Extremal properties of heavy-tailed shot noise processes with applications to food risk assessment

Patrice Bertail

Université Paris Nanterre

11 septembre 2026

Joint work with C. Tiller (UVSQ) and A. Medina-Garay (UFPN, Recife).

Risk analysis in food safety has gained increasing attention in recent years, particularly regarding nutritional aspects and exposure to foodborne contaminants, with cadmium and methylmercury among the most extensively studied cases. This paper develops a dynamic framework for dietary exposure assessment based on shot noise processes, extending the Kinetic Dietary Exposure Model (KDEM) introduced by Bertail Clemencon and Tressou (2008)(2010). The proposed approach provides a flexible way to describe the accumulation, assimilation, and elimination of contaminant intakes over time. Under the assumption of heavy-tailed intake distributions, we derive asymptotic equivalents for the tail distribution of the stationary exposure process and obtain an explicit expression for the extremal index of the associated embedded sequence. These results provide theoretical tools to quantify both the long-run tail behavior of the exposure process and the clustering of high-exposure episodes. We then use this framework to analyze several model specifications, including random elimination rates, delayed assimilation, and an immigration-emigration mechanism with instantaneous release. For these models, we derive explicit or asymptotically tractable expressions for risk indicators such as tail probabilities, the extremal index, the Expected Severity, and the Integrated Expected Severity. We conclude with an application to methylmercury exposure in the French population, where the resulting risk indices are compared across men, women, and children.