years in the distant future, when the effects of medical inflation have had an opportunity to compound over decades, the total

TABLE 5.1

COMPARISON OF MORTALITY RATES AND CLAIMS OPEN AT DIFFERENT DEVELOPMENT YEARS FOR ACCIDENT YEAR 2002

	Mortality Table Assumed		Group Survival Rate		Claims Open at Prior Year-End		% Greater Open
DY	Static	Trended	Static	Trended	Static	Trended	Claims
30	2000	2031	0.941	0.946	88.0	91.5	4.0
35	2000	2036	0.926	0.933	62.8	67.4	7.3
40	2000	2041	0.914	0.922	41.6	46.5	11.7
45	2000	2046	0.902	0.912	25.8	30.3	17.3
50	2000	2051	0.890	0.902	15.0	18.7	24.2
55	2000	2056	0.875	0.889	8.1	10.8	33.3
60	2000	2061	0.853	0.872	3.99	5.82	46.1
65	2000	2066	0.821	0.846	1.68	2.78	65.4
70	2000	2071	0.772	0.811	0.560	1.11	98.9
75	2000	2076	0.709	0.767	0.131	0.351	167.9
80	2000	2081	0.637	0.719	0.019	0.082	329.8
85	2000	2086	0.545	0.716	0.002	0.018	1086.8

reserve indicated by the trended mortality method is decidedly greater than that indicated by the static mortality method.

To fully present the projections of the trended mortality model would require the display of arrays consisting of 37 rows and about 90 columns, with the rows representing accident years and the columns years of development. Since this would be unwieldy, summary arrays will be presented in which data for every fifth accident year are shown at the end of every fifth development year. An example is given in Table 5.2.

Table 5.2 shows the calendar year mortality table that should be used in determining the probability of continuation of a claim for each AY-DY combination. If a current table (e.g., 2000) is used, differences between the static and trended mortality rates will increase the further the year of the appropriate mortality table is from CY 2000.

What effects will the above trends in mortality have on MPD loss reserves? It is not hard to foresee the general effects. Per-

TABLE 5.2

SAMPLE LAYOUT OF SUMMARIZED RESULTS
CALENDAR YEAR OF PAYMENTS—FOR EVERY FIFTH ACCIDENT YEAR AT EVERY FIFTH DEVELOPMENT YEAR

	Development Year															
AY	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
1970	1974	1979	1984	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049
1975	1979	1984	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054
1980	1984	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059
1985	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064
1990	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069
1995	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069	2074
2000	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069	2074	2079

manent disability claimants for more recent accident years are expected to live longer than their counterparts from old accident years. This is a direct consequence of declining mortality rates. As a result, a higher percentage of PD claimants will still be alive at any given age of development. Therefore, the percentage of claims closed will decline at any given age, and thus simple paid loss development projections will need to be adjusted upward to reflect these declines in claims disposal ratios. Hence, tail factors that reflect the effects of declining mortality rates must increase over successive accident years *for every possible development age*.

While the general effects of anticipated future mortality trends are easy to grasp, the best way to quantify these effects is to construct a heuristic model designed to isolate the effects of mortality trends on PLDFs and paid tails. The trended mortality model we have constructed is such that

- The only thing that changes over time is mortality rates, as historically compiled and as officially forecasted by the SSA.
- Medical inflation is a constant 9% per year, both historically and prospectively. Support for this assumption is provided in Section C.4 of Appendix C.

- The number of ultimate reported claims for every accident year, from 1966 through 2002, is held at a constant level of 5,000 per year.
- Claim reporting and closure patterns for SAIF's PD claimants over the past 10 calendar years served as the basis for these key assumptions in order to make the model as realistic as possible.

By designing a model where claimant mortality rates are the only thing that changes from accident year to accident year, the effects of mortality trends can be clearly seen. Details of the model are presented in Appendices C and D.

Projections of the number of open claims were derived from the heuristic model for each accident year from 1966 through 2002 at the end of every development year from the first to the 80th. As noted above, each accident year was assumed to have 5,000 ultimate reported claims. Claim closure patterns, for reasons other than death of the claimant, were held constant for all accident years. The only thing that varied from accident year to accident year in the model was the number of claims closed due to death. In this way the effects of mortality trends on the number of open claims at the end of each development year for each accident year can be isolated.

What is evident from the summarized results presented in Table 5.3 is that the expected number of open claims at any given year of development will slowly increase as one moves from the oldest accident years to the most recent.

For example, at the end of 35 years of development, the number of open claims is expected to increase from 50 for accident year 1970 to 62 for accident year 2000. This is an increase of 24% in the number of open claims. And at the end of 60 years of development, the number of open claims is expected to increase from 3.5 to 5.0, an increase of 42.9%. The percentage rate of increase in the number of open claims for each given column

TABLE 5.3

Number of Open Claims for Representative Accident Years at Five-Year Intervals of Development

	End of Development Year															
AY	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
1970	653	196	149	119	95	71	50	33	21	12	6.9	3.5	1.5	0.5	0.1	0.02
1975	655	197	150	120	97	73	52	34	22	13	7.2	3.7	1.6	0.6	0.1	0.03
1980	659	200	153	123	100	76	54	36	23	14	7.7	3.9	1.7	0.6	0.2	0.03
1985	662	202	156	126	103	79	56	38	24	14	8.1	4.2	1.9	0.7	0.2	0.04
1990	665	204	158	128	105	81	58	39	25	15	8.5	4.4	2.0	0.7	0.2	0.04
1995	668	206	160	130	108	83	60	41	26	16	9.0	4.7	2.1	0.8	0.2	0.05
2000	670	207	161	132	110	86	62	42	27	17	9.5	5.0	2.3	0.9	0.3	0.06

TABLE 5.4

Percentage Increases in the Number of Open Claims at the End of Representative Development Years—from Accident Year 1970 to Accident Year 2000

End of Development Year															
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
2.6	5.6	8.3	11.6	15.6	19.8	23.9	27.4	30.3	33.5	37.5	43.7	54.3	73.2	106.8	164.5

increases as one moves from the earlier development years on the left to the later development years on the right. This is due to the compounding effect of expected declines in future mortality rates. Table 5.4 displays the total percentage increase for each development year column.

Since the number of open claims at any given development year will be increasing steadily over successive accident years, the total proportion of ultimate losses paid through that development year will decline slightly over time. Because of this we would naturally expect that the appropriate tail factors at any given development year will also increase steadily over time. The projected results are displayed in Table 5.5.

TABLE 5.5

INDICATED TAIL FACTORS

	End of Development Year															
AY	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
1970	3.037	2.570	2.375	2.177	1.973	1.773	1.592	1.438	1.311	1.210	1.132	1.075	1.037	1.015	1.004	1.001
1975	3.108	2.628	2.428	2.223	2.012	1.805	1.617	1.456	1.325	1.220	1.139	1.080	1.040	1.016	1.005	1.001
1980	3.197	2.701	2.492	2.279	2.058	1.842	1.645	1.477	1.340	1.231	1.146	1.085	1.043	1.018	1.006	1.001
1985	3.286	2.774	2.558	2.336	2.106	1.879	1.674	1.499	1.356	1.242	1.154	1.090	1.046	1.020	1.007	1.002
1990	3.376	2.848	2.624	2.393	2.154	1.918	1.704	1.521	1.372	1.253	1.162	1.095	1.049	1.021	1.007	1.002
1995	3.466	2.921	2.690	2.451	2.203	1.957	1.733	1.543	1.388	1.265	1.170	1.101	1.053	1.023	1.008	1.002
2000	3.549	2.990	2.752	2.505	2.248	1.993	1.761	1.563	1.402	1.275	1.177	1.105	1.054	1.023	1.008	1.002

TABLE 5.6

INDICATED PERCENTAGE UNDERSTATEMENT IN AY 2000 LOSS RESERVES (IF BASED ON AY 1970 TAIL FACTORS)

End of Development Year															
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
25	27	27	28	28	28	28	29	29	31	34	39	47	59	85	102

Table 5.6 displays the percentage understatement in AY 2000 loss reserves at different development ages, if such reserves were based on AY 1970 tail factors. It clearly indicates that the use of constant tail factors will result in material inadequacies in the indicated loss reserves.

The trended mortality model also indicates that incremental PLDFs at any given maturity will trend upward over time. In Table 5.7, five-year paid loss development factors, each of which are the cumulative products of five successive one-year paid loss development factors, inch upward over time within any given development column.

Table 5.7 rebuts the conjecture that the paid loss development factors for earlier (as well as middle) development years will hold constant over successive accident years. However, it is also evident that the rate of increase in these paid development factors

TABLE 5.7

TRENDS IN FIVE-YEAR PAID LOSS DEVELOPMENT FACTORS

	Development Years															
AY	10/5	15/10	20/15	25/20	30/25	35/30	40/35	45/40	50/45	55/50	60/55	65/60	70/65	75/70	80/75	85/80
1970	1.182	1.082	1.091	1.103	1.113	1.114	1.107	1.097	1.084	1.069	1.053	1.037	1.022	1.010	1.004	1.001
1975	1.183	1.083	1.092	1.105	1.115	1.116	1.110	1.099	1.086	1.071	1.055	1.039	1.023	1.011	1.004	1.001
1980	1.184	1.084	1.094	1.107	1.118	1.119	1.114	1.103	1.089	1.073	1.057	1.040	1.024	1.012	1.004	1.001
1985	1.185	1.084	1.095	1.109	1.120	1.123	1.117	1.106	1.092	1.076	1.059	1.042	1.026	1.013	1.005	1.002
1990	1.186	1.085	1.096	1.111	1.123	1.126	1.120	1.109	1.094	1.078	1.061	1.044	1.027	1.014	1.005	1.002
1995	1.186	1.086	1.097	1.113	1.126	1.129	1.123	1.112	1.097	1.081	1.063	1.046	1.029	1.015	1.006	1.002
2000	1.187	1.087	1.098	1.114	1.128	1.132	1.126	1.115	1.100	1.083	1.065	1.048	1.030	1.015	1.006	1.002

TABLE 5.8

PLDFS FACTORS INDICATED BY THE TRENDED MORTALITY MODEL DURING EARLY YEARS OF DEVELOPMENT

	Years of Development										
AY	2	3	4	5	6	7	8	9	10	11	12
1990	6.81875	1.59471	1.16775	1.09383	1.05240	1.04154	1.03101	1.02670	1.02182	1.01604	1.01618
1991	6.81875	1.59488	1.16781	1.09387	1.05243	1.04157	1.03104	1.02673	1.02185	1.01607	1.01621
1992	6.81875	1.59505	1.16786	1.09392	1.05246	1.04160	1.03107	1.02676	1.02187	1.01609	1.01623
1993	6.81875	1.59522	1.16792	1.09396	1.05250	1.04163	1.03110	1.02679	1.02190	1.01611	1.01625
1994	6.81875	1.59539	1.16797	1.09400	1.05253	1.04166	1.03113	1.02681	1.02192	1.01613	1.01628
1995	6.81875	1.59557	1.16803	1.09405	1.05256	1.04169	1.03115	1.02684	1.02195	1.01615	1.01630
1996	6.81875	1.59571	1.16807	1.09408	1.05259	1.04172	1.03118	1.02686	1.02197	1.01617	1.01632
1997	6.81875	1.59586	1.16812	1.09412	1.05261	1.04174	1.03120	1.02688	1.02199	1.01618	1.01634
1998	6.81875	1.59601	1.16816	1.09415	1.05263	1.04176	1.03122	1.02691	1.02201	1.01620	1.01636
1999	6.81875	1.59616	1.16821	1.09419	1.05266	1.04179	1.03124	1.02693	1.02203	1.01622	1.01638
2000	6.81875	1.59631	1.16825	1.09422	1.05268	1.04181	1.03126	1.02695	1.02205	1.01623	1.01639
2001	6.81875	1.59647	1.16830	1.09426	1.05271	1.04184	1.03129	1.02697	1.02208	1.01625	1.01642
2002	6.81875	1.59662	1.16835	1.09430	1.05273	1.04186	1.03131	1.02699	1.02210	1.01627	1.01644

is small. It is small enough that it would not be detectable to an experienced actuary reviewing historical PLDFs. This becomes even more evident if we look at different sections of the typical triangle of paid loss development factors that are generated by the trended mortality model.

In Table 5.8 the individual PLDFs generated by the model are displayed for AYs 1990–2002 for the earliest development years.

TABLE 5.9

PLDFs Indicated by the Trended Mortality Model During Later Years of Development

	Year of Development										
AY	27	28	29	30	31	32	33	34	35	36	37
1966	1.02103	1.02124	1.02139	1.02147	1.02149	1.02146	1.02136	1.02121	1.02101	1.02077	1.02049
1967	1.02112	1.02134	1.02149	1.02157	1.02160	1.02156	1.02147	1.02132	1.02113	1.02088	1.02060
1968	1.02121	1.02143	1.02159	1.02168	1.02170	1.02167	1.02158	1.02143	1.02124	1.02100	1.02072
1969	1.02130	1.02153	1.02168	1.02178	1.02181	1.02178	1.02169	1.02154	1.02135	1.02111	1.02083
1970	1.02140	1.02163	1.02179	1.02189	1.02192	1.02189	1.02180	**1.02166**	1.02147	1.02123	1.02095
1971	1.02148	1.02171	1.02187	1.02198	1.02201	1.02199	1.02190	1.02176	1.02157	1.02133	1.02106
1972	1.02155	1.02179	1.02196	1.02207	1.02211	1.02209	1.02200	1.02187	1.02168	1.02144	1.02116
1973	1.02163	1.02187	1.02205	1.02216	1.02220	1.02218	1.02211	1.02197	1.02178	1.02155	1.02127
1974	1.02170	1.02195	1.02213	1.02225	1.02230	1.02228	1.02221	1.02208	1.02189	1.02165	1.02138
1975	1.02178	1.02203	1.02222	1.02234	1.02239	1.02238	1.02231	**1.02218**	1.02200	1.02176	1.02148
1976	1.02188	1.02214	1.02233	1.02245	1.02250	1.02250	1.02243	1.02230	1.02211	1.02188	1.02160
1977	1.02199	1.02225	1.02244	1.02256	1.02262	1.02261	1.02254	1.02241	1.02223	1.02200	1.02172

The constant PLDFs in the column for DY 2 merely reflect a simplifying assumption in the model.

In Table 5.9 individual PLDFs generated by the model are displayed for accident years 1966–1977 for the most mature historical development years. Projected PLDFs for the short-term future are also shown below the diagonal.

Table 5.10 provides an example of the kinds of errors in estimating future incremental payments that can occur when it is assumed that PLDFs for each year of development hold constant. First, a PLDF of 1.02138 is selected as the average of the latest four historical factors during the 34th year of development (the boxed items in Table 5.9). By comparing this selection with the true underlying trended PLDF, the percentage error in incremental payments for that development year is shown for every fifth AY. These errors assume, however, that other similar errors did not occur during preceding development years.

Though all of the errors above are small, these errors compound significantly in the calculation of tail factors, which are the product of numerous individual PLDFs.

TABLE 5.10

ERRORS IN PLDFS DURING 34TH YEAR OF DEVELOPMENT DUE TO SELECTING A CONSTANT HISTORICAL AVERAGE PLDF

Accident Year	Selected PLDF	True Underlying PLDF	% Error in Incremental Payments
1970	1.02138	**1.02166**	−1.3
1975	1.02138	**1.02218**	−3.6
1980	1.02138	1.02276	−6.1
1985	1.02138	1.02336	−8.5
1990	1.02138	1.02395	−10.7
1995	1.02138	1.02452	−12.8
2000	1.02138	1.02507	−14.7

TABLE 6.1

A COMPARISON OF INDICATED MPD TAIL FACTORS

Maturity (Years)	Based on SAIF's Experience	Based on Static Mortality Model	Based on Trended Mortality Model
10	2.469	2.684	3.025
15	2.328	2.469	2.783
25	2.054	2.019	2.271
35	1.680	1.594	1.776

Even though it is true that past declines in mortality rates are implicitly embedded in historical PLDFs, the above example clearly illustrates that it would be incorrect to assume that the selection of historical factors as estimates of future PLDFs would implicitly incorporate the effects of future declines in mortality rates. What would be more appropriate would be to select representative PLDFs for each development year based on recent historical factors and then to trend these upward in a manner parallel to the PLDFs indicated by a realistic model.

6. A COMPARISON OF INDICATED TAIL FACTORS

Table 6.1 provides a comparison of the MPD tails indicated by SAIF's own loss experience with those indicated by the static

TABLE 6.2

INDICATED LOSS RESERVE AT DIFFERENT MATURITIES (DOLLARS IN MILLIONS)

Maturity (Years)	MPD Reserve	Other Workers Compensation Reserve	MPD Reserve as a Percentage of Total Workers Compensation Reserve
10	$41.3	$10.4	80
15	39.6	9.5	81
25	34.6	5.7	86
35	27.0	2.5	92

and trended mortality methods. This table repeats the MPD tails indicated by SAIF's experience in Table 2.4.

As noted earlier, the indications of the static mortality model reasonably fit those from SAIF's historical loss experience, except that the model somewhat understates development for DYs 40–54.

The relative contribution of MPD versus all other workers compensation to the total loss reserves for a given AY is much greater if the trended mortality model is assumed. Those percentages at various maturities are shown in the last column of Table 6.2.

The above table is analogous to Table 2.5, which shows results based on SAIF's historical loss experience. In deriving these estimates, total AY ultimate losses of $100 million were assumed, together with a 50–50 split between MPD and other workers compensation. However, the $50 million figure for ultimate MPD was changed to the product of cumulative paid MPD at 10 years of development and the 10 to ultimate tail factor from the trended mortality model. That increased ultimate MPD to $61.75 million.

Table 6.3 provides a side-by-side comparison of the percentages of the total workers compensation loss reserve attributable to MPD, as estimated using historical PLDFs and PLDFs indicated by the trended mortality model.

TABLE 6.3

COMPARISON OF MPD LOSS RESERVE AS A PERCENTAGE OF THE TOTAL WORKERS COMPENSATION LOSS RESERVE (BASED ON DIFFERENT PLDF ASSUMPTIONS; DOLLARS IN MILLIONS)

Maturity (Years)	Indicated by Historical PLDFs	Indicated by Trended Mortality PLDFs	Percentage Increase in MPD Reserve Due to Using Trended Mortality Rates
10	$29.6	$41.3	+39.7
15	28.3	39.6	+39.6
25	25.5	34.6	+35.8
35	20.0	27.0	+34.9

Clearly, the trended mortality model indicates MPD loss reserves that are significantly larger than straight historical experience would indicate.

7. SENSITIVITY CONSIDERATIONS

The most significant factor affecting the indications in this paper is the applicable retention. This paper presents indications on an unlimited basis. Tail factors and PLDFs at more mature years of development should be expected to be significantly less at relatively low retentions. This is evident on an a priori basis.

Consider a hypothetical PD claimant injured on December 15, 2003, at age 35.9 years, with a life expectancy of 40 years. His medical costs are $5,000 during 2004, and future medical inflation is 9% per year. Indemnity losses are a flat $25,000 per year, beginning in 2004. Table 7.1 indicates the total cumulative loss payments at the end of each of the first 41 years of development.

For this hypothetical PD claimant, net paid losses would top out by the end of the ninth year of development with a retention of $250,000; after 16 years with a $500,000 retention; after 26 years with a $1 million retention; and after 37 years with a $2 million retention.

TABLE 7.1

CUMULATIVE LOSS PAYMENTS FOR HYPOTHETICAL PD CLAIMANT

(A) Age of Claimant	(B) DY	(C) Incremental Medical Payments	(D) Cumulative Medical Payments	(E) Cumulative Indemnity Payments	(F) Cumulative Loss Payments	
35	1	0.0	0.0	0.0	0.0	
36	2	5.0	5.0	25.0	30.0	
37	3	5.5	10.5	50.0	60.5	
38	4	5.9	16.4	75.0	91.4	
39	5	6.5	22.9	100.0	122.9	
40	6	7.1	29.9	125.0	154.9	
41	7	7.7	37.6	150.0	187.6	
42	8	8.4	46.0	175.0	221.0	
43	9	9.1	55.1	200.0	255.1	
44	10	10.0	65.1	225.0	290.1	(a)
45	11	10.9	76.0	250.0	326.0	
46	12	11.8	87.8	275.0	362.8	
47	13	12.9	100.7	300.0	400.7	
48	14	14.1	114.8	325.0	439.8	
49	15	15.3	130.1	350.0	480.1	
50	16	16.7	146.8	375.0	521.8	(b)
51	17	18.2	165.0	400.0	565.0	
52	18	19.9	184.9	425.0	609.9	
53	19	21.6	206.5	450.0	656.5	
54	20	23.6	230.1	475.0	705.1	
55	21	25.7	255.8	500.0	755.8	
56	22	28.0	283.8	525.0	808.8	
57	23	30.5	314.4	550.0	864.4	
58	24	33.3	347.7	575.0	922.7	
59	25	36.3	383.9	600.0	983.9	
60	26	39.6	423.5	625.0	1,048.5	(c)
61	27	43.1	466.6	650.0	1,116.6	
62	28	47.0	513.6	675.0	1,188.6	
63	29	51.2	564.8	700.0	1,264.8	
64	30	55.8	620.7	725.0	1,345.7	
65	31	60.9	681.5	750.0	1,431.5	
66	32	66.3	747.9	775.0	1,522.9	
67	33	72.3	820.2	800.0	1,620.2	
68	34	78.8	899.0	825.0	1,724.0	
69	35	85.9	984.9	850.0	1,834.9	
70	36	93.6	1,078.6	875.0	1,953.6	
71	37	102.1	1,180.6	900.0	2,080.6	(d)

Note: (a) Development stops if return is \$250K. (b) Development stops if return is \$500K. (c) Development stops if return is \$1M. (d) Development stops if return is \$2M.

While this dampening effect of retentions can obviously serve to greatly mitigate the magnitude of the applicable tail factors for different insurers and self-insureds, this effect can rapidly dissipate when retentions rise significantly from year to year. It is quite common for insurers as well as self-insureds to significantly increase retentions when faced with costs for excess coverage that have risen substantially as the market has hardened. The effect of recognizing the upward impact greater retentions will have on assumed tails can be sizable.

Other factors that can have a material impact on MPD tail factors are the following:

- The assumed future rate of medical cost escalation.
- The observed tendency of medical losses to step up noticeably as an increasing proportion of claimants become elderly.
- The possibility that actual mortality rates of PD claimants might be higher (or lower) than those for the general populace.
- Variations in the gender mix and age-at-injury mix of PD claimants.

An entire paper could be devoted to quantifying the effects that changes in any or all of the above factors would have on indicated tail factors. Of the above factors, the first two are the most significant. While some believe that the long-term future rate of medical cost escalation will be less than the historical rate of 9%, others believe a constant 9% assumption is reasonable. Arguably, the differential between medical inflation and general inflation may lessen over future decades. However, workers compensation medical costs are a very small portion of total health costs, so a workers compensation medical escalation rate of 9% could continue for a very long period of time without having much effect on the overall medical CPI or GNP. Furthermore, long-term general inflation may move upward as a result of shortages in critical commodities (such as petroleum) and their ubiquitous derivative products (e.g., plastics and synthetics).

We note that SAIF's actual age-at-injury distribution is weighted heavily toward the middle-age groups. If a much younger distribution were assumed, this would dramatically increase the survival probabilities during each year of development, and the resulting tails would be considerably greater than those presented in this paper. The age-at-injury distribution can vary significantly depending on statutory provisions for qualification for a permanent disability award and the nature of the risks insured or self-insured.

In the static mortality model, we started with the assumption of a beginning gender mix of 75% male and 25% female. Because of the higher mortality rates of males at all ages, by the 50th year of development, the percentage of surviving claimants that are male is expected to drop to 64.5%. By the 72nd year of development, a 50–50 gender split is expected.

The magnitude of the elder care cost bulge is quite significant. It fully accounts for the large degree to which SAIF's actual MPD PLDFs exceed those indicated by the static mortality model during later DYs (see Figure 1.2).

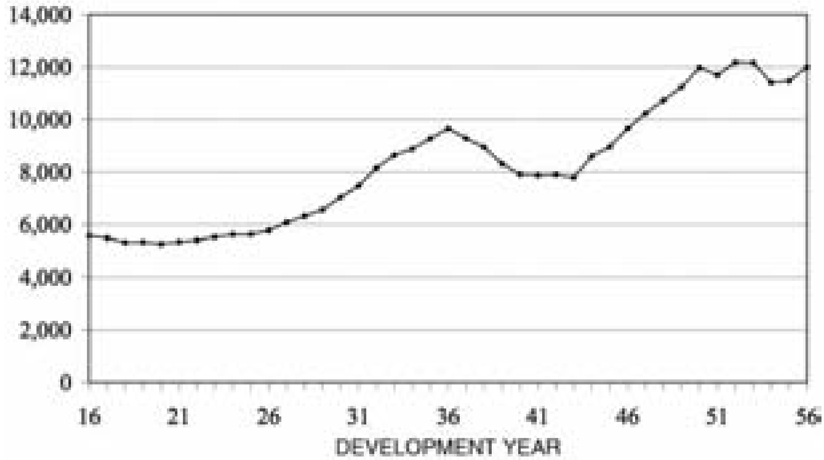
Figure 7.1 provides documentation of the extent of increases in SAIF's incremental paid medical costs per open claim at a constant 2003 cost level for DYs 16–56. If the common actuarial assumption that incremental medical severities are independent of the age of the claimant were true, then the graph line in Figure 7.1 would be essentially flat, since all severities have been placed on a constant 2003 cost level.

The above average costs at 2003 cost level were for AY 1945 and subsequent accident years during CYs 1991–2003. Table E.1, Appendix E provides a summary of the detailed data supporting Figure 7.1.

The implications of Figure 7.1 are serious with respect to the reasonableness of the practice of estimating MPD reserves by

FIGURE 7.1

INCREMENTAL PAID SEVERITY (AT 2003 COST LEVEL)



inflating current annual medical costs for each claim at normal rates of medical cost escalation until the expected year of death. In doing so, the actuary would be assuming, on average for all claims open during DYs 10–20, that an annual severity at a 2003 cost level of approximately $6,000 per year would be appropriate for all future years, regardless of how old the claimant becomes. Figure 7.1 indicates that as each claimant advances into his or her 70s or 80s, a significantly higher assumed severity at a 2003 cost level would be more appropriate.

8. ESTIMATING THE EXPECTED VALUE OF MPD RESERVES

In Tables 8.1A and 8.1B cumulative loss payments for a hypothetical PD claimant are displayed. This might be a profile of paid losses for a male claimant injured on December 15, the reserve evaluation date. At age 35.9, the claimant is expected to live another 40 years. Two different methods of estimating the *medical case reserve* for this claimant at the end of the first year of development are common. They are the following:

1. *Zero Inflation Case Reserve Based on Projected Payments Through Expected Year of Death.* Estimated annual medical expenses of $5,000 per year (during the first full year of development) are multiplied by the life expectancy of 40 years to obtain a case reserve of $200,000.

2. *Inflation Case Reserve (9%) Based on Projected Payments Through Expected Year of Death.* Escalating medical expenses are cumulated up through age 75, yielding a total incurred amount of $1,689,000.

Two additional methods may also be applied. Each of these produces much higher, and more accurate, estimates of the expected value of the case reserve:

3. *Expected Total Payout over Scenarios of All Possible Years of Death.* This method, described below, yields an expected reserve of $2,879,000.

4. *Expected Value of Trials from a Markov Chain Simulation.* This method, described in Section 9, yields an expected reserve of $2,854,000.

In applying the third method, cumulative payments are calculated through each possible future year of death. Each of these estimates represents the scenario of the claimant's death during a specific *n*th year of development. The probability of occurrence of the *n*th scenario is the product of the probability the claimant will live through all prior years of development and then die during the *n*th year of development. The expected value of the case reserve is then the weighted average of all of these estimates of final cumulative payments, weighted by their associated probability of occurrence. In this example, the expected value of total incurred is $2,879,000, which is 70.5% higher than the second estimate. This kind of estimate is often not calculated by self-insureds or insurers who have only a few PD claimants. Yet it is

TABLE 8.1A

Calculation of Case Reserve by Second and Third Methods (Age 36 through 88)

Male Claimant, Age 35.9 at Reserve Date, 9% Future Inflation Assumed

Age	(A) $l(x)$	(B) $d(x)$	(C) Probability of Dying at Age x (B)/(A)@36	(D) Cumulative Probability of Dying at Age x	(E) Incremental Medical Paid (in millions of dollars)	(F) Cumulative Medical Paid (in millions of dollars)	(G) Expected Total Payout (C) × (F) (in millions of dollars)	(H) Cumulative Expected Total Payout (in millions of dollars)	(I) % of Expected Total Payout
36	96023	198	0.00206	0.206%	5	5	0.01	0.01	0.000
37	95825	209	0.00218	0.424%	5	10	0.02	0.03	0.001
38	95616	225	0.00234	0.658%	6	16	0.04	0.07	0.003
39	95391	241	0.00251	0.909%	6	23	0.06	0.13	0.005
40	95150	260	0.00271	1.180%	7	30	0.08	0.21	0.007
41	94890	279	0.00291	1.470%	8	38	0.11	0.32	0.011
42	94611	300	0.00312	1.783%	8	46	0.14	0.46	0.016
43	94311	321	0.00334	2.117%	9	55	0.18	0.65	0.023
44	93990	343	0.00357	2.474%	10	65	0.23	0.9	0.031
45	93647	368	0.00383	2.858%	11	76	0.29	1.2	0.041
46	93279	395	0.00411	3.269%	12	88	0.36	1.5	0.054
47	92884	422	0.00439	3.708%	13	101	0.44	2.0	0.069
48	92462	448	0.00467	4.175%	14	115	0.54	2.5	0.088
49	92014	477	0.00497	4.672%	15	130	0.65	3.2	0.111
50	91537	508	0.00529	5.201%	17	147	0.78	3.9	0.138
51	91029	544	0.00567	5.767%	18	165	0.9	4.9	0.171
52	90485	583	0.00607	6.375%	20	185	1.1	6.0	0.210
53	89902	629	0.00655	7.030%	22	207	1.4	7.3	0.257
54	89273	679	0.00707	7.737%	24	230	1.6	9	0.314
55	88594	735	0.00765	8.502%	26	256	2.0	11	0.383

56	87859	797	0.00830	9.332%	28	284	2.4	13	0.466
57	87062	865	0.00901	10.233%	31	314	2.8	16	0.565
58	86197	936	0.00975	11.208%	33	348	3.4	20	0.684
59	85261	1014	0.01056	12.264%	36	384	4.1	24	0.826
60	84247	1096	0.01141	13.405%	40	424	4.8	28	0.995
61	83151	1184	0.01233	14.638%	43	467	5.8	34	1.197
62	81967	1287	0.01340	15.978%	47	514	6.9	41	1.438
63	80680	1405	0.01463	17.442%	51	565	8.3	49	1.728
64	79275	1532	0.01595	19.037%	56	621	10	59	2.075
65	77743	1669	0.01738	20.775%	61	682	12	71	2.490
66	76074	1803	0.01878	22.653%	66	748	14	85	2.982
67	74271	1923	0.02003	24.656%	72	820	16	102	3.558
68	72348	2023	0.02107	26.762%	79	899	19	120	4.222
69	70325	2109	0.02196	28.959%	86	985	22	142	4.980
70	68216	2203	0.02294	31.253%	94	1,079	25	167	5.847
71	66013	2305	0.02400	33.653%	102	1,181	28	195	6.840
72	63708	2407	0.02507	36.160%	111	1,292	32	228	7.903
73	61301	2504	0.02608	38.768%	121	1,413	37	264	9.182
74	58797	2603	0.02711	41.479%	132	1,545	42	306	10.637
75	56194	2704	0.02816	44.295%	144	1,689	48	354	12.289
76	53490	2808	0.02924	47.219%	157	1,846	54	408	14.164
77	50682	2915	0.03036	50.255%	171	2,018	61	469	16.292
78	47767	3021	0.03146	53.401%	187	2,204	69	538	18.700
79	44746	3119	0.03248	56.649%	203	2,408	78	617	21.416
80	41627	3199	0.03331	59.980%	222	2,629	88	704	24.458
81	38428	3253	0.03388	63.368%	242	2,871	97	802	27.836
82	35175	3281	0.03417	66.785%	263	3,134	107	909	31.555
83	31894	3276	0.03412	70.197%	287	3,421	117	1,025	35.609
84	28618	3232	0.03366	73.563%	313	3,734	126	1,151	39.974
85	25386	3147	0.03277	76.840%	341	4,075	134	1,285	44.612
86	22239	3020	0.03145	79.985%	372	4,447	140	1,424	49.470
87	19219	2852	0.02970	82.955%	405	4,852	144	1,569	54.475
88	16367	2649	0.02759	85.714%	442	5,294	146	1,715	59.547

TABLE 8.1B

CALCULATION OF CASE RESERVE BY SECOND AND THIRD METHODS (AGE 89 THROUGH 109)

Male Claimant, Age 35.9 at Reserve Date, 9% Future Inflation Assumed

Age	(A) $l(x)$	(B) $d(x)$	(C) Probability of Dying at Age x (B)/(A)@36	(D) Cumulative Probability of Dying at Age x	(E) Incremental Medical Paid (in millions of dollars)	(F) Cumulative Medical Paid (in millions of dollars)	(G) Expected Total Payout (C) × (F) (in millions of dollars)	(H) Cumulative Expected Total Payout (in millions of dollars)	(I) % of Expected Total Payout
89	13718	2414	0.02514	88.228%	481	5,776	145	1,860	64.589
90	11304	2159	0.02248	90.476%	525	6,300	142	2,002	69.509
91	9145	1890	0.01968	92.445%	572	6,873	135	2,137	74.207
92	7255	1619	0.01686	94.131%	624	7,496	126	2,263	78.596
93	5636	1355	0.01411	95.542%	680	8,176	115	2,379	82.603
94	4281	1106	0.01152	96.694%	741	8,916	103	2,481	86.169
95	3175	878	0.00914	97.608%	807	9,724	89	2,570	89.257
96	2297	676	0.00704	98.312%	880	10,604	75	2,645	91.850
97	1621	506	0.00527	98.839%	959	11,563	61	2,706	93.966
98	1115	367	0.00382	99.221%	1,046	12,609	48	2,754	95.639
99	748	258	0.00269	99.490%	1,140	13,749	37	2,791	96.922
100	490	178	0.00185	99.675%	1,242	14,991	28	2,819	97.888
101	312	119	0.00124	99.799%	1,354	16,346	20	2,839	98.591
102	193	77	0.00080	99.879%	1,476	17,822	14	2,853	99.087
103	116	49	0.00051	99.930%	1,609	19,431	10	2,863	99.432
104	67	29	0.00030	99.960%	1,754	21,185	6	2,870	99.654
105	38	18	0.00019	99.979%	1,912	23,096	4	2,874	99.804
106	20	10	0.00010	99.990%	2,084	25,180	3	2,876	99.895
107	10	5	0.00005	99.995%	2,271	27,451	1	2,878	99.945
108	5	4	0.00004	99.999%	2,476	29,927	1	2,879	99.988
109	1	1	0.00001	100.000%	2,698	32,625	0	2,879	100.00

in keeping with the standard definition of the expected value of total incurred.

The total case reserve based on this third approach is dramatically higher than that derived from the second approach because the cumulative paid amounts associated with death at ages beyond the claimant's expected year of death are given more weight, due to the compounding effects of medical cost escalation.

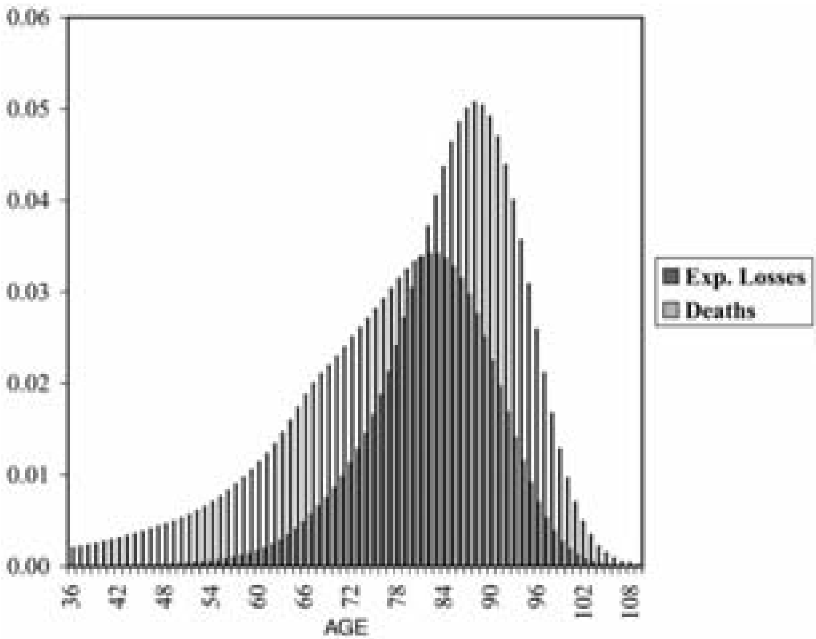
In Tables 8.1A and 8.1B the medical case reserve for the hypothetical PD claimant is calculated for the second and third methods. For the second method, Projected Payments Through Expected Year of Death, the cumulative payments from Column (F) at the end of the expected year of death (at age 75) yields the estimate of $1,689,000.

For the third method, each row is treated as a different scenario, with its probability of occurrence shown in Column (C). These probabilities are the weights applied to the estimates of cumulative medical payments in Column (F) to obtain the components of the expected total payout in Column (G) that are cumulated in Column (H). Hence, the expected value of the case reserve is the bottom number in Column (H) in Table 8.1B ($2,879,000).

The distribution of deaths by age of death (Column (C)) would be the same as the distribution of the different scenarios for the *indemnity* case reserve, since incremental indemnity payments are not generally subject to inflation. Figure 8.1 illustrates the shift in the distribution of the different scenarios for the *medical* case reserve [Column (I) decumulated, or Column (G) divided by Total in Column (H)], due to the effects of compounding medical cost escalation in giving more dollar weight to scenarios where the claimant lives beyond his expected year of death.

FIGURE 8.1

DEATHS AND EXPECTED PAYOUTS BY AGE



The impact of medical cost escalation causes the age corresponding to the median of the distribution of medical payments (87) to exceed the age corresponding to the median of the distribution of the indemnity payments (77) by 10 years. This can be seen by comparing the age corresponding to a cumulative probability of 50% in Column (D) to the age when Column (I) reaches 50% . To further appreciate the significance of this shift, consider the following observations drawn from Table 8.1B:

- While 83% of such claimants die before they reach the age of 87, medical payments to claimants who live beyond 86 years of age account for over half of total expected future medical payments.

- While 90% of such claimants die before they reach the age of 90, medical payments to claimants who live beyond 89 years of age account for over 30% of total expected medical losses.

The ratio of the estimated case reserve based on the second method to that from the first method varies dramatically with the age of the claimant at the reserve date. It is also dependent on gender. This is also true, though to a lesser degree, for the ratio of the third method case reserve to the second method reserve. These ratios are displayed in Table 8.2.

There are a number of reasons to believe that the reserve estimates produced by the static mortality model presented in Section 3 are analogous to estimates produced by the second method. If that is true, then it would be necessary to multiply reserve estimates based on the static mortality model by some weighted average of the ratios in Column (E) of Table 8.2 to arrive at an estimated reserve at the expected level. Whether that ratio is 1.25 or 1.40 or 1.55, it represents a substantial add-on to a reserve estimate that is likely higher than what would be obtained using more traditional methods.

Why are reserve estimates based on the static mortality model similar to those produced by the second method? A fundamental assumption of the model is that all claimants die according to a schedule dictated by current mortality tables. When an expected value of the reserve is calculated, it is based on a weighted average of a full range of scenarios, including those where many claimants die earlier than planned and others die later. Total future payments for those claimants that die later will be given more dollar weight. Hence, the expected value of the reserve will be correspondingly greater than that projected by the static mortality model.

All of the methods presented in this section are based on the common assumption that the current level incremental severities

TABLE 8.2

COMPARISON OF DIFFERENT TYPES OF MPD RESERVE ESTIMATES

Assuming SSA 2000 Male & Female Mortality Tables and 9% Medical Cost Escalation					
	(A)	(B)	(C)	(D)	(E)
	Reserve ($000s) at Eval. Date				
Age at Reserve Date	First Method (Zero Inflation Case Reserve)	Second Method (9% Inflation Case Reserve)	Third Method (Total Expected Future Payout)	Ratio of Second Method Reserve to First Method Reserve	Ratio of Third Method Reserve to Second Method Reserve
	Male Claimants				
20	$273.7	$7,333.9	$11,318.1	26.795	1.543
30	227.3	2,989.5	4,816.3	13.155	1.611
40	181.2	1,321.0	2,042.3	7.290	1.546
50	137.3	590.0	864.0	4.298	1.464
60	96.7	265.3	362.9	2.744	1.368
70	62.9	123.5	153.2	1.965	1.240
80	36.0	57.1	63.4	1.587	1.110
	Female Claimants				
20	$301.0	$10,796.0	$16,724.2	35.867	1.549
30	252.4	4,641.7	7,069.1	18.390	1.523
40	204.7	2,005.7	2,983.6	9.800	1.488
50	158.4	873.8	1,254.5	5.516	1.436
60	115.1	384.3	524.0	3.341	1.363
70	77.0	165.0	217.3	2.144	1.317
80	45.2	76.3	87.2	1.690	1.142

do not increase with the age of the claimant. This was done to simplify the presentation of methods that are already complex. If the tendency of incremental medical severities to increase with age were incorporated into these methods, the differences between the reserves projected by these methods would expand noticeably.

9. ESTIMATING THE VARIABILITY OF THE MPD RESERVE WITH A MARKOV CHAIN SIMULATION

The size of loss distribution for the medical component of a single PD claim is far more skewed to the right than can be modeled by distributions commonly used by casualty actuaries. This distribution can be described by the ultimate costs in Column (F) of Tables 8.1A and 8.1B, with the associated confidence levels taken from Column (D). In attempting to find a distribution that produced a reasonable fit, it was necessary to first transform the ultimate cost amounts by taking the natural log of the natural log of the natural log and then taking the *n*th root before a common distribution could be found. Taking the fifth root of the triple natural log appears to produce a distribution of ultimate costs that conforms well with an extreme value distribution. The fact that such intense transformations were needed suggests that a totally different approach than fitting commonly used distributions should be used.

As is indicated from Table 8.2, the ratio of the expected value of the individual case reserve to the projected payments through expected year of death estimate varies dramatically according to the gender and current age of each claimant. This suggests that the variability of the total MPD reserve can best be modeled by simulating the variability of the future payout for each claim separately. Table 9.1 provides a sample framework for this type of simulation. The sample insurer has 10 open PD claims.

An individual row in Table 9.1 is devoted to each open claim. Census data on the gender and current age of each living PD claimants appears in two columns on the left side of the table. Consider claim number 1 in the top row. Actual medical payments in 2003 were $3,000. A random number between 0 and 1 is generated. If that number is between 0 and q_{75}, the claimant dies during 2004. Recall that q_x denotes the probability of death at age x, given survival to that age. If the random number is greater than q_{75}, the claimant lives throughout 2004.

TABLE 9.1

LAYOUT FOR SIMULATION OF VARIABILITY OF TOTAL MPD RESERVE AT YEAR-END 2003

Claim Number	Gender	Current Age	Projected Annual Medical Costs ($000s) During:											Total Future Medical Payments
			2004	2005	2006	…	2038	2039	2040	…	2068	2069	2070	
1	F	75	3.2	3.5	3.8		0	0	0		0	0	0	10.5
2	F	47	5.6	6.1	6.7		105	114	125		0	0	0	2,354.8
3	M	22	1.9	2.1	2.3		35.6	38.8	42.2		472	515	0	6,211.4
4	M	46	0.7	0.8	0.8		13.1	14.3	15.6		0	0	0	312.1
5	M	55	12.7	13.8	15.1		0	0	0		0	0	0	181.4
6	F	82	6.3	6.9	7.5		0	0	0		0	0	0	55.2
7	M	66	8.1	8.8	9.6		0	0	0		0	0	0	99.7
8	M	34	1.2	1.3	1.4		22.5	24.5	26.7		0	0	0	443.8
9	F	57	4.4	4.8	5.2		82.4	0	0		0	0	0	949.1
10	M	71	3.6	3.9	4.3		67.4	73.5	80.1		0	0	0	1,468.3
													Total:	**12,086.3**

In effect, in Table 9.1, projected annual medical costs for each future year are estimated via a Markov chain simulation model. The state space consists of two outcomes from each trial: (1) the claimant does not die during a given future DY, or (2) the claimant dies during that DY. The transition probabilities in this model are simply the $(1 - q_x)$ and q_x values from a mortality table. The outcome of any trial depends at most upon the outcome of the immediately preceding trial and not upon any other previous outcome. Death is an "absorbing" state, since one cannot transition out of it.

An assumed rate of medical cost escalation of 9% per year is applied to the prior year's payments if the claimant lives throughout the year. Otherwise, if the claimant dies during the year, projected medical payments for the year are still shown, after which medical losses drop to zero for every future year of development. While projected medical payments may arguably be only for half a year, assuming the average claimant dies in the middle of the final year of development, in reality medical costs are often higher during the year of death. Thus assuming a full year's worth of medical payments is a reasonable assumption.

For each trial, total projected future payments from the cell at the bottom right are recorded and confidence levels for the reserve can be derived from a ranking of all of the simulated total reserve estimates. If this is done for a single claim, the resulting probability distribution closely conforms to that described in the first paragraph of this section.

Simulating the variability of the MPD reserve for unreported claims is naturally more complicated. First, the total number of IBNR claims should be represented by a Poisson (or similar) distribution. Then census data of the age at injury of recent claimants can be used to randomly generate these ages for unreported claimants. Then additional rows can be added to Table 9.1 to further simulate future payments for each unreported claimant. The degree of variability of the MPD reserve for unreported claimants is exceptionally high, because some of those claimants may have been quite young when injured, and because the total expected future payment for workers injured at a young age is dramatically higher than for those injured at an older age. An appreciation for this can be gained by reviewing either Columns (B) or (C) of Table 8.2. For example, the total expected future payout for a female who is 20 at the accident date is $16.7 million, while it is only $3.0 million if she is 40.

The Markov chain method presented in this section is based on the common assumption that the current level incremental severities of each claimant remain constant regardless of the age of the claimant during each future year. Clearly, if the tendency of incremental medical severities to increase with age were incorporated into this method, future medical payments for each trial of the simulation would be higher.

10. CONCLUDING REMARKS

In this paper we have seen that common actuarial methods will tend to underestimate the true MPD loss reserve. This is also the case for typical methods of estimating MPD reserves at higher confidence levels based on commonly used size-of-loss distributions. The need to develop and apply new methods that directly reflect the characteristics of MPD payments is substantial.

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APPENDIX A

THE MUELLER INCREMENTAL TAIL METHOD

The Mueller Incremental Tail method calculates tail factors based on cumulative paid loss development triangles augmented by incremental calendar year payments from older accident years.

The method was described in Section 2 of the paper as consisting of three stages:

1. Incremental age-to-age decay ratios.
2. Anchored decay factors.
3. Tail factors.

This Appendix provides more specifics regarding these stages.

1. *Incremental age-to-age decay ratios*. The first step is to calculate incremental age-to-age decay ratios. With the SAIF data, we can calculate incremental paid at age $n + 1$ to incremental paid at age n ratios for n ranging from 29 to 65 years, using 20-year weighted averages.

   Tables A.1 through A.3 display incremental MPD payments for DYs 29 through 40, 40 through 50, and 50 through 60, respectively.

   Because the underlying data for any individual accident year are volatile, the age-to-age factors were smoothed using centered moving averages. The empirical age-to-age decay factors and smoothed factors are shown in Table A.4.

   The empirical factors are calculated directly from the raw data. The centered average is a simple five-year average based on the empirical factor averaged with the two factors above and the two below. When it was not possible to calculate a five-year average, shorter term centered averages were used.

The weighted average is similar but uses corresponding paid losses as weights. The geometric mean provides another level of smoothing. It is also a five-year centered average, but it is the fifth root of the product of the five weighted average factors.

2. *Anchored decay factors.* After selecting the geometric mean incremental age-to-age factors, they are then anchored to a base year. Table A.5 shows the anchored decay factors using five different anchor years. The anchored decay factors represent incremental payments made in year $n+r$ relative to payments made in the anchor year. These anchored decay factors are calculated as the cumulative product starting with the anchor year and moving up the last column on Table A.4. For example, as shown in Table A.5, payments made in development year 50 are 88.0% greater than the payments made in year 37. The main reason that payments rise over time is because the force of medical cost escalation exceeds the force of mortality until most of the claimants are fairly advanced in age, when the force of mortality becomes stronger than the force of medical cost escalation.

By summing the decay factors from 38 to 65, we get the payments made in age 38 to 65 relative to the payments made in the selected anchor year. The sums of the decay factors are similar to tail factors, but instead of being relative to cumulative payments they are relative to the incremental payments made in a given anchor year.

The cumulative decay factors can be interpreted as follows: Payments made in ages 38 to 65 are 30.071 times the payments made in age 37. Similarly, payments made in ages 38 to 65 are 26.961 times the payments made in age 33.

TABLE A.1

DERIVATION OF INCREMENTAL AGE-TO-AGE DECAY RATIOS FOR DYS 30 TO 40

	Incremental Payments ($000s) During DY X:											
AY	29	30	31	32	33	34	35	36	37	38	39	40
1943												4
1944											1	3
1945										16	14	20
1946									1	11	19	5
1947								0	0	3	1	5
1948							7	3	9	16	6	17
1949						49	27	52	29	12	15	48
1950					16	28	20	26	8	30	16	22
1951				17	16	5	7	6	16	6	2	11
1952			4	3	16	11	9	26	32	16	62	9
1953		32	21	14	17	16	28	11	11	9	31	17
1954	54	43	48	59	80	52	109	44	65	81	59	63
1955	25	16	20	14	13	26	33	8	41	22	12	14
1956	45	66	35	68	44	48	24	68	17	40	36	13
1957	53	57	51	35	21	20	39	60	38	36	79	51
1958	26	30	29	33	23	24	30	14	9	75	7	4
1959	110	138	75	81	81	195	122	161	127	148	116	84
1960	47	89	56	71	107	94	69	46	30	26	89	203
1961	97	97	146	118	140	105	101	109	91	121	81	95
1962	96	80	60	46	55	114	57	23	85	108	64	118

1963	82	239	84	81	82	101	85	47	48	36	56	46
1964	465	177	210	178	28	65	106	34	36	55	168	
1965	143	123	107	191	150	153	53	75	69	93		
(A) Sum × 1st:		1,155	943	994	874	1,056	919	812	762	942	933	847
(B) Sum Prior:		1,241	1,187	947	1,011	890	1,105	926	812	763	865	766
(C) Indicated Decay Ratios:		0.931	0.794	1.050	0.864	1.187	0.832	0.877	0.938	1.235	1.079	1.106
(D) Selected Decay Ratios:		0.930	0.933	0.937	0.937	0.953	0.958	0.980	1.001	1.048	1.063	1.088
PLDF–1.0:	0.025	0.030	0.028	0.026	0.025	0.023	0.023	0.022	0.022	0.023	0.022	0.021
PLDF:	1.025	1.030	1.028	1.026	1.025	1.023	1.023	1.022	1.022	1.023	1.022	1.021
Model:	1.024	1.024	1.024	1.024	1.024	1.024	1.024	1.023	1.023	1.022	1.022	1.021

Notes:
(1) The selected decay ratios were derived in Table A.4. See last column.
(2) The PLDFs for DYs 29–37 were derived in Table A.6. (See Row I).
(3) The (PLDF–1.0)s for ages 38 through 40 were computed as the product of the previous (PLDF–1.0) and the current decay ratio, divided by the prior PLDF.

TABLE A.2

DERIVATION OF INCREMENTAL AGE-TO-AGE DECAY RATIOS FOR DYs 40 TO 50

	Incremental Payments ($000s) During DY X:										
AY	40	41	42	43	44	45	46	47	48	49	50
1933											2
1934										2	0
1935									1	4	14
1936								15	0	3	5
1937							0	4	0	1	0
1938						0	0	1	1	0	2
1939					0	3	0	1	0	0	0
1940				1	2	1	3	0	0	4	0
1941			4	1	1	0	0	0	0	0	1
1942		0	7	8	3	1	16	2	0	2	0
1943	4	1	11	4	3	2	4	1	6	7	8
1944	3	3	6	2	1	3	1	1	0	0	0
1945	20	24	17	14	6	15	(1)	50	73	75	63
1946	5	5	(5)	4	9	4	2	30	31	29	31
1947	5	(2)	0	4	0	32	0	0	0	3	5
1948	17	7	2	1	1	12	0	6	7	14	3
1949	48	42	17	9	39	7	20	41	83	225	116
1950	22	18	43	24	11	165	71	9	2	4	1
1951	11	32	12	13	6	4	23	26	19	10	18
1952	9	48	7	7	170	44	12	1	1	22	1
1953	17	10	7	23	13	18	37	15	43	70	68
1954	63	83	49	67	70	142	67	62	96	101	

1955	14	21	26	28	26	21	67	15	13		
1956	13	9	15	21	35	17	8	33			
1957	51	66	367	116	51	28	94				
1958	4	10	19	32	41	21					
1959	84	93	88	83	87						
1960	203	133	181	230							
1961	95	74	158								
1962	118	105									
1963	46										
Sum × 1st:		782	1,027	691	575	540	424	298	375	574	336
Sum Prior × Last:		806	677	873	462	488	519	330	280	363	475
Indicated Decay Ratios:		0.970	1.517	0.792	1.245	1.107	0.817	0.903	1.339	1.581	0.707
Selected Decay Ratios:		1.098	1.101	1.056	1.054	1.058	1.044	1.031	1.047	1.023	0.946
PLDF–1.0:	0.025	0.027	0.029	0.029	0.030	0.031	0.031	0.031	0.032	0.032	0.029
PLDF:	1.025	1.027	1.029	1.029	1.030	1.031	1.031	1.031	1.032	1.032	1.029
Model:	1.021	1.021	1.020	1.020	1.019	1.019	1.018	1.017	1.017	1.016	1.015

Notes:
(1) The selected decay ratios were derived in Table A.4. See last column.
2) The (PLDF–1.0)s for ages 40 through 50 were computed as the product of the previous (PLDF–1.0) and the current decay ratio, divided by the prior PLDF.

TABLE A.3

Derivation of Incremental Age-to-Age Decay Ratios for DYs 50 to 60

	Incremental Payments During DY X:										
AY	50	51	52	53	54	55	56	57	58	59	60
1926								0	3	0	0
1927							0	0	2	0	0
1928						0	0	0	0	0	15
1929					9	5	1	4	0	0	0
1930				0	0	0	0	0	0	0	0
1931			0	0	0	0	0	0	0	0	0
1932		0	0	0	0	0	0	0	0	0	0
1933	2	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0
1935	14	4	0	1	0	0	0	9	0	0	1
1936	5	2	7	1	0	0	0	0	0	0	4
1937	0	0	15	13	0	0	0	0	0	0	0
1938	2	10	0	3	4	0	0	1	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0
1940	0	0	0	0	0	0	0	0	0	0	0
1941	1	1	0	1	5	4	10	37	9	0	0
1942	0	0	1	1	0	0	0	0	0	0	0
1943	8	2	7	8	3	1	0	0	10	0	0
1944	0	0	0	0	0	1	3	1	4	2	
1945	63	63	48	43	35	34	71	11	6		
1946	31	32	7	14	23	6	1	2			

1947	5	0	0	4	0	1	0				
1948	3	0	4	0	35	5					
1949	116	5	8	1	0						
1950	1	3		2							
1951	18	44	32								
1952	1	1									
1953	68										
Sum × 1st:		167	129	92	105	57	86	65	34	2	20
Sum Prior × Last:		270	166	97	90	114	52	86	63	28	0
Indicated Decay Ratios:		0.619	0.777	0.948	1.167	0.500	1.654	0.756	0.540	0.071	
Selected Decay Ratios:		0.888	0.868	0.850	0.851	0.919	1.002	1.067	1.151		
PLDF–1.0:	0.029	0.025	0.021	0.018	0.015	0.013	0.013	0.014	0.016		
PLDF:	1.029	1.025	1.021	1.018	1.015	1.013	1.013	1.014	1.016		
Model:	1.015	1.015	1.014	1.013	1.013	1.012	1.011	1.010	1.010		

Notes:
(1) The selected decay ratios were derived in Table A.4. See last column.
(2) The (PLDF–1.0)s for ages 50 through 58 were computed as the product of the previous (PLDF–1.0) and the current decay ratio, divided by the prior PLDF.

TABLE A.4

Calculation of Age-to-Age Decay Factors

Age to Age	Empirical	Centered Average	Weighted Average	Geometric Mean
58+	1.151	1.151	1.151	1.151
57/56	0.744	1.186	1.108	1.067
56/55	1.661	1.046	0.952	1.002
55/54	0.502	1.001	0.918	0.919
54/53	1.171	1.011	0.907	0.851
53/52	0.928	0.801	0.745	0.850
52/51	0.792	0.843	0.756	0.868
51/50	0.610	0.924	0.946	0.888
50/49	0.712	1.008	1.019	0.946
49/48	1.579	1.028	1.016	1.023
48/47	1.345	1.070	1.022	1.047
47/46	0.892	1.149	1.117	1.031
46/45	0.824	1.081	1.063	1.044
45/44	1.107	0.971	0.946	1.058
44/43	1.237	1.096	1.080	1.054
43/42	0.793	1.125	1.093	1.056
42/41	1.516	1.125	1.094	1.101
41/40	0.970	1.093	1.074	1.098
40/39	1.108	1.182	1.169	1.088
39/38	1.079	1.066	1.064	1.063
38/37	1.235	1.047	1.040	1.048
37/36	0.939	0.992	0.977	1.001
36/35	0.877	1.014	0.999	0.980
35/34	0.832	0.940	0.932	0.958
34/33	1.186	0.962	0.954	0.953
33/32	0.864	0.945	0.931	0.937
32/31	1.049	0.965	0.952	0.937
31/30	0.795	0.925	0.916	0.933
30/29	0.930	0.930	0.930	0.930

TABLE A.5

ANCHORED DECAY FACTORS

Year of Development	Anchor Year 37	36	35	34	33
> **57**	1.184	1.186	1.162	1.113	1.062
57	1.028	1.030	1.009	0.967	0.922
56	0.964	0.966	0.946	0.907	0.864
55	0.962	0.964	0.944	0.905	0.863
54	1.047	1.049	1.028	0.985	0.939
53	1.231	1.233	1.208	1.158	1.104
52	1.448	1.450	1.421	1.362	1.298
51	1.669	1.671	1.637	1.569	1.496
50	1.880	1.882	1.844	1.768	1.685
49	1.987	1.990	1.950	1.869	1.782
48	1.943	1.946	1.907	1.827	1.742
47	1.856	1.859	1.821	1.746	1.664
46	1.800	1.803	1.766	1.693	1.614
45	1.724	1.727	1.692	1.622	1.546
44	1.630	1.633	1.600	1.533	1.462
43	1.547	1.550	1.518	1.455	1.387
42	1.466	1.468	1.438	1.378	1.314
41	1.331	1.332	1.306	1.251	1.193
40	1.211	1.213	1.189	1.139	1.086
39	1.114	1.116	1.093	1.048	0.999
38	1.048	1.049	1.028	0.985	0.939
37	1.000	1.001	0.981	0.940	0.897
36		1.000	0.980	0.939	0.895
35			1.000	0.958	0.914
34				1.000	0.953
33					1.000
Totals (38 to ultimate)	30.071	30.115	29.508	28.280	26.961
Relative to Anchor Year	37	36	35	34	33

Because this approach produces volatile indicated tail factors, Table A.6 presents an approach for stabilizing those indications (see Table 2.6). Each of the average PLDFs for ages 30 through 36 are adjusted to what they would be for age 37 using the appropriate products of incremental decay factors from AY 1965 and prior years. A weighted average of all of these adjusted PLDFs is then used to replace the actual PLDF for DY 37. In this way, the PLDF for DY 37 is changed from being entirely determined by only one historical PLDF for one AY, to being an indication based on all 36 PLDFs for DYs 30 through 37. This results in a reduction of the PLDF for anchor year 37 from 1.033 to 1.022. The final selected tail factor from age 37 to 65 is then 1 plus the product of 0.022/1.022, the cumulative decay factor of 30.071 and 1/1.022 (= 1.634).

Once the best estimate of the PLDF for the anchor year (DY 37) is selected, then all of the subsequent PLDFs can be easily generated using the iterative formula:

$$f_{n+1} = f_n d_{n+1}/[1 + f_n],$$

where f_n is the paid loss development factor, less one, for the nth year of development, and d_{n+1} is the decay ratio between incremental paid during year $(n + 1)$ and year (n). See Section 2 for a derivation of this formula.

3. *Tail factors*. Tail factors can be calculated either by cumulating the age-to-age PLDFs calculated above or directly from the cumulative decay factors D_{n+1} linked to an age-to-age factor f_n from the cumulative triangle using the formula

$$\text{Tail factor}_n = f_n D_{n+1}/[1 + f_n],$$

where D_{n+1} is the cumulative decay factor calculated from the incremental data, and f_n is derived from the normal cumulative triangle. See Section 2.

TABLE A.6

USING THE MUELLER INCREMENTAL TAIL METHOD TO PRODUCE A MORE STABLE ESTIMATE OF THE PLDF FOR ANCHOR YEAR 37

AY	29	30	31	32	33	34	35	36	37
1966	1.015	1.025	1.020	1.017	1.021	1.017	1.026	1.027	1.033
1967	1.019	1.030	1.026	1.026	1.023	1.025	1.025	1.030	
1968	1.013	1.009	1.006	1.004	1.003	1.003	1.004		
1969	1.018	1.017	1.019	1.021	1.013	1.023			
1970	1.017	1.016	1.030	1.013	1.017				
1971	1.014	1.040	1.040	1.026					
1972	1.036	1.021	1.015						
1973	1.042	1.037							
1974	1.025								
(A) Average	1.022	1.024	1.023	1.018	1.015	1.017	1.018	1.029	1.033
(B) Avg. – 1.0	0.022	0.024	0.023	0.018	0.015	0.017	0.018	0.029	0.033
(C) Decay Ratios	0.930	0.933	0.937	0.937	0.953	0.958	0.980	1.001	
(D) Adjustment Factor to Age 37	0.734	0.787	0.840	0.897	0.940	0.981	1.001	1.000	
(E) Row (B) Adjusted to Age 37	0.018	0.018	0.015	0.014	0.016	0.018	0.029	0.033	
(F) Weights for (E)	5%	5%	10%	10%	15%	15%	20%	20%	
(G) Weighted Avg. of (E)								0.022	
(H) Revised (B)	0.030	0.028	0.026	0.025	0.023	0.023	0.022	0.022	
(I) Revised PLDFs	1.030	1.028	1.026	1.025	1.023	1.023	1.022	1.022	

Notes:
(C) From Table A.4, last column.
(D) Product of all decay ratios to the right of given age.
(E) (B) × (D). (H) (G)/(D).

APPENDIX B

HISTORICAL PLDFS FOR ALL OTHER WORKERS COMPENSATION

This section presents SAIF's historical PLDFs for MPD losses as well as workers compensation losses other than MPD. The averages of the latest five PLDFs are shown for each development year in Table B.1. These factors are counterparts to the MPD PLDFs shown in Table 1.1.

The 37 to ultimate tail factor indicated for other workers compensation is 1.039. In Oregon, escalation of indemnity benefits is paid out of a second injury fund. The Other Workers Compensation development factors do not include the escalation of indemnity benefits. The Other than MPD tail factor of 1.039 can be compared to the MPD tail factor of 1.581. These tail factors can be derived from Table B.1 by cumulating backwards.

It is medical losses that contribute significantly to the tail factor and it is the medical cost escalation component of the medical tail factor that contributes significantly to the medical tail factor. Without medical cost escalation, the medical factor drops from 1.581 to 1.030 when put on a current cost basis.

The above PLDFs serve as the basis for the tail factors presented in Table 2.4.

TABLE B.1

A Comparison of Historical Age-to-Age Paid Loss Development Factors (by Year of Development)

	Year of Development													
	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MPD	6.624	1.525	1.140	1.072	1.041	1.027	1.019	1.020	1.015	1.013	1.012	1.013	1.012	1.010
Other Workers Comp.	1.843	1.131	1.043	1.023	1.018	1.013	1.009	1.006	1.005	1.004	1.004	1.004	1.005	1.006
Total Workers Comp.	2.168	1.213	1.069	1.036	1.025	1.017	1.012	1.010	1.008	1.007	1.006	1.007	1.007	1.007

	Year of Development										
	16	17	18	19	20	21	22	23	24	25	26
MPD	1.011	1.013	1.011	1.011	1.012	1.012	1.014	1.012	1.015	1.015	1.016
Other Workers Comp.	1.006	1.008	1.010	1.009	1.009	1.009	1.008	1.009	1.010	1.010	1.010
Total Workers Comp.	1.008	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.012	1.011	1.012

	Year of Development										
	27	28	29	30	31	32	33	34	35	36	37
MPD	1.020	1.023	1.027	1.026	1.022	1.018	1.015	1.017	1.018	1.029	1.033
Other Workers Comp.	1.009	1.008	1.008	1.007	1.007	1.006	1.006	1.005	1.004	1.006	1.006
Total Workers Comp.	1.012	1.012	1.013	1.013	1.011	1.010	1.009	1.009	1.009	1.013	1.014

APPENDIX C

INCORPORATING THE STATIC MORTALITY MODEL INTO THE INCREMENTAL PAID TO PRIOR OPEN CLAIM METHOD

SECTION C.1. OVERVIEW

Given the complexity of this method, Table C.1 provides a road map to the key steps involved in the application of the method and the location of tables and narrative describing those steps. The method was originally introduced in Section 3 by presenting Step 7 since this step is easily understood.

Table C.1 lists the key steps of this method in the order in which they were applied, which is not necessarily the order in which they are presented in this appendix.

This Appendix consists of five sections: (1) Overview; (2) Derivation of Number of Open Claims at the End of Each Development Year; (3) Selection of Representative Values of Incremental Paid to Prior Open Claim; (4) Basis of 9% Assumption for Future Rate of Medical Cost Escalation; and (5) Derivation of Assumed Claim Reporting and Closure Patterns.

SECTION C.2. DERIVATION OF NUMBER OF OPEN CLAIMS AT THE END OF EACH DEVELOPMENT YEAR

The first part of this Appendix describes the derivation of the estimated number of PD claimant deaths shown in Column (3) of Table 3.4. Such estimates also directly become the number by which the total number of open claims declines for each development year after the 20th year. After that year, it is assumed that no new claims will be reported and that the number of claim closures for reasons other than death will be cancelled out by the number of reopened claims for each development year.

The survival probabilities for each development year were derived from a claimant mortality model and these were compared

TABLE C.1

GUIDE TO LOCATION OF DESCRIPTION AND DISPLAY OF KEY STEPS OF METHOD

	Step	Appendix C	Section 3 of Main Text
(1)	Select representative historical claim reporting pattern	Section C.5	
(2)	Select representative historical claim closing pattern	Section C.5	
(3)	Derive historical open count pattern by subtracting (2) from (1)	Section C.5	
(4)	Derive projections of number of claims closed due to death	Section C.2	Table 3.4
(5)	Derive assumptions regarding percentage of claims closed for other reasons	Section C.5	Table 3.4
(6)	Synchronize open count estimates of historical experience and mortality model	Section C.5	Table 3.4
(7)	Select appropriate medical inflation assumption	Section C.4	
(8)	Trend historical incremental paid to prior open claim averages to current level	Section C.3	
(9)	Select representative paid severities	Section C.3	
(10)	Trend paid severities to year of payment	Section C.3	Table 3.2
(11)	Estimate incremental payments as the product of trended paid severities and projections of the number of prior open claims		Table 3.2

with the actual probabilities of a claim remaining open throughout each given development year. For each development year under 10, the probability of a claim remaining open during a given development year was substantially less than the survival probability, since most (or many) claims will close for reasons other than death of the claimant. However, these two sets of probabilities converge for increasing development years until they are virtually identical for development years 20 and higher.

Mortality rates were used to derive a claims closure pattern (due to death) by development year in the following way. A two-

TABLE C.2.1

NUMBER OF LIVING MALE CLAIMANTS FOR ACCIDENT YEAR 2002 AT SUCCESSIVE YEAR-ENDS ASSUMING A 2000 MORTALITY TABLE

Age-at-	Beginning of Development Year						
Injury	1	2	3	4	5	10	20
40	12.99	12.96	12.92	12.88	12.83	12.56	11.50
41	14.71	14.66	14.62	14.57	14.51	14.19	12.89
42	16.09	16.04	15.99	15.93	15.87	15.48	13.94
43	16.03	15.97	15.91	15.85	15.78	15.38	13.71
44	17.48	17.41	17.34	17.27	17.19	16.72	14.74
45	18.86	18.79	18.71	18.62	18.53	17.98	15.66
46	20.12	20.03	19.94	19.84	19.74	19.10	16.41
47	21.43	21.34	21.23	21.12	21.01	20.27	17.14
48	22.69	22.58	22.46	22.34	22.20	21.36	17.75
49	23.02	22.90	22.77	22.63	22.49	21.56	17.59
40–49	**183.41**	**182.68**	**181.89**	**181.06**	**180.16**	**174.61**	**154.38**

dimensional array was created, with the age-at-injury down the leftmost column and the development years as column headings.

Table C.2.1 presents a small portion of the array, including only ages-at-injury from 40 through 49 shown at the beginning of the first five development years and at the beginning of the 10th and 20th development years.

Appendix D provides a more detailed description of the array structure. The arrays described in these two appendices differ only in the applicable mortality tables. For the static method, the 2000 mortality table is assumed for all future years. In the trended method (Appendix D), projections of future mortality tables are used.

Table C.2.1 is a segment of the male lives array. We assumed that the initial PD claimant population consisted of 750 males and 250 females. A corresponding array was used for the female claimants.

The first column to the right of the age-at-injury values is a portion of the distribution of 750 male PD claimants by age, based on individual permanent total disability (PTD) claimant data from SAIF for accident years 1975 through 1990. We assumed that the age-at-injury distribution for PD claims would be the same as for PTD claims. The actual census data were smoothed among different age-at-injury categories to derive the numbers in Column (1).

Consider the row for the age-at-injury of 40. Suppose that 12.99 of the 1,000 total claimants were injured at age 40. The probability of living from age 40 to age 41 from the male 2000 SSA mortality table is used to calculate the expected number of male claimants still alive one year after the accident, and so forth for each subsequent age and year of development out to development year 90. In this way each age-at-injury row is filled out in the array. For each development year column, the expected total number of surviving claimants is simply the sum of the expected number of surviving claimants for each age-at-injury ranging from 40 through 49.

The same calculations were performed for all possible ages-at-injury and all development years from 1 through 90. The resulting estimates of the number of surviving male claimants is summarized in Table C.2.2 for different age-at-injury groupings at different selected years of development. The totals derived in Table C.2.1 are displayed in the 40–49 age-at-injury row in Table C.2.2.

In Table C.2.2, the expected number of surviving claimants at the beginning of development year 5 is 722.1 and at development year 10 is 674.4. Hence the probability of survival during the fifth through ninth development years for all male claimants is 93.4%. It is evident from a review of the bottom row of Table C.2.2 that the survival probabilities steadily decline as the claimant population ages.

TABLE C.2.2

NUMBER OF SURVIVING MALE CLAIMANTS AT THE BEGINNING OF VARIOUS DEVELOPMENT YEARS FOR ACCIDENT YEAR 2002

Age-at-	Number of Surviving Male Claimants at the Beginning of Development Year											
Injury	1	5	10	15	20	25	30	40	50	60	70	80
16–29	30.7	30.5	30.2	29.9	29.4	28.8	27.9	24.6	18.0	8.7	1.5	0.0
30–39	78.9	78.2	77.0	75.4	73.0	69.5	64.3	47.3	22.8	4.0	0.1	0.0
40–49	183.4	180.2	174.6	166.5	154.4	137.0	114.3	56.2	10.2	0.3	0.0	0.0
50–59	321.3	309.0	286.9	255.0	213.4	162.7	106.1	19.7	0.6	0.0	0.0	0.0
60+	135.7	124.2	105.6	83.2	58.0	33.0	13.8	0.6	0.0	0.0	0.0	0.0
TOTAL	750.0	722.1	674.4	609.9	528.1	431.0	326.4	148.3	51.7	13.0	1.6	0.0
Survival Probability*		96.3	93.4	90.4	86.6	81.6	75.7	45.4	34.8	25.1	12.3	2.6

*In %.

TABLE C.2.3

INDICATED MALE CLAIMANT SURVIVAL PROBABILITIES

Age-at-	Beginning of Development Year										
Injury	5	10	15	20	25	30	40	50	60	70	80
16–29	99.4%	99.2%	98.9%	98.5%	97.8%	96.9%	88.1%	73.4%	48.0%	17.0%	2.8%
30–39	99.1%	98.5%	97.8%	96.9%	95.2%	92.5%	73.5%	48.2%	17.5%	3.0%	0.2%
40–49	98.2%	96.9%	95.4%	92.7%	88.7%	83.5%	49.1%	18.2%	3.1%	0.2%	0.0%
50–59	96.2%	92.8%	88.9%	83.7%	76.3%	65.2%	18.6%	3.1%	0.2%	0.0%	
60+	91.6%	85.0%	78.8%	69.7%	56.9%	41.8%	4.1%	0.2%	0.0%		

Table C.2.3 displays the survival probabilities for each age-at-injury grouping during each grouping of development years.

Given that survival probabilities vary significantly for different age-at-injury groups, it is clear that the group survival probabilities will be highly sensitive to the distribution of claimants by age-at-injury. The greater the proportion of younger claimants, the bigger the MPD tail.

TABLE C.3.1

Incremental Paid to Prior Open Claim Averages Trended to 2003 Cost Level (Years 1 through 13)

AY	1	2	3	4	5	6	7	8	9	10	11	12	13
1979													8.43
1980												6.12	6.14
1981											7.30	3.40	2.71
1982										5.62	5.81	2.21	2.81
1983									9.25	4.41	2.81	2.99	2.81
1984								6.15	4.86	3.48	3.44	2.72	2.23
1985							5.77	4.16	4.27	2.47	2.44	3.40	2.07
1986						9.07	5.56	4.84	2.52	4.13	3.27	2.95	2.95
1987					7.54	5.42	3.32	2.09	2.48	1.77	2.44	2.25	2.96
1988				10.27	5.47	5.32	2.58	2.01	2.43	3.12	2.87	2.99	4.31
1989			17.75	8.43	6.35	4.37	2.78	2.70	3.06	3.47	3.30	3.90	5.28
1990		74.81	16.65	7.26	5.41	3.39	2.68	3.42	4.64	2.21	2.64	4.47	4.66
1991		76.98	14.65	4.59	5.24	3.02	1.92	1.74	2.33	2.38	2.82	3.03	
1992		63.73	13.44	5.24	2.94	3.36	3.16	3.03	3.52	5.88	4.61		
1993		70.06	12.53	6.19	3.76	4.44	3.79	3.97	6.94	5.67			
1994		63.18	11.46	3.36	4.03	3.93	2.30	2.24	4.02				
1995		61.45	9.60	7.14	4.56	4.10	5.48	5.39					
1996		63.62	12.44	5.00	4.65	5.39	4.44						
1997		69.86	12.13	7.35	5.31	4.39							
1998		61.95	13.94	5.89	8.70								
1999		62.69	14.60	7.57									
2000		87.44	16.77										
2001		85.81											
2002													
Average		70.13	13.83	6.52	5.33	4.68	3.65	3.48	4.19	3.72	3.64	3.37	3.95
X Hi/Lo		69.27	13.86	6.47	5.23	4.41	3.61	3.39	3.87	3.70	3.40	3.21	3.69
Avg. Last 3		78.65	15.10	6.94	6.22	4.63	4.08	3.87	4.83	4.65	3.35	3.80	4.75
Selected		78.42	15.24	7.06	6.10	4.80	4.50	4.50	4.50	4.50	3.70	3.70	3.70

TABLE C.3.2

Incremental Paid to Prior Open Claim Averages Trended to 2003 Cost Level (Years 14 through 27)

AY	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1966													3.27	4.29
1967												6.80	5.81	6.96
1968											10.50	11.88	8.88	2.71
1969										4.71	6.75	4.72	5.20	3.18
1970									3.85	2.89	3.50	3.20	2.34	2.70
1971								5.47	4.36	3.03	2.37	2.37	1.95	2.02
1972							3.95	2.89	2.76	2.43	2.70	1.44	1.22	1.79
1973						6.55	4.95	3.84	3.64	3.83	4.23	4.28	4.91	6.26
1974					4.74	3.84	4.04	2.69	3.85	2.14	2.28	3.78	0.95	2.70
1975				5.05	3.84	4.09	4.24	5.63	3.63	3.61	3.96	3.29	3.81	5.18
1976			7.97	4.73	3.12	3.44	2.68	2.68	3.20	2.58	2.36	2.03	2.38	1.74
1977		6.72	5.40	3.22	2.55	2.51	3.23	2.84	2.62	2.88	3.24	2.78	3.90	
1978	5.73	4.12	5.11	2.94	3.50	2.64	3.12	2.89	4.34	4.23	3.68	3.67		
1979	6.66	4.05	4.14	5.43	4.26	3.88	4.62	3.79	4.56	4.06	4.03			
1980	3.18	3.08	2.62	3.22	3.28	2.82	2.38	3.40	3.06	2.18				
1981	3.10	4.62	2.72	3.05	3.19	3.27	3.16	2.72	4.46					
1982	2.42	2.78	2.82	2.84	2.73	3.04	3.94	3.49						
1983	1.91	4.26	2.96	3.52	3.78	4.84	3.21							
1984	2.73	2.94	3.39	4.04	3.19	2.82								
1985	2.25	3.58	3.51	5.73	4.68									
1986	3.39	3.18	4.15	4.60										
1987	3.52	3.25	4.20											
1988	3.50	3.74												
1989	5.76													
Average	3.68	3.86	4.08	4.03	3.57	3.65	3.63	3.53	3.69	3.21	4.13	4.19	3.72	3.60
X Hi/Lo	3.56	3.68	3.84	3.98	3.56	3.47	3.62	3.40	3.72	3.17	3.68	3.69	3.48	3.43
Avg. Last 3	4.26	3.39	3.95	4.79	3.89	3.57	3.44	3.20	4.03	3.49	3.65	2.83	3.36	3.21
Selected	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70

SECTION C.3. SELECTION OF REPRESENTATIVE VALUES OF INCREMENTAL PAID TO PRIOR OPEN CLAIM

Historical incremental paid to prior open claim averages were trended to the calendar year 2003 cost level using an assumed annual medical inflation rate of 9% per year. The resultant trended averages are displayed in Tables C.3.1 and C.3.2.

SECTION C.4. BASIS OF 9% ASSUMPTION FOR FUTURE RATE OF MEDICAL COST ESCALATION

Forecasts of future rates of medical cost escalation are based on an analysis of actual medical severity since 1966. Future medical severity is expected to grow on average at the same rate observed over this 38-year period. Internal studies have shown that the best predictor of long-term medical cost escalation is the long-term historical average itself. Short-term medical cost escalation rates are more accurately predicted using shorter-term historical averages.

In this paper we use an expected 9% future medical cost escalation rate. Intuitively, this rate might seem high, especially when compared to the medical component of the CPI (Bureau of Labor Statistics). Table C.4.1 provides a historical comparison of these two measures of change in average medical costs.

SAIF's average rate of medical cost escalation for 1983–1993 was depressed by the effects of significant reform legislation enacted in 1990 and the introduction of managed care into workers compensation. Absent these reforms, SAIF's average difference for 1983–1993 would have been similar in magnitude to the other multiyear periods.

It should be expected that a workers compensation insurer's average rate of medical cost escalation would exceed the aver-

TABLE C.4.1

COMPARISON OF SAIF'S HISTORICAL RATE OF MEDICAL COST ESCALATION WITH AVERAGE CHANGES IN THE MEDICAL COMPONENT OF THE CONSUMER PRICE INDEX

Accident Years	Average Rate of Medical Cost Escalation for Time Loss Claims	Average Rate of Change in Medical Component of the CPI	Average Difference
1966–1973	10.5%	5.7%	4.8%
1973–1983	12.2%	10.0%	2.2%
1983–1993	7.2%	7.2%	0.0%
1993–2003	7.3%	4.0%	3.3%
1966–2003	9.2%	6.8%	2.4%

age rate of change in the medical component of the CPI. The latter measures changes in household expenditures for health insurance premiums, as well as for out-of-pocket medical expenses, whereas the workers compensation medical costs include all medical expenses.

SAIF's rate of medical cost escalation measures the rate of change in all occupational medical costs. The medical cost of workers compensation claims is more difficult for an insurer to control because there are no patient co-pays or deductibles. Workers compensation insurers find it difficult to deny medical benefits when the attending physician deems the service necessary.

As Table C.4.1 shows, the average difference between the rate of change in occupational medical costs and that for consumer medical expenses measured by the medical component of the CPI has been 2.4% per year. That differential for SAIF increased during the most recent years to 7.4%, as documented in Table C.4.2.

TABLE C.4.2

COMPARISON OF SAIF'S RECENT RATES OF MEDICAL COST ESCALATION WITH AVERAGE CHANGES IN THE MEDICAL COMPONENT OF THE CONSUMER PRICE INDEX

Accident Year	Average Rate of Medical Cost Escalation for Time Loss Claims	Average Rate of Change in Medical Component of the CPI	Average Change in Mix and Utilization
1998	9.2%	3.2%	6.0%
1999	5.3%	3.5%	1.8%
2000	18.6%	4.1%	14.5%
2001	13.6%	4.6%	9.0%
2002	12.7%	4.7%	8.0%
2003	9.1%	4.0%	5.0%
1998–2003	11.4%	4.0%	7.4%

Escalation rates for workers compensation medical costs are driven by unit cost inflation, changes in the utilization of services, changes in the relative mix of services across service categories, as well as the substitution of more expensive services for less expensive services within a service category.

The medical cost escalation rate is the change in the cost per claim. The following formulae show one way to decompose the cost per claim into utilization, unit cost, and mix.

Payments are first combined into service categories. Examples of service categories are office visits, pharmacy, physical medicine, surgery, radiology, and so on. *For a particular service category*, the cost per claim can be decomposed into utilization, unit cost and mix.

$$\text{Cost per claim} = \text{Utilization} \times \text{Unit cost} \times \text{Mix},$$

where

$$\text{Utilization} = \frac{\text{Number of services in the service category}}{\begin{array}{c}\text{Number of claims receiving services}\\ \text{in that category}\end{array}}.$$

Utilization measures the number of services per claim for those claims receiving services in that category.

$$\text{Unit cost} = \frac{\text{Paid losses in the service category}}{\text{Number of services in the service category}}.$$

Unit cost measures the average paid loss per service in that service category.

$$\text{Mix} = \frac{\text{Number of claims receiving services in that category}}{\text{Total number of claims receiving any kind of service}}.$$

Mix measures the proportion of claims receiving that service.

If you multiply these three components together you get

$$\text{Cost per claim} = \frac{\text{Paid losses for the service category}}{\begin{array}{c}\text{Total number of claims receiving any kind}\\ \text{of service in that category}\end{array}}.$$

The total cost per claim is then the sum of the cost per claim over all service categories. The 9% medical cost escalation referred to in this paper is the combined effect of utilization, unit cost, and mix on the average cost per claim over time.

SECTION C.5. DERIVATION OF ASSUMED CLAIM REPORTING AND CLOSURE PATTERNS

Tables C.5.1 and C.5.2 disclose the specific assumptions (from SAIF experience) that form the basis for the PLDF static and trended mortality model estimates.

The following assumptions are held constant for all accident years in the model:

- There are 5,000 ultimately reported PD claims.
- A claim-reporting pattern is based on recent historical experience.

TABLE C.5.1

Derivation of Key Assumptions of the Static and Trended Models Accident Year 2002 MPD Losses

	Development Year						
	1	2	3	4	5	6	7
(1) Percentage of Claims Reported	18.52%	74.33%	91.64%	95.93%	97.77%	98.69%	99.08%
(2) Selected Reported Counts	926	3,716	4,582	4,797	4,888	4,935	4,954
(3) Percentage of Reported Still Open	49.65%	41.20%	29.82%	19.78%	13.85%	11.23%	8.00%
(4) Selected Open Counts	460	1,531	1,366	949	677	554	396
(5) Group Survival Probability	0.993	0.992	0.991	0.990	0.990	0.989	0.988
(6) Number Closed by Death	3.46	15.05	17.30	14.09	10.33	7.89	6.88
(7) Total Closed Counts	466	2185	3216	3848	4211	4381	4558
(8) Closed for Other Causes	462.54	1703.95	1013.70	617.91	352.67	162.11	170.12
(9) Newly Reported Counts	926	2,790	866	215	91	47	19
(10) Open+Newly Reported	926	3,250	2,397	1,581	1,040	724	573
(11) Indicated Percentage Closed (Other)	99.26%	52.43%	42.29%	39.08%	33.91%	22.39%	29.69%
(12) Selected Percentage Closed (Other)	99.26%	52.43%	42.29%	39.08%	33.91%	22.39%	29.69%

Notes:
(1) Based on average reported count development factors for the latest 10 CYs.
(2) $5{,}000 \times (1)$. The constant ultimate claim count of 5,000 was assumed for all years.
(3) Based on the average percentage open for the most recent CYs.
(4) $(2) \times (3)$, for DYs 1–10; [Prior $(4) + (9) - (6) - (8)$], for later DYs.
(5) See Section C.1 of Appendix C.
(6) $[(4) + 0.5 \times (9)] \times [(1) - (5)]$.
(7) $(2) - (4)$.
(8) [Change in (7)] $-$ (6).
(9) Change in (2).
(10) $(4) + (9)$.
(11) $(8)/(10)$.
(12) Selected on the basis of (11). Actual percentages were selected for the first 10 DYs.

TABLE C.5.2

Derivation of Key Assumptions of the Static and Trended Models Accident Year 2002 MPD Losses

	Development Year						
	8	9	10	11	12	13	14
(1) Percentage of Claims Reported	99.30%	99.46%	99.56%	99.64%	99.69%	99.76%	99.81%
(2) Selected Reported Counts	4,965	4,973	4,978	4,982	4,985	4,988	4,991
(3) Percentage of Reported Still Open	6.50%	5.00%	4.20%	3.95%	3.74%	3.56%	3.40%
(4) Selected Open Counts	323	249	209	197	187	178	170
(5) Group Survival Probability	0.987	0.986	0.985	0.983	0.982	0.981	0.979
(6) Number Closed by Death	5.31	4.68	3.89	3.52	3.56	3.63	3.72
(7) Total Closed Counts	4,642	4,724	4,769	4,785	4,798	4,810	4,821
(8) Closed for Other Causes	78.69	77.32	41.11	12.54	9.85	8.39	7.10
(9) Newly Reported Counts	11	8	5	4	3	3	3
(10) Open+Newly Reported	407	331	254	213	200	190	181
(11) Indicated Percentage Closed (Other)	19.33%	23.36%	16.19%	5.89%	4.92%	4.43%	3.93%
(12) Selected Percentage Closed (Other)	19.33%	23.36%	16.19%	6.00%	5.00%	4.50%	4.00%

(See notes on Table C.5.1.)

- Percentages of cumulative reported claims still open at the end of each DY are based on recent historical experience.
- Estimates of PD claims closed by death are based on SSA mortality tables.
- Estimates of PD claims closed for reasons other than death are calculated as total claim closures less expected deaths.

From the above, the percentage of claims available for closure that closed for reasons other than death was derived from AY 2002 for the static mortality model. These percentages were also assumed for the trended mortality model. Consequently, the only thing different between the two models is the expected number of claimant deaths during each DY.

APPENDIX D

INCORPORATING THE TRENDED MORTALITY MODEL INTO THE INCREMENTAL PAID TO PRIOR OPEN CLAIM METHOD

Table C.1 displays each of the steps taken in incorporating the static mortality model into the incremental paid to prior open claim method. The trended mortality method is the same as the static mortality method, except for Step (4), where projections of the number of claims closed due to death are derived. In the trended method, mortality tables forecasted by the SSA for the appropriate future development year are used instead of some fixed historical mortality table. The differences between these tables grows exponentially for development years that are decades into the future. A sample of these differences is disclosed in Table 5.1 of Section 5. These differences are compounded by medical costs that have risen dramatically due to expected high future rates of medical inflation.

The focus of this Appendix is to disclose the specific manner by which a series of 90 different mortality tables were derived and applied to the expected number of surviving claimants by age-at-injury for every future development year. The final result is a slowly evolving and elongating series of claims closure patterns for each accident year out to 90 years of development.

Standard mortality tables for each decade since 1970 and projected tables for each decade through 2080 were obtained from the actuarial publications section of the SSA Web Site www.ssa.gov/OACT/NOTES/pdf_studies/.

The separate male and female tables were combined into one using an assumed 75%/25% male/female mix, the proportion indicated from SAIF's PD claimant census data. The resulting weighted mortality rates were then compiled into an array of expected mortality rates for each age at each future calendar year.

TABLE D.1

SAMPLE $q(x)$ VALUES

	Calendar Year						
Age	1970	1980	1990	2000	2020	2040	2060
20	.00175	.00156	.00130	.00110	.00091	.00078	.00066
35	.00239	.00187	.00217	.00172	.00154	.00130	.00110
50	.00861	.00685	.00556	.00496	.00397	.00330	.00278
65	.02961	.02524	.02206	.01938	.01615	.01371	.01182
80	.09386	.08308	.07604	.07028	.05929	.04976	.04261

Six models of the number of PD claimants who would still be alive at the end of each future development year were derived separately for accident years 1975, 1980, 1985, 1990, 1995, and 2000. Each of these models consists of a separate two-dimensional array, such as presented in Tables C.2.1 of Appendix C.

The first step in deriving these arrays was to compile mortality rates from the SSA tables. Table D.1 displays a sampling of these $q(x)$, or probability of death, values.

Each of the one-year $q(x)$ values was converted into survival rates, denoted $l(x)$, by taking the complement, yielding the ratios in Table D.2.

The entire array of resulting one-year $l(x)$s was then shifted so that the rows of the original array became the diagonals of a new array, that is, each successive column was shifted up one row. After the shift, the $l(x)$s were arranged as shown in Table D.3.

Each row thus has a structure similar to an accident year reporting format, as displayed in Table D.4.

This shift facilitated multiplication of the survival ratios times the preceding number of surviving claimants for each age-at-injury row, working successively from left to right within each age-at-injury row.

TABLE D.2

SAMPLE ONE-YEAR $l(x)$ VALUES

	Calendar Year						
Age	1970	1980	1990	2000	2020	2040	2060
20	.99825	.99844	.99870	.99890	.99909	.99922	.99934
35	.99761	.99813	.99783	.99828	.99846	.99870	.99890
50	.99139	.99315	.99444	.99504	.99603	.9967	.99722
65	.97039	.97476	.97794	.98062	.98385	.98629	.98818
80	.90614	.91692	.92396	.92972	.94071	.95024	.95739

TABLE D.3

SHIFTED $l(x)$ ARRAY: AGE

	Year of Development						
Age at Injury	1	2	3	4	5	6	7
20	21	22	23	24	25	26	27
21	22	23	24	25	26	27	28
22	23	24	25	26	27	28	29
23	24	25	26	27	28	29	30
24	25	26	27	28	29	30	31

Table D.5 provides a side-by-side comparison of parallel calculations of the expected number of surviving claimants at the end of each calendar year for the static and trended mortality methods. The example presented is for claimants who were 50 years old when they were injured (during AY 2002).

In Table D.5 we started with the same number of surviving claimants at the beginning of CY 2031 (100.00). Nevertheless, at the beginning of CY 2035, we would be expecting 73.42 such claimants to still be alive using a 2000 mortality table while 79.30 claimants would be alive using a series of mortality tables corresponding to CYs 2031 through 2034. In this example, we would be expecting 8% more claimants to still be alive at the

TABLE D.4

Calendar Year of Payments and Applicable Mortality Table for Each Accident Year and Development Year

	Year of Development								
AY	1	2	3	4	5	6	7	8	9
1996	1996	1997	1998	1999	2000	2001	2002	2003	2004
1997	1997	1998	1999	2000	2001	2002	2003	2004	2005
1998	1998	1999	2000	2001	2002	2003	2004	2005	2006
1999	1999	2000	2001	2002	2003	2004	2005	2006	2007
2000	2000	2001	2002	2003	2004	2005	2006	2007	2008
2001	2001	2002	2003	2004	2005	2006	2007	2008	2009
2002	2002	2003	2004	2005	2006	2007	2008	2009	2010

TABLE D.5

Comparison of the Estimation of the Number of Living Claimants with Age-at-Injury of 50 for Accident Year 2002 at Successive Year-Ends Under the Static and Trended Mortality Methods

Static Mortality Method					
	Calendar Year				
	2031	2032	2033	2034	2035
Number of Surviving Claimants	100.00	93.63	87.05	80.30	73.42
CY of Mortality Table	2000	2000	2000	2000	2000
Survival Probability	.93633	.92972	.92242	.91439	.90562
Trended Mortality Method					
	Calendar Year				
	2031	2032	2033	2034	2035
Number of Surviving Claimants	100.00	95.12	90.05	84.79	79.30
CY of Mortality Table	2031	2032	2033	2034	2035
Survival Probability	.95121	.94671	.94152	.93526	.92769

beginning of CY 2035 assuming the trended mortality method (versus the static method). Although there is little difference in the survival probabilities shown in Table D.5, these differences become fairly significant during future decades. This can be seen by comparing these rates to those shown in the Group Survival Rate columns of Table 5.1.

APPENDIX E

QUANTIFYING THE ELDER CARE COST BULGE

Table E.1 discloses summarized data behind Figure 7.1. The incremental paid amounts in the second column of Table E.1 have been adjusted to a 2003 cost level assuming a constant 9% per year rate of medical cost escalation. The incremental amounts included in these totals were for accident years from 1945 on, during calendar years 1991 through 2003. These have been totaled for groupings of five successive development years.

The claim counts in the third column of Table E.1 are on a different basis than in the rest of this paper in order to focus only on severity changes for claims where ongoing medical payments are being made. Consequently, these counts only include claims where some medical payment was made during the given calendar year.

The magnitude of the increases in on-level incremental severities for later DYs shown in Figure 1.2 is greater than if the number of prior open counts was used. This is because the percentage of MPD claims for which payment activity occurs tends to decline somewhat for later DYs. This decline indicates that

TABLE E.1

INCREMENTAL PAID SEVERITIES AT 2003 LEVEL

Development Years (DYs)	Incremental Paid ($000s)	Claims with Payment Activity	Incremental Paid Severity
16–20	537,626	99,417	5,408
21–25	406,047	73,876	5,496
26–30	318,881	50,646	6,296
31–35	243,062	29,068	8,362
36–40	129,420	14,486	8,934
41–45	60,487	7,429	8,142
46–50	38,960	3,674	10,604
51–55	22,674	1,919	11,816

mortality rates are higher for those MPD claimants with ongoing covered medical costs. However, the disabled life factors indicated by SAIF's total open counts for later DYs are in the range of 70% to 80%, leaving some room for the actual mortality rates of claimants with ongoing covered medical costs to be close to those of the general populace.