



Identifying and Quantifying the Cost Drivers of Loss Development: A Bridge Between the Chain Ladder and Statistical Modeling Methods of Loss Development

Background

The analysis presented in this paper reflects NCCI's ongoing commitment to developing techniques and processes that enhance our methodologies. Recent examples include introducing a new approach to class ratemaking, remapping of hazard groups, changing the treatment of large losses, and developing statistical models for estimating loss trends. This paper addresses recent work at NCCI on enhancing the modeling of loss development.

The Critical Role of Estimating Loss Development

An estimate of ultimate claims costs is essential to setting loss reserves and in determining trends in loss costs, which is a key factor in ratemaking. At its most basic level, this requires some method of estimating future payments on claims from past underwriting periods. In general, it seems appropriate to analyze the observed year-to-year growth in losses of prior underwriting years to estimate how claims costs of more recent years might be expected to evolve. This typically is referred to as "loss development."

The most popular actuarial methods for evaluating and projecting loss development are largely a blend of mechanical and subjective analyses. A leading example is the chain ladder method applied to a loss triangle. The chain ladder method calculates period-to-period rates of growth in reported cumulative losses—typically either cumulative payments or cumulative paid plus case reserves—by underwriting period. These growth rates for a given report period are averaged for various combinations of underwriting periods; actuarial judgment is then used to select a set of development factors deemed to be most representative of the anticipated pattern of future loss development. The selected development factors are then applied to the most recent reported cumulative losses for each open underwriting period to forecast future remaining claim payments and, hence, total ("ultimate") losses for each underwriting period.

Interest is growing in the use of statistical models to estimate ultimate losses. In particular, the models developed by Barnett and Zehnwirth¹ and by Schmid² have garnered the most attention recently. The two models share a common framework but rely on markedly different statistical techniques to analyze claims experience. The common framework characterizes loss development in terms of three time dimensions:

- Calendar year
- Development year
- Exposure or underwriting year

In addition, both approaches analyze the growth in incremental payments. In terms of statistical methods, the Barnett/Zehnwirth model uses maximum likelihood techniques, while the model developed by Schmid is Bayesian and employs Monte Carlo Markov Chain simulation.

¹ "The Best Estimate of Reserves," Glen Barnett and Ben Zehnwirth, *Proceedings of the Casualty Actuarial Society*, November 2000.

² See "The Workers Compensation Tail Revisited," Frank Schmid, *ncci.com*, May 2009.

Both models offer apparent advantages over the traditional chain ladder method. The most notable include:

- Separating the influence of inflation from the period-to-period run-off rate (i.e., the calendar year versus the development year dimensions)
- Generating separate development factors for each policy or accident year
- The ability to identify and quantify the impact of reforms on development

Schmid's Bayesian model has the added advantage of being able to handle sparse and missing data.

The Challenge and the Response

It should come as no surprise that many actuaries are uncomfortable using estimates of loss development and ultimate losses that are generated by unfamiliar and, as yet, unproven statistical models. This is especially true because the chain ladder method is time tested and intuitively appealing. The actuarial literature, however, recognizes some of the challenges with the chain ladder method. A case in point is the recent attention given in *Variance* to the "important paper" by Quarg and Mack on the Munich Chain Ladder Method (MCLM). The MCLM can be viewed as an attempt to address a disadvantage of the traditional chain ladder method—separate calculations based on paid and incurred loss triangles often produce dramatically different estimates of ultimate losses for a given underwriting year; the MCLM forces them to converge over the development horizon.

The challenge lies in addressing the understandable reluctance among actuaries to use the output of statistical models. This paper responds by providing a bridge between the intuitive appeal of the chain ladder loss triangle methods and the analytical underpinnings of statistically based loss development models. In particular, it presents a framework that aligns the time dimensions of the statistical models with readily understood and reasonable drivers of loss development. The statistical estimates generated by the models, estimates of the period-to-period contributions of the drivers of loss development, should be easy to interpret and apply using the framework in this paper.

The first section of the analysis develops a model that describes the loss development process in a way that identifies the key drivers of period-to-period loss development.

The second section offers a series of case studies of how the model might be applied.

- The case study in the second section begins with a step-by-step analysis of the data in the countrywide medical triangle to illustrate the changing contributions of key drivers over the course of development
- This is followed by similar analysis of the countrywide indemnity triangle
- Additional analysis examines differences in comparable drivers of countrywide medical and indemnity losses
- The countrywide analysis concludes with an illustration of how additional data, in this case both unit statistical and transactions data, can be used to identify additional dynamics in the loss development process
- Additional examples are presented under the heading "Putting This Approach to Use"
 - The first example uses state level data to illustrate how the model can help identify and quantify structural changes in the development process
 - This is followed by a description of a presentation at the 1988 CAS Loss Reserving Seminar that used a similar approach to take explicit account for the impact of inflation on loss development
- The paper concludes with a brief discussion of the two leading statistical models and how the recognition and analysis of the key drivers of loss development should make it easier to incorporate the results of statistical models in determining ultimate losses

The Loss Triangle—A General Specification for Tracking Period-to-Period Loss Development

The conventional loss triangle contains data on cumulative costs (typically paid or paid plus case reserves) for claims by accident year (AY) or policy year (PY) as reported at regular intervals ("report" or "evaluation" periods) over time (e.g., at 12 months, 24 months, etc.) As presented in Exhibit 1 (Cumulative Loss Triangle on the next page), the rows represent accident years, and the columns represent report or evaluation periods relative to the start of the accident year (e.g., 12 months indicates the status at the end of the AY; 24 months is the status 12 months following the end of the AY).

The model of loss development below uses a loss triangle framework based on incremental payments: the first differences in cumulative paid losses. Payments rather than incurred losses (i.e., "paid plus case" with or without IBNR) are more likely to reflect the true loss development process. In contrast, the process underlying incurred losses includes the influence of changes in reserving philosophy and in judgment about the underlying loss development process, not just the process itself. Focusing on incremental development rather than the traditional cumulative development avoids potentially serious statistical challenges including the extensive serial correlation in cumulative loss triangles. (See Exhibit 2, Incremental Loss Triangle, based on Exhibit 1 on the next page.)

Exhibit 1—Cumulative Loss Triangle—Countrywide Data (NCCI States)

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th
1980	-	-	-	-	-	-	-	-	-	1,392,724,910	1,411,370,803	1,427,133,114	1,444,935,770	1,462,637,365	1,479,116,228	1,496,511,757	1,510,518,324	1,522,662,417	1,536,367,159	1,543,395,858
1981	-	-	-	-	-	-	-	-	1,556,581,627	1,579,634,876	1,600,479,478	1,620,845,717	1,639,149,423	1,656,428,696	1,677,459,948	1,698,174,737	1,712,939,607	1,727,565,205	1,738,257,606	1,750,425,991
1982	-	-	-	-	-	-	-	-	1,690,776,328	1,712,823,075	1,736,100,177	1,754,096,291	1,776,392,905	1,796,563,496	1,813,508,329	1,826,781,819	1,839,609,859	1,847,442,593	1,860,444,812	1,876,689,580
1983	-	-	-	-	-	-	-	1,895,592,119	1,929,035,240	1,961,527,745	1,987,930,591	2,012,087,597	2,041,444,559	2,067,973,259	2,090,838,645	2,109,791,344	2,131,389,851	2,143,606,870	2,159,047,270	2,176,527,953
1984	-	-	-	-	-	-	-	-	2,383,161,702	2,417,430,834	2,455,288,216	2,490,861,754	2,523,695,395	2,549,171,977	2,576,178,329	2,592,082,045	2,612,475,681	2,632,479,147	2,652,291,681	2,675,375,935
1985	-	-	-	-	-	-	-	-	2,537,785,323	2,597,100,868	2,644,754,302	2,686,682,949	2,727,353,974	2,766,090,385	2,803,432,989	2,830,750,792	2,867,059,161	2,891,076,810	2,916,655,132	2,942,035,838
1986	-	-	-	-	-	-	-	-	2,824,452,765	2,889,097,119	2,938,994,364	2,984,541,752	3,033,262,000	3,080,381,381	3,122,749,263	3,161,303,185	3,199,206,359	3,248,465,149	3,272,834,321	3,296,538,976
1987	-	-	-	-	-	-	-	-	3,026,018,791	3,159,271,424	3,295,842,587	3,327,220,170	3,391,286,997	3,451,405,844	3,501,950,231	3,549,230,187	3,594,485,029	3,632,019,268	3,664,131,748	3,694,520,601
1988	-	-	-	-	-	-	-	-	3,735,338,090	3,837,308,714	3,915,559,191	3,987,308,546	4,052,308,299	4,110,024,706	4,158,965,827	4,209,081,971	4,250,035,799	4,288,793,188	4,329,206,001	4,368,794,575
1989	-	-	-	-	-	-	-	-	4,219,579,716	4,330,292,091	4,425,684,718	4,506,289,147	4,572,471,423	4,629,259,259	4,679,721,798	4,731,723,568	4,774,503,978	4,817,807,682	4,856,045,160	4,900,146,801
1990	-	-	-	-	-	-	-	-	4,425,684,718	4,506,289,147	4,572,471,423	4,629,259,259	4,679,721,798	4,731,723,568	4,774,503,978	4,817,807,682	4,856,045,160	4,900,146,801	4,937,146,076	4,974,404,073
1991	-	-	-	-	-	-	-	-	4,714,052,047	4,790,372,607	4,850,269,547	4,908,948,060	4,957,240,180	4,995,220,877	5,040,217,820	5,082,733,082	5,120,590,410	5,159,515,267	5,199,977,258	-
1992	-	-	-	-	-	-	-	-	4,821,483,092	4,878,692,009	4,928,279,064	4,975,374,820	5,016,596,268	5,055,551,772	5,089,752,322	5,126,910,917	5,162,413,749	5,197,347,674	-	-
1993	-	-	-	-	-	-	-	-	4,908,362,685	4,972,693,209	5,032,537,995	5,087,312,958	5,134,404,639	5,181,203,219	5,228,205,654	5,274,410,470	5,319,832,190	-	-	-
1994	-	-	-	-	-	-	-	-	5,032,537,995	5,087,312,958	5,134,404,639	5,181,203,219	5,228,205,654	5,274,410,470	5,319,832,190	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	5,134,404,639	5,181,203,219	5,228,205,654	5,274,410,470	5,319,832,190	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	5,228,205,654	5,274,410,470	5,319,832,190	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	5,319,832,190	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	5,376,762,668	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Exhibit 2—Incremental Loss Triangle—Countrywide Data (NCCI States)

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th	19th	20th
1980	-	-	-	-	-	-	-	-	-	-	18,645,893	15,768,311	17,796,656	17,701,585	16,478,872	17,395,530	14,006,566	12,144,094	13,704,741	7,028,699
1981	-	-	-	-	-	-	-	-	-	23,053,249	20,844,602	20,366,238	18,303,707	17,273,272	21,031,252	20,714,789	14,764,870	16,625,598	10,632,402	12,168,385
1982	-	-	-	-	-	-	-	-	23,877,197	22,046,747	23,277,103	17,996,113	22,896,614	19,570,591	16,944,833	13,273,489	12,828,040	7,832,724	13,022,228	16,244,763
1983	-	-	-	-	-	-	-	33,443,121	32,492,505	26,402,846	24,167,006	29,356,962	26,528,700	22,865,386	18,952,698	21,598,508	12,217,018	15,440,400	17,480,683	15,856,576
1984	-	-	-	-	-	-	54,755,805	44,050,580	37,905,709	34,279,132	37,857,382	35,573,538	32,833,640	25,476,582	27,006,352	15,903,716	20,393,636	20,003,465	19,812,514	23,084,275
1985	-	-	-	-	-	77,611,914	59,335,545	47,653,433	41,928,648	40,671,024	38,736,411	37,342,605	27,317,803	36,308,369	24,017,649	25,578,321	25,380,707	22,289,347	25,760,805	26,657,522
1986	-	-	-	-	121,562,073	81,927,557	63,644,354	50,897,245	45,547,388	48,720,248	47,719,381	41,767,882	38,553,922	37,903,174	25,740,234	23,518,556	24,369,172	23,704,654	23,765,058	24,271,150
1987	-	-	-	217,740,357	133,252,633	96,371,163	71,577,582	64,066,727	60,118,947	50,544,386	47,279,956	45,254,842	37,534,237	32,112,482	30,388,853	30,524,111	29,658,810	29,991,306	33,607,601	28,918,446
1988	-	-	467,167,207	244,378,901	151,083,607	101,370,623	78,260,478	71,739,355	64,999,753	57,716,407	48,941,121	50,116,143	40,953,829	38,747,389	40,422,813	39,588,574	38,602,088	32,730,930	31,417,931	-
1989	-	1,581,332,427	531,557,342	271,216,121	163,828,979	110,712,375	95,392,627	80,604,429	66,182,275	56,787,836	50,462,540	52,007,770	42,774,409	43,303,704	38,237,478	44,101,642	36,999,275	37,257,997	-	-
1990	-	1,691,395,989	541,923,050	269,323,933	166,008,344	125,405,246	92,568,955	76,320,560	59,896,940	58,678,513	48,292,120	37,980,637	44,996,943	42,515,261	37,857,328	38,924,857	40,461,991	-	-	-
1991	-	1,544,863,379	489,937,274	222,520,706	152,927,570	95,184,268	68,200,101	64,330,523	55,585,855	47,095,755	41,221,448	38,955,504	34,200,551	37,158,595	35,831,223	34,290,861	-	-	-	-
1992	-	1,474,788,092	409,983,208	207,388,007	117,456,280	78,925,645	61,894,700	51,632,262	42,990,282	40,734,949	35,953,914	35,638,798	33,455,743	32,621,700	32,667,124	-	-	-	-	-
1993	-	1,299,454,177	370,461,989	172,862,765	101,036,701	70,709,135	53,539,263	45,809,633	38,774,962	39,091,681	41,798,581	33,002,435	28,897,815	29,469,040	-	-	-	-	-	-
1994	-	1,323,026,474	358,803,822	176,774,567	96,306,539	66,711,845	55,091,777	45,062,879	40,471,968	37,846,040	32,460,316	35,004,553	32,110,771	-	-	-	-	-	-	-
1995	-	1,158,942,044	331,955,858	161,022,411	93,371,035	63,453,446	56,024,493	41,798,015	41,242,530	38,281,895	34,082,829	34,704,470	-	-	-	-	-	-	-	-
1996	-	1,187,014,817	341,547,493	162,245,291	95,761,429	65,086,553	50,080,638	41,767,871	43,760,595	48,163,155	36,167,028	-	-	-	-	-	-	-	-	-
1997	-	1,318,820,951	372,264,272	186,198,290	119,452,686	84,512,148	65,048,451	54,054,268	52,028,477	42,746,783	-	-	-	-	-	-	-	-	-	-
1998	-	1,237,663,711	377,177,771	198,172,999	122,665,337	85,453,553	70,081,133	65,765,300	53,755,296	-	-	-	-	-	-	-	-	-	-	-
1999	-	1,424,904,822	454,768,407	229,994,500	150,961,643	86,747,938	79,036,227	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	1,471,969,054	473,938,470	239,331,087	148,942,493	113,047,107	86,661,370	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	1,543,511,879	495,033,891	256,065,237	163,050,559	120,988,208	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002	-	1,657,118,492	516,894,678	269,295,419	165,759,375	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	1,689,520,027	528,528,295	265,443,580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	1,798,151,889	529,903,894	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	1,822,354,698	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Developing a Model of the Drivers of Loss Development

In general, the amount of loss payments in any given period can be described by the following definition:³

Total Claim Costs = Number of claims * Average number of payments per claim * Average cost per payment

- Total claims costs (Pt)
- The number of claims active/open in the period (CLt)
- The average number of payments per claim in the period (e.g., indemnity checks, medical bills – NPt)
- The average amount per payment (CPt)

$$Pt = CLt * NPt * CPt$$

Loss Triangles and Incremental Growth in Two Time Dimensions

This general specification can be modified to describe two time dimensions in loss development triangles:

- Development/run-off time—across columns
- Calendar periods—down the diagonals—from upper left corner to lowest right diagonal

Development Period Analysis (adjacent columns t and t + 1 in a single row i)

Incremental development can be measured by the ratio of total (incremental) payments in two successive report periods.

Incremental growth:⁴ $Gt + 1 = Pt + 1 / Pt = [(CLt + 1 * NPt + 1 * CPt + 1) / (CLt * NPt * CPt)]$

The log growth rate:⁵ $\ln Gt + 1 = \ln (Pt + 1 / Pt) = \ln Pt + 1 - \ln Pt =$

$[\ln CLt + 1 - \ln CLt] + [\ln NPt + 1 - \ln NPt] + [\ln CPt + 1 - \ln CPt]$

- $[\ln CLt + 1 - \ln CLt]$ is equivalent to the period-to-period claims closure rate.
- $[\ln NPt + 1 - \ln NPt]$ is a measure of the period-to-period rate of change in the average number of transactions per claim—a key component in the change in utilization.
- $[\ln CPt + 1 - \ln CPt]$ reflects the rate of change in average cost per payment—primarily reflecting inflation in prices applicable to the payment. There may well be changes between report periods in the mix of services that also impact the average size of payments; changes in mix are generally considered another component in changes in utilization.

To some, this approach may be appealing in theory, but they may question its value in practice. To address this challenge, the following sections apply this model to loss triangle data for countrywide workers compensation medical and indemnity claims as reported to NCCI in its Financial Call for 2007.

³ The proposed approach is based on a common definition: Cost = Price * Quantity
Or, alternatively: Cost = Price * Utilization
Where: Utilization includes Quantity and Mix

⁴ Note that the incremental growth factor $[Gt + 1 = Pt + 1 / Pt]$ is the incremental equivalent to the period-to-period link ratio used in the traditional chain ladder method.

⁵ Log values of the ratios technically are log growth rates; log growth rates have at least two useful characteristics.

First, they are symmetrical. For small rates of change, they are roughly the same as arithmetic growth rates; for large changes, arithmetic and log growth rates convey different meanings:

- A change from 100 to 101 is a 1% arithmetic increase and a .995% log arithmetic increase
- A change from 1540 to 735 (the high and low for the S&P 500 in the most recent recession) is a 52% decline arithmetically, whereas a recovery from 735 to 1540 would require a 110% increase
- In contrast, a change from 1540 to 735 is a 74% decline in log rates and a change from 735 to 1540 is a 74% increase

initial value	100	101	1540	735
end value	101	100	735	1540
arithmetic	1.000%	-0.990%	-52%	110%
log arithmetic	0.995%	-0.995%	-74%	74%

Second, when working with products of variables, their log growth rates are additive. This feature is used extensively in this analysis of the drivers of loss development.

Case Studies in the Analysis of the Drivers of Loss Development

Identifying and Quantifying the Cost Drivers of Countrywide⁶ Medical Loss Development

The analysis of the components of medical loss development starts with a display of the data as reported; this is followed by data showing two of the components—medical inflation and estimates of claim closure rates. The residuals after adjusting for these two factors are estimates of the rates of change in average transactions per claim.

- As Reported—Nominal
- Deflated—Real
- Adjusted for Claims Closure Rates
- The Residual—An Estimate of Average Transactions per Claim

⁶ The data for countrywide loss development covers only NCCI states. The source is Financial Call data for 2007.

Step 1

Countrywide Medical Loss Development—As Reported—Incremental Growth Rates:

$$\ln G_t + 1 = \ln (P_t + 1 / P_t)$$

As indicated in the previous exhibits, the Financial Call data covers portions of up to 20 report periods for the 26 accident years from 1980 through 2005. Chart 1a shows the log growth rates of incremental medical payments by report period.

Chart 1a
Growth in Incremental Payments by Report Periods—
Log Growth Rates (arithmetic equivalent shown as [%] in the y-axis)

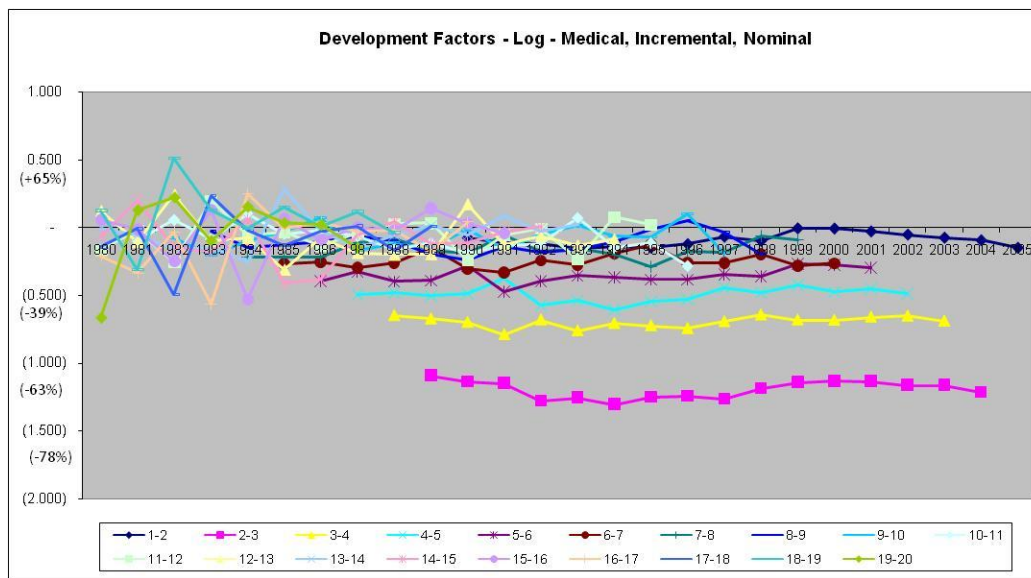


Chart 1b
The Impact of Medical-Only Payments Dominates the Early Report Periods—
Marked Rates of Decrease Over Periods 2 to 3 and 3 to 4

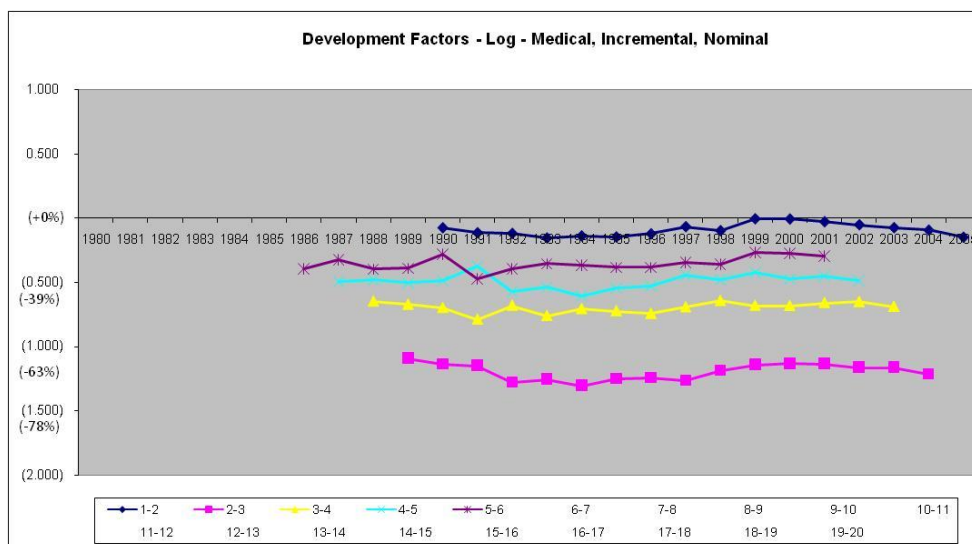


Chart 1c

Smaller Rates of Decrease Over Periods 5 to 6 through 10 to 11

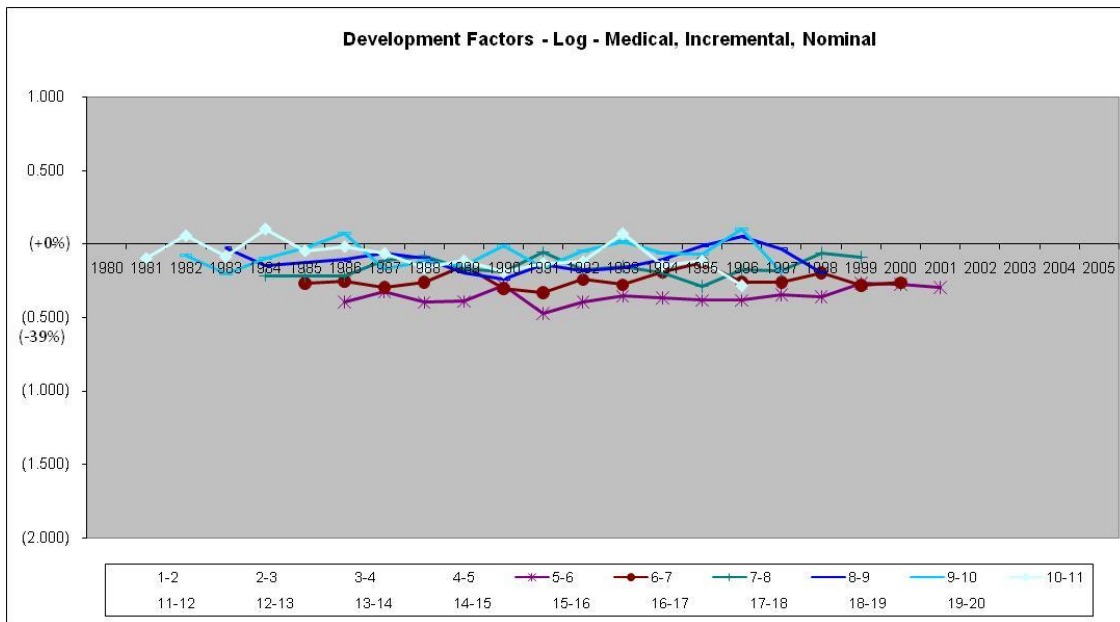
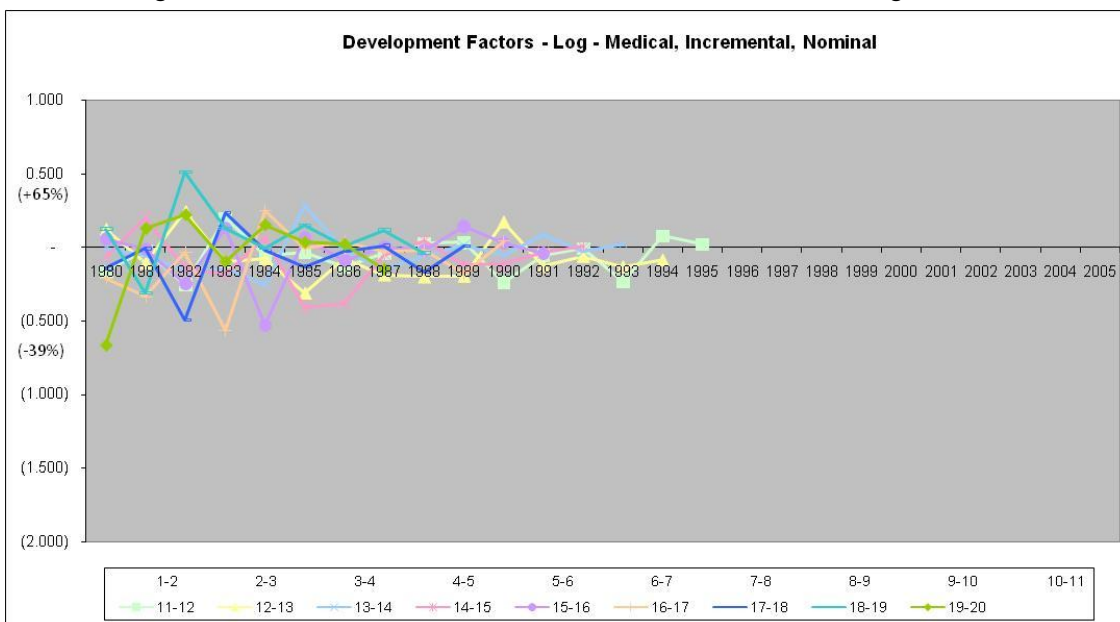


Chart 1d

Large Variance in Rates of Decrease Over Periods 11 to 12 through 19 to 20



High-Level Observations on the Pattern of Incremental Medical Loss Development

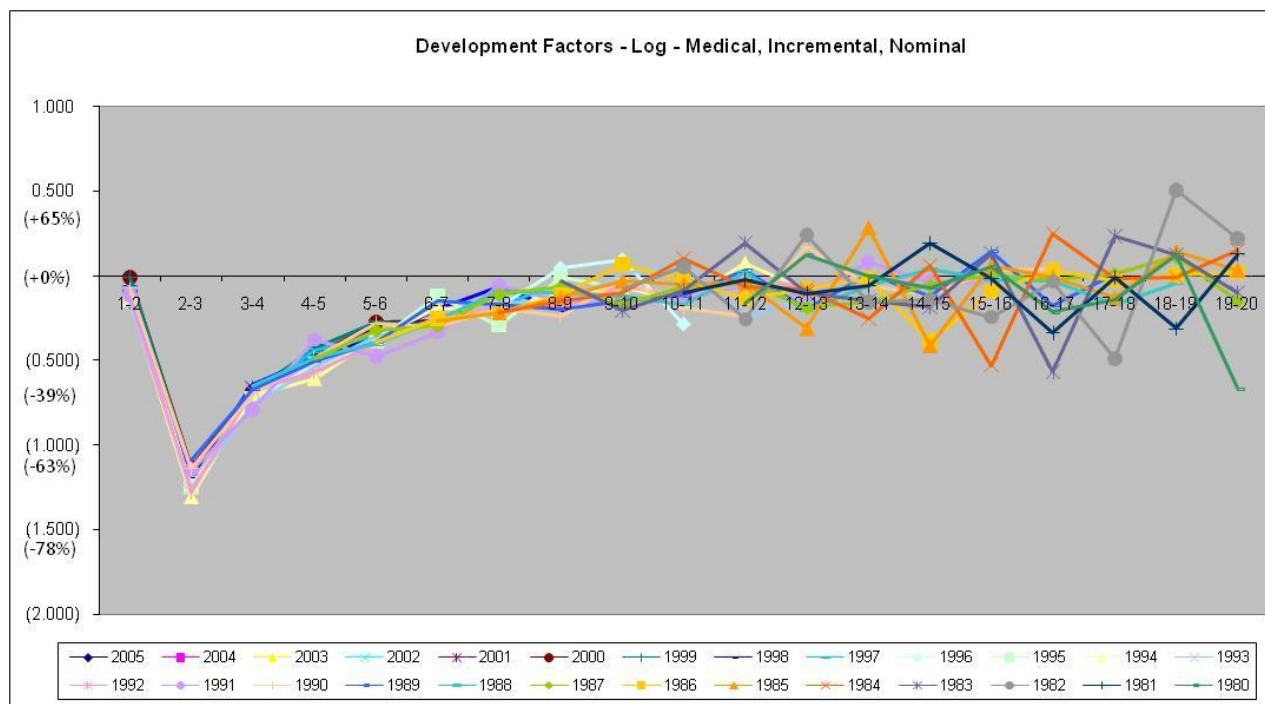
Paid medical losses remain unchanged to slightly down in the first two years of the typical accident year. This likely reflects the ongoing payments for accidents that occur late in the AY, which extend into the second 12 months of the AY. (See Chart 1b.)

Thereafter, the payments begin to decline—at first (periods 2 to 3 and 3 to 4) rather dramatically because medical-only and many temporary claims are closed. The rate of decline then begins to ease over periods 4 through 6. (See Charts 1b and 1c.)

Late in development, the rates of change, on average, are rather modest with a large variance with, for example, a large increase often being followed by a large decrease as a large payment moves from the numerator to the denominator of the ratio of payments. (See Chart 1d.)

The changing pattern in the development of medical payments is also reflected in Chart 2, which presents the same data by accident year.

Chart 2
Accident Year Patterns—
The Impact of Medical-Only Payments Dominates the Early Report Periods—
Steadily Smaller Rates of Decrease After Period 2 to 3 and
Increased Variance Late in Development With Some Apparent Serial Correlation in AY Factors



Step 2

Countrywide Medical Loss Development—Accounting for the Impact of Inflation on Medical Loss Development: In $G_t + 1 - [\ln CPT + 1 - \ln CPT]$

Changes in the rate of medical inflation are reflected in medical payments and, therefore, in the pattern of loss development. It was no coincidence, for example, that medical severity grew markedly in the early 1980s; as seen in the charts below, medical price inflation was extremely high.⁷ Chart 3a depicts the log rate of inflation in the medical consumer price index (MCPI) for Calendar Years 1981 through 2006. Chart 3b illustrates how calendar year inflation would be expected to impact the loss development of a given accident year, in this case AY 1980.

Chart 3a
Calendar Year Medical Inflation

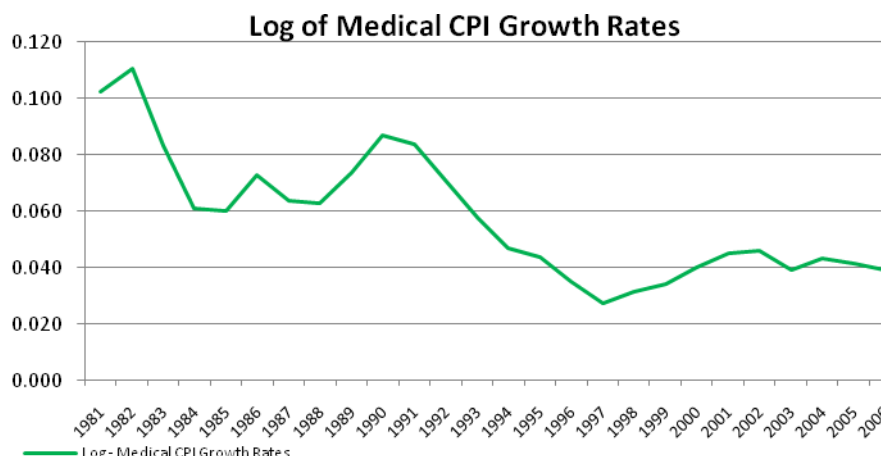
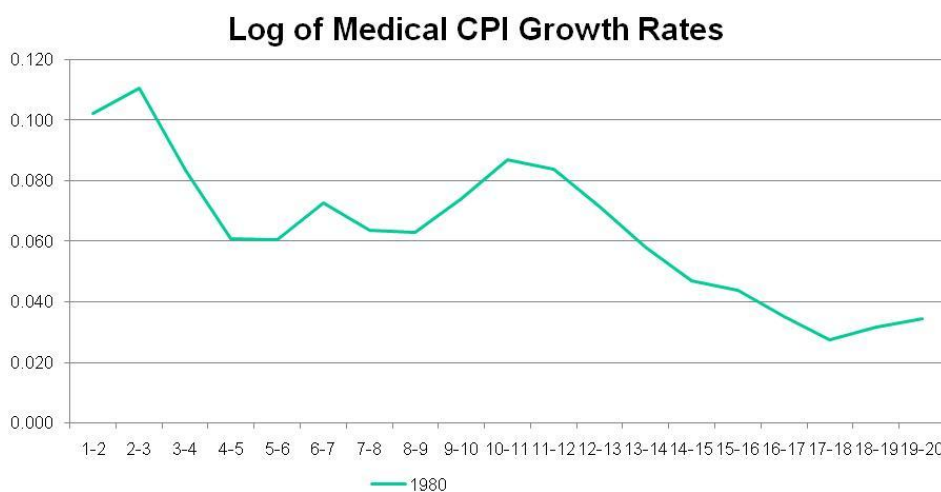


Chart 3b
AY 1980 Development Period Medical Inflation



⁷ The late 1970s was a period of high inflation. Paul Volker was appointed chairman of the Federal Reserve and given the assignment of bringing inflation under control. The impact of his monetary policy is reflected in the decline in medical inflation in the early 1980s.

Chart 4

Inflation-Adjusted Incremental Growth Rates Are Moderately Lower than Nominal, Reflecting Reasonably Stable Medical Inflation Since the Mid-1980s

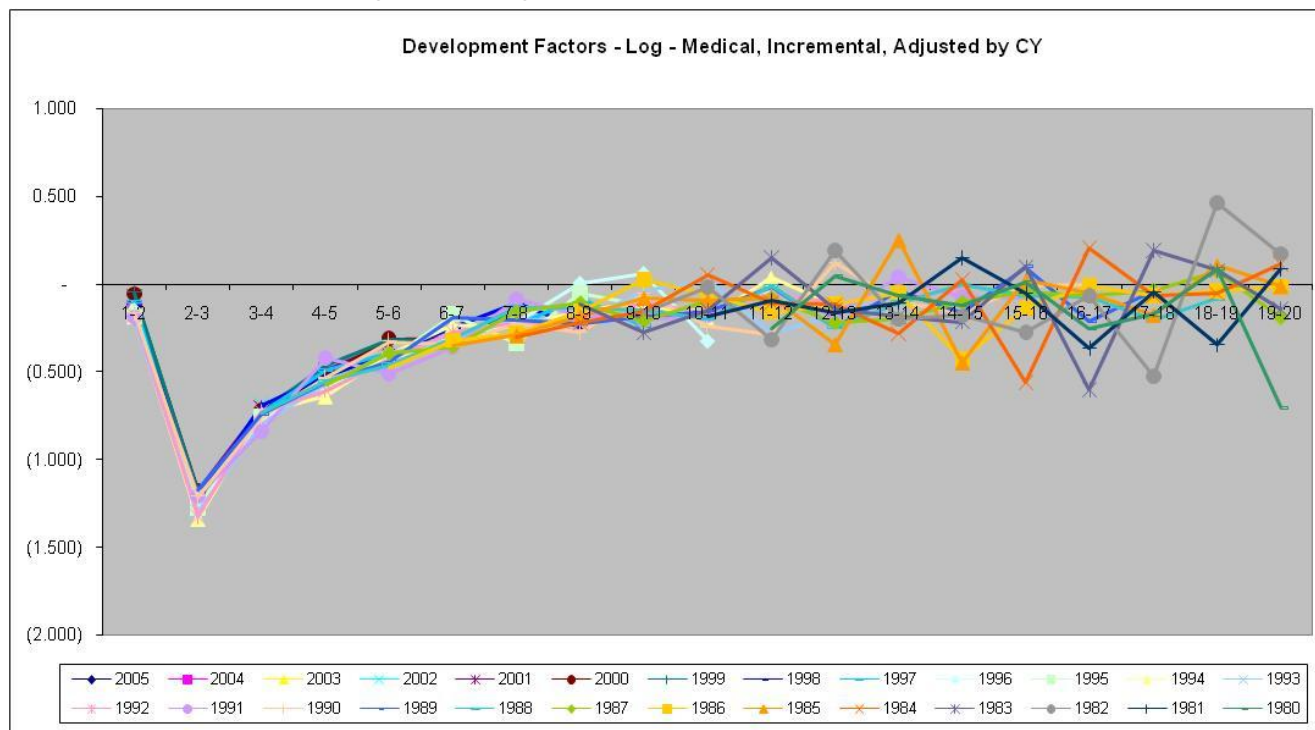


Chart 4 shows the incremental growth rates of medical payments after subtracting medical inflation. As a consequence, each AY curve is slightly lower in Chart 4 relative to Chart 2. This can be seen by comparing the location of the values for development between report periods 1 and 2. The inflation adjusted values in Chart 4 are slightly negative, whereas the nominal values in Chart 2 are close to zero. The downward shift is modest because medical inflation since the early 1980s has been relatively modest and stable.

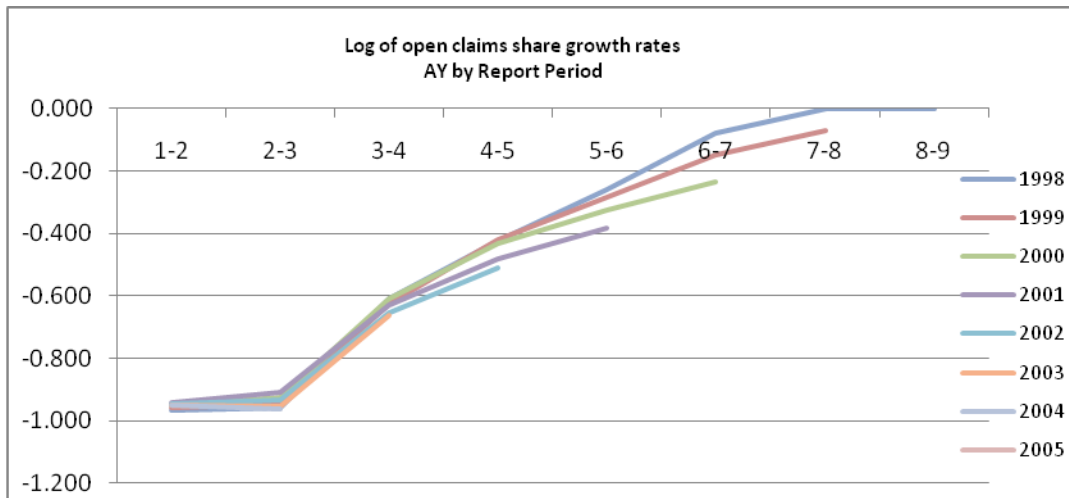
Step 3

Countrywide Medical Loss Development—Claims Closure Is a Major Factor in Medical Loss Development

It is not surprising that claims closure is the key factor in the changing rates of incremental medical loss development. Chart 5 indicates that the rate of closure of medical claims⁸ is high from periods 1 to 2 and periods 2 to 3. The pace eases steadily over subsequent development periods. One observation: it appears that, deeper into development, the rate of incremental claims closure has been trending upward in recent years. The curves in Chart 5 are more negative for more recent accident years.

⁸ Estimates of claim closure rates are based on analysis of Unit Stat Plan data to capture the influence of medical-only claims and Financial Call data for lost-time claims included in the medical payments data. For more details, see Appendix B.

Chart 5
Medical Claims Closure—Estimated Rates of Change



Step 4

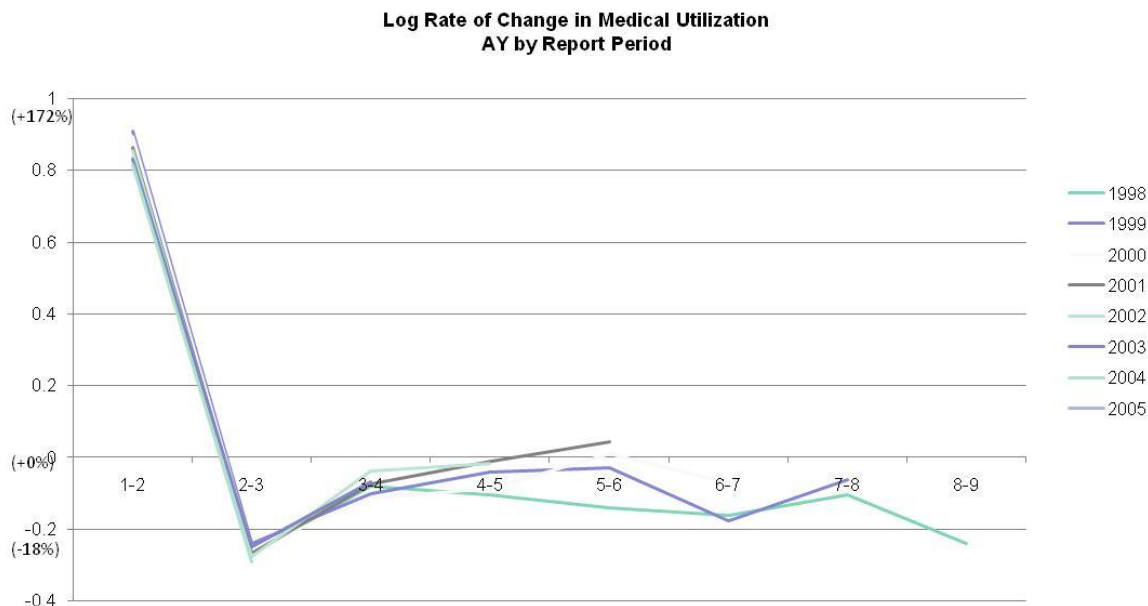
Changes in Medical Transactions per Claim—The Third Driver of Medical Loss Development: $$[\ln N_{Pt} + 1 - \ln N_{Pt}] \Rightarrow \ln G_t + 1 - [\ln C_{Pt} + 1 - \ln C_{Pt}] - [\ln CL_t + 1 - \ln CL_t]$$

After accounting for inflation and claims closure, the balance of changes in incremental loss development should be attributed to changes in the average number of transactions (i.e., payments) per claim. The values of the residuals for medical loss development are shown in Chart 6. One prominent feature is the apparent marked increase in the average number of payments per claim from period 1 to period 2. This is consistent with the data in Charts 2, 4, and 5. The rate of change in incremental medical payments is close to zero and the impact of medical inflation is modestly negative. This means that there must be a material increase in the average number of payments per claim to offset the high rate of claim closures. There are at least two potential explanations for this: (1) the bulk of the claims closed early in development are medical only, which typically have relatively few payments per claim; and (2) there likely is a difference in the average mix of medical treatments between the two periods because the higher share of lost-time claims in period 2 should result in relatively more claims in that period receiving higher cost medical services.

The subsequent ongoing decline in the proxy for the average number of payments per claim likely reflects the gradual transition of medical treatment from active to maintenance; for example, a marked reduction in physical therapy sessions but continuing use of prescription drugs. This is examined in more detail in a later section of this paper.

Chart 6

**The Residual—A Proxy for the Change in Payments per Claim—
Medical Transactions per Claim Appear to Increase From 1 to 2,
Likely Reflecting the Distribution of Injuries Over the Accident Year;
Modest Declines Observed Over Subsequent Periods**



Medical Loss Development—Observations

Assessing the Key Cost Drivers of Medical Loss Development Provides Insight Into the Underlying Process of Loss Development

The preceding analysis suggests that the impact of medical inflation on loss development has been relatively modest and stable at least since the mid-1980s. The rate of claim closures is the key driver of incremental loss development and is especially prominent early in development due to the closure of the large number of medical-only claims. Some of the impact of the closing of medical-only claims is offset by increases in utilization likely reflecting the increased share of lost-time claims, which typically have higher average number of payments per claim and higher average cost of those payments. As measured by the residual in the changes in loss development, the impact of changes in utilization becomes modestly negative later in development.

Given the apparent prominent role of medical-only claims early in the development of medical losses, it seems likely that the development of indemnity losses, which involve only lost-time claims, will exhibit a different pattern early in development.

Identifying and Quantifying the Cost Drivers of Countrywide⁹ Indemnity Loss Development

The analysis of the components of indemnity loss development also starts with a display of the data as reported; this is followed by data showing two of the components—wage inflation and estimates of indemnity claim closure rates. The residual, after adjusting for these two factors, is an estimate of the rates of change in average transactions per claim:

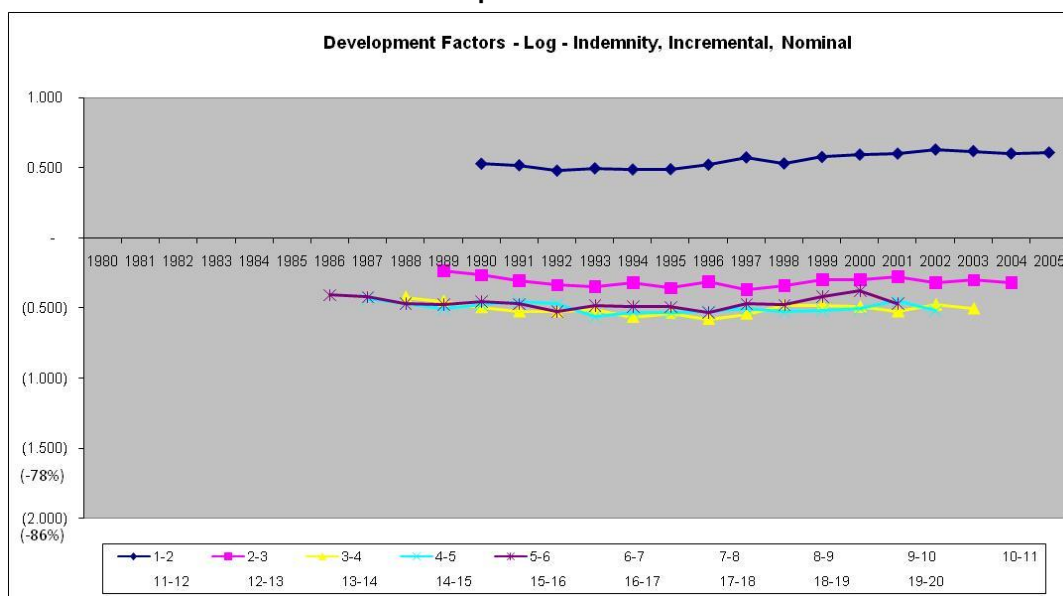
- As Reported—Nominal
- Deflated—Real
- Adjusted for Claims Closure Rates
- The Residual—An Estimate of Average Transactions per Claim

Step 1

Indemnity Loss Development—As Reported—Nominal Data: Incremental Growth Rates: $\ln Gt + 1 = \ln (Pt + 1 / Pt)$

As indicated in the previous exhibits, the Financial Call data covers portions of up to 20 report periods for the 26 accident years from 1980 through 2005. Charts 7a–7c show the log growth rates of incremental indemnity payments by report period.

Chart 7a
Incremental Indemnity Growth Rates Within Development Periods Are Reasonably Stable, With
Increases in Incremental Payments between Periods 1 and 2; Decreases Thereafter
As Reported—Nominal



⁹ The data for countrywide loss development covers only NCCI states. The source is Financial Call data for 2007.

Chart 7b

Incremental Indemnity Growth Rates Within Development Periods Are Reasonably Stable, With Continuing Decreases in Incremental Payments and Slightly Smaller Declines Deeper in Development—As Reported—Nominal

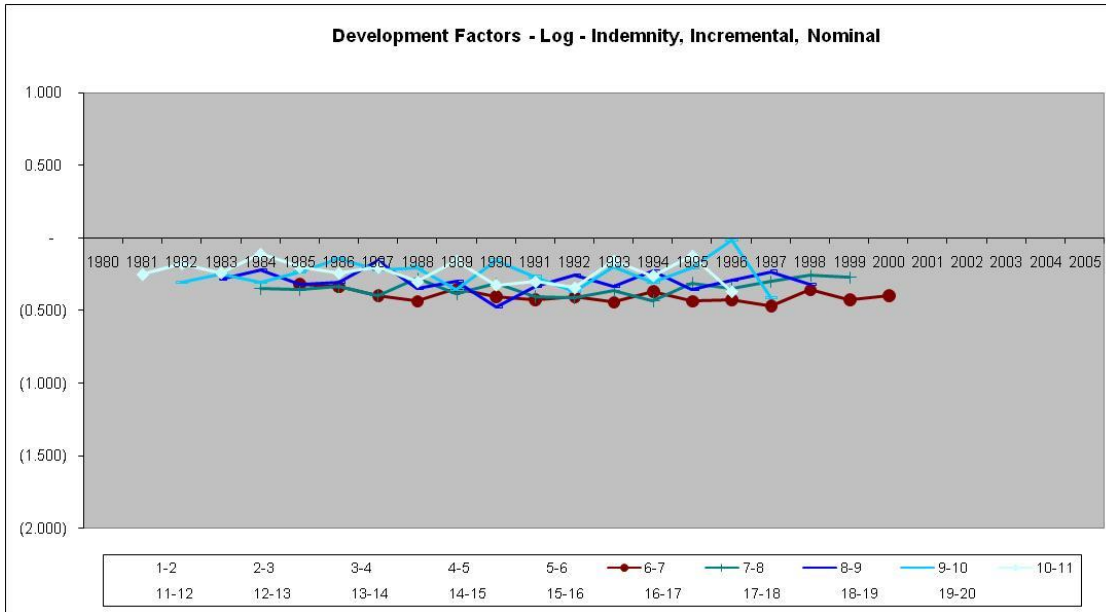
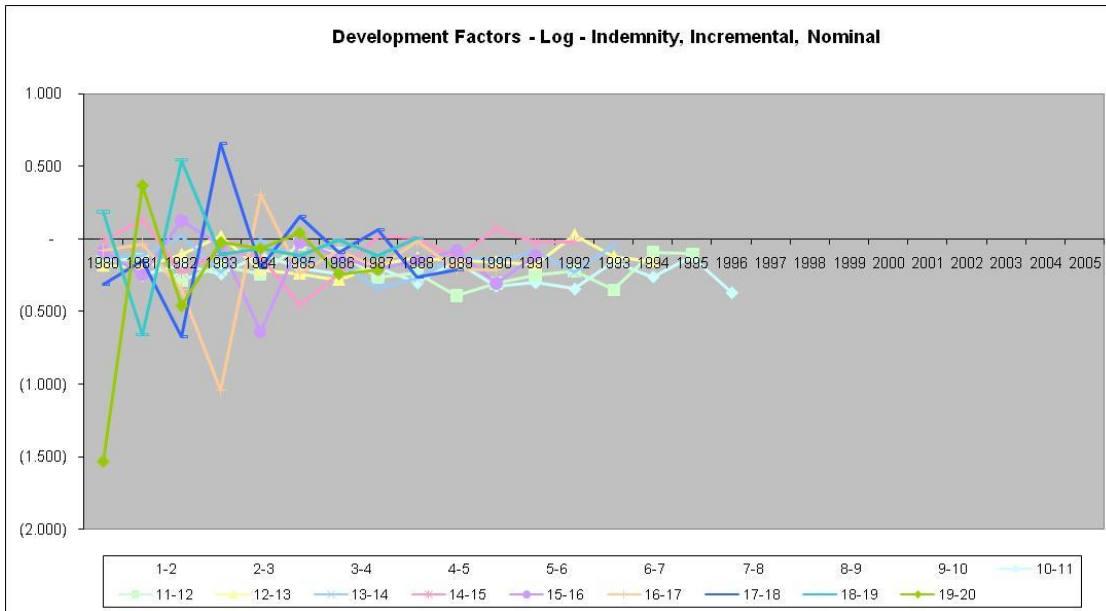


Chart 7c

Incremental Indemnity Growth Rates Within Development Periods Are Reasonably Stable, With Continuing Decreases in Incremental Payments and Slightly Smaller Declines Deeper in Development and Increased Variance Late in Development With Some Apparent Serial Correlation—As Reported—Nominal



High-Level Observations on the Pattern of Incremental Indemnity Loss Development

Paid indemnity losses increase markedly in the second year of the typical accident year. This likely reflects the ongoing payments for accidents that occur late in the AY, which will extend into the second 12 months of the AY.

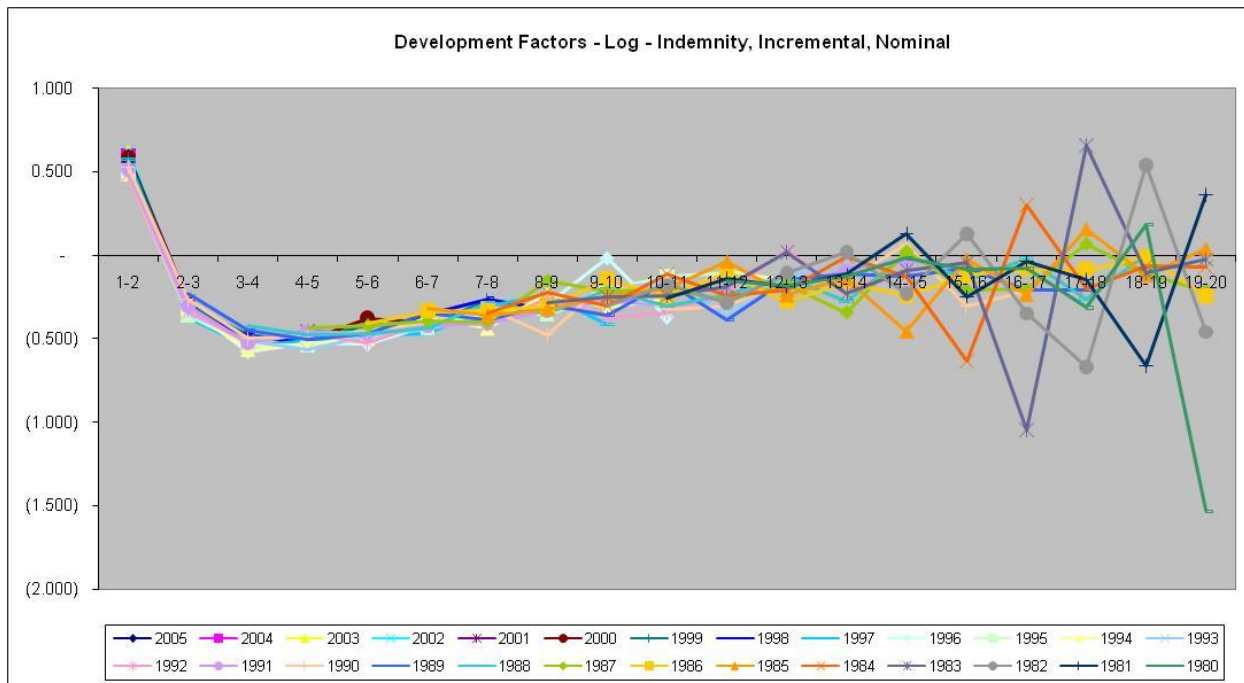
Thereafter, the payments begin to decline—modestly at first (period 2 to 3) and then (periods 3 to 4, 4 to 5, and 5 to 6) faster but at a reasonably uniform pace as temporary claims are closed. The rate of decline then begins to ease over periods 6 through 10.

Late in development, the rates of change, on average, remain rather modest with a large variance with, for example, a large increase often being followed by a large decrease as a large payment moves from the numerator to the denominator of the ratio of payments.

The changing pattern in the development of indemnity payments is also reflected in Chart 8, which presents the same data by accident year.

Chart 8

Incremental Indemnity Growth Rates Are Reasonably Stable Across Accident Years, With Variance Increases in Later Report Periods—As Reported—Nominal



Step 2

Indemnity Loss Development—Accounting for the Impact of Inflation on Indemnity Loss Development: $\ln Gt + 1 - [\ln Cpt + 1 - \ln Cpt]$

Changes in the rate of wage inflation are reflected in the level of accident year indemnity payments;¹⁰ the influence on loss development, however, depends on the nature of a state's WC benefits. In particular, only in a few states do indemnity benefits for outstanding claims change to reflect changes in the state's general wage level, often referred to as "escalation." As seen in the charts below, wage inflation was also extremely high in the early 1980s. Chart 9a depicts the log rate of inflation in the countrywide average weekly wage (AWW) for Calendar Years 1981 through 2006. Chart 9b illustrates how, in states with escalation, calendar year inflation would be expected to impact the loss development of a given accident year, in this case AY 1980.

Chart 9a

Illustrates Cost Drivers of Loss Development and Changing Pattern in Wage Inflation Impacting AY Payments

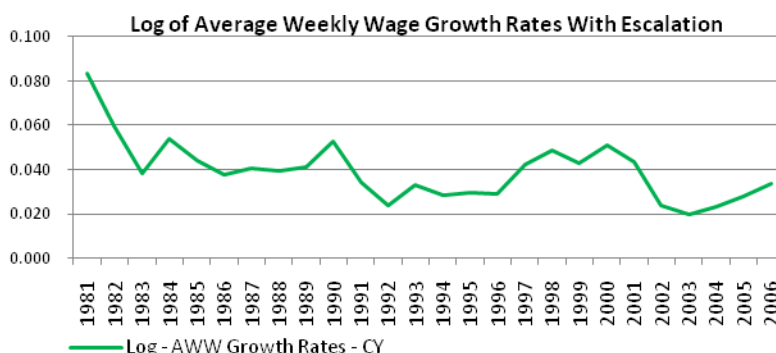


Chart 9b

Illustrates Cost Drivers of Loss Development and Deflating AY 1980 Incremental Indemnity Payments if Indemnity Benefits Include Escalation



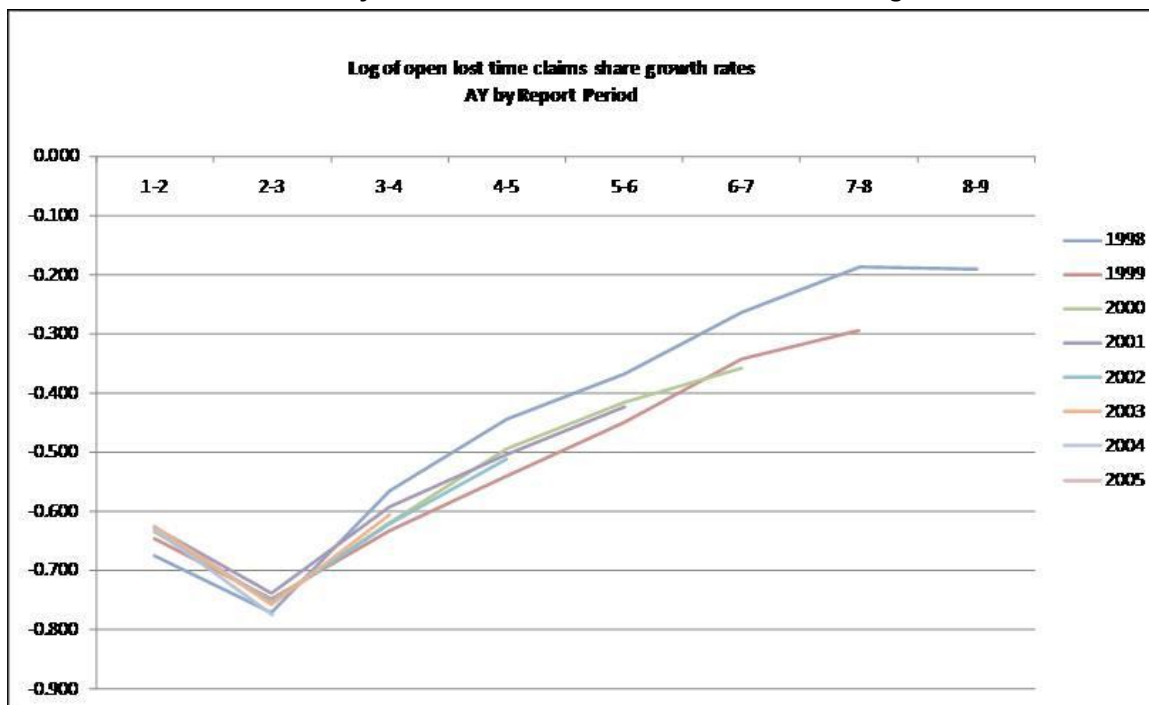
¹⁰ See Appendix A for a discussion of how this model can be extended to include changes in accident year claim costs.

Step 3

Indemnity Loss Development—Claims Closure Is a Major Factor in Indemnity Loss Development

It is not surprising that claims closure is also the key factor in the changing rates of incremental indemnity loss development. Chart 10 indicates that the rate of closure of indemnity claims¹¹ is high in period 1 to 2 and increases from 2 to 3. The pace then eases steadily over subsequent development periods. Deeper into development, the rate of incremental claims closure is similar to the closure of medical claims because most medical-only claims are already closed. As with medical, the curves for indemnity claims in Chart 10 are more negative for more recent accident years.

Chart 10
Illustrates Cost Drivers of Loss Development and
Indemnity Claims Closure—Estimated Rates of Change



¹¹ Estimates of indemnity claim closure rates are based on an analysis of Financial Call data for lost-time claims. For more details, see Appendix B.

Step 4a

Indemnity Loss Development—Changes in Indemnity Transactions per Claim—The Third Driver of Indemnity Loss Development: $[\ln \text{NPT} + 1 - \ln \text{NPT}] \Rightarrow \ln \text{Gt} + 1 - [\ln \text{CLt} + 1 - \ln \text{CLt}]$

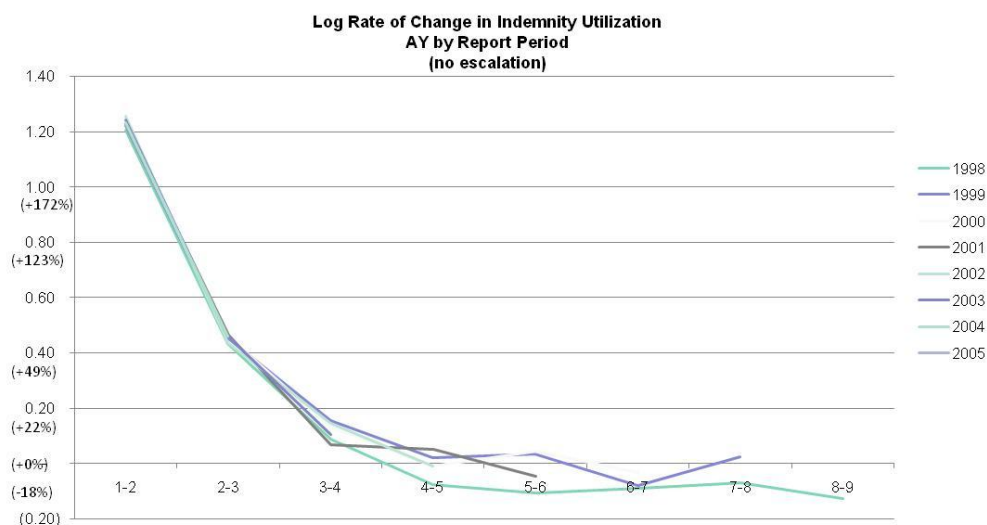
After accounting for claims closure (and assuming no escalation), the balance of changes in incremental loss development should be attributed to changes in the average number of transactions (i.e., payments) per claim. For indemnity claims, this is primarily a function of claim duration. The values of the residuals for indemnity loss development are shown in Charts 11a and 11b. One prominent feature is the apparent marked increase in the average number of payments per claim from period 1 to period 2. This is consistent with the data in Charts 8 and 10.

The rate of change in incremental indemnity payments is strongly positive and, by assumption, there is no provision for escalation in indemnity benefits. This means that there must be a material increase in the average number of payments per claim to offset the high rate of claim closures. There are at least two potential explanations for this: (1) the bulk of the claims closed early in development were of short duration, which, therefore, are likely to have relatively few payments per claim; and (2) there likely is a difference in the average mix of indemnity claims between the two periods because the higher level of permanent claims in period 2 should result in relatively more claims in that period having more payments due to their longer duration.

The subsequent decline in the proxy for the average number of payments per claim likely reflects the ongoing shift in the mix of indemnity claims from temporary toward longer duration permanent claims, which often have higher benefit levels. This shift seems to end between periods 3 and 4 because the rate of change in the proxy for average number of payments per claim appears to level off near or just above 0%.

Chart 11a

The Proxy for the Number of Payments per Indemnity Claim (no escalation)
Appears to Increase Early in Development, Then to Decline to Near 0%



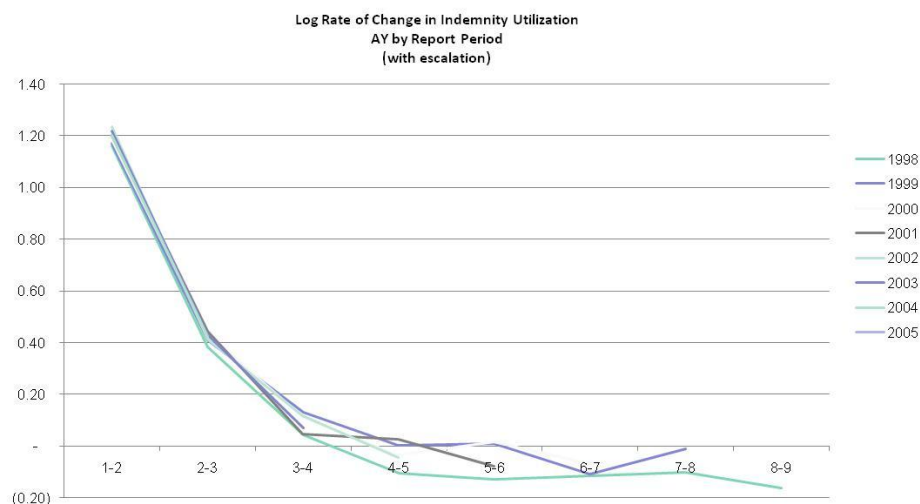
Step 4b

Indemnity Loss Development—Changes in Indemnity Transactions per Claim When Adjusting for Escalation: $[\ln \text{NPT} + 1 - \ln \text{NPT}] \Rightarrow \ln \text{Gt} + 1 - [\ln \text{CPT} + 1 - \ln \text{CPT}] - [\ln \text{CLt} + 1 - \ln \text{CLt}]$

Chart 11b includes the projected impact if incremental payments were deflated by the wage inflation depicted in Chart 9a. The effect is small between periods 3 and 4 because the rate of change in the proxy for average number of payments per claim appears to level off near or just below 0%. The actual impact of escalation on the development of countrywide indemnity losses likely lies between no escalation (Chart 11a) and comprehensive escalation (Chart 11b).

Chart 11b

**The Proxy for the Number of Payments per Indemnity Claim (with escalation)
Appears to Increase Early in Development, Then to Decline to Near 0%**



Indemnity Loss Development—Observations

Assessing the Key Cost Drivers of Indemnity Loss Development Provides Insight Into the Underlying Process of Loss Development

The preceding analysis suggests that the impact of wage inflation on indemnity loss development has been relatively modest and stable at least since the mid-1980s. The rate of claim closures is the key driver of incremental indemnity loss development and is especially prominent early in development due to the closure of a large number of temporary claims. Some of the impact of the closing of these short duration temporary claims is offset by increases in utilization likely reflecting both increases in the average number of payments per claim and the higher average cost of those payments as the share of higher cost and longer duration permanent claims increases. As measured by the residual in the changes in loss development, the impact of changes in utilization becomes negligible later in development.

Comparing Patterns in the Drivers of Countrywide Medical and Indemnity Loss Development

Observed Differences Between Countrywide Medical and Indemnity Seem Reasonable

Incremental Growth Rates¹²

- Incremental Development Patterns Seem to Converge After Periods 4 to 5
- Late in Development:
 - Indemnity Slightly More Negative
 - Indemnity Exhibits Greater Variance

Chart 12a (repeat of Chart 2)

Accident Year Patterns—Incremental Medical Payments— The Impact of Medical-Only Payments Dominates the Early Report Periods

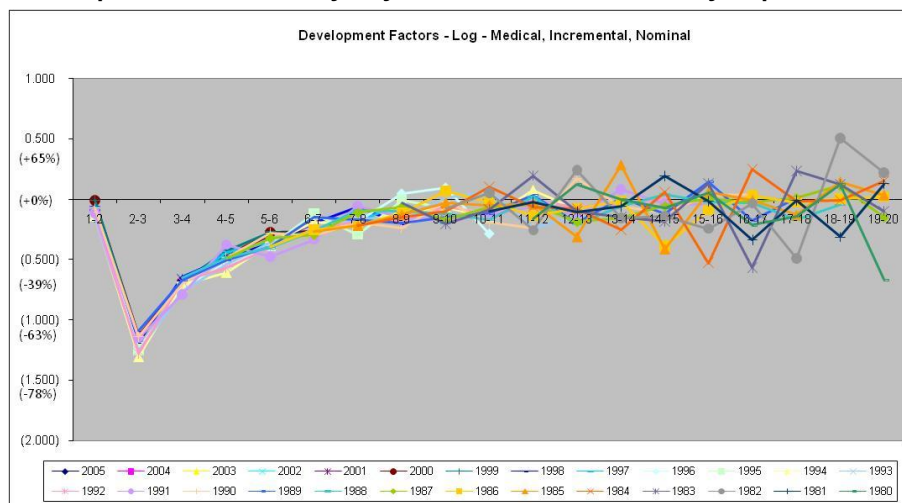
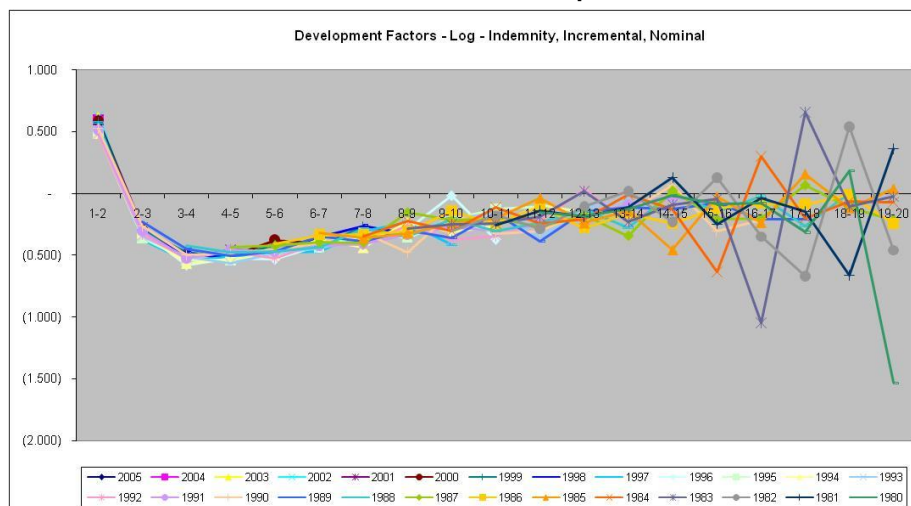


Chart 12b (repeat of Chart 8)

Accident Year Patterns—Incremental Indemnity Payments, With Variance Increases in Later Report Periods



¹² Charts in this section (pp. 20–22) are duplicates of charts presented earlier.

Observed Differences Between Countrywide Medical and Indemnity Seem Reasonable

Incremental Claims Closure

- Role of Medical-Only Apparent in Periods 1 to 2
- Incremental Claim Closure Patterns Seem to Exhibit Similar Paths After Periods 2 to 3
- Later in Development:
 - Indemnity Rates of Closure Are Higher
 - Medical Rates of Closure Become Small, Arguably Approaching Zero

Chart 13a (repeat of Chart 5)
Claim Closure Patterns—Medical

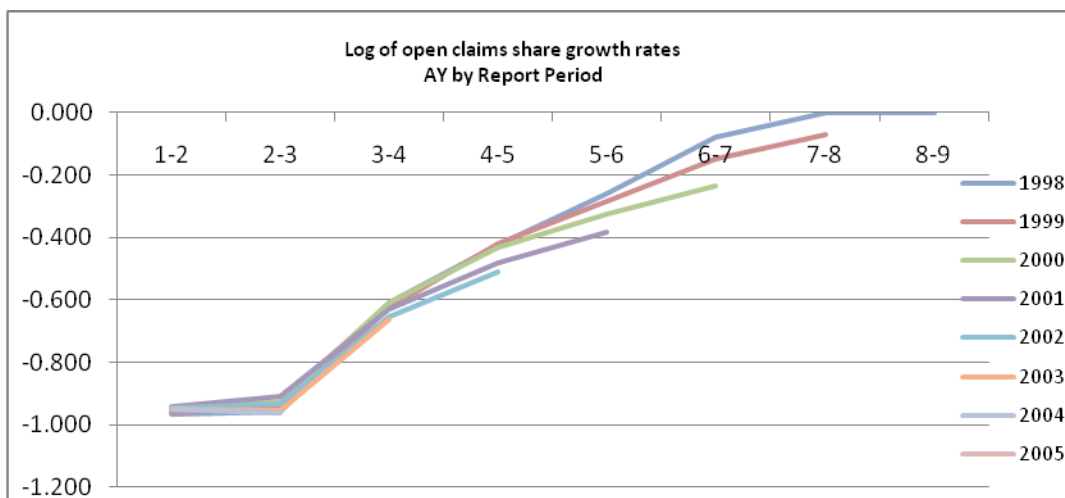
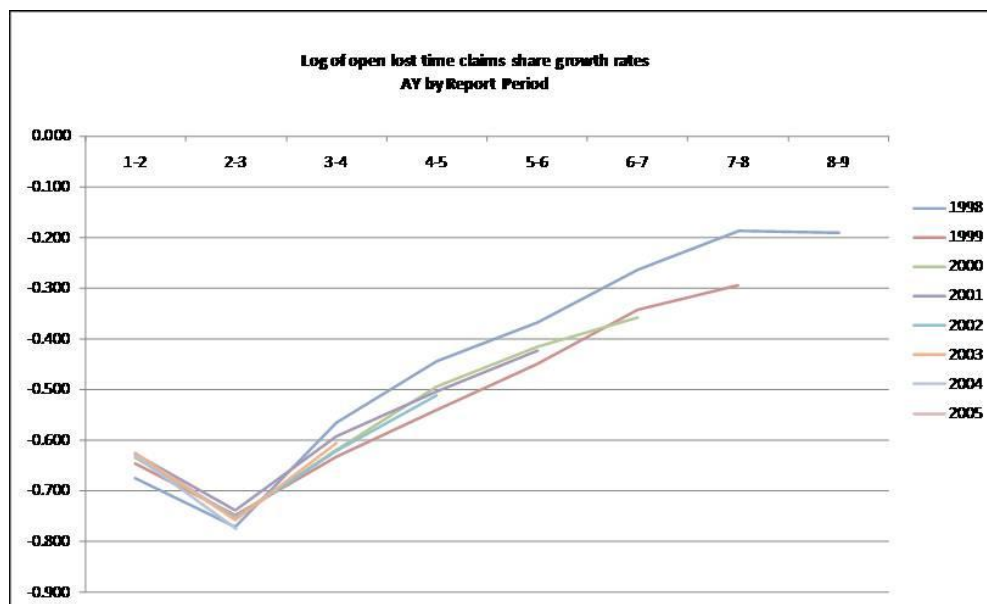


Chart 13b (repeat of Chart 10)
Claim Closure Patterns—Indemnity



Observed Differences Between Countrywide Medical and Indemnity Seem Reasonable

The Residual: Average Number of Transactions per Claim

- Role of Medical-Only Apparent in Periods 1 to 2

Chart 14a (repeat of Chart 6)
Transactions per Claim—Medical

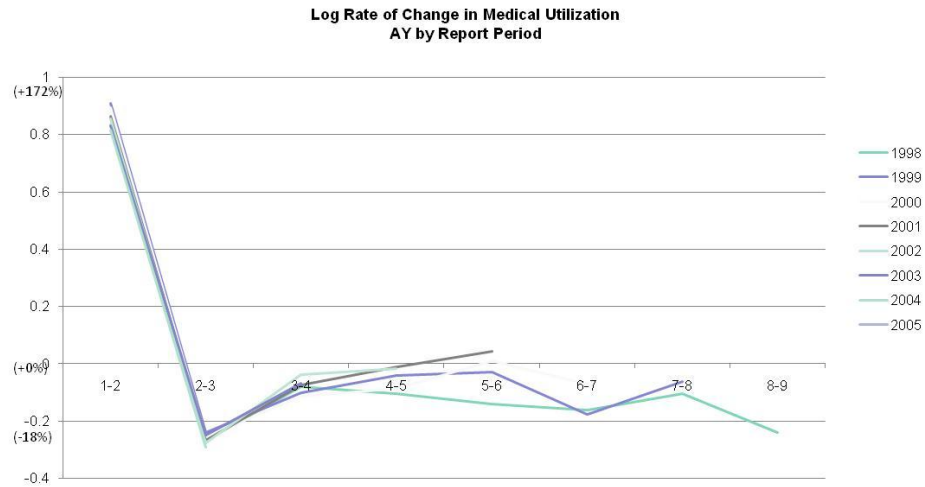
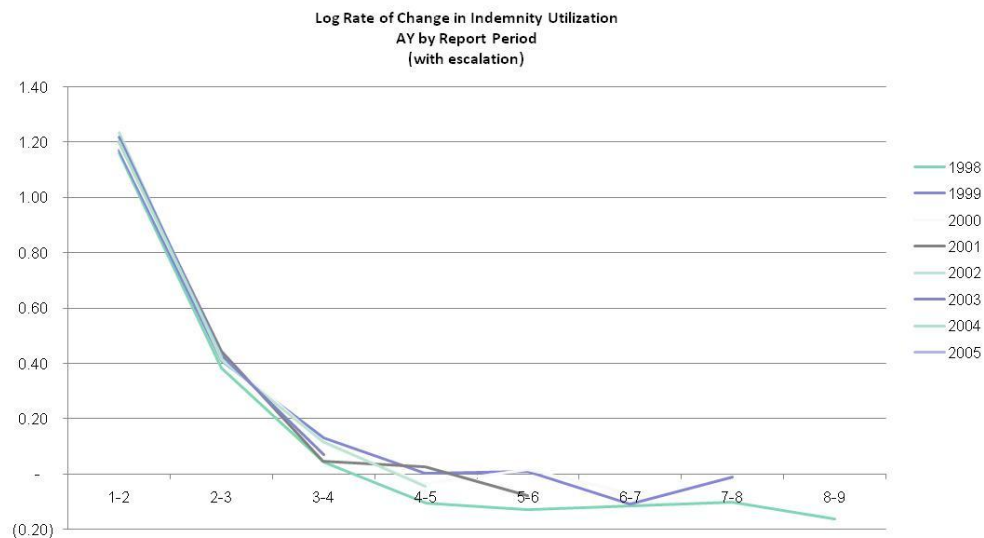


Chart 14b (repeat of Chart 11b)
Transactions per Claim—Indemnity



Once the influence of medical only is diminished (period 3), the estimates for utilization change appear to be comparable for medical and indemnity loss development.

Using Additional Data to Enhance the Understanding of the Drivers of Loss Development

Observed Differences in Estimates of Average Number of Medical Transactions per Claim

Likely Evidence of a Change in Mix of Medical Services Over Development—The Residual vs. Estimated Average Number of Transactions per Claim Using Transactions Data

Chart 15 (repeat of Chart 6)

The Residual—An Estimate of Average Medical Number of Transactions per Claim

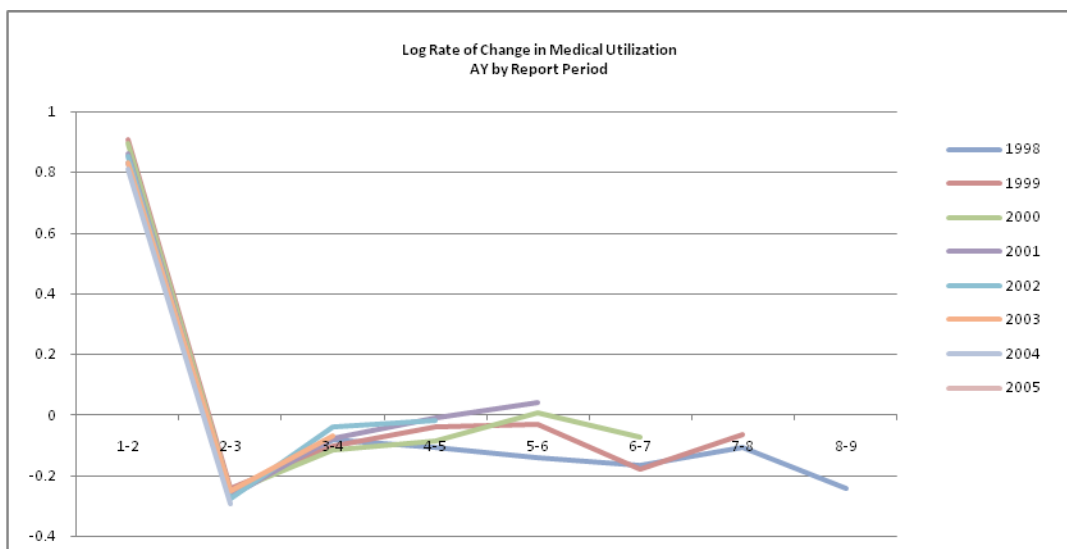


Chart 16

An Estimate of Average Medical Number of Transactions per Claim—Transactions Data

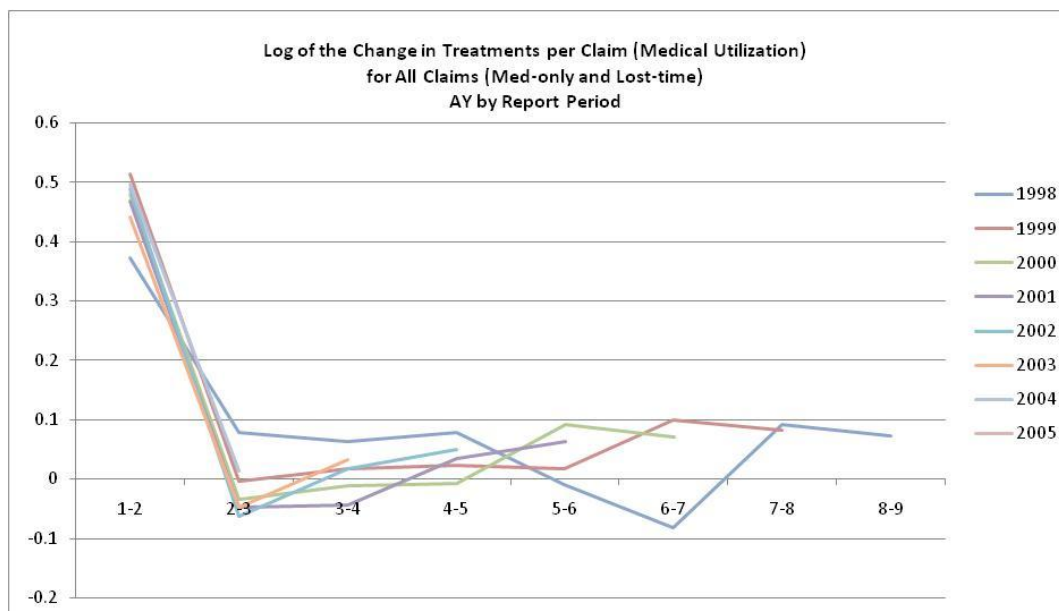
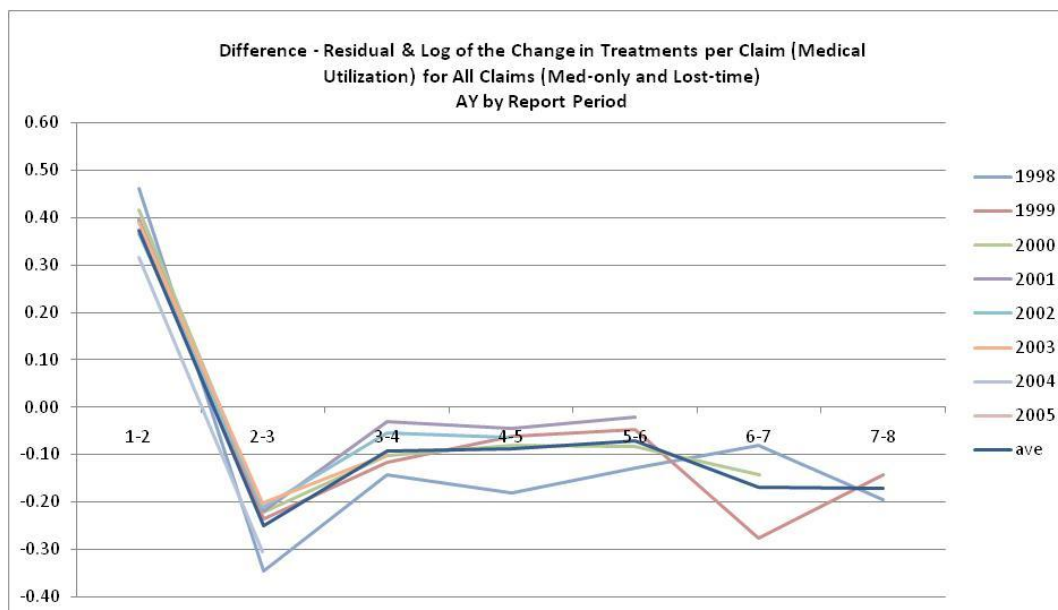


Chart 17

Differences in Alternative Estimates of Average Medical Number of Transactions per Claim— Residual vs. Transactions Data



The differences between these two measures of “utilization” suggest that medical loss development is also impacted by the changes in the mix of medical services over development periods. In particular, from period 1 to 2 the residual estimate is larger than the estimate based on an analysis of directly observed data; this suggests that between these two periods there is a relative increase in higher cost treatments. This is consistent with the data for periods 1 to 2 shown in Chart 19. In contrast, between periods 2 and 3 the difference in Chart 17 becomes negative. This could reflect a shift toward a less costly mix of services. However, Chart 19 indicates that, based on an alternative set of data, the shift to a more costly mix of treatments continued from periods 2 to 3. A different explanation, therefore, is needed. In particular, the residual also reflects the impact of estimated changes in claims closure rates. If the closure rate from periods 2 to 3 is overstated the decline in treatments per claim would be understated, resulting in a residual that was probably more negative than appropriate. This suggests that additional effort is required to more clearly estimate the claims closure rate that underlies this loss development triangle.

This ambiguous pattern continues at a modest level from period 3 on into development. Charts 15 through 17 indicate that the residual measure of changes in utilization remains slightly lower than the directly observed estimate of changes in the number of treatments per claim. In contrast, Chart 19 indicates that on average the directly observed change in average cost per treatment was typically equal to or greater than the change in the Medical Consumer Price Index. Thus, differences in the two estimates of utilization beyond period 3 also likely reflect differences in the estimates of the timing of claim closures.

Chart 18

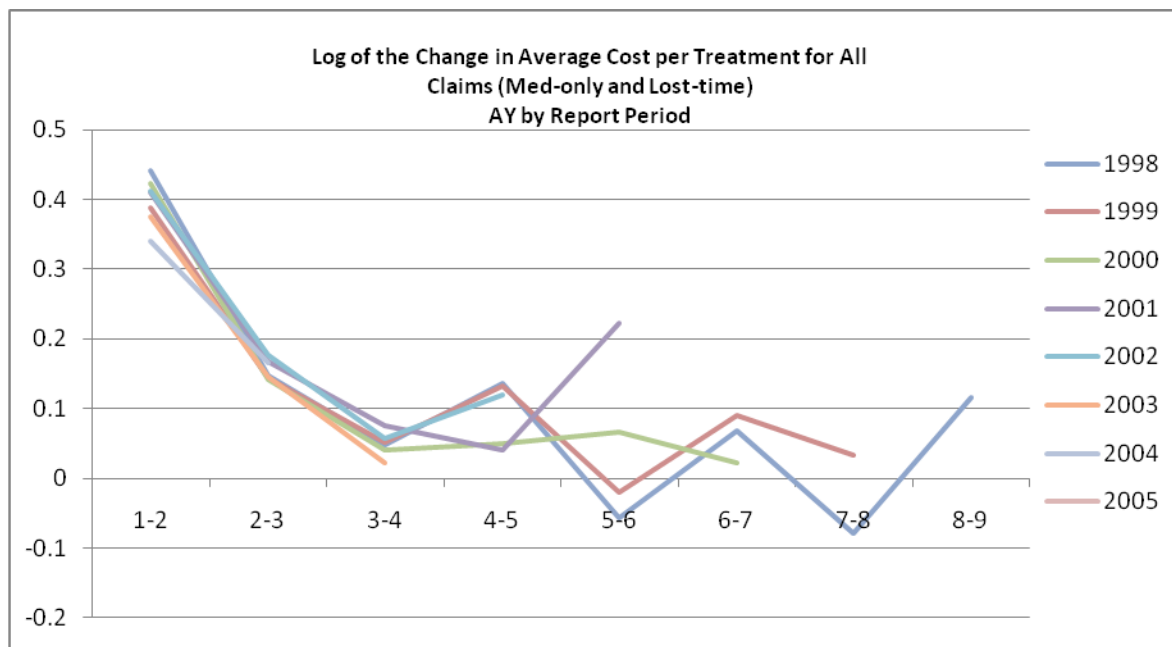
Log Rate of Change in Average Cost per Billed Treatment (i.e., Transaction)—Transaction Data

Chart 19

**Difference: Log Rate of Change in Average Cost per Billed Treatment (Transaction Data)
Less Log Rate of Change in MCPI**

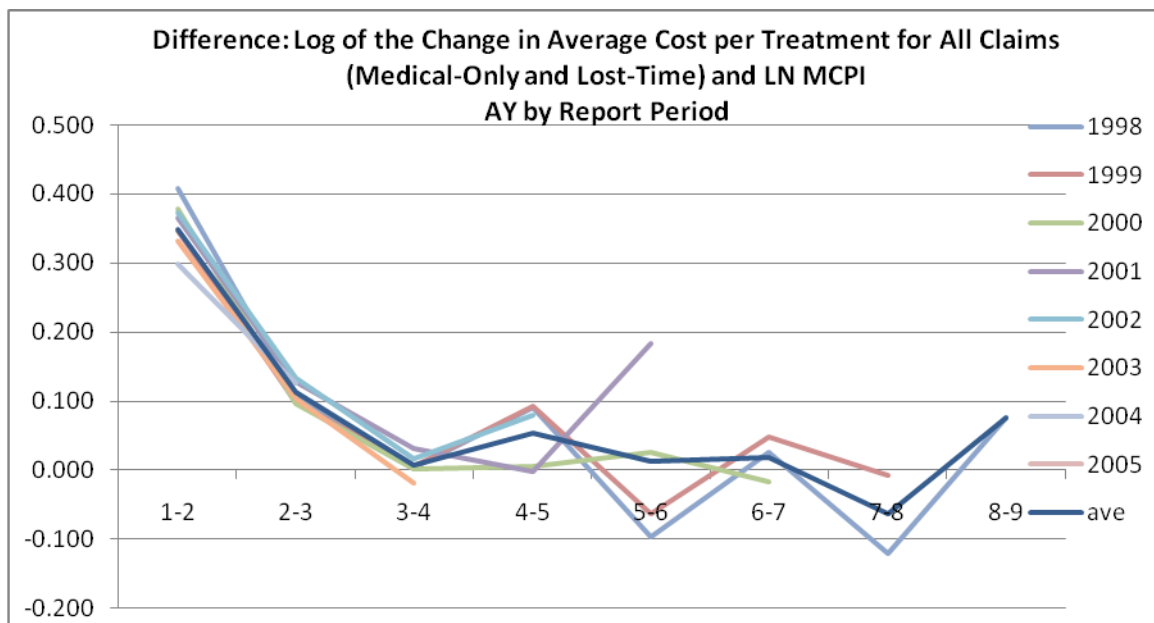


Chart 19 indicates that, early in development (periods 1 to 2 and 2 to 3), the rate of change in the average cost per billed treatment is considerably higher than would be expected based on medical price inflation alone. This is due to the change in the mix of claims and the related change in the mix of billed medical treatments (a measure of transactions). Charts 20 and 21 confirm this. Chart 20 indicates that the increase in the number of treatments per claim for higher cost complex surgery from report period 1 to 2 was higher than average, while the relative increases in the number of lower cost office visits and simple surgery were below average. The decline in relatively low cost physical therapy and an increase in higher cost drugs and durable medical equipment are the key changes in mix from period 2 to 3. Such changes in mix are generally considered to be a component of changes in utilization.

Chart 20

**Percentage Change in the Average Number of Treatments per Claim
by Medical Service Group—Report Periods 1 to 2 and 2 to 3**

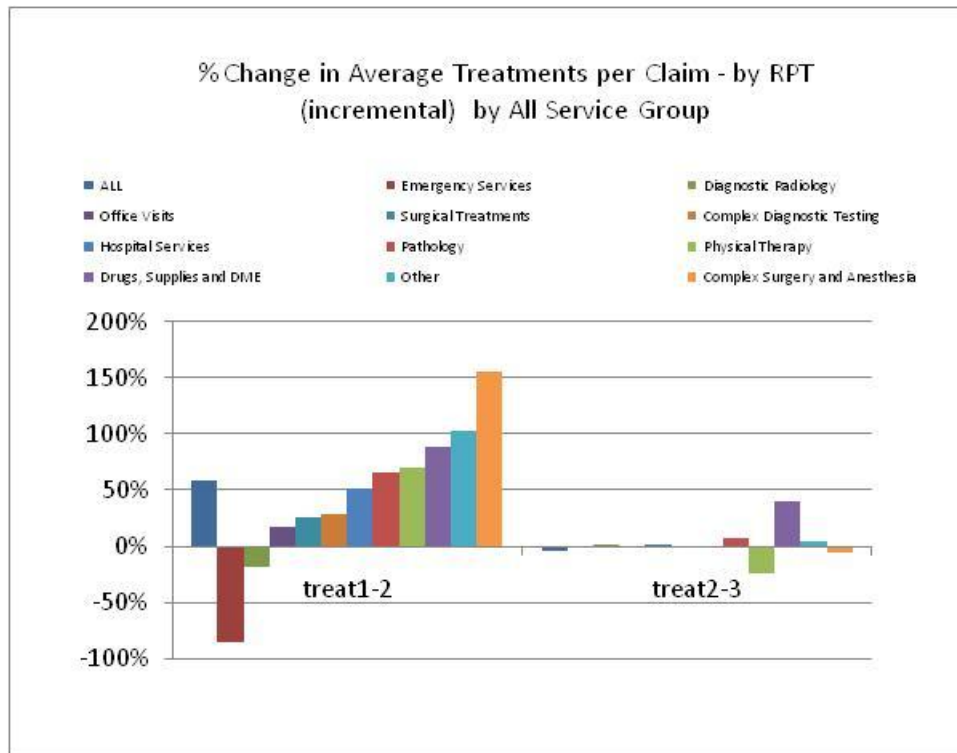
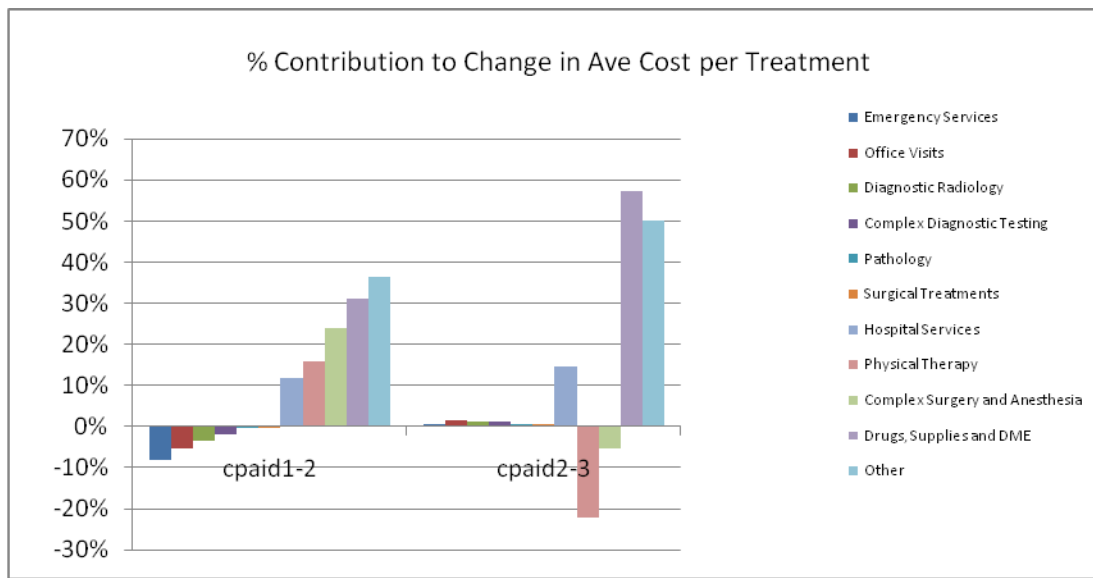


Chart 21 provides further evidence of the impact in the change in the mix of medical services early in the development of medical losses. The increase in the overall average cost per treatment from period 1 to 2 was driven largely by higher cost medical services including hospital services, complex surgery, and drugs, supplies, and durable medical equipment. The contributions from lower cost services such as office visits and X-rays (diagnostic radiology) were negative. From period 2 to 3, increases in hospital services, drugs, supplies, and durable medical equipment (along with all “other”) offset declines due to complex surgery and physical therapy.

Chart 21

**Percentage Contribution to Change in Average Cost per Treatment
by Medical Service Group by Report Period 1 to 2 and Period 2 to 3**



Putting This Approach to Use

Identifying Possible Structural Changes

It is often difficult to identify, much less to quantify, in cumulative data the impact of structural changes on loss development and, therefore, on ultimate losses. The charts below suggest that the analysis of incremental payments may help to address this challenge. These charts also track the log rate of change in incremental payments for the first four development periods for an individual state. Note that the increase in indemnity payments from the first to the second report period dropped steadily from 1989 to 1994. The rate of change in incremental medical payments followed a similar trend and actually began to show declines in AY 1992. This likely reflects structural changes in this state's workers compensation system during the turmoil in the voluntary market and the growth of the state's residual market.

Chart 22a

Pattern of Log Growth Rates of Incremental Indemnity Payments AY 1989–AY 2005—
First Through Fifth Report Periods

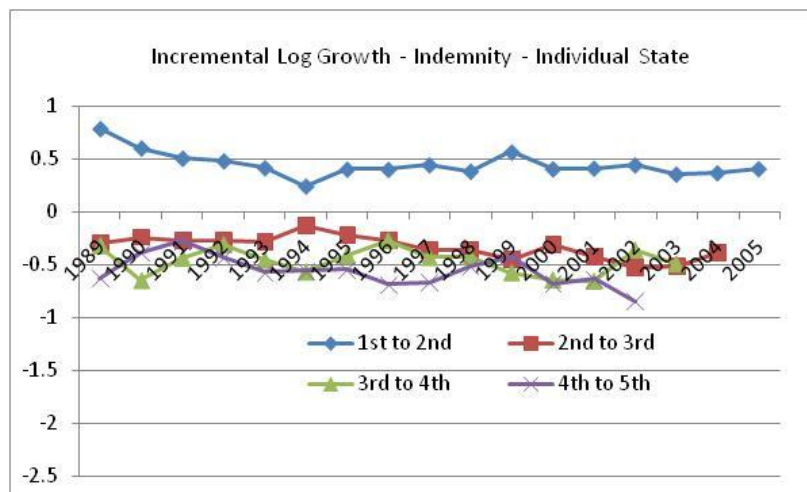
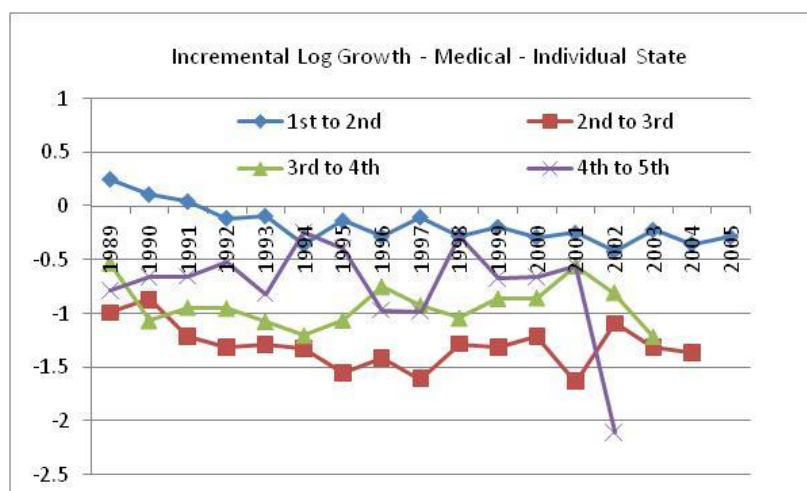


Chart 22b

Pattern of Log Growth Rates of Incremental Medical Payments AY 1989–AY 2005—
First Through Fifth Report Periods

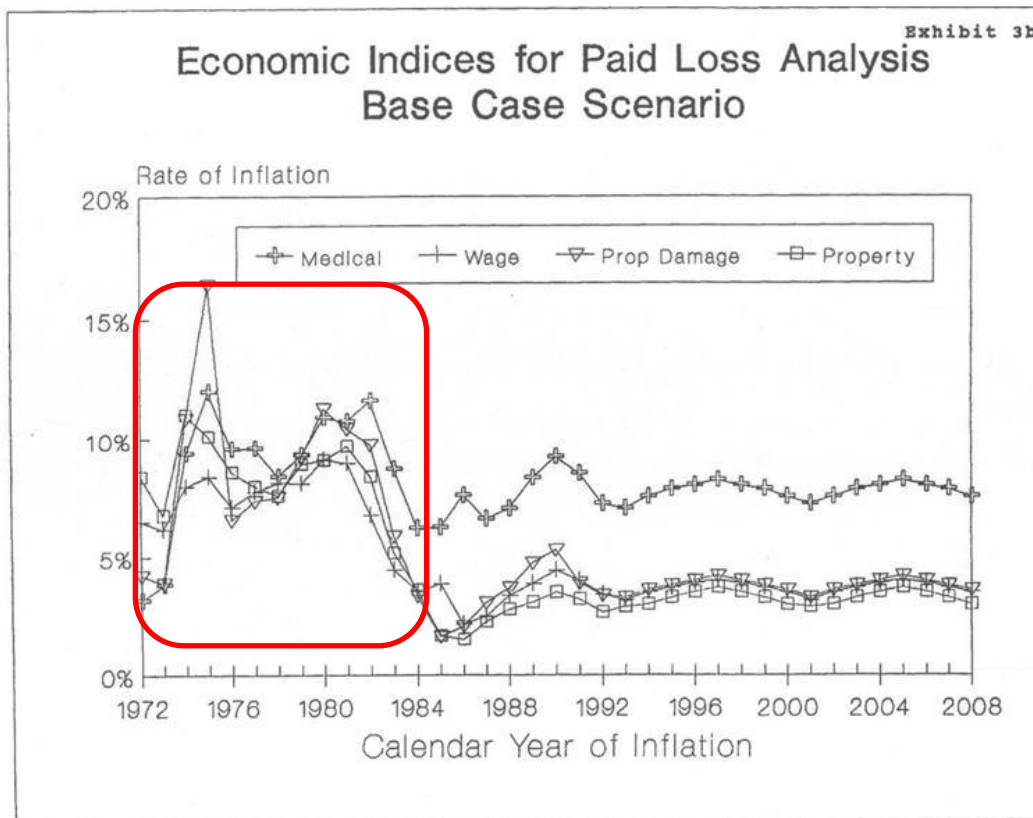


Addressing the Differential Impact of Inflation

The approach outlined in this paper should not be viewed in isolation. Indeed, this analysis of the drivers of loss development should be viewed as an extension of the conventional chain ladder method that uses cumulative payment data. In this regard, it is interesting to note that Frank Ceplenski used something very similar in a paper that he presented at a session on "Explicit Methods to Handle Inflation" at the 1988 CAS Loss Reserve Seminar. As noted above, medical and indemnity severity had been strongly impacted by the high rates of inflation experienced in the late 1970s (see Chart 23 for Ceplenski's selection of relevant inflation rates). These rates of inflation were imbedded in the link ratios based on loss triangles of data from that period. The Ceplenski paper proposed a method to adjust historical loss development to account for differences in past inflation and the anticipated lower inflation in future development periods.

Chart 23

Rates of Inflation That Would Be Expected to Impact Loss Development¹³



The first five steps outlined in Ceplenski's presentation are virtually identical to the first steps in the incremental payments approach described above. Steps six and seven reflect a return to squaring the conventional cumulative triangle, based on deflated payment data. The remaining steps describe the process of converting the deflated cumulative payments into cumulative payments that reflect inflation rates anticipated over future development:

1. Identify the Appropriate Economic Indexes
2. Determine Medical Prices and Wage Rates
3. Obtain Paid Loss Data
4. Decumulate (i.e., get incremental payments)
5. Deflate

¹³ Source: "An Analysis Using Industry Paid Loss Data: Methodology and Results," Frank Ceplenski, CAS Loss Reserve Seminar, September 19, 1988.

6. Recumulate the Triangle
7. Square/Rectangle the Triangle Using Calculated (cumulative) Development Factors
8. Decumulate
9. Reinflate (using forecast price indexes)
10. Recumulate
11. Result: An Estimate of Ultimate Paid Losses

Bridging the Gap Between the Chain Ladder and Statistical Modeling Methods of Analyzing Loss Development

Statistical Models of the Drivers of Loss Development

Barnett and Zenwirth have described a statistical modeling approach for analyzing loss development. (“Best Estimates for Reserves,” Glen Barnett and Ben Zehnwrith, *Proceedings of the Casualty Actuarial Society*, November 2000, pp. 245–321.) It features the use of incremental payment data and models “trends in the three directions; viz., development-year, accident-year and payment/calendar-year” (p. 266). This is a statistical approach to modeling the drivers of loss development described above.

Frank Schmid has developed an alternative statistical model for evaluating loss development. Schmid also models incremental paid development in the three time dimensions identified by Barnett and Zehnwrith. (“The Workers Compensation Tail Revisited,” Frank Schmid, September 25, 2009, submitted to the journal *Variance* and available on ncci.com.) However, the two approaches employ markedly different statistical methods; Barnett and Zehnwrith employ frequentist tools of maximum likelihood in their analysis. In contrast, Schmid uses Bayesian statistics and Markov Chain Monte Carlo simulation (MCMC).

The Challenge

The challenge lies in addressing the understandable reluctance among actuaries to use the output of unfamiliar statistical models. These statistical models have been sometimes characterized as being a “black box”; that is, it is not clear what the models are doing. In fact, each model is designed to estimate the impact of the drivers of loss development—claim closure rates and systematic changes in mix over development years, inflation across calendar years, and, as illustrated in Appendix A, inflation and changes in frequency and exposure over accident years.

The Bridge

This paper responds by providing a bridge between the intuitive appeal of the chain ladder loss triangle methods and the analytical underpinnings of statistically based loss development models. In particular, a framework is developed that aligns the time dimensions of the statistical models with the drivers of loss development. The statistical technology may be different but, as illustrated by the case studies in this paper, the estimates generated by the models—estimates of the period-to-period contributions of the drivers of loss development—should be easy to interpret and apply.

Final Observations

The analysis presented in this paper reflects NCCI’s ongoing commitment to look for opportunities to enhance our methodologies. The analysis of loss development is critical to both reserving and ratemaking. Building a bridge between the standard chain ladder method and the emerging area of statistical modeling should enhance the value of each approach. A key next step is already under way at NCCI; models based on Schmid’s Bayesian framework are being used to analyze incremental payment data derived from triangles used in NCCI’s standard ratemaking. This should help to identify the strengths of each approach and will be key in determining how the two methods can best be used to jointly provide greater insight into the loss development process. The analysis of systematic changes in the drivers of the observed loss development will contribute to this assessment.

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APPENDIX A

Examining the Third Dimension in Loss Development: Underwriting Period—Down the Columns

The focus of this paper was identifying the drivers of loss development; these operate in two dimensions—development years and calendar years. There is a third dimension, as mentioned by Barnett, Zehnworth, and Schmid—underwriting year (i.e., accident or policy years). Specifically, in a loss triangle, this would be down the rows, especially down the first column.

Loss Triangles and incremental growth—adding the third dimension:

- The specification of the initial payment period (the first column) must be modified from the one used above
- The number of claims (CL_{t,1}) is replaced by the product of frequency (FR_{t,1}) and exposure (XP_{t,1}), i.e., number of claims = frequency times exposure

Number of claims = Frequency times exposure:

- $CL_{t,1} = FR_{t,1} * XP_{t,1}$ where the “t” represents underwriting period (e.g., AY 2004)
- $[\ln CL_{t+1,1} - \ln CL_{t,1}] = [\ln FR_{t+1,1} - \ln FR_{t,1}] + [\ln XP_{t+1,1} - \ln XP_{t,1}]$
- $[\ln FR_{t+1,1} - \ln FR_{t,1}]$ is equivalent to the rate of change in frequency
- $[\ln XP_{t+1,1} - \ln XP_{t,1}]$ is a measure of the *rate of change in exposure*

Including exposure makes it possible to incorporate in the analysis the impact of factors such as shifts to and from large deductible policies and changes in the level and mix of employment over the business cycle.

Applying the change in frequency establishes an estimate of the initial number of claims, which serves as a base for the modeling of the claims closure portion of subsequent period development.

The log incremental AY to AY growth rate: $\ln G_{t+1,1} = \ln (P_{t+1,1} / P_{t,1}) = \ln P_{t+1,1} - \ln P_{t,1} =$

- $[\ln FR_{t+1,1} - \ln FR_{t,1}] + [\ln XP_{t+1,1} - \ln XP_{t,1}] + [\ln NP_{t+1,1} - \ln NP_{t,1}] + [\ln CP_{t+1,1} - \ln CP_{t,1}]$
- $[\ln FR_{t+1,1} - \ln FR_{t,1}]$ is equivalent to the trend rate of change in frequency
- $[\ln XP_{t+1,1} - \ln XP_{t,1}]$ is a measure of the rate of change in exposure
- $[\ln NP_{t+1,1} - \ln NP_{t,1}]$ is a measure of the period to period rate of change in utilization in the initial payment period
- $[\ln CP_{t+1,1} - \ln CP_{t,1}]$ reflects the rate of change in prices applicable to the initial payment period

APPENDIX B

Documentation of Data Sources and Assumptions in the Analysis of Drivers of Loss Development

Estimates of claims closure rates and inflation were required to decompose the factors driving loss development. For inflation, we used the countrywide average weekly wages derived from Current Population Survey data for indemnity and the medical consumer price index for medical.

Obtaining estimates of claims closure rates was a little more involved and required several assumptions. First, we estimated the share of claims closed (percentage of closed claims to total claims) for each report period and accident year. For indemnity, we used Financial Call data consistent with that used for the loss development triangles used in this project. Data was available for up to nine report periods for Accident Years 1998–2006. Since Financial Call data excludes medical-only claims in the claim counts, we turned to data from the Workers Compensation Statistical Plan (WCSP) for the share of claims closed for medical. From this data source, we obtained claims closure rates for all claims (lost-time and medical-only) combined. The following conversions and assumptions were made:

1. WCSP data is reported at months 18, 30, 42, etc., while Financial Call data is reported at months 12, 24, 36, etc. For reports 2 through 9, the WCSP data was adjusted to be consistent with the Financial Call data by averaging two successive reports. For example, to be consistent with the Financial Call data used in this analysis, a 2nd report for 24 months was obtained by averaging the WCSP data for 1st report (at 18 months) and 2nd report (at 30 months).
2. To obtain an estimate that is consistent with first report at 12 months, we assumed that 90% of the medical-only claims closed at 18 months are closed at 12 months and applied that percentage to the share of medical-only claims at 18 months. To that we added the product of the share of indemnity claims closed at 12 months from the Financial Call data and the share of lost-time claims at 18 months from WCSP data. Essentially, this is the sum obtained by applying the share of closed claims for medical-only and lost-time to the share that medical-only and lost-time claims represent of total claims.

Using the estimates of claims closed for each report period and accident year, we then estimated the average share of claims open each period for reports 2 through 9. First, we calculated the share of open claims each period by taking 1 minus the share of closed claims discussed above. Then, we subtracted the share of open claims at the end of the current period from the share of open claims at the end of the previous period, divided by 2 and added that to the share of open claims at the end of the current period.

$$\{[(1 - \text{share closed at end of previous period}) - (1 - \text{share closed at end of current period})] / 2\} + (1 - \text{share of claims closed at end of current period}).$$

$(1 - \text{share closed at end of a period}) = \text{the share open at the end of a period}.$

So it is essentially $\{[(\text{share open at start of period}) - (\text{share open at end of period})] / 2\} + (\text{share open at end of period}).$

Dividing the difference in the average number at the beginning and end of the period by 2 is intended to approximate the average number of claims with transactions during the period.

We used a crude model to obtain an estimate of the average share open for the 1st report by calculating the weighted sum of the claims in the initial buildup and the claims when closure offsets new claims. We assumed we start with a claim a day for 365 days. If claims are coming in evenly over the period, then the share open at the end of the period is linked to the duration. For example, if 50% of claims are open at the end of the period, then that means 50% are closed. If you assume that they come in evenly over the period, then the average duration is half of 365 or 182.5 days. If 60% are open at the end, then the average duration is 219 if we assume they come in evenly over the period. Using this assumption, we can estimate the net new claims each day and the total claims open each day. The sum of the total open claims gives the number of claim days. Taking the ratio of the number of claim days to the maximum possible number of claim days gives an estimate of the share open during the period.

Once we have the average share of claims open each period, taking the ratio of adjoining columns results in the change in the share of open claims in each period. The log of the ratio is the log rate of change or a claims closure rate.

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