

CHAPTER OVERVIEW

9: ANCOVA Part I

Objectives

Upon completion of this chapter, you should be able to:

1. Be familiar with the basics of the General Linear Model (GLM) necessary for ANCOVA implementation.
2. Develop the ANCOVA procedure by extending the ANOVA methodology to include a continuous predictor.
3. Carry out the testing sequences for ANCOVA with equal and unequal slopes.

The analysis of covariance (ANCOVA) procedure is used when the statistical model has both quantitative and qualitative predictors and is based on the concepts of the General Linear Model (GLM). In ANCOVA, we will combine the concepts applicable to categorical factors learned so far in this course with the principles and foundations of regression, applicable to continuous predictors learned in STAT 501.

In this chapter, we will address the classic case of ANCOVA where the ANOVA model is extended to include the linear effect of a continuous variable, known as the covariate. In the next chapter, we will generalize the ANCOVA model to include the quadratic and cubic effects of the covariate as well.

You might find it interesting that when SAS first came out they had PROC ANOVA and PROC REGRESSION and that was it. Then people asked, "What about the case when you have categorical factors and you want to do an ANOVA but now you have this other variable, a continuous variable, that you can use as a covariate to account for extraneous variability in the response?" So, SAS came out with PROC GLM, which is the general linear model. With PROC GLM you could take the continuous regression variable and pop it into the ANOVA model and it runs. Or, conversely, if you are running a regression and you have a categorical predictor like gender, you could include it into the regression model and it runs. The general linear model handles both the regression and the categorical variables in the same model. There is no PROC ANCOVA in SAS, but there is PROC MIXED. PROC GLM had problems when it came to random effects and was effectively replaced by PROC MIXED. The same sort of process can be seen in Minitab and accounts for the multiple tabs under Stat > ANOVA and Stat > Regression. In SAS PROC MIXED or in Minitab's General Linear Model, you have the capacity to include covariates and correctly work with random effects. But enough about history; let's get to this lesson.

Introduction to Analysis of Covariance (ANCOVA)

A "classic" ANOVA tests for differences in mean responses to categorical factor (treatment) levels. When there is heterogeneity in experimental units, sometimes restrictions on the randomization (blocking) can improve the accuracy of significance testing results. In some situations, however, the opportunity to construct blocks may not exist, but there may be a continuous variable that may be causing the heterogeneity in the experimental units. Such sources of extraneous variability are referred to as "covariates", and historically have been also termed "nuisance" or "concomitant" variables.

Note that an ANCOVA model is formed by including a continuous covariate in an ANOVA model. As the continuous covariate enters the model as a regression variable, an ANCOVA requires a few additional steps that should be combined with the ANOVA procedure.

[9.1: Role of the Covariate](#)

[9.2: ANCOVA in the GLM Setting - The Covariate as a Regression Variable](#)

[9.3: Steps in ANCOVA](#)

[9.4: Using Technology - Equal Slopes Model](#)

[9.5: Using Technology - Unequal Slopes Model](#)

[9.6: Chapter 9 Summary](#)