Predictive Modeling for WC Reserves

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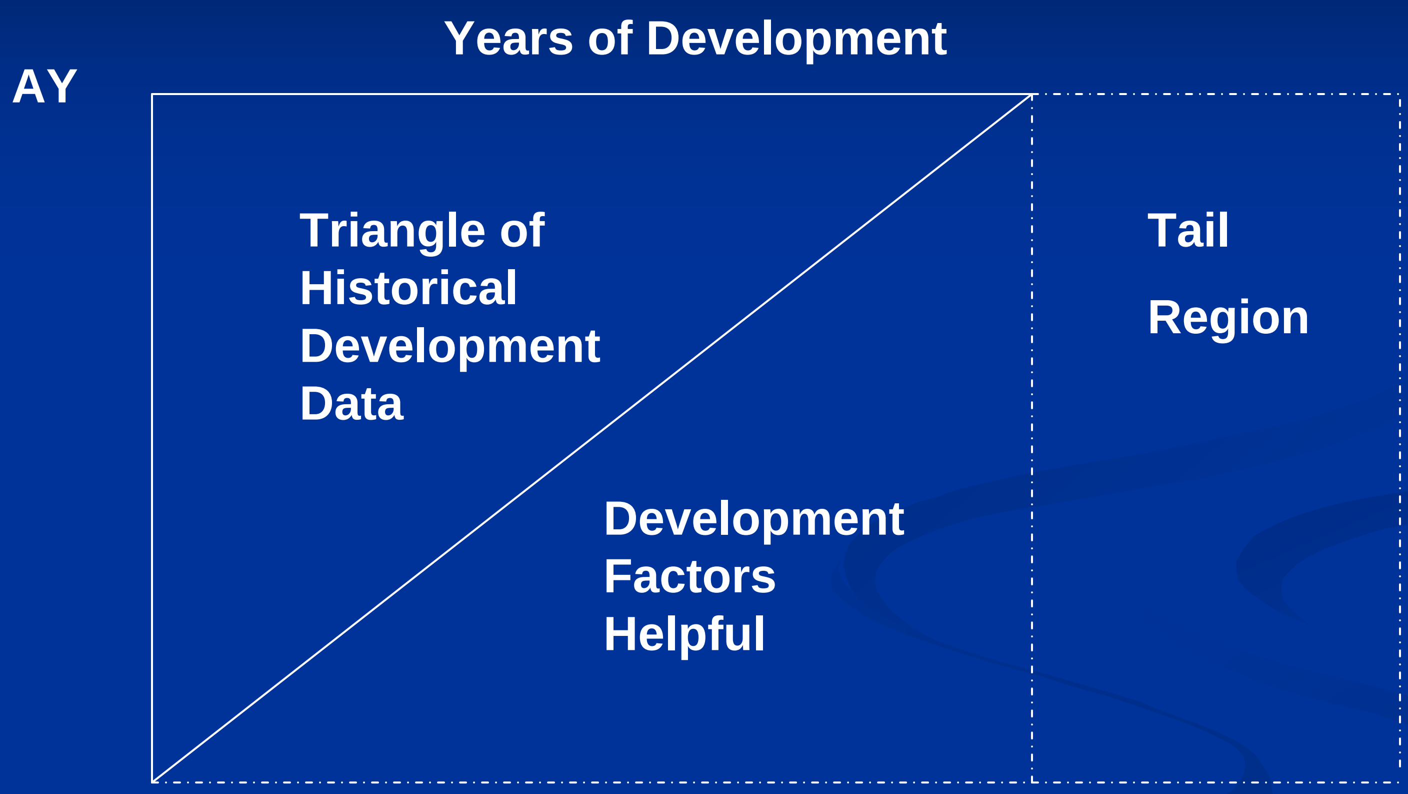
A Typical WC Reserve Analysis: 15 DYs



Estimating the WC Tail @ DY 15

You have 15 year triangle & the latest large claim listing. Your options?

- Accept the case?
- Extrapolate ILDFs and PLDFs? How?
- Use external data? Different state?
- Adjust the case? Use a primitive predictive model?
- Use more complex predictive models?

Dead on Arrival (DOA) Data

Drop Your Aggregate Baggage

- Actuaries conditioned to apply methods to aggregate loss experience by AY, etc.
- Need to start over and focus on individual permanent disability claims as a basis for applying predictive modeling techniques.
- Use predictive models at both the individual claim level and on an aggregate basis.

Accept the Case Reserve?

- What rate of medical inflation was assumed, if any?
- Stair-stepping is quite common.
- Medical condition often evolves with aging.
- Reopened claims potential.
- Expected value of future payments is typically 25%-60% higher than the sum of projected payments until age at death.

A Very Simple PPD Claim

- Jeremy's right leg amputated in 2004 because of work injury. He is 55.
- Artificial leg costs $1,000.
- Leg must be replaced every 15 years, at double the prior cost.
- Jeremy is expected to live until age 78, so adjuster sets up a case reserve to cover one replacement leg when Jeremy is 70.

Three Scenarios

Scenario (Age at Death)	Number of Legs	Cost of New Leg	Total Future Payments
< 70	0	$0	$0
70 - 84	1	$2,000	$2,000
85 +	2	$4,000	$6,000

Expected Value – 4.7% Med. Infl.

Age at Death	Future Payments	Probability	Fut. Pay x Probability
< 70	$0	25 %	$0
70 - 84	**$2,000**	50 %	$1,000
85 +	$6,000	25 %	$1,500
Expected Value of Future Payments			**$2,500**

Expected Value – 9.7% Med. Infl.

Age at Death	Future Payments	Probability	Fut. Pay x Probability
< 70	$0	25 %	$0
70 - 84	**$4,000**	50 %	$2,000
85 +	$20,000	25 %	$5,000
Expected Value of Future Payments			**$7,000**

Estimating the WC Tail, PCAS 2005

Expected value of future payments is typically 25%-60% higher than the sum of projected payments until age at death.

See Section 8 of Paper

Adjusting the Case Reserve Using A Large Claim Listing

Data in the large claim listing (AY, DY, Age at Injury or Current Age, Paid to Date, Case Reserve, Injury Description, Gender)

<u>A Typical Approach</u>:

- Split reserve into medical and indemnity.
- What rate of future medical cost escalation was assumed by the claims adjuster?
- Remove adjuster's medical cost escalation adjustment, using the claimant's life expectancy.
- Assume constant on-level incremental paids until claimant dies or claim is closed, and inflate future medical payments at your chosen rate of medical cost escalation.

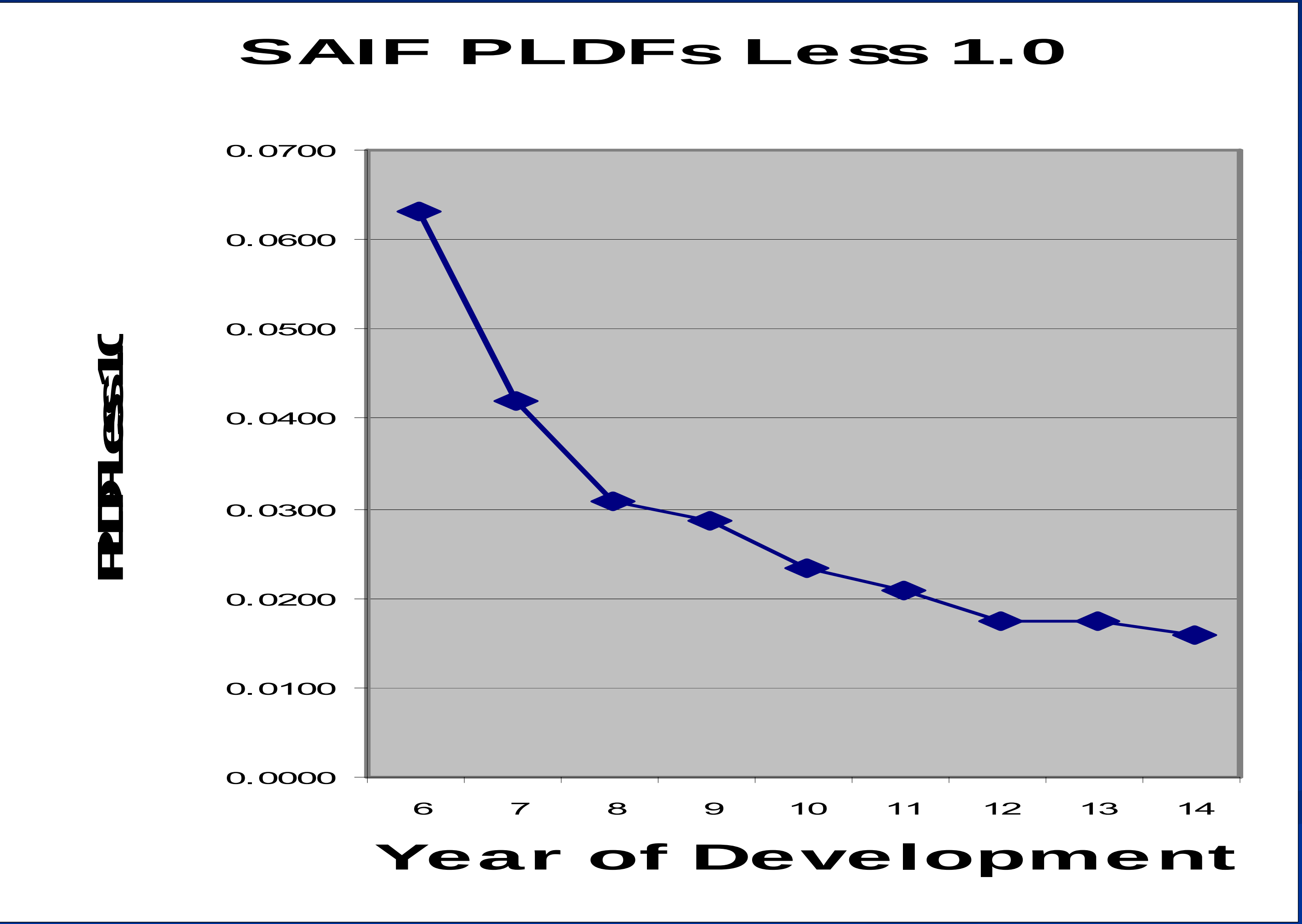
Different Approaches

- Simple Simon: Just project payments until expected year of death, assuming medical inflation?
- Smart Simon: Get series of large claim listings. Apply Shawn's approach. Obtain a better estimate of next year's increm paid by claim, based on regression. Apply this successively?
- Apply Markov chain projections…..
- Do on-level increm paids remain flat?
- Do perm dis claims close for reasons other than death?

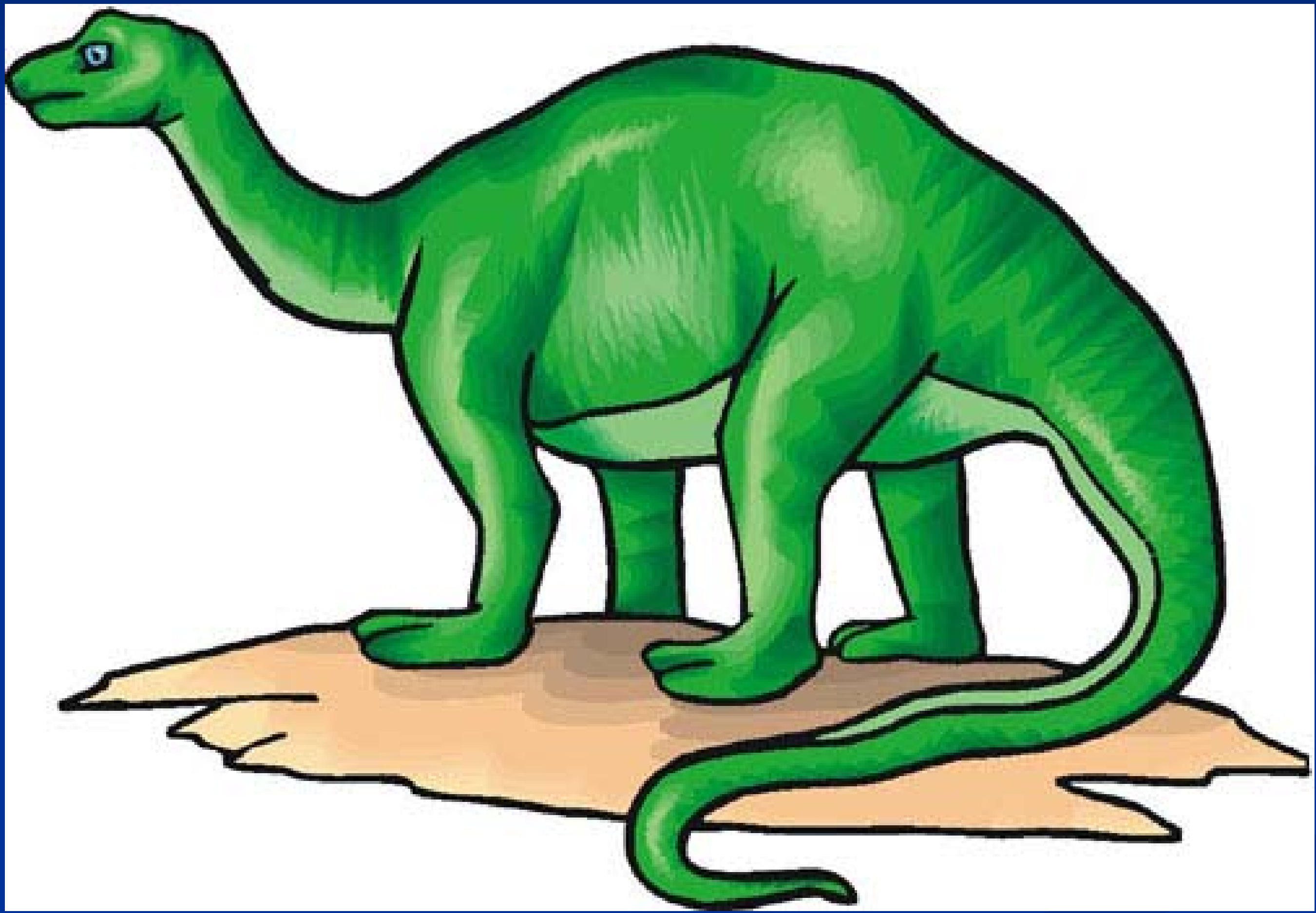
Workers Compensation Medical Permanent Disability (MPD)

Paid Loss Development Factors

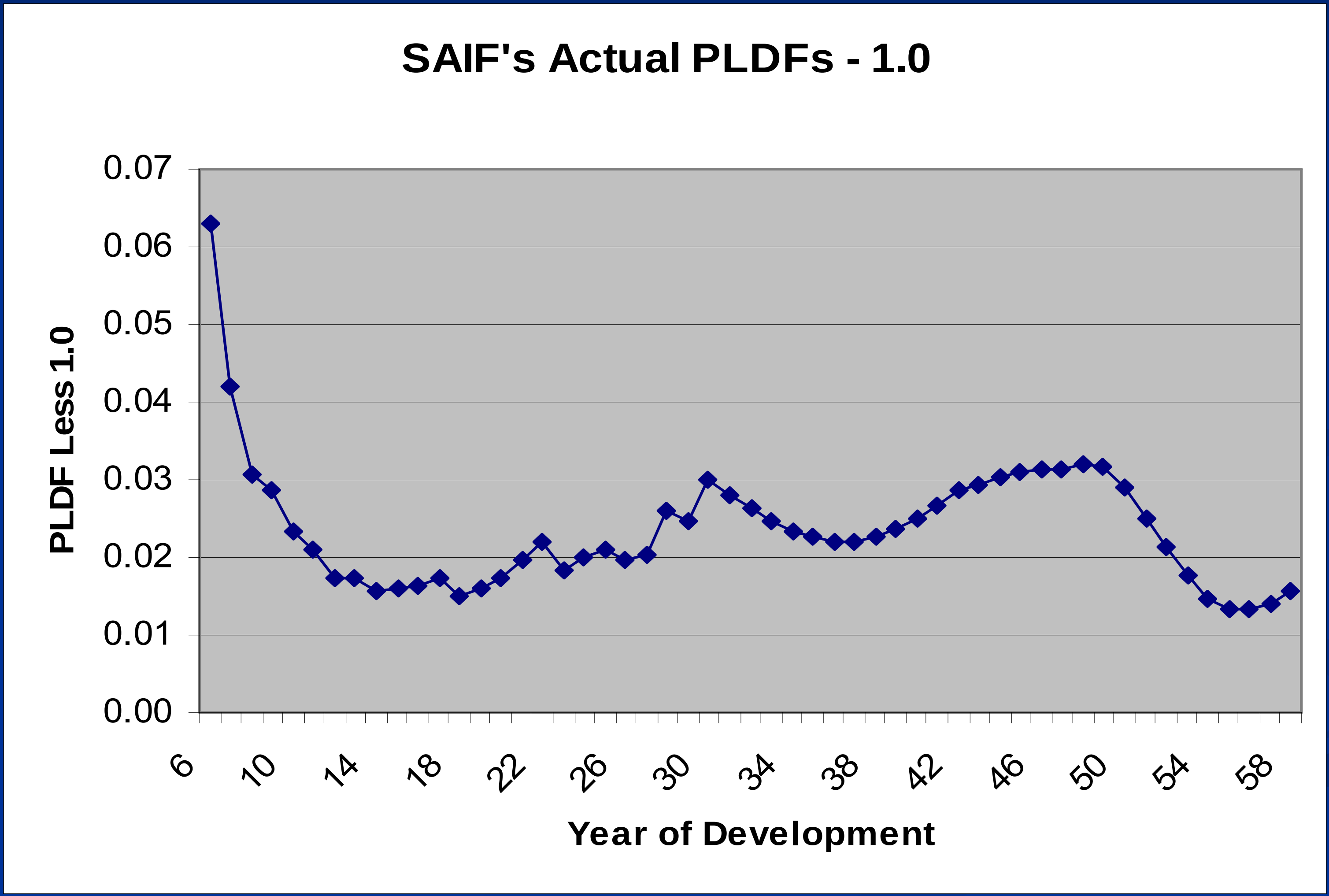
SAIF's Actual PLDFs – 1.0



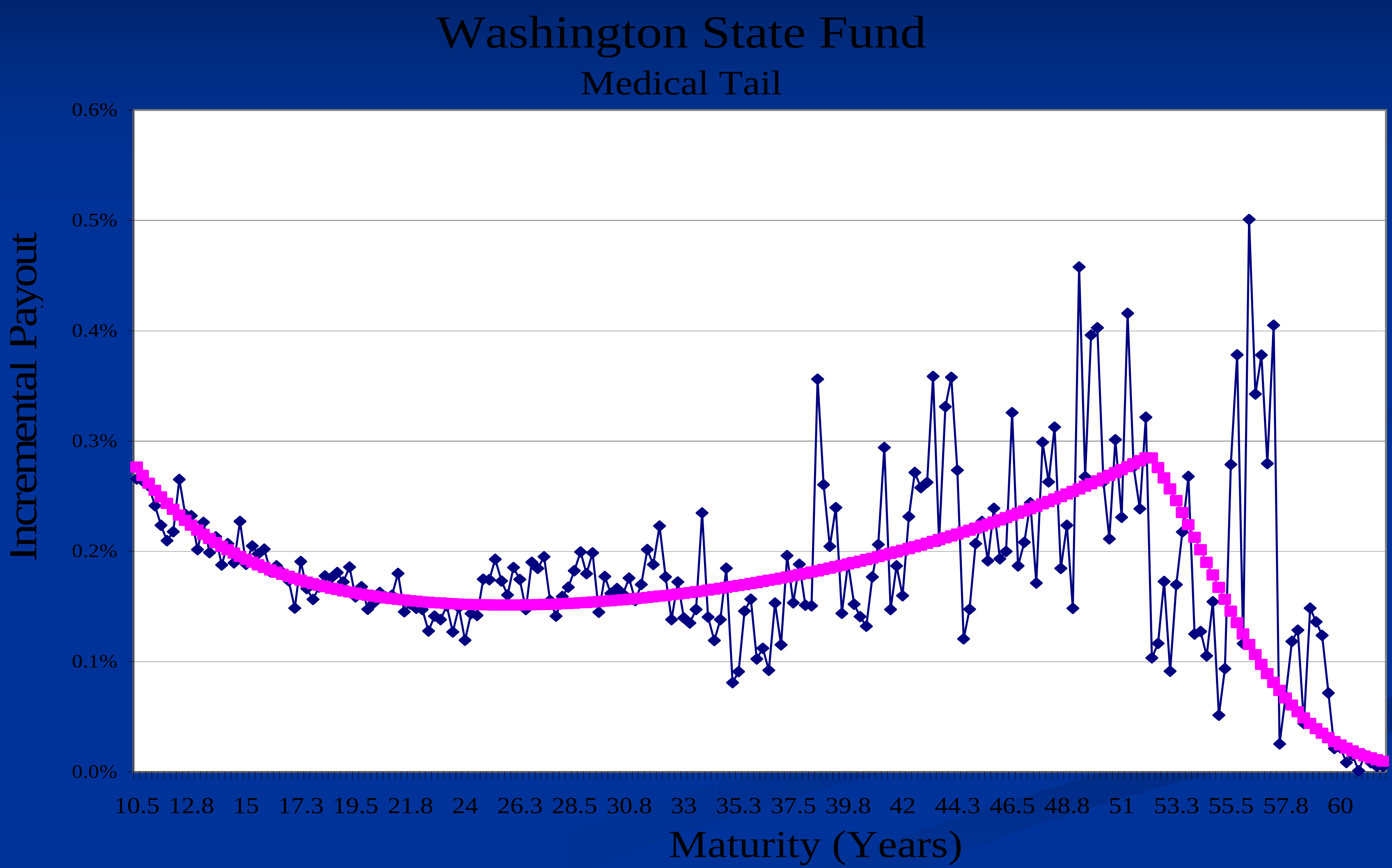
We assume a brontosaurus tail.



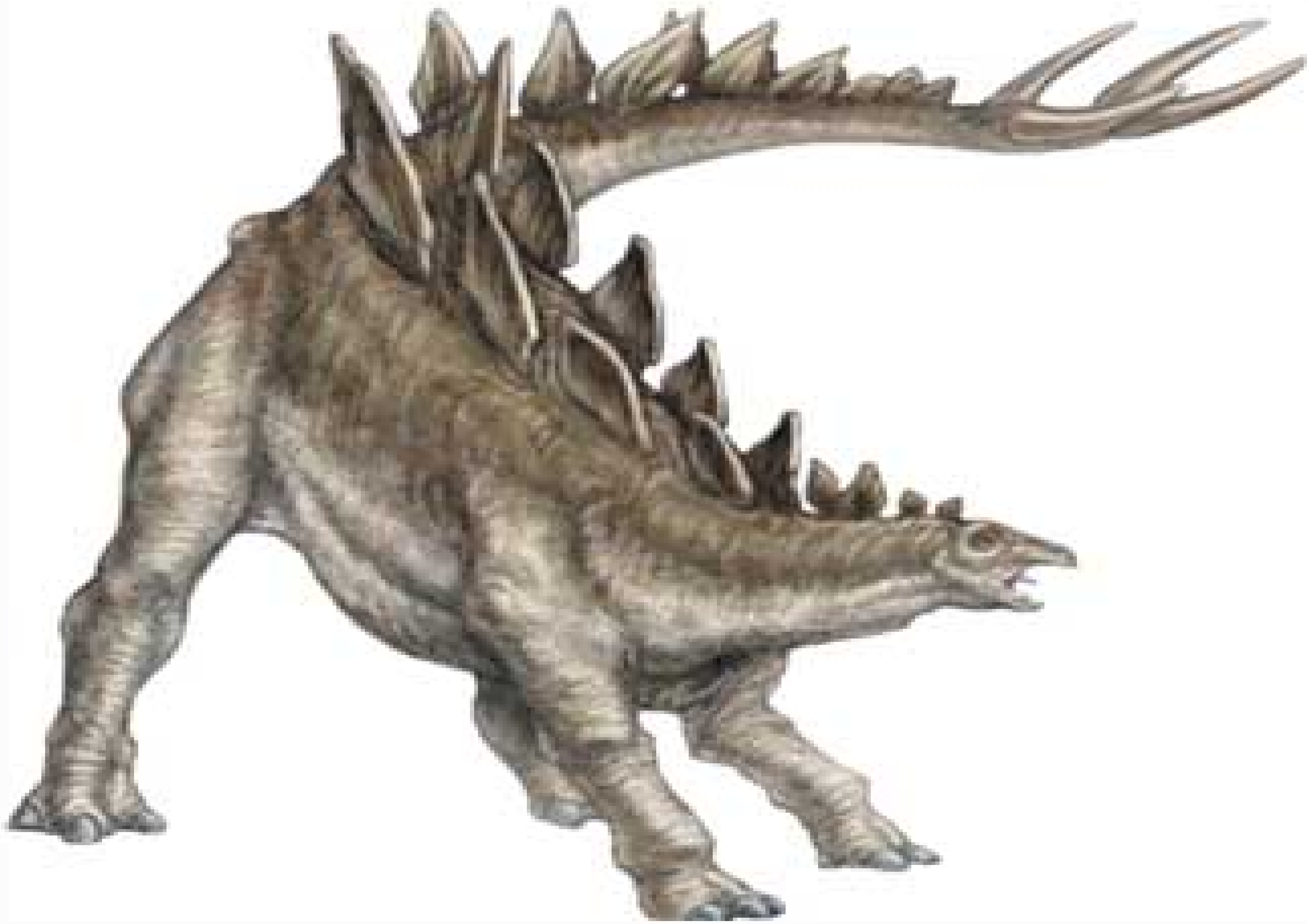
PLDFs – 1.0 Out to DY 58



Washington State Fund PLDFs – 1.0

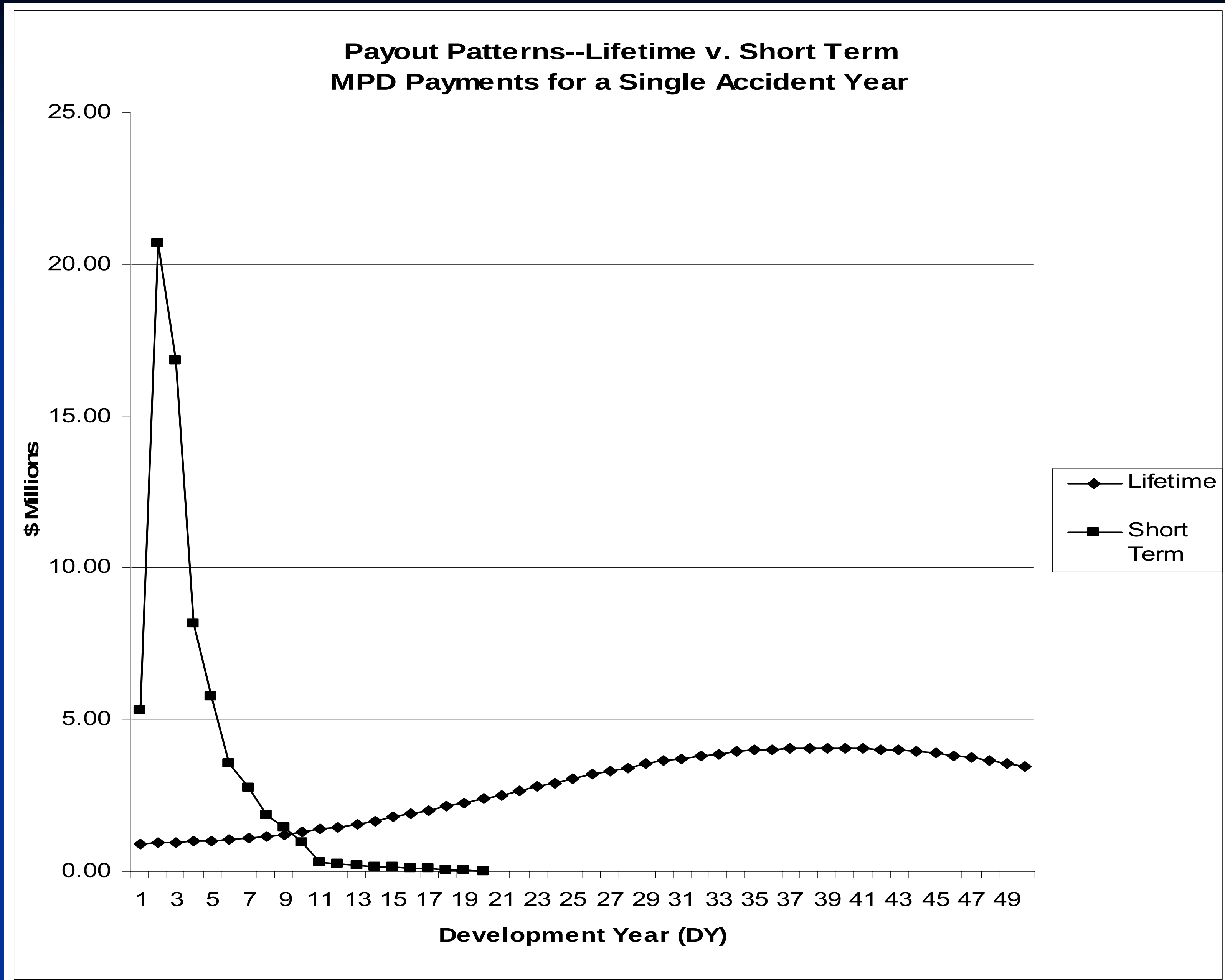


MPD payments: Stegosaurus tail.

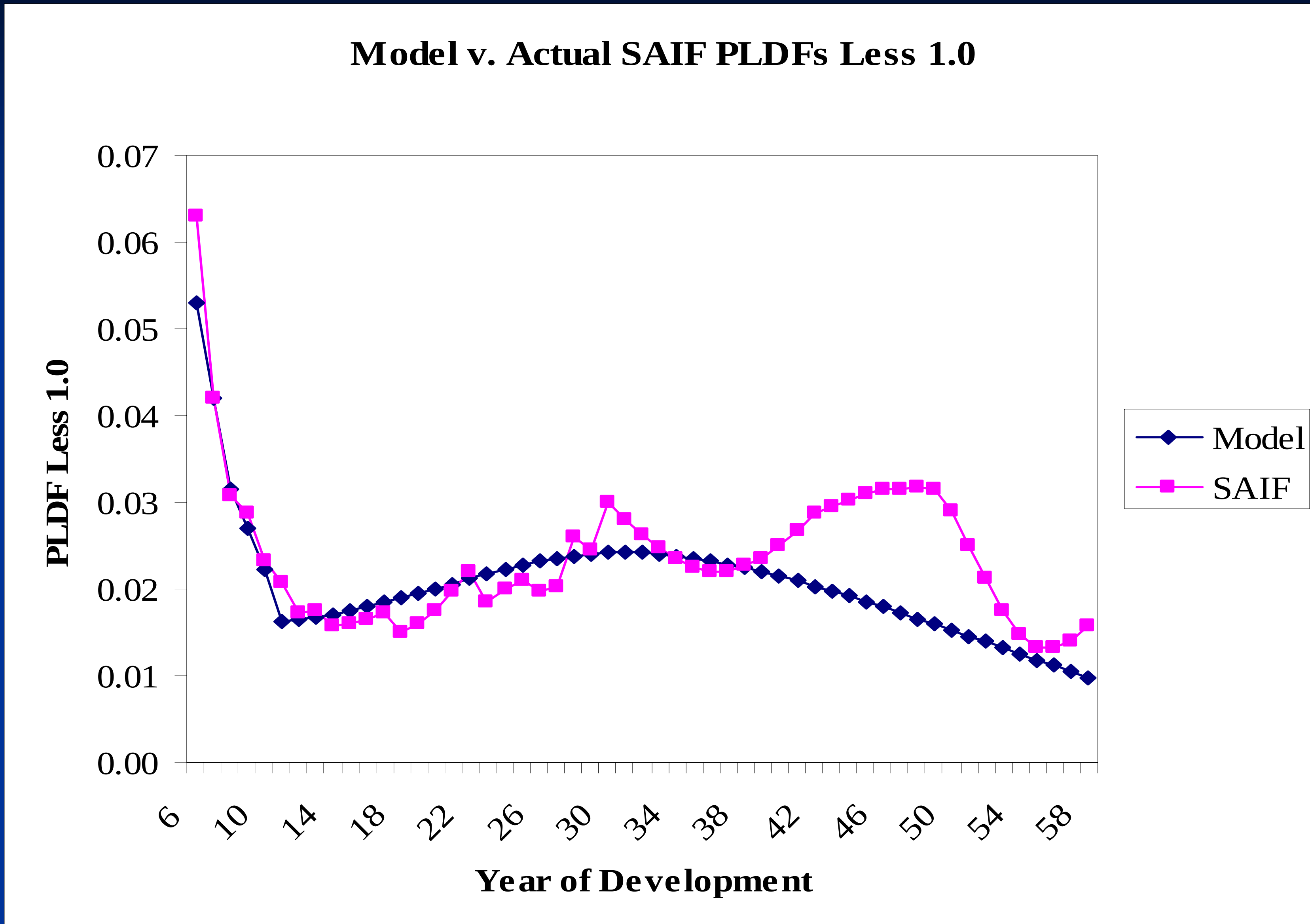


Two Radically Different Payment Distributions in WC

- Short term payments
- Lifetime payments to permanently disabled claimants.
- Reviewing paid data for the first 15 DYs key in predicting future short term payments, but it provides highly misleading indications of the extent of future lifetime payments to perm dis claimants.



Payout Patterns--Lifetime v. Short Term
MPD Payments for a Single Accident Year
25.00
20.00
15.00
10.00
5.00
0.00
$ Millions
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49
Development Year (DY)
Lifetime
Short Term



Model v. Actual SAIF PLDFs Less 1.0
PLDF Less 1.0
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
6
10
14
18
22
26
30
34
38
42
46
50
54
58
Year of Development
Model
SAIF

Mortality Model vs. SAIF's Actual

- 9% rate of future medical cost escalation assumed.
- Mortality rates of general population assumed.
- Model fit well out to development year (DY) 40.
- Model noticeably underestimated actual development beyond DY 40.

Types of WC Data Available

- Aggregate incremental paid by AY and DY
- Same, but separately for PTD & PPD
- Aggregate open counts by AY and DY
- Large claim listing
- Large claim listings for the past 5 yearends
- Perm Dis increm paids for past 5 CYs, and gender, age at injury, PTD v. PPD and AY/DY.

Define Predictive Modeling for WC Reserving

- Determining the relationship of incremental payments (the dependent variable) to various independent variables.
- Utilization of the above relationships and the future values of independent variables to forecast future payments.

Types of WC Reserving Predictive Models

- Markov Chain Incr. Pd – Fcn of prior increm paids and current case reserve.
- Markov Chain Incremental Payments (Prob of Closure vs. Death Rate, Prob of Change in Increm Paid v. DY, Age)
- Mortality Method with Incremental Severities
- Incremental Severity by DY and Age at Injury, Gender and PTD vs. PPD

One Large Claim Listing

- Shows cumulative paid and case reserve for each large claim. Also shows current age, gender and type of injury.
- A possible model: Divide case reserve (with no future medical inflation anticipated) by life expectancy. Inflate expected future payments.
- Use mortality table probabilities of death to create a Markov Chain simulation of future payments. Will discover that expected value of future payments is much greater than sum of inflated payments up to the expected age at death.

Five Successive Large Claim Listings

- Can calculate incremental payments by claim for the last 4 CYs.
- Can note the ratio of incremental payments to the decline in the case reserve (runoff ratio).
- Can use three oldest incremental paids and the prior year's case reserve (divided by life expectancy) to predict the latest year's incremental paid and determine which is better correlated.
- Can use above correlations to predict next year's incremental paid.

Calculating Regression Factors

Claim Number	Paid in Calendar Year 2000	2001	2002	2003	2004	**Average Annual Payment**
1	100	200	200	200	250	**190**
2	300	400	500	600	700	**500**
3	1,000	1,000	1,000	1,000	1,000	**1,000**
4	10,000	25,000	40	10,000	5,000	**10,008**

Claim Number	Current Case Reserve	Future Life Expectancy	**Estimated Annual Payment**
1	1,000	20.0	**50**
2	100	10.0	**10**
3	5,000	8.0	**625**
4	50,000	16.0	**3,125**

Paid in 2005
300
200
1,200
15,000

Regression Formula

Paid in 2005 = α_1 x Avg Annual Pmt + α_2 x Avg Case Reserve + β

Calculating Next Year's Payment

Claim Number	Paid in Calendar Year 2001	2002	2003	2004	2005	**Average Annual Payment**
1	200	200	200	250	300	**230**
2	400	500	600	700	200	**480**
3	1,000	1,000	1,000	1,000	1,200	**1,040**
4	25,000	40	10,000	5,000	15,000	**11,008**

Claim Number	Current Case Reserve	Future Life Expectancy	**Estimated Annual Payment**
1	970	19.5	**50**
2	1,000	9.5	**105**
3	3,800	7.5	**507**
4	75,000	15.5	**4,839**

Paid in 2006
222
464
1,088
11,359

Regression Formula

Paid in 2006 = 0.9 x Avg Annual Pmt + 0.3 x Avg Case Reserve + 0.0

AY 1980 Perm. Dis. Claims

Claim No.	CY 2005	CY 2006	CY 2007
1	600	700	750
2	1000	1100	- - -
3	2500	2800	3200
TOT. PAID	4100	4600	3950
# Open	4	4	3
Incr. Sev.	1025	1150	1317

	Incremental	Paid	
AY	DY 26	DY 27	DY 28
1980	60,000	58,000	52,300
1981	74,600	68,300	
	Prior	Open Counts	
AY	DY 26	DY 27	DY 28
1980	12	11	9
1981	14	12	
	Incremental	Paid per Prior	Open
AY	DY 26	DY 27	DY 28
1980	5,000	5,273	5,811
1981	5,329	5,692	

		Incre	mental	Paid	
AY	**DY 27**	**DY 28**	**DY 29**	**DY 30**	**DY 31**
1980	58,000	52,300	*8 * 6,200*	*8 * 6,600*	*7 * 7,050*
1981	68,300	*11 * 6,050*	*10 * 6,450*	*9 * 6,900*	*8 * 7,400*
		Prior	**Open**	**Counts**	
AY	**DY 27**	**DY 28**	**DY 29**	**DY 30**	**DY 31**
1980	11	9	*8*	*8*	*7*
1981	12	*11*	*10*	*9*	*8*
	Incre	**mental**	**Paid per**	**Prior**	**Open**
AY	**DY 27**	**DY 28**	**DY 29**	**DY 30**	**DY 31**
1980	5,273	5,811	*6,200*	*6,600*	*7,050*
1981	5,692	*6,050*	*6,450*	*6,900*	*7,400*

The Need to Separate

1. **The effects of mortality on the remaining number of open claims; and**
2. **The effects of medical cost escalation on claim severities.**

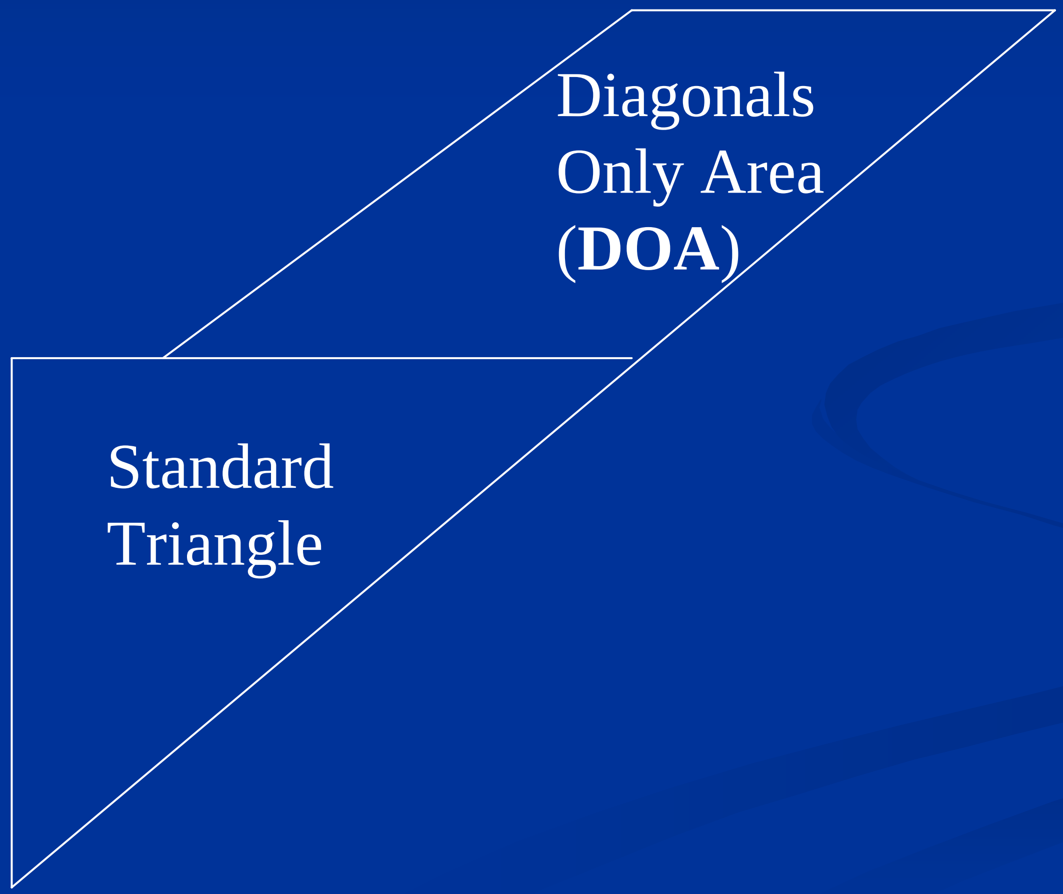
This **<u>cannot</u>** be done with the standard paid loss development method.

Opposite Influences

OPEN COUNTS PROJECTED
USING MORTALITY FACTORS
(AND CLAIM CLOSURE RATES)

AVERAGE PAYMENTS PROJECTED
USING MEDICAL ESCALATION RATES

Dead on Arrival (DOA) Data

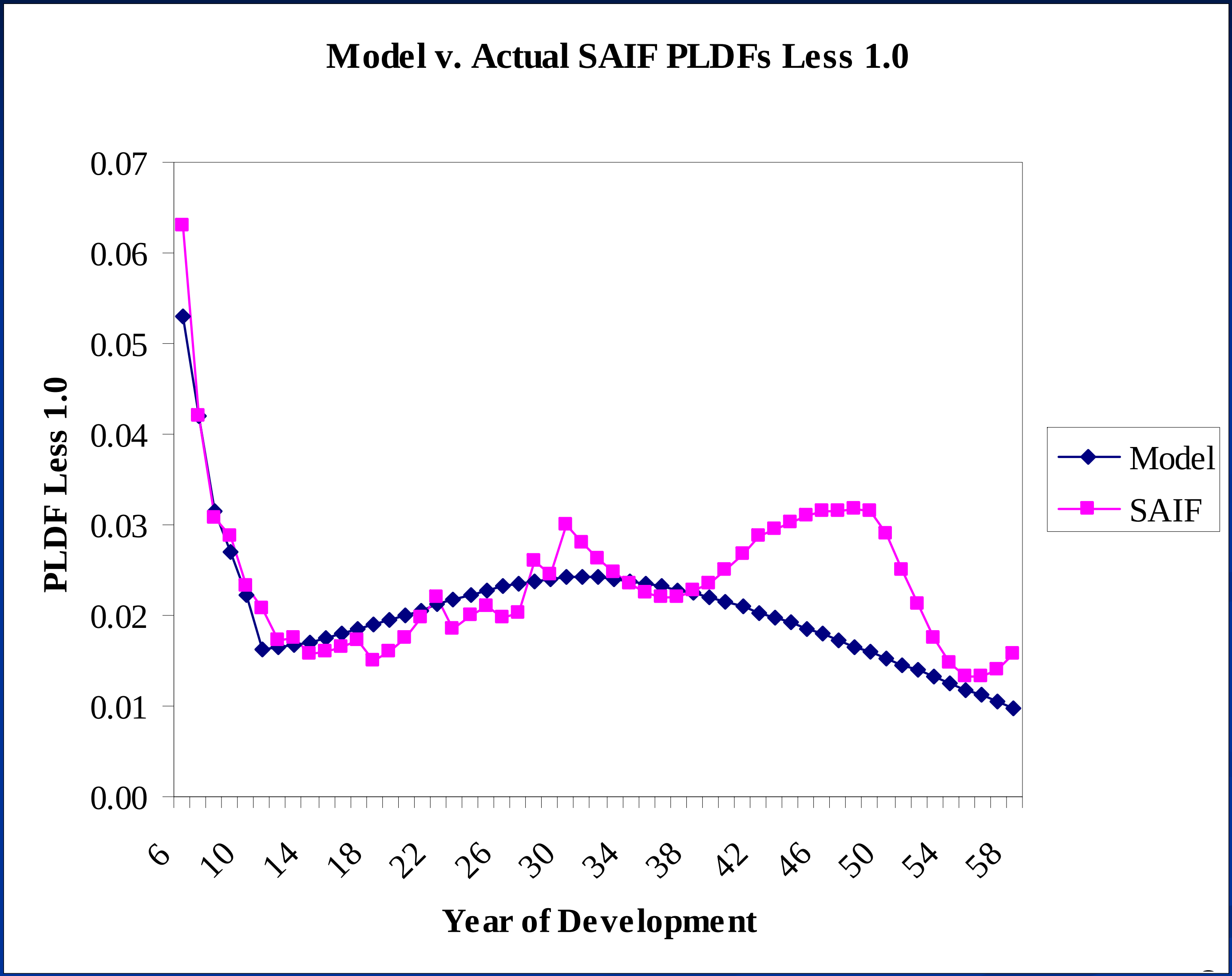


Deriving & Expanding Incremental Paid

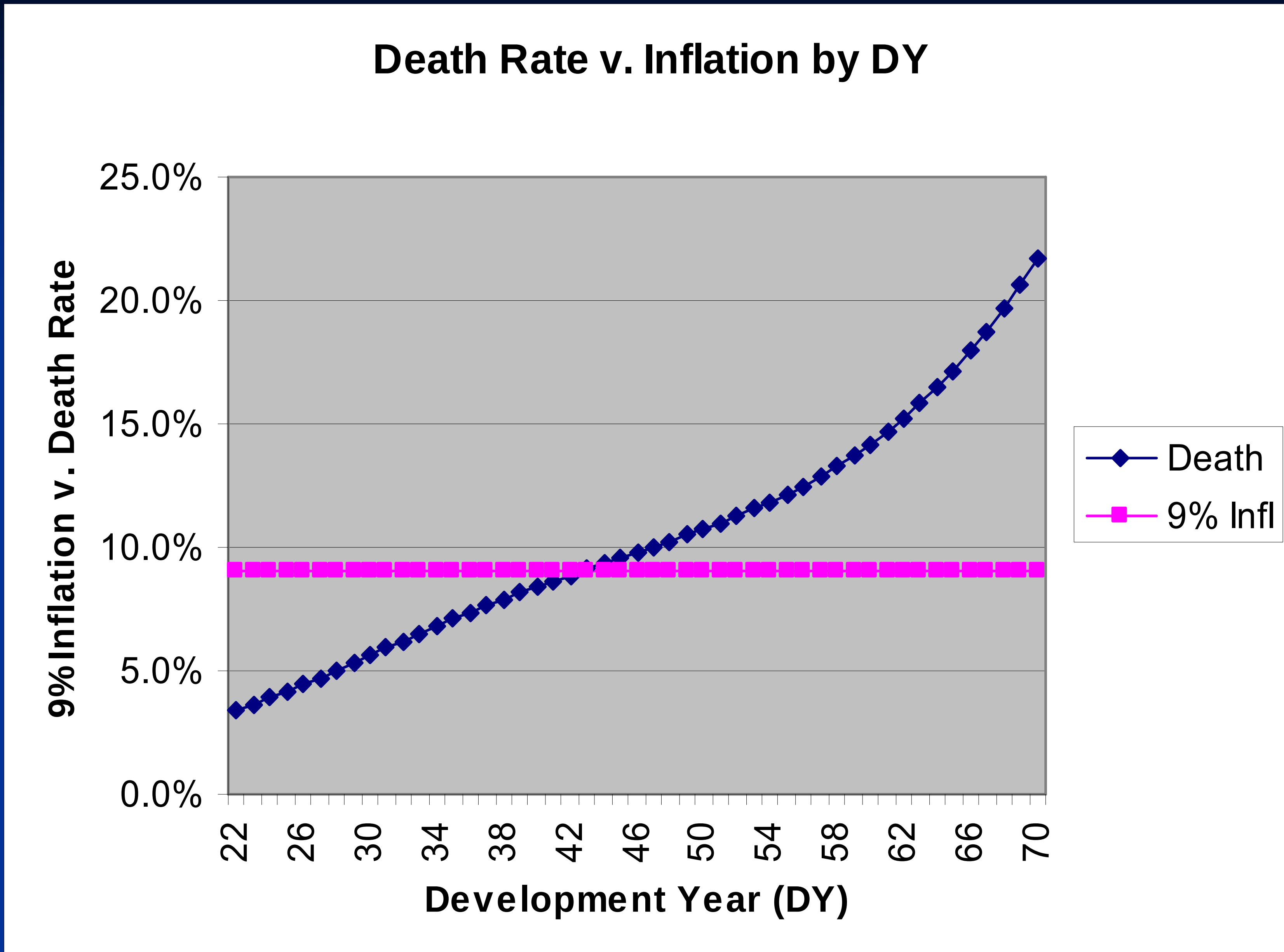
	AY	12	24	36
Cumulative	2002	3,000	18,000	28,000
Paid Losses	2003	3,000	18,000	
($000's)	2004	3,000		

	AY	CY 02	CY 03	CY 04
Incremental	2000	10,000	4,000	2,500
Paid ($000's)	2001	15,000	10,000	4,000

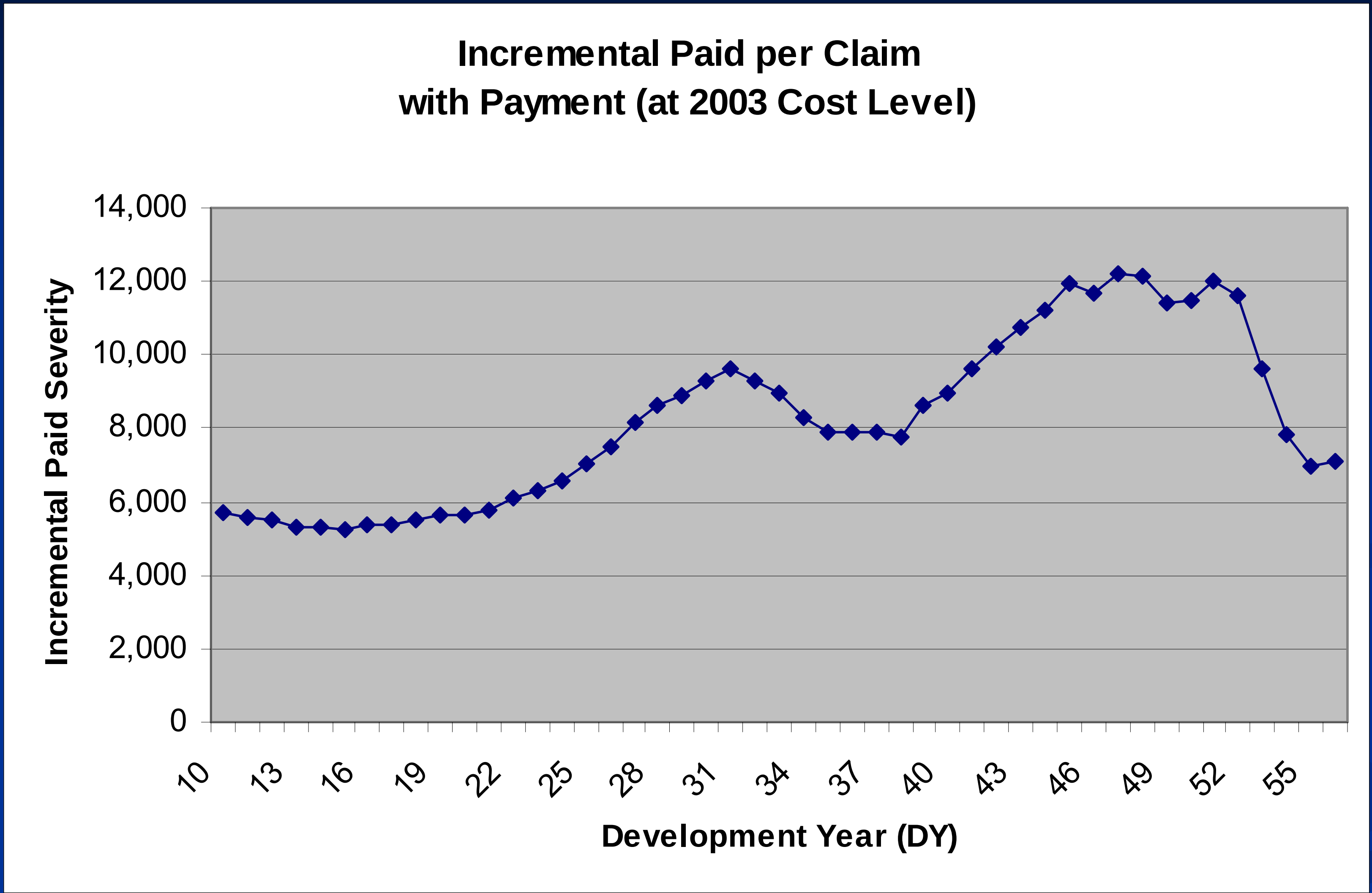
	AY	12	24	36	48	60
	2000			***10,000***	***4,000***	***2,500***
	2001		***15,000***	***10,000***	***4,000***	
Incremental	2002	3,000	15,000	10,000		
Paid ($000's)	2003	3,000	15,000			
	2004	3,000				



Model v. Actual SAIF PLDFs Less 1.0
PLDF Less 1.0
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
6
10
14
18
22
26
30
34
38
42
46
50
54
58
Year of Development
Model
SAIF



Death Rate v. Inflation by DY
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
9% Inflation v. Death Rate
22
26
30
34
38
42
46
50
54
58
62
66
70
Development Year (DY)
Death
9% Infl



Incremental Paid per Claim
with Payment (at 2003 Cost Level)
Incremental Paid Severity
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
Development Year (DY)

Separate Frequency & Severity Analyses

- Compare claim closure rates with rates of mortality – Calculate relativities (e.g., 150%)
- Need to have current ages and genders of all remaining claimants.
- Track any movements in on-level severities over many years.
- Indications will be volatile unless open counts for each AY are sizeable.

Claim Closure/Mortality Relativities

	DY 40	DY 41	DY 42
# of Claim Closures	8	11	9
Expected Deaths	4.6	4.9	5.4
Relativity	1.74	2.24	1.67

Predictive Models Stabilize Extrapolations

- Volume of Open Counts will drop for higher DYs, making frequency and severity indications increasingly volatile.
- Actuary will impose judgment and indications from predictive models to cope with the high volatility for higher DYs.

Why the rise in on-level incremental severities for late DYs?

- Answered by developing a more detailed predictive model.
- On-level incremental severities examined by age-at-injury, gender, claim type & DY.
- As the DY increases, the composition of surviving claimants by age-at-injury shifts dramatically to lower ages, where on-level severities are much higher.
- Younger workers are given the hazardous jobs.

Average On-Level Incremental Paid

Avg Age at Injury	DYs 16-25	DYs 26-40	DYs 41+	DYs 16+
15-35	5,957	8,579	16,094	**7,482**
36-45	5,495	6,707		**5,952**
46+	2,647	5,132		**3,509**
All	**4,630**	**7,126**	**11,749**	

Multiple Regression

- Dependent Variable:

On Level Incremental Severity

- Independent Variables:

Age-at-Injury, DY

% Young at Injury by DY

DY	20	30	40	50	60
% Young At Injury	46%	57%	71%	87%	98%

$7,000 Young & $3,500 Older

	DY 20	DY 30	DY 40	DY 50	DY 60
% Injured Young	46%	57%	71%	87%	98%
Wtd. Severity	5,100	5,495	5,985	6,545	6,930

Average On-Level Incremental Paid

Avg Age at Injury	DYs 16-25	DYs 26-40	DYs 41+	DYs 16+
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