Negative Binomial Quasi Poisson Combined

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Both negative binomial regression and quasi Poisson regression are used when the equality of variance and mean cannot be met. The quasi Poisson assumes that the variance is a linear function of mean. The negative binomial regression assumes that the variance is a quadratic function of mean. The expectation is still $E(Y) = \mu$ and $\mu = exp(x'\beta)$.

$$\begin{aligned} E[Y_i|x_i, \tau_i] &= \mu_i \tau_i \\ &= e^{x_i\beta + \epsilon_i} \\ E[Y_i|x_i, \tau_i] &= e^{x_1\beta_1 + x_2\beta_2 + \epsilon_1 + \epsilon_2} \\ first\ diff\ &= e^{\beta_1 + x_2\beta_2 + \epsilon_1 + \epsilon_2} - e^{x_2\beta_2 + \epsilon_1 + \epsilon_2} \end{aligned}$$

The introduction of τ is to generalize the Poisson regression.