VectorRisk

FRTB Solution

FINTECH INNOVATION AWARDS 2016 FINALIST
VectorRisk is an Australian company with customers in Australia, New Zealand, Singapore and the United States that provides cloud based risk software solutions to banks, hedge funds, government and corporate treasuries.

Our risk system calculates market and credit risk exposures in real-time. Our clients have implemented the system as the engine behind credit limit monitoring, collateral stress testing, market VAR and stress, and CVA.

**[LARGE BANK]**

- The foundation of the product is a high performance risk engine.
- Vectorised pricing allows FRTB and CVA to run on large bank portfolios. Over 1 billion valuations per minute (CVA) or 180 million per minute (FRTB) for a mixed portfolio on a moderate Azure cluster (80 CPU cores).
- The architecture fully separates the risk engine from the workflow and GUI via web services. Customers can use the workflow to organize all the calculations for a daily process, or call directly into the risk engine for stateless real-time calculations.
- FRTB calculations are available now for impact assessment or subscription. Our internal model offering is characterised by raw speed. Our standard model offering employs a curve driven, all-inclusive approach to the definition and generation of sensitivities.
- Multi-tenancy cloud solution (Microsoft Azure) vastly reduces IT costs, implementation timeframes and project risk. Private cloud is an option.

**[SMALL BANK]**

- The pricing and risk analytics are proven inside large banks.
- The workflow is defined around a daily process, with a task list for loading data, running calculations and producing reports. It is simple to use “out of the box”.
- Our FRTB standard model automates the critical step of defining and generating the delta/curvature/vega sensitivities. The sensitivities are applied to the appropriate vertices for the capital calculation.
- Customers can progress to the internal model if warranted by capital savings or other benefits.
- Multi-tenancy cloud solution (Microsoft Azure) vastly reduces IT costs, implementation timeframes and project risk. Put simply, the solution is inexpensive.
**Benchmarks on Microsoft Azure**

**FRTB benchmark (internal model – historic simulation 250 path current period, 250 path stress period)**

- **Desks:** 14 (plus 20 parent aggregations up to global IMCC)
- **Trades:** 331,000 (42% swaps, 21% options, 37% FX)
- **Historic Simulations:** 1260 (14 x 3 x 5 x 6. Parent business units use scenario aggregation)
- **Trade valuations:** 2,215,230,420
- **Cashflow valuations:** 30,050,754,264
- **CPU cores:** 80
- **Run time:** 12 MINUTES

**FRTB benchmark (standard model)**

- **Desks:** 14 (plus 20 parent aggregations up to global IMCC)
- **Trades:** 331,000 (42% swaps, 21% options, 37% FX)
- **Sensitivities:** 76,878 (6,372 portfolio + 70,506 trade level vega)
- **Trade Valuations:** 54,872,271
- **Cashflow Valuations:** 767,525,862
- **CPU cores:** 80
- **Run time:** 8 MINUTES

**CVA benchmark (5000 path Monte Carlo):**

- **Counterparties:** 2000
- **Trades:** 150,000 (60% swaps, 10% options, 30% FX)
- **Trade valuations:** 32,709,985,689
- **Cashflow valuations:** 698,835,209,270
- **CPU cores:** 80
- **Run time:** 22 MINUTES

Vector Risk analytics always perform full revaluations on every scenario. There is no trade compression. Analytics with larger scenario sets such as Monte Carlo are better able to utilize vectorization in the pricing library and therefore have comparatively higher valuation throughput.

**Trade Load and database caching for the above 331,000 trade portfolio: 30 minutes.**

This is a volume test. Full product coverage includes equity, commodity and credit derivatives. Benchmarks performed in February 2016.

**FRTB Model Highlights**

**[ STANDARD MODEL ]**

- Our solution breaks the task into two main processes:
  - Generation of sensitivities for delta/vega/curvature on all the standard model vertices.
  - Aggregation of the sensitivities using the standard model correlation & aggregation formulae, plus default risk and residual charges.
- The workflow runs the standard model for all business units from desk level to the enterprise total (see Fig. 1).
- Standard model summary report shows the breakdown of capital by desk (see Fig. 2). Detail reports show breakdown by market and risk type (delta, vega, curvature) for any desk or aggregation.
- Sensitivity generation relies on our curve definitions. Each curve has a regular four-part key along with optional sector and liquidity tags. Our stress tests contain curves or curve wild cards and filters for sector and liquidity (see Fig. 3). This allows the stress tests to identify the correct curves to shift for each FRTB sensitivity. Only the trades that are sensitive to these curve shifts will change in value. Vega sensitivities are generated at the individual trade level.
- Default risk charge and residual risk uses an object populated for each trade by the pricing library. The same object is used by Vector Risk’s SACCR calculation.

**[ INTERNAL MODEL ]**

- The workflow runs the internal model for all business units from desk level to the enterprise total.
- The FRTB liquidity logic is able to re-use the sector and liquidity tags we set up in the standard model. The system looks sequentially down the list (see Fig. 4) for a curve/sector/liquidity match and uses this to assign curves to one or more liquidity band simulations.
- The changes over VaR are the move to ES 97.5 (average of the tail), the need to run three calculations to scale the current ES to the stress period, single market simulations to limit diversification, across five liquidity bands which are then combined back into the IMCC result (see Fig. 5).
- Full revaluation is used (there is no trade compression). The trade/rate map allows the system to identify all scenarios where a trade’s value is affected and only revalue on those paths, substituting the trade’s initial value for all other scenarios. This is important because the FRTB calculation space is sparse compared to traditional VaR; any given trade is only active in a subset of the simulations.
- Internal Model Default Risk Charge is based on a simulation of default across the credit references. (See Fig. 4)
- Automated identification of the enterprise historic stress window (the 1 year window that produces the highest expected shortfall out of 10 to 15 years of historic data).

**FRTB Model Benchmarks**

- **FRTB CAPITAL**
  - The workflow is able to look back over daily results to calculate the final capital number (larger of the average capital over 60 days scaled by a multiplier, or yesterday’s capital).
  - There is a need to monitor the criteria for each desk’s inclusion in the internal model. This emerges from P&L attribution and back testing. Hypothetical and actual P&L need to be uploaded by the bank for this process. Vector Risk includes all of these supporting metrics.
### FIGURE 1: VECTOR RISK DAILY WORKFLOW – TASK LIST SHOWING STANDARD MODEL

### FIGURE 2: STANDARD MODEL SUMMARY REPORT

#### Market Standard Summary Report

- **Organization:** Demo
- **Currency:** USD
- **Environments:** FRB
- **Date:** 20 Jan 2013

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<td>12,046.489</td>
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<tr>
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<td>Southeast Asia</td>
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- **Run Date:** 2016-02-09 01:34 AM (UTC)
FIGURE 3: SAMPLE DEFINITIONS USED TO GENERATE STANDARD MODEL SENSITIVITIES

FIGURE 4: INTERNAL MODEL DEFAULT RISK CHARGE EXAMPLE
**FIGURE 5: MARKET INTERNAL RESULT**

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<td>Reporting Currency</td>
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<td>IMCC (%)</td>
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<th>ESFC</th>
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<td>Interest</td>
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**Detail Results**

- **Total EARR**: 5,042,567.25
- **ESRC**: 5,164,668.35
- **ESFC**: 5,297,487.85

- **Total ESRC**: 4,956,795.96
- **ESFC**: 5,115,042.75

- **Total ESFC**: 779,170.47
- **ESRC**: 650,285.60

- **Total IMCC (C)**: 7,128,574.81
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