



UCD Michael Smurfit
Graduate Business School

Group-25

Risk Modelling Project

Recommendation of Investment Risk estimates

3rd May 2024

FIN 41360 Portfolio & Risk Management

Shailesh Bharadwaj | Bilal Rasheed | Finn Burke | Pranjal Kharbanda | Ishika Trivedi

Agenda

1. Executive Summary
2. Characteristics of the portfolio
3. Definition of Risk Measures
4. Equity Risk Portfolio
5. Interest Rate Risk Portfolio
6. Combined Risk Portfolio
7. Other Considerations
8. Conclusion
9. Q&A

Executive summary

We propose our recommendations based on backtesting analysis and support our analysis with other considerations affecting our decision.



Objective

Recommend a **risk estimate/measure** for each of the three investments: 1) Equity, 2) Risk, and 3) Equity/Risk



Proposal

Equity

Normal Linear VaR

Bond

Normal linear Var

Equity/Bond

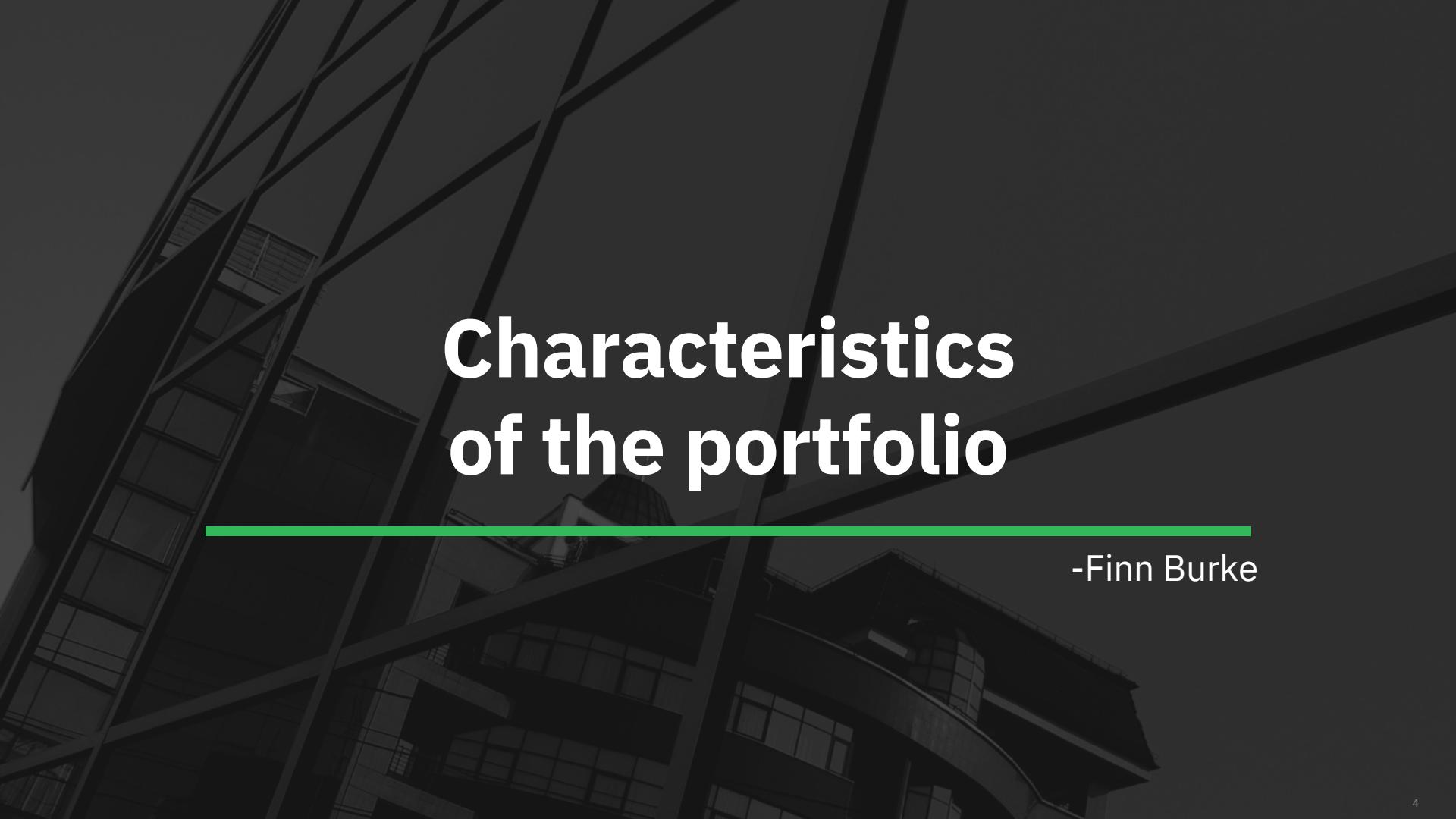
Normal linear VaR



Additional Factors

Bondmarket liquidity concerns

Uncertainty over inflation and the timing of next rate cut



Characteristics of the portfolio

-Finn Burke

Equity Risk Portfolio: Tangency portfolio consisting of one stock from each sector in the S&P 500

Holdings



Portfolio 5-year Characteristics

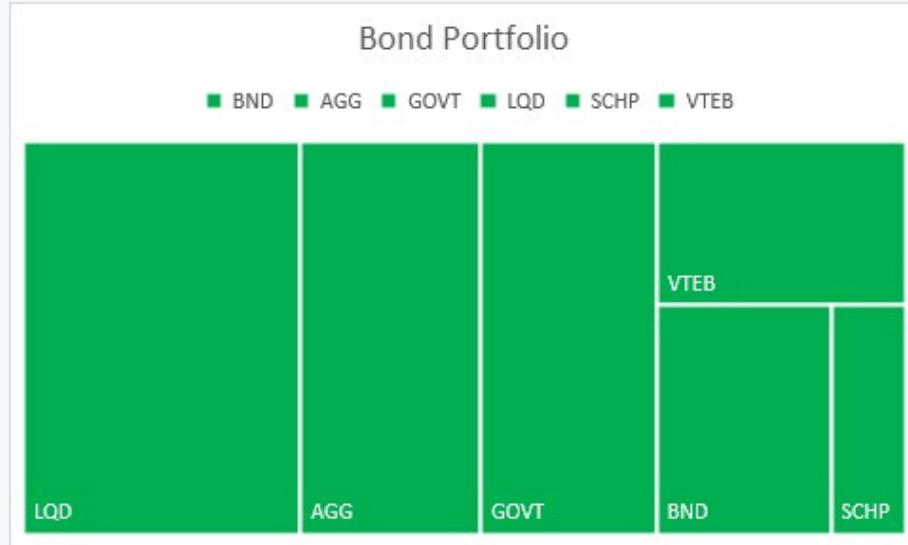
Annualised Volatility	42.37
Annualised Expected Return	18.94%
Sharpe Ratio	0.45



Interest Rate Portfolio mimicking the typical portfolio holdings of a financial institution

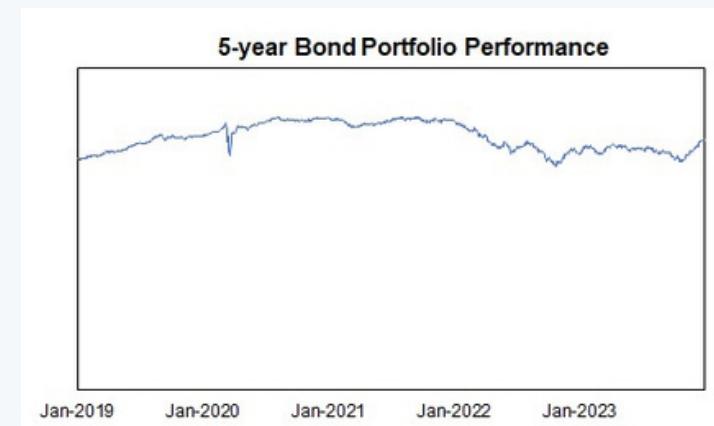


Holdings



Portfolio 5-year Characteristics

Annualised Volatility	7.02%
Annualised Expected Return	1.43%
Sharpe Ratio	0.43



Equity/Interest Rate Risk Portfolio



Holdings

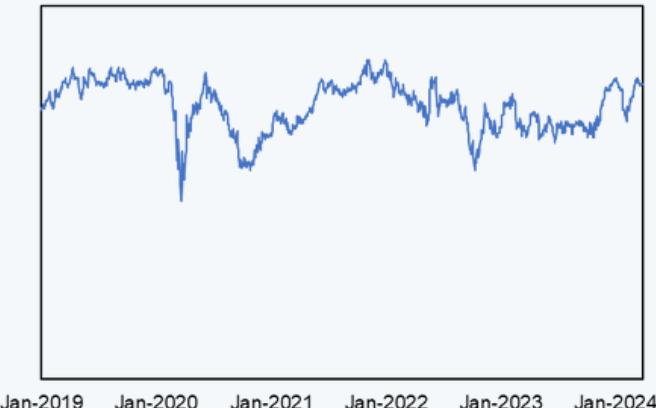
- Short Position
- Long Position



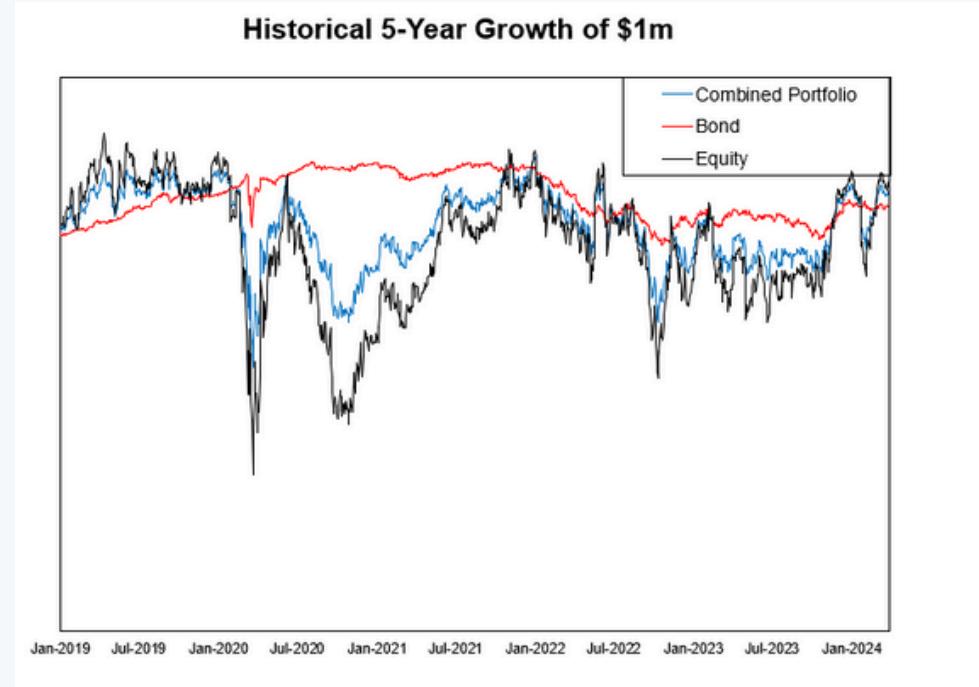
Portfolio 5-year Characteristics

Annualised Volatility	26.03%
Annualised Expected Return	12.47%
Sharpe Ratio	0.48

5-year Portfolio Performance



Combined Portfolio Historical 5-year Performance





Overview of Risk Measures

-Finn Burke

Brief definitions and explanations of the risk measures used in our risk analysis



Normal Linear VaR: Estimates potential losses based on a normal distribution assumption

Advantage: Easy to compare across portfolios

Weakness: Misses tail activity

T- Student VaR: Like Normal Linear VaR, but accounts for fatter tails in the distribution of returns

Advantage: More robust to extreme events (tails)

Weakness: Sensitive to degrees of freedom

Historical VaR: Based on past returns

Advantage: Based on actual returns –no distributional assumptions

Weakness: Assumes future will resemble the past

Brief definitions and explanations of the risk measures used in our risk analysis



Volatility-weighted VaR: Accounts for the volatility of individual portfolio assets

Advantage: Sensitive to current volatility estimates

Weakness: Judgement of decay factor can be erroneous

Backtesting: Process of testing a risk model against historical data to assess its accuracy

Advantage: Helps identify potential sources of model risk

Weakness: Does not necessarily indicate future model accuracy

Spectral Risk Measure: Uses statistical properties of asset returns to capture tail risk

Advantage: Accounts for higher moments – useful for tail risk

Weakness: Computationally intensive

Data and sample period

Estimation Sample: Period from January 2, 2019, to March 9, 2021, used as a historical dataset for initial 1-day VaR calculations to predict potential future losses

Backtest (Evaluation Sample): From March 10, 2021, to March 27, 2024, used to assess the accuracy of VaR and ES predictions from the initial sample, evaluating the effectiveness of these risk measures.

Volatility-weighted Rolling-window: 500 trading days

Volatility-weighted Lambda: 0.94 (BNP paribas) Risk Report)

Confidence level: 99%

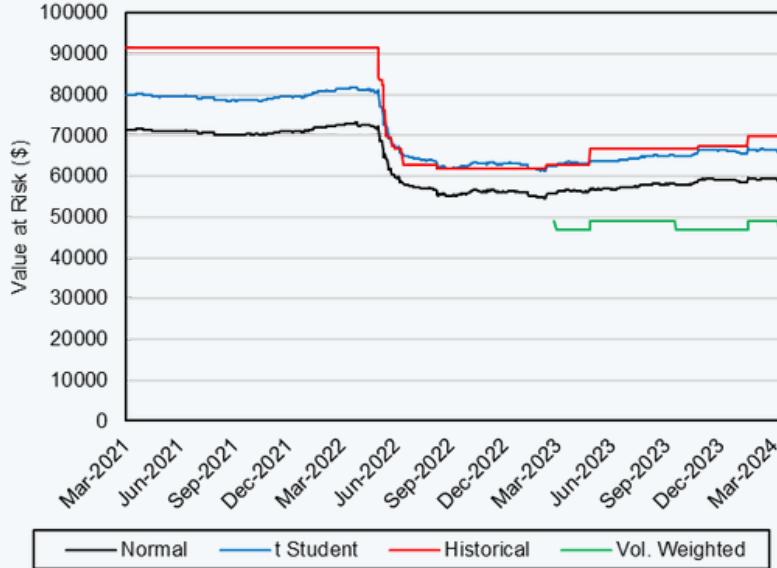


Equity Risk Portfolio

-Pranjal kharbanda

We recommend the parametric Normal Linear VaR/ES measure for the Equity Risk Portfolio based on the Lopez backtesting measure

VaR Backtesting Comparison



Equity Lopez back testing

	Sample Size	Conf Level	QPS
Equity			
Historical	768	1%	0.035
Volatility-Weighted	268	1%	0.040
Normal	768	1%	0.014
t Student	768	1%	0.035

VaR and ES Estimates

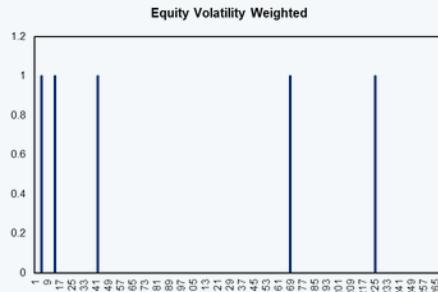
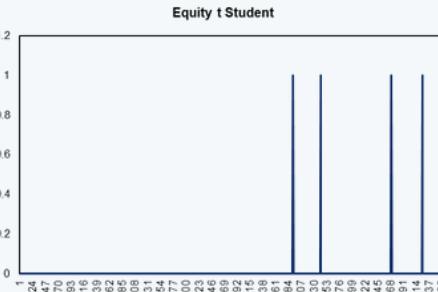
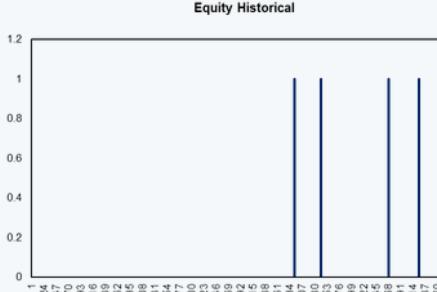
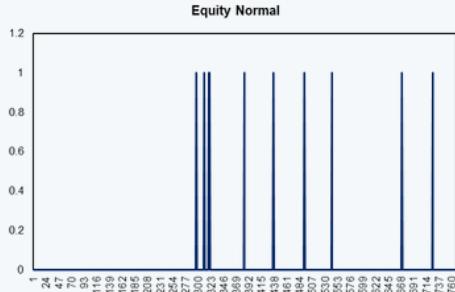
	Equity	
	VaR	ES
Historical	70008.62	101839.26
Volatility-Weighted	34110.35	53279.88
Normal	61983.32	71125.15
t Student	69432.30	69747.10
Cornish-Fisher	114827.84	-

The recommendation is supported by analyzing a one-tailed back test and the frequency and clustering of exceedances

One-tailed Backtests

	Sample Size	Exceedances	Conf Level	Probability of Exceedance	Test
Equity					
Historical	768	4	99%	88.18%	Accept
Volatility-Weighted	268	4	99%	13.31%	Accept
Nominal	768	10	99%	15.26%	Accept
t Student	768	4	99%	88.18%	Accept

Backtesting-Exceedances



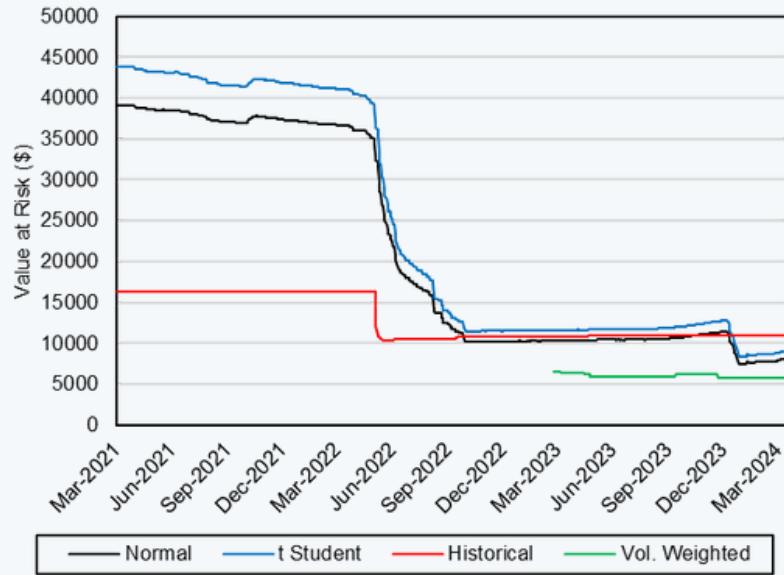


Interest Rate Risk Portfolio

-Pranjal kharbanda

We recommend the parametric Normal VaR/ES measure for the Bond Risk Portfolio based on the Lopez backtesting measure

VaR Backtesting Comparison



Lopez Backtest

Lopez Test			
	Sample Size	Conf Level	QPS
Historical	768	1%	0.602
Volatility-Weighted	268	1%	1.526
Normal	768	1%	0.007
t Student	768	1%	0.057

VaR and ES Estimates

	Bond	
	VaR	ES
Historical	8119.04	13205.66
Volatility-Weighted	7052.84	9003.29
Normal	10224.00	11778.08
t Student	12170.43	12254.24
Cornish-Fisher	29861.47	-

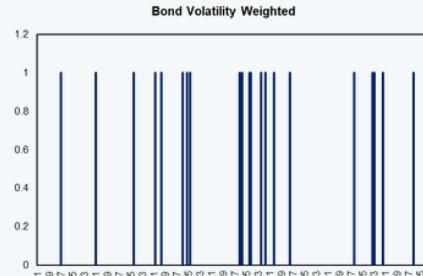
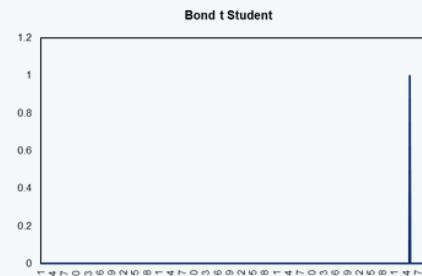
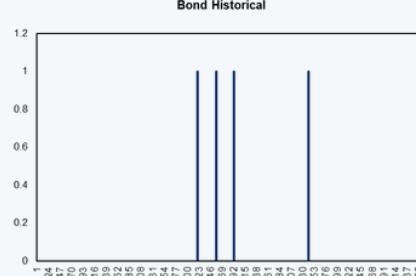
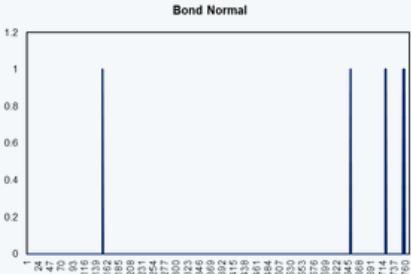
The recommendation is supported by analysing a one-tailed backtest and the frequency and clustering of exceedances

One-tailed Backtests

One-tailed Binomial Test

	Sample Size	Exceedances	Conf Level	Probability of Exceedance	Test
Bond					
Historical	768	4	99%	88.18%	Accept
Volatility-Weighted	268	21	99%	0.00%	Reject
Normal	768	6	99%	64.71%	Accept
t Student	768	3	99%	94.83%	Accept

Backtesting-Exceedances

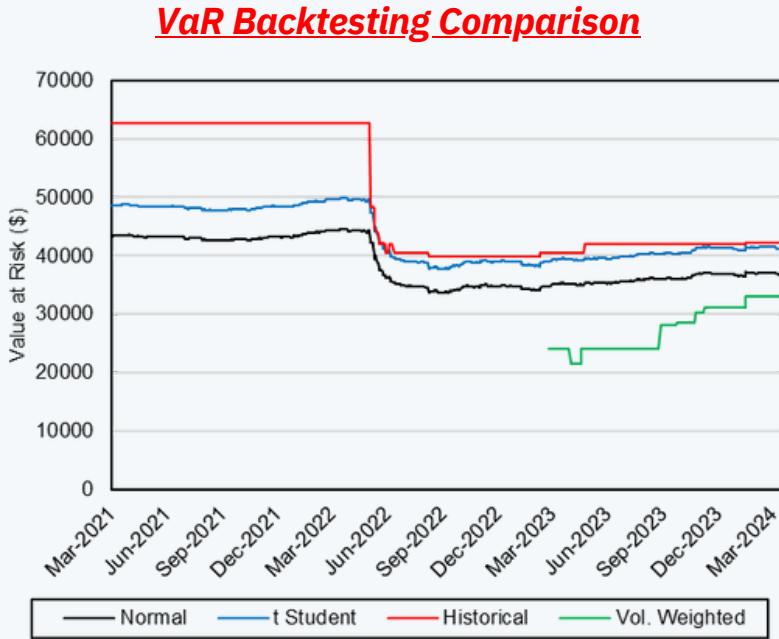




Combined Risk Portfolio

-Pranjal kharbanda

We recommend the parametric Normal LinearVaR/ES measure for the CombinedRisk Portfolio based on the Lopez backtestingmeasure



Lopez Backtest

	Sample Size	Conf Level	QPS
Historical	768	1%	0.035
Volatility-Weighted	268	1%	0.139
Normal	768	1%	0.014
t Student	768	1%	0.035

VaR and ES Estimates

	Equity/Bond	
	VaR	ES
Historical	26013.76	63063.30
Volatility-Weighted	21330.87	31645.86
Normal	38058.12	43695.59
t Student	42827.61	43042.86
Cornish-Fisher	70754.48	-

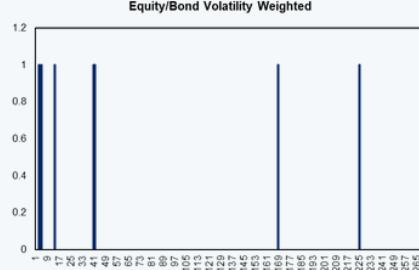
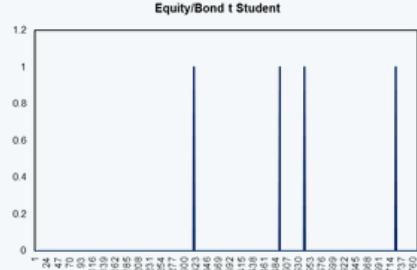
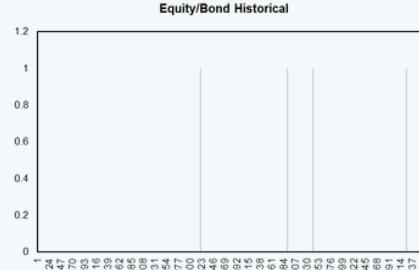
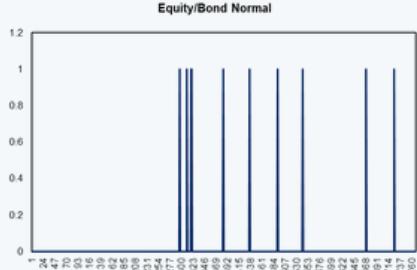
The recommendation is supported by analysing a one-tailed backtest and the frequency and clustering of exceedances



One-tailed Backtests

One-tailed Binomial Test					
	Sample Size	Exceedances	Conf Level	Probability of Exceedance	Test
Equity/Bond					
Historical	768	4	99%	11.82%	Reject
Volatility-Weighted	268	7	99%	99.39%	Reject
Normal	768	10	99%	15.26%	Accept
t Student	768	4	99%	88.18%	Accept

Backtesting-Exceedances





Additional Factors

-Finn Burke

Pertinent Additional Aspects for the Board Risk Committee to Consider



- Inflation expected to fall the future (IMF) Uncertainty of timing of rate cuts
- Increase value of financial assets

- Ukraine-Russia Conflict
- Middle eastern regional conflict
- Volatility would increase VaR

- Market volatility
- Liquidity may decrease akin to covid - 19

Conclusion

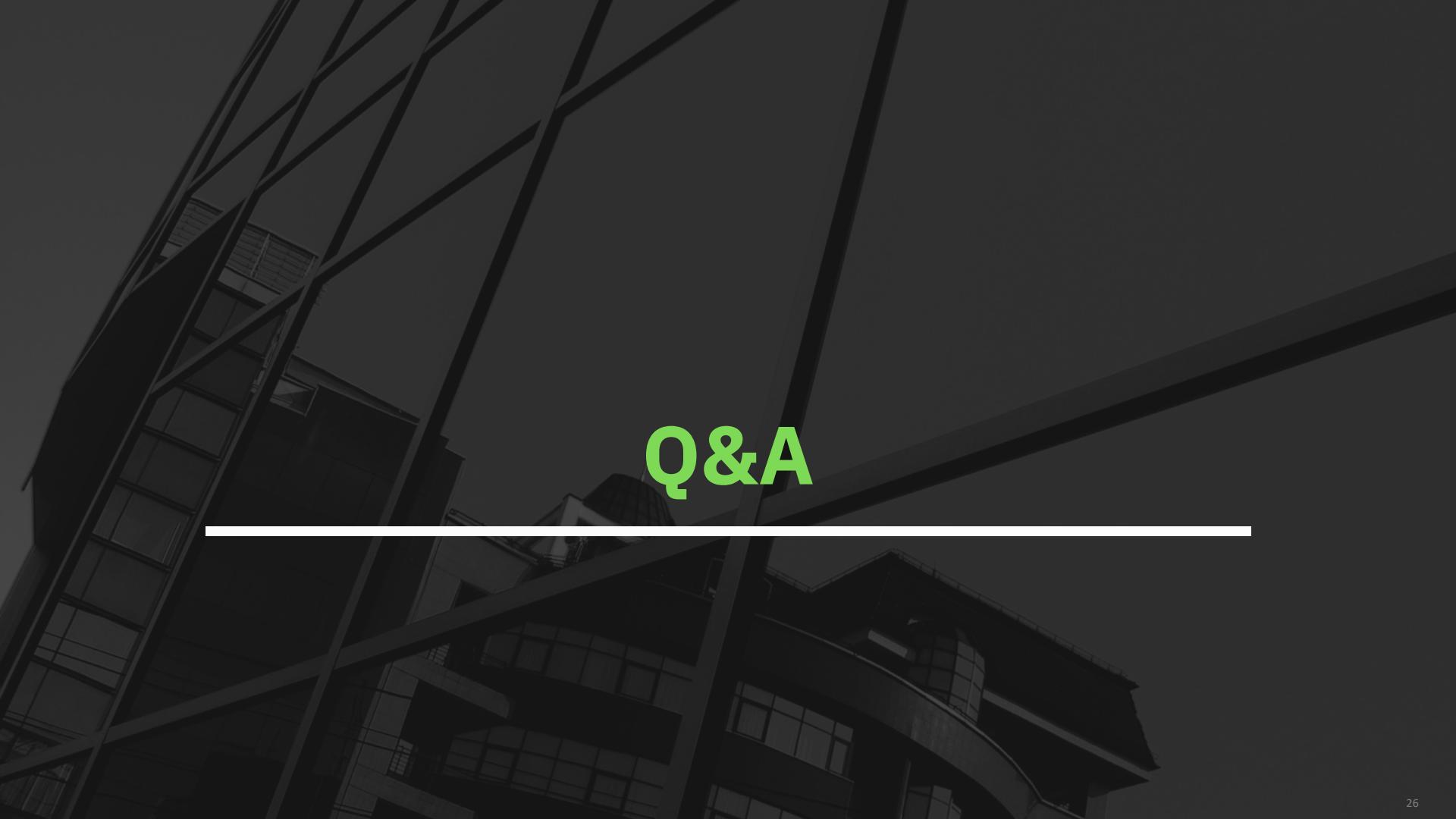
Finn Burke

Recommendation summary and key benefits of chosen risk measures

- **EquityPortfolio:** Normal Var
- **Portfolio:** Normal VaR
- **Combined Risk Portfolio:** Normal Linear VaR

Other Considerations

- Geopolitical tension
- Inflation



Q&A

Appendix

Sensitivity Analysis:

Equity/Bond: Cornish-Fisher Confidence

Sensitivity Analysis	
Confidence	VaR
99%	70754.48261
97.50%	41511.41017
95%	23859.49946

Sensitivity analysis for weights

	60-40 Portfolio	50-50 portfolio	70-30 portfolio
VaR (percentile)	44080.164	37278.11749	49957.958
VaR (Dowd)	44134.090	37433.25184	50200.509
Var (Hull)	44463.719	37518.85636	52406.742
ES (Dowd)	61711.211	51894.96696	71710.489
ES (Hull)	63063.298	53007.40659	73365.103
Min	-100254.987	-84666.27408	-115843.701
Max	109440.255	95205.30108	123675.210

Bond-Volatility-Weighted (Lambda)

Sensitivity Analysis		
Lambda	Var(Dowd)	Var(Hull)
0.94	7023.808345	7059.214362
0.90	5707.98	5711.006797
0.85	5143.272821	5200.084427

Equity-Volatility-Weighted (Lambda)

Sensitivity Analysis		
Lambda	Var(Dowd)	Var(Hull)
0.94	42687.751	46665.14758
0.90	36672.6	38952.69037
0.85	33720.323	34195.96794

Equity/Bond-Volatility- Weighted (Lambda)

Sensitivity Analysis		
Lambda	Var(Dowd)	Var(Hull)
0.94	28090	29232.8519
0.90	24008.4	24248.8815
0.85	20825	21449.5188