Transition Models Underlying Statistical Case Estimation

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Statistical Case Estimation

- Estimation of ultimate finalised claim cost from individual reported claim characteristics

- Trade off between

  i) Fewer variables in claim size model and simpler transition modelling: injury severity, operational time, finalisation quarter; or

  ii) More variables in claim size model and complex transition modelling. Potential variables include more detailed injury data on all injuries, litigation status, age, gender etc

Claim Transitioning

- Claims tend to transition to higher severity (higher cost) characteristics
- Adds up to 220% to the liability relative to the untransitioned liability
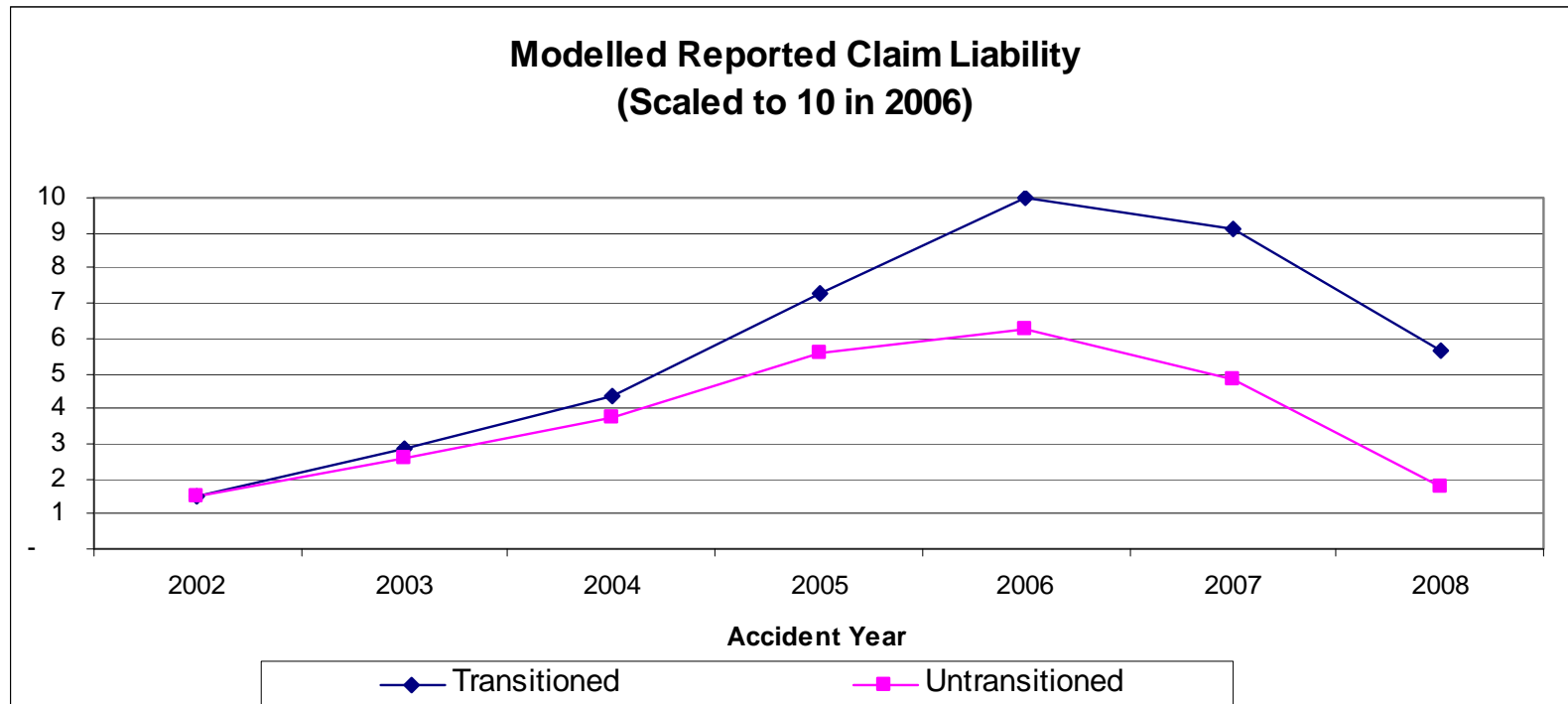
Modelled Reported Claim Liability
(Scaled to 10 in 2006)

X-axis: Accident Year (2002–2008)

Legend: Transitioned, Untransitioned

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Sources of Transitioning

1) Genuine change of claim state as a result of new action by either the claimant or the insurer, eg legal representation may be sought.

2) Greater completeness of information about the claim. For example, doctors' reports may become available.

3) Erroneous information may exist in the claim data and be corrected, eg gender or the age of the claimant at the date of the incident.

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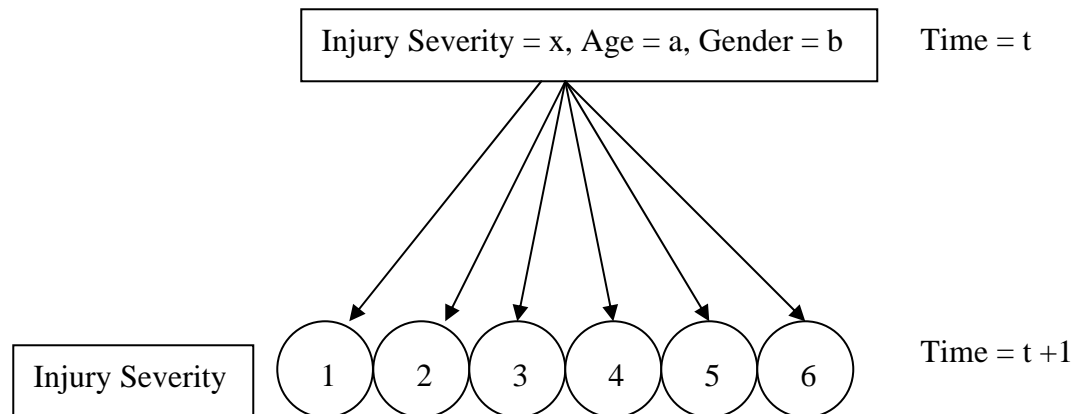*Thriving on Change*

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Transition Modelling

State(time t+1) ~ Multinomial(predictors at time t)

Generalised logit function for non-ordinal responses

$$\log\left(\frac{p_{ij}}{p_{ir}}\right) = \alpha_j + x'_i\,\beta_j$$

| Injury Severity = x, Age = a, Gender = b | Time = t |

Injury Severity | 1 2 3 4 5 6 | Time = t +1

- State j at time t+1
- Characteristics i at time t
- Referent state r at time t+1

Markov assumption

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Interaction and Variable Combinations

- Which variables should be combined?

- Injury severity or injury type, of 1, 2, 3, more injuries?

- Combinations becomes unwieldly

- Collapse levels if need be. Eg Collapse severities 2 and 3.

- Talk to claims staff about drivers of cost and interaction between characteristics

Variable Selection

- Behaviour of claim subsets

- Absorbing states

- Categorical vs continuous variables

- Time frame

- Effect of finalisation on transitioning

- Effect of duration on transitioning

Legislative Change

- Include scheme in parameterisation and application
  - NSW CTP: MACA
  - QLD CTP: CLA
  - Subset experience by scheme, or blend by scheme or include scheme as a predictor
- New legislation needs special treatment with identification of proxy variables. Eg, particular injury codes may be a proxy for LTCS

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Example
(Injury 1 Severity) : (Injury 1 Region) : (Injury 2 Severity)

Multinomial logistic regression predictor variables

- A flag indicating if the severity of the most serious injury is zero or not (ie there are no genuine injuries recorded) at time t.
- A flag indicating if the second most serious injury has severity 1 or not at time t.
- A flag indicating if the claim is litigated at time t.
- Two spline-based transformations of the claimant's age at accident.
- Two spline-based transformations of the development period (ie number of quarters between lodgement and data capture) at time t.
- The reporting delay.
- The number of injuries recorded at time t.

With the Inj1Sev:Inj1Reg:Inj2Sev combined variable at time t+1 predicted, decompose this into the individual component variables

Model validation using standard GLM validation techniques and misclassification tables

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Error Estimation

1) Model misspecification error
2) Parameter error
3) Process error

- Error is specific to transition model. Claim size model error needs to be estimated separately

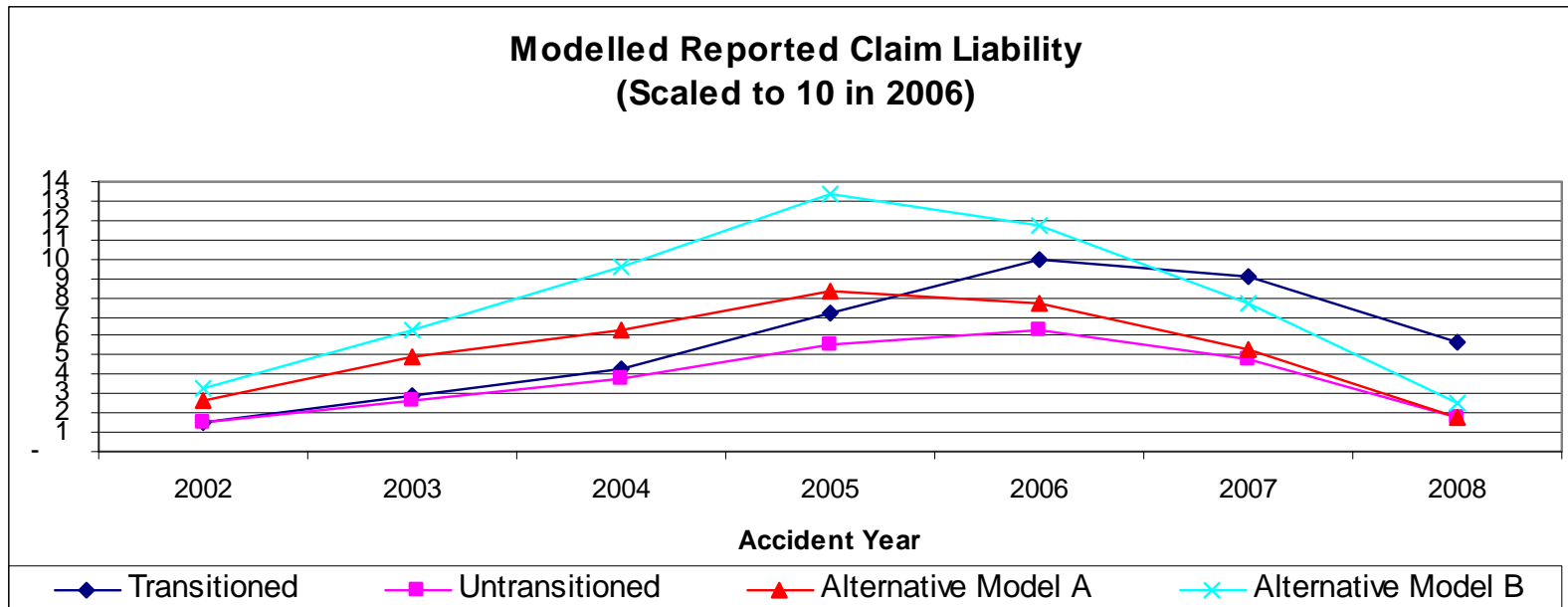- Useful for model selection and risk margin calculation

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Model Misspecification Error

Modelled Reported Claim Liability
(Scaled to 10 in 2006)

Legend: Transitioned · Untransitioned · Alternative Model A · Alternative Model B

- Variability around 'base' transition model
- Alternative Model A projects the combined variable Inj1Sev:Inj1Reg:Inj2Sev at time t+1 based only on its value at time t
- Alternative Model B projected Inj1Sev, Inj1Reg, Inj2Sev separately and independently
- Need to test 'unreasonable' models too

Parameter Error

Modelled Reported Claim Liability
(Scaled to 10 in 2006)

Accident Year

- Transitioned (Apr 08)
- Transitioned (Jan 08)
- Transitioned (Oct 07)
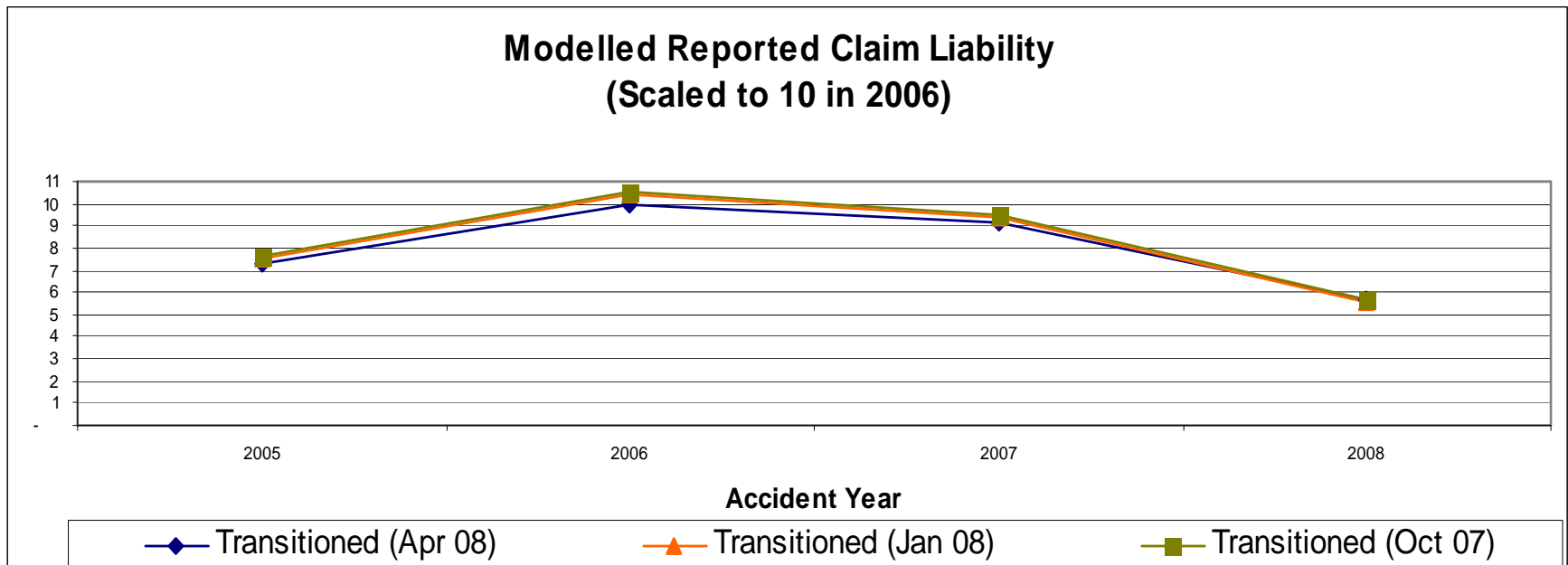
- Parameters estimated using an eight quarter moving window
- Liability shifts up to 5% by shifting window by one quarter.
- Test different sampling period

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Process Error

Liability Simulation Distribution — histogram of Relative Proportion vs Liability ('000)
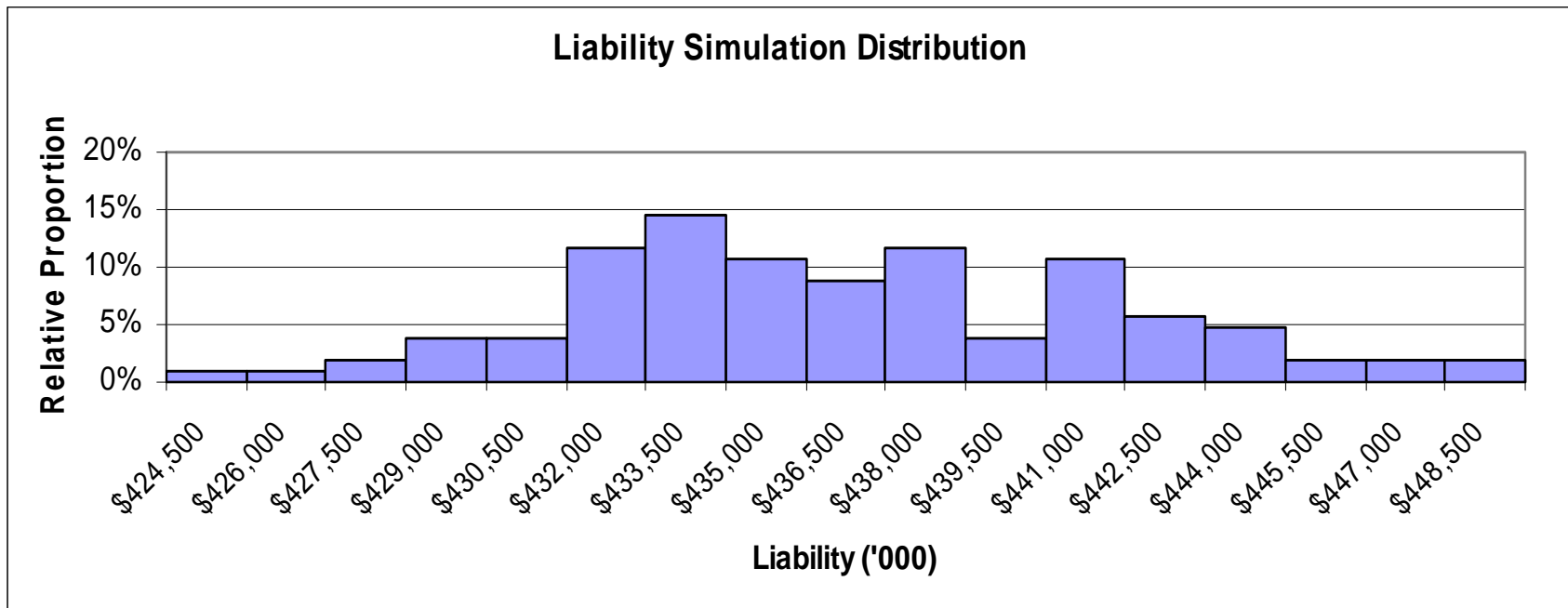
- Simulation outcome histogram (rescaled to disguise liability size)
- Stochastic variation of transitioning simulation

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Conclusion

Trade-off between:

1) Granular claim size model and complex transitioning; or

2) Simple claim size model and 'reliable' transitioning

Questions?

Misclassification Table

Severities 0,1,2,3 Only	Predicted														
		0:0:0	1:0:0	1:1:0	1:1:1	1:2:0	1:2:1	1:7:0	1:7:1	2:1:0	…	3:7:0	3:7:1	3:7:2	3:7:3	Total
Actual	0:0:0	3740	58	77	52	4	4	143	226	28	…	10	14	4	2	4581
	1:0:0	51	736	32	3	3	0	54	11	21	…	2	1	0	0	934
	1:1:0	78	5	268	24	7	2	659	85	217	…	31	6	9	2	1745
	1:1:1	52	24	23	390	1	29	48	1196	18	…	2	73	2	0	2768
	1:2:0	4	0	7	1	0	0	20	3	6	…	1	0	0	0	50
	1:2:1	4	3	2	28	0	3	5	92	1	…	0	7	0	0	229
	1:7:0	146	9	649	57	18	5	2693	287	530	…	117	22	37	7	5682
	1:7:1	228	68	82	1180	4	92	273	5543	70	…	15	413	14	2	12147
	2:1:0	28	2	215	20	5	2	532	74	188	…	30	6	11	2	1455
	….	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
	3:7:0	9	0	33	3	1	0	116	18	30	…	10	2	7	3	353
	3:7:1	14	2	7	73	0	7	23	413	7	…	2	45	2	0	1006
	3:7:2	4	0	6	3	0	0	33	18	8	…	9	2	32	22	529
	3:7:3	1	0	2	1	0	0	11	4	2	…	3	1	21	24	382
	Total	4581	934	1745	2768	50	229	5682	12147	1455	…	353	1006	529	382	