



Research article

Hedge asset for stock markets: Cryptocurrency, Cryptocurrency Volatility Index (CVI) or Commodity

**Rubaiyat Ahsan Bhuiyan¹, Tanusree Chakravarty Mukherjee^{2,*}, Kazi Md Tarique³ and
Changyong Zhang²**

¹ School of Business, University of Southampton Malaysia, Johor Bahru, Malaysia

² Faculty of Business, Curtin University Malaysia, Miri, Malaysia

³ School of Business, University of Liberal Arts Bangladesh, Dhaka, Bangladesh

* **Correspondence:** Email: tanusree@curtin.edu.my.

Supplementary

Appendix 1:

Multivariate GARCH with underlying multivariate t-distribution

Converged after 25 iterations

Based on 1663 observations from 29-Jul-16 to 30-Dec-22.

The variables (asset returns) in the multivariate GARCH model are:

FTSIN FTSMY NIFTY FTSE100 SNP500 NUKKIE GOLD

Volatility decay factors unrestricted, same for all variables.

Correlation decay factors unrestricted, same for all variables.

Devolitized Returns based on 20-Period Rolling Historical Volatilities

Parameter	Estimate	Standard Error	T-Ratio [Prob]
lambda1	.91231	.0081724	111.6327[.000]
lambda2	.057216	.0045131	12.6778[.000]
delta1	.98809	.0031567	313.0134[.000]
delta2	.0060374	.0011181	5.3997[.000]
df	7.7070	.39706	19.4098[.000]

Maximized Log-Likelihood = 39797.3

df is the degrees of freedom of the multivariate t distribution

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

	FTSIN	FTSMY	NIFTY	FTSE100	SNP500	NUKKIE
FTSIN	.013388	.37276	.40330	.20889	.19375	.21324
FTSMY	.37276	.39146	.25771	.12383	.36910	.36910
NIFTY	.40330	.39146	.010781	.46183	.30324	.36823
FTSE100	.20889	.25771	.46183	.010147	.54132	.33602
SNP500	.19375	.12383	.30324	.54132	.012136	.22564
NUKKIE	.21324	.36910	.36823	.33602	.22564	.011483
GOLD	.043297	.031836	.060183	.058088	.11348	-.044182

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

	GOLD
FTSIN	.043297
FTSMY	.031836
NIFTY	.060183
FTSE100	.058088
SNP500	.11348
NUKKIE	-.044182
GOLD	.0085866

For the time-varying conditional volatilities and correlations see the Post
Estimation Menu.

Multivariate GARCH with underlying multivariate t-distribution

Converged after 31 iterations

Based on 948 observations from 30-Apr-19 to 30-Dec-22.

The variables (asset returns) in the multivariate GARCH model are:

FTSIN FTSMY NIFTY FTSE100 SNP500 NUKKIE CVI

Volatility decay factors unrestricted, different for each variable.

Correlation decay factors unrestricted, same for all variables.

Devolatized Returns based on 20-Period Rolling Historical Volatilities

Parameter	Estimate	Standard Error	T-Ratio [Prob]
lambda1_FTSIN	.81190	.037687	21.5435[.000]
lambda1_FTSMY	.86718	.041991	20.6517[.000]
lambda1_NIFTY	.88267	.025838	34.1623[.000]
lambda1_FTSE100	.87146	.040274	21.6384[.000]
lambda1_SNP500	.85128	.024059	35.3824[.000]
lambda1_NUKKIE	.89941	.029693	30.2904[.000]
lambda1_CVI	.56270	.081281	6.9229[.000]
lambda2_FTSIN	.14666	.026705	5.4917[.000]
lambda2_FTSMY	.061162	.016546	3.6964[.000]
lambda2_NIFTY	.093746	.018692	5.0152[.000]
lambda2_FTSE100	.096085	.027584	3.4834[.001]
lambda2_SNP500	.12246	.018741	6.5347[.000]
lambda2_NUKKIE	.052030	.012897	4.0342[.000]
lambda2_CVI	.30633	.050536	6.0616[.000]
delta1	.99244	.0012609	787.0819[.000]
delta2	.0056950	.8601E-3	6.6216[.000]
df	6.6462	.41667	15.9509[.000]

Maximized Log-Likelihood = 20128.5

df is the degrees of freedom of the multivariate t distribution

Estimated Unconditional Volatility Matrix

948 observations used for estimation from 30-Apr-19 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

	FTSIN	FTSMY	NIFTY	FTSE100	SNP500	NUKKIE
FTSIN	.015188	.37100	.42499	.22969	.22094	.24237
FTSMY	.37100	.0082502	.41720	.26826	.14083	.38197
NIFTY	.42499	.41720	.012897	.49880	.33416	.39179
FTSE100	.20889	.25771	.46183	.010147	.54132	.33602
SNP500	.22094	.14083	.33416	.58166	.014623	.24948
NUKKIE	.24237	.38197	.39179	.37771	.24948	.012421
CVI	-.10024	-.089505	-.12004	-.017191	-.083099	-.050157

Estimated Unconditional Volatility Matrix

948 observations used for estimation from 30-Apr-19 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

CVI

FTSIN	-.10024
FTSMY	-.089505
NIFTY	-.12004
FTSE100	-.017191
SNP500	-.083099
NUKKIE	-.050157
CVI	.058652

For the time-varying conditional volatilities and correlations see the Post
Estimation Menu.

Multivariate GARCH with underlying multivariate t-distribution

Converged after 28 iterations

Based on 1663 observations from 29-Jul-16 to 30-Dec-22.

The variables (asset returns) in the multivariate GARCH model are:

FTSIN FTSMY NIFTY FTSE100 SNP500 NUKKIE BTC

Volatility decay factors unrestricted, different for each variable.

Correlation decay factors unrestricted, same for all variables.

Devolatized Returns based on 20-Period Rolling Historical Volatilities

Parameter	Estimate	Standard Error	T-Ratio [Prob]
lambda1_FTSIN	.88482	.021525	41.1062[.000]
lambda1_FTSMY	.94710	.012559	75.4106[.000]
lambda1_NIFTY	.91865	.014299	64.2448[.000]
lambda1_FTSE100	.94897	.012057	78.7045[.000]
lambda1_SNP500	.87978	.016554	53.1467[.000]
lambda1_NUKKIE	.90300	.023617	38.2348[.000]
lambda1_BTC	.90868	.020496	44.3349[.000]
lambda2_FTSIN	.083107	.013582	6.1189[.000]
lambda2_FTSMY	.035251	.0072557	4.8584[.000]
lambda2_NIFTY	.050871	.0082435	6.1710[.000]
lambda2_FTSE100	.034695	.0068785	5.0440[.000]
lambda2_SNP500	.087127	.010965	7.9458[.000]
lambda2_NUKKIE	.064257	.012909	4.9775[.000]
lambda2_BTC	.072892	.013888	5.2486[.000]
delta1	.99081	.0020327	487.4407[.000]
delta2	.0054200	.8673E-3	6.2493[.000]

df 7.3064 .36494 20.0208[.000]

Maximized Log-Likelihood = 37063.9

df is the degrees of freedom of the multivariate t distribution

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

	FTSIN	FTSMY	NIFTY	FTSE100	SNP500	NUKKIE
FTSIN	.013388	.37276	.40330	.20889	.19375	.21324
FTSMY	.37276	.0070568	.39146	.25771	.12383	.36910
NIFTY	.40330	.39146	.010781	.46183	.30324	.36823
FTSE100	.20889	.25771	.46183	.010147	.54132	.33602
SNP500	.19375	.12383	.30324	.54132	.012136	.22564
NUKKIE	.21324	.36910	.36823	.33602	.22564	.011483
BTC	.038909	.026714	.084877	.16621	.24107	.049393

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

BTC

FTSIN	.038909
FTSMY	.026714
NIFTY	.084877
FTSE100	.16621
SNP500	.24107
NUKKIE	.049393
BTC	.046480

For the time-varying conditional volatilities and correlations see the Post

Estimation Menu.

Multivariate GARCH with underlying multivariate t-distribution

Converged after 28 iterations

Based on 1663 observations from 29-Jul-16 to 30-Dec-22.

The variables (asset returns) in the multivariate GARCH model are:

FTSIN FTSMY NIFTY FTSE100 SNP500 NUKKIE ETH

Volatility decay factors unrestricted, different for each variable.

Correlation decay factors unrestricted, same for all variables.

Devolatized Returns based on 20-Period Rolling Historical Volatilities

Parameter	Estimate	Standard Error	T-Ratio [Prob]
lambda1_FTSIN	.89442	.019767	45.2484[.000]
lambda1_FTSMY	.94766	.012374	76.5838[.000]
lambda1_NIFTY	.91951	.014178	64.8567[.000]
lambda1_FTSE100	.94417	.014112	66.9042[.000]
lambda1_SNP500	.87474	.017179	50.9190[.000]
lambda1_NUKKIE	.89821	.024559	36.5741[.000]
lambda1_ETH	.84117	.037141	22.6480[.000]
lambda2_FTSIN	.075140	.012319	6.0997[.000]
lambda2_FTSMY	.034408	.0071022	4.8447[.000]
lambda2_NIFTY	.050616	.0083696	6.0476[.000]
lambda2_FTSE100	.037294	.0078448	4.7540[.000]
lambda2_SNP500	.089340	.011341	7.8773[.000]
lambda2_NUKKIE	.065034	.013065	4.9775[.000]
lambda2_ETH	.10965	.022224	4.9338[.000]
delta1	.98919	.0024267	407.6237[.000]
delta2	.0059919	.9716E-3	6.1669[.000]

df	7.3718	.37425	19.6975[.000]
----	--------	--------	---------------

Maximized Log-Likelihood = 36470.8

df is the degrees of freedom of the multivariate t distribution

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

	FTSIN	FTSMY	NIFTY	FTSE100	SNP500	NUKKIE
FTSIN	.013388	.37276	.40330	.20889	.19375	.21324
FTSMY	.37276	.0070568	.39146	.25771	.12383	.36910
NIFTY	.40330	.39146	.010781	.46183	.30324	.36823
FTSE100	.20889	.25771	.46183	.010147	.54132	.33602
SNP500	.19375	.12383	.30324	.54132	.012136	.22564
NUKKIE	.21324	.36910	.36823	.33602	.22564	.011483
ETH	.036535	.066611	.12694	.12131	.10520	.075543

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

ETH

FTSIN	.036535
FTSMY	.066611
NIFTY	.12694
FTSE100	.12131
SNP500	.10520
NUKKIE	.075543
ETH	.065331

For the time-varying conditional volatilities and correlations see the Post
Estimation Menu.

25/1/2023

3:08:57 PM

Multivariate GARCH with underlying multivariate t-distribution

Converged after 24 iterations

Based on 1663 observations from 29-Jul-16 to 30-Dec-22.

The variables (asset returns) in the multivariate GARCH model are:

FTSIN FTSMY NIFTY FTSE100 SNP500 NUKKIE WTI

Volatility decay factors unrestricted, different for each variable.

Correlation decay factors unrestricted, same for all variables.

Devolitized Returns based on 20-Period Rolling Historical Volatilities

Parameter	Estimate	Standard Error	T-Ratio [Prob]
lambda1_FTSIN	.89592	.020107	44.5578[.000]
lambda1_FTSMY	.95273	.011202	85.0496[.000]
lambda1_NIFTY	.92311	.013819	66.7990[.000]
lambda1_FTSE100	.95189	.010946	86.9626[.000]
lambda1_SNP500	.88132	.016991	51.8700[.000]
lambda1_NUKKIE	.90993	.023444	38.8134[.000]
lambda1_WTI	.88020	.012628	69.7021[.000]
lambda2_FTSIN	.074870	.012646	5.9206[.000]
lambda2_FTSMY	.030961	.0065152	4.7520[.000]
lambda2_NIFTY	.047810	.0078679	6.0765[.000]
lambda2_FTSE100	.032273	.0061966	5.2082[.000]
lambda2_SNP500	.083594	.011055	7.5613[.000]
lambda2_NUKKIE	.057465	.012305	4.6702[.000]
lambda2_WTI	.10219	.010285	9.9358[.000]
delta1	.98838	.0025825	382.7203[.000]
delta2	.0063694	.0010087	6.3146[.000]

df	7.5723	.39536	19.1527[.000]
----	--------	--------	---------------

Maximized Log-Likelihood = 38061.6

df is the degrees of freedom of the multivariate t distribution

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

	FTSIN	FTSMY	NIFTY	FTSE100	SNP500	NUKKIE
FTSIN	.013388	.37276	.40330	.20889	.19375	.21324
FTSMY	.37276	.0070568	.39146	.25771	.12383	.36910
NIFTY	.40330	.39146	.010781	.46183	.30324	.36823
FTSE100	.20889	.25771	.46183	.010147	.54132	.33602
SNP500	.19375	.12383	.30324	.54132	.012136	.22564
NUKKIE	.21324	.36910	.36823	.33602	.22564	.011483
WTI	-.0044045	-.030930	-.080488	-.0019750	.061218	.037390

Estimated Unconditional Volatility Matrix

1663 observations used for estimation from 29-Jul-16 to 30-Dec-22

Unconditional Volatilities (Standard Errors) on the Diagonal Elements

Unconditional Correlations on the Off-Diagonal Elements

WTI

FTSIN	-.0044045
FTSMY	-.030930
NIFTY	-.080488
FTSE100	-.0019750
SNP500	.061218
NUKKIE	.037390
WTI	.038039

For the time-varying conditional volatilities and correlations see the Post

Estimation Menu.



AIMS Press

© 2025 the Author(s), licensee AIMS Press. This is an open access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0>)