

Lectures on Count Time Series Analysis

Syllabus

Department of Economics & Finance

University Tor-Vergata

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Course Description: This series of research lectures introduces students to the problem of statistical analysis for count time series with a particular focus on network time series. A first attempt towards the analysis of count time series was introduced by Alzaid and Al-Osh (1988) based on the concept of integer autoregressive process. We review this type of processes but our point of view is based mostly on the theory of generalized linear models as outlined in McCullagh and Nelder (1989) and extended by Kedem and Fokianos (2002). Recent references include the edited volume by Davis et al. (2016) and the text by Weiß (2018).

I will introduce univariate and multivariate models for count time series. We will be studying basic properties (mean and autocovariance function) and develop estimation methodology. These topics provide solid foundations for progressing the main theme of network models for both continuous and count data. Besides basic properties, estimation and inference, students will see a case study related to tourist industry. In addition I will present, as time allows, current research topics like space-time data, non-stationary processes and high-dimensional data.

Most of the results that will be presented have been obtained in a series of papers by Fokianos et al. (2009), Fokianos and Fried (2010, 2012), Fokianos (2012), Fokianos and Tjøstheim (2012), Christou and Fokianos (2014), Christou and Fokianos (2015), Liboschik et al. (2017), Fokianos et al. (2020), Jia et al. (2021), Davis et al. (2021), Armillotta and Fokianos (2023, 2024), Armillotta et al. (2024) and Maletz et al. (2024).

More precisely, I will cover the following topics accompanied with the use of **R** software using the packages **tscount**—see Liboschik et al. (2017) and **PNAR**—see Armillotta et al. (2023):

Lecture 1: Introduction to regression models for time series of counts. Basic properties, Integer autoregressive processes, estimation, GLM based models, simple properties and inference. Integer GARCH models: examples, estimation and inference, inclusion of covariates intervention analysis.

Lecture 2: Multivariate models for integer valued time series, examples stochastic properties, inference. Network models for time series for both continuous and count time series.

Lecture 3: Network models for count time series: non-linear models, case study in Advanced Topics: Space-Time data, High-dimensional data—non-stationary processes: examples, inference, open problems.

Prerequisites: It is helpful to have some background on time series analysis at the level of Shumway and Stoffer (2011). More advanced time series theory has been given by Brockwell and Davis (1991). See also Tsay (2010) for financial time series analysis. The book by Francq and Zakoïan (2010) provides an excellent introduction to GARCH models. Finally some exposure on multivariate data will be useful when dealing with models for network time series and multivariate discrete distributions; see Cameron and Trivedi (2013), for instance. We will be using the software **R** and **Rstudio**. The main packages that we will be applying to data analysis are **tscount** and **PNAR**.

Timeline: The lectures will run as follows (classroom will be announced later):

Lecture 1	September 22	11.00–13.00
Lecture 2	September 23	11.00–13.00
Lecture 3	September 29	11.00–13.00

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