**Chapter 22 Summary**

The primary goal of this chapter was to introduce the reader to the rapidly evolving field of hierarchical linear models (HLM). HLM has useful applications in a variety of fields, as mentioned in the introduction.

In analyzing hierarchical or multi-level data, we have three choices: OLS with robust standard errors, OLS with clustered standard errors, and multilevel modeling. The standard OLS model assumes, among other things, that the regression errors are identically and independently distributed as a normal distribution with zero mean and constant variance. In hierarchical data, such assumptions are not usually tenable because observations within a cluster or group (say, students in a class) are likely to be correlated due to environmental factors.

OLS with clustered standard errors is an improvement over the standard OLS method because it at least takes into account correlation within a cluster. But it assumes that the errors among clusters are uncorrelated. The point estimates of the regression parameters are identical to those obtained from OLS with robust standard errors, but the clustered standard errors are generally higher than those of the standard OLS model.

Since neither the standard OLS nor OLS with cluster standard errors approach takes into account intra-class correlations (ICC) nor the correlation among clusters, an alternative is the HLM. In HLM, we take these factors into account and it also provides estimates of the variances and covariances of the component error terms.

The HLM coefficients and their standard errors are generally different from the other two approaches. We also considered some technical aspects of HLM, such as the difference between Full Information Maximum Likelihood (FML) and Restricted Maximum Likelihood (RML) estimation of HLMs. In addition, we also discussed the appropriate number of individual and group observations to carry out several aspects of HLM.

In this chapter we have considered only the linear hierarchical models. But there are several multilevel nonlinear models that can be estimated in *Stata* by using the commands **xtlogit**, **xtprobit**, **xttobit**, **xtpoisson**, **xtmelogit** and **xtmepoisson**. The interested reader may consult the *Stata* manuals (or SAS or SPSS manuals) for further details.