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# Rating Variables in Pricing Health Insurance

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- Individual Health Insurance:
  - Typical pricing methodology
  - Simplifying assumptions for illustrative purposes
  - Traditional rating variables
  - Advanced rating variables
  
- Extension to Group Health Insurance:
  - Credibility Theory
  - Additional rating variables unique to group insurance



# Typical Individual Health Pricing Methodology

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- Step 1: Gather experience period claims data
- Step 2: Apply prospective Medical Trend
- Step 3: Convert into a claims distribution
- Step 4: Apply risk factors (rating variables) to claim distribution
- Step 5: Apply benefit design to claim distribution
- Step 6: Apply retention to derive gross premium
- Step 7: Apply underwriting judgment, if applicable



# Simplifying Assumptions for Illustration

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- Guaranteed Acceptance; underwriting questions may be used for rating but not to decline
- Pricing methodology is quite flexible with limited legal interference
- Insurance is entirely private; no public coordination
- Benefit design is “US style”



# Individual Health Pricing – Step 1

Step 1: Gather experience period claims data

- Assume experience period = Jan 2009 – Dec 2009
- Include an IBNR estimate, if necessary
- “Gross up” for benefit design and any utilization dampening, if applicable

<b>Policy ID #</b>	<b>Gross Claims</b>
1	2,631
2	0
3	4,070
Etc..	Etc..



# Individual Health Pricing – Step 2

## Step 2: Apply prospective medical trend

- Assume annual medical trend = 8%
- Assume effective date of coverage = Oct 2010
- Number of Months of Medical Trend = 21 (midpoint to midpoint)
- Medical Trend Factor =  $(1.08)^{(21/12)} = 1.144$

Policy ID #	Gross Claims	Medical Trend	Proj Claims
1	2,631	1.144	3,010
2	0	1.144	0
3	4,070	1.144	4,657
Etc..	Etc..	Etc..	Etc..



# Individual Health Pricing – Step 3

Step 3: Convert into a claims distribution (illustrative)

Probability	Cumulative	Proj Claims
30%	30%	0
5%	35%	200
10%	45%	700
13%	58%	1,300
15%	73%	2,000
12%	85%	3,000
8%	93%	5,500
4%	97%	8,000
2%	99%	35,000
1%	100%	200,000
Weighted		4,369



# Individual Health Pricing – Step 4

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Step 4: Apply risk factors to claims distribution

## Traditional Rating Variables

- Age
- Gender
- Industry / Occupation
- Geographic Area





# Individual Health Pricing – Step 4 (cont'd)

## Development of “Age / Sex” Factors

- Combine age and gender variables since shape of factors varies for M/F
- Typically shape these around 1.00 to normalize data properly
- Generally the most important rating variable

Illustrative Male Factors:	
0-18	0.75
19-29	0.65
30-34	0.75
35-39	0.85
40-44	1.00
45-49	1.10
50-54	1.40
55-59	1.65
60-64	1.90
65+	2.25

Females:	
0-18	0.75
19-29	0.80
30-34	1.20
35-39	1.10
40-44	0.95
45-49	1.05
50-54	1.25
55-59	1.50
60-64	1.75
65+	2.00



# Individual Health Pricing – Step 4 (cont'd)

## Development of Industry / Occupation Factors

- Difficult to accurately classify all insureds, so keep it simple
- Less variability than other rating factors

<b>Illustrative Occupational Class Factors:</b>	
Finance Professional	0.85
Computer Programmer	0.90
Retail Sales	1.00
Hotel Employee	1.10
Restaurant Employee	1.20
Hospital Employee	1.30
Construction Worker	1.40
Etc..	Etc..



# Individual Health Pricing – Step 4 (cont'd)

## Development of Geographic / Area Factors

- Due to variation in unit costs (hospital / physician charge scales) or utilization patterns (certain regions demonstrate healthier behaviors)

<b>Illustrative Geographic Factors:</b>	
Woodlands	0.80
East Coast	0.90
Sentosa	1.00
Jurong	1.10
Holland Village	1.20
Orchard	1.30
Etc..	Etc..



# Individual Health Pricing – Step 4 (cont'd)

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Step 4: Apply risk factors to claims distribution

## Non-Traditional Rating Variables

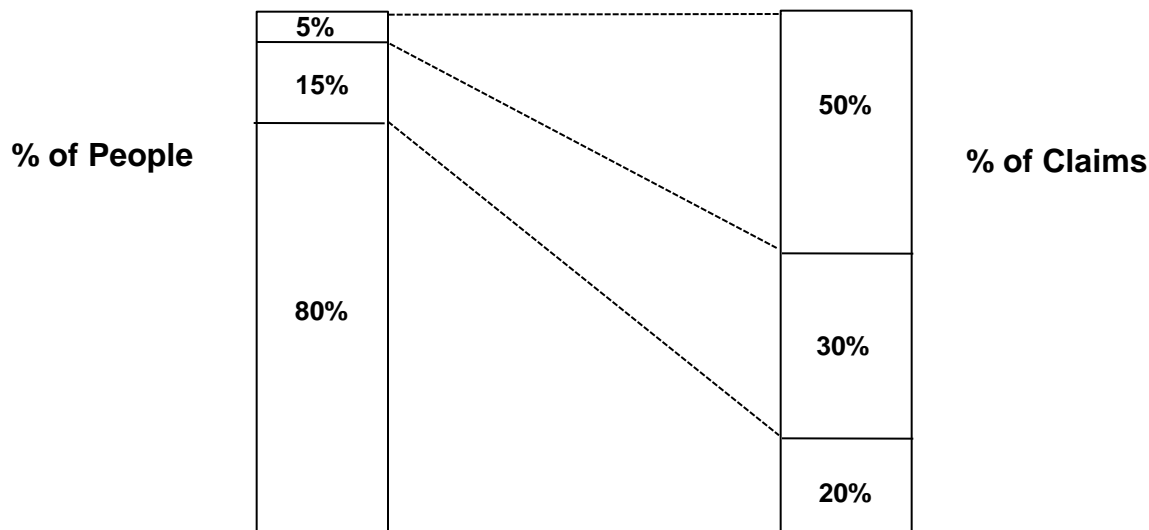
- Predictive model using historical claims experience
- Behavioral / transactional data from external data sources
- Income
- Race
- Education level
- Smoker status
- Family history



# Individual Health Pricing – Step 4 (cont'd)

## Predictive model using historical claims experience

- Medical claims by individual typically have a high degree of variation
- In the US, 5% of people typically create 50% of the claims. 20% create 80%.
- Traditional rating variables have a ratio of about 5:1 from the worst to best risks. Predictive modeling can increase the differential to as much as 10,000:1, due to greater refinement in the medical cost projections.



# Individual Health Pricing – Step 4 (cont'd)

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## Predictive Modeling: how is it done?

- Develop the model: use x years of historical data: need both a base period and a projection period within your data to back-test properly
- Typically use logistic regression or similar technique
- Actual claim history used in the model (typically ICD-9 / 10 codes for medical claims, and also use pharmaceutical data)
- Supplement actual claim history with demographic data
- The advantages:
  - Last year's low cost claimants could become this year's high cost
  - Last year's high cost claimants may improve in the future (especially if acute cause of claim)
  - Systemic way of evaluating experience



# Individual Health Pricing – Step 4 (cont'd)

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## Predictive Modeling: other ways to enhance your model

- External data sources, such as Medical Insurance Bureau (MIB) in US that provides pharmaceutical data on individuals
- Credit scoring bureaus (such as big 3 in USA)
- Other demographic statistics: income, race, education level, smoker status, family history
- The possibilities are endless!



# Individual Health Pricing – Step 4 (cont'd)

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Illustrative Example:

Male Age 35 (Factor = 0.85)

Insurance Professional (Factor = 0.85)

Orchard area resident (Factor = 1.30)

No data available on non-traditional rating variables

Total Risk Factors =  $0.85 * 0.85 * 1.30 = 0.94$





# Individual Health Pricing – Step 4

Step 4: Apply risk factors to claim distribution

Probability	Cumulative	Proj Claims	Risk Factor	Risk Adjusted Claims
30%	30%	0	0.94	0
5%	35%	200	0.94	188
10%	45%	700	0.94	657
13%	58%	1,300	0.94	1,221
15%	73%	2,000	0.94	1,879
12%	85%	3,000	0.94	2,818
8%	93%	5,500	0.94	5,166
4%	97%	8,000	0.94	7,514
2%	99%	35,000	0.94	32,874
1%	100%	200,000	0.94	187,850
Weighted		4,369	0.94	4,104



# Individual Health Pricing – Step 5

## Step 5: Apply benefit design to claim distribution

- Benefit design may include coinsurance, deductibles, out of pocket maximums, benefit maximums
- Benefit design may apply on an annual basis or a per-event basis
- One should also estimate the policyholder behavior change introduced by the benefit design (“Utilization Dampening”) – example:

Benefit Plan	Deductible	Coinsurance	Out of Pocket Maximum	Utilization Dampening Factor
Plan 1	0	0	0	100%
Plan 2	\$300	20%	\$5,000	85%



# Individual Health Pricing – Step 5

(assume \$300 Deductible, 20% Coinsurance, \$5000 OOP Max)

Probability	Cumulative	Risk Adjusted Claims	Utilization Dampening	Benefit Design Impact	Benefit Adjusted Claims
30%	30%	0	85%	0	0
5%	35%	188	85%	(160)	0
10%	45%	657	85%	(352)	207
13%	58%	1,221	85%	(448)	590
15%	73%	1,879	85%	(559)	1,037
12%	85%	2,818	85%	(719)	1,676
8%	93%	5,166	85%	(1,118)	3,273
4%	97%	7,514	85%	(1,517)	4,870
2%	99%	32,874	85%	(5,000)	22,943
1%	100%	187,850	85%	(5,000)	154,673
<b>Weighted</b>		<b>4,104</b>			<b>2,924</b>



# Individual Health Pricing – Step 6

Step 6: Apply retention to derive gross premium

- Acquisition expenses (assume 5% of premium)
- Maintenance expenses (assume \$100 per policy per year)
- Commissions (assume 5% of premium)
- Premium Taxes, GST, VAT (assume 3% of premium)
- Profit allowance (assume 10% of premium)

Gross Premium = (Total Claims + Fixed Retention) / (1 – Variable Retention)

= (2,924 + 100) / (1 – 5% - 5% - 3% - 10%)

= 3,928



# Individual Health Pricing – Step 7

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## Step 7: Apply underwriting judgment, if applicable

- Many jurisdictions allow prices to vary from filed methodology by +/- x% due to other considerations
- These other considerations may involve some of the non-traditional rating factors, or a host of other reasons



# Conclusion – Individual Pricing Methodology

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- Potential insureds are not homogenous
- Better estimation of risk factors will result in more attractive pricing for the best risks and less attractive pricing for the worst risks
- Analytical expertise and actuarial sophistication are key to winning in the individual health space



# Extension to Group Health Insurance

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Many of the same concepts apply, but with the following exceptions:

- Credibility theory is critical; the value of non-traditional rating variables at the individual level begins to diminish
- The composition of the group may change; thus several group-level underwriting factors should be considered



Historical actual claims experience for a group becomes more important as the group size increases.

- Many insurers consider a group to be “fully credible” if it has 500-1500 members
- For partially credible groups, the historical experience should be blended with the “Manual Rate” (or book rate)
- It is important to understand the nature of the group when determining the amount of credibility to apply to the experience
- Some insurers use only one year while others use multiple years in applying credibility to groups





# Credibility Theory (cont'd)

Suppose an insurer uses the following table to determine credibility, based upon one year of experience:

# Members in Group	Credibility
<100	0%
100-199	20%
200-499	50%
500-1000	75%
>1000	100%



# Credibility Theory (cont'd)

- Suppose a group of 150 members has actual claims experience of \$3,000 per member in the experience period. Medical trend (midpoint to midpoint) is estimated at 15% to project the claims to the renewal date. Assume the demographic mix shift is minimal from the experience period to today.
- The “Manual Rate” for this group (reflecting rating variables applied to each individual) is \$2,500 per member for the projection period.
- The credibility-weighted claim expectation is therefore:

20% Credibility \* \$3,000 \* 1.15 +

80% Non Credible \* \$2,500 = \$2,690



# Group Specific Rating Variables

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- Nature of the Group: is it employer sponsored or something else?
- Turnover Rate of the Group
- Expected mix shift due to new entrants and leavers of the group
- Participation Rate
- Contribution Rate



# Nature / Turnover of the Group

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- Is the group employer sponsored? Will some members of the group join or stay in the group purely for the benefits?
- Is the plan the only offering available? Or is it one of many competing plans available to the group's members? ("Slice")
- What is the turnover rate of the group? High turnover should imply lower credibility of the claims experience, and greater anti-selection risk due to mix shift.



# Expected Mix Shift

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- How have the group's demographics changed since the experience period?
- Is the group comprised of many women in child bearing ages?
- Are many of the insureds near retirement and therefore likely to leave the group?
- How is geographic concentration expected to change in the future?



# Participation and Contribution Rates

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For non-compulsory group insurance, these variables are vital.

- Participation Rate: what is the take up rate? Typically higher take-up results in better risk selection.
- Contribution Rate: does the group sponsor pay all or some of the premiums? Typically higher sponsor contribution rates will result in higher take up, and therefore better risk selection.

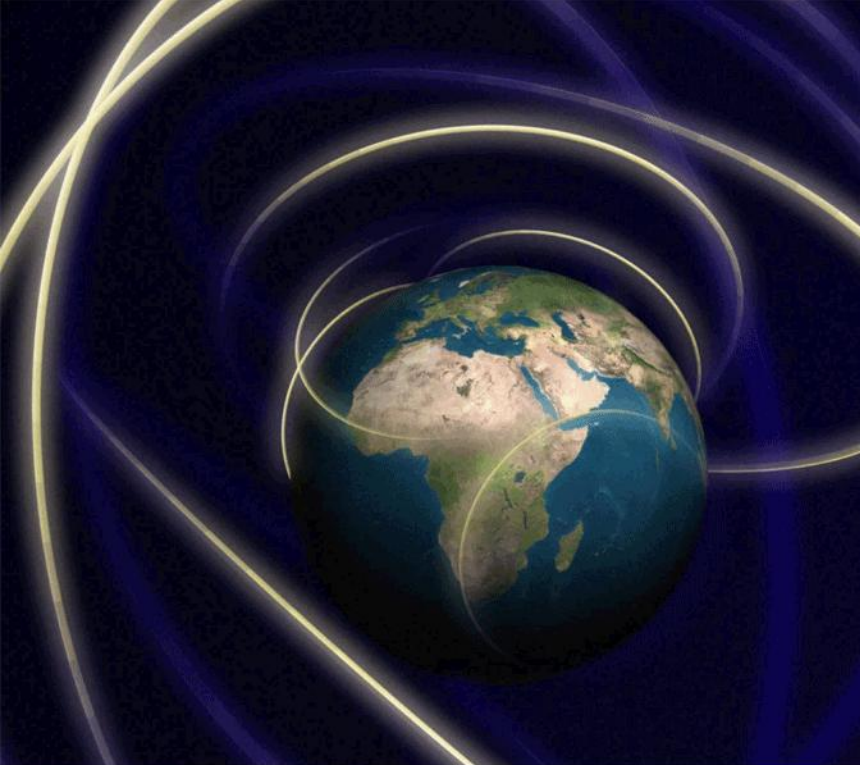


# Conclusion – Group Pricing Methodology

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- Many of the same principles apply as in individual pricing
- Credibility theory is key, but should not be used blindly
- Group level assessment must be applied to ensure that one understands potential mix shift and sponsor intentions
- Pricing mistakes can be costly as they may apply to a large base





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