Markets do not run at one speed.

Bespoke solutions to a universal pricing problem.

A quiet afternoon and a market shock occupy the same calendar. They live in very different financial time. Our research turns that distinction into **new mathematics for derivatives pricing and risk**.



Time, reimagined. Original AI-assisted illustration for Cryptorado.

A price is a snapshot. Risk is a moving picture.

A model can match today's option prices and still tell the wrong story about tomorrow's risk. For a barrier, an autocall or an early-exercise decision, the journey matters as much as the destination.

Decades of empirical research document heavy tails, clustered volatility and asymmetric relationships between returns and risk. More recent work identifies irregular volatility at short horizons alongside persistent behaviour over longer ones. These observations motivate our architecture: **build the market behaviour into the dynamics, then test the resulting prices**.

What if risk keeps its own time?

Calendar time counts minutes. A variance clock counts accumulated uncertainty; a volatility clock describes the pace at which volatility itself changes. These need not march together. Financial clocks have a distinguished history in the work of Mandelbrot and Taylor, Clark, and Geman and collaborators. Our contribution develops this perspective into original analytical constructions and a working numerical framework.

The ambition is a practical financial time machine: explore possible market paths, revalue contingent obligations and understand how risk changes along the way. A visual echo of Dalí's *The Persistence of Memory* and a literary nod to Wells's *The Time Machine*; here, the journey through time is mathematical.

Original mathematics. Built to be used.

Market behaviour shapes the architecture. Short-horizon roughness, longer-horizon persistence and return–volatility dependence guide the design. The aim is to connect the smile in option prices with a coherent account of how risk evolves.

The model and the method are one research effort. Original analytical solutions, bespoke numerical methods and GPU computation are developed together. The working engine supports SPX option calibration and pricing; numerical checks and later-date option-surface studies form part of the research programme.

Complex contracts, reusable machinery. A flexible payoff framework represents contingent cashflows, including basket autocalls and memory coupons. Research also includes Monte Carlo valuation for selected products with exercise rights.

A quantitative engine within the client's workflow

The product vision connects a financial professional's existing AI application to product definition, market calibration, valuation and hedge construction, using the client's data and computing resources. The mathematical engine is the foundation; AI provides a natural way to reach it. The integrated workflow is in development. Today's public MCP provides access to the published research and SHTAR documents.

Ideas with a history

The following works establish the empirical and mathematical context. The live research page provides brief explanations and links.

Cont (2001). *Empirical properties of asset returns: stylized facts and statistical issues.* Quantitative Finance.

Mandelbrot & Taylor (1967). *On the Distribution of Stock Price Differences.* Operations Research.

Clark (1973). *A Subordinated Stochastic Process Model with Finite Variance for Speculative Prices.* Econometrica.

Ané & Geman (2000). *Order Flow, Transaction Clock, and Normality of Asset Returns.* Journal of Finance.

Geman, Madan & Yor (2001). *Time Changes for Lévy Processes.* Mathematical Finance.

Heston (1993). *A Closed-Form Solution for Options with Stochastic Volatility with Applications to Bond and Currency Options.* Review of Financial Studies.

Gatheral, Jaisson & Rosenbaum (2018). *Volatility is rough.* Quantitative Finance.

Bayer, Friz & Gatheral (2016). *Pricing under rough volatility.* Quantitative Finance.

Bennedsen, Lunde & Pakkanen (2022). *Decoupling the Short- and Long-Term Behavior of Stochastic Volatility.* Journal of Financial Econometrics.

Selected public work

Roughly Rough: Tractable Markov Processes Emulating Rough Volatility. SSRN preprint, 2024.

Unspanned Stochastic Volatility, Conformal Symmetries, and Stochastic Time. SSRN preprint, 2017.

Duality, Deltas, and Derivatives Pricing. Conference presentation, 2015; slides on ResearchGate.

Explore the research at cryptorado.ai October 2026