Engineered Feature EDA

Tickers: USO, UNG, UGA

- Schema & Missingness
- Numeric Quality & Ranges
- Numeric Overview
- Correlation Heatmap
- Price Trend & Volatility
- Log-Return Distribution
- Cross-Ticker Price Overlay
- Cross-Ticker Return Correlation

UGA • Schema & Missingness

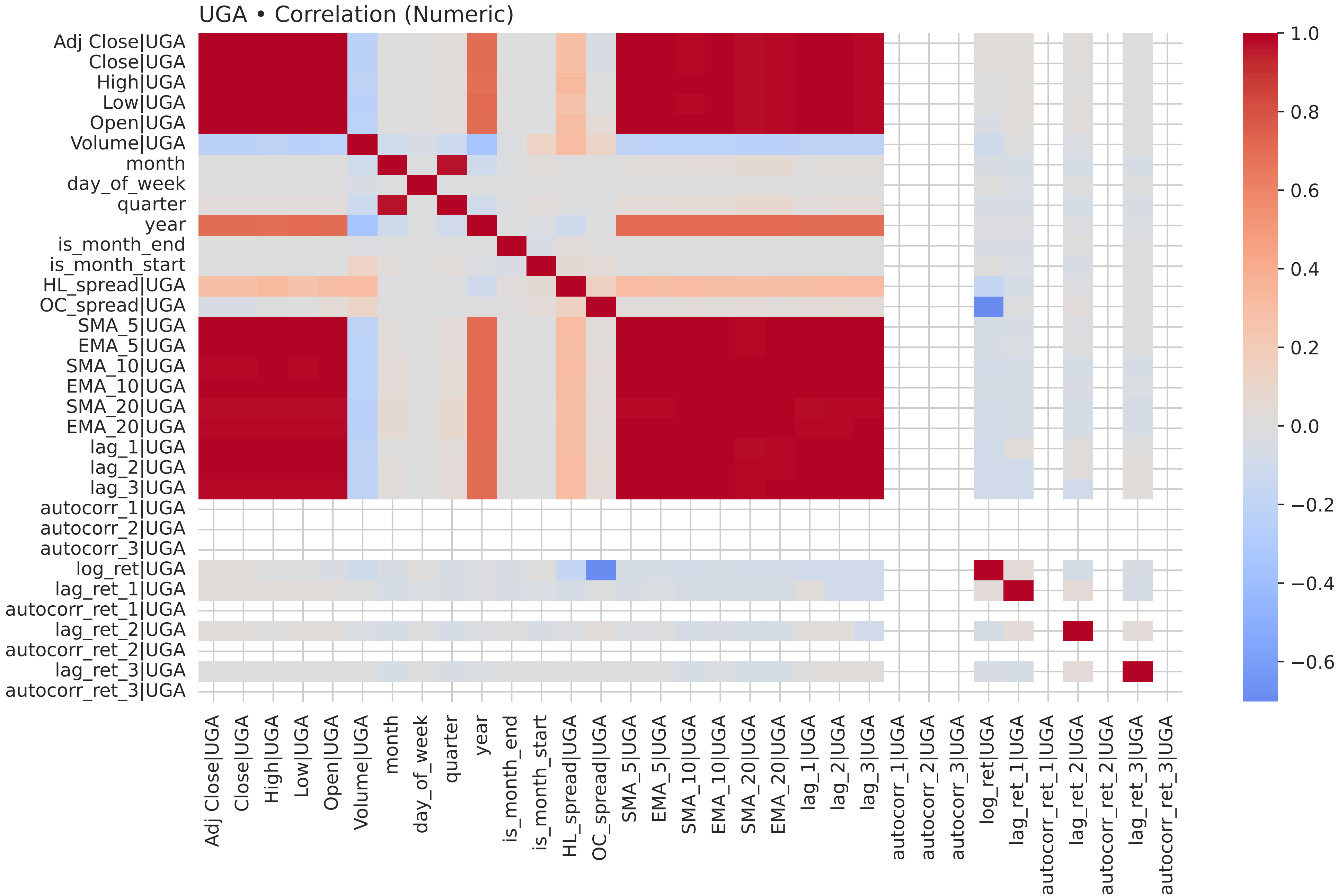
Column	dtype	non_null	missing	missing_%	unique	sample
Adj Close|UGA	float64	1255	0	0.0	980	28.88
Close|UGA	float64	1255	0	0.0	980	28.88
High|UGA	float64	1255	0	0.0	978	28.91
Low|UGA	float64	1255	0	0.0	989	28.56
Open|UGA	float64	1255	0	0.0	994	28.63
Volume|UGA	int64	1255	0	0.0	692	44900.0
month	int32	1255	0	0.0	12	2.0
day_of_week	int32	1255	0	0.0	5	0.0
quarter	int32	1255	0	0.0	4	1.0
year	int32	1255	0	0.0	6	2021.0
is_month_end	int64	1255	0	0.0	2	0.0
is_month_start	int64	1255	0	0.0	2	0.0
HL_spread|UGA	float64	1255	0	0.0	721	0.35
OC_spread|UGA	float64	1255	0	0.0	843	-0.25
SMA_5|UGA	float64	1255	0	0.0	1232	28.88
EMA_5|UGA	float64	1255	0	0.0	1255	28.88
SMA_10|UGA	float64	1255	0	0.0	1245	28.88
EMA_10|UGA	float64	1255	0	0.0	1255	28.88
SMA_20|UGA	float64	1255	0	0.0	1250	28.88
EMA_20|UGA	float64	1255	0	0.0	1255	28.88
lag_1|UGA	float64	1254	1	0.08	979	28.88
lag_2|UGA	float64	1253	2	0.16	978	28.88
lag_3|UGA	float64	1252	3	0.24	977	28.88
autocorr_1|UGA	float64	1255	0	0.0	1	0.9945
autocorr_2|UGA	float64	1255	0	0.0	1	0.9887
autocorr_3|UGA	float64	1255	0	0.0	1	0.9833
log_ret|UGA	float64	1254	1	0.08	1247	-0.0042
lag_ret_1|UGA	float64	1253	2	0.16	1246	-0.0042
autocorr_ret_1|UGA	float64	1255	0	0.0	1	0.0301
lag_ret_2|UGA	float64	1252	3	0.24	1245	-0.0042
autocorr_ret_2|UGA	float64	1255	0	0.0	1	-0.0527
lag_ret_3|UGA	float64	1251	4	0.32	1244	-0.0042
autocorr_ret_3|UGA	float64	1255	0	0.0	1	-0.0424

UGA • Numeric Quality & Ranges

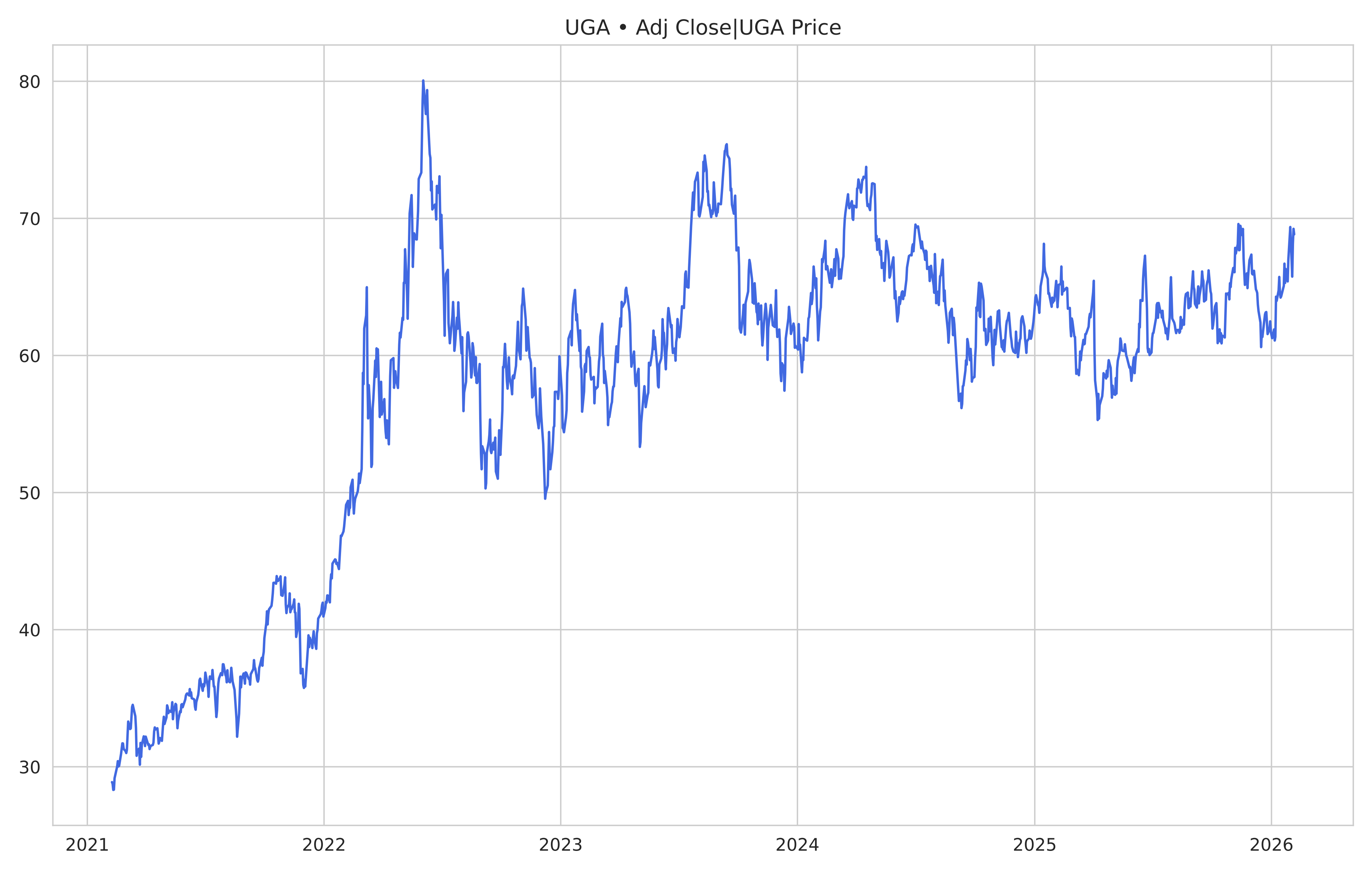
Column	non_null	missing	missing_%	zeros	negatives	min	p01	q1	median	mean	q3	p99	max	std
dj Close|UGA	1255	0	0.0	0	0	28.31	30.9724	54.88	61.23	57.553	64.68	74.6522	80.06	11.4829
Close|UGA	1255	0	0.0	0	0	28.31	30.9724	54.88	61.23	57.553	64.68	74.6522	80.06	11.4829
High|UGA	1255	0	0.0	0	0	28.63	31.3754	55.715	61.75	58.1118	65.245	75.3738	80.29	11.5829
Low|UGA	1255	0	0.0	0	0	28.3	30.5224	54.05	60.64	56.9414	64.22	73.8284	79.12	11.3827
Open|UGA	1255	0	0.0	0	0	28.54	30.9094	54.99	61.18	57.5404	64.69	74.8106	79.31	11.4877
Volume|UGA	1255	0	0.0	0	0	1700.0	4654.0	16350.0	30800.0	48053.5171	57000.0	277028.0	570500.0	56109.4825
month	1255	0	0.0	0	0	1.0	1.0	4.0	7.0	6.5538	10.0	12.0	12.0	3.432
day_of_week	1255	0	0.0	233	0	0.0	0.0	1.0	2.0	2.0247	3.0	4.0	4.0	1.399
quarter	1255	0	0.0	0	0	1.0	1.0	2.0	3.0	2.5171	4.0	4.0	4.0	1.1158
year	1255	0	0.0	0	0	2021.0	2021.0	2022.0	2023.0	2023.0932	2024.0	2026.0	2026.0	1.4455
s_month_end	1255	0	0.0	1213	0	0.0	0.0	0.0	0.0	0.0335	0.0	1.0	1.0	0.1799
_month_start	1255	0	0.0	1216	0	0.0	0.0	0.0	0.0	0.0311	0.0	1.0	1.0	0.1736
_spread|UGA	1255	0	0.0	0	0	0.22	0.3	0.69	1.02	1.1704	1.48	3.516	7.67	0.6951
_spread|UGA	1255	0	0.0	4	656	-3.23	-2.21	-0.51	-0.04	-0.0126	0.455	2.4738	4.47	0.8805
SMA_5|UGA	1255	0	0.0	0	0	28.57	31.0306	55.204	61.174	57.4897	64.623	74.4452	78.782	11.481
EMA_5|UGA	1255	0	0.0	0	0	28.5522	31.1552	55.4282	61.2372	57.4901	64.5562	74.3527	78.2683	11.4593
SMA_10|UGA	1255	0	0.0	0	0	28.57	30.5304	55.733	61.334	57.4118	64.455	74.016	77.491	11.4935
EMA_10|UGA	1255	0	0.0	0	0	28.6806	30.6707	55.5966	61.2977	57.414	64.4482	73.7861	76.6472	11.4574
SMA_20|UGA	1255	0	0.0	0	0	28.57	30.0243	55.0765	61.2115	57.2652	64.427	73.4911	74.6305	11.5347
EMA_20|UGA	1255	0	0.0	0	0	28.7691	30.04	55.4006	61.2982	57.2682	64.3936	72.7642	73.7765	11.4727
lag_1|UGA	1254	1	0.08	0	0	28.31	30.9718	54.86	61.23	57.544	64.68	74.6529	80.06	11.4831
lag_2|UGA	1253	2	0.16	0	0	28.31	30.9712	54.84	61.23	57.5347	64.68	74.6536	80.06	11.4829
lag_3|UGA	1252	3	0.24	0	0	28.31	30.9706	54.82	61.225	57.5262	64.6725	74.6543	80.06	11.4836
tocorr_1|UGA	1255	0	0.0	0	0	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.0
tocorr_2|UGA	1255	0	0.0	0	0	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887	0.0
tocorr_3|UGA	1255	0	0.0	0	0	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833	0.0
log_ret|UGA	1254	1	0.08	8	565	-0.1204	-0.0547	-0.0118	0.0019	0.0007	0.0139	0.0467	0.0756	0.0208
g_ret_1|UGA	1253	2	0.16	8	564	-0.1204	-0.0548	-0.0118	0.0019	0.0007	0.0139	0.0467	0.0756	0.0208
rr_ret_1|UGA	1255	0	0.0	0	0	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301	0.0
g_ret_2|UGA	1252	3	0.24	8	564	-0.1204	-0.0548	-0.0118	0.0019	0.0007	0.0139	0.0467	0.0756	0.0208
rr_ret_2|UGA	1255	0	0.0	0	1255	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	0.0
g_ret_3|UGA	1251	4	0.32	8	564	-0.1204	-0.0548	-0.0118	0.0019	0.0007	0.0138	0.0467	0.0756	0.0208
rr_ret_3|UGA	1255	0	0.0	0	1255	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	0.0

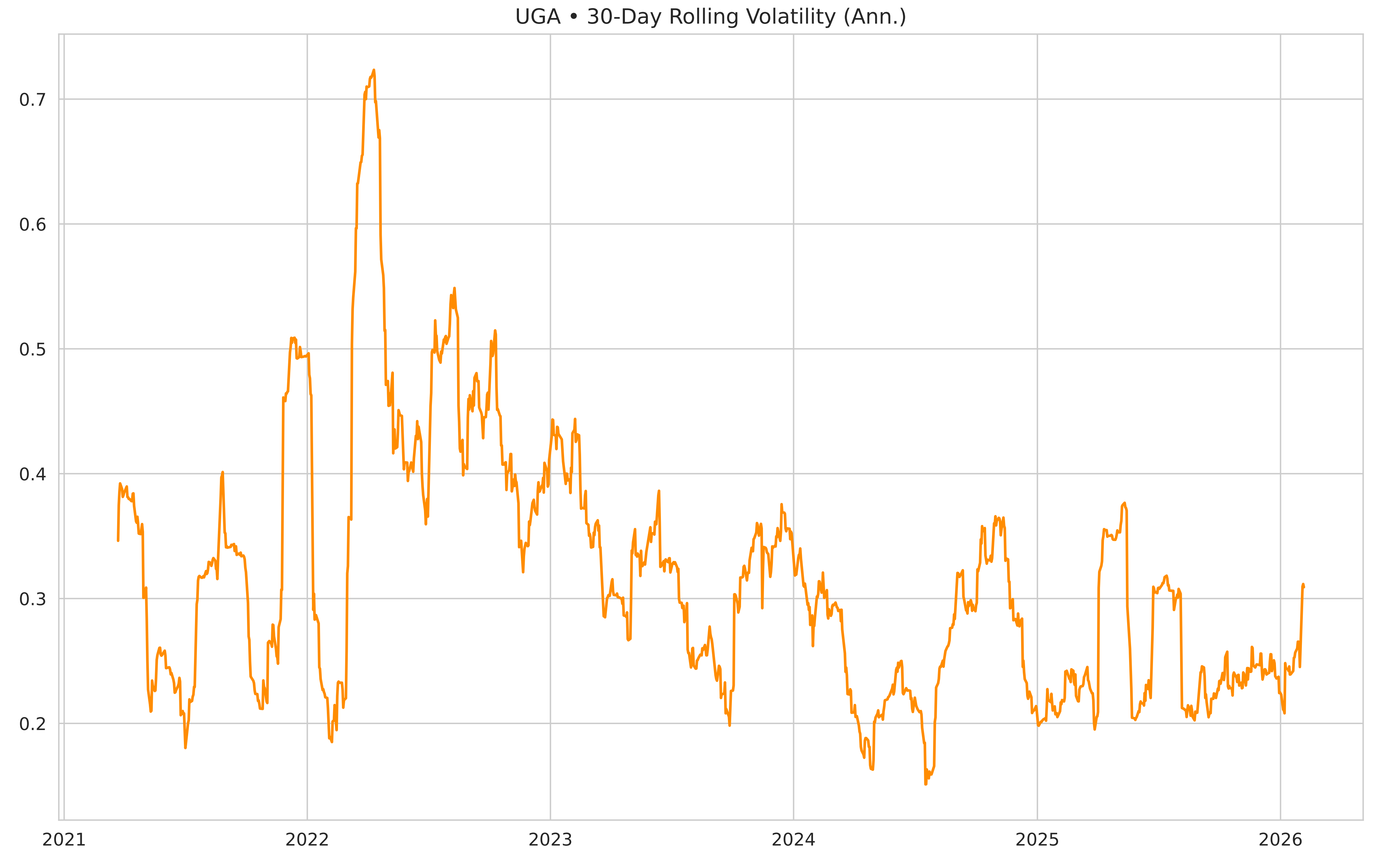
UGA • Numeric Overview

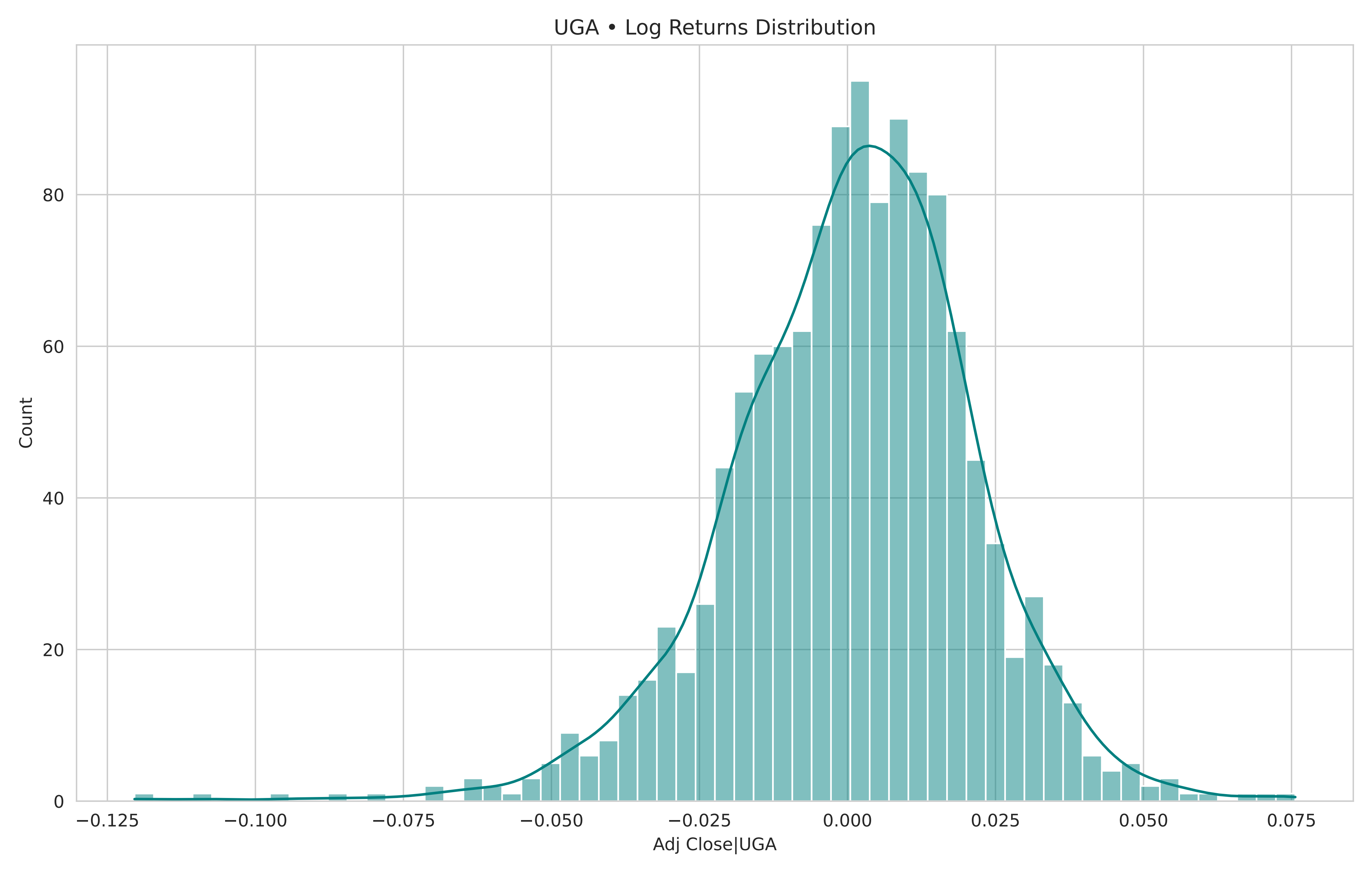
Variable	count	mean	std	min	1%	5%	25%	50%	75%	95%	99%	max
Adj Close|UGA	1255.0	57.553	11.4829	28.31	30.9724	33.823	54.88	61.23	64.68	71.387	74.6522	80.06
Close|UGA	1255.0	57.553	11.4829	28.31	30.9724	33.823	54.88	61.23	64.68	71.387	74.6522	80.06
High|UGA	1255.0	58.1118	11.5829	28.63	31.3754	34.037	55.715	61.75	65.245	72.225	75.3738	80.29
Low|UGA	1255.0	56.9414	11.3827	28.3	30.5224	33.421	54.05	60.64	64.22	70.639	73.8284	79.12
Open|UGA	1255.0	57.5404	11.4877	28.54	30.9094	33.609	54.99	61.18	64.69	71.326	74.8106	79.31
Volume|UGA	1255.0	48053.5171	56109.4825	1700.0	4654.0	7600.0	16350.0	30800.0	57000.0	148020.0	277028.0	570500.0
month	1255.0	6.5538	3.432	1.0	1.0	1.0	4.0	7.0	10.0	12.0	12.0	12.0
day_of_week	1255.0	2.0247	1.399	0.0	0.0	0.0	1.0	2.0	3.0	4.0	4.0	4.0
quarter	1255.0	2.5171	1.1158	1.0	1.0	1.0	2.0	3.0	4.0	4.0	4.0	4.0
year	1255.0	2023.0932	1.4455	2021.0	2021.0	2021.0	2022.0	2023.0	2024.0	2025.0	2026.0	2026.0
is_month_end	1255.0	0.0335	0.1799	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
s_month_start	1255.0	0.0311	0.1736	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
IL_spread|UGA	1255.0	1.1704	0.6951	0.22	0.3	0.407	0.69	1.02	1.48	2.483	3.516	7.67
C_spread|UGA	1255.0	-0.0126	0.8805	-3.23	-2.21	-1.333	-0.51	-0.04	0.455	1.433	2.4738	4.47
SMA_5|UGA	1255.0	57.4897	11.481	28.57	31.0306	33.8096	55.204	61.174	64.623	71.2704	74.4452	78.782
EMA_5|UGA	1255.0	57.4901	11.4593	28.5522	31.1552	33.8014	55.4282	61.2372	64.5562	71.4735	74.3527	78.2683
SMA_10|UGA	1255.0	57.4118	11.4935	28.57	30.5304	33.6387	55.733	61.334	64.455	71.4834	74.016	77.491
EMA_10|UGA	1255.0	57.414	11.4574	28.6806	30.6707	33.6325	55.5966	61.2977	64.4482	71.3253	73.7861	76.6472
SMA_20|UGA	1255.0	57.2652	11.5347	28.57	30.0243	32.9453	55.0765	61.2115	64.427	71.5188	73.4911	74.6305
EMA_20|UGA	1255.0	57.2682	11.4727	28.7691	30.04	33.1225	55.4006	61.2982	64.3936	70.9282	72.7642	73.7765
lag_1|UGA	1254.0	57.544	11.4831	28.31	30.9718	33.8135	54.86	61.23	64.68	71.3915	74.6529	80.06
lag_2|UGA	1253.0	57.5347	11.4829	28.31	30.9712	33.804	54.84	61.23	64.68	71.396	74.6536	80.06
lag_3|UGA	1252.0	57.5262	11.4836	28.31	30.9706	33.7945	54.82	61.225	64.6725	71.4005	74.6543	80.06
utocorr_1|UGA	1255.0	0.9945	0.0	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945
utocorr_2|UGA	1255.0	0.9887	0.0	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887	0.9887
utocorr_3|UGA	1255.0	0.9833	0.0	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833	0.9833
log_ret|UGA	1254.0	0.0007	0.0208	-0.1204	-0.0547	-0.0343	-0.0118	0.0019	0.0139	0.0321	0.0467	0.0756
lag_ret_1|UGA	1253.0	0.0007	0.0208	-0.1204	-0.0548	-0.0343	-0.0118	0.0019	0.0139	0.0321	0.0467	0.0756
corr_ret_1|UGA	1255.0	0.0301	0.0	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301	0.0301
lag_ret_2|UGA	1252.0	0.0007	0.0208	-0.1204	-0.0548	-0.0343	-0.0118	0.0019	0.0139	0.0321	0.0467	0.0756
corr_ret_2|UGA	1255.0	-0.0527	0.0	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527	-0.0527
lag_ret_3|UGA	1251.0	0.0007	0.0208	-0.1204	-0.0548	-0.0343	-0.0118	0.0019	0.0138	0.032	0.0467	0.0756
corr_ret_3|UGA	1255.0	-0.0424	0.0	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424	-0.0424



UGA • Correlation (Numeric)
Adj Close|UGA
Close|UGA
High|UGA
Low|UGA
Open|UGA
Volume|UGA
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|UGA
OC_spread|UGA
SMA_5|UGA
EMA_5|UGA
SMA_10|UGA
EMA_10|UGA
SMA_20|UGA
EMA_20|UGA
lag_1|UGA
lag_2|UGA
lag_3|UGA
autocorr_1|UGA
autocorr_2|UGA
autocorr_3|UGA
log_ret|UGA
lag_ret_1|UGA
autocorr_ret_1|UGA
lag_ret_2|UGA
autocorr_ret_2|UGA
lag_ret_3|UGA
autocorr_ret_3|UGA
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6


UGA • Adj Close|UGA Price
80
70
60
50
40
30
2021
2022
2023
2024
2025
2026


UGA • 30-Day Rolling Volatility (Ann.)
0.7
0.6
0.5
0.4
0.3
0.2
2021
2022
2023
2024
2025
2026



UGA • Log Returns Distribution
Count
0
20
40
60
80
−0.125
−0.100
−0.075
−0.050
−0.025
0.000
0.025
0.050
0.075
Adj Close|UGA

UNG • Schema & Missingness

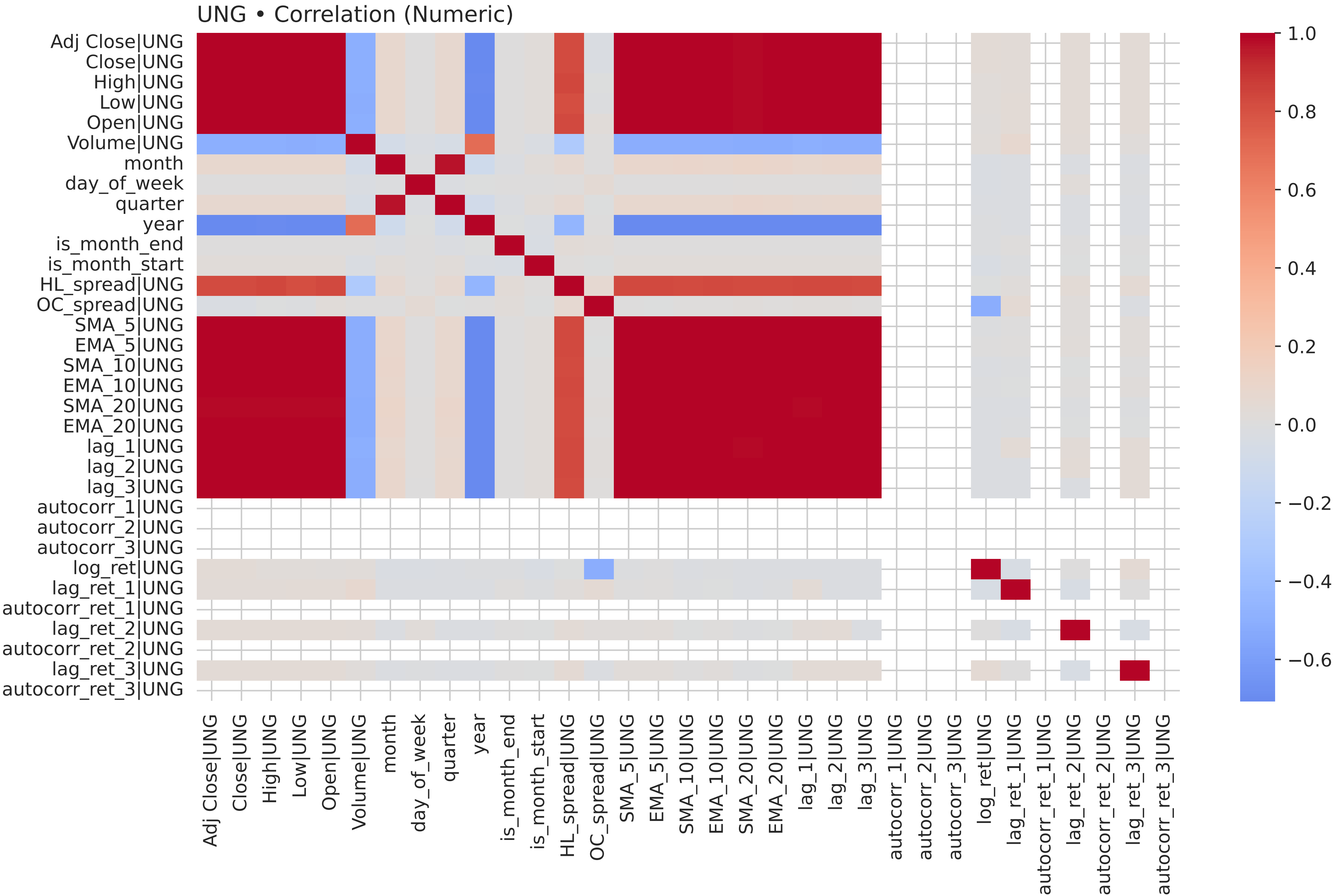
Column	dtype	non_null	missing	missing_%	unique	sample
Adj Close|UNG	float64	1255	0	0.0	1001	42.36
Close|UNG	float64	1255	0	0.0	1001	42.36
High|UNG	float64	1255	0	0.0	969	42.56
Low|UNG	float64	1255	0	0.0	996	41.68
Open|UNG	float64	1255	0	0.0	978	42.32
Volume|UNG	int64	1255	0	0.0	1250	1178350.0
month	int32	1255	0	0.0	12	2.0
day_of_week	int32	1255	0	0.0	5	0.0
quarter	int32	1255	0	0.0	4	1.0
year	int32	1255	0	0.0	6	2021.0
is_month_end	int64	1255	0	0.0	2	0.0
is_month_start	int64	1255	0	0.0	2	0.0
HL_spread|UNG	float64	1255	0	0.0	723	0.88
OC_spread|UNG	float64	1255	0	0.0	808	-0.04
SMA_5|UNG	float64	1255	0	0.0	1231	42.36
EMA_5|UNG	float64	1255	0	0.0	1255	42.36
SMA_10|UNG	float64	1255	0	0.0	1240	42.36
EMA_10|UNG	float64	1255	0	0.0	1255	42.36
SMA_20|UNG	float64	1255	0	0.0	1247	42.36
EMA_20|UNG	float64	1255	0	0.0	1255	42.36
lag_1|UNG	float64	1254	1	0.08	1000	42.36
lag_2|UNG	float64	1253	2	0.16	1000	42.36
lag_3|UNG	float64	1252	3	0.24	999	42.36
autocorr_1|UNG	float64	1255	0	0.0	1	0.9972
autocorr_2|UNG	float64	1255	0	0.0	1	0.9945
autocorr_3|UNG	float64	1255	0	0.0	1	0.9917
log_ret|UNG	float64	1254	1	0.08	1243	-0.0268
lag_ret_1|UNG	float64	1253	2	0.16	1242	-0.0268
autocorr_ret_1|UNG	float64	1255	0	0.0	1	-0.0407
lag_ret_2|UNG	float64	1252	3	0.24	1241	-0.0268
autocorr_ret_2|UNG	float64	1255	0	0.0	1	0.0039
lag_ret_3|UNG	float64	1251	4	0.32	1240	-0.0268
autocorr_ret_3|UNG	float64	1255	0	0.0	1	0.0501

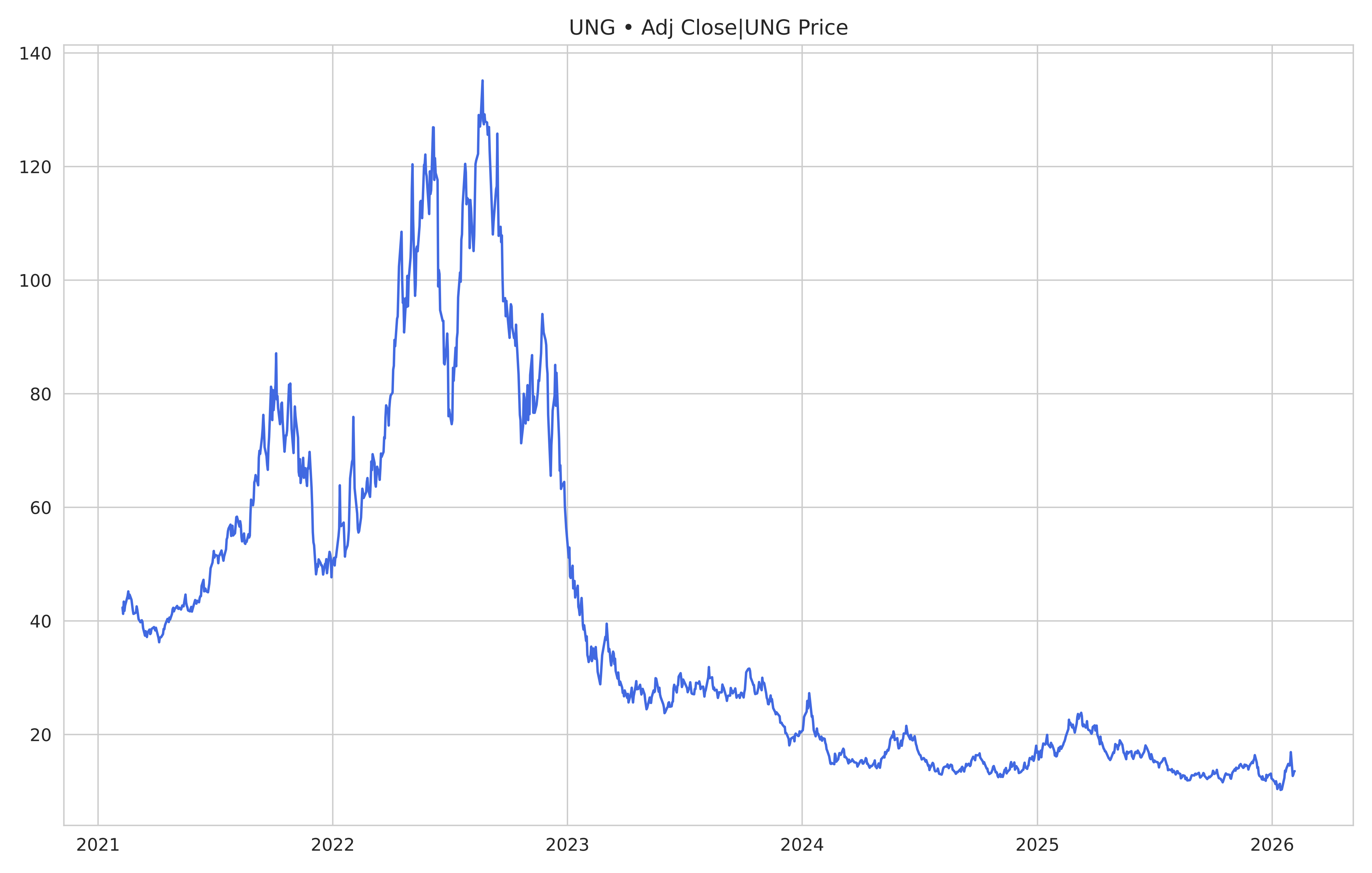
UNG • Numeric Quality & Ranges

Column	non_null	missing	missing_%	zeros	negatives	min	p01	q1	median	mean	q3	p99	max	std
dj Close|UNG	1255	0	0.0	0	0	10.24	11.8754	15.805	27.44	39.9259	56.06	126.7288	135.16	30.3388
Close|UNG	1255	0	0.0	0	0	10.24	11.8754	15.805	27.44	39.9259	56.06	126.7288	135.16	30.3388
High|UNG	1255	0	0.0	0	0	10.37	11.9708	16.09	28.0	40.7764	57.02	128.2304	138.0	31.1313
Low|UNG	1255	0	0.0	0	0	9.95	11.644	15.62	27.04	39.0499	55.38	122.4736	130.2	29.4811
Open|UNG	1255	0	0.0	0	0	10.2	11.7878	15.965	27.48	39.9227	56.0	125.6608	136.2	30.3323
Volume|UNG	1255	0	0.0	0	0	223850.0	329124.5	1867262.5	4602600[illegible]	[illegible]650487.612	7300600.0	27964448.0	5462330[illegible]	[illegible]1863.6822
month	1255	0	0.0	0	0	1.0	1.0	4.0	7.0	6.5538	10.0	12.0	12.0	3.432
day_of_week	1255	0	0.0	233	0	0.0	0.0	1.0	2.0	2.0247	3.0	4.0	4.0	1.399
quarter	1255	0	0.0	0	0	1.0	1.0	2.0	3.0	2.5171	4.0	4.0	4.0	1.1158
year	1255	0	0.0	0	0	2021.0	2021.0	2022.0	2023.0	2023.0932	2024.0	2026.0	2026.0	1.4455
s_month_end	1255	0	0.0	1213	0	0.0	0.0	0.0	0.0	0.0335	0.0	1.0	1.0	0.1799
_month_start	1255	0	0.0	1216	0	0.0	0.0	0.0	0.0	0.0311	0.0	1.0	1.0	0.1736
_spread|UNG	1255	0	0.0	0	0	0.17	0.25	0.54	0.88	1.7265	2.16	9.48	16.68	1.9928
_spread|UNG	1255	0	0.0	23	630	-11.88	-5.2	-0.4	-0.01	-0.0033	0.395	4.9968	12.68	1.5511
SMA_5|UNG	1255	0	0.0	0	0	10.674	12.0291	15.917	27.608	39.9719	56.288	123.295	129.608	30.2528
EMA_5|UNG	1255	0	0.0	0	0	10.5831	12.0507	15.917	27.5986	39.9716	56.5048	122.8929	129.0258	30.2195
SMA_10|UNG	1255	0	0.0	0	0	10.973	12.2802	16.037	27.58	40.0276	56.402	120.8612	128.74	30.1593
EMA_10|UNG	1255	0	0.0	0	0	10.9844	12.2743	16.0277	27.7369	40.0287	56.0839	120.7032	126.7982	30.087
SMA_20|UNG	1255	0	0.0	0	0	11.7195	12.2844	16.0452	27.586	40.1455	56.659	121.1818	124.296	29.9718
EMA_20|UNG	1255	0	0.0	0	0	11.6321	12.5316	16.1739	27.9623	40.1455	56.6265	119.1023	123.3601	29.807
ag_1|UNG	1254	1	0.08	0	0	10.24	11.8753	15.82	27.44	39.947	56.13	126.7316	135.16	30.3418
ag_2|UNG	1253	2	0.16	0	0	10.24	11.8752	15.85	27.44	39.9681	56.2	126.7344	135.16	30.3446
ag_3|UNG	1252	3	0.24	0	0	10.24	11.8751	15.85	27.44	39.9897	56.22	126.7372	135.16	30.3472
ocorr_1|UNG	1255	0	0.0	0	0	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972	0.0
ocorr_2|UNG	1255	0	0.0	0	0	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.0
ocorr_3|UNG	1255	0	0.0	0	0	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917	0.0
log_ret|UNG	1254	1	0.08	12	615	-0.2857	-0.0989	-0.0252	0.0002	-0.0009	0.0241	0.0888	0.1802	0.0403
g_ret_1|UNG	1253	2	0.16	12	615	-0.2857	-0.0989	-0.0252	0.0	-0.0009	0.0241	0.0889	0.1802	0.0404
rr_ret_1|UNG	1255	0	0.0	0	1255	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	0.0
g_ret_2|UNG	1252	3	0.24	12	615	-0.2857	-0.0989	-0.0252	0.0	-0.0009	0.024	0.0889	0.1802	0.0404
rr_ret_2|UNG	1255	0	0.0	0	0	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0
g_ret_3|UNG	1251	4	0.32	12	615	-0.2857	-0.0989	-0.0252	0.0	-0.001	0.024	0.089	0.1802	0.0404
rr_ret_3|UNG	1255	0	0.0	0	0	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0

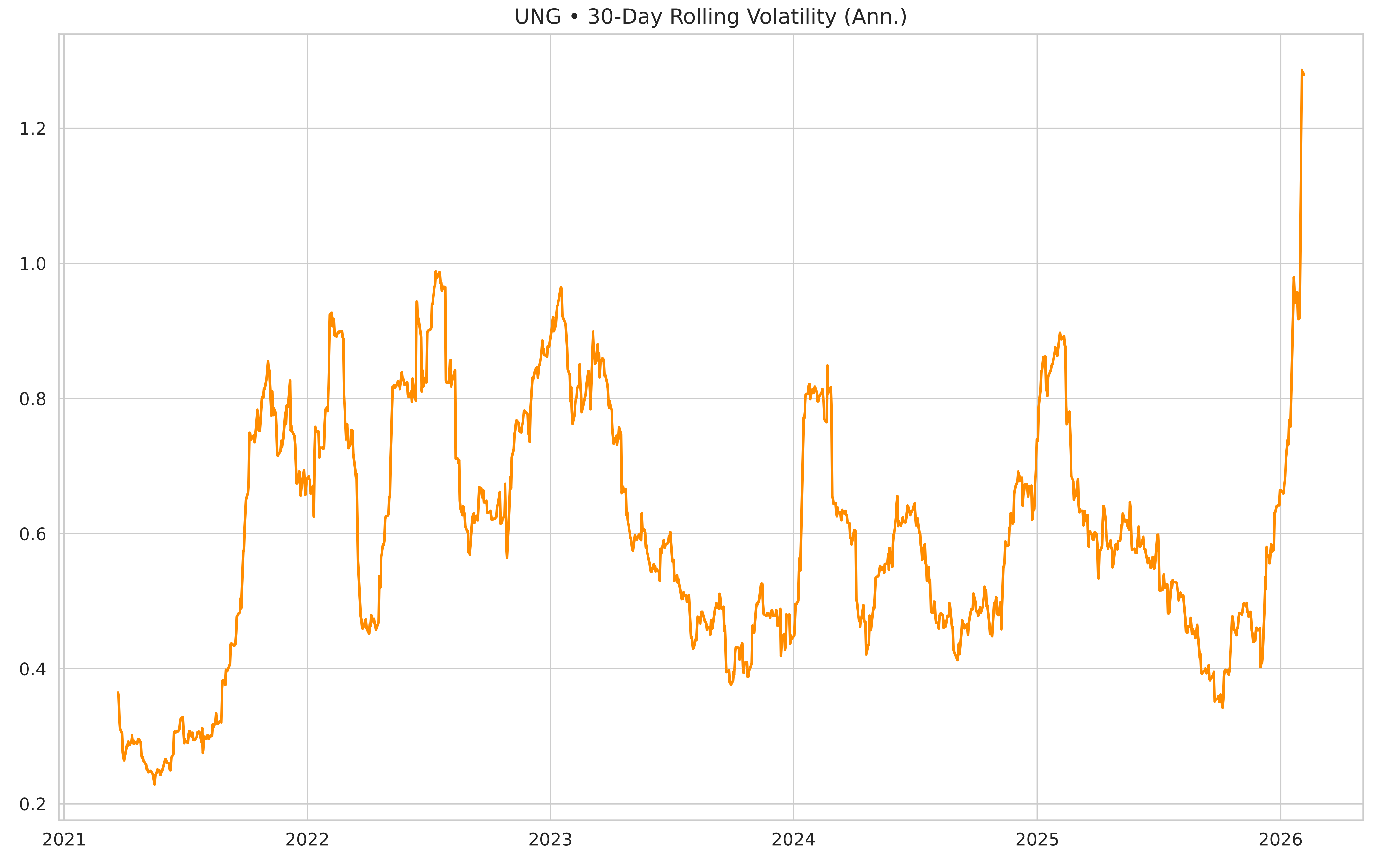
UNG • Numeric Overview

Variable	count	mean	std	min	1%	5%	25%	50%	75%	95%	99%	max
Adj Close|UNG	1255.0	39.9259	30.3388	10.24	11.8754	12.858	15.805	27.44	56.06	107.852	126.7288	135.16
Close|UNG	1255.0	39.9259	30.3388	10.24	11.8754	12.858	15.805	27.44	56.06	107.852	126.7288	135.16
High|UNG	1255.0	40.7764	31.1313	10.37	11.9708	13.06	16.09	28.0	57.02	110.692	128.2304	138.0
Low|UNG	1255.0	39.0499	29.4811	9.95	11.644	12.607	15.62	27.04	55.38	105.392	122.4736	130.2
Open|UNG	1255.0	39.9227	30.3323	10.2	11.7878	12.832	15.965	27.48	56.0	107.44	125.6608	136.2
Volume|UNG	1255.0	5650487.61[illegible]	2631863.6822	223850.0	329124.5	553610.0	1867262.5	4602600.0	7300600.0	14196260.0	27964448.0	54623300.0
month	1255.0	6.5538	3.432	1.0	1.0	1.0	4.0	7.0	10.0	12.0	12.0	12.0
day_of_week	1255.0	2.0247	1.399	0.0	0.0	0.0	1.0	2.0	3.0	4.0	4.0	4.0
quarter	1255.0	2.5171	1.1158	1.0	1.0	1.0	2.0	3.0	4.0	4.0	4.0	4.0
year	1255.0	2023.0932	1.4455	2021.0	2021.0	2021.0	2022.0	2023.0	2024.0	2025.0	2026.0	2026.0
is_month_end	1255.0	0.0335	0.1799	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
s_month_start	1255.0	0.0311	0.1736	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
L_spread|UNG	1255.0	1.7265	1.9928	0.17	0.25	0.31	0.54	0.88	2.16	5.56	9.48	16.68
C_spread|UNG	1255.0	-0.0033	1.5511	-11.88	-5.2	-2.212	-0.4	-0.01	0.395	2.08	4.9968	12.68
SMA_5|UNG	1255.0	39.9719	30.2528	10.674	12.0291	12.8302	15.917	27.608	56.288	109.4304	123.295	129.608
EMA_5|UNG	1255.0	39.9716	30.2195	10.5831	12.0507	12.8278	15.917	27.5986	56.5048	108.9667	122.8929	129.0258
SMA_10|UNG	1255.0	40.0276	30.1593	10.973	12.2802	12.8655	16.037	27.58	56.402	108.1684	120.8612	128.74
EMA_10|UNG	1255.0	40.0287	30.087	10.9844	12.2743	12.8575	16.0277	27.7369	56.0839	107.7405	120.7032	126.7982
SMA_20|UNG	1255.0	40.1455	29.9718	11.7195	12.2844	12.7915	16.0452	27.586	56.659	106.3986	121.1818	124.296
EMA_20|UNG	1255.0	40.1455	29.807	11.6321	12.5316	12.9207	16.1739	27.9623	56.6265	105.5805	119.1023	123.3601
lag_1|UNG	1254.0	39.947	30.3418	10.24	11.8753	12.856	15.82	27.44	56.13	107.854	126.7316	135.16
lag_2|UNG	1253.0	39.9681	30.3446	10.24	11.8752	12.854	15.85	27.44	56.2	107.856	126.7344	135.16
lag_3|UNG	1252.0	39.9897	30.3472	10.24	11.8751	12.852	15.85	27.44	56.22	107.858	126.7372	135.16
utocorr_1|UNG	1255.0	0.9972	0.0	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972	0.9972
utocorr_2|UNG	1255.0	0.9945	0.0	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945	0.9945
utocorr_3|UNG	1255.0	0.9917	0.0	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917	0.9917
log_ret|UNG	1254.0	-0.0009	0.0403	-0.2857	-0.0989	-0.0668	-0.0252	0.0002	0.0241	0.0609	0.0888	0.1802
lag_ret_1|UNG	1253.0	-0.0009	0.0404	-0.2857	-0.0989	-0.0668	-0.0252	0.0	0.0241	0.0609	0.0889	0.1802
corr_ret_1|UNG	1255.0	-0.0407	0.0	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407	-0.0407
lag_ret_2|UNG	1252.0	-0.0009	0.0404	-0.2857	-0.0989	-0.0668	-0.0252	0.0	0.024	0.061	0.0889	0.1802
corr_ret_2|UNG	1255.0	0.0039	0.0	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
lag_ret_3|UNG	1251.0	-0.001	0.0404	-0.2857	-0.0989	-0.0668	-0.0252	0.0	0.024	0.061	0.089	0.1802
corr_ret_3|UNG	1255.0	0.0501	0.0	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501

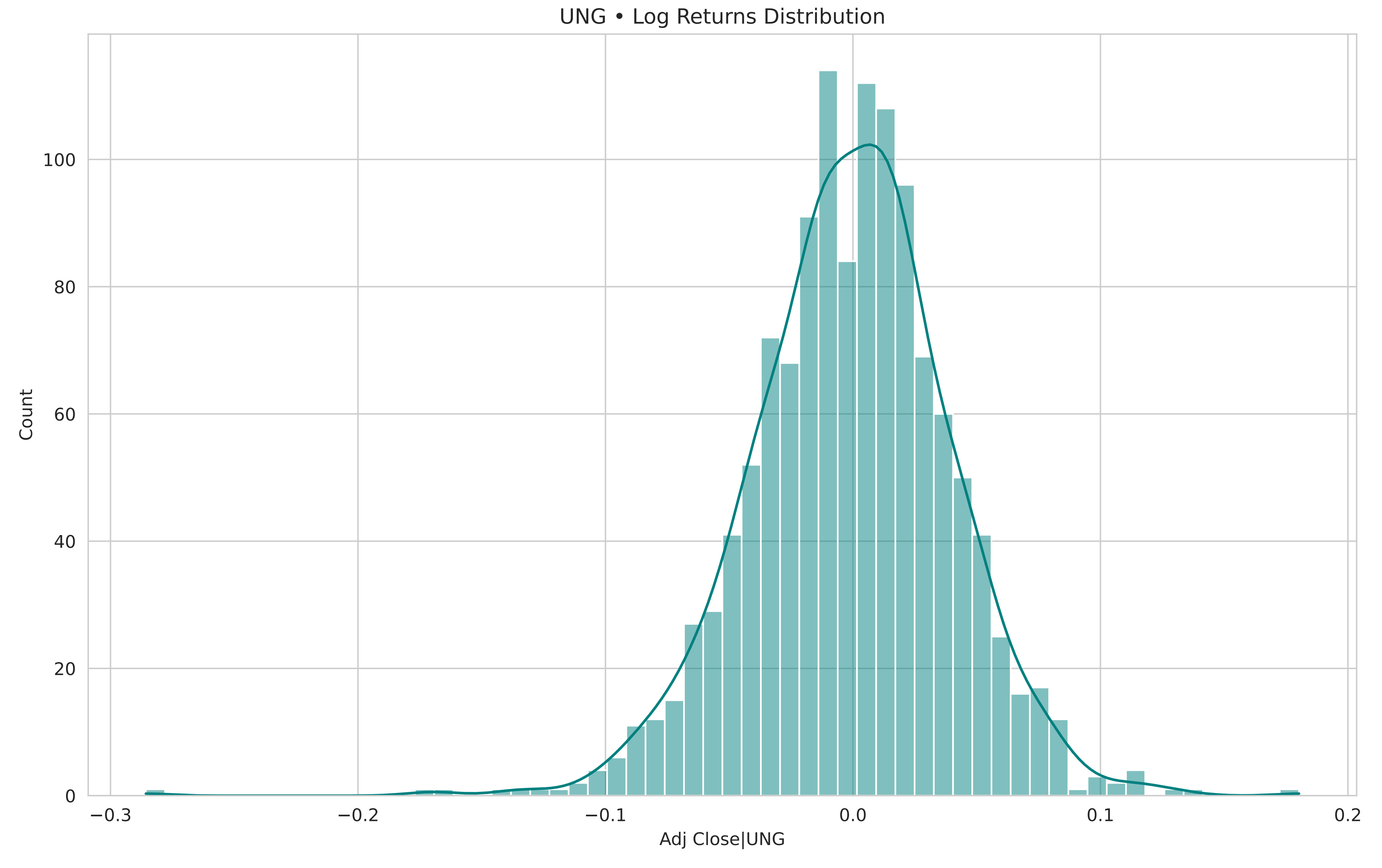

UNG • Correlation (Numeric)
Adj Close|UNG
Close|UNG
High|UNG
Low|UNG
Open|UNG
Volume|UNG
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|UNG
OC_spread|UNG
SMA_5|UNG
EMA_5|UNG
SMA_10|UNG
EMA_10|UNG
SMA_20|UNG
EMA_20|UNG
lag_1|UNG
lag_2|UNG
lag_3|UNG
autocorr_1|UNG
autocorr_2|UNG
autocorr_3|UNG
log_ret|UNG
lag_ret_1|UNG
autocorr_ret_1|UNG
lag_ret_2|UNG
autocorr_ret_2|UNG
lag_ret_3|UNG
autocorr_ret_3|UNG
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6



UNG • Adj Close|UNG Price
140
120
100
80
60
40
20
2021
2022
2023
2024
2025
2026



UNG • 30-Day Rolling Volatility (Ann.)
1.2
1.0
0.8
0.6
0.4
0.2
2021
2022
2023
2024
2025
2026



UNG • Log Returns Distribution
Count
0
20
40
60
80
100
−0.3
−0.2
−0.1
0.0
0.1
0.2
Adj Close|UNG

USO • Schema & Missingness

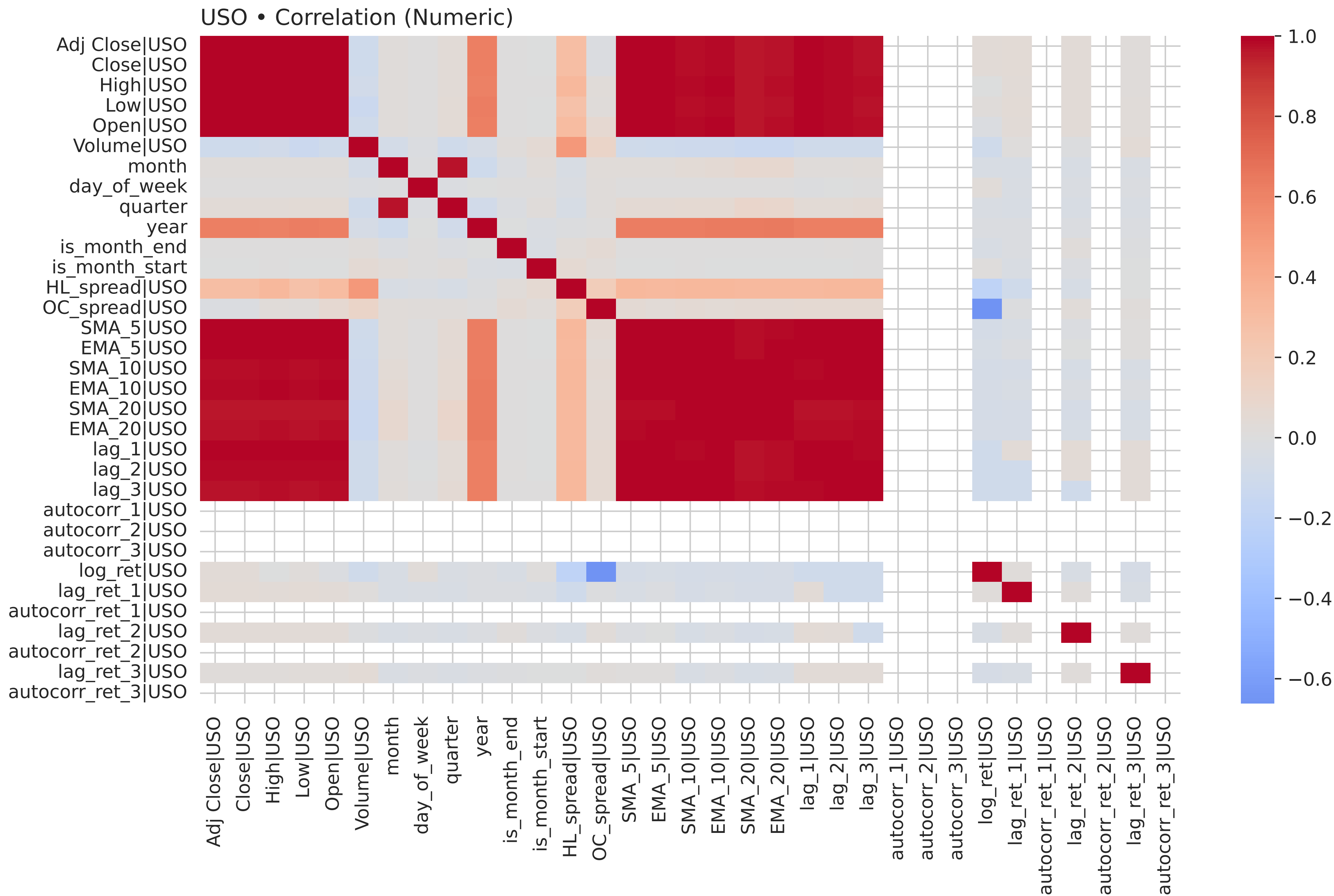
Column	dtype	non_null	missing	missing_%	unique	sample
Adj Close|USO	float64	1255	0	0.0	1002	38.94
Close|USO	float64	1255	0	0.0	1002	38.94
High|USO	float64	1255	0	0.0	1024	38.98
Low|USO	float64	1255	0	0.0	1026	38.47
Open|USO	float64	1255	0	0.0	1010	38.47
Volume|USO	int64	1255	0	0.0	1246	4216200.0
month	int32	1255	0	0.0	12	2.0
day_of_week	int32	1255	0	0.0	5	0.0
quarter	int32	1255	0	0.0	4	1.0
year	int32	1255	0	0.0	6	2021.0
is_month_end	int64	1255	0	0.0	2	0.0
is_month_start	int64	1255	0	0.0	2	0.0
HL_spread|USO	float64	1255	0	0.0	585	0.51
OC_spread|USO	float64	1255	0	0.0	702	-0.47
SMA_5|USO	float64	1255	0	0.0	1220	38.94
EMA_5|USO	float64	1255	0	0.0	1255	38.94
SMA_10|USO	float64	1255	0	0.0	1241	38.94
EMA_10|USO	float64	1255	0	0.0	1255	38.94
SMA_20|USO	float64	1255	0	0.0	1251	38.94
EMA_20|USO	float64	1255	0	0.0	1255	38.94
lag_1|USO	float64	1254	1	0.08	1001	38.94
lag_2|USO	float64	1253	2	0.16	1000	38.94
lag_3|USO	float64	1252	3	0.24	999	38.94
autocorr_1|USO	float64	1255	0	0.0	1	0.991
autocorr_2|USO	float64	1255	0	0.0	1	0.9816
autocorr_3|USO	float64	1255	0	0.0	1	0.9728
log_ret|USO	float64	1254	1	0.08	1249	0.0059
lag_ret_1|USO	float64	1253	2	0.16	1248	0.0059
autocorr_ret_1|USO	float64	1255	0	0.0	1	0.0143
lag_ret_2|USO	float64	1252	3	0.24	1247	0.0059
autocorr_ret_2|USO	float64	1255	0	0.0	1	-0.0401
lag_ret_3|USO	float64	1251	4	0.32	1246	0.0059
autocorr_ret_3|USO	float64	1255	0	0.0	1	-0.0595

USO • Numeric Quality & Ranges

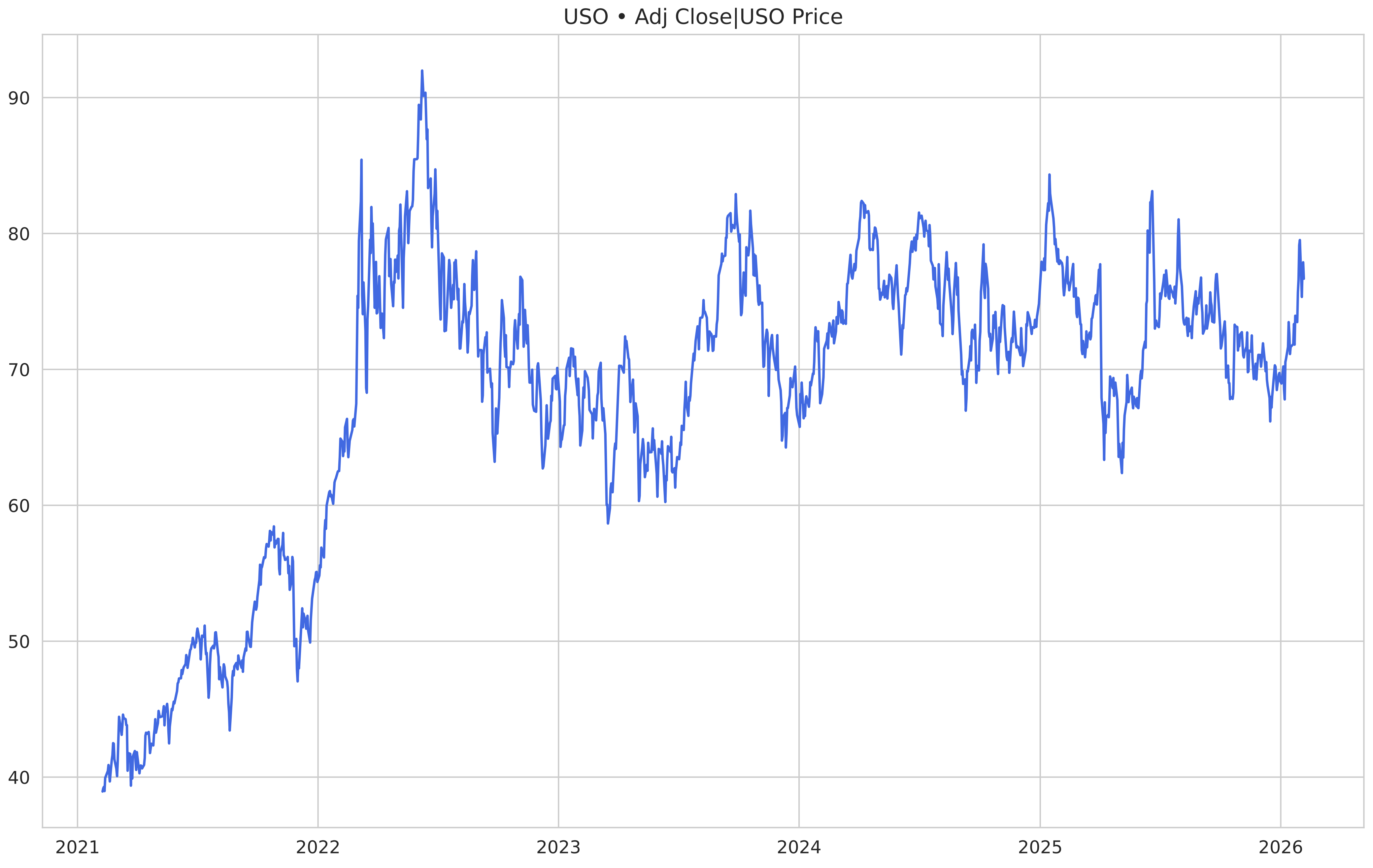
Column	non_null	missing	missing_%	zeros	negatives	min	p01	q1	median	mean	q3	p99	max	std
dj Close|USO	1255	0	0.0	0	0	38.94	40.5024	64.37	71.24	68.0683	75.27	85.4646	91.99	10.8855
Close|USO	1255	0	0.0	0	0	38.94	40.5024	64.37	71.24	68.0683	75.27	85.4646	91.99	10.8855
High|USO	1255	0	0.0	0	0	38.98	41.0608	65.085	71.94	68.7967	76.11	87.3334	92.2	11.0103
Low|USO	1255	0	0.0	0	0	38.47	40.0916	63.56	70.45	67.3118	74.545	84.3814	90.72	10.7674
Open|USO	1255	0	0.0	0	0	38.47	40.6308	64.45	71.31	68.0945	75.36	86.1376	91.03	10.9084
Volume|USO	1255	0	0.0	0	0	734700.0	1388242.0	2945350.0	4143000.0	4799773.039	5539700.0	17911856.0	50659400.0	3019627.7901
month	1255	0	0.0	0	0	1.0	1.0	4.0	7.0	6.5538	10.0	12.0	12.0	3.432
day_of_week	1255	0	0.0	233	0	0.0	0.0	1.0	2.0	2.0247	3.0	4.0	4.0	1.399
quarter	1255	0	0.0	0	0	1.0	1.0	2.0	3.0	2.5171	4.0	4.0	4.0	1.1158
year	1255	0	0.0	0	0	2021.0	2021.0	2022.0	2023.0	2023.0932	2024.0	2026.0	2026.0	1.4455
s_month_end	1255	0	0.0	1213	0	0.0	0.0	0.0	0.0	0.0335	0.0	1.0	1.0	0.1799
_month_start	1255	0	0.0	1216	0	0.0	0.0	0.0	0.0	0.0311	0.0	1.0	1.0	0.1736
_spread|USO	1255	0	0.0	0	0	0.33	0.4554	0.96	1.3	1.4849	1.8	4.3968	8.83	0.8069
_spread|USO	1255	0	0.0	5	640	-5.85	-2.2438	-0.575	-0.02	0.0262	0.58	2.7392	6.84	1.0063
SMA_5|USO	1255	0	0.0	0	0	38.94	40.7872	64.358	71.242	68.0077	75.451	85.1468	90.72	10.8632
EMA_5|USO	1255	0	0.0	0	0	38.94	40.8342	64.3772	71.2777	68.0075	75.4705	85.0734	90.1606	10.8334
SMA_10|USO	1255	0	0.0	0	0	38.94	40.8395	64.448	71.131	67.9318	75.293	85.2312	89.45	10.8593
EMA_10|USO	1255	0	0.0	0	0	38.94	40.8623	64.3682	71.2335	67.9343	75.3375	84.7669	88.8389	10.819
SMA_20|USO	1255	0	0.0	0	0	38.94	40.4436	64.5007	71.177	67.7949	75.1637	85.6826	86.8325	10.8934
EMA_20|USO	1255	0	0.0	0	0	38.94	40.3587	64.5769	71.3485	67.7977	75.0175	84.4846	86.6567	10.8276
lag_1|USO	1254	1	0.08	0	0	38.94	40.5018	64.36	71.205	68.0614	75.2575	85.4647	91.99	10.8872
lag_2|USO	1253	2	0.16	0	0	38.94	40.5012	64.35	71.17	68.0536	75.25	85.4648	91.99	10.888
lag_3|USO	1252	3	0.24	0	0	38.94	40.5006	64.3375	71.165	68.0461	75.2425	85.4649	91.99	10.8891
tocorr_1|USO	1255	0	0.0	0	0	0.991	0.991	0.991	0.991	0.991	0.991	0.991	0.991	0.0
tocorr_2|USO	1255	0	0.0	0	0	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.0
tocorr_3|USO	1255	0	0.0	0	0	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728	0.0
log_ret|USO	1254	1	0.08	4	584	-0.124	-0.0567	-0.0119	0.0015	0.0005	0.0137	0.0483	0.0761	0.0211
ag_ret_1|USO	1253	2	0.16	4	583	-0.124	-0.0567	-0.0119	0.0015	0.0006	0.0137	0.0483	0.0761	0.0211
rr_ret_1|USO	1255	0	0.0	0	0	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0
ag_ret_2|USO	1252	3	0.24	4	583	-0.124	-0.0568	-0.0119	0.0015	0.0005	0.0137	0.0483	0.0761	0.0211
rr_ret_2|USO	1255	0	0.0	0	1255	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	0.0
ag_ret_3|USO	1251	4	0.32	4	583	-0.124	-0.0568	-0.0119	0.0015	0.0005	0.0137	0.0484	0.0761	0.0211
rr_ret_3|USO	1255	0	0.0	0	1255	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	0.0

USO • Numeric Overview

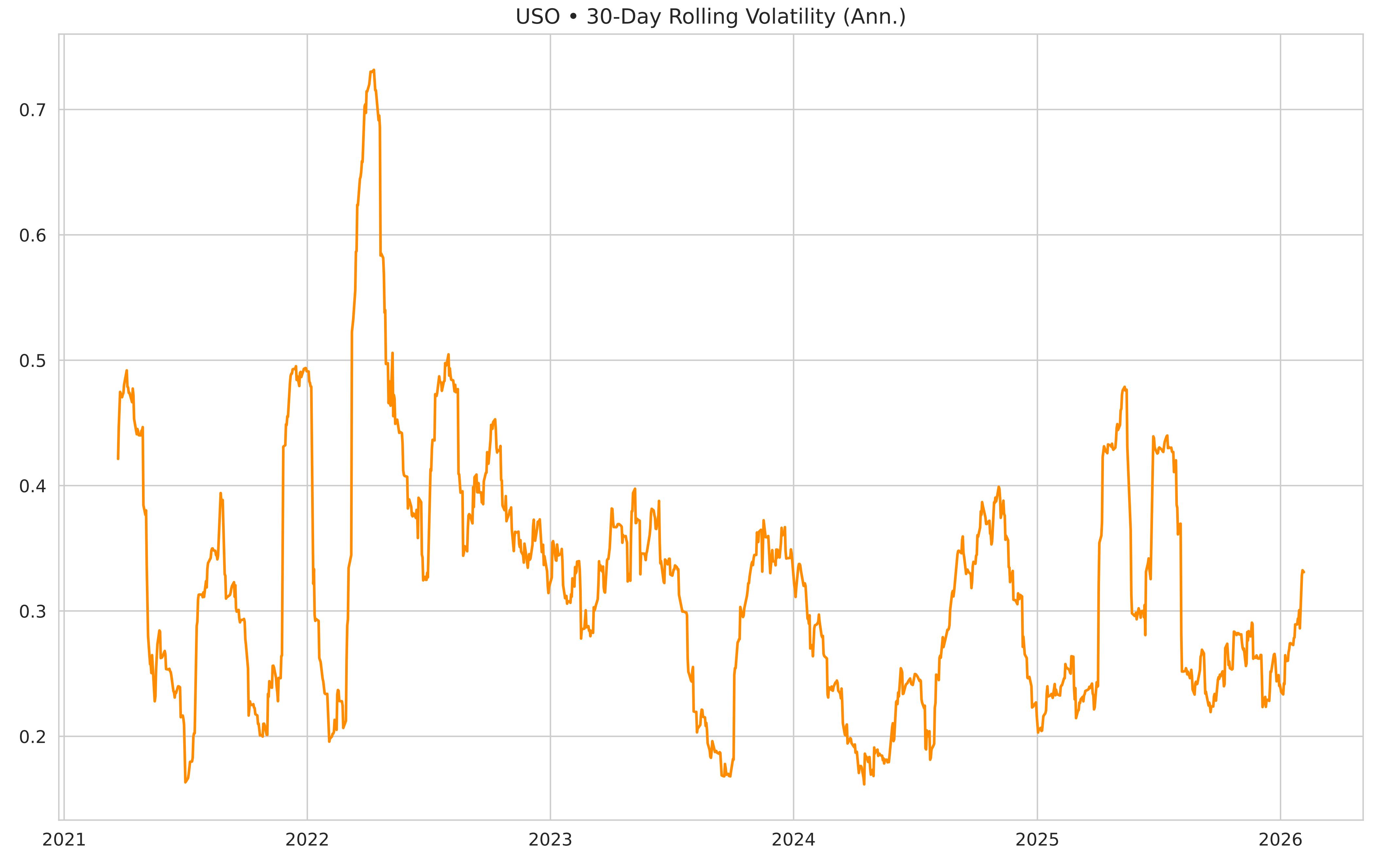
Variable	count	mean	std	min	1%	5%	25%	50%	75%	95%	99%	max
Adj Close|USO	1255.0	68.0683	10.8855	38.94	40.5024	44.424	64.37	71.24	75.27	81.061	85.4646	91.99
Close|USO	1255.0	68.0683	10.8855	38.94	40.5024	44.424	64.37	71.24	75.27	81.061	85.4646	91.99
High|USO	1255.0	68.7967	11.0103	38.98	41.0608	44.63	65.085	71.94	76.11	81.759	87.3334	92.2
Low|USO	1255.0	67.3118	10.7674	38.47	40.0916	43.882	63.56	70.45	74.545	80.09	84.3814	90.72
Open|USO	1255.0	68.0945	10.9084	38.47	40.6308	44.108	64.45	71.31	75.36	81.103	86.1376	91.03
Volume|USO	1255.0	4799773.039	3519627.7901	734700.0	1388242.0	1800750.0	2945350.0	4143000.0	5539700.0	9546880.0	17911856.0	50659400.0
month	1255.0	6.5538	3.432	1.0	1.0	1.0	4.0	7.0	10.0	12.0	12.0	12.0
day_of_week	1255.0	2.0247	1.399	0.0	0.0	0.0	1.0	2.0	3.0	4.0	4.0	4.0
quarter	1255.0	2.5171	1.1158	1.0	1.0	1.0	2.0	3.0	4.0	4.0	4.0	4.0
year	1255.0	2023.0932	1.4455	2021.0	2021.0	2021.0	2022.0	2023.0	2024.0	2025.0	2026.0	2026.0
is_month_end	1255.0	0.0335	0.1799	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
s_month_start	1255.0	0.0311	0.1736	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
IL_spread|USO	1255.0	1.4849	0.8069	0.33	0.4554	0.63	0.96	1.3	1.8	2.926	4.3968	8.83
C_spread|USO	1255.0	0.0262	1.0063	-5.85	-2.2438	-1.473	-0.575	-0.02	0.58	1.703	2.7392	6.84
SMA_5|USO	1255.0	68.0077	10.8632	38.94	40.7872	44.1714	64.358	71.242	75.451	80.6242	85.1468	90.72
EMA_5|USO	1255.0	68.0075	10.8334	38.94	40.8342	44.1953	64.3772	71.2777	75.4705	80.4958	85.0734	90.1606
SMA_10|USO	1255.0	67.9318	10.8593	38.94	40.8395	44.0355	64.448	71.131	75.293	80.2559	85.2312	89.45
EMA_10|USO	1255.0	67.9343	10.819	38.94	40.8623	43.962	64.3682	71.2335	75.3375	80.0345	84.7669	88.8389
SMA_20|USO	1255.0	67.7949	10.8934	38.94	40.4436	43.2763	64.5007	71.177	75.1637	79.6831	85.6826	86.8325
EMA_20|USO	1255.0	67.7977	10.8276	38.94	40.3587	43.3814	64.5769	71.3485	75.0175	79.1982	84.4846	86.6567
lag_1|USO	1254.0	68.0614	10.8872	38.94	40.5018	44.423	64.36	71.205	75.2575	81.0645	85.4647	91.99
lag_2|USO	1253.0	68.0536	10.888	38.94	40.5012	44.422	64.35	71.17	75.25	81.068	85.4648	91.99
lag_3|USO	1252.0	68.0461	10.8891	38.94	40.5006	44.421	64.3375	71.165	75.2425	81.0715	85.4649	91.99
utocorr_1|USO	1255.0	0.991	0.0	0.991	0.991	0.991	0.991	0.991	0.991	0.991	0.991	0.991
utocorr_2|USO	1255.0	0.9816	0.0	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816	0.9816
utocorr_3|USO	1255.0	0.9728	0.0	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728	0.9728
log_ret|USO	1254.0	0.0005	0.0211	-0.124	-0.0567	-0.0338	-0.0119	0.0015	0.0137	0.0321	0.0483	0.0761
lag_ret_1|USO	1253.0	0.0006	0.0211	-0.124	-0.0567	-0.0338	-0.0119	0.0015	0.0137	0.0321	0.0483	0.0761
corr_ret_1|USO	1255.0	0.0143	0.0	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143
lag_ret_2|USO	1252.0	0.0005	0.0211	-0.124	-0.0568	-0.0338	-0.0119	0.0015	0.0137	0.0321	0.0483	0.0761
corr_ret_2|USO	1255.0	-0.0401	0.0	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401	-0.0401
lag_ret_3|USO	1251.0	0.0005	0.0211	-0.124	-0.0568	-0.0338	-0.0119	0.0015	0.0137	0.0321	0.0484	0.0761
corr_ret_3|USO	1255.0	-0.0595	0.0	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595	-0.0595



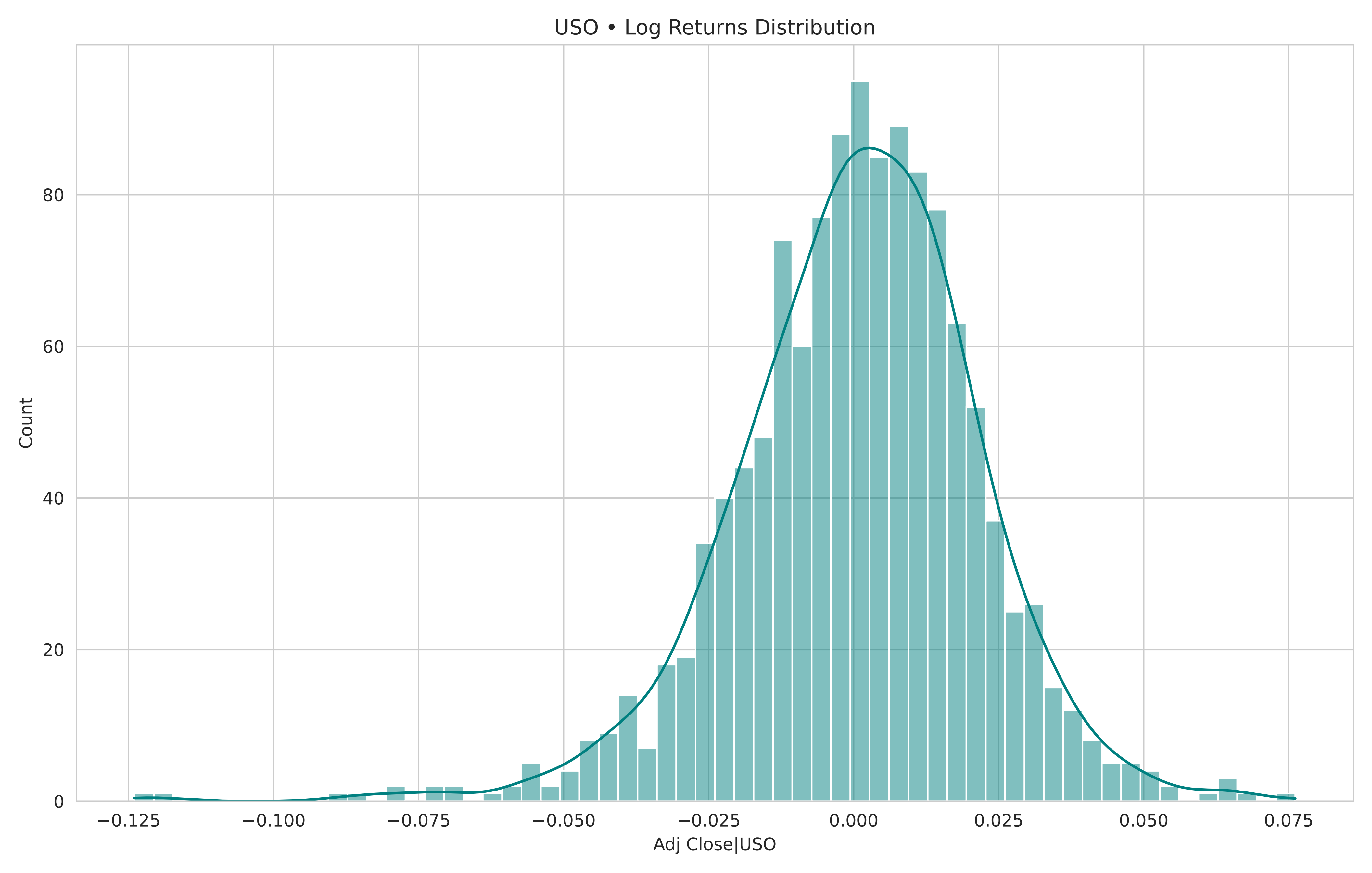
USO • Correlation (Numeric)
Adj Close|USO
Close|USO
High|USO
Low|USO
Open|USO
Volume|USO
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|USO
OC_spread|USO
SMA_5|USO
EMA_5|USO
SMA_10|USO
EMA_10|USO
SMA_20|USO
EMA_20|USO
lag_1|USO
lag_2|USO
lag_3|USO
autocorr_1|USO
autocorr_2|USO
autocorr_3|USO
log_ret|USO
lag_ret_1|USO
autocorr_ret_1|USO
lag_ret_2|USO
autocorr_ret_2|USO
lag_ret_3|USO
autocorr_ret_3|USO
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6

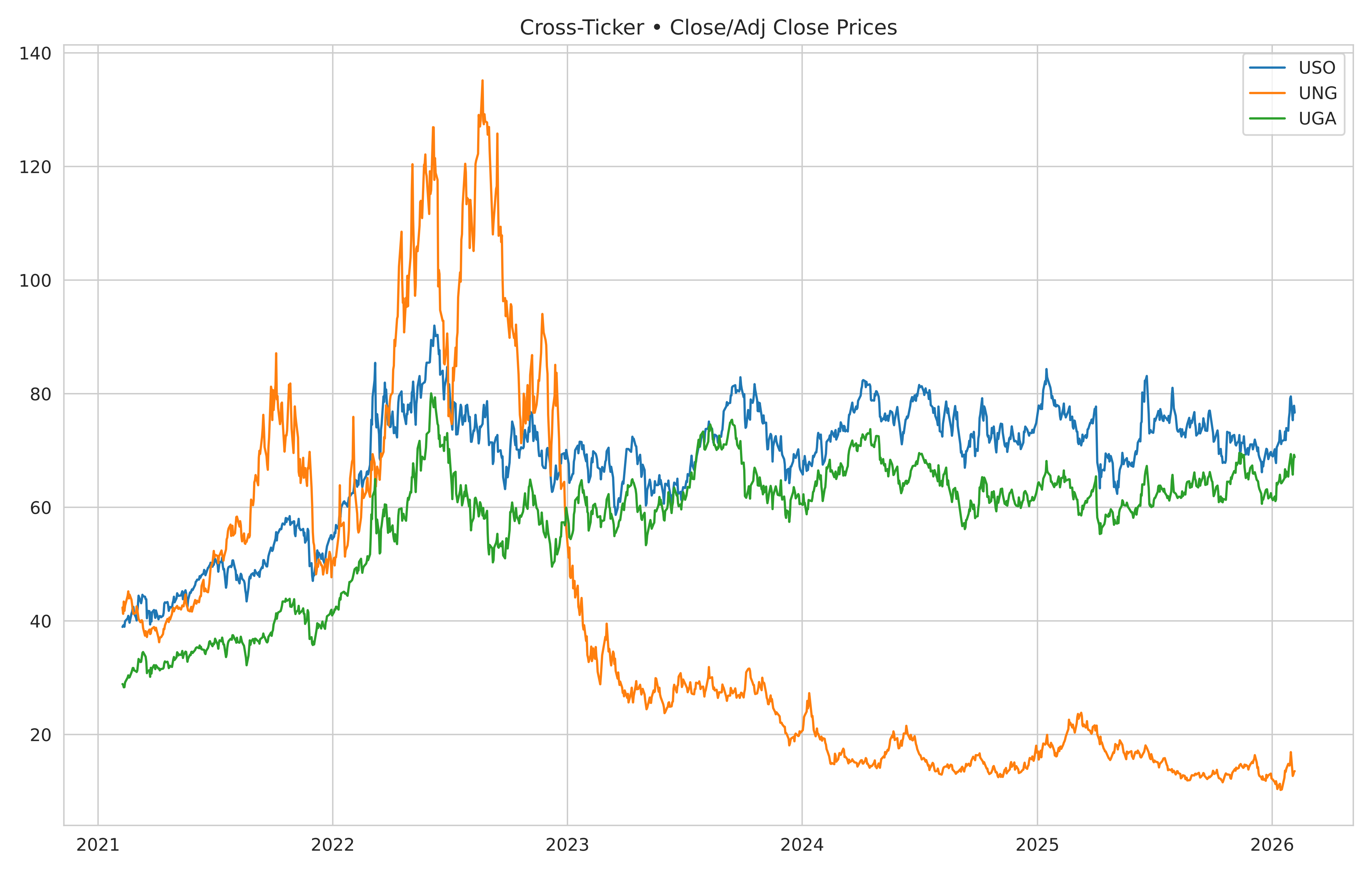


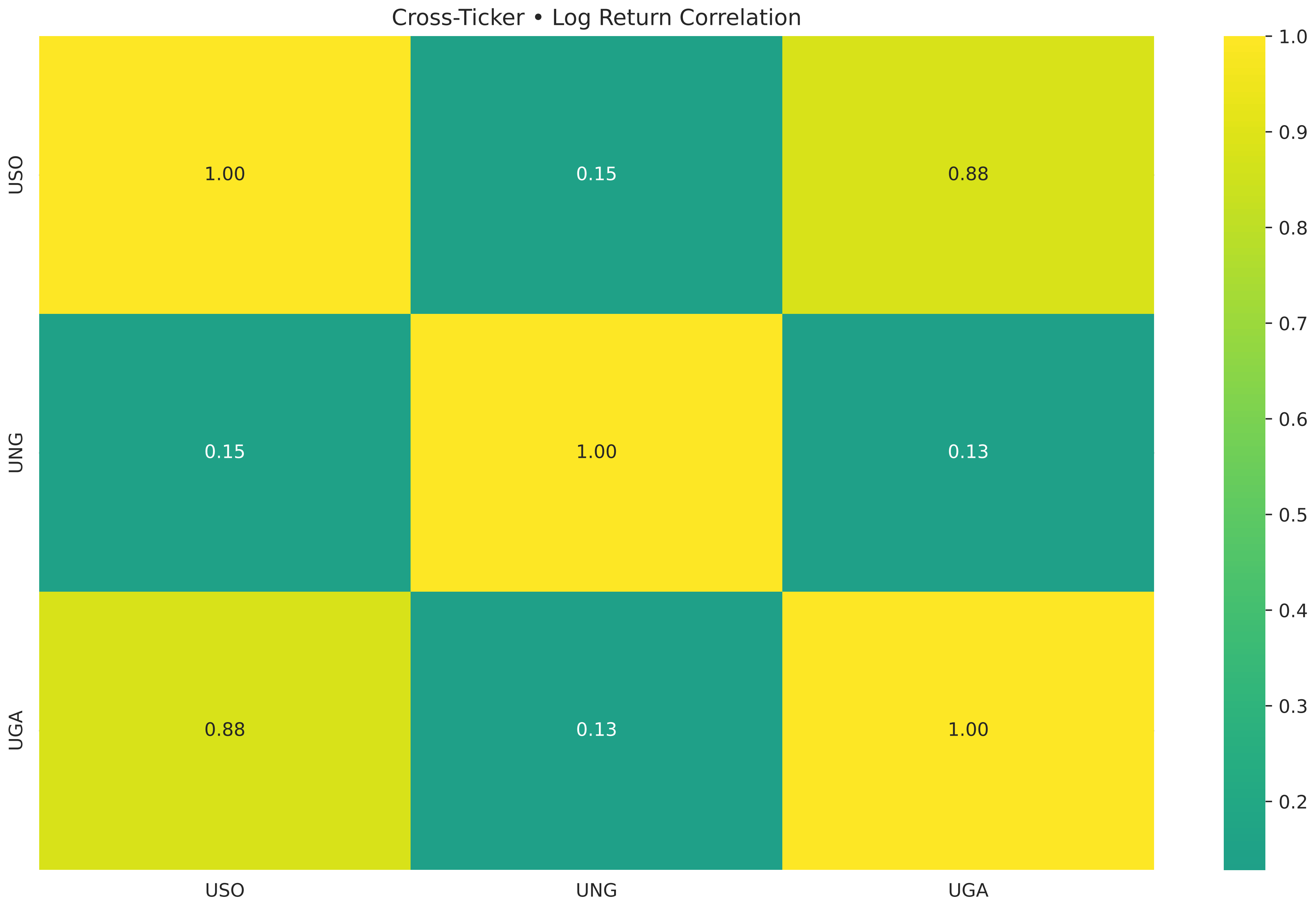
USO • Adj Close|USO Price
90
80
70
60
50
40
2021
2022
2023
2024
2025
2026



USO • 30-Day Rolling Volatility (Ann.)
0.7
0.6
0.5
0.4
0.3
0.2
2021
2022
2023
2024
2025
2026


USO • Log Returns Distribution
Count
Adj Close|USO
0
20
40
60
80
−0.125
−0.100
−0.075
−0.050
−0.025
0.000
0.025
0.050
0.075


Cross-Ticker • Close/Adj Close Prices
USO
UNG
UGA
140
120
100
80
60
40
20
2021
2022
2023
2024
2025
2026


Cross-Ticker • Log Return Correlation
USO
UNG
UGA
1.00
0.15
0.88
0.15
1.00
0.13
0.88
0.13
1.00
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2