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# Longitudinal Data Analysis

TODD D. LITTLE, PASCAL DEBOECK, and WEI WU

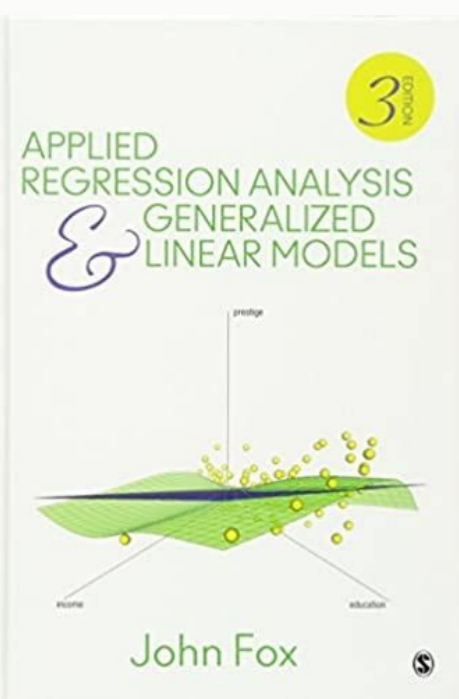
## Abstract

In this essay we review some of the emerging trends in modeling repeated measures data. Three general forms of longitudinal models are discussed: panel model designs, growth curve models, and intensive within-person assessments. Each section discusses design elements that should be considered when using each of these types of longitudinal models, and introduces some emerging trends. In the section on panel designs, continuous time models and planned missing data models are introduced; these ideas will revolutionize the modeling and collection of panel data. In the section on growth curve models, the necessity of separately evaluating mean and covariance model fit is discussed. This section also introduces methods being used to carefully consider the time of measurements in temporal designs. Finally, the budding analysis of intensive within individual observations is considered, including recent work from mathematics that limits the generalizability of interindividual studies to individual outcomes.

## INTRODUCTION

Longitudinal data analysis refers to any form of repeated assessments on the same person(s). Three general categories of longitudinal model exist. The first is the panel model where two or more assessment occasions are administered to a sample of persons. The panel model, as we detail later, focuses on the individual differences across a sample of persons (or entities). The types of model that can be fit to multioccasion data include discrete time models, such as the cross-lag panel model, and continuous time models. A second category of longitudinal model is the latent growth curve model, which focuses on intraindividual differences in change across multiple occasions. The third type of model is the intensive within-person assessment approach. These models, which are sometimes called p-technique, dynamic p-technique, or dynamical systems models, focus on within-person changes across a very large number of observations; these models also can be specified as either discrete or continuous time forms. In the following, we delve into the pros and cons of each approach. We then discuss a number of emerging trends

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## CHAPTER 16

### Autoregressive and Cross-Lagged Panel Analysis for Longitudinal Data

JAMES P. SELIG  
TODD D. LITTLE

The type of models we discuss in this chapter fall under the larger heading of structural equation models (SEMs) for longitudinal data. Many different names have been used for these models, including causal models (Bentler, 1980; Kenny, 1975), cross-lagged panel models (Mayer, 1986), linear panel models (Greenberg & Kessler, 1982), and autoregressive cross-lagged models (Bollen & Curran, 2006). These models are also related to the autoregressive model and the simplex model. For simplicity, we refer to these models as panel models. What all these hold in common is that they are used to examine the structural relations of repeatedly measured constructs. Recently, several authors have critiqued the frequent use of panel models. We believe that, although many of the criticisms are justified, the panel model remains a useful tool for developmental scientists.

Figure 16.1 shows a path diagram for a two-wave, two-variable panel model. Here two latent variables,  $X$  and  $Y$ , are measured on two occasions. For convenience, only the structural portion of the model is displayed, and the underlying measurement model with multiple indicators is omitted. See Little (in press) and Little, Preacher, Selig, and Card (2007) for a thorough treatment of measurement models for longitudinal data. This model can be described with the two following equations:

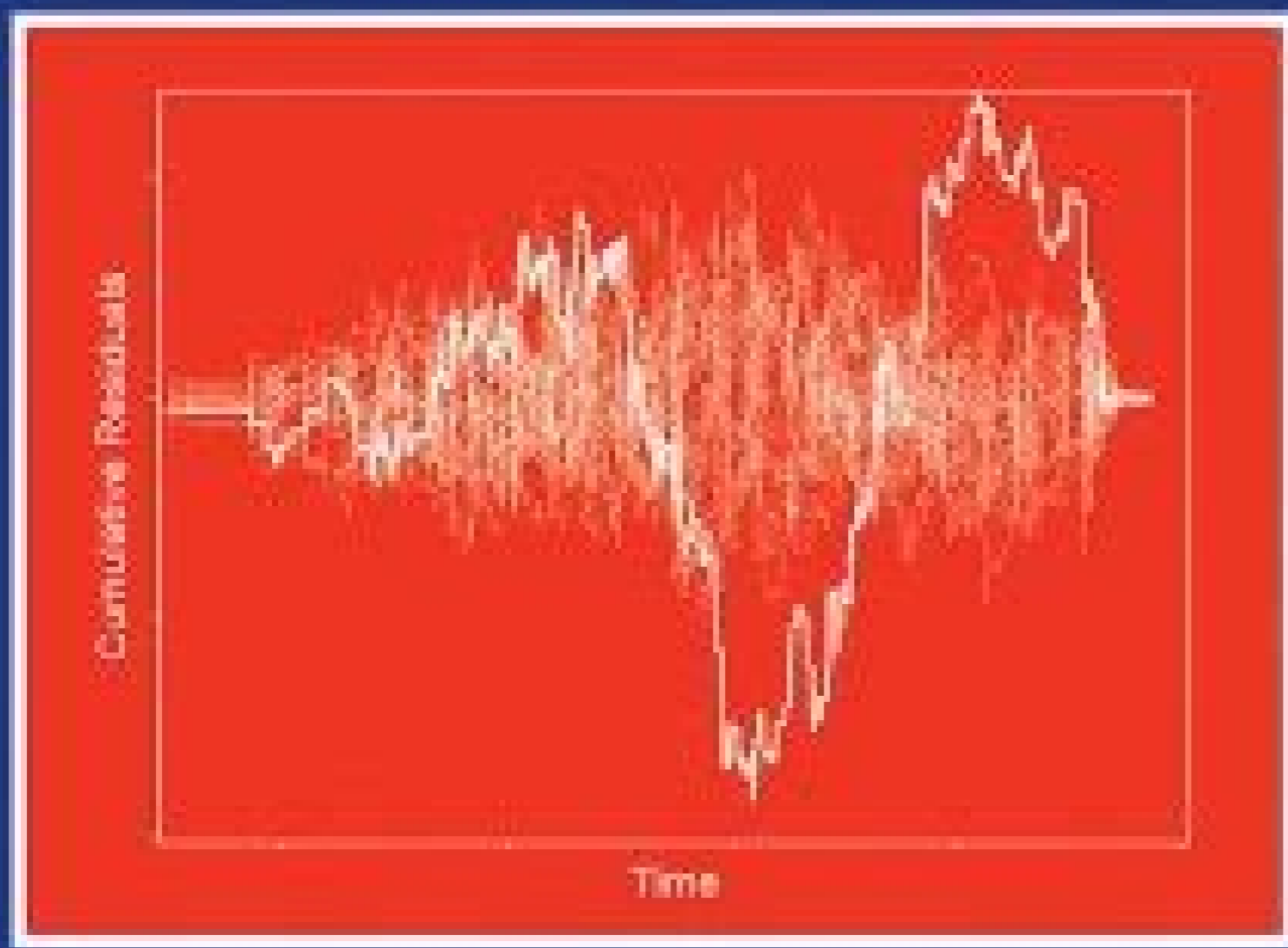
$$X_t = \beta_1 X_{t-1} + \beta_2 Y_{t-1} + \zeta_t$$
$$Y_t = \beta_3 Y_{t-1} + \beta_4 X_{t-1} + \zeta_t$$

Here,  $X$  and  $Y$  are two different constructs measured at two time points (denoted with a subscript 1 for time 1 and 2 for time 2). The linear regression coefficients  $\beta_1$  and  $\beta_2$  describe the autoregressive effects, or the effect of a construct on itself measured at a later time. The autoregressive effects describe the stability of the constructs from one occasion to the next.



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Secondary data analysis refers to the analysis of existing data collected by others. Secondary analysis affords researchers the opportunity to investigate research questions using large-scale data sets that are often inclusive of under-represented groups, while saving time and resources. Despite the immense potential for secondary analysis as a tool for researchers in the social ... Gathered data is frequently not in a numerical form allowing immediate appliance of the quantitative mathematical-statistical methods. In this paper are some basic aspects examining how quantitative-based statistical methodology can be utilized in the analysis of qualitative data sets. The transformation of qualitative data into numeric values is considered as the entrance ... Gathered data is frequently not in a numerical form allowing immediate appliance of the quantitative mathematical-statistical methods. 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