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BAYESIAN AND FREQUENTIST INFERENCE FOR THE WEIBULL-ACD MODEL WITH CALENDAR EFFECTS IN HIGH-FREQUENCY FINANCIAL DATA

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ABSTRACT

This study develops an enhanced Weibull Autoregressive Conditional Duration (W-ACD-X) framework designed to endogenously incorporate calendar-effect variables for the simultaneous modeling of intraday seasonality and stochastic duration clustering. Unlike traditional ACD methodologies that rely on a two-step pre-filtering approach, which can distort underlying data dynamics and introduce statistical artifacts, the proposed W-ACD-X model employs a one-step simultaneous estimation strategy that preserves the integrity of raw high-frequency data.To ensure methodological robustness, the study employs a dual-estimation approach: Frequentist Maximum Likelihood Estimation (MLE) and a Bayesian framework based on Hamiltonian Monte Carlo (HMC) with the No-U-Turn Sampler (NUTS). The W-ACD-X specification is rigorously compared with Gompertz-ACD-X and Lomax-ACD-X models through both Monte Carlo simulations and an empirical application to high-frequency IBM transaction data. The Weibull specification consistently provides a superior fit, outperforming alternative distributions across AIC, BIC, WAIC, and LOOIC metrics. While both estimation frameworks yield consistent point estimates indicating high duration persistence, the Bayesian NUTS approach offers additional advantages by enabling comprehensive quantification of parameter uncertainty through posterior distributions. The proposed framework offers a robust and precise methodology for practitioners in operations research to model complex market microstructure without information loss associated with external data adjustment.

***K*eywords** Bayesian inference · W-ACD-X model · High-Frequency Data · Simultaneous estimation · Intraday seasonality · Weibull distribution

References

[1] Bhogal, S. K., and Thekke Variyam, R. (2019). Conditional duration models for high-frequency data: A review on recent developments. Journal of Economic Surveys, 33(1), 252–273.

[2] Tabash, M. I., et al. (2024). Modeling high-frequency financial data using R and Stan: A Bayesian autoregressive conditional duration approach. Journal of Open Innovation, 10(2), 100249.

[3] Yatigammana, R., Chan, J., and Gerlach, R. (2019). Forecasting trade durations via ACD models with mixture distributions. Quantitative Finance, 19(12), 2051–2067.

[4] Sorensen, D. (2025). Bayesian methods. In Statistical learning in genetics (pp. 147–227). Springer.

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