

# Exploratory Data Analysis — VLO Next-Day Direction

Generated: 2026-02-24 18:18:39

Dataset: Engineered features joined across VLO, PSX, MPC, ^GSPC, CL=F, GC=F, ^VIX.  
This report includes schema, missing values, numeric summaries, and univariate feature analyses.  
Also includes target comparisons for: y, vlo\_next\_dir, vlo\_next\_ret.  
NEW: Includes numeric stats + tests for vlo\_next\_dir (positive vs negative) on vlo\_next\_ret.

# Schema: dtypes, Non-Null Counts, Missing Ratios (page 1/2)

column	dtype	non_null	nulls	null_ratio
ret_VLO	float64	3459	0	0.0%
ret_PSX	float64	3459	0	0.0%
ret_MPC	float64	3459	0	0.0%
ret_^GSPC	float64	3459	0	0.0%
ret_CL=F	float64	3459	0	0.0%
ret_GC=F	float64	3459	0	0.0%
ret_^VIX	float64	3459	0	0.0%
ret2_VLO	float64	3459	0	0.0%
ret2_PSX	float64	3459	0	0.0%
ret2_MPC	float64	3459	0	0.0%
ret2_^GSPC	float64	3459	0	0.0%
ret2_CL=F	float64	3459	0	0.0%
ret2_GC=F	float64	3459	0	0.0%
ret2_^VIX	float64	3459	0	0.0%
PX_VLO	float64	3459	0	0.0%
PX_PSX	float64	3459	0	0.0%
PX_MPC	float64	3459	0	0.0%
PX_^GSPC	float64	3459	0	0.0%
PX_CL=F	float64	3459	0	0.0%
PX_GC=F	float64	3459	0	0.0%
PX_^VIX	float64	3459	0	0.0%
PXlag1_VLO	float64	3459	0	0.0%
PXlag1_PSX	float64	3459	0	0.0%
PXlag1_MPC	float64	3459	0	0.0%
PXlag1_^GSPC	float64	3459	0	0.0%
PXlag1_CL=F	float64	3459	0	0.0%
PXlag1_GC=F	float64	3459	0	0.0%
PXlag1_^VIX	float64	3459	0	0.0%
PXlag2_VLO	float64	3459	0	0.0%
PXlag2_PSX	float64	3459	0	0.0%
PXlag2_MPC	float64	3459	0	0.0%
PXlag2_^GSPC	float64	3459	0	0.0%
PXlag2_CL=F	float64	3459	0	0.0%
PXlag2_GC=F	float64	3459	0	0.0%
PXlag2_^VIX	float64	3459	0	0.0%
VOL_VLO	int64	3459	0	0.0%
VOL_PSX	int64	3459	0	0.0%
VOL_MPC	int64	3459	0	0.0%
VOL_^GSPC	int64	3459	0	0.0%
VOL_CL=F	int64	3459	0	0.0%
VOL_GC=F	int64	3459	0	0.0%
VOL_^VIX	int64	3459	0	0.0%
HL_VLO	float64	3459	0	0.0%
OC_VLO	float64	3459	0	0.0%
HL_PSX	float64	3459	0	0.0%

# Schema: dtypes, Non-Null Counts, Missing Ratios (page 2/2)

column	dtype	non_null	nulls	null_ratio
OC_PSX	float64	3459	0	0.0%
HL_MPC	float64	3459	0	0.0%
OC_MPC	float64	3459	0	0.0%
HL_^GSPC	float64	3459	0	0.0%
OC_^GSPC	float64	3459	0	0.0%
HL_CL=F	float64	3459	0	0.0%
OC_CL=F	float64	3459	0	0.0%
HL_GC=F	float64	3459	0	0.0%
OC_GC=F	float64	3459	0	0.0%
HL_^VIX	float64	3459	0	0.0%
OC_^VIX	float64	3459	0	0.0%
vlo_next_ret	float64	3459	0	0.0%
vlo_next_dir	object	3459	0	0.0%
y	int64	3459	0	0.0%
EquityDown_OilDown	int64	3459	0	0.0%
RiskOff	int64	3459	0	0.0%
HighVIX	int64	3459	0	0.0%
VLO_vol5	float64	3459	0	0.0%
VLO_vol10	float64	3459	0	0.0%
VLO_vol20	float64	3459	0	0.0%
VLO_vol_ratio_5_20	float64	3459	0	0.0%
OilShock	int64	3459	0	0.0%
GoldShock	int64	3459	0	0.0%
VLO_minus_SPX	float64	3459	0	0.0%
RefinerPeerAvg	float64	3459	0	0.0%
VLO_minus_Peers	float64	3459	0	0.0%
Oil_minus_SPX	float64	3459	0	0.0%
Oil_minus_Refiners	float64	3459	0	0.0%
VLO_mom3	float64	3459	0	0.0%
VLO_mom5	float64	3459	0	0.0%
VLO_ret5_avg	float64	3459	0	0.0%
VLO_reversal_signal	float64	3459	0	0.0%
VLO_zscore20	float64	3459	0	0.0%
SPX_zscore20	float64	3459	0	0.0%
Oil_zscore20	float64	3459	0	0.0%

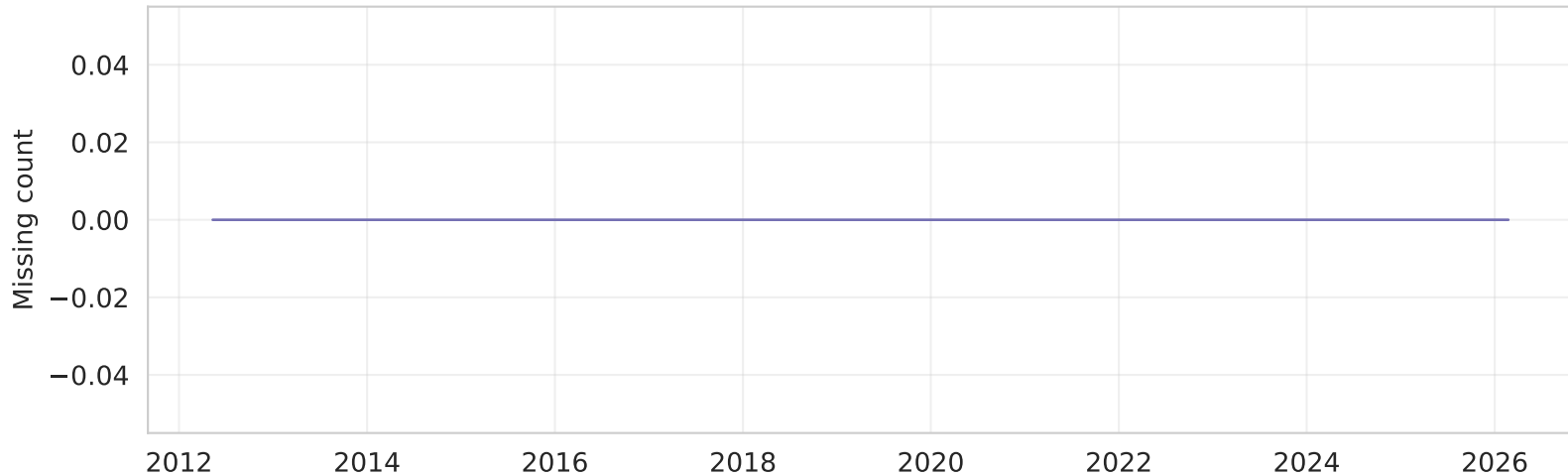
## Missing Values Summary (by Column) (page 1/2)

column	nulls	null_ratio_%
ret_VLO	0	0.0
ret_PSX	0	0.0
ret_MPC	0	0.0
ret_^GSPC	0	0.0
ret_CL=F	0	0.0
ret_GC=F	0	0.0
ret_^VIX	0	0.0
ret2_VLO	0	0.0
ret2_PSX	0	0.0
ret2_MPC	0	0.0
ret2_^GSPC	0	0.0
ret2_CL=F	0	0.0
ret2_GC=F	0	0.0
ret2_^VIX	0	0.0
PX_VLO	0	0.0
PX_PSX	0	0.0
PX_MPC	0	0.0
PX_^GSPC	0	0.0
PX_CL=F	0	0.0
PX_GC=F	0	0.0
PX_^VIX	0	0.0
PXlag1_VLO	0	0.0
PXlag1_PSX	0	0.0
PXlag1_MPC	0	0.0
PXlag1_^GSPC	0	0.0
PXlag1_CL=F	0	0.0
PXlag1_GC=F	0	0.0
PXlag1_^VIX	0	0.0
PXlag2_VLO	0	0.0
PXlag2_PSX	0	0.0
PXlag2_MPC	0	0.0
PXlag2_^GSPC	0	0.0
PXlag2_CL=F	0	0.0
PXlag2_GC=F	0	0.0
PXlag2_^VIX	0	0.0
VOL_VLO	0	0.0
VOL_PSX	0	0.0
VOL_MPC	0	0.0
VOL_^GSPC	0	0.0
VOL_CL=F	0	0.0
VOL_GC=F	0	0.0
VOL_^VIX	0	0.0
HL_VLO	0	0.0
OC_VLO	0	0.0
HL_PSX	0	0.0
OC_PSX	0	0.0
HL_MPC	0	0.0
OC_MPC	0	0.0
HL_^GSPC	0	0.0
OC_^GSPC	0	0.0

## Missing Values Summary (by Column) (page 2/2)

column	nulls	null_ratio_%
HL_CL=F	0	0.0
OC_CL=F	0	0.0
HL_GC=F	0	0.0
OC_GC=F	0	0.0
HL_^VIX	0	0.0
OC_^VIX	0	0.0
vlo_next_ret	0	0.0
vlo_next_dir	0	0.0
y	0	0.0
EquityDown_OilDown	0	0.0
RiskOff	0	0.0
HighVIX	0	0.0
VLO_vol5	0	0.0
VLO_vol10	0	0.0
VLO_vol20	0	0.0
VLO_vol_ratio_5_20	0	0.0
OilShock	0	0.0
GoldShock	0	0.0
VLO_minus_SPX	0	0.0
RefinerPeerAvg	0	0.0
VLO_minus_Peers	0	0.0
Oil_minus_SPX	0	0.0
Oil_minus_Refiners	0	0.0
VLO_mom3	0	0.0
VLO_mom5	0	0.0
VLO_ret5_avg	0	0.0
VLO_reversal_signal	0	0.0
VLO_zscore20	0	0.0
SPX_zscore20	0	0.0
Oil_zscore20	0	0.0

Total Missing Values per Date



# Numeric Summary: count / mean / std / min / max (page 1/3)

feature	count	mean	std	min	max
ret_VLO	3459.0	0.000809	0.023963	-0.213452	0.271572
ret_PSX	3459.0	0.000597	0.021059	-0.172757	0.200262
ret_MPC	3459.0	0.000794	0.024395	-0.314833	0.187546
ret_^GSPC	3459.0	0.000476	0.010628	-0.127652	0.090895
ret_CL=F	3459.0	-2.6e-05	0.025792	-0.282206	0.22394
ret_GC=F	3459.0	0.000333	0.010374	-0.120657	0.059054
ret_^VIX	3459.0	-4.7e-05	0.078569	-0.442449	0.768245
ret2_VLO	3459.0	0.000769	0.023847	-0.213452	0.271572
ret2_PSX	3459.0	0.000561	0.020987	-0.172757	0.200262
ret2_MPC	3459.0	0.000768	0.024276	-0.314833	0.187546
ret2_^GSPC	3459.0	0.000475	0.010623	-0.127652	0.090895
ret2_CL=F	3459.0	9.2e-05	0.026319	-0.282206	0.319634
ret2_GC=F	3459.0	0.000342	0.01037	-0.120657	0.059054
ret2_^VIX	3459.0	-5.9e-05	0.078652	-0.442449	0.768245
PX_VLO	3459.0	70.220005	41.986821	11.446172	203.919998
PX_PSX	3459.0	73.159696	29.812657	18.661118	162.348068
PX_MPC	3459.0	67.247861	50.415012	11.53328	210.061356
PX_^GSPC	3459.0	3280.729059	1457.518283	1278.040039	6978.600098
PX_CL=F	3459.0	68.395233	20.269051	12.34	123.699997
PX_GC=F	3459.0	1733.529082	691.430705	1050.800049	5318.399902
PX_^VIX	3459.0	17.669188	6.577706	9.14	82.690002
PXlag1_VLO	3459.0	70.16582	41.942691	11.446172	203.919998
PXlag1_PSX	3459.0	73.120068	29.793894	18.661118	162.348068
PXlag1_MPC	3459.0	67.195449	50.378388	11.53328	210.061356
PXlag1_^GSPC	3459.0	3279.119502	1456.635394	1278.040039	6978.600098
PXlag1_CL=F	3459.0	68.402692	20.278318	12.34	123.699997
PXlag1_GC=F	3459.0	1732.502803	688.917473	1050.800049	5318.399902
PXlag1_^VIX	3459.0	17.670269	6.580728	9.14	82.690002
PXlag2_VLO	3459.0	70.112794	41.894467	11.446172	203.919998
PXlag2_PSX	3459.0	73.082286	29.773453	18.661118	162.348068
PXlag2_MPC	3459.0	67.142758	50.338276	11.53328	210.061356
PXlag2_^GSPC	3459.0	3277.504263	1455.697778	1278.040039	6978.600098
PXlag2_CL=F	3459.0	68.408419	20.291469	10.01	123.699997
PXlag2_GC=F	3459.0	1731.486208	686.586486	1050.800049	5318.399902
PXlag2_^VIX	3459.0	17.672232	6.586615	9.14	82.690002

# Numeric Summary: count / mean / std / min / max (page 2/3)

feature	count	mean	std	min	max
VOL_VLO	3459.0	5090551.727089	2921869.264975	559800.0	44023700.0
VOL_PSX	3459.0	3230484.446372	1483976.274953	605700.0	16579800.0
VOL_MPC	3459.0	5468792.252096	3016965.448958	957900.0	39153800.0
VOL_^GSPC	3459.0	3984612807.169702	998803734.318692	0.0	9976520000.0
VOL_CL=F	3459.0	404911.509685	208129.964633	0.0	1774383.0
VOL_GC=F	3459.0	5163.032958	28010.080762	0.0	386334.0
VOL_^VIX	3459.0	0.0	0.0	0.0	0.0
HL_VLO	3459.0	2.493334	1.710245	0.292505	15.729996
OC_VLO	3459.0	-0.00668	1.786214	-12.120003	12.120003
HL_PSX	3459.0	2.233336	1.250729	0.409996	14.799995
OC_PSX	3459.0	-0.006042	1.508879	-10.279999	11.529999
HL_MPC	3459.0	2.176284	1.671188	0.275	17.680008
OC_MPC	3459.0	0.010106	1.621084	-12.770004	15.790001
HL_^GSPC	3459.0	35.520107	31.607609	3.699951	532.909668
OC_^GSPC	3459.0	0.627437	30.437772	-218.060059	491.620117
HL_CL=F	3459.0	2.107586	1.31627	0.48	23.209999
OC_CL=F	3459.0	-0.027103	1.443755	-15.960007	7.720001
HL_GC=F	3459.0	18.563979	25.772925	0.0	740.5
OC_GC=F	3459.0	0.173054	22.004735	-662.5	223.700195
HL_^VIX	3459.0	1.953273	2.170285	0.240001	42.340004
OC_^VIX	3459.0	-0.144201	1.648693	-17.360001	24.860001
vlo_next_ret	3459.0	0.000793	0.023963	-0.213452	0.271572
EquityDown_OilDown	3459.0	0.2573	0.437209	0.0	1.0
RiskOff	3459.0	0.182712	0.386486	0.0	1.0
HighVIX	3459.0	0.352414	0.477791	0.0	1.0
VLO_vol5	3459.0	0.020025	0.013245	0.001679	0.14472
VLO_vol10	3459.0	0.020816	0.011795	0.003353	0.131768
VLO_vol20	3459.0	0.021304	0.010785	0.005059	0.109765
VLO_vol_ratio_5_20	3459.0	0.940678	0.344322	0.118163	2.002188
OilShock	3459.0	0.057531	0.232888	0.0	1.0
GoldShock	3459.0	0.059844	0.237232	0.0	1.0
VLO_minus_SPX	3459.0	0.000333	0.020734	-0.140149	0.25994
RefinerPeerAvg	3459.0	0.000696	0.02156	-0.243795	0.172114
VLO_minus_Peers	3459.0	0.000113	0.011429	-0.058135	0.099458
Oil_minus_SPX	3459.0	-0.000502	0.0253	-0.296403	0.233195



feature	count	mean	std	min	max
Oil_minus_Refiners	3459.0	-0.000722	0.027052	-0.318885	0.240933
VLO_mom3	3459.0	0.002436	0.041085	-0.354101	0.334982
VLO_mom5	3459.0	0.004048	0.053132	-0.440812	0.369257
VLO_ret5_avg	3459.0	0.00081	0.010626	-0.088162	0.073851
VLO_reversal_signal	3459.0	-0.00081	0.010626	-0.073851	0.088162
VLO_zscore20	3459.0	-0.008513	0.97902	-3.910115	3.829064
SPX_zscore20	3459.0	-0.036052	0.990919	-3.779699	3.370961
Oil_zscore20	3459.0	-0.017942	0.9816	-3.749012	3.594037

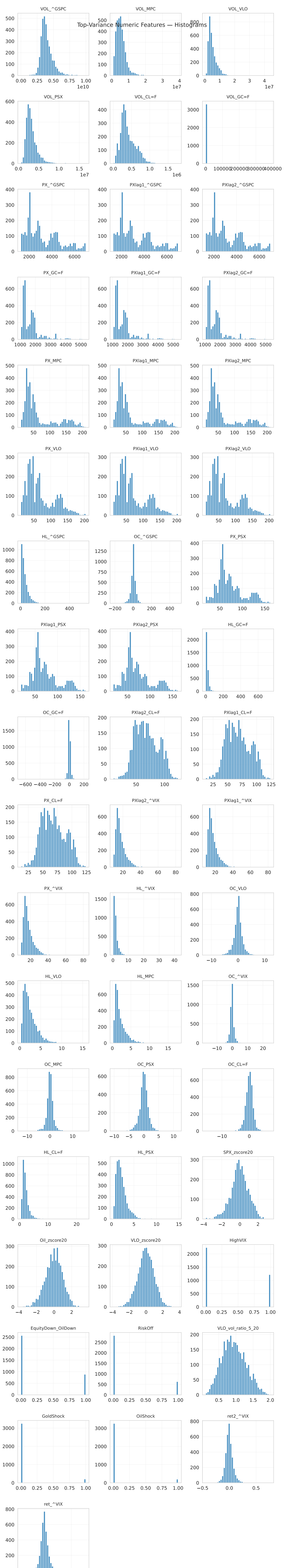
# Numeric Percentile Distribution: 1% / 5% / 25% / 50% / 75% / 95% / 99% (page 1/3)

feature	1%	5%	25%	50%	75%	95%	99%
ret_VLO	-0.063443	-0.035729	-0.010665	0.001099	0.013093	0.035263	0.058786
ret_PSX	-0.059707	-0.032252	-0.009233	0.000942	0.011061	0.031411	0.052553
ret_MPC	-0.063393	-0.035616	-0.01127	0.001732	0.013249	0.035176	0.058906
ret_^GSPC	-0.030313	-0.01586	-0.003651	0.000687	0.005567	0.014847	0.024788
ret_CL=F	-0.069014	-0.037647	-0.011887	0.000951	0.01226	0.033529	0.060732
ret_GC=F	-0.027532	-0.016099	-0.004448	0.00036	0.005613	0.016172	0.027104
ret_^VIX	-0.180934	-0.11204	-0.042795	-0.006368	0.03555	0.126971	0.23803
ret2_VLO	-0.063443	-0.035729	-0.010657	0.001099	0.013065	0.035218	0.058214
ret2_PSX	-0.059707	-0.032252	-0.009244	0.000935	0.011061	0.031324	0.051574
ret2_MPC	-0.063393	-0.035616	-0.011237	0.001732	0.013277	0.035176	0.058652
ret2_^GSPC	-0.030313	-0.01586	-0.003651	0.000687	0.005558	0.014847	0.024682
ret2_CL=F	-0.068459	-0.037537	-0.011863	0.00096	0.012268	0.033682	0.061139
ret2_GC=F	-0.027532	-0.016048	-0.004434	0.000363	0.005617	0.016172	0.027104
ret2_^VIX	-0.180934	-0.11204	-0.042795	-0.006417	0.035342	0.127143	0.23803
PX_VLO	13.418263	21.048291	37.888813	58.460007	103.141006	149.541685	178.840107
PX_PSX	21.28783	35.154854	53.7027	65.766357	88.19149	132.714281	147.810155
PX_MPC	14.364454	21.061863	31.250174	45.769184	94.041634	171.727405	194.267587
PX_^GSPC	1343.965203	1487.662976	2075.590088	2844.73999	4288.219971	6093.086182	6879.674561
PX_CL=F	25.954	39.438999	52.365	66.879997	83.289997	103.029999	109.914399
PX_GC=F	1082.943982	1166.780042	1273.099976	1566.0	1892.649963	3331.729956	4449.467969
PX_^VIX	9.7858	11.219	13.42	15.98	20.059999	29.35	40.1814
PXlag1_VLO	13.339033	20.937914	37.884985	58.436863	103.066158	149.323523	178.572671
PXlag1_PSX	21.17825	34.884612	53.678444	65.745155	88.176155	132.711627	147.702605
PXlag1_MPC	14.311432	20.98956	31.250174	45.731922	94.009403	171.683981	194.267587
PXlag1_^GSPC	1343.965203	1485.475977	2075.345093	2842.73999	4287.774902	6092.162158	6879.674561
PXlag1_CL=F	25.954	39.438999	52.365	66.879997	83.314999	103.029999	109.914399
PXlag1_GC=F	1082.943982	1166.780042	1273.099976	1566.0	1891.599976	3331.729956	4446.573975
PXlag1_^VIX	9.7858	11.22	13.42	15.98	20.045	29.35	40.4648
PXlag2_VLO	13.278909	20.920859	37.884985	58.433132	102.967117	149.282683	178.286016
PXlag2_PSX	21.160937	34.772803	53.667	65.736816	88.169975	132.676071	147.594886
PXlag2_MPC	14.202428	20.976939	31.244494	45.661903	93.858261	171.65275	194.157766
PXlag2_^GSPC	1343.965203	1480.108948	2075.234985	2842.73999	4285.675049	6090.459033	6876.825566
PXlag2_CL=F	25.954	39.438999	52.365	66.889999	83.34	103.029999	109.914399
PXlag2_GC=F	1082.943982	1166.780042	1273.099976	1566.0	1890.700012	3329.980054	4440.133984
PXlag2_^VIX	9.7858	11.219	13.42	15.98	20.059999	29.35	40.728401

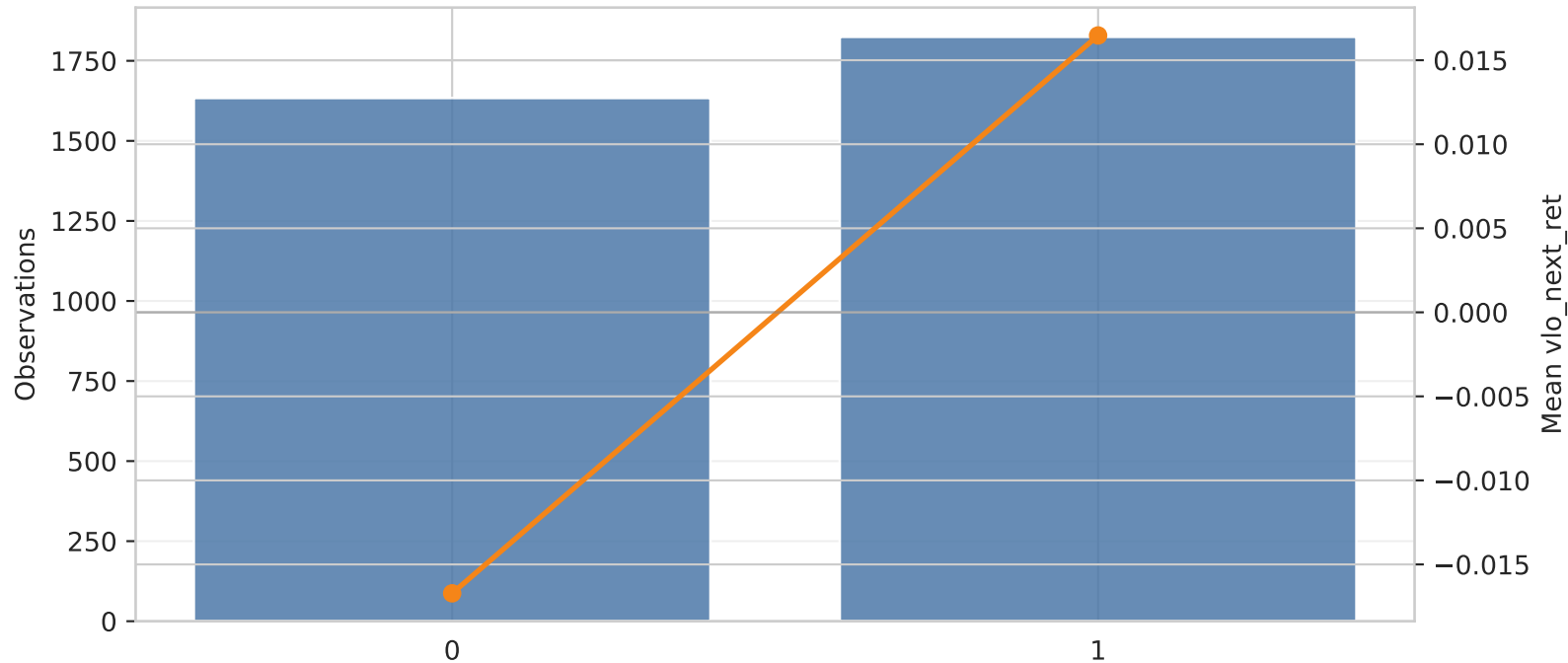
Numeric Percentile Distribution: 1% / 5% / 25% / 50% / 75% / 95% / 99% (page 2/3)							
feature	1%	5%	25%	50%	75%	95%	99%
VOL_VLO	1648864.0	2126250.0	3096850.0	4275800.0	6311200.0	10584110.0	14588802.36
VOL_PSX	1244616.0	1617040.0	2284250.0	2896000.0	3776850.0	5988720.0	8472708.0
VOL_MPC	1372622.0	1905990.0	3383500.0	5010200.0	6812750.0	10600080.0	15789906.0
VOL_^GSPC	2220868400.0	2813755000.0	3360305000.0	3778120000.0	4401770000.0	5784337999.999999	7755245000.0
VOL_CL=F	78278.08	121015.3	259086.0	351161.0	530974.5	791551.2	1004983.82
VOL_GC=F	0.0	6.0	48.0	187.0	597.0	6047.1	180877.14
VOL_^VIX	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HL_VLO	0.501591	0.68	1.269999	2.029999	3.254997	5.793001	8.398796
OC_VLO	-5.366794	-2.919999	-0.790005	0.059998	0.807193	2.711006	5.152599
HL_PSX	0.615797	0.838997	1.365	1.950005	2.779999	4.611001	6.388393
OC_PSX	-4.202602	-2.579995	-0.75	0.029999	0.805	2.320993	3.8742
HL_MPC	0.4279	0.630001	1.060001	1.630001	2.775002	5.360001	8.174211
OC_MPC	-4.934206	-2.372002	-0.682505	0.029999	0.740002	2.330002	4.698404
HL_^GSPC	5.643237	7.839087	14.440125	26.169922	46.494995	94.246021	143.808208
OC_^GSPC	-93.140293	-47.661157	-9.670044	1.25	13.290039	42.933154	75.455293
HL_CL=F	0.66	0.880001	1.330002	1.780006	2.480001	4.364001	7.0852
OC_CL=F	-3.944196	-2.279999	-0.779999	0.049995	0.779999	2.029999	3.559401
HL_GC=F	0.0	0.299927	7.349976	13.400024	22.599976	48.910022	101.184077
OC_GC=F	-52.594028	-24.409912	-6.049988	0.0	6.950012	25.209949	52.051948
HL_^VIX	0.360001	0.53	0.889999	1.380001	2.27	4.853	10.189401
OC_^VIX	-3.7978	-1.992	-0.78	-0.22	0.349999	2.141	4.8494
vlo_next_ret	-0.063443	-0.035729	-0.010673	0.001094	0.013086	0.035263	0.058786
EquityDown_OilDown	0.0	0.0	0.0	0.0	1.0	1.0	1.0
RiskOff	0.0	0.0	0.0	0.0	0.0	1.0	1.0
HighVIX	0.0	0.0	0.0	0.0	1.0	1.0	1.0
VLO_vol5	0.003874	0.006655	0.012273	0.017306	0.024294	0.040763	0.071274
VLO_vol10	0.00652	0.009608	0.014118	0.018413	0.024293	0.038331	0.071663
VLO_vol20	0.00805	0.011207	0.015613	0.019326	0.023559	0.037781	0.073604
VLO_vol_ratio_5_20	0.258142	0.405787	0.6853	0.919884	1.181407	1.545243	1.755665
OilShock	0.0	0.0	0.0	0.0	0.0	1.0	1.0
GoldShock	0.0	0.0	0.0	0.0	0.0	1.0	1.0
VLO_minus_SPX	-0.054574	-0.032339	-0.010243	0.000557	0.011086	0.032379	0.055172
RefinerPeerAvg	-0.057405	-0.032221	-0.009411	0.001254	0.011882	0.031239	0.050627
VLO_minus_Peers	-0.027841	-0.018078	-0.006283	0.000139	0.006263	0.017653	0.029955
Oil_minus_SPX	-0.066122	-0.037068	-0.01197	-0.000256	0.011916	0.034422	0.060881

feature	1%	5%	25%	50%	75%	95%	99%
Oil_minus_Refiners	-0.063196	-0.038042	-0.014915	-0.000732	0.012777	0.037923	0.067049
VLO_mom3	-0.107409	-0.063645	-0.018694	0.003275	0.025148	0.060535	0.095684
VLO_mom5	-0.143933	-0.080194	-0.02344	0.005451	0.033972	0.081201	0.133278
VLO_ret5_avg	-0.028787	-0.016039	-0.004688	0.00109	0.006794	0.01624	0.026656
VLO_reversal_signal	-0.026656	-0.01624	-0.006794	-0.00109	0.004688	0.016039	0.028787
VLO_zscore20	-2.429141	-1.64155	-0.6278	-0.000649	0.632197	1.555626	2.272767
SPX_zscore20	-2.638829	-1.697463	-0.610832	-0.034128	0.595498	1.578741	2.126496
Oil_zscore20	-2.450381	-1.684892	-0.644687	0.029318	0.642463	1.533584	2.075658

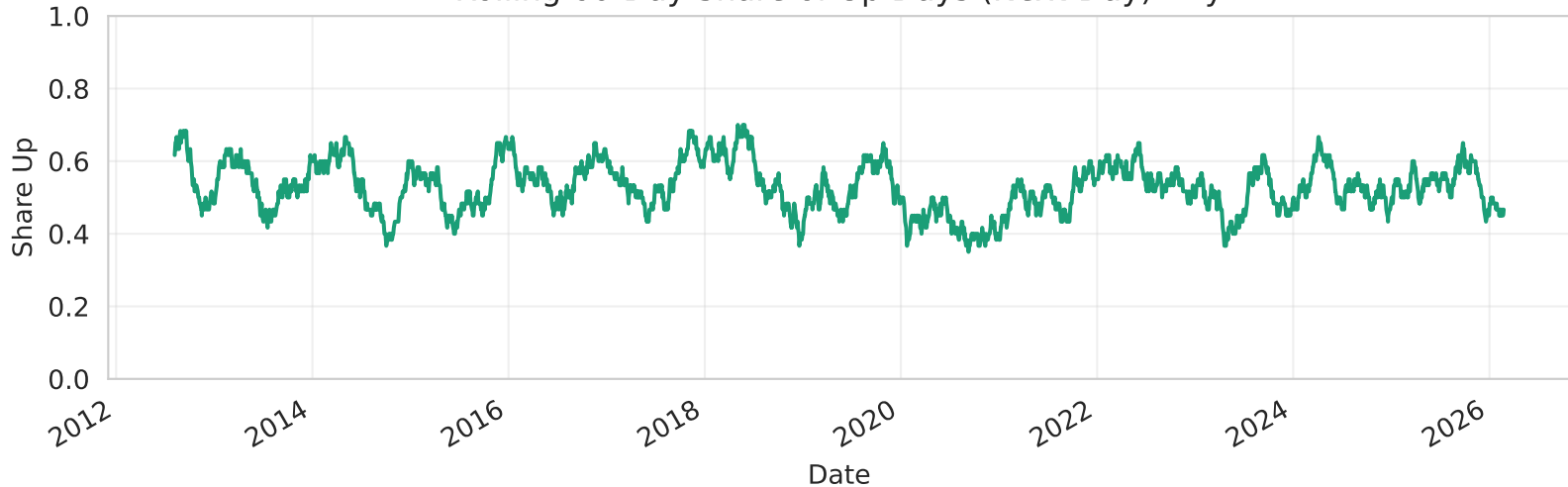
Top-Variance Numeric Features — Histograms



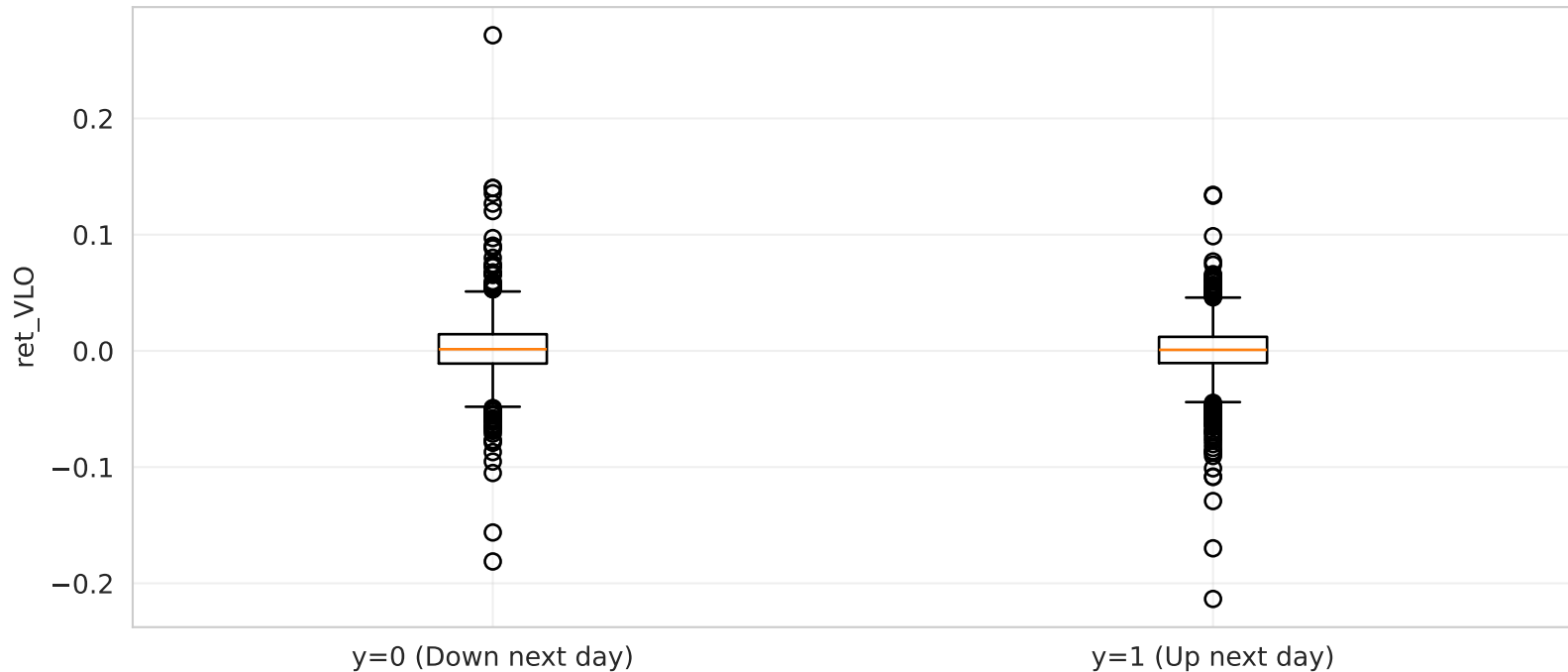
Class Counts — y (VLO Next-Day Direction) + Mean Next-Day Return (vlo\_next\_ret)



Rolling 60-Day Share of Up Days (Next-Day) — y

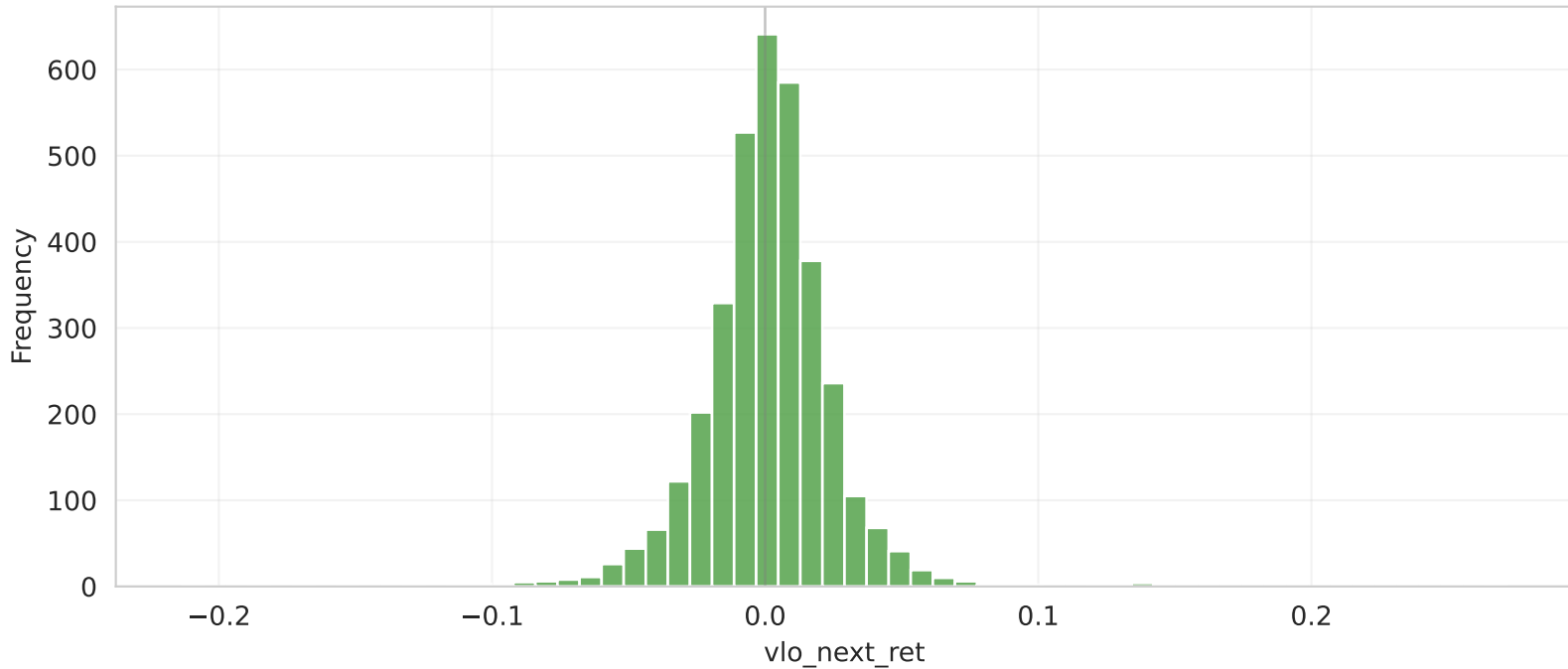


VLO Daily Log Returns (ret\_VLO) by Next-Day Direction (y)

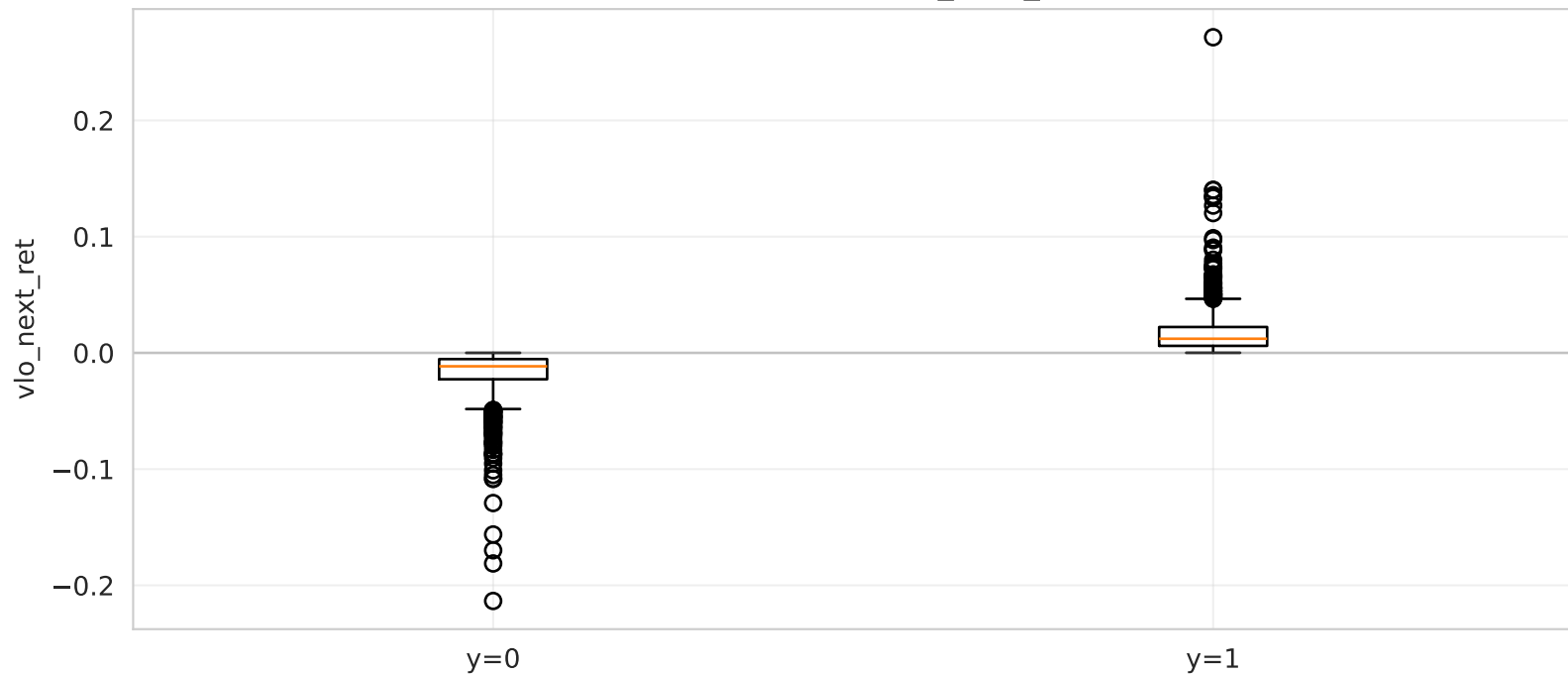




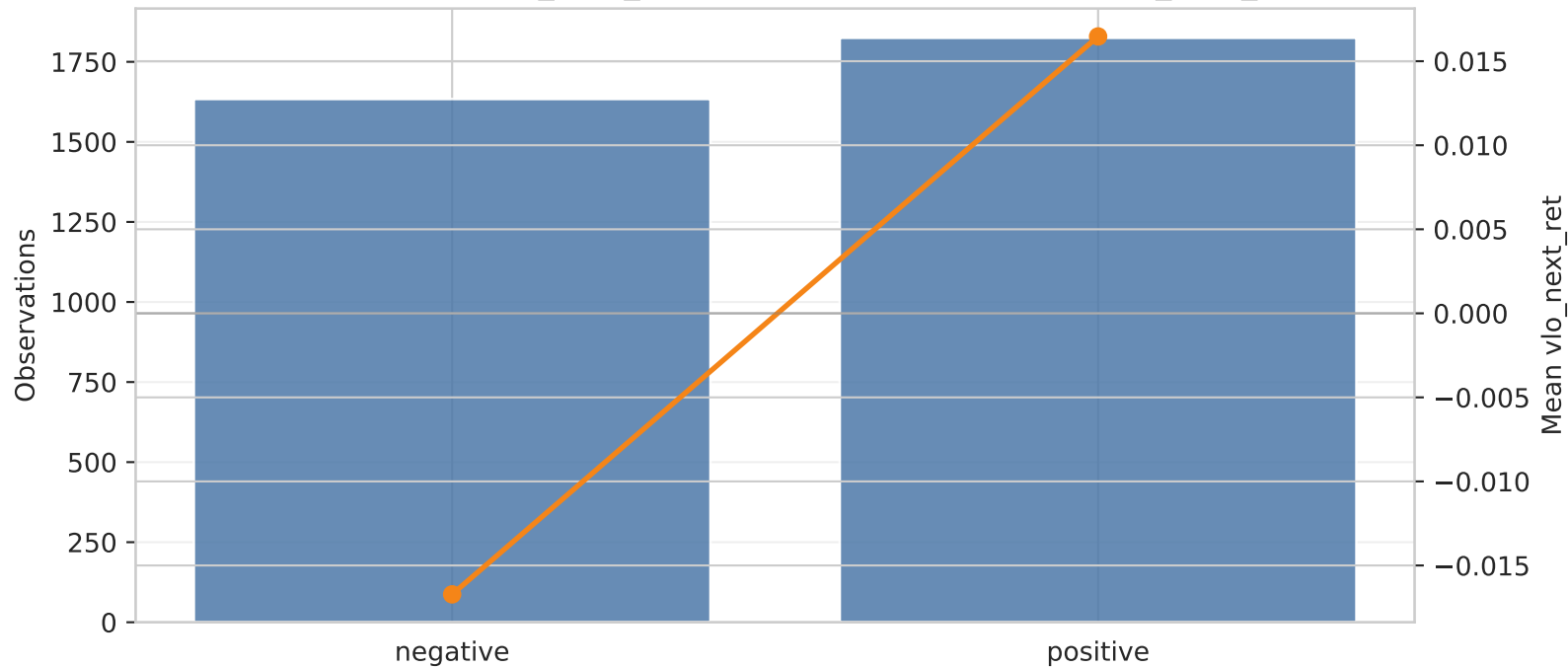
Distribution — Next-Day VLO Return (vlo\_next\_ret)



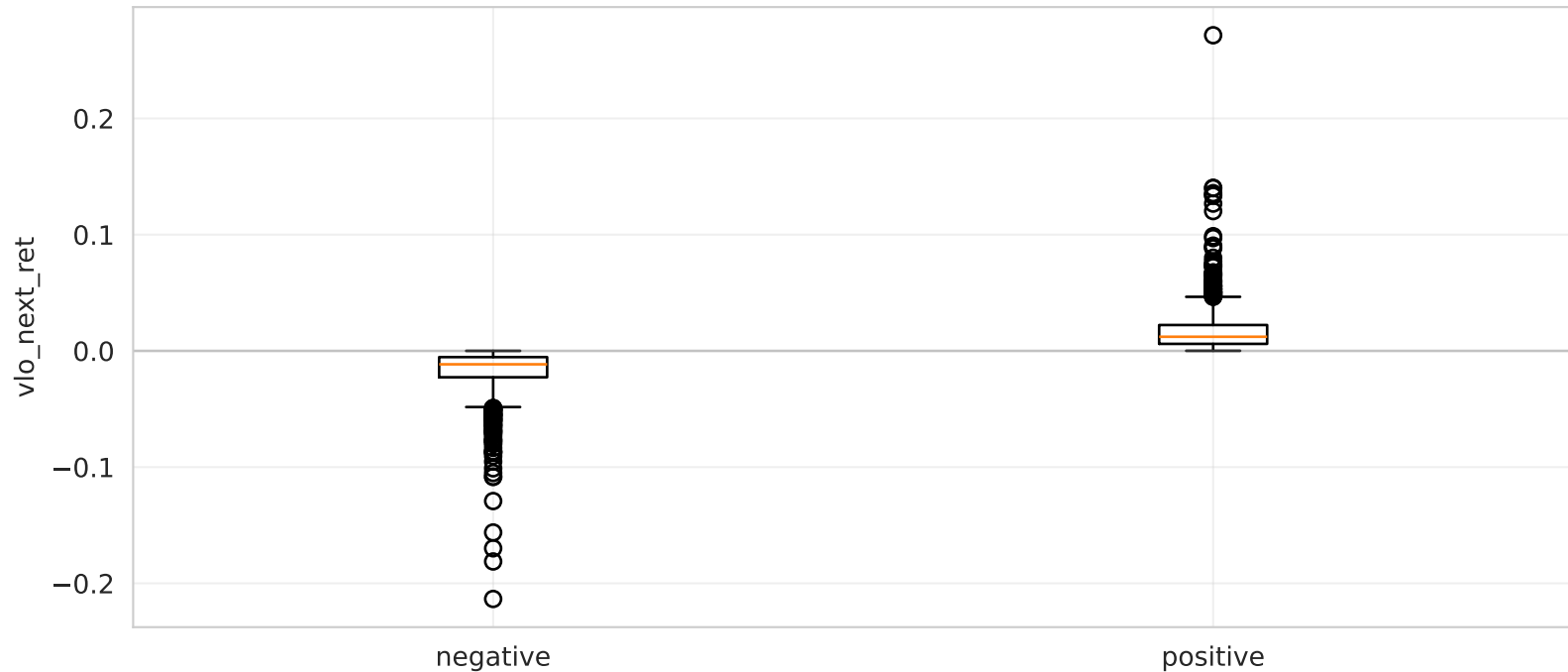
Next-Day VLO Return (vlo\_next\_ret) by y



Class Counts — vlo\_next\_dir + Mean Next-Day Return (vlo\_next\_ret)



Next-Day VLO Return (vlo\_next\_ret) by vlo\_next\_dir



Next-Day Return Stats by vlo\_next\_dir (metrics as rows; groups as columns)

metric	negative	positive
n	1634.0	1825.0
mean	-0.01671975	0.01647241
median	-0.01155561	0.01214429
std	0.01790377	0.01676052
sem	0.00044291	0.00039233
min	-0.21345158	5.063e-05
p01	-0.07985171	0.00025942
p05	-0.04808611	0.0010693
p25	-0.02270212	0.00602479
p75	-0.00535098	0.02224586
p95	-0.00088465	0.04502633
p99	-0.00013192	0.07256604
max	0.0	0.27157182
skew	-3.3522771	4.13921588
kurtosis_excess	21.52519419	38.91488089
win_rate	0.0	1.0
mean_if_up	nan	0.01647241
mean_if_down	-0.0168227	nan
sharpe_ann	-14.82468506	15.60162978
t_mean_vs_0	-37.74950243	41.98567425
p_mean_vs_0	0.0	0.0

Between-Group Comparison (positive vs negative): metrics as rows

metric	value
pos_label	positive
neg_label	negative
n_pos	1825
n_neg	1634
mean_pos	0.01647241
mean_neg	-0.01671975
mean_diff_pos_minus_neg	0.03319216
median_pos	0.01214429
median_neg	-0.01155561
median_diff_pos_minus_neg	0.0236999
std_pos	0.01676052
std_neg	0.01790377
welch_t	56.09713359
welch_p	0.0
ks_stat	1.0
ks_p	0.0
cohens_d	1.91751629
cliffs_delta	1.0
win_rate_pos	1.0
win_rate_neg	0.0
win_rate_diff_pos_minus_neg	1.0

# All Features — Univariate Associations with y (page 1/2)

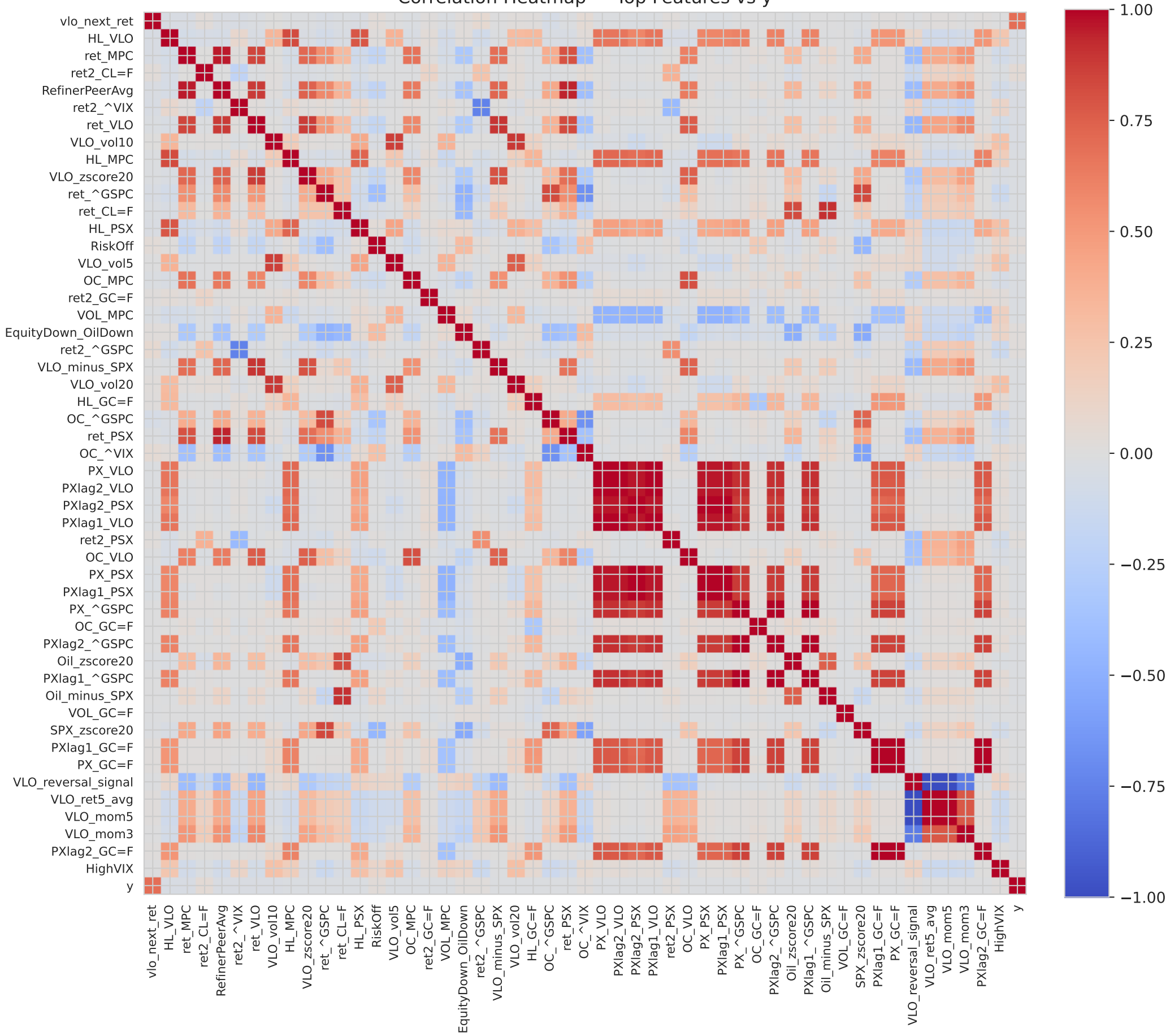
feature	corr_y	abs_corr_y	tstat_y	ks_y	auc_y	mi_y
vlo_next_ret	0.691619	0.691619	56.097134	1.0	1.0	0.691766
HL_VLO	-0.044332	0.044332	-2.593851	0.038674	0.480021	0.0
ret_MPC	-0.042287	0.042287	-2.48891	0.036044	0.488842	0.0
ret2_CL=F	0.042253	0.042253	2.505418	0.039735	0.521735	0.0
RefinerPeerAvg	-0.033644	0.033644	-1.978106	0.023725	0.495242	0.005399
ret2_^VIX	-0.033354	0.033354	-1.954799	0.046068	0.483362	0.003182
ret_VLO	-0.031618	0.031618	-1.852138	0.040258	0.489039	0.008008
VLO_vol10	-0.031258	0.031258	-1.83038	0.032182	0.48738	0.000123
HL_MPC	-0.030606	0.030606	-1.792196	0.039563	0.483994	0.0
VLO_zscore20	-0.027095	0.027095	-1.591572	0.040073	0.486015	0.011045
ret_^GSPC	-0.026639	0.026639	-1.5628	0.037271	0.48426	0.008567
ret_CL=F	-0.026405	0.026405	-1.553466	0.051018	0.484979	0.0
HL_PSX	-0.026028	0.026028	-1.521277	0.029419	0.493874	0.011242
RiskOff	0.024803	0.024803	1.46205	0.019198	0.509599	0.011727
VLO_vol5	-0.024454	0.024454	-1.432874	0.035917	0.48926	0.018236
OC_MPC	-0.024156	0.024156	-1.411619	0.019614	0.496886	0.0
ret2_GC=F	-0.024073	0.024073	-1.417414	0.046815	0.478184	0.0
VOL_MPC	-0.023542	0.023542	-1.383422	0.027917	0.489495	0.0
EquityDown_OilDown	0.023087	0.023087	1.359701	0.020215	0.510108	0.0
ret2_^GSPC	0.022904	0.022904	1.34324	0.017491	0.501715	0.002043
VLO_minus_SPX	-0.022887	0.022887	-1.339084	0.028866	0.493048	0.0
VLO_vol20	-0.02139	0.02139	-1.254175	0.028539	0.491498	0.00387
HL_GC=F	-0.021064	0.021064	-1.222552	0.025652	0.488918	0.022028
OC_^GSPC	-0.021051	0.021051	-1.234074	0.042203	0.488093	0.007725
ret_PSX	-0.019903	0.019903	-1.168802	0.02587	0.501923	0.0
OC_^VIX	0.019629	0.019629	1.153966	0.026035	0.507767	0.0
PX_VLO	-0.0192	0.0192	-1.127614	0.025781	0.488711	0.0
PXlag2_VLO	-0.018704	0.018704	-1.098468	0.027811	0.489746	0.008733
PXlag2_PSX	-0.018154	0.018154	-1.067084	0.029954	0.490719	0.009663
PXlag1_VLO	-0.018116	0.018116	-1.06401	0.024367	0.489827	0.0
ret2_PSX	0.017965	0.017965	1.051129	0.028754	0.511011	0.0
OC_VLO	-0.01788	0.01788	-1.04371	0.036423	0.491684	0.0
PX_PSX	-0.017733	0.017733	-1.042414	0.026955	0.489879	0.008844
PXlag1_PSX	-0.016884	0.016884	-0.992533	0.023926	0.490951	0.0
PX_^GSPC	-0.016439	0.016439	-0.967199	0.046167	0.487066	0.00227
OC_GC=F	0.01641	0.01641	0.956368	0.035662	0.516812	0.0
PXlag2_^GSPC	-0.016292	0.016292	-0.958621	0.045747	0.487058	0.0
Oil_zscore20	-0.01608	0.01608	-0.943974	0.050136	0.48706	0.000276
PXlag1_^GSPC	-0.015758	0.015758	-0.927176	0.04532	0.487278	0.0
Oil_minus_SPX	-0.015728	0.015728	-0.924224	0.043254	0.490234	0.002942

# All Features — Univariate Associations with y (page 2/2)

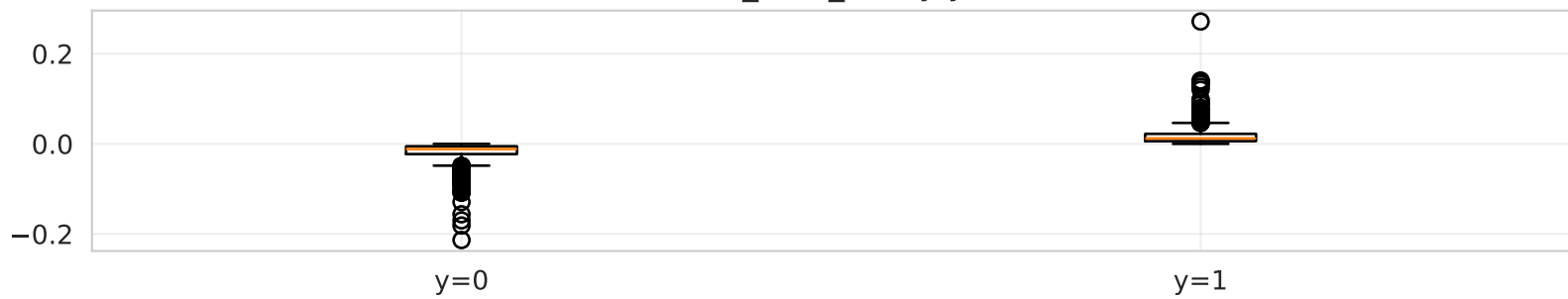
feature	corr_y	abs_corr_y	tstat_y	ks_y	auc_y	mi_y
VOL_GC=F	-0.01443	0.01443	-0.845747	0.04879	0.475172	0.00639
SPX_zscore20	-0.013554	0.013554	-0.795391	0.036097	0.489233	0.0
PXlag1_GC=F	-0.013442	0.013442	-0.789046	0.034054	0.494526	0.002539
PX_GC=F	-0.013359	0.013359	-0.784111	0.032709	0.494269	0.0
VLO_reversal_signal	0.012935	0.012935	0.759042	0.019599	0.501405	0.011621
VLO_ret5_avg	-0.012935	0.012935	-0.759042	0.019599	0.498595	0.011362
VLO_mom5	-0.012935	0.012935	-0.759042	0.019599	0.498595	0.011394
VLO_mom3	-0.012795	0.012795	-0.750711	0.017696	0.498961	0.000238
PXlag2_GC=F	-0.012612	0.012612	-0.740441	0.033833	0.495034	0.0
HighVIX	0.011933	0.011933	0.701967	0.011419	0.505709	0.0
PX_MPC	-0.011747	0.011747	-0.69005	0.021825	0.493461	0.0
PXlag1_CL=F	0.011592	0.011592	0.681473	0.019331	0.506749	0.009776
OC_CL=F	-0.011227	0.011227	-0.660163	0.046521	0.487385	0.0
PXlag2_MPC	-0.011141	0.011141	-0.654455	0.018262	0.494652	0.00203
PXlag1_MPC	-0.010741	0.010741	-0.630964	0.017918	0.494816	0.004214
PX_CL=F	0.010664	0.010664	0.627079	0.018114	0.506392	0.0
OilShock	-0.009933	0.009933	-0.582848	0.004633	0.497683	0.017679
VLO_vol_ratio_5_20	-0.009267	0.009267	-0.544206	0.028731	0.494509	0.002435
PXlag2_CL=F	0.008514	0.008514	0.500501	0.019691	0.505364	2.5e-05
HL_^VIX	0.008325	0.008325	0.490354	0.022998	0.50509	0.0
ret2_MPC	0.0082	0.0082	0.479095	0.029998	0.508891	0.01112
VOL_^GSPC	-0.006988	0.006988	-0.410251	0.03471	0.490419	0.0
VOL_VLO	0.006795	0.006795	0.400042	0.022884	0.503318	0.009263
PXlag1_^VIX	-0.006018	0.006018	-0.352841	0.029527	0.502184	0.0
OC_PSX	-0.005191	0.005191	-0.304145	0.025864	0.5038	0.006963
HL_^GSPC	-0.004895	0.004895	-0.286936	0.029557	0.491744	0.007193
PXlag2_^VIX	0.004729	0.004729	0.278091	0.026808	0.505889	0.001993
VOL_CL=F	-0.004543	0.004543	-0.267245	0.024619	0.495246	0.0
VLO_minus_Peers	-0.002827	0.002827	-0.165608	0.034993	0.49631	0.007235
ret_^VIX	0.002394	0.002394	0.140639	0.021594	0.497265	0.00073
VOL_PSX	-0.00211	0.00211	-0.124074	0.016834	0.49974	0.0
GoldShock	0.001916	0.001916	0.112713	0.00091	0.500455	0.0
Oil_minus_Refiners	0.001638	0.001638	0.096383	0.029188	0.494016	0.005367
HL_CL=F	-0.001106	0.001106	-0.065524	0.035783	0.488569	0.007043
ret_GC=F	0.001012	0.001012	0.059416	0.02601	0.502306	0.0
ret2_VLO	0.000998	0.000998	0.058331	0.024499	0.499433	0.01945
PX_^VIX	-0.000783	0.000783	-0.046042	0.019033	0.500034	0.0
VOL_^VIX	nan	nan	nan	0.0	nan	0.0



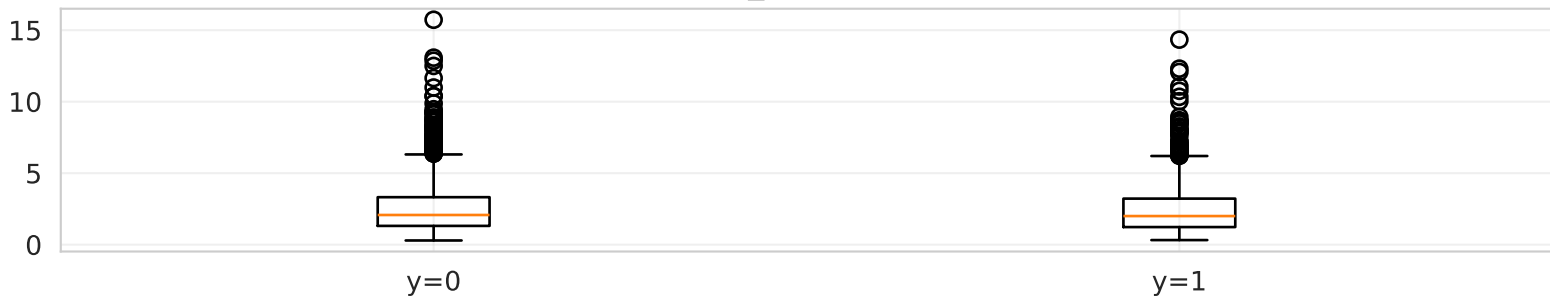
Correlation Heatmap — Top Features vs y



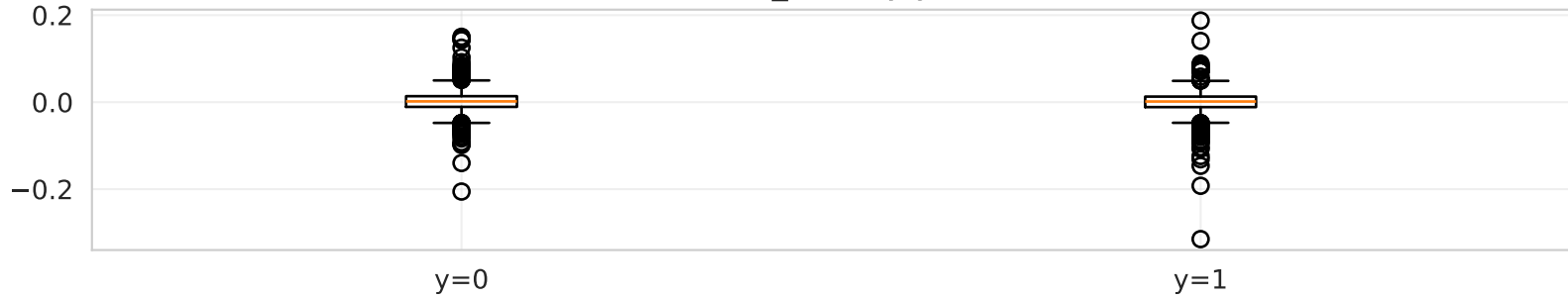
vlo\_next\_ret by y



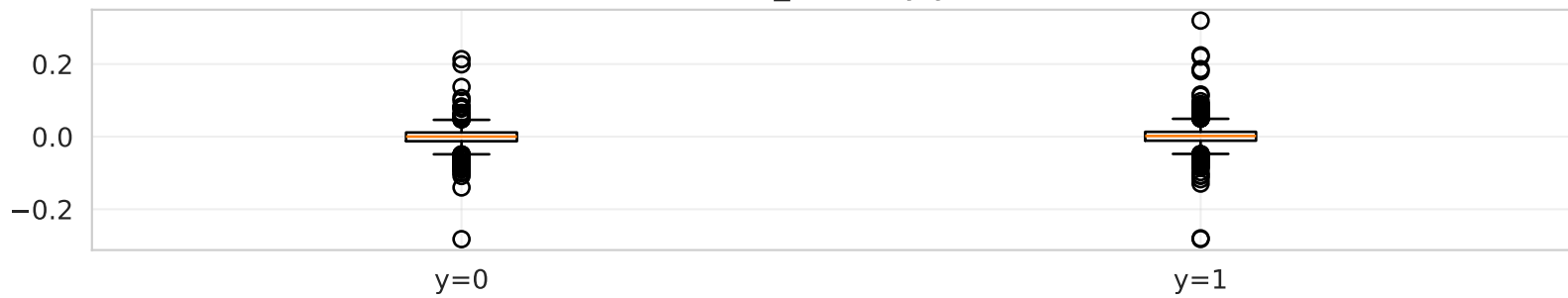
HL\_VLO by y



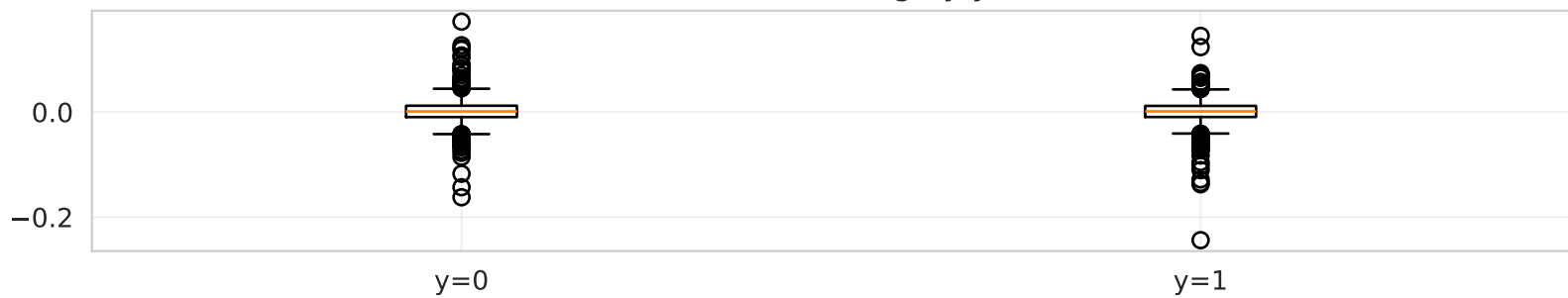
ret\_MPC by y



ret2\_CL=F by y



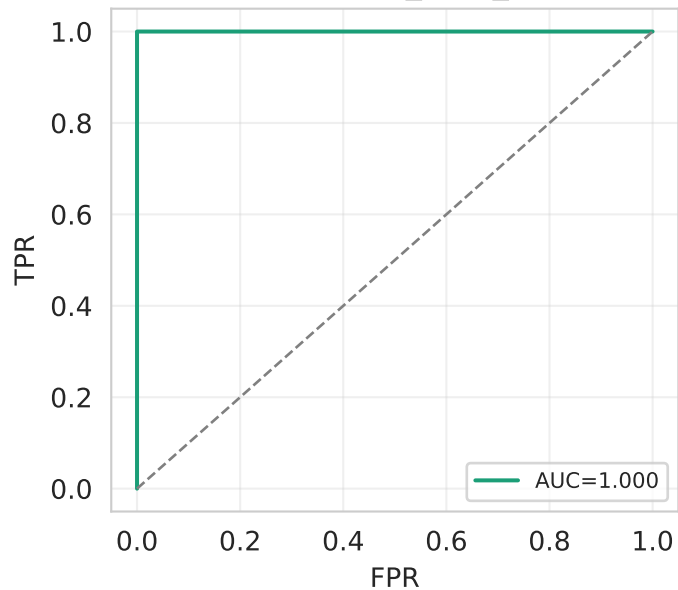
RefinerPeerAvg by y



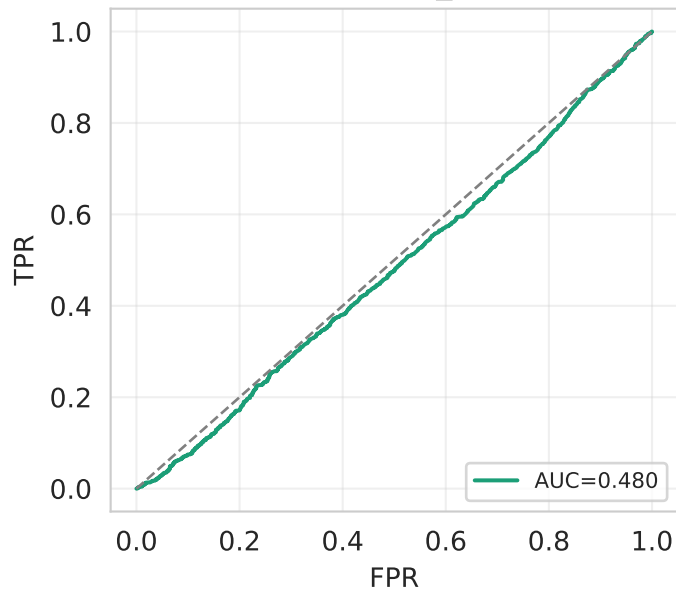
ret2\_^VIX by y



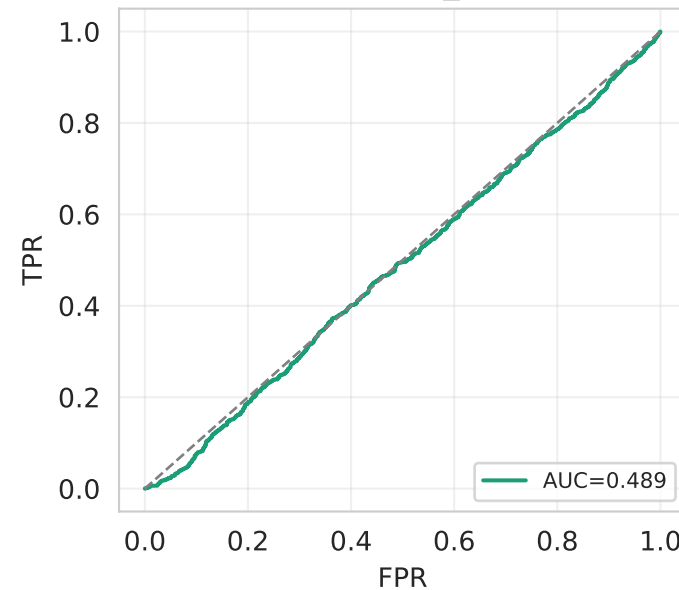
ROC — vlo\_next\_ret



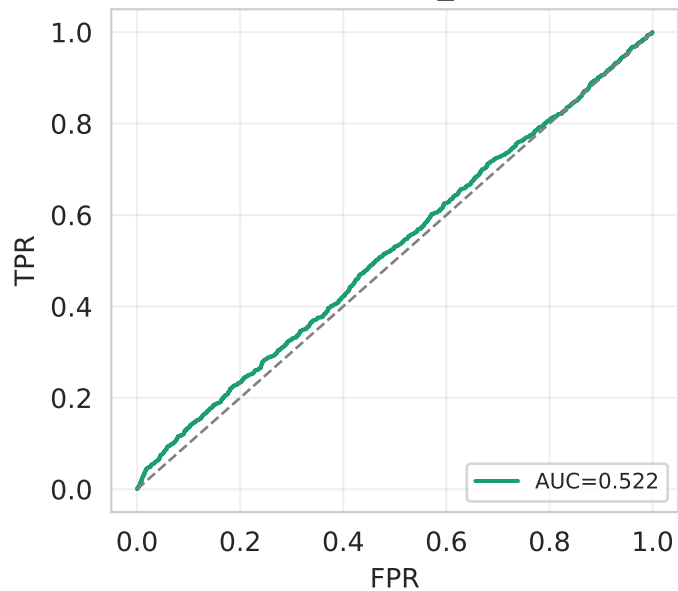
ROC — HL\_VLO



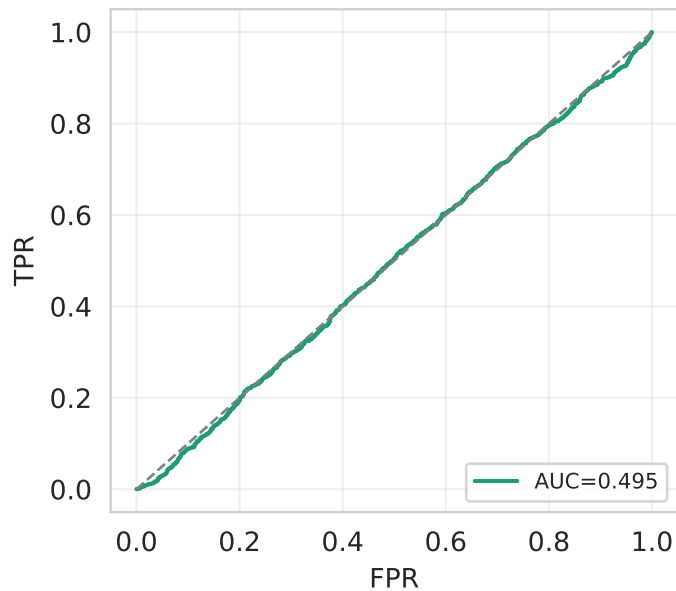
ROC — ret\_MPC



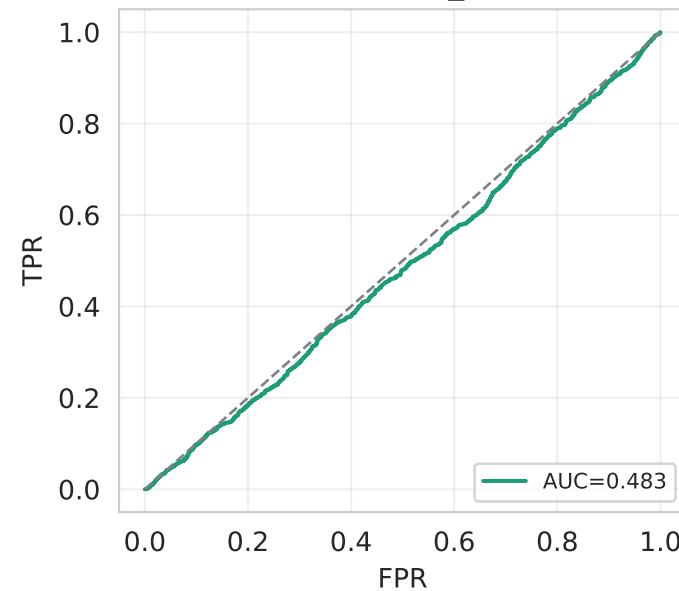
ROC — ret2\_CL=F



ROC — RefinerPeerAvg



ROC — ret2\_VIX



## Class-Wise Summary (Key Series)

ret_1^GSPC mean	ret_1^GSPC std	ret_1^GSPC min	ret_1^GSPC median	ret_1^GSPC max	ret_CL=F count	ret_CL=F mean	ret_CL=F std	ret_CL=F min
0.000775	0.010884	-0.127652	0.000907	0.090895	1634.0	0.000693	0.025726	-0.099945
0.000208	0.010389	-0.099945	0.000452	0.089683	1825.0	-0.000671	0.025841	-0.127652

## t Metadata

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Features (numeric): 78  
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scipy available: True  
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