# Chapter 3

# Estimation in the LMCD Assuming Normally Distributed Errors with Unbalanced Designs/Missing Data

In Chapter 2 we considered only designs with equal numbers of observations, $n$, on each subject. It often happens that $n_i \neq n$ and hence $\text{var}\,(Y_i) = \sum_{i\,(n_i \times n_i)}$; this can arise in different settings. We can have studies with unequal $n_i$ by design: e.g., clustering, sampling households or litters, or family studies. In this case the $Y_i$ are complete responses on the sampling unit, and the LMCD assumes

$$\underset{n_i \times 1}{E\,(Y_i)} = \underset{n_i \times pp \times 1}{X_i \quad \beta} \tag{3.1}$$

and

$$\text{var}\,(Y_i) = \underset{n_i \times n_i}{\Sigma_i}\,, \tag{3.2}$$

for appropriate choices of $X_i$, $\beta$ and $\Sigma_i$. Here $\Sigma_i$ depends on $i$ through its dimension, and possibly also $X_i$, but we will assume a common parameter set for the $\Sigma_i$, so that we may write $\Sigma_i(\theta)$, where $\theta$ contains all of the variance covariance parameters. For example, if each observation has the same variance $\sigma^2$ and any two pairs of $Y_{ij}$, $Y_{ik}$ have the same covariance, then each $\Sigma_i$ has the compound symmetry form with different dimension $n_i$.