Computation of b:

$$\mathrm{cov}(u_i, \tilde{y}_i) = \mathrm{cov}\left(u_i, \left[\mu + u_i + pe_i + \frac{1}{k}\sum_{j=1}^{k} te_{ij}\right]\right)$$

$$= \frac{1}{k}\sum_{j=1}^{k} y_{ij} = \frac{1}{k}\sum_{j=1}^{k}\left[\mu + u_i + pe_i + te_{ij}\right]$$

genetic model

$$= \underbrace{\frac{1}{k}\sum_{j=1}^{k}\mu}_{\mu} + \underbrace{\frac{1}{k}\sum_{j=1}^{k} u_i}_{u_i} + \underbrace{\frac{1}{k}\sum_{j=1}^{k} pe_i}_{pe_i} + \underbrace{\frac{1}{k}\sum_{j=1}^{k} te_{ij}}$$

$$\frac{1}{k}\cdot k\cdot\mu = \mu$$

$$\mathrm{cov}(u_i, \tilde{y}_i) = \underbrace{\mathrm{cov}(u_i, \mu)}_{=0} + \mathrm{cov}(u_i, u_i) + \underbrace{\mathrm{cov}(u_i, pe_i)}_{=0} + \underbrace{\mathrm{cov}\left(u_i, \frac{1}{k}\sum_{j=1}^{k} te_{ij}\right)}_{=0}$$

$$= \mathrm{cov}(u_i, u_i) = \mathrm{var}(u_i) = \sigma_u^2$$

genetic additive variance