

---

# Preface

Panel count data occur in studies that concern recurrent events, or event history studies, when study subjects are observed only at discrete time points. By recurrent events, we mean the event that can occur or happen multiple times or repeatedly. In other words, study subjects could experience recurrences of the same event and the resulting data are usually referred to as event history data. Examples of recurrent events include disease infections, hospitalizations or tumor occurrences in medical studies and warranty claims of automobiles or system break-downs in reliability studies. There also exist many other fields that often yield event history data such as demographic studies, economic studies and social sciences.

The event history study can be generally classified into two types. One is the studies that monitor study subjects continuously and the resulting data are usually referred to as recurrent event data (Cook and Lawless, 2007). In this case, the times of all occurrences of the event of interest are recorded. That is, one has complete data or sample paths on the underlying point or recurrent event process that characterizes the occurrence of the recurrent event of interest. The other is the studies in which study subjects are observed only at discrete time points and thus they produce panel count data. In this situation, one knows only the numbers of occurrences of the event between observation times and thus has incomplete data or sample paths on the underlying recurrent event process. The occurrence of panel count data could be due to many different reasons. For example, it may be too expensive, impossible, or not realistic to conduct continuous follow-ups.

For the analysis of recurrent event data, there exists a great deal of literature, especially a couple of excellent books. For example, Andersen et al. (1993) provide a comprehensive coverage of counting process approaches for the analysis of recurrent event data. Cook and Lawless (2007) give a relatively complete and thorough review of the recent literature on recurrent event data. Comparatively, only sparse literature exists on the analysis of panel count data. It is of interest and helpful to mention that in addition to the amount of relevant information available being different between

recurrent event data and panel count data, yet another key difference is the observation process. In the case of the former, the observation process means the length of the whole follow-up, while in the case of the latter, it also includes a sequence of consecutive observation times. Also to analyze recurrent event data, it is common and convenient to characterize the occurrences of recurrent events by point processes and to model the intensity process of the point process. On the other hand, for the analysis of panel count data, it is usually more convenient to work directly on the mean function of the point processes due to the incomplete nature of the observed information.

This book is intended to provide an up-to-date reference for those who are conducting research on the analysis of panel count data as well as those who need to analyze panel count data to answer practical questions. It can also be used as a text for a graduate course in statistics or biostatistics that has basic knowledge of probability and statistics as a prerequisite. The main focus of the book is on methodology, but some applications of the methods to real data are also provided.

Chapter 1 contains introductory material and surveys basic concepts and point process models commonly used for the analysis of panel count data. Examples of panel count data as well as recurrent event data are discussed, and some key features of panel count data are described. Chapter 2 discusses some Poisson assumption-based models and inference procedures with the focus on parametric approaches. To be complete, regression analysis of simple count data is first briefly considered.

Chapters 3–6 concern nonparametric and semiparametric approaches for panel count data. Specifically, Chap. 3 deals with one-sample analysis of panel count data with the focus on nonparametric estimation of the mean function of the underlying recurrent event process of interest. In Chap. 4, the two-sample comparison problem for panel count data and some nonparametric procedures are discussed. Regression analysis of panel count data is the topic of Chaps. 5 and 6. In Chap. 5, we discuss the situation where the observation process is independent of the underlying recurrent event process given covariate processes. In this case, the inference can be made conditional on the observation process. Chapter 6 considers the situation where the observation process may be related to the underlying recurrent event process, and some joint modeling inference procedures are described.

Through Chaps. 2–6, it is assumed that there exists only one recurrent event process of interest. Sometimes there may exist several related recurrent event processes of interest and in this case, we have multivariate panel count data. Chapter 7 considers the analysis of multivariate panel count data with the focus on nonparametric treatment comparison and semiparametric regression analysis. To keep the book at a reasonable length, many important topics about panel count data cannot be investigated in details. Chapter 8 provides some brief investigation on several such topics. They include variable selection with panel count data, the analysis of mixed recurrent event and panel count data, and the analysis of panel count data arising from multi-

state models. In addition, some discussions are given on Bayesian approaches for the analysis of panel count data and the analysis of panel count data arising from mixture models or with measurement errors.

In all chapters except Chap. 8, we have used references sparsely except in the last section of each chapter, which provides bibliographical notes including related references. Also we have chosen not to provide in-depth coverage of the asymptotic results related to the approaches described in the book as well as counting process and martingale theory needed for the derivation of the asymptotic results.

We owe thanks to many persons who have contributed directly and indirectly to this book. First we are indebted to Xin He, Yang Li, Do-Hwan Park, Hui Zhao and Qingning Zhou, who either read parts of the draft and gave their important comments or provided great computational help. We want to thank many of our collaborators on the subject over the years including Narayanaswamy Balakrishnan, Richard Cook, Joan Hu, Jack Kalbfleisch, Ni Li, Liuquan Sun, Xingwei Tong, LJ Wei, and Liang Zhu, whose collaborations and contributions to the field made this book possible. Also, we would like to express our thanks to Howard Bailey and KyungMann Kim for kindly providing the skin cancer panel count data.

Finally, we thank our family and especially Xianghuan (Jianguo's wife) and Feng (Xingqiu's husband) for their patience and support during this project.

Columbia, MO, USA  
Hong Kong, China

Jianguo Sun  
Xingqiu Zhao

Statistical Analysis of Panel Count Data

Sun, J.; Zhao, X.

2013, XV, 271 p. 18 illus., 11 illus. in color., Hardcover

ISBN: 978-1-4614-8714-2