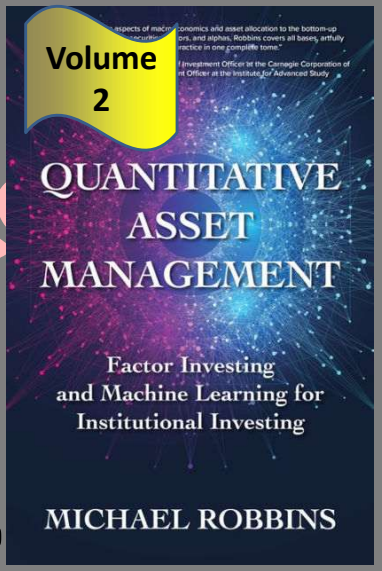
Summer Projects

VINE COPULAS



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Vine Copulas

Vine Copulas

Exercise 18-5: Vine Copula

Problem Statement & Introduction

"Pure" factor portfolios (long/short, dollar-neutral baskets that isolate one characteristic such as Value or Momentum) are built to be mutually uncorrelated in sample, yet their realized returns still show:

- Non-linear spill-overs (e.g., the combined Value + Quality crash of 2020),
- Asymmetric tail dependence (Momentum often rallies in mild sell-offs until a sharp reversal wipes out both Momentum and Low-Volatility), and
- Regime-switching cross-correlations (factors decouple in calm times but cluster in crises).

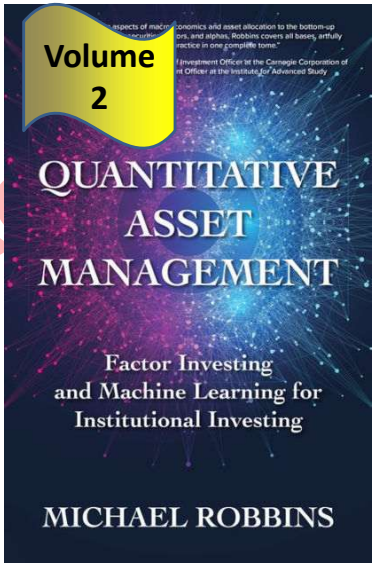
Classical multivariate-normal or linear-beta frameworks cannot capture these subtleties, whereas vine copulas[88] (hierarchical assemblies of bivariatecopulas) model any mix of lower-tail, upper-tail and symmetric dependence, yielding materially better VaR and ES forecasts for factor portfolios.

Key Advantages of Vine Copulas for Pure-Factor Models

- Tail Dependence: Many financial factors exhibit stronger co-movement in extreme markets.
- Asymmetry: You can select Clayton to capture lower-tail clustering, Gumbel for upper tails, or Student's t for symmetric fat tails.
- Dimension Scalability: Instead of fitting one large 10×10 multivariate copula outright, you fit a sequence of bivariate copulas.
- Interpretability: You see which pairs of pure factors have significant tail coupling.

Data
Methods
Discussion
Results & Conclusion
References

[88] Brechmann E. C. & Schepsmeier U. (2013) "Modelling dependence with pair-copula constructions and the VineCopula R-package." Journal of Statistical Software, 52 (3), 1–26.



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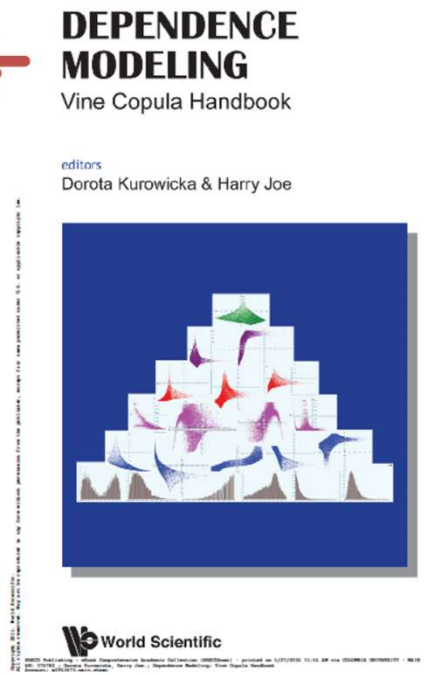
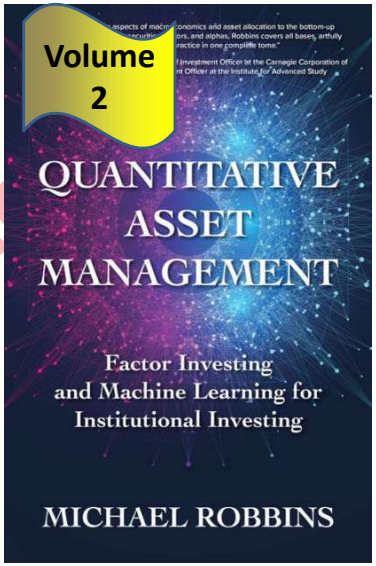
Data Tables



vine1.txt

Vine2.txt



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Appendix 22-2: Asset Class Proxy Data Table [[GT]]

SECTOR	TICKER	NAME
Cash	SBMMTB3 INDEX	3 Month Trea Bill Local
Cash	LD12TRUU INDEX	BarCap 90-Day US Treasury
Commodities	GSG US EQUITY	ISHARES S&P GSCI COMMODITY I
Commodities	SPGCCITR INDEX	S&P GSCI Official Close Index
EM Debt	EMB US EQUITY	ISHARES JP MORGAN USD EMERGI
Emerging Markets	NDUEEGF INDEX	MSCI Daily TR Net Emergii
Emerging Markets	VWO US EQUITY	VANGUARD FTSE EMERGING MARKE
Non-US Developed	EFA US EQUITY	ISHARES MSCI EAFE ETF
Non-US Developed	NDDUEAFE INDEX	MSCI Daily TR Net EAFE &
Non-US Govt Debt	IGOV US EQUITY	ISHARES INTERNATIONAL TREASU
Non-US Govt Debt	SBNNU INDEX	Non-USD WGBI USD
US Asset Backed Securities	LUABTRUU INDEX	BarCap US Agg ABS TR Unhedged USD
US Commercial Mortgages	LCMTRUU INDEX	BarCap US Agg CMBS TR Unhedged USD
US High Yield Debt	HYG US EQUITY	ISHARES IBOXX HIGH YLD CO
US High Yield Debt	JNK US EQUITY	SPDR BBG Barc High YIELD BND
US Investment Grade Debt	LF98TRUU INDEX	US Corporate High Yield
US Investment Grade Debt	LQD US EQUITY	ISHARES IBOXX INVESTMENT GRA
US Investment Grade Debt	LUACTRUU INDEX	BarCap US Agg Credit TR Unhedged USD
US Large-Cap	GDDUUS INDEX	MSCI Daily USA Gross TR
US Large-Cap Growth	MLGUUSA INDEX	MSCI Daily TR Net USA Gr
US Large-Cap Value	MLVUUSA INDEX	MSCI USA Large Value USD
US Long Treasuries	LULTRUU INDEX	BarCap US Aggregate Long Treasury TR Unhedged USD
US Long Treasuries	TLT US EQUITY	ISHARES 20+ YEAR TREASURY BO
US REITs	IYR US EQUITY	ISHARES US REAL ESTATE ETF
US REITs	RMS G INDEX	Gross MSCI US REIT TR Gross
US REITs	RMSG INDEX	MSCI US REIT
US REITs	RMZ INDEX	MSCI US REIT INDEX
US REITs	VNQ US EQUITY	VANGUARD REAL ESTATE ETF
US Residential Mortgages	LUMSTRUU INDEX	BarCap US MBS TR Unhedged USD
US Securitized Debt	LD19TRUU INDEX	BarCap US MBS/ABS/CMBS TR Unhedged USD
US Small-Cap	GCUDUS INDEX	MSCI Daily TR Gross Smal
US Small-Cap	IWM US EQUITY	ISHARES RUSSELL 2000 ETF
US Small-Cap	VB US EQUITY	VANGUARD SMALL-CAP ETF
US TIPs	LBUTTRUU INDEX	BarCap US Treasury Inflation Notes TR Unhedged USD
US TIPs	TIP US EQUITY	ISHARES TIPS BOND ETF

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Overview

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	A	B	C	D	E	F	G	H	I	J	K
1	Start Date	1/1/1990									
2	End Date										
3											
4		SBMMTB3 INDEX	LD12TRUU INDEX	GSG US EQUITY	SPGCCITR INDEX	EMB US EQUITY	NDUEEGF INDEX	VWO US EQUITY	EFA US EQUITY	NDDUEAFE INDEX	IGOV US EQUITY
5		Last Price	Last Price	Last Price	Last Price	Last Price	Last Price	Last Price	Last Price	Last Price	Last Price
6	Dates	PX_LAST	PX_LAST	PX_LAST	PX_LAST	PX_LAST	PX_LAST	PX_LAST	PX_LAST	PX_LAST	PX_LAST
7	6/12/2025			22.38	3771.767	91.49		49.12	90.39		42.5
8	6/11/2025	758.2059	232.99	22.37	3774.491	91.33	652.834	49.11	89.7	9565.982	42.1
9	6/10/2025	758.115	232.97	21.98	3712.067	91.06	648.169	48.95	89.85	9551.282	42.0
10	6/9/2025	758.0242	232.94	22.04	3724.514	90.66	644.126	48.59	89.73	9541.655	41.9
11	6/6/2025	757.7518	232.91	21.98	3711.991	90.43	638.22	48.24	89.74	9513.879	41.9
12	6/5/2025	757.661	232.83	21.76	3677.164	90.57	638.022	48.03	89.42	9544.499	42.0
13	6/4/2025	757.5702	232.8	21.64	3651.069	90.79	632.473	47.91	89.48	9544.304	42.
14	6/3/2025	757.4795	232.77	21.7	3661.412	90.45	624.668	47.44	89.08	9459.121	41.
15	6/2/2025	757.3887	232.74	21.6	3635.558	90.16	622.082	47.33	89.76	9492.098	42.
16	5/30/2025	757.2073	232.71	21.17	3567.079	90.6	623.981	47	88.81	9445.127	41.7
17	5/29/2025	757.0264	232.63	21.26	3586.51	90.6	630.784	47.55	88.68	9441.259	41.
18	5/28/2025	756.936	232.61	21.33	3611.131	90.29	627.315	47.34	88.29	9377.958	41.4
19	5/27/2025	756.8456	232.58	21.41	3608.604	90.48	627.375	47.63	89.32	9450.295	41.7
20	5/26/2025	756.7552	232.55				630.592			9460.604	
21	5/23/2025	756.4842	232.55	21.56	3634.234	89.93	631.02	47.8	88.04	9361.71	41.6
22	5/22/2025	756.3938	232.44	21.39	3620.291	89.84	627.961	47.6	87.92	9344.116	41.2
23	5/21/2025	756.3035	232.42	21.54	3641.369	89.54	632.816	47.71	87.97	9443.035	41.
24	5/20/2025	756.2132	232.39	21.66	3641.455	90.37	628.914	47.83	88.49	9390.805	41.2
25	5/19/2025	756.1229	232.36	21.46	3619.142	90.51	628.476	47.93	88.07	9327.751	41.2
26	5/16/2025	755.852	232.33	21.44	3618.273	90.45	631.501	47.73	87.24	9241.383	40.9
27	5/15/2025	755.7617	232.25	21.47	3614.7	90.28	631.808	47.68	87.04	9229.493	40.9
28	5/14/2025	755.6715	232.22	21.6	3656.695	89.98	631.749	47.76	86.1	9219.128	40.6
29	5/13/2025	755.5812	232.19	21.77	3677.182	90.28	622.568	47.37	86.52	9185.021	40.8

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