Potential Evolution of IMM Models in a Changing Regulatory and Risk Management Landscape

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Vladimir Chorniy
Risk Analytics & Modelling, BNP Paribas

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Agenda

- Risk regulations and models evolution. The rise and fall of User Test
  - History
  - Multimode implications
  - Credit to Liquidity conversion and role of Initial Margining (IM)
- Impact of IM on IMM CCR
  - Modelling IM
  - Payment risk
  - Impact of Initial Margin on risk factor modelling: modelling extreme scenarios
- Capturing extreme scenarios/events
  - Single asset class
  - Long term evolution: extreme events vs. extreme scenarios
  - Cross-asset
  - Discussion. Lessons from IMA market risk
- Conclusion
- References; Acknowledgments
- Appendix. Modelling IM

Risk regulations and models (I): from no connection

- Basel I (published 1988)
  - "to secure international convergence of … the capital adequacy of international banks"
  - A very basic definition of Risk Weighted Assets (weight was function of the asset category)
  - Only credit risk was included in the framework
  - Rules for taking into account diversification practically non existent; [Market and Operational risk introduced later: 1996 and 2006]
- Best risk practices in quantitative risk and regulatory requirements are not usually connected – risk is treated under "Dual Mode"
  - Change starts with CAD II: VAR.
- CAD II - Capital Adequacy Directive (published 1996):
  - Possibility to calculate capital requirements based on bank's internal model, portfolio based - VAR

Risk regulations and models (II) : … to aligned

- Basel II (2006)
  - Takes account of portfolio risk framework – Economic Capital style model as ultimate driver
  - Takes into account changes in banking and risk management
  - Revision of the standard framework; the granularity of the risk weights is increased; operational risk capital charge is introduced

- Best risk practice in quantitative risk area and regulatory requirements are further aligned: possibility of calculating the capital requirements via internal model also for counterparty risk
  - Two pillars of quantitative risk modelling of investment banking: VAR and PFE (EPE) are aligned
  - Dual mode is allowed*, but discouraged

*"The IRB Use Test: Background and Implementation", Newsletter No. 9, BCBS, September 2006

Risk regulations and models (III) : to prescribed…

- Basel 2.5 (live* 2012): more capital on market risk
  - IRC: “internal” model with prescribed risks; CRM: “internal” model and a standard floor
    - Up to 1 year horizons (liquidity horizon: 3 months to 1 year)
  - Stressed VAR: “internal” choice of period & proxies
- Basel 3 (live* 2014)
  - More regulation on liquidity, more capital
  - Prescriptive amendments to EPE (PFE): stressed EPE; VAR on “CVA”; stressed VAR on “CVA”; “internal” choice of period; modelling approach is a hybrid between internal and prescribed (WWR, treatment, reg. CVA)
  - Is Dual/[multi] Mode coming back? (and who pays for it?)
- [Basel 4:]
- Fundamental Review of the Trading Book ~ 2019-2021*…
  - Expected Shortfall; long(er) horizons; more aggressive hybrid between internal and prescribed modelling
  - Prominent role for Standard Approach
- SA CCR, changes to CVA, Operational Risk, potential introduction of various floors ~ 2019-2021…

**in EU*

Risk regulations and models

- The recognition of models (or at least the need for models) is preserved, but the best risk practice and regulatory requirements/incentives are not well aligned
  - "Multi-mode" IMM may not be affordable financially and politically
- What does it mean for our profession and our plans? Are regulators killing or strengthening the profession of quantitative risk?
  - Is affordability of "multi-mode" the only problem? – It will take us more then this presentation to have a detailed discussion, but let's take a wider look:
- Evolution of "Risk Conversion" paradigm
  - We started with collateral (CSA) introducing "VM" – Credit to Liquidity conversion
  - Then moved to Credit to Market conversion - hedging of (C)xVA
  - And now again Credit to Liquidity conversion via **IM margining** (CCP, EMIR…)
  - Is it always better? Are we equipped to model liquidity risk?
- Evolution of markets (emergence of regular dislocations), extreme scenarios
- Potential blending of functions:
  - Risk vs. Capital vs. Funding costs (FVA/MVA) vs. ALM
  - Are we equipped to act across department lines or merge them?
- (Longer term question: what risks should stay within the banks?)

Introduction of IM: impact on IMM CCR

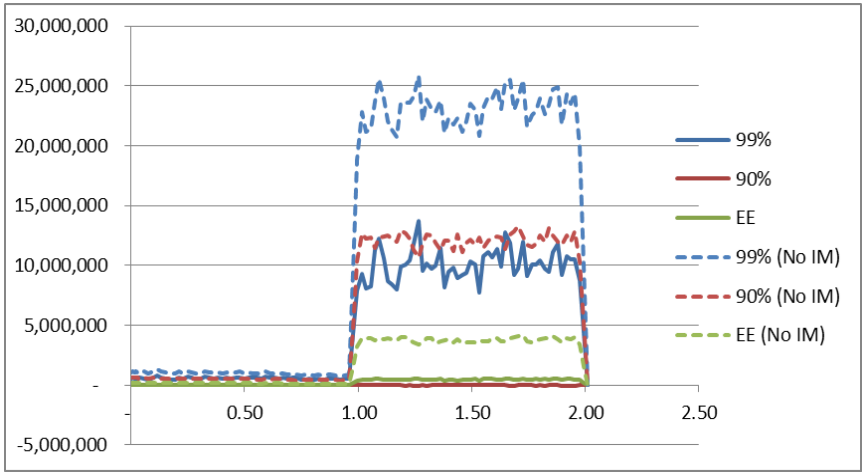
- We return to narrow question of model evolution
- **Introduction of Initial Margin is key influence on IMM CCR evolution in the medium future**
- Initial Margin (IM) is collateral taken to cover the exposure arising from the Margin Period Of Risk, i.e. a short horizon "VaR"[1]
- Now we have increasing use of VaR based margin:
  - CCPs mostly use VaR-based margin and we pass on these margin requirements to clients for cleared derivatives
  - "Bilateral Margining" for non-cleared OTC became a requirement, whereby both parties post IM to a third-party. The industry started to use of a standardised VaR Model (SIMM) to calculate these IM requirements
- IM very significantly offsets exposure on client trades but possibly increases exposure on CCPs[2]. We focus here on the client (and bilateral) exposures, i.e. where the IM reduces exposure
  - Example portfolio – 2 vanilla calls 1Y (short) and 2Y (long) maturity; IM calculated with dynamic model. (For IM modelling discussion also see [1])

[1] With some subtleties – the VaR, coming purely from moves in the underlying market factors, is one component of the MPOR exposure; there are also cashflow effects and wrong-way risk effects, which are conventionally not included in IM calculation.

[2] Whether or not we are at direct risk of losing the IM posted to a CCP depends on its set up. We would not usually be at risk for the IM posted to a third-party unless it also defaults.

Introduction of IM: impact on IMM CCR

- Example portfolio – 2 vanilla calls 1Y (short) and 2Y (long) maturity



- IM has three main sequences on IMM CCR model:
  1. We need to model IM and understand approximations involved
- Introduction of IM removes significant part of CCR (Credit to Liquidity risk conversion). The residual risk becomes more prominent:
  2. Payment risk (“spikes”)
  3. Remaining exposure is based largely on extreme scenarios

Capturing IM in CCR

- Static IM attached to trades is easy to model in counterparty exposures. Much harder though to simulate the future evolution of variable IM
- For Risk challenge is to represent the future evolution of IM conservatively, i.e. biased toward under-estimation of the future IM. Good model should cover extreme scenarios. (xVA/pricing requires accurate expectations)
- Broadly there are four possibilities:
  - Flat IM – we keep the IM constant through time. This can be considered as a base assumption but potentially: conservative at the short, aggressive at long end
  - Static trade allocation – we split the portfolio IM known at day zero amongst the trades but then keep them static through time, except that as trades mature in simulation time, their IM portion disappears
  - Dynamic – we use the “VaR” calculated within the CCR model at each forward time (i.e. from our MPOR exposure calculation) as a proxy for the IM* – we get a profile of IM
  - Stochastic – we estimate the VaR within the CCR model at each forward time per scenario – we have a distribution of IM
  - For detailed examples see Appendix and References slides

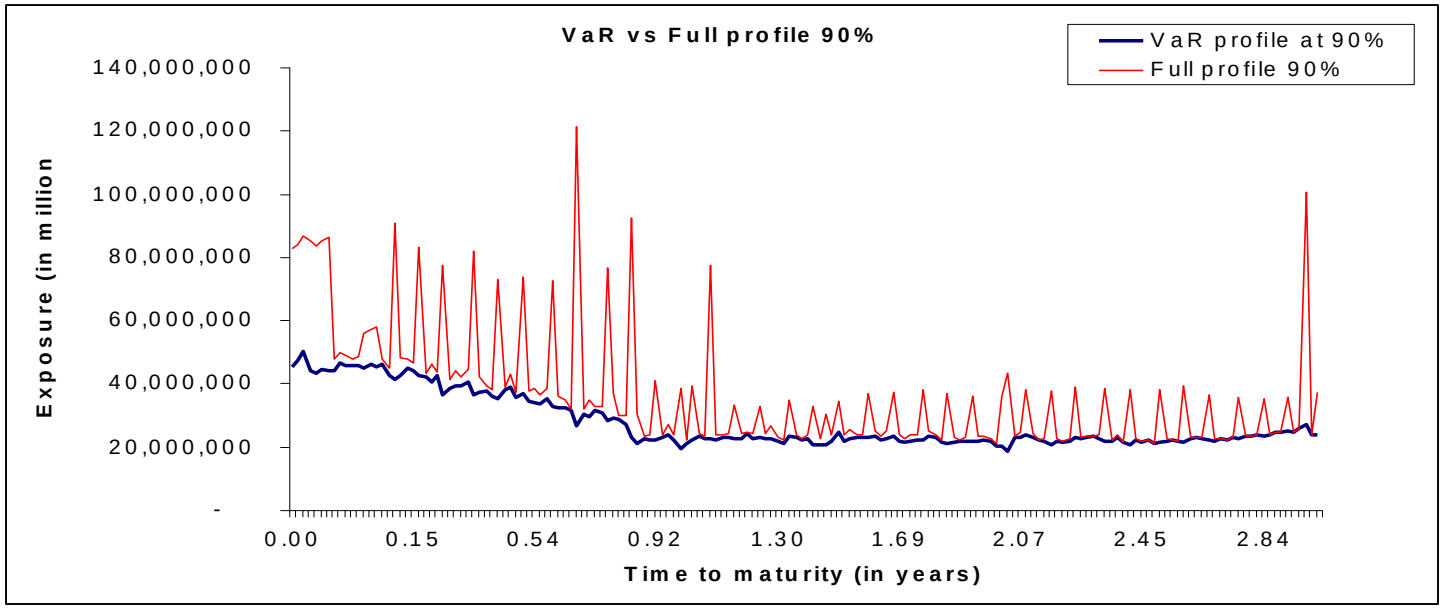
* Potentially with some scaling / basis

Modelling residual risk. Payment Risk ("spikes")

- Recall: Introduction of IM removes significant part of CCR (Credit to Liquidity risk conversion). The residual risk becomes more prominent:
  2. **Payment risk ("spikes")**
  3. Remaining exposure is based largely on extreme scenarios
- Payment risk is a close relation of familiar settlement risk, however it reflects pre-settlement dynamics and collateral agreements
- Two level of modelling
  - Basic – trade's payment vs. collateral payment
  - Advanced – payments variability during MPOR (conditionality on default)
- Basic: MTM < 0, we post collateral, (abs(*MTM*) = *c* under gold standard CSA). Trade "re-sets": regular payments; re-setting of equity swap; settlement at the end of the trade. In default, for equity swap we pay full MTM, but collateral is not returned. This produces payment "spike"
- Advanced: MPOR is separated into "control" and "no control" period
  - Defaulted counterparties do not pay during grace period
    - No cashflows in, but initially we still pay out ("no control" period)
  - We do not pay once default is recognised
    - Nothing in, nothing out ("control" period)

Payment Risk (“spikes”)

- Collateral – actual cashflows are conditional on default
  - No cashflows in, but we pay (“no control” period)
  - Nothing in, nothing out (“control” period)
- Conditionality on default makes backtesting difficult. Realised valued from portfolio observations (no default):
  - All in, all out
  - In fact, backtesting of residual risk is a general problem
- Full risk profile = VaR profile + Payment (Cashflow) Risk



Modelling residual risk: extreme scenarios

- Exposure (VAR-profile) not covered by IM is based largely on some extreme scenarios (**which are unlikely to be very well modelled…**) – are we stretching the IMM/PFE/EEPE concept too far?
- What to do?
- Modelling extreme events for risk factors is needed to capture post-IM exposure reliably
  - Extreme exposure scenarios may not be linked to extreme scenarios of underlying market risk factors, but often are
  - Counterparty portfolios are often directional
  - Existing exposure hedges may not target extreme events

Modelling extreme events

- Modelling extreme events come with three main challenges

- **Challenge 1.** Extreme events in a **single asset class**
  - What problems do we face?
- Example. Industry standard – GBM (simple Black-Scholes) is a common IMM CCR model for equity asset class and does not cover extreme events
- What needs to be added? Two broad sources of extreme events:
  - Firm's economics – catastrophic deterioration (i.e., rapid and not anticipated by markets) of firm's health
    - This can be reflected via rapid (jump-like) rating migration and/or default.
  - Capital markets – rapid change in market sentiment; could be name specific and market wide
    - Adding jumps to a diffusion process is a common modelling approach
- Additional modelling considerations. The modelling of extreme events should be compatible with WWR/conditionality of default; multi-mode use (regulator, internal risk/limits, xVA), stress testing framework

Modelling extreme events

- **Challenge 2.** Extreme ***events*** assume ***fas***t risk factor change (within MPOR time scale), however ***long term extreme scenarios can also have an impact***
  - Example. Charge of main risk drivers: path to default may be a slow process (not catastrophic), but once nearing or in default recovery becomes major driving risk factor, not secondary
  - Other low probability long term scenarios with potentially different risk regimes:
    - Hyper inflation
    - De-pegging
    - Peak oil/all-renewables
- Again, additional modelling considerations. The modelling of extreme scenarios should be compatible with WWR/conditionality of default; multi-mode use (regulator, internal risk/limits, xVA), stress testing framework

Modelling extreme events

- **Challenge 3.** Building a model for single asset class is only a part of the required solution. ***Extreme events tend to propagate across asset classes***
  - Example. Equity-credit link. If a name defaults, equity goes to (near) zero, credit is driven by recovery values
- Extreme events are best modelled in cross-asset framework, but modelling joint extreme events has a particularly large model uncertainty
- Most banks have pre-existing IMM models and development will be incremental
- Ability to model extreme events across asset classes may influence existing single asset models
  - *Cross-asset* links may change the *intra-asset* dependence
  - Example. Introduction of a jump-to-default mechanism into the equity processes (assuming one is already present and therefore copied from IMM CCR credit spread model), will change the dependence between any two equities – long term evolution will be affected by their default correlation

Modelling extreme events: discussion and questions

- Have we seen similar challenges before? and what did we learn?
  - Single asset class: IRC and CRM operating at 99.9% aiming to capture extreme events (migration and default) [3]
  - Cross-asset: DRC covers default in equity and credit [4], (Stressed) ES is a cross-asset mean-over-threshold measure with similarities to EE under IM
- Advanced model for extreme scenarios/rare events can
  - Make potential catastrophic events visible within common modelling framework
  - Complement direct stress tests, enable model-based reverse stress tests
- But also
  - Has high model uncertainty and high calibration uncertainty
  - Model review and validation are challenging
  - Backtesting a percentile at high confidence level (e.g. 99.9%) or a mean-over-threshold – usual approaches are not practical
  - IRC/DRC and SES are not backtested – should EEPE or PFE? ES is backtested (primarily – recall *p* values) at 97.5% and 99%, not above. What will be regulator's stance?
  - However regulators oppose "unwarranted model variability"
- Should bank invest in such models and for which mode (capital, PFE/limits, xVA)?

Conclusion

Regulatory impact on IMM, and specifically on IMM CCR, is on-going and multi-faceted. In next 3-5 years we may find significant shift in industry and regulatory consensus on:

- Purpose of our model (what we use the model for?)
  - Risking, capital, pricing, stress testing….
- Technical aspects of the model
  - Modelling of IM, payment risk, cross-asset and extreme scenarios
- Model review and validation
  - Further regulatory evolution possible

References

Further references from BNP Paribas in the public domain:

1. Moran L, Wilkens S, 2016. *Capturing Initial Margin in Counterparty Risk Calculations*. Available at http://ssrn.com/abstract=2803499.
2. Chorniy C, Greenberg A, 2015. *Review of Equity-Credit Dependence Studies: Towards Building a Practical Equity-Credit Model for Counterparty Risk*. Available at http://ssrn.com/abstract=2708143.
3. Wilkens S, Brunac J-B, Chorniy V, 2013*. IRC and CRM: Modelling Framework for the 'Basel 2.5' Risk Measures.* European Financial Management Vol. 19, Issue 4, pp. 801-829.
4. Wilkens S, Predescu M, 2016. *Default Risk Charge (DRC): Modeling Framework for the 'Basel' Risk Measure.* Available at http://ssrn.com/abstract=2638415, forthcoming in: Journal of Risk.

Additional references on IM and 'spike' modelling:

5. Andersen L, Pykhtin M, Sokol A, 2016, *Rethinking Margin Period of Risk*, https://ssrn.com/abstract=2719964.
6. Andersen L, Pykhtin M, Sokol A, 2016, *Credit Exposure in the Presence of Initial Margin*, https://ssrn.com/abstract=2806156.

Acknowledgments

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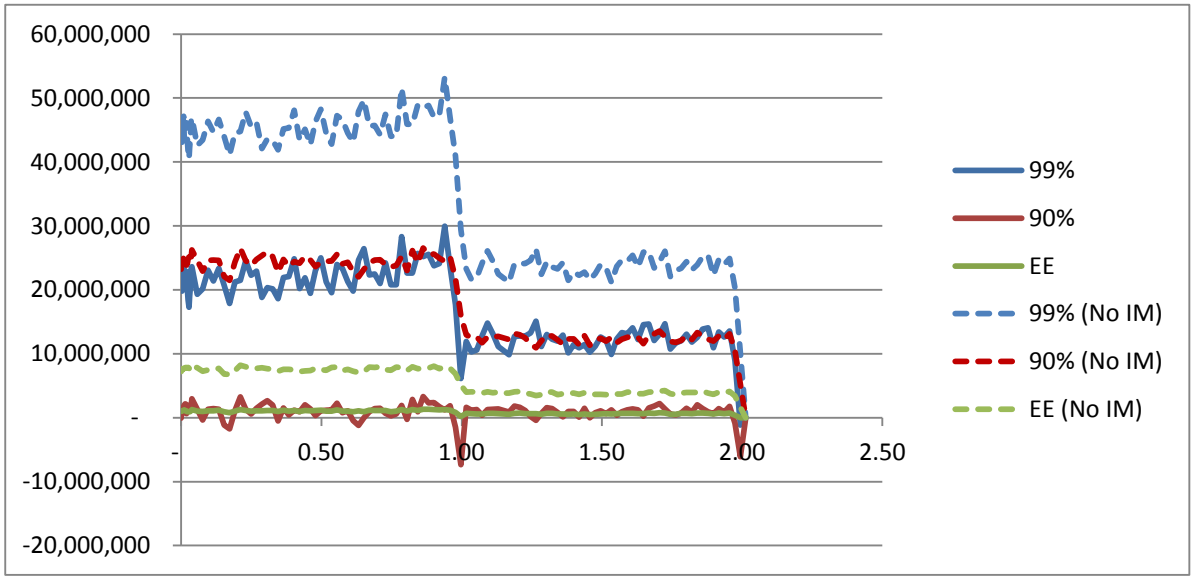
Appendix: IM models. Static

- Static model proposal*
  - Allocate day zero to IM to each trade, i, pro-rata using standalone day zero VaR.

$$IM^i(u,t) = IM(0)\frac{VaR^i(0)}{\sum_i VaR^i(0)} \qquad \text{for all } u,t$$

  - For the purposes of illustration we assume IM is calculated on 90% 10-day VaR and look at client-side portfolios (where we hold the IM.)
  - Example portfolio – 2 long vanilla calls 1Y and 2Y maturity:



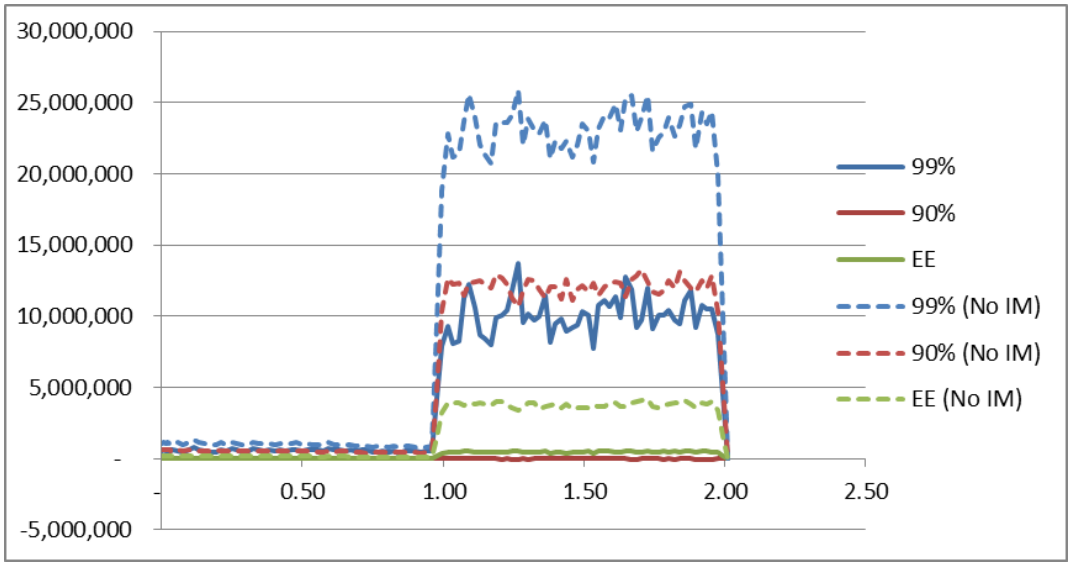
*These IM slides are adopted from presentation by Lee Moran and Peter Dobranszky and follow [1]: Moran L, Wilkens S, 2016.

Appendix: IM models. Dynamic

- Dynamic model proposal
  - Day zero portfolio IM scaled at each future time, t, by VaR at t

$$IM(u,t) = IM(0)\frac{VaR(t)}{VaR(0)}$$

  - Second example portfolio – 2 vanilla calls 1Y (short) and 2Y (long) maturity:



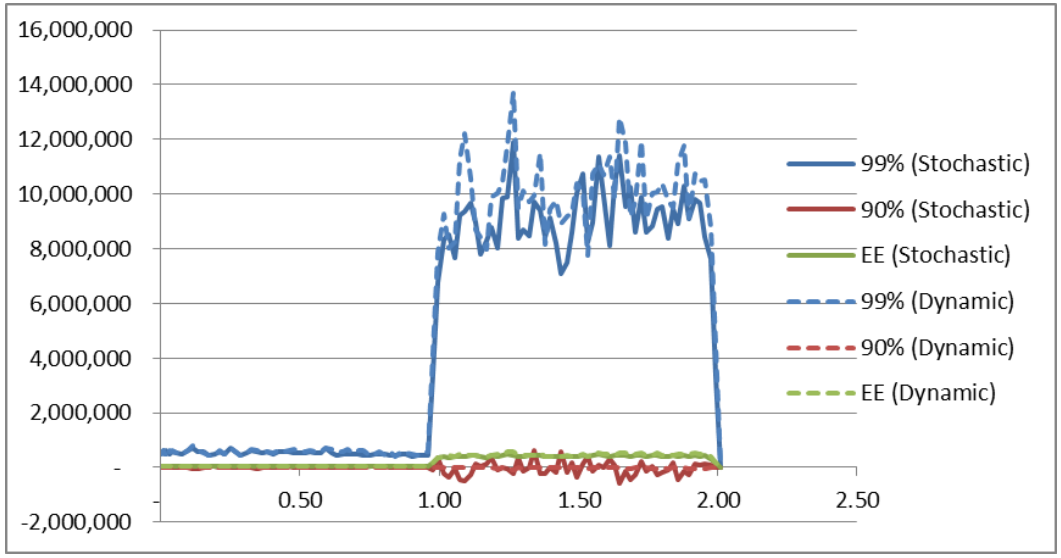
- Dynamic model copes with trade roll-off and portfolio offset effects generally

Appendix: IM models. Stochastic

- Stochastic model proposal
  - Day zero portfolio IM is scaled by an estimate of the VaR at each future date within each path[1].

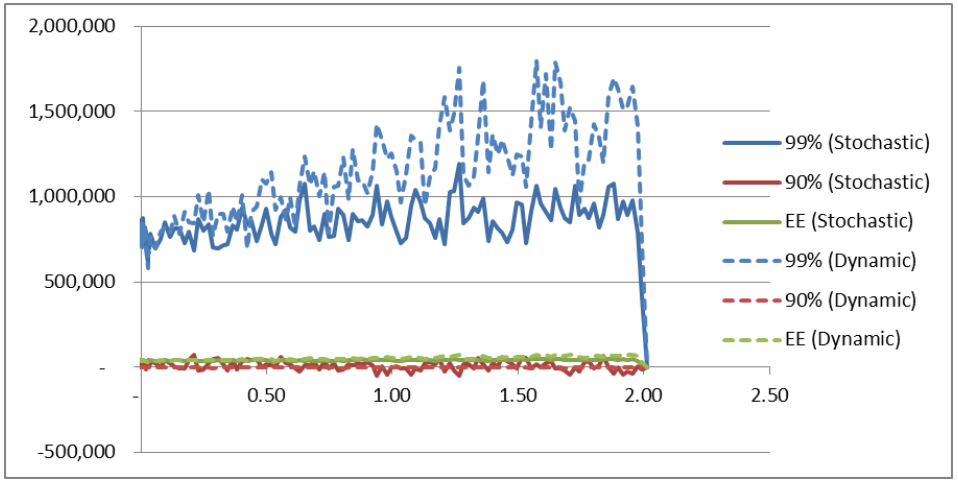
$$IM(u,t) = IM(0)\frac{VaR_q(u,t)}{VaR_q(0)}$$

  - On the second portfolio the stochastic model performance is similar to the dynamic

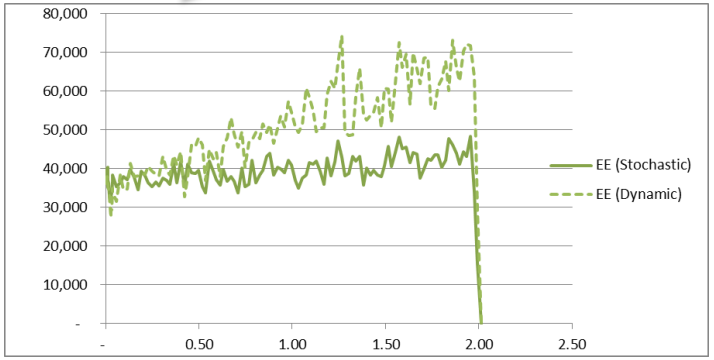


Appendix: IM models. Stochastic

- For illustrative purposes we take a third portfolio, a high volatility, out of the money call where the VaR is more strongly scenario dependent[2].



Focus on EE



- Can give a [relatively] material reduction in the EE. Extreme scenarios could be even stronger affected

[1] How we approximate that without resorting to a brute force simulation approach is the clever part, see [1]

[2] Volatility is not stochastic in these simulations but if it were then the results would be further emphasised

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