
Fourier-Laplace Transform Discontinuities and Computation in the Volterra Stein-Stein Model: A Fredholm–Wishart Approach

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Abstract

We investigate analytical and numerical challenges arising in the computation of the Fourier-Laplace transform for the Volterra Stein-Stein model, where the volatility is driven by a Volterra-type Gaussian process. A key difficulty stems from the complex square root of a Fredholm determinant, which becomes discontinuous when the determinant crosses the negative real axis. We characterize these crossings and provide a corrected expression for the joint Fourier-Laplace transform of the log-price and integrated variance. Furthermore, we propose a new derivation of the transform by interpreting the joint law of the integrated variance and log-price as the infinite-dimensional limit of a Wishart distribution. This novel approach naturally yields a convergent numerical method, for which we establish a convergence rate. Applying our algorithms to Fourier-based pricing in the rough Stein-Stein model, we achieve a significant increase in accuracy while drastically reducing computational cost compared to existing methods.

This presentation is based on (1) and an ongoing working paper. (1). Abi Jaber E., Guellil M., “Complex discontinuities of the square root of Fredholm determinants in the Volterra Stein-Stein model,” arXiv:2503.02965 (2025).

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