Numerix Models by Asset Class*

FIXED INCOME
- Deterministic (zero volatility) model
- Black Scholes Analytic Model
- Black model
- Hull-White (single/multi-factor)
- Black-Karasinski (one/two-factor)
- Shifted Black Karasinski
- Skew Black Karasinski
- Libor Market Model (LMM)
- Classic BGM
- Shifted LMM
- Stochastic Volatility LMM
- N-currency LMM
- Multi-currency models with HW/BK models for IR components and BS/Heston model for FX
- Bounded Short Rate – Alpha

INFLATION
- Inflation Market Model (IMM)
- Heston IMM
- SABR IMM
- Generalized Jarrow-Yildirim model
- Cross-Currency JY hybrid model

EQUITY
- Anderson-Buffum model for liquid convertible bonds
- Black-Scholes model
- Dupire local volatility model, also with advanced fit of local volatility surface
- Heston stochastic volatility model with constant and time-dependent coefficients
- Bates stochastic volatility jump-diffusion model
- Local stochastic volatility model
- SABR model
- Quanto equity model
- Multi-factor BS/Dupire/Heston/Bates basket models
- One-factor Dupire and Two-Factor Heston models for equity index exotics

COMMODITIES
- Gabillon model
- Black model
- Schwartz 1F model (mean-reverting)
- Gibson-Schwartz 2F model (stochastic convenience yield)
- Heston stochastic volatility model
- Estimating seasonality coefficients from historical data
- Support of rolling underlying future contracts

*Not a comprehensive list

Independent, Transparent, Trusted

As per key regulations such as the Basel Committee on Banking Supervision directive 21 and Solvency II, financial institutions are required to quantify model risk. Specific to OTC derivatives—the model risk associated with using a possibly incorrect valuation, and to identify the risk associated with using unobservable calibration parameters. To accelerate compliance, financial institutions are investing in independent resources from trading and risk operations to ensure models have been implemented properly, perform as expected providing good hedges in all market conditions, and to understand model behavior and limitations under extreme market scenarios.

To help institutions accelerate their model risk management, Numerix—the leader in pricing and risk analytics for OTC derivatives—has developed *Model Validation Studio* groundbreaking software for automated testing, in addition to a full range of *Model Performance Reporting Services* and *Model Validation Services*.

Numerix Model Validation Studio

Automated Model Validation Testing Technology: Tighter Testing, More Thorough, Higher Speed

Whether your front office and risk department are utilizing Numerix analytics, third party models or you are utilizing your own proprietary models, Numerix Model Validation Studio provides a new suite of automated tests, rooted in the underlying math, which confirms model accuracy and performance. They are run in an automated test environment utilizing Numerix's CrossAsset Server risk platform, on thousands of test scenarios, to lift Model Validation to a new standard of thoroughness. Automated tests for Correctness of Implementation—tests that we apply to our own models, and our clients, include:

- *Smoothness tests for Greeks*
- *Calibration Round Trip Tests*
- *Limiting PDE Tests*

Additionally, Numerix Model Validation Studio can test a model's fidelity to the markets, how realistic the model is. These tests evaluate the realism and stability of the model's volatility surfaces, and most important of all, the quality of its hedge:

- *Calibration Stability Tests*
- *Calibration Error Tests*
- *Hedge Performance Tests*

The Core: Numerix Models & Methods

At the core of the Numerix Model Validation Studio is Numerix CrossAsset—which provides access to over 100 market standard models and methodologies for all major asset classes, including fixed income, inflation, credit, equity, FX and commodities. Our cross-asset expertise has also allowed us to provide the industry's only commercially available hybrid model framework for pricing multi-asset basket trades.

Complete Payoff Flexibility

Through an object-oriented architecture and payoff scripting language, Numerix analytics give you the ability to describe any bespoke derivative or structured product. Instruments are constructed by defining "Application Objects" that represent various components of the deal, such as events, pricing model, market data and indices. These objects are combined like building blocks in an interconnected structure that identifies the dependencies and relationships between each component.

Benchmark Your Model against Multiple Numerix Models, Calibration & Interpolation Methods

The Numerix architecture permits the user to swap models, calibration methods, calibration instruments, pricing methods and interpolation methods. Once a deal type has been structured for one model, it is then price-able in all models, with all methods. Thus, a model may be validated by comparing it to a large collection of Numerix models, to see how it's pricing compares to each one of those models, and to the group as a whole.

Stress Testing of Models

The Numerix Bump functionality allows the user to customize as many market scenario "bumps" as desired, which can then be applied to any market scenario from history. We may therefore stress the model with either a standardized (e.g. a ladder report) or randomized set of bumps applied to various scenarios taken from historical data.

Test of the Model by Instrument Decomposition

Because Numerix separates the model from the payoff and the method, a Numerix model may be further explored by using the same model to remove features from the instrument—some or all of the call or put dates, a barrier, or a digital feature such as a range accrual. These features are often subject to errors of numerical implementation, and these types of errors they may be rapidly be tracked down by the decomposition that the Numerix architecture allows.

Auditability

Any validation test can be serialized and exported into a self-contained Numerix XML file that captures all model inputs, including terms and conditions, market data, model choice and calibration assumptions, calendars and more. For those utilizing Numerix models in trading and risk operations, once converted to XML, the model can be ported throughout the institution for use within any operations. Additionally models can be "rehydrated" at any future date allowing users to audit and review the model all without the need to reconstruct historical pricing environments. The Numerix XML can also be ported to any regulatory or audit agency if required.

Model Performance Reporting Services

In conjunction with the Numerix Model Validation Studio, Numerix can also provide a subscription service of model performance reports. The reports, published quarterly, provide in-depth testing of all standard Numerix models, and expert opinions as to model use and suitability of the models based on market conditions. These reports cover all key elements required from regulators and internal audit including model use parameters, limitations and extensive testing and analysis of results.

For those institutions who require customized reporting on Numerix models or their own internal models, Numerix has broadened its Quantitative Services to offer bespoke validation services.

Numerix Model Validation Services

To help institutions achieve a greater level of independent assessment, Numerix—with over 100 PhDs on staff—offers a full model validation service. Utilizing the Numerix CrossAsset platform, our financial engineers and quantitative research teams can provide transparent testing and reporting accommodating individual data preference and internal tolerance levels. Most importantly, we can help you fully understand the roles of the models within your organization, the risks hidden in portfolios and provide the transparency required to make better management decisions.

For more information, contact sales@numerix.com.

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