What High Performance Computing Can Do for You:
Dynamo HPC Open Access Model

William C. Scheel
And
Gerry Kirschner

Speaker: William Scheel, Ph.D.

Bill is a consultant with DFA Technologies, LLC currently working in the area of High Performance Computing (HPC) and using HPC Excel for Solvency II (S II) internal models.

During the last couple of decades, Bill has designed systems for actuarial, accounting, hedge fund and commercial software companies. He served as consultant to the U.S. Department of Labor, the Federal Trade Commission, the U.S. Justice Department and the National Association of Insurance Commissioners. Bill was a Professor of Risk and Insurance for over a decade.

Deloitte.

Speaker: Gerry Kirschner, FCAS, MAAA

Gerry is a Specialist Leader at Deloitte Consulting LLP. Gerry's area of actuarial specialization are:

- Guiding company preparations for financial modernization, including the application of financial models and finance and accounting systems to support Economic Capital Modeling, Solvency II and International Financial Reporting Standards (IFRS) for insurance enterprises
- Leading advanced analytic initiatives such as the development and installation of predictive modeling tools for the commercial insurance space

References

W. C. Scheel and G. Kirschner, "Effects of Simulation Volume on Risk Metrics for Dynamo DFA Model, http://www.casact.org/pubs/forum/12sumforum/Sheel_Kirschner.pdf

Microsoft, *Step By Step* Windows HPC Server 2008 R2, 2010 Microsoft Corporation, 302 pp.

http://resourcekit.windowshpc.net/doc31.htm

Solvency II Association Reading Room

http://www.solvency-ii-association.com/Reading_Room.htm

Solvency II Directive

http://www.solvency-ii-association.com/Solvency_ii_Directive_Text.html

What We Hope to Accomplish Today

- PART 1
  - Discuss the pros and cons of using Excel as the platform for a Dynamic Financial Model
  - Show the importance of high simulation counts (>100K) when constructing risk metrics
- PART 2
  - Discuss important under-the-hood features of Excel 2010 HPC
  - Examine what an "Actuarial HPC Cluster" might do for you and its essential components
  - An overview of both HPC and non-HPC enhancements to the CAS Dynamo model running live on an actuarial cluster in Connecticut

PART 1

Excel as a DFA Platform: Pros/Cons

Pros	Cons
Easy to work in (for a while)	Very difficult to establish and maintain rigorous version control
Low cost to acquire	Time consuming to do large volumes of simulations
Very flexible development structure	No pre-built insurance operation modeling structure
Small learning curve (for a while anyway)	Complex models can get very large and/or very cumbersome
	Complex to change once a model is built
	Complexity to drill down and analyze drivers of results when running model stochastically

Observations on Dynamo 4 – A Few Cautions

- Simple economic scenario generator – single factor Cox-Ingersoll-Ross model

- Financial statements not currently in alignment between Balance Sheet, Income Statement and Cash Flow statements

- Long run-time – 5,000 simulations took almost 3 hours to complete

Do I Need to Do More Than 5,000 Simulations?

- Short answer – yes.
- Longer answer – yes, because the metrics we are most interested in tend to be tail events that don't happen very often.

Why Do I Need to Do More Than 5,000 Simulations?

1. Stabilization of tail results

2. More consistent estimate of the values in the tails of the distributions

Simple example: simulation of random values from 2 different lognormal variables

Variable	Mean	Standard Deviation
1	10,000	5,000
2	250,000	11,000

- For each of these variables, we can calculate the mean and a 99.5% Value at Risk of the resulting distribution after running anywhere from 1,000 to 750,000 simulations
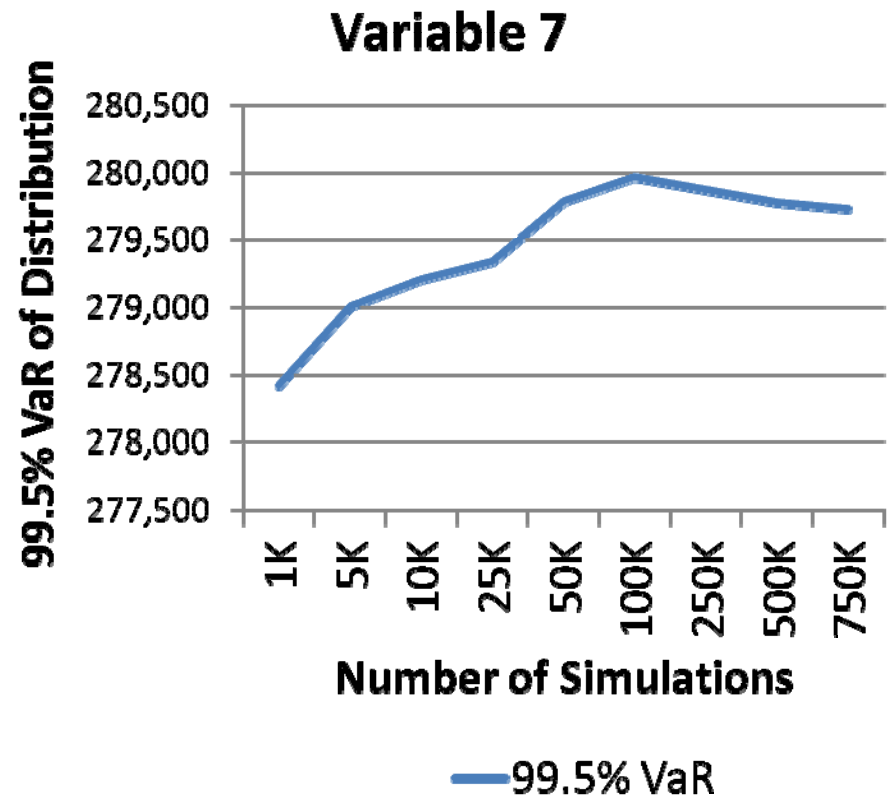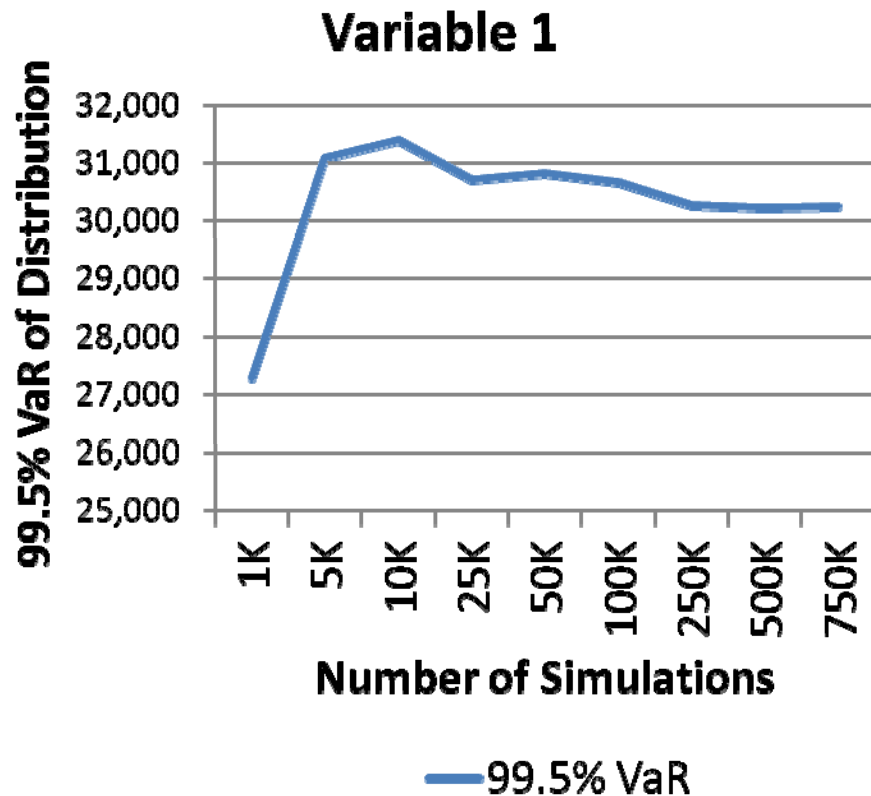
Empirical Evidence of Tail Result Stabilization

- Evaluate stabilization as the ratio of the distribution's 99.5% VaR / mean:
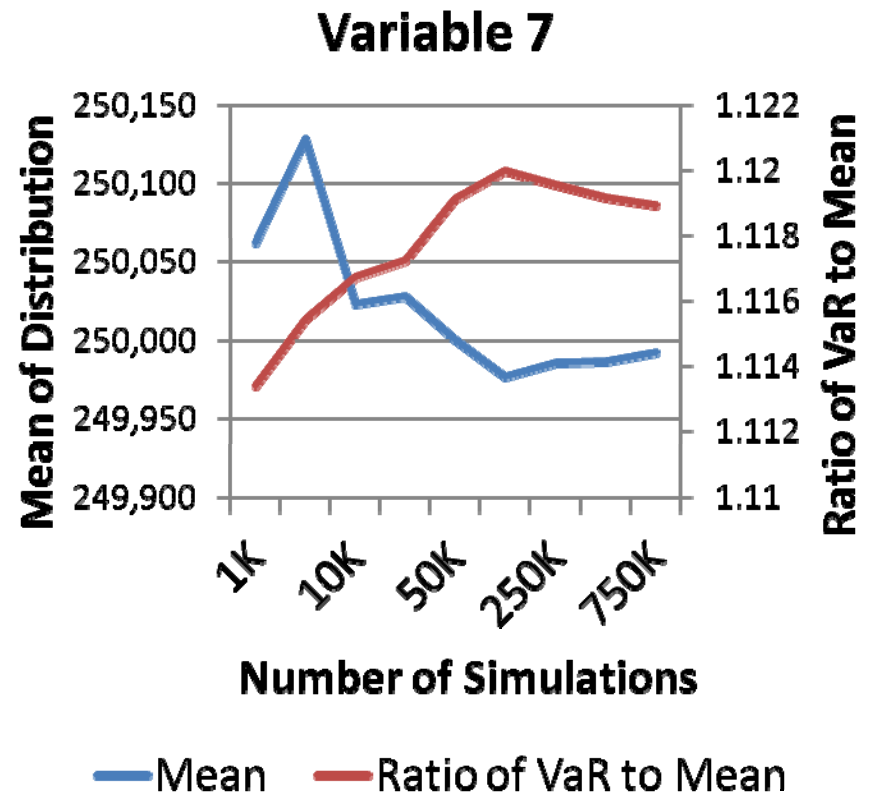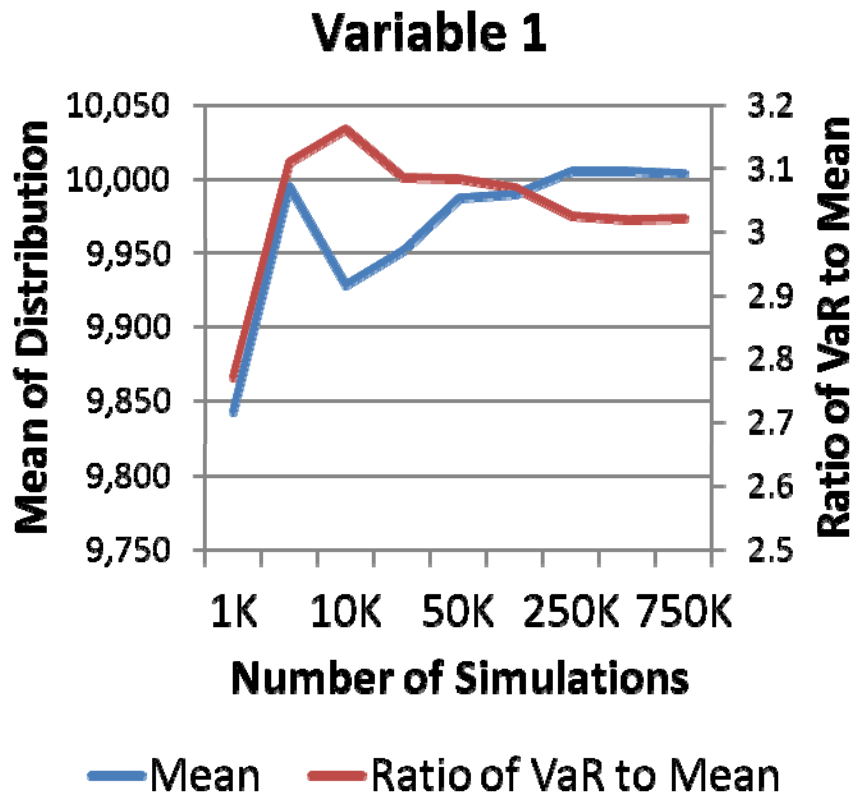
Empirical Evidence of More Consistent Tail Value Estimates

- Evaluate consistency of tail value estimates by calculating distribution's 99.5% VaR
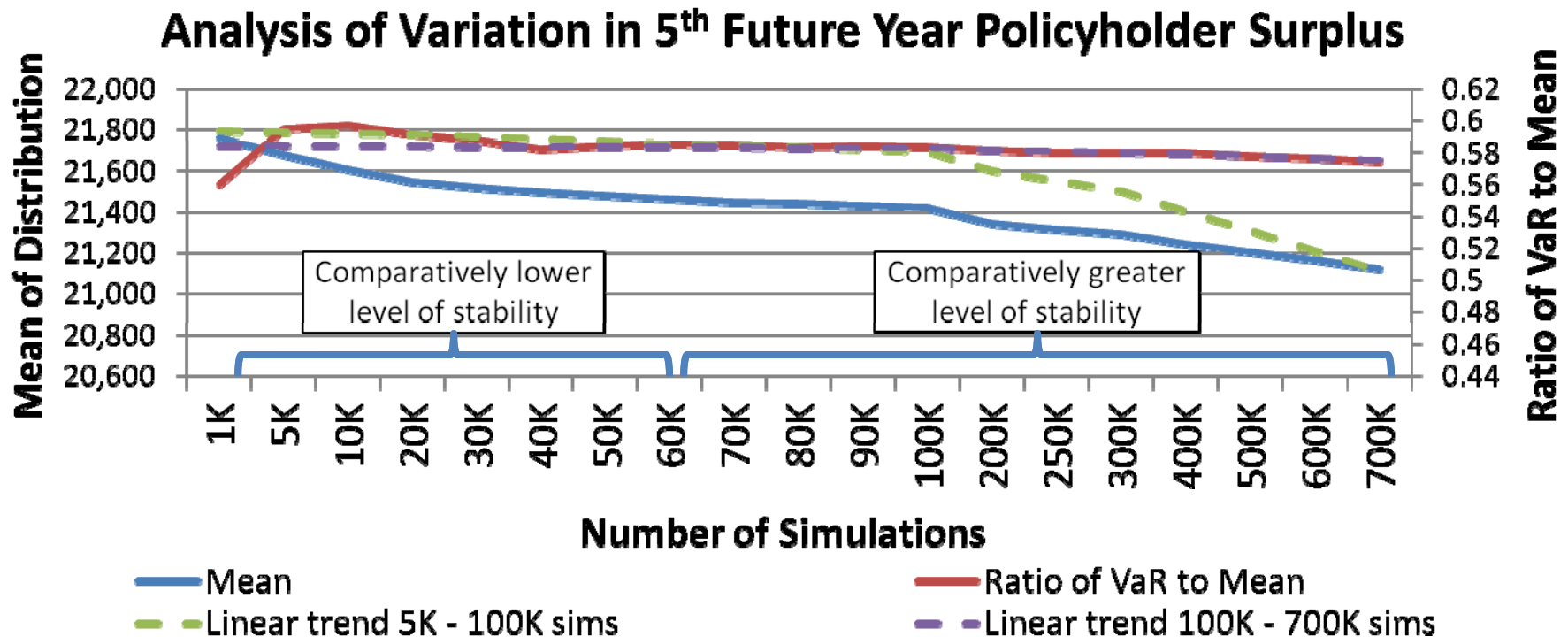
Simulation Volume Effects on the Dynamo Entity's Overall Surplus Level

- In it "out of the box" setup, Dynamo has in excess of 760 different random processes.

- These individual random outcomes all come together in the financial statement projections

- We focused our analysis on the variations in projected policyholder surplus in the 5th future year
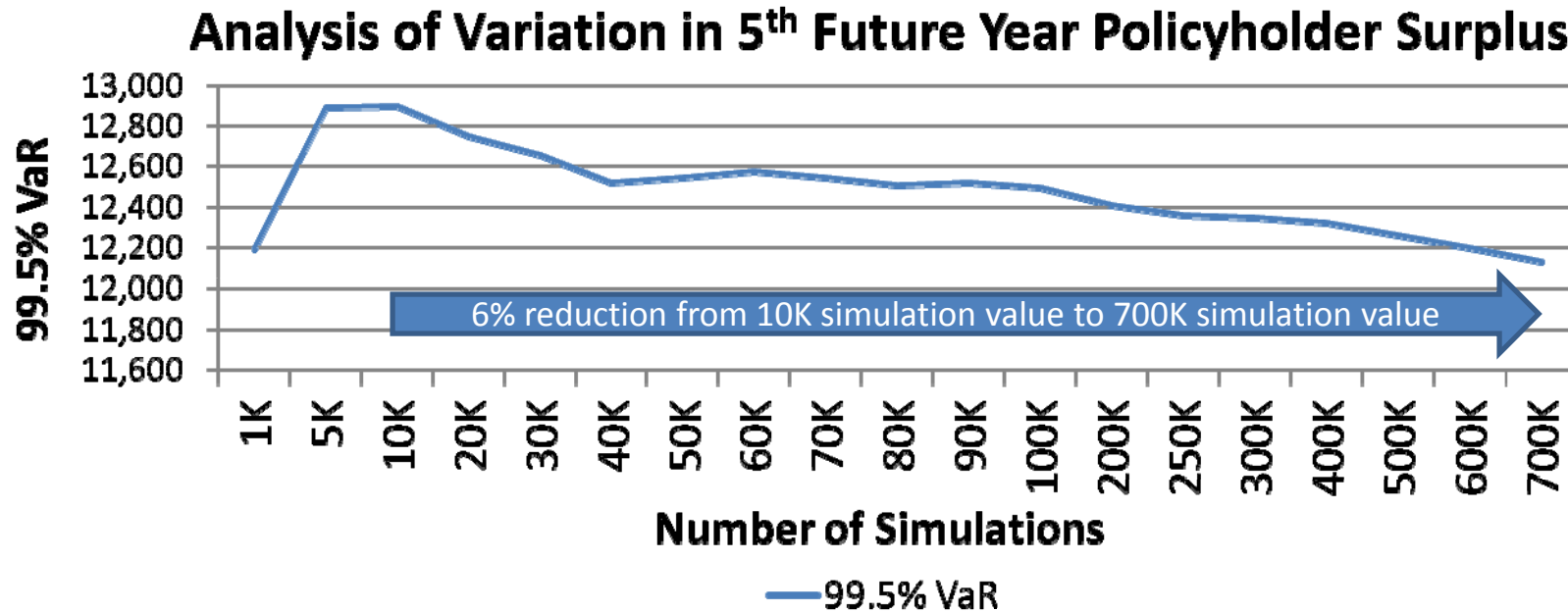
Simulation Volume Effects on the Dynamo Entity's Overall Surplus Level

- Using the ratio of VaR to simulation mean as a way to evaluate when tail results stabilize, we see results begin stabilizing above 60K simulations

Analysis of Variation in 5th Future Year Policyholder Surplus

Simulation Volume Effects on the Dynamo Entity's Overall Surplus Level

- Higher simulation volumes naturally result in more tail observations. It was very interesting to us that the higher simulation volume led to a steadily decreasing 99.5% VaR value.

Analysis of Variation in 5th Future Year Policyholder Surplus

6% reduction from 10K simulation value to 700K simulation value

99.5% VaR

Number of Simulations

—— 99.5% VaR

Conclusion

- When using insurance models to calculate conditional tail probabilities, such as are used for Solvency II, it is important to use tools that are capable of producing hundreds of thousands of simulations.

PART 2

Why HPC Excel?

- Performance gains
- Precision gains
- New brute force simulation possibilities
- Highly scalable methodologies using rules and algorithms in workbooks for actuarial simulations, principles-based reserving, classification, risk metrics, and myriad other HPC "F9-ers"
- Re-tool existing workbook models while retaining extensible modeling capabilities
- Graphics Processing Units (GPUs) wrappers

My Most Asked Question: "How Much Excel VBA Do I Need To Know for HPC?"

Possibly more than you do now ☺

Probably less than you might expect ☺☺

1. The macro recorder will not help with HPC.
2. You need to be comfortable with the Range object and moving data in and out of variants.
3. You need to work with (COM) objects.
4. You need to learn cluster management ☹

High Performance Grid Computational Setup for HPC Actuarial Cluster

- HPC Cluster with 20-50 cores (approx 4 computers)
- Software requirements
  - Microsoft Server 2008 HPC
    - Head and broker nodes
    - Compute nodes
  - HPC Pack (all computers)
  - Windows 7—compute nodes
  - 1 copy of Excel 2010 on each computer

The New Programming Paradigm

- Deconstructed SERIAL LOOP
- "Embarrassingly" Parallel
- *Event* programming
- Independent trials doesn't mean independent variables (old Dynamo)
- Uniform Random Number Conundrum
- *Programming and data handling considerations determine the best method of parallelization. Neither is inherently the best.*

What's New in Dynamo 5?

- Ease-of-use enhancements
- Multivariate random variables
- Much faster single computer usage (you don't need HPC)
- New risk metrics (EPD, VaR, TVaR)
- Up to about 1 million simulations
- Improved graphics
- Utilities for formula substring search and inspection; ShrinkIt to avoid workbook bloat; extendible help

The Dark Side

- *Simulations done simultaneously on separate Excel instances leads to complexity in random number handling to enable replicable experiments*

- Fire hose problem. Excel is too slow when inserting results into a worksheet (workaround: write a file and do insertion and statistics at end of run)

On the "To Do" Side

- Extensions to use R
- C/C++/R code with exported functions that become Excel cellular functions through an add-in (a cluster safe XLL)
- Link Dynamo and CAS Loss Simulation Model
- Streamline adding new lines of business to Dynamo
- Direct import of NAIC reporting data

Questions?

DFA TECHNOLOGIES, LLC

» Financial Modeling »
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Actuarial Programming » .NET Programming » Database Design » Hedge Strategies » Insurance » Accounting » Dynamic Financial Analysis »

93 Silkey Road
North Granby, CT 06060

E: scheel@cox.net
P: 860.653.7169
M: 860.558.0968

Bill Scheel
scheel@cox.net

Deloitte.

200 Clarendon Street
Boston, MA 02116
P: 617.437.2337

Gerry Kirschner
gkirschner@deloitte.com