Risk Measurement Assignment: Methods and Results

Michael Vitale · RMI 655 Risk Financing Techniques, UW–Madison, Fall 2024. A walkthrough of each part of the assignment: what it asked, how I built it in Excel and the @RISK simulation add-in, and what it showed. The regression and the portfolio work are in the companion Excel workbook.

1. Regression: how gold miners respond to gold and the market

What was asked	Estimate how sensitive two gold-mining stocks, Barrick (ABX) and Harmony (HMY), are to gold prices and to the stock market, and explain the difference.
How I set it up	Converted monthly prices for gold, the S&P 500, ABX and HMY (149 months) into monthly returns. Ran Excel's regression tool with each stock's return as the dependent variable and gold and S&P 500 returns as the independent variables: $R_{i,t} = \alpha_i + \beta_{im}R_{m,t} + \beta_{ig}R_{g,t} + \varepsilon_t$.
Result	ABX: R = 0.0038 + 0.40 × market + 0.63 × gold. Both coefficients are significant (p = 0.02 and p = 0.002). HMY: R = 0.0042 + 0.32 × market + 1.12 × gold. Gold is significant (p < 0.001); the market coefficient is not (p = 0.19). A 1% move in gold moves Harmony about 1.12% but Barrick only about 0.63%. Barrick hedges much of its production (for example, selling future output at fixed prices), so its cash flows depend less on the gold price and its stock behaves more like the broader market.

2. Combining frequency and severity distributions

What was asked	Model a firm's annual fire losses and find the chance of very large losses, the volatility of losses and the 95th-percentile loss.
How I set it up	Frequency: Poisson with a mean of 0.5 fires a year. Severity: lognormal with a mean of $300,000 and a standard deviation of $100,000. Combined them with RiskCompound(frequency, severity), set the result as an @RISK output and ran 1,000 iterations.
Result	Chance that annual losses exceed $2 million: 0%. Chance they stay under $500,000: 91.6%. Standard deviation of annual losses: $221,763. 95th-percentile loss: $609,482.

3. Defining outputs: revenue, cost and profit

What was asked	Simulate a firm’s revenue, costs and profit and answer questions about each distribution.
How I set it up	Revenue = price × quantity, with price Normal(40, 8) and quantity Lognormal(2,000, 700). Cost = input cost × number of inputs, with input cost Logistic(30, 10) and inputs Uniform(1,500, 2,300). Profit = revenue − cost. All three set as @RISK outputs; 1,000 iterations.
Result	Chance revenue exceeds $150,000: 3.6%. Chance costs exceed $150,000: 0.8%. Expected profit: $22,829. 75th-percentile profit: $52,352.

4. Fitting claim frequency and severity from data

What was asked	Fit distributions to historical claim counts and claim sizes, combine them into an aggregate loss distribution and measure its tail.
How I set it up	Used @RISK’s distribution fitting: a chi-squared test chose a negative binomial for claim counts, RiskNegbin(1, 0.716), and a Kolmogorov–Smirnov test chose a Levy distribution for claim size, RiskLevy(−234.25, 2,301.47). Multiplied the two into an aggregate loss output and simulated it.
Result	Chance aggregate losses exceed $100,000: 5%. Chance they exceed $500,000: 1.9%. Percentile values of aggregate losses reported: $16,067, and $2,491,936 at the 99th percentile. The jump between them shows how heavy the tail of a Levy severity distribution is.

5. Value at risk for a $300,000 portfolio

What was asked	Measure the 1% value at risk of a $300,000 portfolio, then again after reallocating toward lower-volatility assets.
How I set it up	Built the covariance matrix from the correlation matrix and standard deviations, then portfolio volatility as SQRT(MMULT(MMULT(weights, covariance), TRANSPOSE(weights))) and expected return with SUMPRODUCT. Scaled both to $300,000 of wealth, modeled end-of-period wealth with RiskNormal, and read the 1% tail from the simulation.
Result	Original weights: expected wealth $333,900; the worst 1% of outcomes falls below $147,653, a 1% VaR of $186,247 relative to the expected value. After reallocating: expected wealth $331,169; 1% threshold $160,683, a VaR of $170,486. Moving toward lower-volatility assets gave up about $2,700 of expected value and cut the 1% VaR by about $15,800.

Simulation results come from 1,000 @RISK iterations and will vary slightly from run to run.