4. (1.75 points)

An actuary has historical information relating to customer retention. A logistic model was used to estimate the probability of renewal for a given customer. The two variables determined to be significant were the size of rate change and number of phone calls the insured made to the company. The parameter estimates were determined to be as follows:

Rate Change	Parameter Estimate
Decrease to 3.9% increase	0.3323
4.0% to 6.9% increase	0
Increase of 7.0% or more	-0.4172

Number of Phone Calls in Past Year	Parameter Estimate
0	0
1	-0.2128
2+	-0.4239

Intercept Term	1.793

a. (0.75 point)

Calculate the renewal probability for a customer who has a 7% rate increase and called the company twice in the past year.

b. (1 point)

The company needs policyholder retention to be above 78% to maintain growth and expense ratio goals. A possible strategy is to add the number of phone calls to the classification plan and use the model results to determine the rate increase.

Construct an argument either in favor of or against the strategy above, describing two reasons for that position.

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Question 4:

Model Solution 1

a)

$E(Y_i) = g^{-1}(B_0 + B_1X_1 + B_2X_2)$

Where B_0 = intercept,
X_1 = rate change group: increase of 7%
X_2 = # phone calls: 2
For logistic model, $g^{-1}(x) = e^x / (1 + e^x)$
$E(Y) = g^{-1}(1.793 - 0.4172 - 0.4239)$
$E(Y) = g^{-1}(0.9519)$
$E(Y) = e^{0.9519} / (1 + e^{0.9519}) = .7215$

b)

Against adding # phone calls to the class plan:

i.) It is easily manipulated by the insured

ii.) The variable lack constancy = the insureds # of phone calls might change dramatically year to year.

Model Solution 2

a)

$\eta = \sum x\beta = 1.793 - 0.4172 - 0.4239 = 0.9519$

Logistic model uses logit link, i.e.

$\log\left(\frac{y}{1-y}\right) = \eta$ and $E(Y) = e^n / (1 + e^n) = e^{0.9519} / (1 + e^{0.9519}) = 0.7215$

Renewal prob for the risk is 0.7215

b)

The strategy does not sound reasonable because:

1.) It is not based expected loss potential: insured who don't call the insurer may be those with clean history. They never find the need to make a phone call. While those who make phone calls may be those who had claims in the past. But insured can make phone calls for other purposes not related to claims.

2.) It is possible be manipulated by the insured: Once the insureds know making phone calls to the insurer can potentially alter the rate, they will either choose to call or NOT call depending what the impact is.

Examiner's Comments

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Part a

Most candidates were successful in calculating the systematic component, but struggled to remember the inverse link function for the logistic model. Candidates received partial credit if they assumed a different link function (and solved correctly). Candidates also received partial credit if they demonstrated knowledge of the logistic model (e.g. "the logistic model is a combination of the logit link function and a binomial error term") or by correctly identifying the link function or inverse link function; even if they did not solve the problem.

Part b

Candidates struggled to get points on this question. Several candidates provided arguments both IN FAVOR and AGAINST the strategy, in which case credit was potentially given for the first position taken. Some candidates also provided more than two arguments IN FAVOR or AGAINST, in which case credit was potentially given for the first 2 arguments provided.

Otherwise, most well formulated arguments that relied on the considerations in designing a risk classification plan (AAA Risk Classification Statement of Principles) paper were given full credit, including but not limited to:

1.) Underwriting of individual risk is separate

2.) Marketing has an important influence on the mix of business attracted

3.) Program design - Degree of choice available to the buyer

4.) Statistical - Credibility, Predictive Stability:

5.) Operational - Expense: low as possible, minimize adverse selection, maximize equity; Constancy: variable should be constant in relation to the risk; Availability of Coverage; Avoidance of extreme ambiguities (collectively exhaustive and mutually exclusive); Manipulation: minimize ability to misrepresent; Measureability: moral character not determinable

6.) Causality: more acceptable to public if cause/effect relationship between risk and cost is demonstrable

7.) Controllability: risk control its own characteristics (good unless manipulation)

The ability for the insured to "manipulate the # calls" was a commonly chosen argument for which full credit was given, except in cases where the candidate argued that the insured would call less often.

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