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How Covariance Data Helped Destroy Wall Street (and my Retirement Account) – And Can it do the Same for Criticality Safety?

R. D. McKnight
Nuclear Engineering Division

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Outline

- **Two Topics in Criticality Safety currently of high interest**
  - **Covariance Data**
    - ***Lessons from Wall Street***
    - ***Nuclear Data Covariances – Today and Tomorrow***
  - **Sensitivity/Uncertainty Data**
- **Conclusions**

Covariance Data – Lessons from Wall Street

- First, my credentials:
  - A significant number of my friends are Bankers!
  - They tell me,

    “Rich, let’s get together sometime.”

    “I’d like to show you how we can take
    your money and my experience
    and make it
    my money and your experience.”

Excerpted from: "A Formula for Disaster" by Felix Salmon (Wired Magazine) – 1

- A Bond or Mortgage is an IOU
  - The higher the perceived risk; the higher the interest rate
- Bond (and Mortgage) Investors are comfortable with "Probability"
  - If risk is 1% higher; interest rate is 2% higher
  - Somewhat like a Casino operation
- Create Mortgage Pools
  - Profit potential is staggering
  - Americans have mortgages totally > $11 trillion
- Tranching (slices or portions of pools)
  - Investors like "risk" – as long as they can price it
  - Investors hate "uncertainty"
- Wall Street desperately wants to measure, model and price correlation
  - This is excruciatingly difficult

Excerpted from: "A Formula for Disaster" by Felix Salmon (Wired Magazine) – 2

- Enter David Li – mathematician with JPMorgan Chase
  - "On Default Correlation: A Copula Function Approach" published in *The Journal of Fixed Income (2000)*
  - An ingenious way to model default correlation without even looking at historical default data
- Credit Default Swaps (CDSs) & Collateralized Debt Obligations (CDOs)
  - Even CDO-squared (a second tier tranche)
    - *so far removed from any real equity that no one had a clue what was it included*
- How could one formula have such an enormous effect?
  - "The corporate CDO world relied almost exclusively on this copula-based correlation model"
  - "Correlation trading has spread through the psyche of the financial markets like a highly infectious though virus"

Excerpted from: "A Formula for Disaster" by Felix Salmon (Wired Magazine) – 3

- CDOs were invariably sold on the premise that the correlation was more of a constant than a variable
  - "People got very excited about the Gaussian copula because of its mathematical elegance, but the thing never worked. … Co-association between securities is not measurable using correlation. … because past history can never prepare you for that one day when everything does south. … Anything that relies on correlation is charlatanism."
  - "… then people invest on the basis of those probabilities, without stopping to wonder whether the numbers make any sense at all."
- As Li himself said of his own model: "The most dangerous part is when people believe everything coming out of it."

Nuclear Data Covariances – Today and Tomorrow – 1

- There are many “parallels” between the Lessons from Wall Street and Nuclear Data Covariances
  - Quantifying the probabilities and the correlations is extremely difficult
  - Invalid correlation data will lead to invalid conclusions
  - There is currently debate about the quality of the covariance data
  - There is no consensus on the best method to evaluate the covariance data
  - Some methods rely only on model data, some on measured data, and some on both
- Nuclear Renaissance (maybe)
  Nuclear Data Covariance Renaissance (definitely)
  - Modern nuclear data files today contain very little “high fidelity” covariance data – but these data are being aggressively pursued (with limited resources).

Nuclear Data Covariances – Today and Tomorrow – 2

- There is a healthy dialog on the proper means to evaluate covariance data
  - Spirited “questioning” of the values
  - Diverse approaches (least-squares, stochastic, …) are being studied
  - There is a healthy dialog on what covariances are actually needed by the user community.
- Many unanswered questions remain
  - What is needed in the resonance region?
  - What reaction channels are needed?
  - How important are cross correlations?
  - Should integral data be included in the evaluation methodology for covariance data?

Nuclear Data Covariances – Today and Tomorrow – 3

- Within the ENDF community there is a concerted effort to institute adequate quality assurance into the generation of covariance data at this "formative" stage
  - Methods for Producing Covariances
  - Completeness of the Covariances
  - Numerical Detail of the Covariances
  - Mathematical Properties of Covariances
  - Covariance Formats
  - Covariance Processing
  - Covariance Documentation
  - Covariance Quality Assurance Review Process

Sensitivity/Uncertainty Data

- These methods are the best means to determine nuclear data needs and target accuracies.
  - This application (determining data needs, target accuracies, and priorities) remains sadly under-utilized in the field of Criticality Safety.
- These methods combined with “data adjustment” methods, are the best means to utilize measured (evaluated) differential and integral data.
- These methods have been in use for several decades – this is a renaissance for the application of these methods.
  - The principle difference in their application today is the potential use of greatly expanded data sets.

Conclusions

- Covariance data (like all input) data should be subjected to rigorous QA, including a “sanity” or “sensibility” test. (Just because it came out of a sophisticated code doesn’t necessarily make it correct!)

- We should acknowledge that we have abundant measured and evaluated differential and integral and benchmark data and that the overall quality of these databases is very good. Therefore, we should give more thought and effort to defining unique or high value (differential and integral) measurements that meet specific priority data needs.

- We are trying to overcome our failure to maintain technical expertise in many critical areas. But this will take a sustained effort; cannot be done overnight; and in critical to meet our mission and vision for criticality safety.