

Fox Module 23 Generalized linear models, probabilities

- Binomial response variables
- Logit and probit GLMs

Read Section 14.1, “Models for Dichotomous Data,” on pages 335-337. This section is an introduction, with an example from a Chilean vote.

Read Section 14.1.1, “Linear-probability model,” on pages 337 through the end of the gray box on page 338. Know the three problems of using classical regression analysis for probability data in the three bullet points on pages 337-338 and repeated in the gray box on page 338.

Read Section 14.1.2, “Transformations of π : logit and probit models,” on pages 339 through the first line on page 340. Skip the cumulative rectangular distributions for the constrained linear-probability model and the unit-normal distribution in equations 14.5 and 14.6.

Know equation 14.7 and the second bullet point (bottom of the page) with equation 14.8.

Read pages 341-342, stopping before equation 14.10. The final exam gives a probability and asks you to form the log-odds (or *vice versa*).

GLMs don't have simple closed-form solutions. Final exam problems stress the concepts, not the details of GLMs.

Logit and probit transformations enable us to model probabilities. Actuaries model renewal rates in each line of business to judge long-term profitability.

New business is often written at a loss, since initial underwriting is expensive and agents' commissions are high. Underwriting and acquisition expenses on a new permanent life policy are more than the first-year premium. Insurers earn money on renewal business, so they seek customers who will not lapse. Logit transformations and link functions enable us to model probabilities of renewal.

Existing customers of one line are often the best markets for other lines. Some insurers sell personal auto at cost and then sell more profitable Homeowners or life insurance to these customers. Actuaries use logit transformations and link functions to estimate how many personal auto policyholders buy Homeowners or life insurance.

You can do a student project using a transformation. If you work as a pricing actuary, you might examine how renewal rates vary with the number of years already insured.

- For a student project using Excel, use a logit transformation to convert the renewal rates to a linear function the explanatory variables. See the homework assignment for an example.

- For a full GLM analysis, use R. This course does not require GLMs, but they are a most useful actuarial tool. R has built-in functions that do all the GLM work.