# Engineered Feature EDA Report

Tickers: SPY, GLD, CL=F, PSX, VLO, MPC, EUR_USD

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

## CL=F • Schema & Missingness

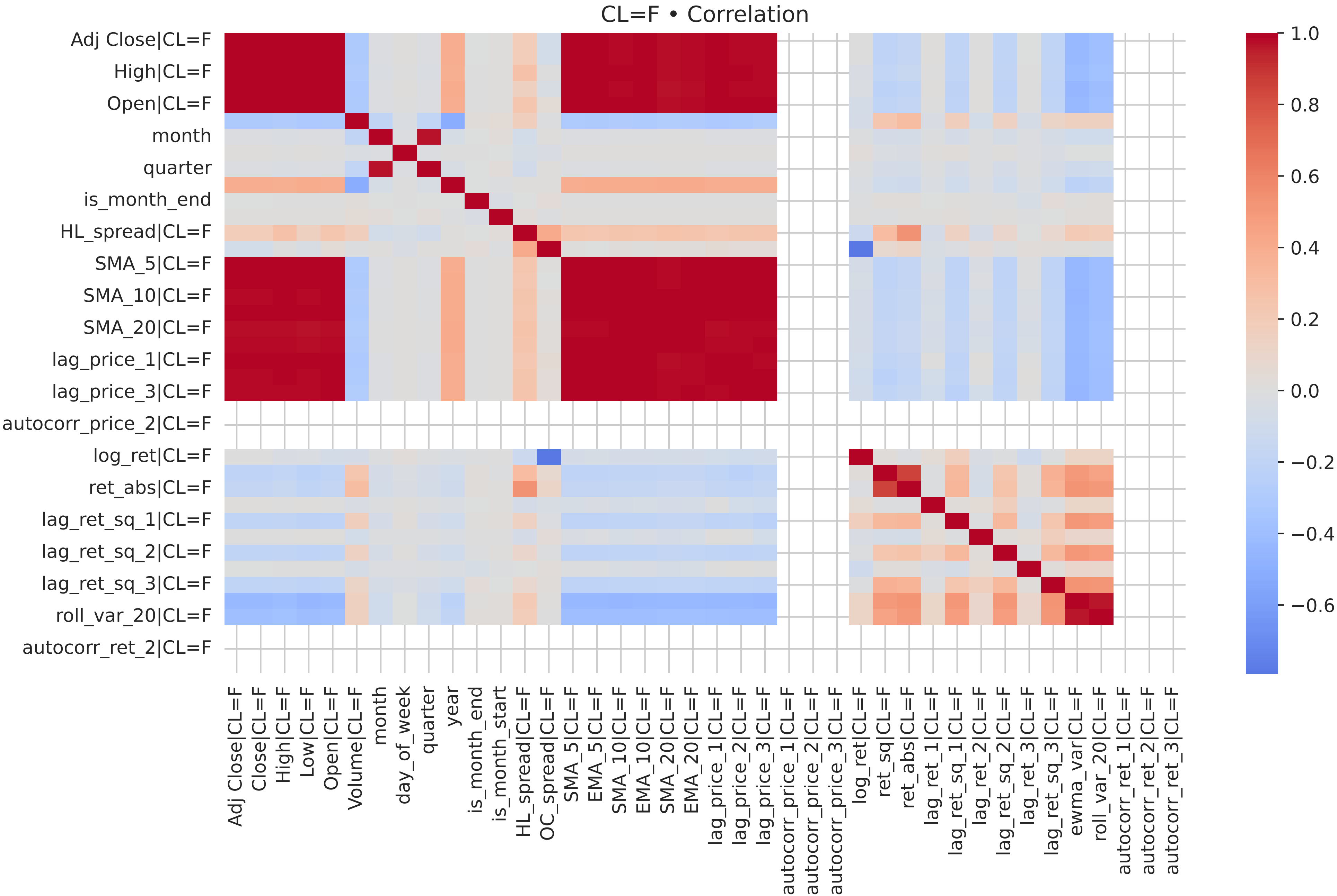
| Column | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|
| Adj Close CL=F | float64 | 1793 | 0 | 0.0 | 1539 | 46.54 |
| Close CL=F | float64 | 1793 | 0 | 0.0 | 1539 | 46.54 |
| High CL=F | float64 | 1793 | 0 | 0.0 | 1512 | 47.78 |
| Low CL=F | float64 | 1793 | 0 | 0.0 | 1535 | 44.35 |
| Open CL=F | float64 | 1793 | 0 | 0.0 | 1531 | 45.8 |
| Volume CL=F | int64 | 1793 | 0 | 0.0 | 1781 | 850480.0 |
| month | int32 | 1793 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | int32 | 1793 | 0 | 0.0 | 5 | 2.0 |
| quarter | int32 | 1793 | 0 | 0.0 | 4 | 1.0 |
| year | int32 | 1793 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | int64 | 1793 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | int64 | 1793 | 0 | 0.0 | 2 | 0.0 |
| HL_spread CL=F | float64 | 1793 | 0 | 0.0 | 1022 | 3.43 |
| OC_spread CL=F | float64 | 1793 | 0 | 0.0 | 1158 | -0.74 |
| SMA_5 CL=F | float64 | 1793 | 0 | 0.0 | 1765 | 46.54 |
| EMA_5 CL=F | float64 | 1793 | 0 | 0.0 | 1793 | 46.54 |
| SMA_10 CL=F | float64 | 1793 | 0 | 0.0 | 1782 | 46.54 |
| EMA_10 CL=F | float64 | 1793 | 0 | 0.0 | 1793 | 46.54 |
| SMA_20 CL=F | float64 | 1793 | 0 | 0.0 | 1788 | 46.54 |
| EMA_20 CL=F | float64 | 1793 | 0 | 0.0 | 1793 | 46.54 |
| lag_price_1 CL=F | float64 | 1792 | 1 | 0.06 | 1538 | 46.54 |
| lag_price_2 CL=F | float64 | 1791 | 2 | 0.11 | 1537 | 46.54 |
| lag_price_3 CL=F | float64 | 1790 | 3 | 0.17 | 1536 | 46.54 |
| autocorr_price_1 CL=F | float64 | 1793 | 0 | 0.0 | 1 | 0.9904 |
| autocorr_price_2 CL=F | float64 | 1793 | 0 | 0.0 | 1 | 0.985 |
| autocorr_price_3 CL=F | float64 | 1793 | 0 | 0.0 | 1 | 0.9802 |
| log_ret CL=F | float64 | 1790 | 3 | 0.17 | 1781 | 0.0117 |
| ret_sq CL=F | float64 | 1790 | 3 | 0.17 | 1781 | 0.0001 |
| ret_abs CL=F | float64 | 1790 | 3 | 0.17 | 1781 | 0.0117 |
| lag_ret_1 CL=F | float64 | 1789 | 4 | 0.22 | 1780 | 0.0117 |
| lag_ret_sq_1 CL=F | float64 | 1789 | 4 | 0.22 | 1780 | 0.0001 |
| lag_ret_2 CL=F | float64 | 1788 | 5 | 0.28 | 1779 | 0.0117 |
| lag_ret_sq_2 CL=F | float64 | 1788 | 5 | 0.28 | 1779 | 0.0001 |
| lag_ret_3 CL=F | float64 | 1787 | 6 | 0.33 | 1778 | 0.0117 |
| lag_ret_sq_3 CL=F | float64 | 1787 | 6 | 0.33 | 1778 | 0.0001 |
| ewma_var CL=F | float64 | 1792 | 1 | 0.06 | 1790 | 0.0001 |
| roll_var_20 CL=F | float64 | 1788 | 5 | 0.28 | 1787 | 0.0003 |
| autocorr_ret_1 CL=F | float64 | 1793 | 0 | 0.0 | 1 | 0.0477 |
| autocorr_ret_2 CL=F | float64 | 1793 | 0 | 0.0 | 1 | -0.038 |
| autocorr_ret_3 CL=F | float64 | 1793 | 0 | 0.0 | 1 | -0.1045 |

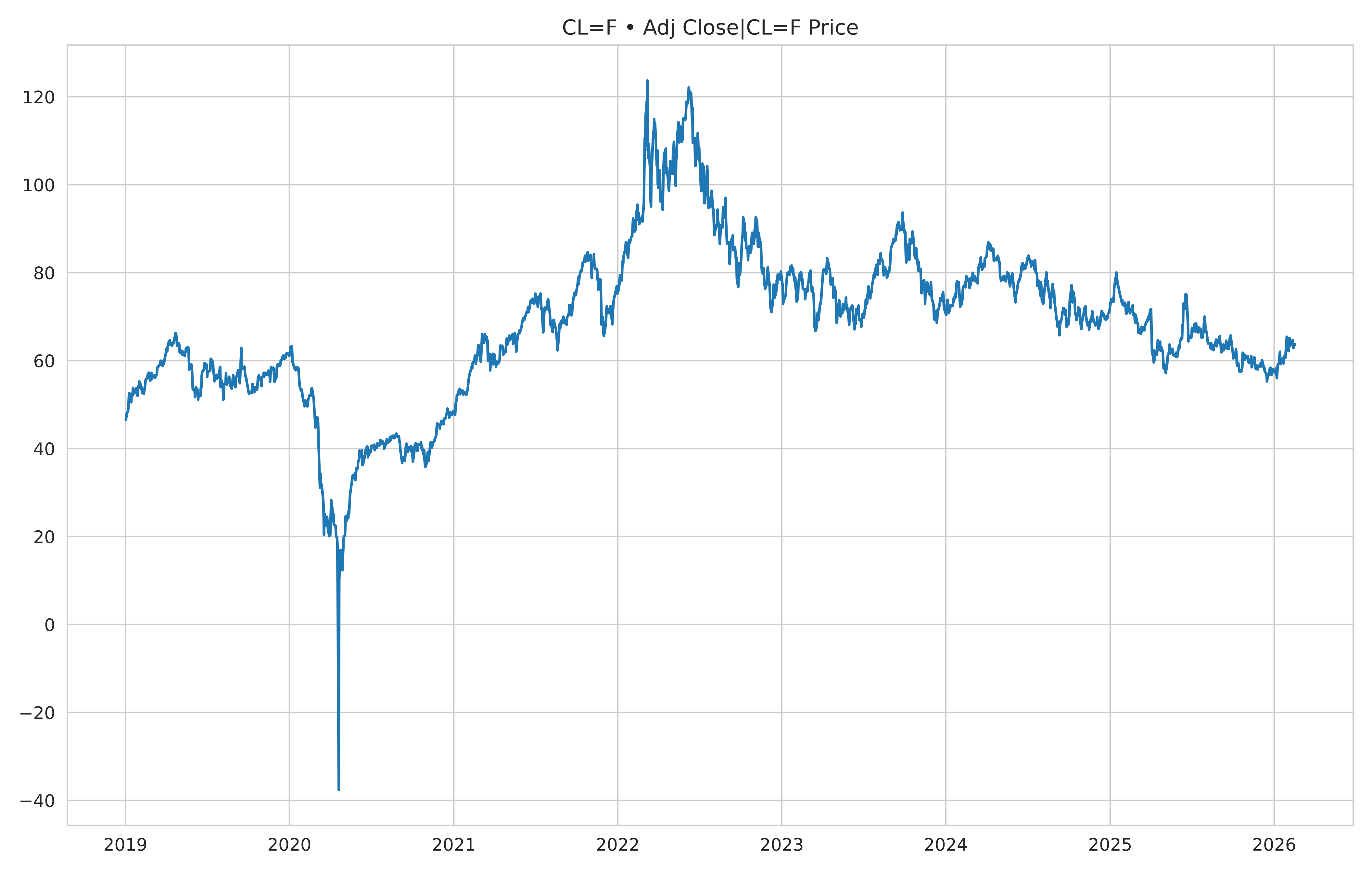
# CL=F • Numeric Quality & Ranges

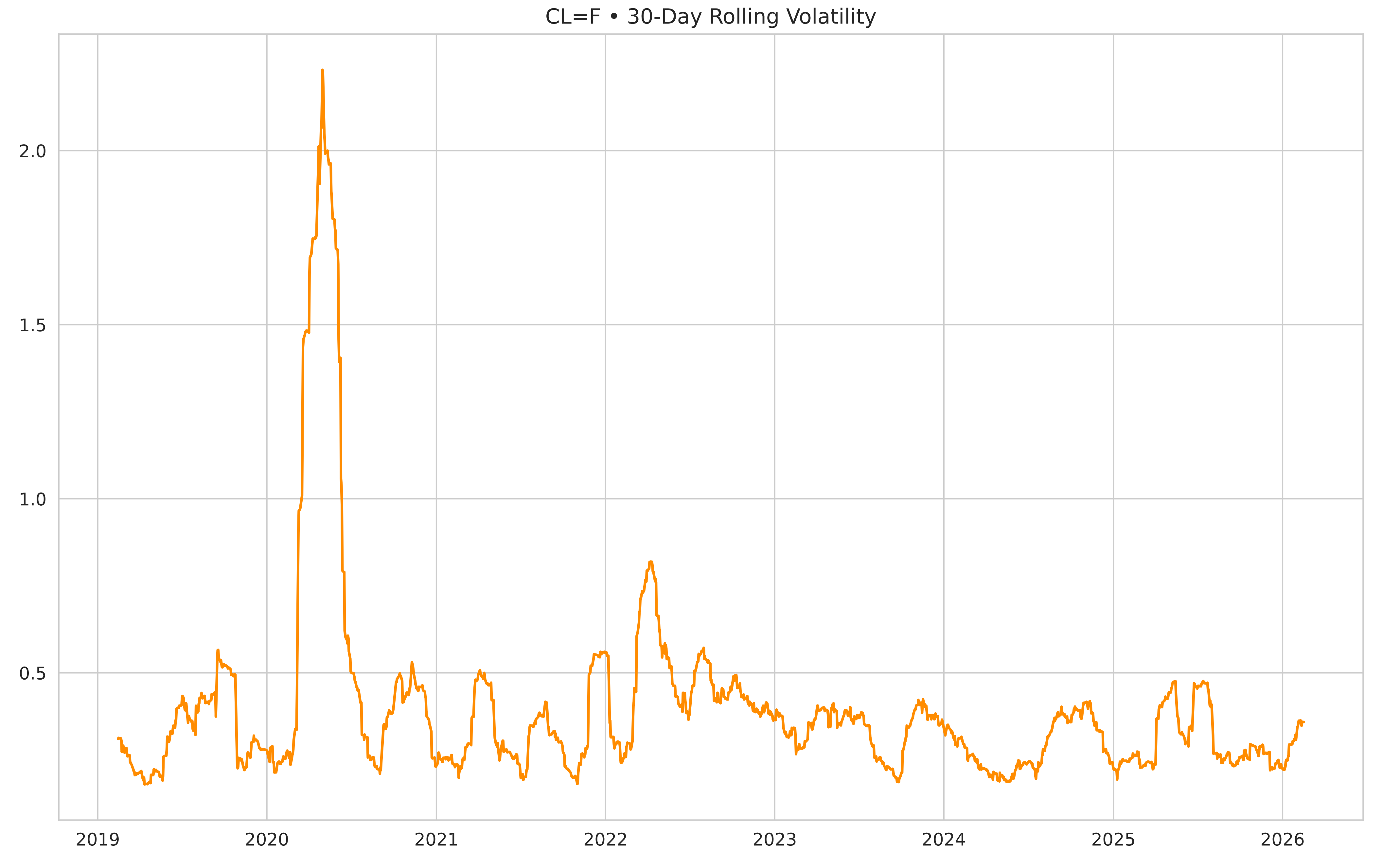
| Column | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| j Close CL=F | 1793 | 0 | 0.0 | 0 | 1 | -37.63 | 20.4728 | 58.01 | 68.72 | 67.9744 | 78.48 | 114.2376 | 123.7 | 17.8106 |
| Close CL=F | 1793 | 0 | 0.0 | 0 | 1 | -37.63 | 20.4728 | 58.01 | 68.72 | 67.9744 | 78.48 | 114.2376 | 123.7 | 17.8106 |
| High CL=F | 1793 | 0 | 0.0 | 0 | 0 | 13.69 | 23.4112 | 58.74 | 69.89 | 69.205 | 79.6 | 116.5756 | 130.5 | 18.017 |
| Low CL=F | 1793 | 0 | 0.0 | 0 | 2 | -40.32 | 20.0052 | 57.2 | 67.71 | 66.7358 | 77.25 | 110.6292 | 120.79 | 17.5547 |
| Open CL=F | 1793 | 0 | 0.0 | 0 | 1 | -14.0 | 21.2384 | 58.05 | 68.98 | 68.0192 | 78.48 | 114.2216 | 124.66 | 17.7695 |
| Volume CL=F | 1793 | 0 | 0.0 | 6 | 0 | 0.0 | 69900.92 | 275331.0 | 345368.0 | 386041.42 | 458006.0 | 1011916.44 | 2288230 | 198168.4901 |
| month | 1793 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4584 | 9.0 | 12.0 | 12.0 | 3.4701 |
| day_of_week | 1793 | 0 | 0.0 | 335 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0234 | 3.0 | 4.0 | 4.0 | 1.4001 |
| quarter | 1793 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4902 | 3.0 | 4.0 | 4.0 | 1.1235 |
| year | 1793 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0669 | 2024.0 | 2026.0 | 2026.0 | 2.0521 |
| s_month_end | 1793 | 0 | 0.0 | 1734 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0329 | 0.0 | 1.0 | 1.0 | 0.1784 |
| _month_start | 1793 | 0 | 0.0 | 1738 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0307 | 0.0 | 1.0 | 1.0 | 0.1725 |
| spread CL=F | 1793 | 0 | 0.0 | 0 | 0 | 0.62 | 0.7284 | 1.44 | 2.02 | 2.4692 | 2.84 | 9.0532 | 58.17 | 2.175 |
| spread CL=F | 1793 | 0 | 0.0 | 12 | 933 | -24.01 | -4.0316 | -0.86 | -0.08 | 0.0448 | 0.81 | 5.0132 | 55.36 | 2.1925 |
| SMA_5 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 3.92 | 22.0309 | 57.838 | 69.054 | 67.956 | 78.43 | 113.0436 | 120.926 | 17.7191 |
| EMA_5 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 0.8439 | 22.0131 | 57.8955 | 69.1224 | 67.9555 | 78.4277 | 111.9791 | 120.4604 | 17.6902 |
| MA_10 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 9.689 | 22.4555 | 57.77 | 69.339 | 67.9341 | 78.258 | 112.1218 | 119.383 | 17.6629 |
| MA_10 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 10.5557 | 22.108 | 57.5886 | 69.4641 | 67.9319 | 78.3044 | 111.2735 | 118.8597 | 17.6119 |
| MA_20 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 15.709 | 18.8401 | 57.606 | 69.3845 | 67.8956 | 78.1485 | 112.3873 | 116.281 | 17.5742 |
| MA_20 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 16.034 | 21.4475 | 57.5779 | 69.5875 | 67.8886 | 78.0271 | 111.5554 | 116.1898 | 17.4674 |
| price_1 CL=F | 1792 | 1 | 0.06 | 0 | 1 | -37.63 | 20.4719 | 58.01 | 68.73 | 67.9768 | 78.4825 | 114.2423 | 123.7 | 17.8153 |
| price_2 CL=F | 1791 | 2 | 0.11 | 0 | 1 | -37.63 | 20.471 | 58.01 | 68.74 | 67.9796 | 78.485 | 114.247 | 123.7 | 17.8199 |
| price_3 CL=F | 1790 | 3 | 0.17 | 0 | 1 | -37.63 | 20.4701 | 58.01 | 68.755 | 67.9825 | 78.4875 | 114.2517 | 123.7 | 17.8245 |
| price_1 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.0 |
| price_2 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.0 |
| price_3 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.0 |
| log_ret CL=F | 1790 | 3 | 0.17 | 9 | 828 | -0.2822 | -0.0805 | -0.0129 | 0.0019 | 0.0005 | 0.0141 | 0.0674 | 0.3196 | 0.0304 |
| ret_sq CL=F | 1790 | 3 | 0.17 | 9 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0009 | 0.0006 | 0.0098 | 0.1022 | 0.0049 |
| ret_abs CL=F | 1790 | 3 | 0.17 | 9 | 0 | 0.0 | 0.0002 | 0.0064 | 0.0139 | 0.0191 | 0.0241 | 0.0989 | 0.3196 | 0.0237 |
| g_ret_1 CL=F | 1789 | 4 | 0.22 | 9 | 828 | -0.2822 | -0.0806 | -0.0129 | 0.0019 | 0.0005 | 0.0141 | 0.0674 | 0.3196 | 0.0304 |
| et_sq_1 CL=F | 1789 | 4 | 0.22 | 9 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0009 | 0.0006 | 0.0098 | 0.1022 | 0.0049 |
| g_ret_2 CL=F | 1788 | 5 | 0.28 | 9 | 828 | -0.2822 | -0.0806 | -0.0129 | 0.0019 | 0.0005 | 0.0141 | 0.0674 | 0.3196 | 0.0304 |
| et_sq_2 CL=F | 1788 | 5 | 0.28 | 9 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0009 | 0.0006 | 0.0098 | 0.1022 | 0.0049 |
| g_ret_3 CL=F | 1787 | 6 | 0.33 | 9 | 827 | -0.2822 | -0.0806 | -0.0128 | 0.0019 | 0.0005 | 0.0141 | 0.0674 | 0.3196 | 0.0304 |
| et_sq_3 CL=F | 1787 | 6 | 0.33 | 9 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0009 | 0.0006 | 0.0098 | 0.1022 | 0.0049 |
| ma_var CL=F | 1792 | 1 | 0.06 | 0 | 0 | 0.0001 | 0.0001 | 0.0003 | 0.0005 | 0.0009 | 0.0007 | 0.0126 | 0.0209 | 0.0022 |
| var_20 CL=F | 1788 | 5 | 0.28 | 0 | 0 | 0.0001 | 0.0001 | 0.0002 | 0.0004 | 0.0009 | 0.0007 | 0.0159 | 0.0236 | 0.0025 |
| r_ret_1 CL=F | 1793 | 0 | 0.0 | 0 | 0 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0 |
| r_ret_2 CL=F | 1793 | 0 | 0.0 | 0 | 1793 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | 0.0 |
| r_ret_3 CL=F | 1793 | 0 | 0.0 | 0 | 1793 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | 0.0 |

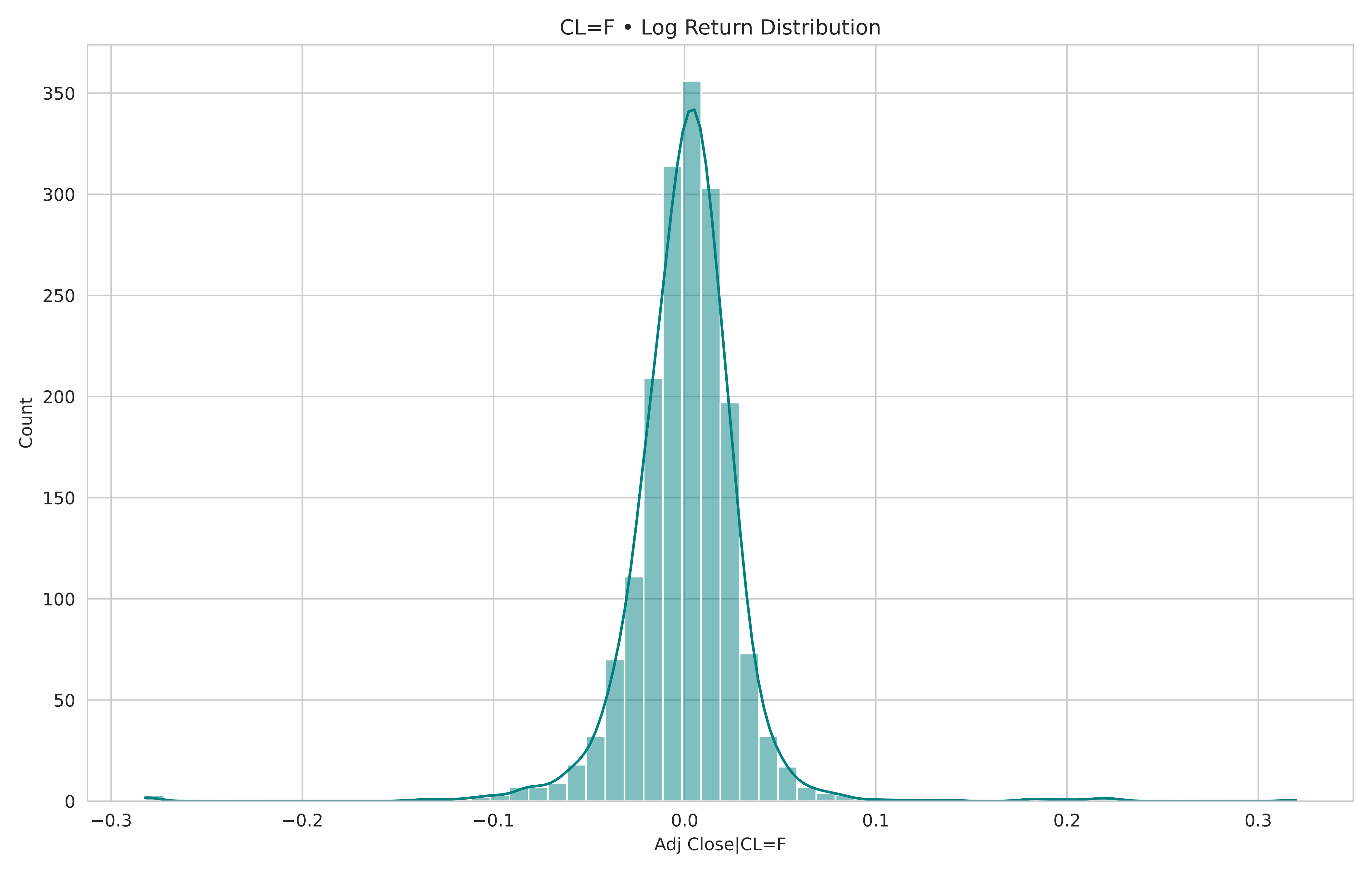
# CL=F • Describe

| Variable | | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close | CL=F | 1793.0 | 67.9744 | 17.8106 | -37.63 | 20.4728 | 39.192 | 58.01 | 68.72 | 78.48 | 97.858 | 114.2376 | 123.7 |
| Close | CL=F | 1793.0 | 67.9744 | 17.8106 | -37.63 | 20.4728 | 39.192 | 58.01 | 68.72 | 78.48 | 97.858 | 114.2376 | 123.7 |
| High | CL=F | 1793.0 | 69.205 | 18.017 | 13.69 | 23.4112 | 39.866 | 58.74 | 69.89 | 79.6 | 101.63 | 116.5756 | 130.5 |
| Low | CL=F | 1793.0 | 66.7358 | 17.5547 | -40.32 | 20.0052 | 37.682 | 57.2 | 67.71 | 77.25 | 95.172 | 110.6292 | 120.79 |
| Open | CL=F | 1793.0 | 68.0192 | 17.7695 | -14.0 | 21.2384 | 39.042 | 58.05 | 68.98 | 78.48 | 98.19 | 114.2216 | 124.66 |
| Volume | CL=F | 1793.0 | 386041.42 | 198168.4901 | 0.0 | 69900.92 | 102217.0 | 275331.0 | 345368.0 | 458006.0 | 753814.8 | 1011916.44 | 2288230.0 |
| month | | 1793.0 | 6.4584 | 3.4701 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | | 1793.0 | 2.0234 | 1.4001 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | | 1793.0 | 2.4902 | 1.1235 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | | 1793.0 | 2022.0669 | 2.0521 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | | 1793.0 | 0.0329 | 0.1784 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | | 1793.0 | 0.0307 | 0.1725 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| _spread | CL=F | 1793.0 | 2.4692 | 2.175 | 0.62 | 0.7284 | 0.99 | 1.44 | 2.02 | 2.84 | 5.338 | 9.0532 | 58.17 |
| C_spread | CL=F | 1793.0 | 0.0448 | 2.1925 | -24.01 | -4.0316 | -2.29 | -0.86 | -0.08 | 0.81 | 2.678 | 5.0132 | 55.36 |
| SMA_5 | CL=F | 1793.0 | 67.956 | 17.7191 | 3.92 | 22.0309 | 39.1544 | 57.838 | 69.054 | 78.43 | 99.3564 | 113.0436 | 120.926 |
| EMA_5 | CL=F | 1793.0 | 67.9555 | 17.6902 | 0.8439 | 22.0131 | 39.0393 | 57.8955 | 69.1224 | 78.4277 | 99.65 | 111.9791 | 120.4604 |
| SMA_10 | CL=F | 1793.0 | 67.9341 | 17.6629 | 9.689 | 22.4555 | 39.0564 | 57.77 | 69.339 | 78.258 | 100.1336 | 112.1218 | 119.383 |
| EMA_10 | CL=F | 1793.0 | 67.9319 | 17.6119 | 10.5557 | 22.108 | 39.1836 | 57.5886 | 69.4641 | 78.3044 | 100.8638 | 111.2735 | 118.8597 |
| SMA_20 | CL=F | 1793.0 | 67.8956 | 17.5742 | 15.709 | 18.8401 | 39.306 | 57.606 | 69.3845 | 78.1485 | 101.582 | 112.3873 | 116.281 |
| EMA_20 | CL=F | 1793.0 | 67.8886 | 17.4674 | 16.034 | 21.4475 | 39.2744 | 57.5779 | 69.5875 | 78.0271 | 101.9887 | 111.5554 | 116.1898 |
| _price_1 | CL=F | 1792.0 | 67.9768 | 17.8153 | -37.63 | 20.4719 | 39.1885 | 58.01 | 68.73 | 78.4825 | 97.8915 | 114.2423 | 123.7 |
| _price_2 | CL=F | 1791.0 | 67.9796 | 17.8199 | -37.63 | 20.471 | 39.185 | 58.01 | 68.74 | 78.485 | 97.925 | 114.247 | 123.7 |
| _price_3 | CL=F | 1790.0 | 67.9825 | 17.8245 | -37.63 | 20.4701 | 39.1815 | 58.01 | 68.755 | 78.4875 | 97.9585 | 114.2517 | 123.7 |
| _price_1 | CL=F | 1793.0 | 0.9904 | 0.0 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 | 0.9904 |
| _price_2 | CL=F | 1793.0 | 0.985 | 0.0 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 |
| _price_3 | CL=F | 1793.0 | 0.9802 | 0.0 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 | 0.9802 |
| log_ret | CL=F | 1790.0 | 0.0005 | 0.0304 | -0.2822 | -0.0805 | -0.0398 | -0.0129 | 0.0019 | 0.0141 | 0.0355 | 0.0674 | 0.3196 |
| ret_sq | CL=F | 1790.0 | 0.0009 | 0.0049 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0025 | 0.0098 | 0.1022 |
| ret_abs | CL=F | 1790.0 | 0.0191 | 0.0237 | 0.0 | 0.0002 | 0.0013 | 0.0064 | 0.0139 | 0.0241 | 0.0504 | 0.0989 | 0.3196 |
| ag_ret_1 | CL=F | 1789.0 | 0.0005 | 0.0304 | -0.2822 | -0.0806 | -0.0398 | -0.0129 | 0.0019 | 0.0141 | 0.0355 | 0.0674 | 0.3196 |
| ret_sq_1 | CL=F | 1789.0 | 0.0009 | 0.0049 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0025 | 0.0098 | 0.1022 |
| ag_ret_2 | CL=F | 1788.0 | 0.0005 | 0.0304 | -0.2822 | -0.0806 | -0.0399 | -0.0129 | 0.0019 | 0.0141 | 0.0355 | 0.0674 | 0.3196 |
| ret_sq_2 | CL=F | 1788.0 | 0.0009 | 0.0049 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0025 | 0.0098 | 0.1022 |
| ag_ret_3 | CL=F | 1787.0 | 0.0005 | 0.0304 | -0.2822 | -0.0806 | -0.0399 | -0.0128 | 0.0019 | 0.0141 | 0.0356 | 0.0674 | 0.3196 |
| ret_sq_3 | CL=F | 1787.0 | 0.0009 | 0.0049 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0025 | 0.0098 | 0.1022 |
| wma_var | CL=F | 1792.0 | 0.0009 | 0.0022 | 0.0001 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0007 | 0.0022 | 0.0126 | 0.0209 |
| l_var_20 | CL=F | 1788.0 | 0.0009 | 0.0025 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0004 | 0.0007 | 0.0017 | 0.0159 | 0.0236 |
| orr_ret_1 | CL=F | 1793.0 | 0.0477 | 0.0 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 | 0.0477 |
| orr_ret_2 | CL=F | 1793.0 | -0.038 | 0.0 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 | -0.038 |
| orr_ret_3 | CL=F | 1793.0 | -0.1045 | 0.0 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 | -0.1045 |


CL=F • Correlation
Adj Close|CL=F
High|CL=F
Open|CL=F
month
quarter
is_month_end
HL_spread|CL=F
SMA_5|CL=F
SMA_10|CL=F
SMA_20|CL=F
lag_price_1|CL=F
lag_price_3|CL=F
autocorr_price_2|CL=F
log_ret|CL=F
ret_abs|CL=F
lag_ret_sq_1|CL=F
lag_ret_sq_2|CL=F
lag_ret_sq_3|CL=F
roll_var_20|CL=F
autocorr_ret_2|CL=F
Adj Close|CL=F
Close|CL=F
High|CL=F
Low|CL=F
Open|CL=F
Volume|CL=F
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|CL=F
OC_spread|CL=F
SMA_5|CL=F
EMA_5|CL=F
SMA_10|CL=F
EMA_10|CL=F
SMA_20|CL=F
EMA_20|CL=F
lag_price_1|CL=F
lag_price_2|CL=F
lag_price_3|CL=F
autocorr_price_1|CL=F
autocorr_price_2|CL=F
autocorr_price_3|CL=F
log_ret|CL=F
ret_sq|CL=F
ret_abs|CL=F
lag_ret_1|CL=F
lag_ret_sq_1|CL=F
lag_ret_2|CL=F
lag_ret_sq_2|CL=F
lag_ret_3|CL=F
lag_ret_sq_3|CL=F
ewma_var|CL=F
roll_var_20|CL=F
autocorr_ret_1|CL=F
autocorr_ret_2|CL=F
autocorr_ret_3|CL=F
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6


CL=F • Adj Close|CL=F Price
120
100
80
60
40
20
0
−20
−40
2019
2020
2021
2022
2023
2024
2025
2026


CL=F • 30-Day Rolling Volatility
2.0
1.5
1.0
0.5
2019
2020
2021
2022
2023
2024
2025
2026


CL=F • Log Return Distribution
Count
350
300
250
200
150
100
50
0
−0.3
−0.2
−0.1
0.0
0.1
0.2
0.3
Adj Close|CL=F

# EUR_USD • Schema & Missingness

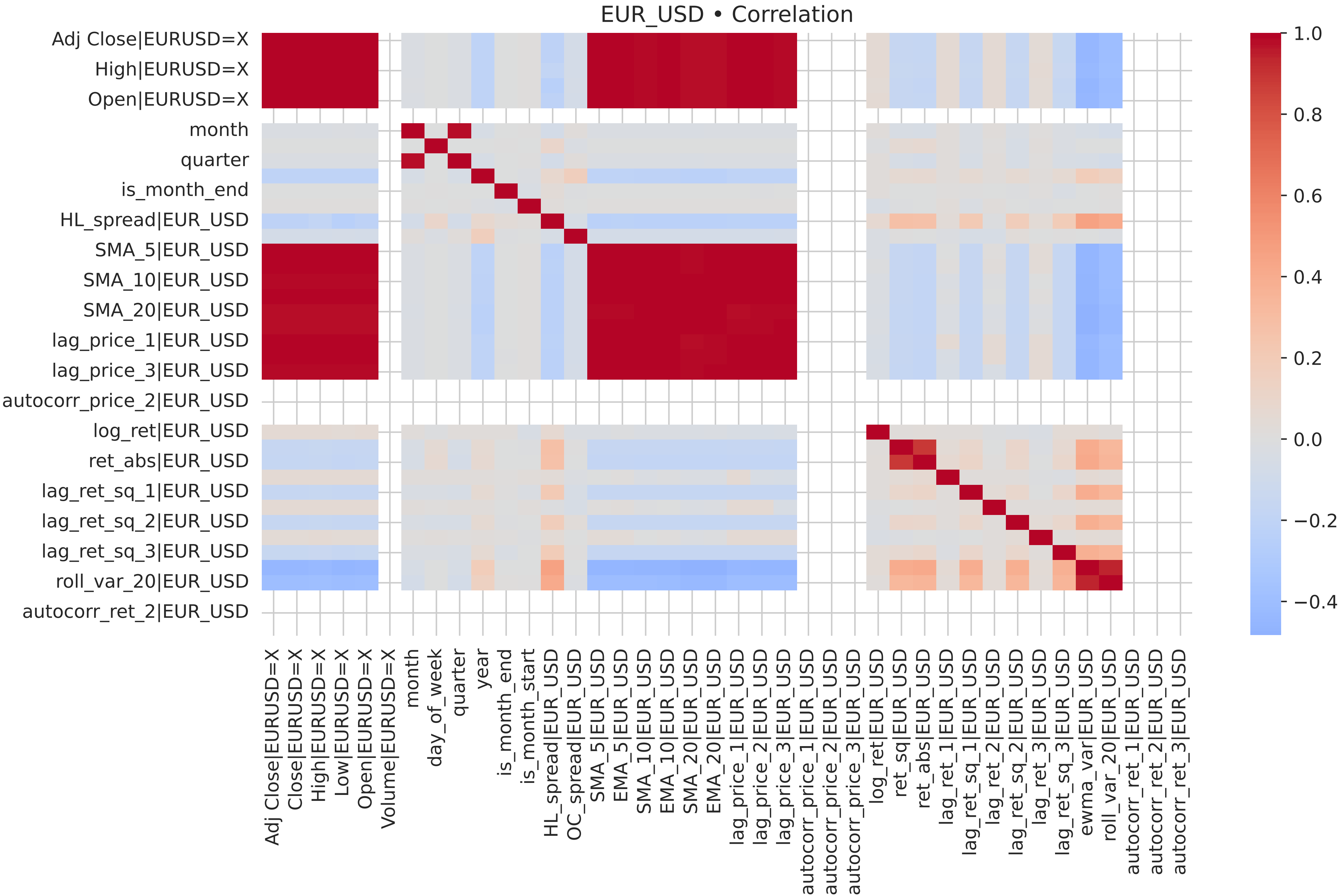
| Column | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|
| Adj Close \| EURUSD=X | float64 | 1854 | 0 | 0.0 | 1686 | 1.1493 |
| Close \| EURUSD=X | float64 | 1854 | 0 | 0.0 | 1686 | 1.1493 |
| High \| EURUSD=X | float64 | 1854 | 0 | 0.0 | 1599 | 1.155 |
| Low \| EURUSD=X | float64 | 1854 | 0 | 0.0 | 1727 | 1.1465 |
| Open \| EURUSD=X | float64 | 1854 | 0 | 0.0 | 1707 | 1.1494 |
| Volume \| EURUSD=X | int64 | 1854 | 0 | 0.0 | 1 | 0.0 |
| month | int32 | 1854 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | int32 | 1854 | 0 | 0.0 | 5 | 1.0 |
| quarter | int32 | 1854 | 0 | 0.0 | 4 | 1.0 |
| year | int32 | 1854 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | int64 | 1854 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | int64 | 1854 | 0 | 0.0 | 2 | 1.0 |
| HL_spread \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1845 | 0.0085 |
| OC_spread \| EUR_USD | float64 | 1854 | 0 | 0.0 | 810 | 0.0001 |
| SMA_5 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1854 | 1.1493 |
| EMA_5 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1854 | 1.1493 |
| SMA_10 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1853 | 1.1493 |
| EMA_10 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1854 | 1.1493 |
| SMA_20 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1854 | 1.1493 |
| EMA_20 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1854 | 1.1493 |
| lag_price_1 \| EUR_USD | float64 | 1853 | 1 | 0.05 | 1686 | 1.1493 |
| lag_price_2 \| EUR_USD | float64 | 1852 | 2 | 0.11 | 1685 | 1.1493 |
| lag_price_3 \| EUR_USD | float64 | 1851 | 3 | 0.16 | 1684 | 1.1493 |
| tocorr_price_1 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1 | 0.9957 |
| tocorr_price_2 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1 | 0.9912 |
| tocorr_price_3 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1 | 0.9869 |
| log_ret \| EUR_USD | float64 | 1853 | 1 | 0.05 | 1848 | -0.0027 |
| ret_sq \| EUR_USD | float64 | 1853 | 1 | 0.05 | 1848 | 0.0 |
| ret_abs \| EUR_USD | float64 | 1853 | 1 | 0.05 | 1848 | 0.0027 |
| lag_ret_1 \| EUR_USD | float64 | 1852 | 2 | 0.11 | 1847 | -0.0027 |
| lag_ret_sq_1 \| EUR_USD | float64 | 1852 | 2 | 0.11 | 1847 | 0.0 |
| lag_ret_2 \| EUR_USD | float64 | 1851 | 3 | 0.16 | 1846 | -0.0027 |
| lag_ret_sq_2 \| EUR_USD | float64 | 1851 | 3 | 0.16 | 1846 | 0.0 |
| lag_ret_3 \| EUR_USD | float64 | 1850 | 4 | 0.22 | 1845 | -0.0027 |
| lag_ret_sq_3 \| EUR_USD | float64 | 1850 | 4 | 0.22 | 1845 | 0.0 |
| ewma_var \| EUR_USD | float64 | 1853 | 1 | 0.05 | 1853 | 0.0 |
| roll_var_20 \| EUR_USD | float64 | 1849 | 5 | 0.27 | 1849 | 0.0001 |
| autocorr_ret_1 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1 | 0.0223 |
| autocorr_ret_2 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1 | -0.0094 |
| autocorr_ret_3 \| EUR_USD | float64 | 1854 | 0 | 0.0 | 1 | -0.0368 |

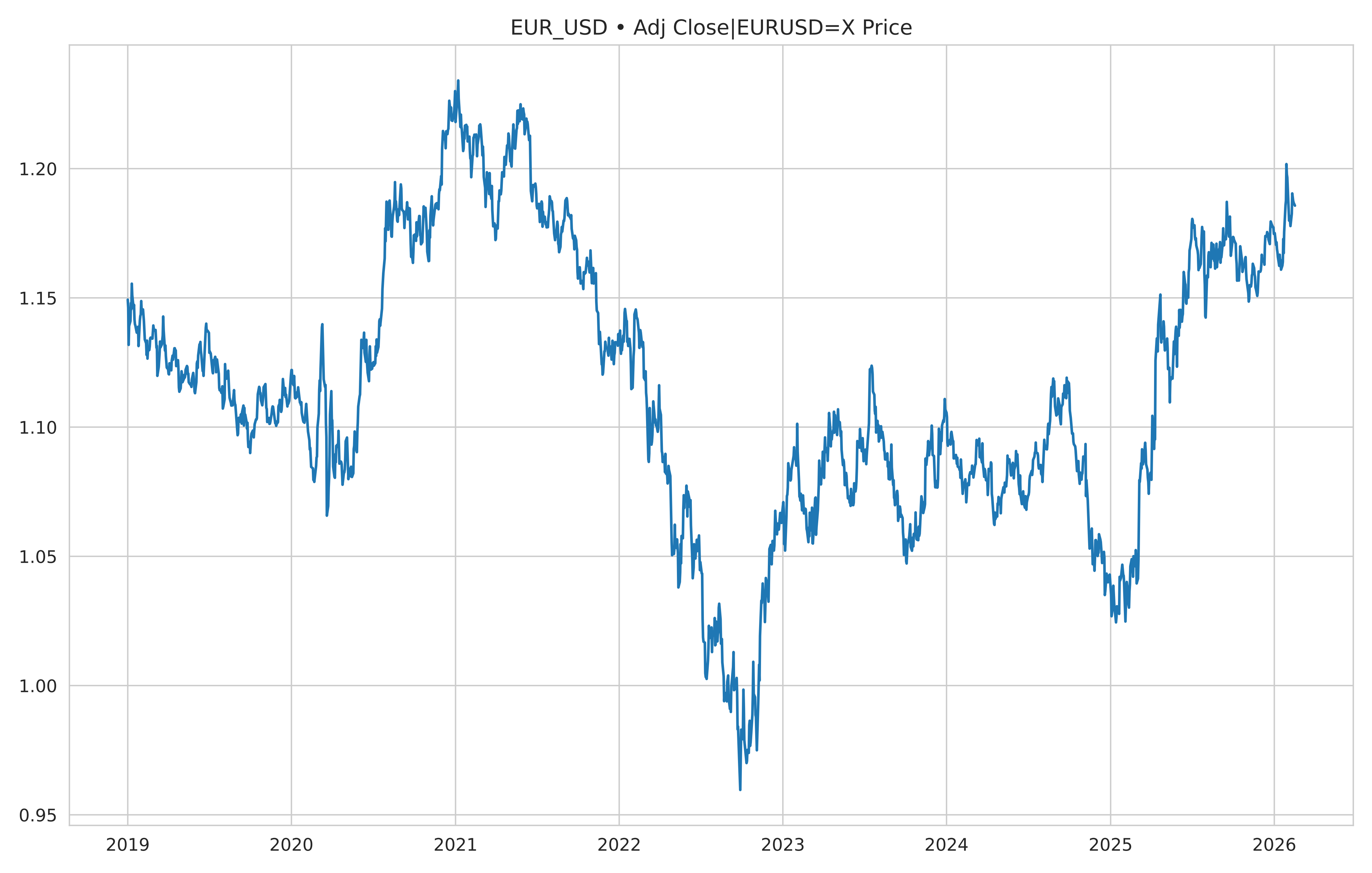
## EUR_USD • Numeric Quality & Ranges

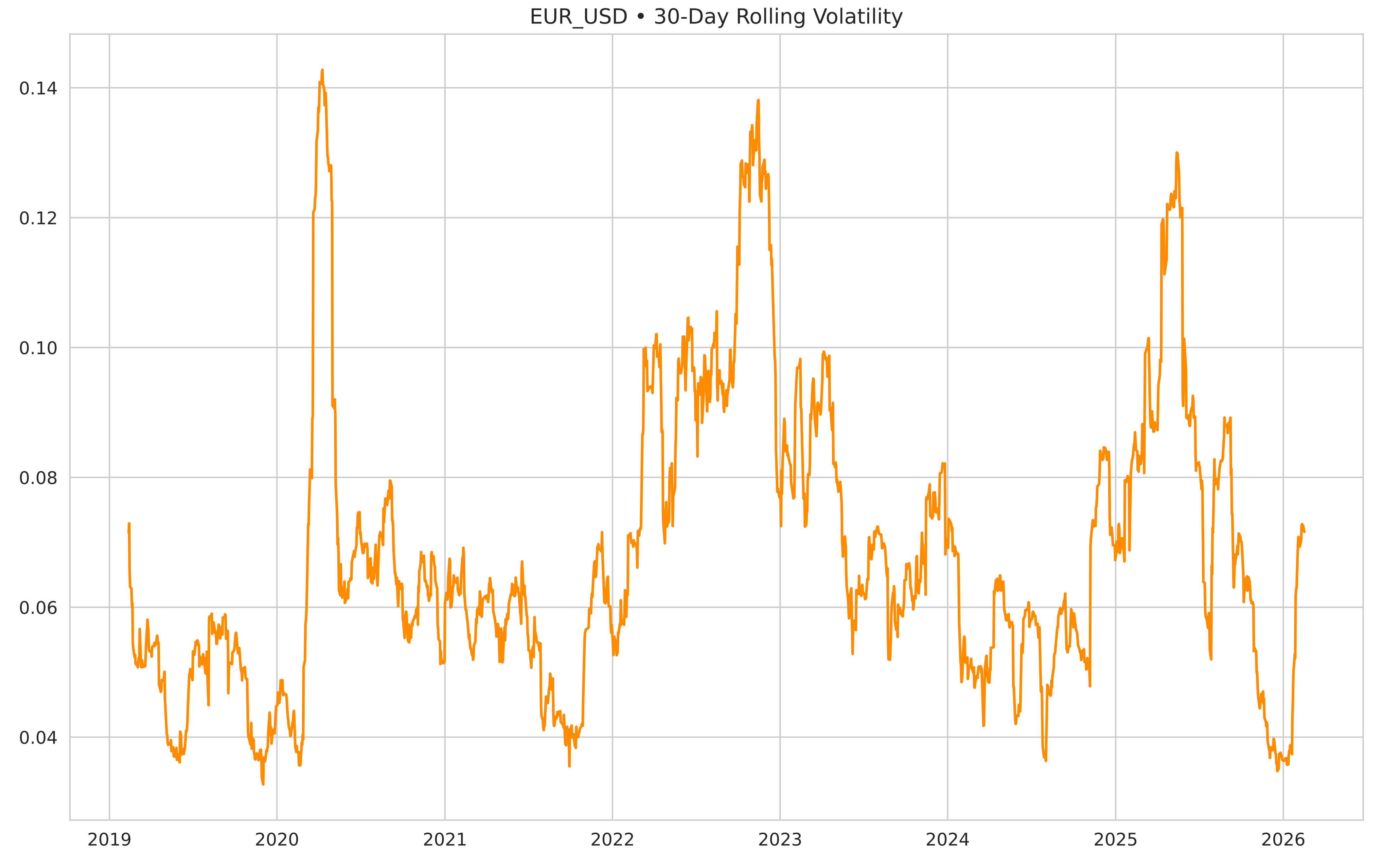
| Column | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| e\|EURUSD=X | 1854 | 0 | 0.0 | 0 | 0 | 0.9596 | 0.9837 | 1.0803 | 1.1091 | 1.1144 | 1.1599 | 1.2207 | 1.2341 | 0.0537 |
| e\|EURUSD=X | 1854 | 0 | 0.0 | 0 | 0 | 0.9596 | 0.9837 | 1.0803 | 1.1091 | 1.1144 | 1.1599 | 1.2207 | 1.2341 | 0.0537 |
| h\|EURUSD=X | 1854 | 0 | 0.0 | 0 | 0 | 0.967 | 0.9882 | 1.0838 | 1.1119 | 1.1176 | 1.1621 | 1.2234 | 1.235 | 0.0533 |
| v\|EURUSD=X | 1854 | 0 | 0.0 | 0 | 0 | 0.954 | 0.9776 | 1.0776 | 1.1068 | 1.111 | 1.1568 | 1.2173 | 1.2267 | 0.054 |
| n\|EURUSD=X | 1854 | 0 | 0.0 | 0 | 0 | 0.9596 | 0.9837 | 1.0802 | 1.1091 | 1.1144 | 1.1599 | 1.2208 | 1.2338 | 0.0536 |
| e\|EURUSD=X | 1854 | 0 | 0.0 | 1854 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| month | 1854 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4369 | 9.0 | 12.0 | 12.0 | 3.4869 |
| day_of_week | 1854 | 0 | 0.0 | 371 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 1.9989 | 3.0 | 4.0 | 4.0 | 1.415 |
| quarter | 1854 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4838 | 3.0 | 4.0 | 4.0 | 1.125 |
| year | 1854 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0636 | 2024.0 | 2026.0 | 2026.0 | 2.0483 |
| s_month_end | 1854 | 0 | 0.0 | 1794 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0324 | 0.0 | 1.0 | 1.0 | 0.177 |
| _month_start | 1854 | 0 | 0.0 | 1794 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0324 | 0.0 | 1.0 | 1.0 | 0.177 |
| ad\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.0013 | 0.0024 | 0.0043 | 0.0059 | 0.0066 | 0.0081 | 0.0177 | 0.0272 | 0.0033 |
| ad\|EUR_USD | 1854 | 0 | 0.0 | 992 | 520 | -0.0018 | -0.0004 | -0.0 | 0.0 | -0.0 | 0.0 | 0.0003 | 0.0023 | 0.0001 |
| _5\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.969 | 0.9851 | 1.0815 | 1.1092 | 1.1143 | 1.1597 | 1.2207 | 1.2283 | 0.0534 |
| _5\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.9709 | 0.9837 | 1.0816 | 1.1097 | 1.1143 | 1.1597 | 1.2203 | 1.2287 | 0.0533 |
| 10\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.976 | 0.9824 | 1.0817 | 1.1091 | 1.1143 | 1.1592 | 1.2201 | 1.2258 | 0.0532 |
| 10\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.976 | 0.984 | 1.0816 | 1.1087 | 1.1143 | 1.1598 | 1.2187 | 1.226 | 0.053 |
| 20\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.9768 | 0.9844 | 1.0808 | 1.1081 | 1.1142 | 1.1597 | 1.2189 | 1.2231 | 0.0527 |
| 20\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.9804 | 0.9868 | 1.0809 | 1.1073 | 1.1142 | 1.1606 | 1.2167 | 1.2214 | 0.0524 |
| e_1\|EUR_USD | 1853 | 1 | 0.05 | 0 | 0 | 0.9596 | 0.9837 | 1.0803 | 1.1091 | 1.1143 | 1.1599 | 1.2207 | 1.2341 | 0.0536 |
| e_2\|EUR_USD | 1852 | 2 | 0.11 | 0 | 0 | 0.9596 | 0.9837 | 1.0802 | 1.109 | 1.1143 | 1.1598 | 1.2207 | 1.2341 | 0.0536 |
| e_3\|EUR_USD | 1851 | 3 | 0.16 | 0 | 0 | 0.9596 | 0.9837 | 1.0802 | 1.109 | 1.1143 | 1.1598 | 1.2207 | 1.2341 | 0.0536 |
| e_1\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.0 |
| e_2\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.0 |
| e_3\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.0 |
| ret\|EUR_USD | 1853 | 1 | 0.05 | 6 | 939 | -0.0281 | -0.0123 | -0.0025 | -0.0001 | 0.0 | 0.0026 | 0.0122 | 0.0275 | 0.0045 |
| sq\|EUR_USD | 1853 | 1 | 0.05 | 6 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0 |
| bs\|EUR_USD | 1853 | 1 | 0.05 | 6 | 0 | 0.0 | 0.0001 | 0.0011 | 0.0026 | 0.0034 | 0.0046 | 0.014 | 0.0281 | 0.0031 |
| t_1\|EUR_USD | 1852 | 2 | 0.11 | 6 | 938 | -0.0281 | -0.0123 | -0.0025 | -0.0001 | 0.0 | 0.0026 | 0.0122 | 0.0275 | 0.0045 |
| q_1\|EUR_USD | 1852 | 2 | 0.11 | 6 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0 |
| t_2\|EUR_USD | 1851 | 3 | 0.16 | 6 | 937 | -0.0281 | -0.0123 | -0.0025 | -0.0001 | 0.0 | 0.0026 | 0.0122 | 0.0275 | 0.0045 |
| q_2\|EUR_USD | 1851 | 3 | 0.16 | 6 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0 |
| t_3\|EUR_USD | 1850 | 4 | 0.22 | 6 | 936 | -0.0281 | -0.0123 | -0.0025 | -0.0001 | 0.0 | 0.0026 | 0.0122 | 0.0275 | 0.0045 |
| q_3\|EUR_USD | 1850 | 4 | 0.22 | 6 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0 |
| var\|EUR_USD | 1853 | 1 | 0.05 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0 |
| 20\|EUR_USD | 1849 | 5 | 0.27 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0 |
| t_1\|EUR_USD | 1854 | 0 | 0.0 | 0 | 0 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0 |
| t_2\|EUR_USD | 1854 | 0 | 0.0 | 0 | 1854 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | 0.0 |
| t_3\|EUR_USD | 1854 | 0 | 0.0 | 0 | 1854 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | 0.0 |

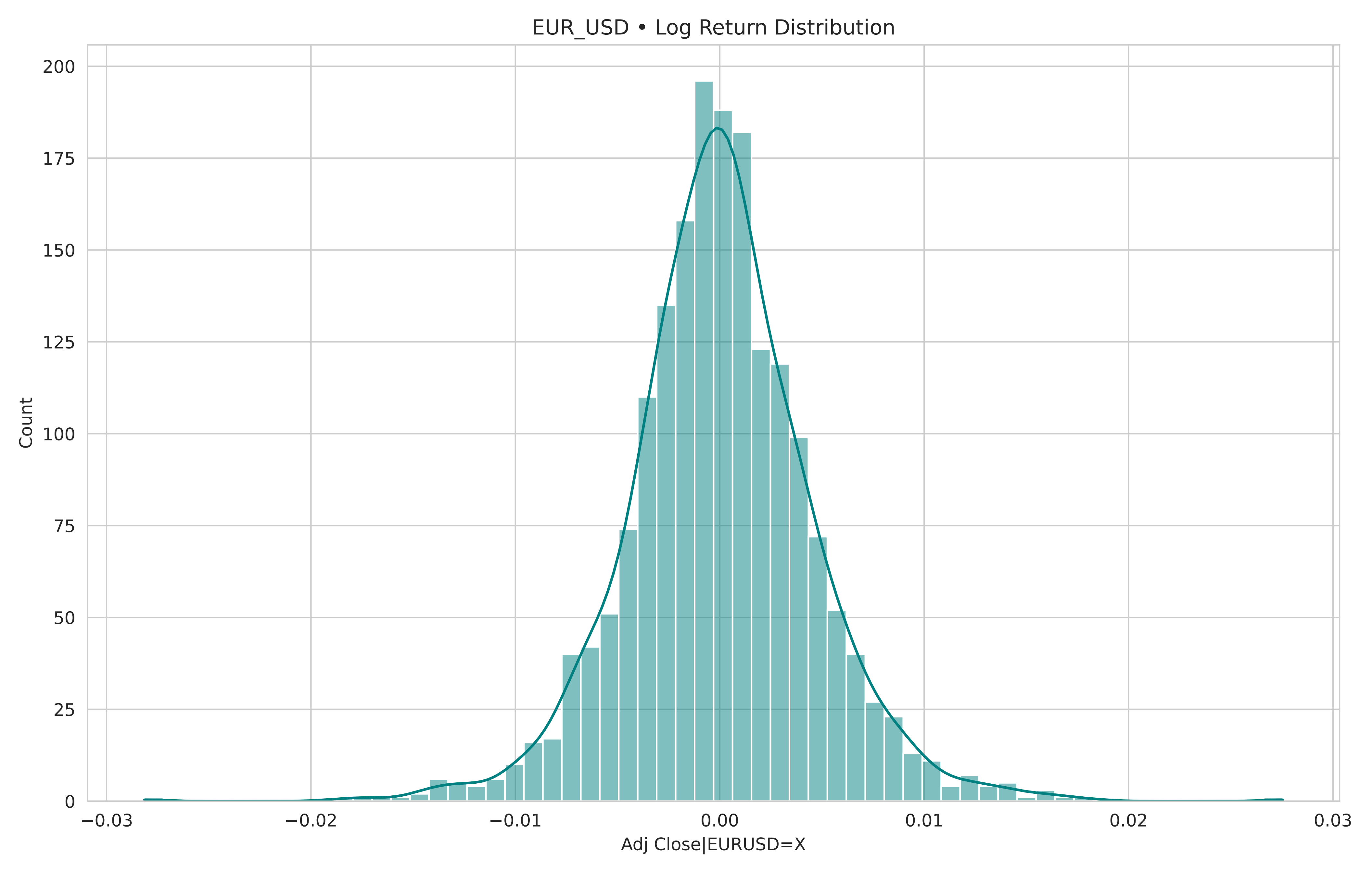
# EUR_USD • Describe

| Variable | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| se EURUSD=X | 1854.0 | 1.1144 | 0.0537 | 0.9596 | 0.9837 | 1.026 | 1.0803 | 1.1091 | 1.1599 | 1.2064 | 1.2207 | 1.2341 |
| se EURUSD=X | 1854.0 | 1.1144 | 0.0537 | 0.9596 | 0.9837 | 1.026 | 1.0803 | 1.1091 | 1.1599 | 1.2064 | 1.2207 | 1.2341 |
| gh EURUSD=X | 1854.0 | 1.1176 | 0.0533 | 0.967 | 0.9882 | 1.0309 | 1.0838 | 1.1119 | 1.1621 | 1.2088 | 1.2234 | 1.235 |
| ow EURUSD=X | 1854.0 | 1.111 | 0.054 | 0.954 | 0.9776 | 1.0218 | 1.0776 | 1.1068 | 1.1568 | 1.2027 | 1.2173 | 1.2267 |
| en EURUSD=X | 1854.0 | 1.1144 | 0.0536 | 0.9596 | 0.9837 | 1.026 | 1.0802 | 1.1091 | 1.1599 | 1.2062 | 1.2208 | 1.2338 |
| ne EURUSD=X | 1854.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| month | 1854.0 | 6.4369 | 3.4869 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | 1854.0 | 1.9989 | 1.415 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | 1854.0 | 2.4838 | 1.125 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | 1854.0 | 2022.0636 | 2.0483 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | 1854.0 | 0.0324 | 0.177 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | 1854.0 | 0.0324 | 0.177 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| read EUR_USD | 1854.0 | 0.0066 | 0.0033 | 0.0013 | 0.0024 | 0.0029 | 0.0043 | 0.0059 | 0.0081 | 0.0129 | 0.0177 | 0.0272 |
| read EUR_USD | 1854.0 | -0.0 | 0.0001 | -0.0018 | -0.0004 | -0.0003 | -0.0 | 0.0 | 0.0 | 0.0002 | 0.0003 | 0.0023 |
| MA_5 EUR_USD | 1854.0 | 1.1143 | 0.0534 | 0.969 | 0.9851 | 1.0273 | 1.0815 | 1.1092 | 1.1597 | 1.2064 | 1.2207 | 1.2283 |
| MA_5 EUR_USD | 1854.0 | 1.1143 | 0.0533 | 0.9709 | 0.9837 | 1.0269 | 1.0816 | 1.1097 | 1.1597 | 1.207 | 1.2203 | 1.2287 |
| A_10 EUR_USD | 1854.0 | 1.1143 | 0.0532 | 0.976 | 0.9824 | 1.0255 | 1.0817 | 1.1091 | 1.1592 | 1.207 | 1.2201 | 1.2258 |
| A_10 EUR_USD | 1854.0 | 1.1143 | 0.053 | 0.976 | 0.984 | 1.0242 | 1.0816 | 1.1087 | 1.1598 | 1.2057 | 1.2187 | 1.226 |
| A_20 EUR_USD | 1854.0 | 1.1142 | 0.0527 | 0.9768 | 0.9844 | 1.0246 | 1.0808 | 1.1081 | 1.1597 | 1.206 | 1.2189 | 1.2231 |
| A_20 EUR_USD | 1854.0 | 1.1142 | 0.0524 | 0.9804 | 0.9868 | 1.0245 | 1.0809 | 1.1073 | 1.1606 | 1.204 | 1.2167 | 1.2214 |
| ce_1 EUR_USD | 1853.0 | 1.1143 | 0.0536 | 0.9596 | 0.9837 | 1.026 | 1.0803 | 1.1091 | 1.1599 | 1.2064 | 1.2207 | 1.2341 |
| ce_2 EUR_USD | 1852.0 | 1.1143 | 0.0536 | 0.9596 | 0.9837 | 1.026 | 1.0802 | 1.109 | 1.1598 | 1.2064 | 1.2207 | 1.2341 |
| ce_3 EUR_USD | 1851.0 | 1.1143 | 0.0536 | 0.9596 | 0.9837 | 1.026 | 1.0802 | 1.109 | 1.1598 | 1.2065 | 1.2207 | 1.2341 |
| ce_1 EUR_USD | 1854.0 | 0.9957 | 0.0 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 | 0.9957 |
| ce_2 EUR_USD | 1854.0 | 0.9912 | 0.0 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 | 0.9912 |
| ce_3 EUR_USD | 1854.0 | 0.9869 | 0.0 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 | 0.9869 |
| g_ret EUR_USD | 1853.0 | 0.0 | 0.0045 | -0.0281 | -0.0123 | -0.0071 | -0.0025 | -0.0001 | 0.0026 | 0.0073 | 0.0122 | 0.0275 |
| t_sq EUR_USD | 1853.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0002 | 0.0008 |
| _abs EUR_USD | 1853.0 | 0.0034 | 0.0031 | 0.0 | 0.0001 | 0.0002 | 0.0011 | 0.0026 | 0.0046 | 0.009 | 0.014 | 0.0281 |
| et_1 EUR_USD | 1852.0 | 0.0 | 0.0045 | -0.0281 | -0.0123 | -0.0071 | -0.0025 | -0.0001 | 0.0026 | 0.0073 | 0.0122 | 0.0275 |
| sq_1 EUR_USD | 1852.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0002 | 0.0008 |
| et_2 EUR_USD | 1851.0 | 0.0 | 0.0045 | -0.0281 | -0.0123 | -0.0071 | -0.0025 | -0.0001 | 0.0026 | 0.0074 | 0.0122 | 0.0275 |
| sq_2 EUR_USD | 1851.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0002 | 0.0008 |
| et_3 EUR_USD | 1850.0 | 0.0 | 0.0045 | -0.0281 | -0.0123 | -0.0071 | -0.0025 | -0.0001 | 0.0026 | 0.0074 | 0.0122 | 0.0275 |
| sq_3 EUR_USD | 1850.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0002 | 0.0008 |
| _var EUR_USD | 1853.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 |
| r_20 EUR_USD | 1849.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 |
| et_1 EUR_USD | 1854.0 | 0.0223 | 0.0 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 | 0.0223 |
| et_2 EUR_USD | 1854.0 | -0.0094 | 0.0 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 | -0.0094 |
| et_3 EUR_USD | 1854.0 | -0.0368 | 0.0 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 | -0.0368 |


EUR_USD • Correlation
Adj Close|EURUSD=X
High|EURUSD=X
Open|EURUSD=X
month
quarter
is_month_end
HL_spread|EUR_USD
SMA_5|EUR_USD
SMA_10|EUR_USD
SMA_20|EUR_USD
lag_price_1|EUR_USD
lag_price_3|EUR_USD
autocorr_price_2|EUR_USD
log_ret|EUR_USD
ret_abs|EUR_USD
lag_ret_sq_1|EUR_USD
lag_ret_sq_2|EUR_USD
lag_ret_sq_3|EUR_USD
roll_var_20|EUR_USD
autocorr_ret_2|EUR_USD
Adj Close|EURUSD=X
Close|EURUSD=X
High|EURUSD=X
Low|EURUSD=X
Open|EURUSD=X
Volume|EURUSD=X
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|EUR_USD
OC_spread|EUR_USD
SMA_5|EUR_USD
EMA_5|EUR_USD
SMA_10|EUR_USD
EMA_10|EUR_USD
SMA_20|EUR_USD
EMA_20|EUR_USD
lag_price_1|EUR_USD
lag_price_2|EUR_USD
lag_price_3|EUR_USD
autocorr_price_1|EUR_USD
autocorr_price_2|EUR_USD
autocorr_price_3|EUR_USD
log_ret|EUR_USD
ret_sq|EUR_USD
ret_abs|EUR_USD
lag_ret_1|EUR_USD
lag_ret_sq_1|EUR_USD
lag_ret_2|EUR_USD
lag_ret_sq_2|EUR_USD
lag_ret_3|EUR_USD
lag_ret_sq_3|EUR_USD
ewma_var|EUR_USD
roll_var_20|EUR_USD
autocorr_ret_1|EUR_USD
autocorr_ret_2|EUR_USD
autocorr_ret_3|EUR_USD
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4


EUR_USD • Adj Close|EURUSD=X Price
1.20
1.15
1.10
1.05
1.00
0.95
2019
2020
2021
2022
2023
2024
2025
2026


EUR_USD • 30-Day Rolling Volatility
0.14
0.12
0.10
0.08
0.06
0.04
2019
2020
2021
2022
2023
2024
2025
2026


EUR_USD • Log Return Distribution
Count
200
175
150
125
100
75
50
25
0
−0.03
−0.02
−0.01
0.00
0.01
0.02
0.03
Adj Close|EURUSD=X

# GLD • Schema & Missingness

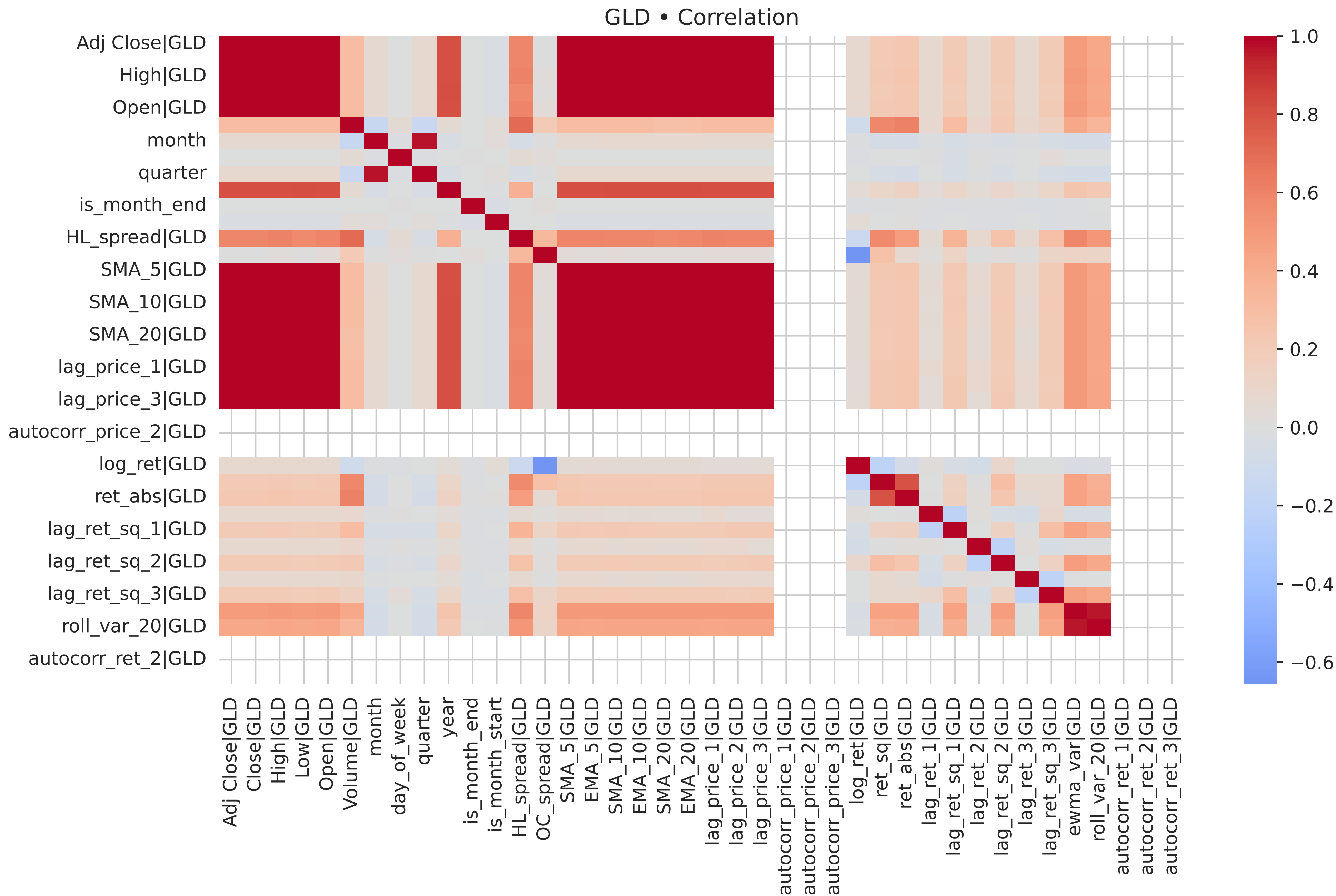
| Column | | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|---|
| Adj Close | GLD | float64 | 1790 | 0 | 0.0 | 1632 | 121.33 |
| Close | GLD | float64 | 1790 | 0 | 0.0 | 1632 | 121.33 |
| High | GLD | float64 | 1790 | 0 | 0.0 | 1617 | 121.75 |
| Low | GLD | float64 | 1790 | 0 | 0.0 | 1626 | 120.88 |
| Open | GLD | float64 | 1790 | 0 | 0.0 | 1630 | 121.35 |
| Volume | GLD | int64 | 1790 | 0 | 0.0 | 1779 | 12776200.0 |
| month | | int32 | 1790 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | | int32 | 1790 | 0 | 0.0 | 5 | 2.0 |
| quarter | | int32 | 1790 | 0 | 0.0 | 4 | 1.0 |
| year | | int32 | 1790 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| HL_spread | GLD | float64 | 1790 | 0 | 0.0 | 1057 | 0.87 |
| OC_spread | GLD | float64 | 1790 | 0 | 0.0 | 1214 | 0.02 |
| SMA_5 | GLD | float64 | 1790 | 0 | 0.0 | 1777 | 121.33 |
| EMA_5 | GLD | float64 | 1790 | 0 | 0.0 | 1790 | 121.33 |
| SMA_10 | GLD | float64 | 1790 | 0 | 0.0 | 1776 | 121.33 |
| EMA_10 | GLD | float64 | 1790 | 0 | 0.0 | 1790 | 121.33 |
| SMA_20 | GLD | float64 | 1790 | 0 | 0.0 | 1787 | 121.33 |
| EMA_20 | GLD | float64 | 1790 | 0 | 0.0 | 1790 | 121.33 |
| lag_price_1 | GLD | float64 | 1789 | 1 | 0.06 | 1631 | 121.33 |
| lag_price_2 | GLD | float64 | 1788 | 2 | 0.11 | 1630 | 121.33 |
| lag_price_3 | GLD | float64 | 1787 | 3 | 0.17 | 1629 | 121.33 |
| autocorr_price_1 | GLD | float64 | 1790 | 0 | 0.0 | 1 | 0.9991 |
| autocorr_price_2 | GLD | float64 | 1790 | 0 | 0.0 | 1 | 0.9982 |
| autocorr_price_3 | GLD | float64 | 1790 | 0 | 0.0 | 1 | 0.9976 |
| log_ret | GLD | float64 | 1789 | 1 | 0.06 | 1786 | 0.009 |
| ret_sq | GLD | float64 | 1789 | 1 | 0.06 | 1786 | 0.0001 |
| ret_abs | GLD | float64 | 1789 | 1 | 0.06 | 1786 | 0.009 |
| lag_ret_1 | GLD | float64 | 1788 | 2 | 0.11 | 1785 | 0.009 |
| lag_ret_sq_1 | GLD | float64 | 1788 | 2 | 0.11 | 1785 | 0.0001 |
| lag_ret_2 | GLD | float64 | 1787 | 3 | 0.17 | 1784 | 0.009 |
| lag_ret_sq_2 | GLD | float64 | 1787 | 3 | 0.17 | 1784 | 0.0001 |
| lag_ret_3 | GLD | float64 | 1786 | 4 | 0.22 | 1783 | 0.009 |
| lag_ret_sq_3 | GLD | float64 | 1786 | 4 | 0.22 | 1783 | 0.0001 |
| ewma_var | GLD | float64 | 1789 | 1 | 0.06 | 1789 | 0.0001 |
| roll_var_20 | GLD | float64 | 1785 | 5 | 0.28 | 1785 | 0.0 |
| autocorr_ret_1 | GLD | float64 | 1790 | 0 | 0.0 | 1 | 0.0178 |
| autocorr_ret_2 | GLD | float64 | 1790 | 0 | 0.0 | 1 | -0.0697 |
| autocorr_ret_3 | GLD | float64 | 1790 | 0 | 0.0 | 1 | -0.0059 |

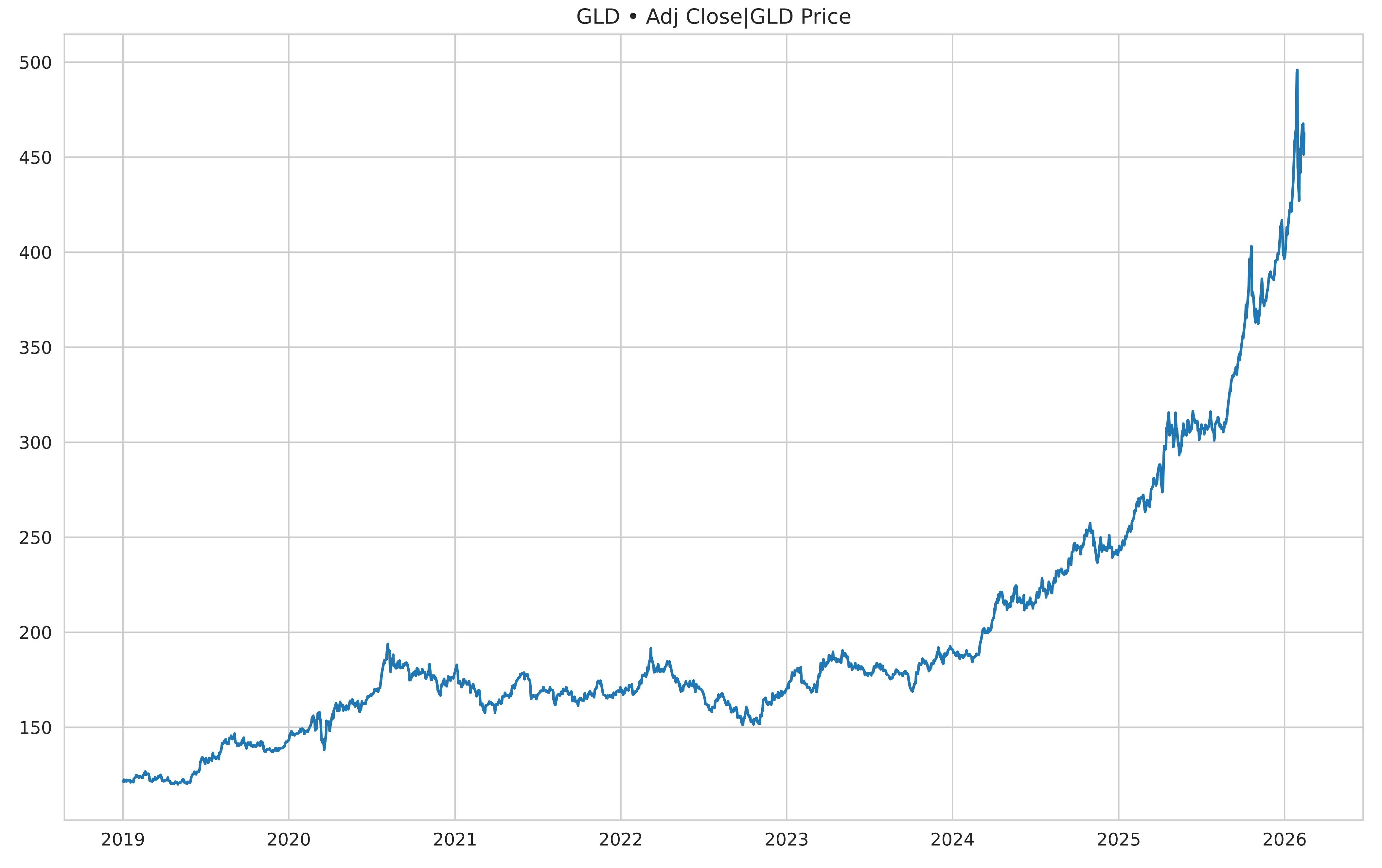
# GLD • Numeric Quality & Ranges

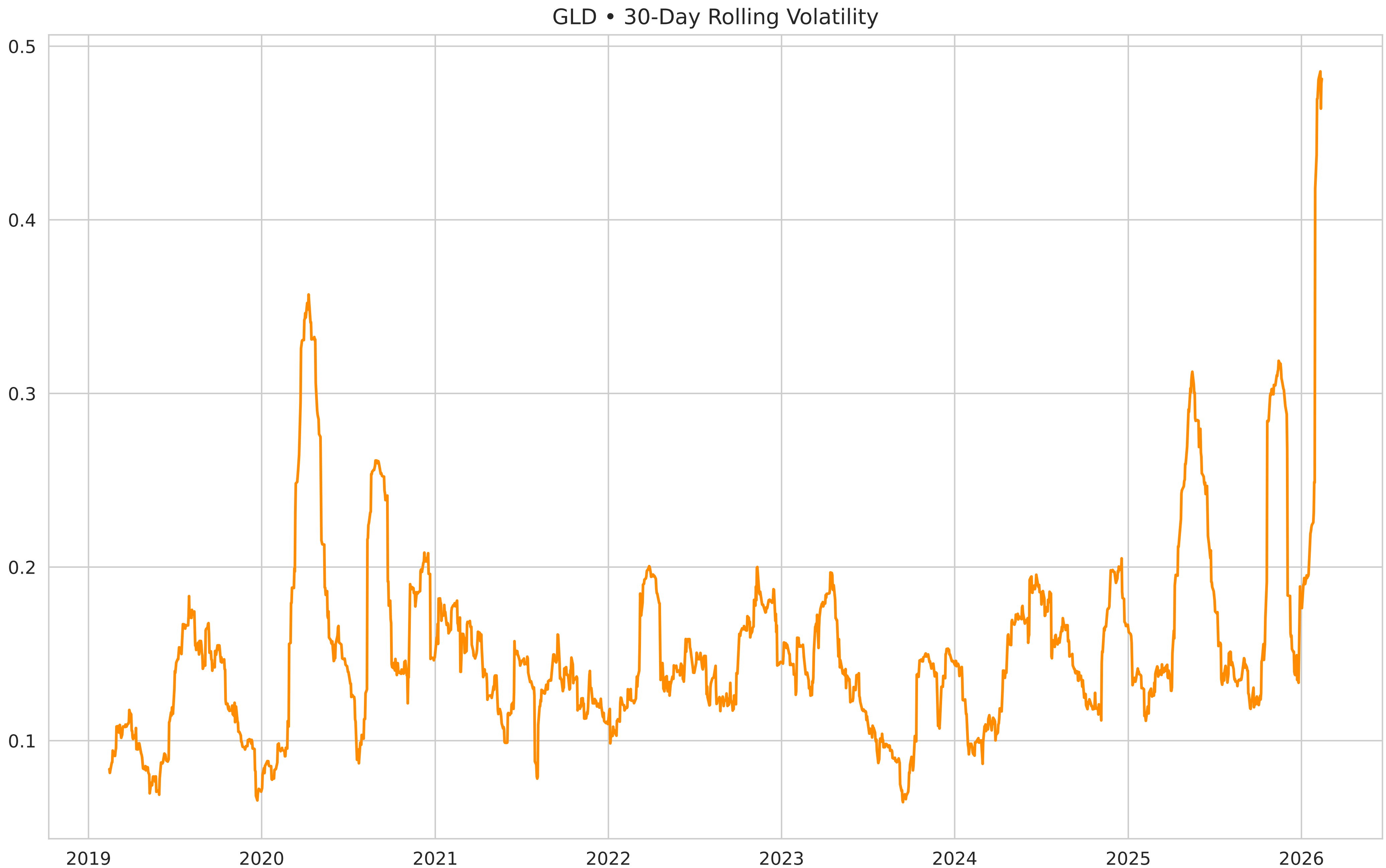
| Column | | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dj Close | GLD | 1790 | 0 | 0.0 | 0 | 0 | 119.94 | 120.9056 | 162.285 | 175.495 | 197.4593 | 215.115 | 428.241 | 495.9 | 67.3705 |
| Close | GLD | 1790 | 0 | 0.0 | 0 | 0 | 119.94 | 120.9056 | 162.285 | 175.495 | 197.4593 | 215.115 | 428.241 | 495.9 | 67.3705 |
| High | GLD | 1790 | 0 | 0.0 | 0 | 0 | 120.11 | 121.3545 | 163.1625 | 176.415 | 198.3599 | 215.9325 | 438.4304 | 509.7 | 67.8713 |
| Low | GLD | 1790 | 0 | 0.0 | 0 | 0 | 119.54 | 120.7434 | 161.5675 | 174.87 | 196.4275 | 214.32 | 423.7156 | 481.25 | 66.6635 |
| Open | GLD | 1790 | 0 | 0.0 | 0 | 0 | 119.67 | 120.96 | 162.3675 | 175.83 | 197.4578 | 215.0425 | 434.3048 | 509.51 | 67.4023 |
| Volume | GLD | 1790 | 0 | 0.0 | 0 | 0 | 1436500.0 | 3142314.0 | 5800350.0 | 7871859.0 | [illegible]2843.2402 | 11068125.0 | 31099792.0 | 86593500.0 | [illegible]94500.7613 |
| month | | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4637 | 9.0 | 12.0 | 12.0 | 3.469 |
| day_of_week | | 1790 | 0 | 0.0 | 334 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0229 | 3.0 | 4.0 | 4.0 | 1.3995 |
| quarter | | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4916 | 3.0 | 4.0 | 4.0 | 1.1233 |
| year | | 1790 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0615 | 2024.0 | 2026.0 | 2026.0 | 2.0493 |
| s_month_end | | 1790 | 0 | 0.0 | 1731 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.033 | 0.0 | 1.0 | 1.0 | 0.1786 |
| _month_start | | 1790 | 0 | 0.0 | 1735 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0307 | 0.0 | 1.0 | 1.0 | 0.1726 |
| _spread | GLD | 1790 | 0 | 0.0 | 0 | 0 | 0.23 | 0.39 | 1.0 | 1.46 | 1.9324 | 2.23 | 8.9365 | 41.19 | 2.0492 |
| _spread | GLD | 1790 | 0 | 0.0 | 9 | 911 | -11.17 | -4.0622 | -0.65 | -0.03 | -0.0015 | 0.59 | 4.4519 | 21.3 | 1.5771 |
| SMA_5 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 120.322 | 120.9147 | 162.431 | 175.715 | 197.081 | 215.0035 | 426.3673 | 477.852 | 66.7956 |
| EMA_5 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 120.4876 | 120.9435 | 162.3916 | 175.646 | 197.0812 | 214.9421 | 427.1236 | 479.5632 | 66.7802 |
| SMA_10 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 120.564 | 121.1666 | 162.2017 | 175.512 | 196.6106 | 215.0295 | 420.3366 | 462.139 | 66.094 |
| EMA_10 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 120.6955 | 121.0592 | 162.2226 | 175.3853 | 196.6126 | 215.1249 | 421.4187 | 462.9107 | 66.0698 |
| SMA_20 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 120.8035 | 121.1777 | 162.0638 | 175.2582 | 195.6688 | 215.2989 | 412.7662 | 456.596 | 64.6607 |
| EMA_20 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 121.0764 | 121.3621 | 162.5184 | 175.0023 | 195.7061 | 214.3212 | 413.7449 | 451.6672 | 64.7312 |
| _price_1 | GLD | 1789 | 1 | 0.06 | 0 | 0 | 119.94 | 120.9052 | 162.28 | 175.49 | 197.3111 | 215.04 | 426.0828 | 495.9 | 67.0967 |
| _price_2 | GLD | 1788 | 2 | 0.11 | 0 | 0 | 119.94 | 120.9048 | 162.2725 | 175.465 | 197.169 | 215.0175 | 423.6693 | 495.9 | 66.8457 |
| _price_3 | GLD | 1787 | 3 | 0.17 | 0 | 0 | 119.94 | 120.9044 | 162.265 | 175.44 | 197.0176 | 215.0 | 422.384 | 495.9 | 66.5573 |
| _price_1 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.0 |
| _price_2 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.0 |
| _price_3 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.0 |
| log_ret | GLD | 1789 | 1 | 0.06 | 4 | 805 | -0.1084 | -0.0288 | -0.0045 | 0.0009 | 0.0007 | 0.0062 | 0.027 | 0.0616 | 0.0106 |
| ret_sq | GLD | 1789 | 1 | 0.06 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0011 | 0.0118 | 0.0004 |
| ret_abs | GLD | 1789 | 1 | 0.06 | 4 | 0 | 0.0 | 0.0001 | 0.0026 | 0.0055 | 0.0075 | 0.01 | 0.0327 | 0.1084 | 0.0075 |
| ag_ret_1 | GLD | 1788 | 2 | 0.11 | 4 | 805 | -0.1084 | -0.0288 | -0.0045 | 0.0009 | 0.0007 | 0.0062 | 0.027 | 0.0616 | 0.0106 |
| ret_sq_1 | GLD | 1788 | 2 | 0.11 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0011 | 0.0118 | 0.0004 |
| ag_ret_2 | GLD | 1787 | 3 | 0.17 | 4 | 804 | -0.1084 | -0.0283 | -0.0045 | 0.0009 | 0.0008 | 0.0062 | 0.027 | 0.0616 | 0.0106 |
| ret_sq_2 | GLD | 1787 | 3 | 0.17 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.001 | 0.0118 | 0.0004 |
| ag_ret_3 | GLD | 1786 | 4 | 0.22 | 4 | 804 | -0.1084 | -0.0283 | -0.0045 | 0.0009 | 0.0007 | 0.0062 | 0.027 | 0.0616 | 0.0106 |
| ret_sq_3 | GLD | 1786 | 4 | 0.22 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.001 | 0.0118 | 0.0004 |
| wma_var | GLD | 1789 | 1 | 0.06 | 0 | 0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0004 | 0.0012 | 0.0001 |
| _var_20 | GLD | 1785 | 5 | 0.28 | 0 | 0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0005 | 0.0013 | 0.0001 |
| rr_ret_1 | GLD | 1790 | 0 | 0.0 | 0 | 0 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0 |
| rr_ret_2 | GLD | 1790 | 0 | 0.0 | 0 | 1790 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | 0.0 |
| rr_ret_3 | GLD | 1790 | 0 | 0.0 | 0 | 1790 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | 0.0 |

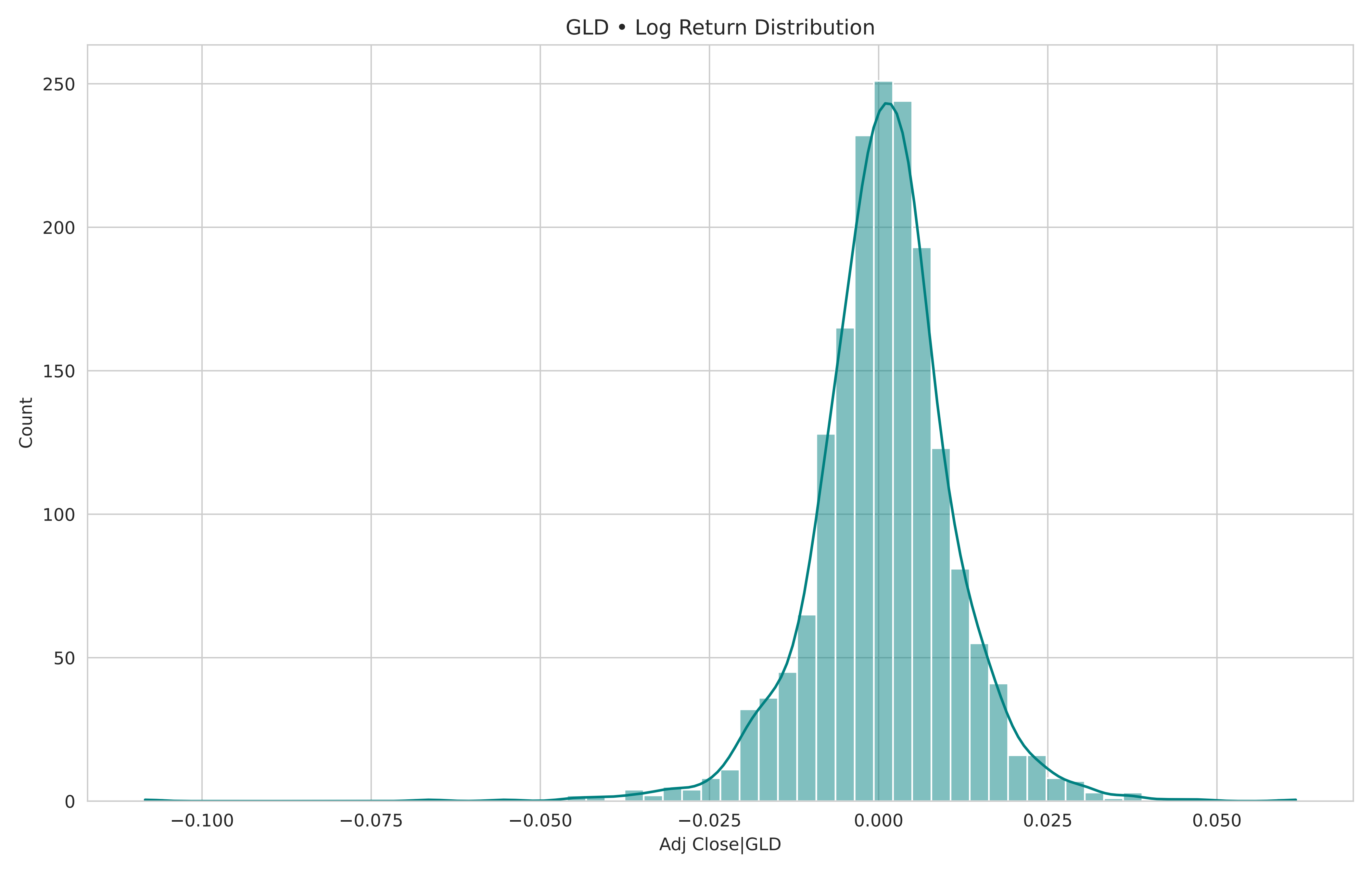
# GLD • Describe

| Variable | | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close | GLD | 1790.0 | 197.4593 | 67.3705 | 119.94 | 120.9056 | 124.2415 | 162.285 | 175.495 | 215.115 | 362.694 | 428.241 | 495.9 |
| Close | GLD | 1790.0 | 197.4593 | 67.3705 | 119.94 | 120.9056 | 124.2415 | 162.285 | 175.495 | 215.115 | 362.694 | 428.241 | 495.9 |
| High | GLD | 1790.0 | 198.3599 | 67.8713 | 120.11 | 121.3545 | 124.528 | 163.1625 | 176.415 | 215.9325 | 365.3 | 438.4304 | 509.7 |
| Low | GLD | 1790.0 | 196.4275 | 66.6635 | 119.54 | 120.7434 | 123.936 | 161.5675 | 174.87 | 214.32 | 360.802 | 423.7156 | 481.25 |
| Open | GLD | 1790.0 | 197.4578 | 67.4023 | 119.67 | 120.96 | 124.317 | 162.3675 | 175.83 | 215.0425 | 362.0025 | 434.3048 | 509.51 |
| Volume | GLD | 1790.0 | 9342843.2405 | 2994500.7613 | 1436500.0 | 3142314.0 | 4031940.0 | 5800350.0 | 7871850.0 | 11068125.0 | 19626760.0 | 31099792.0 | 36593500.0 |
| month | | 1790.0 | 6.4637 | 3.469 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | | 1790.0 | 2.0229 | 1.3995 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | | 1790.0 | 2.4916 | 1.1233 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | | 1790.0 | 2022.0615 | 2.0493 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | | 1790.0 | 0.033 | 0.1786 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | | 1790.0 | 0.0307 | 0.1726 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| HL_spread | GLD | 1790.0 | 1.9324 | 2.0492 | 0.23 | 0.39 | 0.59 | 1.0 | 1.46 | 2.23 | 4.522 | 8.9365 | 41.19 |
| OC_spread | GLD | 1790.0 | -0.0015 | 1.5771 | -11.17 | -4.0622 | -2.0555 | -0.65 | -0.03 | 0.59 | 1.951 | 4.4519 | 21.3 |
| SMA_5 | GLD | 1790.0 | 197.081 | 66.7956 | 120.322 | 120.9147 | 124.0029 | 162.431 | 175.715 | 215.0035 | 358.8489 | 426.3673 | 477.852 |
| EMA_5 | GLD | 1790.0 | 197.0812 | 66.7802 | 120.4876 | 120.9435 | 123.9354 | 162.3916 | 175.646 | 214.9421 | 359.3302 | 427.1236 | 479.5632 |
| SMA_10 | GLD | 1790.0 | 196.6106 | 66.094 | 120.564 | 121.1666 | 123.689 | 162.2017 | 175.512 | 215.0295 | 353.293 | 420.3366 | 462.139 |
| EMA_10 | GLD | 1790.0 | 196.6126 | 66.0698 | 120.6955 | 121.0592 | 123.6952 | 162.2226 | 175.3853 | 215.1249 | 354.3341 | 421.4187 | 462.9107 |
| SMA_20 | GLD | 1790.0 | 195.6688 | 64.6607 | 120.8035 | 121.1777 | 123.295 | 162.0638 | 175.2582 | 215.2989 | 345.7285 | 412.7662 | 456.596 |
| EMA_20 | GLD | 1790.0 | 195.7061 | 64.7312 | 121.0764 | 121.3621 | 123.3306 | 162.5184 | 175.0023 | 214.3212 | 346.5107 | 413.7449 | 451.6672 |
| g_price_1 | GLD | 1789.0 | 197.3111 | 67.0967 | 119.94 | 120.9052 | 124.238 | 162.28 | 175.49 | 215.04 | 360.448 | 426.0828 | 495.9 |
| g_price_2 | GLD | 1788.0 | 197.169 | 66.8457 | 119.94 | 120.9048 | 124.2345 | 162.2725 | 175.465 | 215.0175 | 357.0765 | 423.6693 | 495.9 |
| g_price_3 | GLD | 1787.0 | 197.0176 | 66.5573 | 119.94 | 120.9044 | 124.231 | 162.265 | 175.44 | 215.0 | 355.862 | 422.384 | 495.9 |
| r_price_1 | GLD | 1790.0 | 0.9991 | 0.0 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 |
| r_price_2 | GLD | 1790.0 | 0.9982 | 0.0 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 | 0.9982 |
| r_price_3 | GLD | 1790.0 | 0.9976 | 0.0 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 | 0.9976 |
| log_ret | GLD | 1789.0 | 0.0007 | 0.0106 | -0.1084 | -0.0288 | -0.016 | -0.0045 | 0.0009 | 0.0062 | 0.0167 | 0.027 | 0.0616 |
| ret_sq | GLD | 1789.0 | 0.0001 | 0.0004 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0004 | 0.0011 | 0.0118 |
| ret_abs | GLD | 1789.0 | 0.0075 | 0.0075 | 0.0 | 0.0001 | 0.0005 | 0.0026 | 0.0055 | 0.01 | 0.0207 | 0.0327 | 0.1084 |
| lag_ret_1 | GLD | 1788.0 | 0.0007 | 0.0106 | -0.1084 | -0.0288 | -0.016 | -0.0045 | 0.0009 | 0.0062 | 0.0165 | 0.027 | 0.0616 |
| _ret_sq_1 | GLD | 1788.0 | 0.0001 | 0.0004 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0004 | 0.0011 | 0.0118 |
| lag_ret_2 | GLD | 1787.0 | 0.0008 | 0.0106 | -0.1084 | -0.0283 | -0.0159 | -0.0045 | 0.0009 | 0.0062 | 0.0165 | 0.027 | 0.0616 |
| _ret_sq_2 | GLD | 1787.0 | 0.0001 | 0.0004 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0004 | 0.001 | 0.0118 |
| lag_ret_3 | GLD | 1786.0 | 0.0007 | 0.0106 | -0.1084 | -0.0283 | -0.0159 | -0.0045 | 0.0009 | 0.0062 | 0.0165 | 0.027 | 0.0616 |
| _ret_sq_3 | GLD | 1786.0 | 0.0001 | 0.0004 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0004 | 0.001 | 0.0118 |
| ewma_var | GLD | 1789.0 | 0.0001 | 0.0001 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0001 | 0.0003 | 0.0004 | 0.0012 |
| oll_var_20 | GLD | 1785.0 | 0.0001 | 0.0001 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0001 | 0.0003 | 0.0005 | 0.0013 |
| corr_ret_1 | GLD | 1790.0 | 0.0178 | 0.0 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 | 0.0178 |
| corr_ret_2 | GLD | 1790.0 | -0.0697 | 0.0 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 | -0.0697 |
| corr_ret_3 | GLD | 1790.0 | -0.0059 | 0.0 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 | -0.0059 |


GLD • Correlation
Adj Close|GLD
High|GLD
Open|GLD
month
quarter
is_month_end
HL_spread|GLD
SMA_5|GLD
SMA_10|GLD
SMA_20|GLD
lag_price_1|GLD
lag_price_3|GLD
autocorr_price_2|GLD
log_ret|GLD
ret_abs|GLD
lag_ret_sq_1|GLD
lag_ret_sq_2|GLD
lag_ret_sq_3|GLD
roll_var_20|GLD
autocorr_ret_2|GLD
Adj Close|GLD
Close|GLD
High|GLD
Low|GLD
Open|GLD
Volume|GLD
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|GLD
OC_spread|GLD
SMA_5|GLD
EMA_5|GLD
SMA_10|GLD
EMA_10|GLD
SMA_20|GLD
EMA_20|GLD
lag_price_1|GLD
lag_price_2|GLD
lag_price_3|GLD
autocorr_price_1|GLD
autocorr_price_2|GLD
autocorr_price_3|GLD
log_ret|GLD
ret_sq|GLD
ret_abs|GLD
lag_ret_1|GLD
lag_ret_sq_1|GLD
lag_ret_2|GLD
lag_ret_sq_2|GLD
lag_ret_3|GLD
lag_ret_sq_3|GLD
ewma_var|GLD
roll_var_20|GLD
autocorr_ret_1|GLD
autocorr_ret_2|GLD
autocorr_ret_3|GLD
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6


GLD • Adj Close|GLD Price
500
450
400
350
300
250
200
150
2019
2020
2021
2022
2023
2024
2025
2026


GLD • 30-Day Rolling Volatility
0.5
0.4
0.3
0.2
0.1
2019
2020
2021
2022
2023
2024
2025
2026


GLD • Log Return Distribution
Count
250
200
150
100
50
0
−0.100
−0.075
−0.050
−0.025
0.000
0.025
0.050
Adj Close|GLD

# MPC • Schema & Missingness

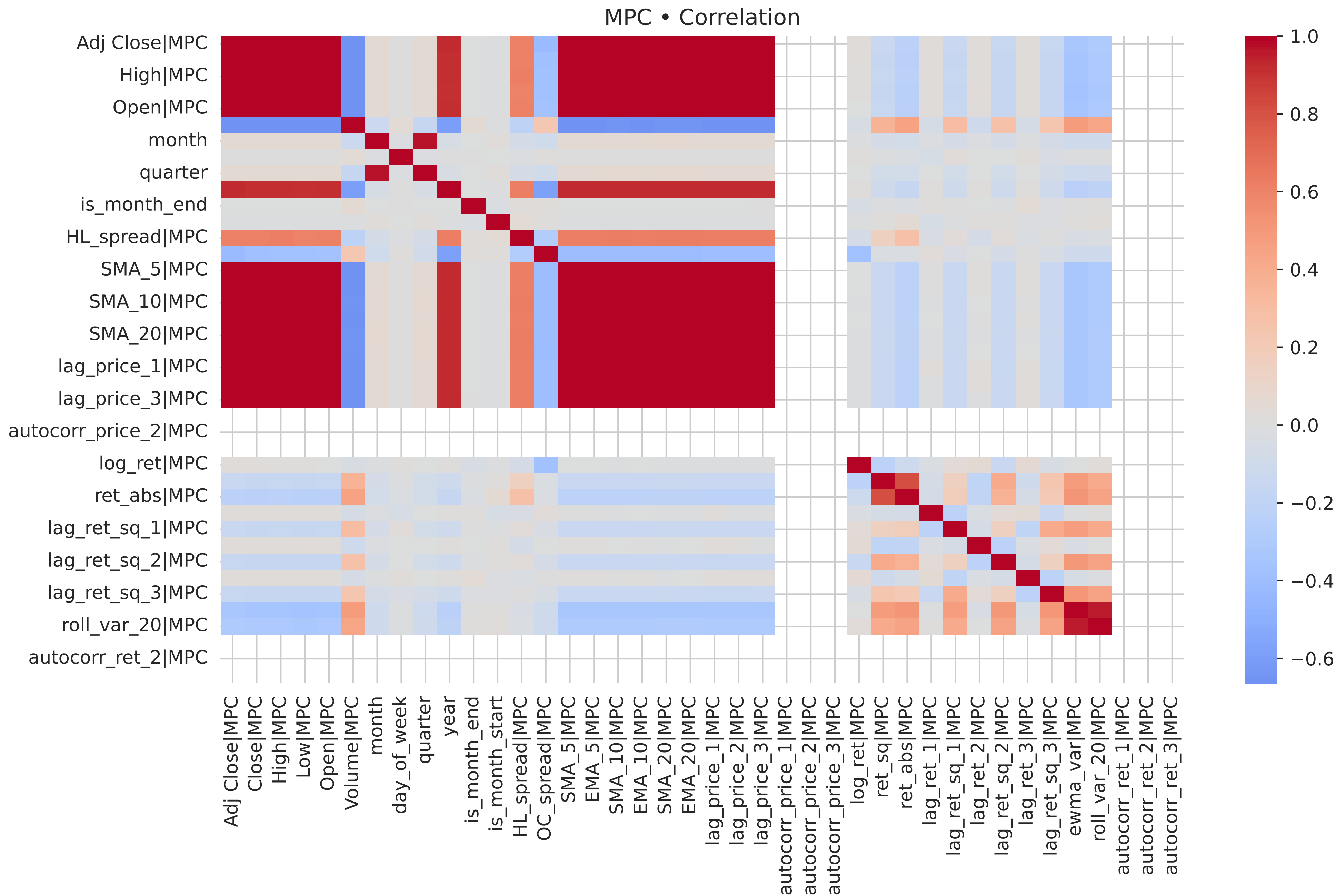
| Column | | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|---|
| Adj Close | MPC | float64 | 1790 | 0 | 0.0 | 1758 | 47.6237 |
| Close | MPC | float64 | 1790 | 0 | 0.0 | 1657 | 59.64 |
| High | MPC | float64 | 1790 | 0 | 0.0 | 1667 | 60.28 |
| Low | MPC | float64 | 1790 | 0 | 0.0 | 1655 | 57.79 |
| Open | MPC | float64 | 1790 | 0 | 0.0 | 1645 | 58.17 |
| Volume | MPC | int64 | 1790 | 0 | 0.0 | 1770 | 6608000.0 |
| month | | int32 | 1790 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | | int32 | 1790 | 0 | 0.0 | 5 | 2.0 |
| quarter | | int32 | 1790 | 0 | 0.0 | 4 | 1.0 |
| year | | int32 | 1790 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| HL_spread | MPC | float64 | 1790 | 0 | 0.0 | 1372 | 2.49 |
| OC_spread | MPC | float64 | 1790 | 0 | 0.0 | 1789 | 10.5463 |
| SMA_5 | MPC | float64 | 1790 | 0 | 0.0 | 1784 | 47.6237 |
| EMA_5 | MPC | float64 | 1790 | 0 | 0.0 | 1790 | 47.6237 |
| SMA_10 | MPC | float64 | 1790 | 0 | 0.0 | 1789 | 47.6237 |
| EMA_10 | MPC | float64 | 1790 | 0 | 0.0 | 1790 | 47.6237 |
| SMA_20 | MPC | float64 | 1790 | 0 | 0.0 | 1789 | 47.6237 |
| EMA_20 | MPC | float64 | 1790 | 0 | 0.0 | 1790 | 47.6237 |
| lag_price_1 | MPC | float64 | 1789 | 1 | 0.06 | 1757 | 47.6237 |
| lag_price_2 | MPC | float64 | 1788 | 2 | 0.11 | 1756 | 47.6237 |
| lag_price_3 | MPC | float64 | 1787 | 3 | 0.17 | 1755 | 47.6237 |
| autocorr_price_1 | MPC | float64 | 1790 | 0 | 0.0 | 1 | 0.9991 |
| autocorr_price_2 | MPC | float64 | 1790 | 0 | 0.0 | 1 | 0.9983 |
| autocorr_price_3 | MPC | float64 | 1790 | 0 | 0.0 | 1 | 0.9973 |
| log_ret | MPC | float64 | 1789 | 1 | 0.06 | 1786 | -0.0147 |
| ret_sq | MPC | float64 | 1789 | 1 | 0.06 | 1786 | 0.0002 |
| ret_abs | MPC | float64 | 1789 | 1 | 0.06 | 1786 | 0.0147 |
| lag_ret_1 | MPC | float64 | 1788 | 2 | 0.11 | 1785 | -0.0147 |
| lag_ret_sq_1 | MPC | float64 | 1788 | 2 | 0.11 | 1785 | 0.0002 |
| lag_ret_2 | MPC | float64 | 1787 | 3 | 0.17 | 1784 | -0.0147 |
| lag_ret_sq_2 | MPC | float64 | 1787 | 3 | 0.17 | 1784 | 0.0002 |
| lag_ret_3 | MPC | float64 | 1786 | 4 | 0.22 | 1783 | -0.0147 |
| lag_ret_sq_3 | MPC | float64 | 1786 | 4 | 0.22 | 1783 | 0.0002 |
| ewma_var | MPC | float64 | 1789 | 1 | 0.06 | 1789 | 0.0002 |
| roll_var_20 | MPC | float64 | 1785 | 5 | 0.28 | 1784 | 0.0005 |
| autocorr_ret_1 | MPC | float64 | 1790 | 0 | 0.0 | 1 | -0.0301 |
| autocorr_ret_2 | MPC | float64 | 1790 | 0 | 0.0 | 1 | 0.0525 |
| autocorr_ret_3 | MPC | float64 | 1790 | 0 | 0.0 | 1 | 0.0643 |

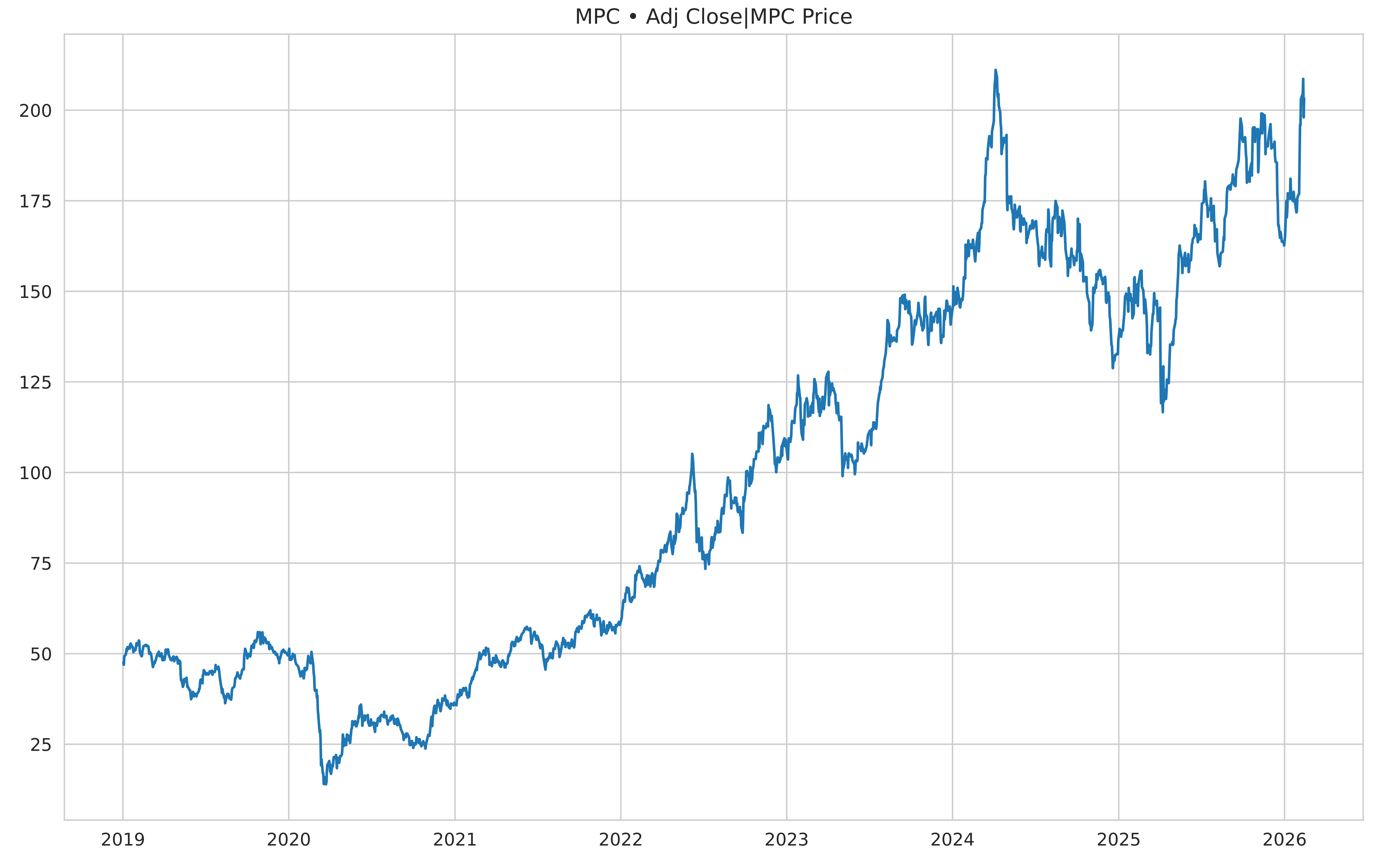
## MPC • Numeric Quality & Ranges

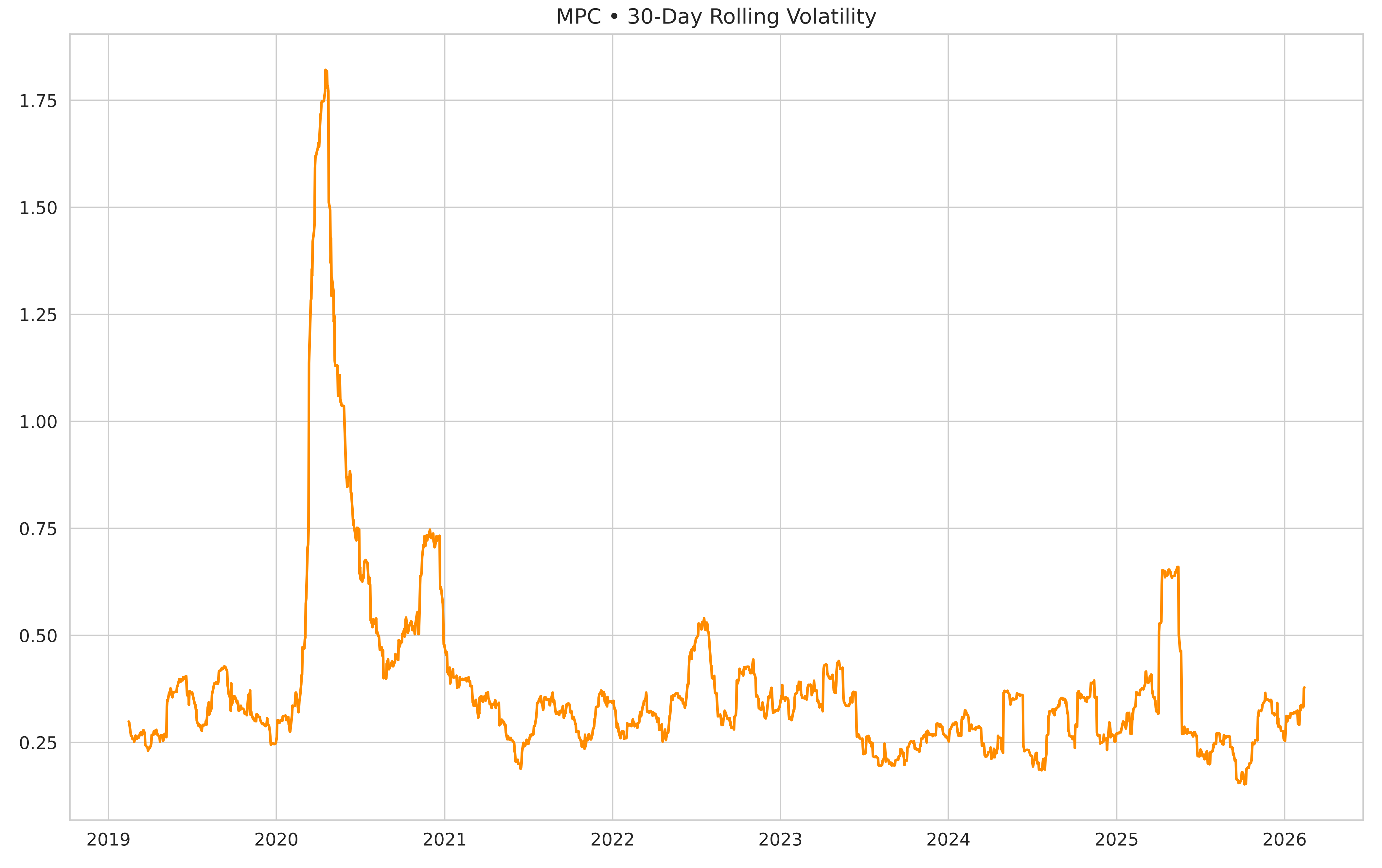
| Column | | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dj Close | MPC | 1790 | 0 | 0.0 | 0 | 0 | 13.9231 | 19.8618 | 49.0161 | 89.0326 | 97.2969 | 147.5461 | 198.0849 | 211.1141 | 54.0587 |
| Close | MPC | 1790 | 0 | 0.0 | 0 | 0 | 16.62 | 23.709 | 57.6375 | 96.175 | 103.3748 | 152.4825 | 201.6056 | 219.13 | 52.6875 |
| High | MPC | 1790 | 0 | 0.0 | 0 | 0 | 17.77 | 25.258 | 58.57 | 97.4 | 104.8644 | 154.675 | 204.2755 | 221.11 | 53.2575 |
| Low | MPC | 1790 | 0 | 0.0 | 0 | 0 | 15.26 | 22.4912 | 56.8575 | 94.38 | 101.8893 | 150.7875 | 197.8639 | 217.63 | 52.1099 |
| Open | MPC | 1790 | 0 | 0.0 | 0 | 0 | 17.01 | 23.9473 | 57.8825 | 95.92 | 103.3498 | 152.6 | 201.0319 | 219.57 | 52.6682 |
| Volume | MPC | 1790 | 0 | 0.0 | 0 | 0 | 957900.0 | 1276836.0 | 2701325.0 | 4289550.0 | 5042910.9497 | 6491850.0 | 16711845.0 | 31341800.0 | 3233504.3995 |
| month | | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4637 | 9.0 | 12.0 | 12.0 | 3.469 |
| day_of_week | | 1790 | 0 | 0.0 | 334 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0229 | 3.0 | 4.0 | 4.0 | 1.3995 |
| quarter | | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4916 | 3.0 | 4.0 | 4.0 | 1.1233 |
| year | | 1790 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0615 | 2024.0 | 2026.0 | 2026.0 | 2.0493 |
| s_month_end | | 1790 | 0 | 0.0 | 1731 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.033 | 0.0 | 1.0 | 1.0 | 0.1786 |
| _month_start | | 1790 | 0 | 0.0 | 1735 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0307 | 0.0 | 1.0 | 1.0 | 0.1726 |
| _spread | MPC | 1790 | 0 | 0.0 | 0 | 0 | 0.57 | 0.79 | 1.64 | 2.525 | 2.975 | 3.8 | 9.4632 | 17.68 | 1.8769 |
| _spread | MPC | 1790 | 0 | 0.0 | 0 | 104 | -13.6751 | -2.7586 | 4.2262 | 5.995 | 6.0529 | 8.2228 | 13.4601 | 19.4174 | 3.5216 |
| SMA_5 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 14.4994 | 20.0937 | 48.8861 | 88.55 | 97.1235 | 147.2385 | 196.4304 | 207.9907 | 53.9301 |
| EMA_5 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 15.3243 | 20.2564 | 48.965 | 88.4151 | 97.1247 | 146.9026 | 196.3168 | 206.7877 | 53.911 |
| SMA_10 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 16.2964 | 19.9501 | 48.991 | 88.3989 | 96.9098 | 146.654 | 195.0512 | 205.2179 | 53.7735 |
| EMA_10 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 18.3087 | 20.1215 | 48.9672 | 88.2046 | 96.9205 | 146.405 | 195.229 | 202.8595 | 53.7532 |
| SMA_20 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 17.6908 | 20.543 | 49.1531 | 88.3228 | 96.5317 | 145.8313 | 193.8693 | 199.1224 | 53.5375 |
| EMA_20 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 20.7033 | 21.873 | 49.0185 | 87.5108 | 96.539 | 145.2347 | 192.9587 | 197.1175 | 53.4904 |
| _price_1 | MPC | 1789 | 1 | 0.06 | 0 | 0 | 13.9231 | 19.8609 | 49.0045 | 89.0221 | 97.2377 | 147.5438 | 197.7337 | 211.1141 | 54.0157 |
| _price_2 | MPC | 1788 | 2 | 0.11 | 0 | 0 | 13.9231 | 19.8601 | 48.997 | 88.874 | 97.1813 | 147.4555 | 197.0316 | 211.1141 | 53.9782 |
| _price_3 | MPC | 1787 | 3 | 0.17 | 0 | 0 | 13.9231 | 19.8592 | 48.9896 | 88.726 | 97.1189 | 147.4126 | 196.4768 | 211.1141 | 53.9288 |
| _price_1 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.0 |
| _price_2 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.0 |
| _price_3 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.0 |
| log_ret | MPC | 1789 | 1 | 0.06 | 4 | 829 | -0.3148 | -0.0754 | -0.0118 | 0.0018 | 0.0008 | 0.0139 | 0.0746 | 0.1875 | 0.0277 |
| ret_sq | MPC | 1789 | 1 | 0.06 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0006 | 0.0093 | 0.0991 | 0.0033 |
| ret_abs | MPC | 1789 | 1 | 0.06 | 4 | 0 | 0.0 | 0.0002 | 0.0059 | 0.0128 | 0.0183 | 0.0242 | 0.0963 | 0.3148 | 0.0208 |
| g_ret_1 | MPC | 1788 | 2 | 0.11 | 4 | 829 | -0.3148 | -0.0754 | -0.0118 | 0.0018 | 0.0008 | 0.0139 | 0.0746 | 0.1875 | 0.0277 |
| et_sq_1 | MPC | 1788 | 2 | 0.11 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0006 | 0.0093 | 0.0991 | 0.0033 |
| g_ret_2 | MPC | 1787 | 3 | 0.17 | 4 | 828 | -0.3148 | -0.0755 | -0.0118 | 0.0018 | 0.0008 | 0.0139 | 0.0746 | 0.1875 | 0.0277 |
| et_sq_2 | MPC | 1787 | 3 | 0.17 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0006 | 0.0093 | 0.0991 | 0.0033 |
| g_ret_3 | MPC | 1786 | 4 | 0.22 | 4 | 828 | -0.3148 | -0.0755 | -0.0118 | 0.0018 | 0.0008 | 0.0139 | 0.0746 | 0.1875 | 0.0277 |
| et_sq_3 | MPC | 1786 | 4 | 0.22 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0006 | 0.0093 | 0.0991 | 0.0033 |
| wma_var | MPC | 1789 | 1 | 0.06 | 0 | 0 | 0.0001 | 0.0002 | 0.0003 | 0.0004 | 0.0008 | 0.0006 | 0.0092 | 0.0126 | 0.0014 |
| _var_20 | MPC | 1785 | 5 | 0.28 | 0 | 0 | 0.0001 | 0.0001 | 0.0003 | 0.0004 | 0.0008 | 0.0006 | 0.0088 | 0.0163 | 0.0016 |
| rr_ret_1 | MPC | 1790 | 0 | 0.0 | 0 | 1790 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | 0.0 |
| rr_ret_2 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0 |
| rr_ret_3 | MPC | 1790 | 0 | 0.0 | 0 | 0 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0 |

# MPC • Describe

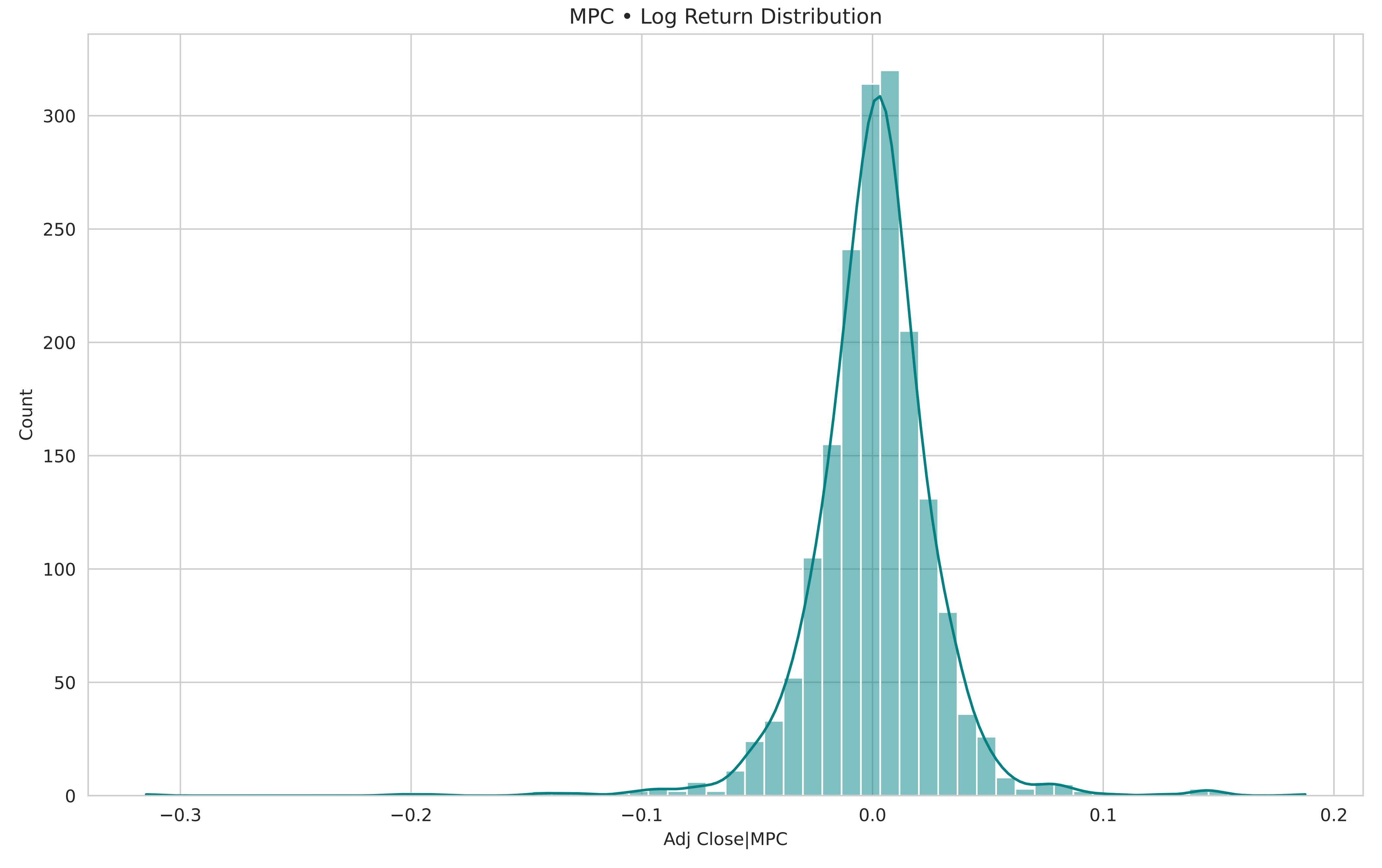
| Variable | | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close | MPC | 1790.0 | 97.2969 | 54.0587 | 13.9231 | 19.8618 | 27.9721 | 49.0161 | 89.0326 | 147.5461 | 185.4321 | 198.0849 | 211.1141 |
| Close | MPC | 1790.0 | 103.3748 | 52.6875 | 16.62 | 23.709 | 33.0345 | 57.6375 | 96.175 | 152.4825 | 186.732 | 201.6056 | 219.13 |
| High | MPC | 1790.0 | 104.8644 | 53.2575 | 17.77 | 25.258 | 34.194 | 58.57 | 97.4 | 154.675 | 188.766 | 204.2755 | 221.11 |
| Low | MPC | 1790.0 | 101.8893 | 52.1099 | 15.26 | 22.4912 | 31.9935 | 56.8575 | 94.38 | 150.7875 | 184.0155 | 197.8639 | 217.63 |
| Open | MPC | 1790.0 | 103.3498 | 52.6682 | 17.01 | 23.9473 | 33.067 | 57.8825 | 95.92 | 152.6 | 186.0 | 201.0319 | 219.57 |
| Volume | MPC | 1790.0 | 5042910.9497 | 3233504.3995 | 957900.0 | 1276836.0 | 1645455.0 | 2701325.0 | 4289550.0 | 6491850.0 | 10946630.0 | 16711845.0 | 31341800.0 |
| month | | 1790.0 | 6.4637 | 3.469 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | | 1790.0 | 2.0229 | 1.3995 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | | 1790.0 | 2.4916 | 1.1233 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | | 1790.0 | 2022.0615 | 2.0493 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | | 1790.0 | 0.033 | 0.1786 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | | 1790.0 | 0.0307 | 0.1726 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| lL_spread | MPC | 1790.0 | 2.975 | 1.8769 | 0.57 | 0.79 | 0.99 | 1.64 | 2.525 | 3.8 | 6.4455 | 9.4632 | 17.68 |
| C_spread | MPC | 1790.0 | 6.0529 | 3.5216 | -13.6751 | -2.7586 | -0.2549 | 4.2262 | 5.995 | 8.2228 | 11.8406 | 13.4601 | 19.4174 |
| SMA_5 | MPC | 1790.0 | 97.1235 | 53.9301 | 14.4994 | 20.0937 | 28.1538 | 48.8861 | 88.55 | 147.2385 | 185.0742 | 196.4304 | 207.9907 |
| EMA_5 | MPC | 1790.0 | 97.1247 | 53.911 | 15.3243 | 20.2564 | 28.1729 | 48.965 | 88.4151 | 146.9026 | 184.7564 | 196.3168 | 206.7877 |
| SMA_10 | MPC | 1790.0 | 96.9098 | 53.7735 | 16.2964 | 19.9501 | 28.3869 | 48.991 | 88.3989 | 146.654 | 184.6069 | 195.0512 | 205.2179 |
| EMA_10 | MPC | 1790.0 | 96.9205 | 53.7532 | 18.3087 | 20.1215 | 28.4756 | 48.9672 | 88.2046 | 146.405 | 184.6739 | 195.229 | 202.8595 |
| SMA_20 | MPC | 1790.0 | 96.5317 | 53.5375 | 17.6908 | 20.543 | 28.6779 | 49.1531 | 88.3228 | 145.8313 | 184.5765 | 193.8693 | 199.1224 |
| EMA_20 | MPC | 1790.0 | 96.539 | 53.4904 | 20.7033 | 21.873 | 28.6099 | 49.0185 | 87.5108 | 145.2347 | 184.2357 | 192.9587 | 197.1175 |
| g_price_1 | MPC | 1789.0 | 97.2377 | 54.0157 | 13.9231 | 19.8609 | 27.9708 | 49.0045 | 89.0221 | 147.5438 | 185.301 | 197.7337 | 211.1141 |
| g_price_2 | MPC | 1788.0 | 97.1813 | 53.9782 | 13.9231 | 19.8601 | 27.9695 | 48.997 | 88.874 | 147.4555 | 184.9965 | 197.0316 | 211.1141 |
| g_price_3 | MPC | 1787.0 | 97.1189 | 53.9288 | 13.9231 | 19.8592 | 27.9682 | 48.9896 | 88.726 | 147.4126 | 184.4025 | 196.4768 | 211.1141 |
| r_price_1 | MPC | 1790.0 | 0.9991 | 0.0 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 | 0.9991 |
| r_price_2 | MPC | 1790.0 | 0.9983 | 0.0 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 | 0.9983 |
| r_price_3 | MPC | 1790.0 | 0.9973 | 0.0 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 | 0.9973 |
| log_ret | MPC | 1789.0 | 0.0008 | 0.0277 | -0.3148 | -0.0754 | -0.039 | -0.0118 | 0.0018 | 0.0139 | 0.0376 | 0.0746 | 0.1875 |
| ret_sq | MPC | 1789.0 | 0.0008 | 0.0033 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0025 | 0.0093 | 0.0991 |
| ret_abs | MPC | 1789.0 | 0.0183 | 0.0208 | 0.0 | 0.0002 | 0.0012 | 0.0059 | 0.0128 | 0.0242 | 0.0496 | 0.0963 | 0.3148 |
| lag_ret_1 | MPC | 1788.0 | 0.0008 | 0.0277 | -0.3148 | -0.0754 | -0.039 | -0.0118 | 0.0018 | 0.0139 | 0.0376 | 0.0746 | 0.1875 |
| _ret_sq_1 | MPC | 1788.0 | 0.0008 | 0.0033 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0025 | 0.0093 | 0.0991 |
| lag_ret_2 | MPC | 1787.0 | 0.0008 | 0.0277 | -0.3148 | -0.0755 | -0.0387 | -0.0118 | 0.0018 | 0.0139 | 0.0376 | 0.0746 | 0.1875 |
| _ret_sq_2 | MPC | 1787.0 | 0.0008 | 0.0033 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0024 | 0.0093 | 0.0991 |
| lag_ret_3 | MPC | 1786.0 | 0.0008 | 0.0277 | -0.3148 | -0.0755 | -0.0387 | -0.0118 | 0.0018 | 0.0139 | 0.0376 | 0.0746 | 0.1875 |
| _ret_sq_3 | MPC | 1786.0 | 0.0008 | 0.0033 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0006 | 0.0024 | 0.0093 | 0.0991 |
| ewma_var | MPC | 1789.0 | 0.0008 | 0.0014 | 0.0001 | 0.0002 | 0.0002 | 0.0003 | 0.0004 | 0.0006 | 0.0022 | 0.0092 | 0.0126 |
| oll_var_20 | MPC | 1785.0 | 0.0008 | 0.0016 | 0.0001 | 0.0001 | 0.0002 | 0.0003 | 0.0004 | 0.0006 | 0.0022 | 0.0088 | 0.0163 |
| corr_ret_1 | MPC | 1790.0 | -0.0301 | 0.0 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 | -0.0301 |
| corr_ret_2 | MPC | 1790.0 | 0.0525 | 0.0 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 | 0.0525 |
| corr_ret_3 | MPC | 1790.0 | 0.0643 | 0.0 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 | 0.0643 |


MPC • Correlation
Adj Close|MPC
High|MPC
Open|MPC
month
quarter
is_month_end
HL_spread|MPC
SMA_5|MPC
SMA_10|MPC
SMA_20|MPC
lag_price_1|MPC
lag_price_3|MPC
autocorr_price_2|MPC
log_ret|MPC
ret_abs|MPC
lag_ret_sq_1|MPC
lag_ret_sq_2|MPC
lag_ret_sq_3|MPC
roll_var_20|MPC
autocorr_ret_2|MPC
Adj Close|MPC
Close|MPC
High|MPC
Low|MPC
Open|MPC
Volume|MPC
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|MPC
OC_spread|MPC
SMA_5|MPC
EMA_5|MPC
SMA_10|MPC
EMA_10|MPC
SMA_20|MPC
EMA_20|MPC
lag_price_1|MPC
lag_price_2|MPC
lag_price_3|MPC
autocorr_price_1|MPC
autocorr_price_2|MPC
autocorr_price_3|MPC
log_ret|MPC
ret_sq|MPC
ret_abs|MPC
lag_ret_1|MPC
lag_ret_sq_1|MPC
lag_ret_2|MPC
lag_ret_sq_2|MPC
lag_ret_3|MPC
lag_ret_sq_3|MPC
ewma_var|MPC
roll_var_20|MPC
autocorr_ret_1|MPC
autocorr_ret_2|MPC
autocorr_ret_3|MPC
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6


MPC • Adj Close|MPC Price
200
175
150
125
100
75
50
25
2019
2020
2021
2022
2023
2024
2025
2026



MPC • 30-Day Rolling Volatility
1.75
1.50
1.25
1.00
0.75
0.50
0.25
2019
2020
2021
2022
2023
2024
2025
2026


MPC • Log Return Distribution
Count
Adj Close|MPC
0
50
100
150
200
250
300
−0.3
−0.2
−0.1
0.0
0.1
0.2

# PSX • Schema & Missingness

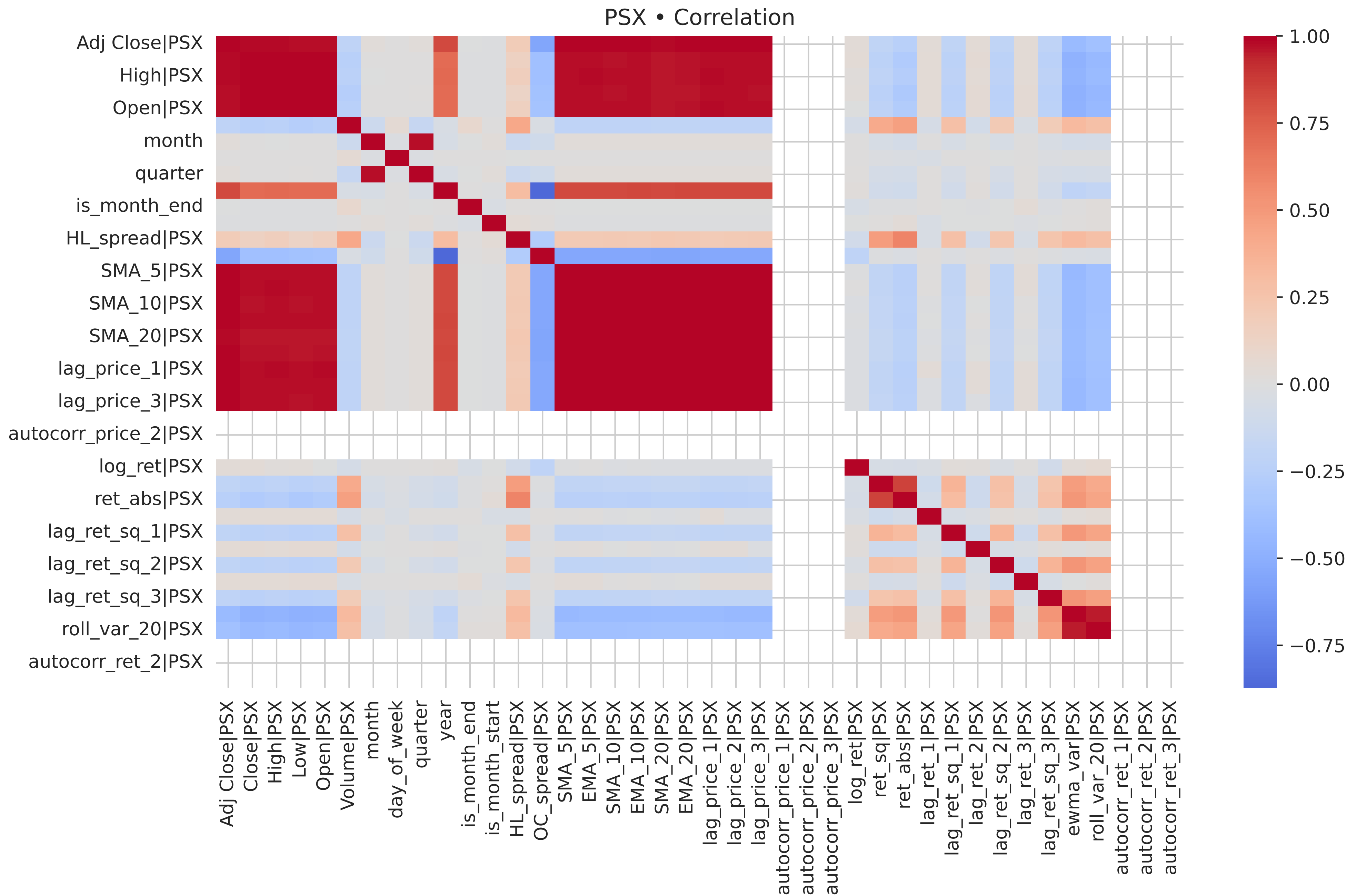
| Column | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|
| Adj Close PSX | float64 | 1790 | 0 | 0.0 | 1758 | 66.3993 |
| Close PSX | float64 | 1790 | 0 | 0.0 | 1616 | 88.12 |
| High PSX | float64 | 1790 | 0 | 0.0 | 1632 | 88.44 |
| Low PSX | float64 | 1790 | 0 | 0.0 | 1624 | 85.0 |
| Open PSX | float64 | 1790 | 0 | 0.0 | 1573 | 85.32 |
| Volume PSX | int64 | 1790 | 0 | 0.0 | 1739 | 3147800.0 |
| month | int32 | 1790 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | int32 | 1790 | 0 | 0.0 | 5 | 2.0 |
| quarter | int32 | 1790 | 0 | 0.0 | 4 | 1.0 |
| year | int32 | 1790 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| HL_spread PSX | float64 | 1790 | 0 | 0.0 | 1188 | 3.44 |
| OC_spread PSX | float64 | 1790 | 0 | 0.0 | 1790 | 18.9207 |
| SMA_5 PSX | float64 | 1790 | 0 | 0.0 | 1790 | 66.3993 |
| EMA_5 PSX | float64 | 1790 | 0 | 0.0 | 1790 | 66.3993 |
| SMA_10 PSX | float64 | 1790 | 0 | 0.0 | 1790 | 66.3993 |
| EMA_10 PSX | float64 | 1790 | 0 | 0.0 | 1790 | 66.3993 |
| SMA_20 PSX | float64 | 1790 | 0 | 0.0 | 1790 | 66.3993 |
| EMA_20 PSX | float64 | 1790 | 0 | 0.0 | 1790 | 66.3993 |
| lag_price_1 PSX | float64 | 1789 | 1 | 0.06 | 1757 | 66.3993 |
| lag_price_2 PSX | float64 | 1788 | 2 | 0.11 | 1756 | 66.3993 |
| lag_price_3 PSX | float64 | 1787 | 3 | 0.17 | 1755 | 66.3993 |
| autocorr_price_1 PSX | float64 | 1790 | 0 | 0.0 | 1 | 0.9977 |
| autocorr_price_2 PSX | float64 | 1790 | 0 | 0.0 | 1 | 0.9954 |
| autocorr_price_3 PSX | float64 | 1790 | 0 | 0.0 | 1 | 0.9929 |
| log_ret PSX | float64 | 1789 | 1 | 0.06 | 1786 | -0.0139 |
| ret_sq PSX | float64 | 1789 | 1 | 0.06 | 1786 | 0.0002 |
| ret_abs PSX | float64 | 1789 | 1 | 0.06 | 1786 | 0.0139 |
| lag_ret_1 PSX | float64 | 1788 | 2 | 0.11 | 1785 | -0.0139 |
| lag_ret_sq_1 PSX | float64 | 1788 | 2 | 0.11 | 1785 | 0.0002 |
| lag_ret_2 PSX | float64 | 1787 | 3 | 0.17 | 1784 | -0.0139 |
| lag_ret_sq_2 PSX | float64 | 1787 | 3 | 0.17 | 1784 | 0.0002 |
| lag_ret_3 PSX | float64 | 1786 | 4 | 0.22 | 1783 | -0.0139 |
| lag_ret_sq_3 PSX | float64 | 1786 | 4 | 0.22 | 1783 | 0.0002 |
| ewma_var PSX | float64 | 1789 | 1 | 0.06 | 1789 | 0.0002 |
| roll_var_20 PSX | float64 | 1785 | 5 | 0.28 | 1785 | 0.0005 |
| autocorr_ret_1 PSX | float64 | 1790 | 0 | 0.0 | 1 | -0.0308 |
| autocorr_ret_2 PSX | float64 | 1790 | 0 | 0.0 | 1 | 0.0133 |
| autocorr_ret_3 PSX | float64 | 1790 | 0 | 0.0 | 1 | 0.0112 |

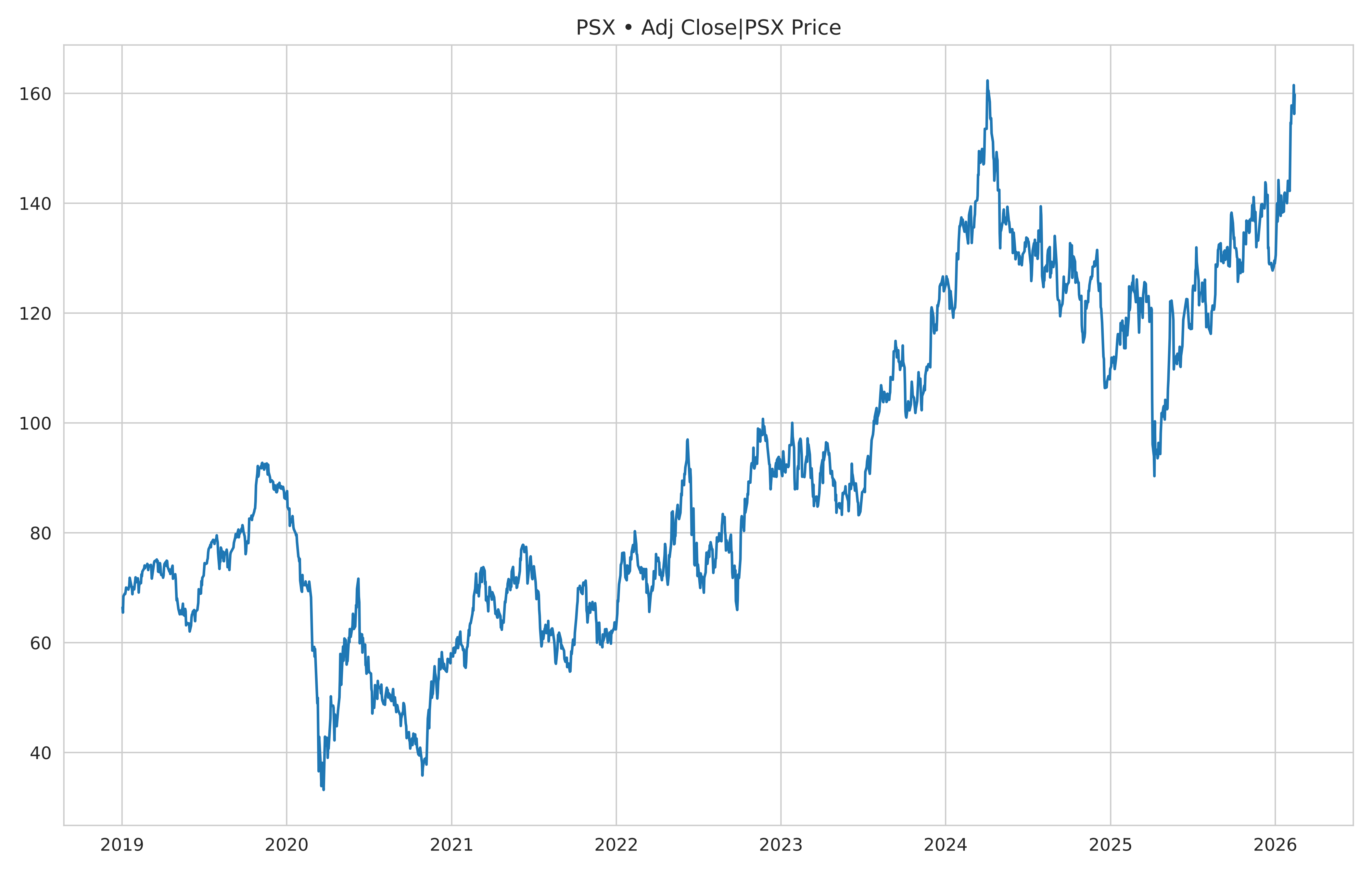
# PSX • Numeric Quality & Ranges

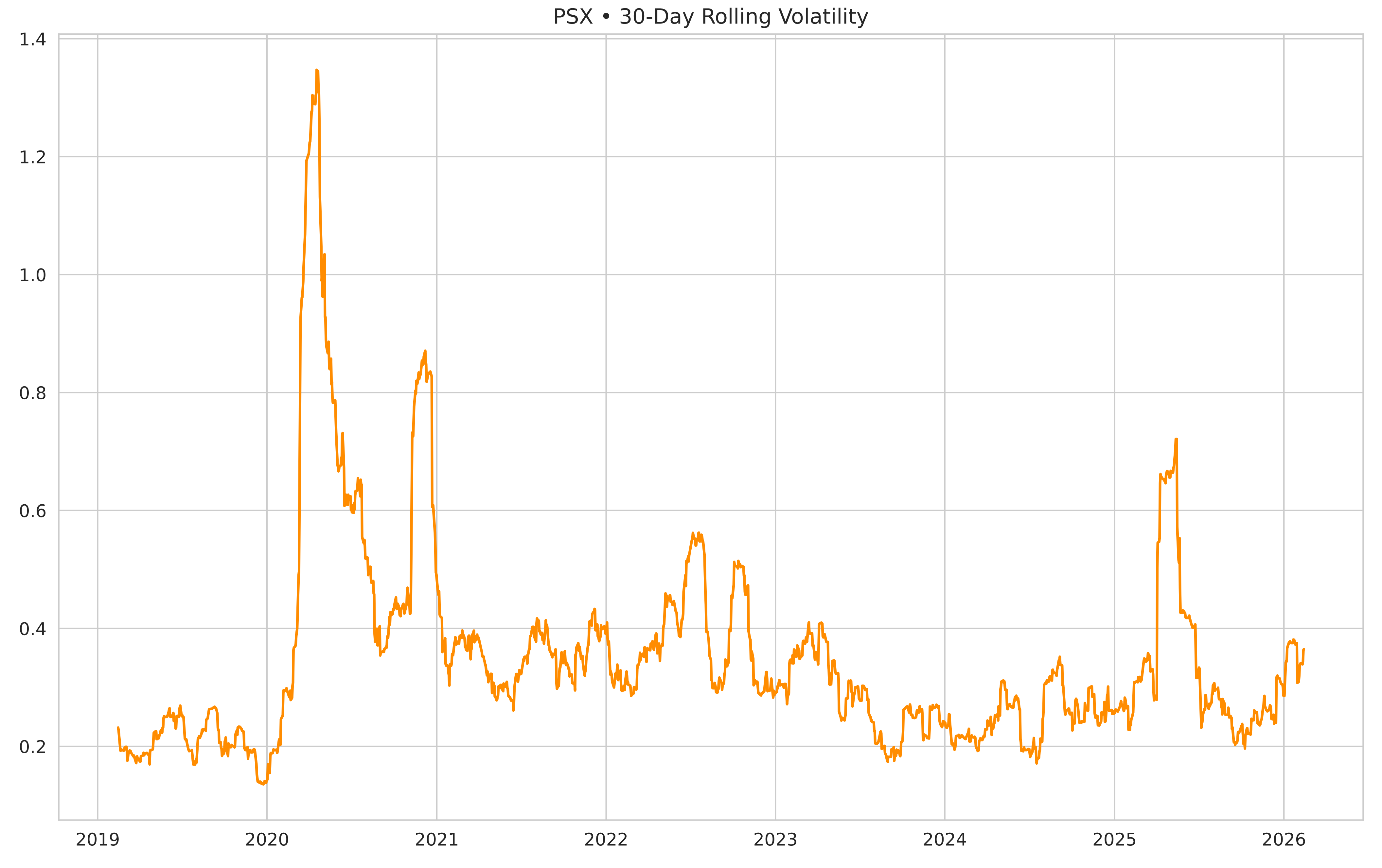
| Column | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close PSX | 1790 | 0 | 0.0 | 0 | 0 | 33.1872 | 39.0371 | 69.1618 | 84.6583 | 90.6265 | 118.911 | 152.8291 | 162.3481 | 29.1046 |
| Close PSX | 1790 | 0 | 0.0 | 0 | 0 | 42.09 | 48.6793 | 82.7875 | 98.85 | 101.6677 | 123.0525 | 158.8532 | 172.71 | 26.0167 |
| High PSX | 1790 | 0 | 0.0 | 0 | 0 | 46.18 | 50.908 | 84.2025 | 100.405 | 103.0723 | 124.2825 | 159.8011 | 174.08 | 26.1047 |
| Low PSX | 1790 | 0 | 0.0 | 0 | 0 | 40.04 | 47.3849 | 81.5625 | 97.83 | 100.3048 | 121.39 | 156.2922 | 170.64 | 25.9143 |
| Open PSX | 1790 | 0 | 0.0 | 0 | 0 | 43.25 | 48.9512 | 83.0025 | 98.895 | 101.6874 | 122.9775 | 159.0374 | 173.18 | 25.999 |
| Volume PSX | 1790 | 0 | 0.0 | 0 | 0 | 942700.0 | 1346328.0 | 2284025.0 | 2841500.0 | 3165478.8827 | 3616175.0 | 8540424.0 | 16579800.0 | 1449609.0355 |
| month | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4637 | 9.0 | 12.0 | 12.0 | 3.469 |
| day_of_week | 1790 | 0 | 0.0 | 334 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0229 | 3.0 | 4.0 | 4.0 | 1.3995 |
| quarter | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4916 | 3.0 | 4.0 | 4.0 | 1.1233 |
| year | 1790 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0615 | 2024.0 | 2026.0 | 2026.0 | 2.0493 |
| s_month_end | 1790 | 0 | 0.0 | 1731 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.033 | 0.0 | 1.0 | 1.0 | 0.1786 |
| _month_start | 1790 | 0 | 0.0 | 1735 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0307 | 0.0 | 1.0 | 1.0 | 0.1726 |
| _spread PSX | 1790 | 0 | 0.0 | 0 | 0 | 0.65 | 1.0089 | 1.88 | 2.485 | 2.7675 | 3.29 | 7.5911 | 14.8 | 1.3197 |
| C_spread PSX | 1790 | 0 | 0.0 | 0 | 54 | -8.695 | -1.7582 | 7.2238 | 10.2988 | 11.0609 | 13.784 | 26.0772 | 29.0009 | 6.6545 |
| SMA_5 PSX | 1790 | 0 | 0.0 | 0 | 0 | 35.4297 | 39.9569 | 69.0903 | 84.7706 | 90.5233 | 118.4031 | 150.2627 | 160.2105 | 28.9719 |
| EMA_5 PSX | 1790 | 0 | 0.0 | 0 | 0 | 36.1281 | 40.3375 | 68.9909 | 84.9508 | 90.5243 | 118.6315 | 150.6909 | 158.8165 | 28.9449 |
| SMA_10 PSX | 1790 | 0 | 0.0 | 0 | 0 | 37.1273 | 39.7116 | 68.8333 | 85.0903 | 90.3983 | 118.5571 | 150.1972 | 157.4356 | 28.8158 |
| EMA_10 PSX | 1790 | 0 | 0.0 | 0 | 0 | 38.6172 | 40.6223 | 68.8226 | 85.2668 | 90.4039 | 118.69 | 149.931 | 156.1105 | 28.7729 |
| SMA_20 PSX | 1790 | 0 | 0.0 | 0 | 0 | 39.6061 | 40.9213 | 68.5774 | 85.0128 | 90.1766 | 117.8724 | 149.0842 | 153.3423 | 28.5545 |
| EMA_20 PSX | 1790 | 0 | 0.0 | 0 | 0 | 39.5654 | 42.5051 | 68.3305 | 84.6474 | 90.182 | 117.2842 | 149.0271 | 152.6163 | 28.4782 |
| _price_1 PSX | 1789 | 1 | 0.06 | 0 | 0 | 33.1872 | 39.037 | 69.1555 | 84.6401 | 90.5879 | 118.859 | 151.3598 | 162.3481 | 29.0668 |
| _price_2 PSX | 1788 | 2 | 0.11 | 0 | 0 | 33.1872 | 39.037 | 69.1484 | 84.5841 | 90.5512 | 118.8426 | 150.051 | 162.3481 | 29.0333 |
| _price_3 PSX | 1787 | 3 | 0.17 | 0 | 0 | 33.1872 | 39.0369 | 69.1413 | 84.5281 | 90.5115 | 118.7979 | 149.5845 | 162.3481 | 28.9929 |
| _price_1 PSX | 1790 | 0 | 0.0 | 0 | 0 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.0 |
| _price_2 PSX | 1790 | 0 | 0.0 | 0 | 0 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.0 |
| _price_3 PSX | 1790 | 0 | 0.0 | 0 | 0 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.0 |
| log_ret PSX | 1789 | 1 | 0.06 | 4 | 847 | -0.1728 | -0.0728 | -0.0105 | 0.0008 | 0.0005 | 0.0128 | 0.0658 | 0.2003 | 0.0248 |
| ret_sq PSX | 1789 | 1 | 0.06 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.0005 | 0.0066 | 0.0401 | 0.0019 |
| ret_abs PSX | 1789 | 1 | 0.06 | 4 | 0 | 0.0 | 0.0002 | 0.0052 | 0.0118 | 0.0169 | 0.0223 | 0.0815 | 0.2003 | 0.0182 |
| ag_ret_1 PSX | 1788 | 2 | 0.11 | 4 | 847 | -0.1728 | -0.0728 | -0.0105 | 0.0008 | 0.0005 | 0.0128 | 0.0658 | 0.2003 | 0.0248 |
| ret_sq_1 PSX | 1788 | 2 | 0.11 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.0005 | 0.0066 | 0.0401 | 0.0019 |
| ag_ret_2 PSX | 1787 | 3 | 0.17 | 4 | 846 | -0.1728 | -0.0728 | -0.0105 | 0.0008 | 0.0005 | 0.0128 | 0.0658 | 0.2003 | 0.0248 |
| ret_sq_2 PSX | 1787 | 3 | 0.17 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.0005 | 0.0066 | 0.0401 | 0.0019 |
| ag_ret_3 PSX | 1786 | 4 | 0.22 | 4 | 846 | -0.1728 | -0.0728 | -0.0105 | 0.0008 | 0.0005 | 0.0128 | 0.0658 | 0.2003 | 0.0248 |
| ret_sq_3 PSX | 1786 | 4 | 0.22 | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.0005 | 0.0067 | 0.0401 | 0.0019 |
| wma_var PSX | 1789 | 1 | 0.06 | 0 | 0 | 0.0001 | 0.0001 | 0.0002 | 0.0004 | 0.0006 | 0.0006 | 0.005 | 0.0065 | 0.0008 |
| l_var_20 PSX | 1785 | 5 | 0.28 | 0 | 0 | 0.0 | 0.0001 | 0.0002 | 0.0004 | 0.0006 | 0.0006 | 0.0051 | 0.0088 | 0.0009 |
| orr_ret_1 PSX | 1790 | 0 | 0.0 | 0 | 1790 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | 0.0 |
| orr_ret_2 PSX | 1790 | 0 | 0.0 | 0 | 0 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0 |
| orr_ret_3 PSX | 1790 | 0 | 0.0 | 0 | 0 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0 |

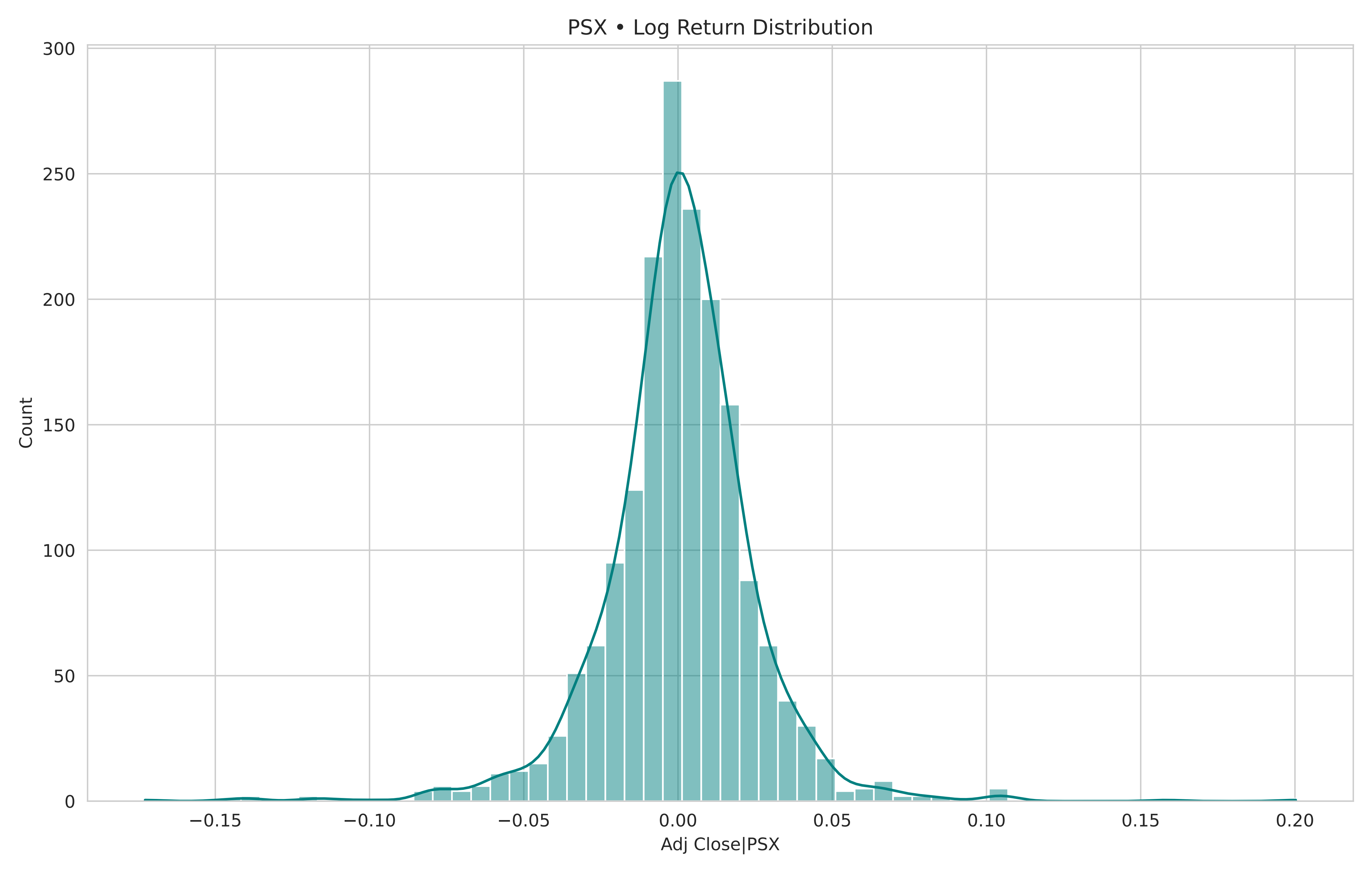
# PSX • Describe

| Variable | | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close | PSX | 1790.0 | 90.6265 | 29.1046 | 33.1872 | 39.0371 | 48.8404 | 69.1618 | 84.6583 | 118.911 | 137.6415 | 152.8291 | 162.3481 |
| Close | PSX | 1790.0 | 101.6677 | 26.0167 | 42.09 | 48.6793 | 60.97 | 82.7875 | 98.85 | 123.0525 | 143.0705 | 158.8532 | 172.71 |
| High | PSX | 1790.0 | 103.0723 | 26.1047 | 46.18 | 50.908 | 62.0315 | 84.2025 | 100.405 | 124.2825 | 144.661 | 159.8011 | 174.08 |
| Low | PSX | 1790.0 | 100.3048 | 25.9143 | 40.04 | 47.3849 | 59.53 | 81.5625 | 97.83 | 121.39 | 141.4555 | 156.2922 | 170.64 |
| Open | PSX | 1790.0 | 101.6874 | 25.999 | 43.25 | 48.9512 | 61.0 | 83.0025 | 98.895 | 122.9775 | 143.272 | 159.0374 | 173.18 |
| Volume | PSX | 1790.0 | 3165478.8827 | 1449609.0355 | 942700.0 | 1346328.0 | 1663495.0 | 2284025.0 | 2841500.0 | 3616175.0 | 5813825.0 | 8540424.0 | 16579800.0 |
| month | | 1790.0 | 6.4637 | 3.469 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | | 1790.0 | 2.0229 | 1.3995 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | | 1790.0 | 2.4916 | 1.1233 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | | 1790.0 | 2022.0615 | 2.0493 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | | 1790.0 | 0.033 | 0.1786 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | | 1790.0 | 0.0307 | 0.1726 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| HL_spread | PSX | 1790.0 | 2.7675 | 1.3197 | 0.65 | 1.0089 | 1.28 | 1.88 | 2.485 | 3.29 | 5.111 | 7.5911 | 14.8 |
| OC_spread | PSX | 1790.0 | 11.0609 | 6.6545 | -8.695 | -1.7582 | 0.7083 | 7.2238 | 10.2988 | 13.784 | 23.9045 | 26.0772 | 29.0009 |
| SMA_5 | PSX | 1790.0 | 90.5233 | 28.9719 | 35.4297 | 39.9569 | 49.0375 | 69.0903 | 84.7706 | 118.4031 | 137.2193 | 150.2627 | 160.2105 |
| EMA_5 | PSX | 1790.0 | 90.5243 | 28.9449 | 36.1281 | 40.3375 | 49.4487 | 68.9909 | 84.9508 | 118.6315 | 137.045 | 150.6909 | 158.8165 |
| SMA_10 | PSX | 1790.0 | 90.3983 | 28.8158 | 37.1273 | 39.7116 | 49.3352 | 68.8333 | 85.0903 | 118.5571 | 136.7139 | 150.1972 | 157.4356 |
| EMA_10 | PSX | 1790.0 | 90.4039 | 28.7729 | 38.6172 | 40.6223 | 49.3494 | 68.8226 | 85.2668 | 118.69 | 137.071 | 149.931 | 156.1105 |
| SMA_20 | PSX | 1790.0 | 90.1766 | 28.5545 | 39.6061 | 40.9213 | 49.2694 | 68.5774 | 85.0128 | 117.8724 | 136.2318 | 149.0842 | 153.3423 |
| EMA_20 | PSX | 1790.0 | 90.182 | 28.4782 | 39.5654 | 42.5051 | 49.1985 | 68.3305 | 84.6474 | 117.2842 | 136.4623 | 149.0271 | 152.6163 |
| g_price_1 | PSX | 1789.0 | 90.5879 | 29.0668 | 33.1872 | 39.037 | 48.8367 | 69.1555 | 84.6401 | 118.859 | 137.5344 | 151.3598 | 162.3481 |
| g_price_2 | PSX | 1788.0 | 90.5512 | 29.0333 | 33.1872 | 39.037 | 48.8331 | 69.1484 | 84.5841 | 118.8426 | 137.4659 | 150.051 | 162.3481 |
| g_price_3 | PSX | 1787.0 | 90.5115 | 28.9929 | 33.1872 | 39.0369 | 48.8294 | 69.1413 | 84.5281 | 118.7979 | 137.4306 | 149.5845 | 162.3481 |
| rr_price_1 | PSX | 1790.0 | 0.9977 | 0.0 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 | 0.9977 |
| rr_price_2 | PSX | 1790.0 | 0.9954 | 0.0 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 | 0.9954 |
| rr_price_3 | PSX | 1790.0 | 0.9929 | 0.0 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 | 0.9929 |
| log_ret | PSX | 1789.0 | 0.0005 | 0.0248 | -0.1728 | -0.0728 | -0.0368 | -0.0105 | 0.0008 | 0.0128 | 0.0363 | 0.0658 | 0.2003 |
| ret_sq | PSX | 1789.0 | 0.0006 | 0.0019 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0005 | 0.0023 | 0.0066 | 0.0401 |
| ret_abs | PSX | 1789.0 | 0.0169 | 0.0182 | 0.0 | 0.0002 | 0.0009 | 0.0052 | 0.0118 | 0.0223 | 0.0477 | 0.0815 | 0.2003 |
| lag_ret_1 | PSX | 1788.0 | 0.0005 | 0.0248 | -0.1728 | -0.0728 | -0.0368 | -0.0105 | 0.0008 | 0.0128 | 0.0363 | 0.0658 | 0.2003 |
| g_ret_sq_1 | PSX | 1788.0 | 0.0006 | 0.0019 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0005 | 0.0023 | 0.0066 | 0.0401 |
| lag_ret_2 | PSX | 1787.0 | 0.0005 | 0.0248 | -0.1728 | -0.0728 | -0.0368 | -0.0105 | 0.0008 | 0.0128 | 0.0363 | 0.0658 | 0.2003 |
| g_ret_sq_2 | PSX | 1787.0 | 0.0006 | 0.0019 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0005 | 0.0023 | 0.0066 | 0.0401 |
| lag_ret_3 | PSX | 1786.0 | 0.0005 | 0.0248 | -0.1728 | -0.0728 | -0.0368 | -0.0105 | 0.0008 | 0.0128 | 0.0363 | 0.0658 | 0.2003 |
| g_ret_sq_3 | PSX | 1786.0 | 0.0006 | 0.0019 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0005 | 0.0023 | 0.0067 | 0.0401 |
| ewma_var | PSX | 1789.0 | 0.0006 | 0.0008 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0004 | 0.0006 | 0.002 | 0.005 | 0.0065 |
| oll_var_20 | PSX | 1785.0 | 0.0006 | 0.0009 | 0.0 | 0.0001 | 0.0001 | 0.0002 | 0.0004 | 0.0006 | 0.0021 | 0.0051 | 0.0088 |
| corr_ret_1 | PSX | 1790.0 | -0.0308 | 0.0 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 | -0.0308 |
| corr_ret_2 | PSX | 1790.0 | 0.0133 | 0.0 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 | 0.0133 |
| corr_ret_3 | PSX | 1790.0 | 0.0112 | 0.0 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 | 0.0112 |


PSX • Correlation
Adj Close|PSX
High|PSX
Open|PSX
month
quarter
is_month_end
HL_spread|PSX
SMA_5|PSX
SMA_10|PSX
SMA_20|PSX
lag_price_1|PSX
lag_price_3|PSX
autocorr_price_2|PSX
log_ret|PSX
ret_abs|PSX
lag_ret_sq_1|PSX
lag_ret_sq_2|PSX
lag_ret_sq_3|PSX
roll_var_20|PSX
autocorr_ret_2|PSX
Adj Close|PSX
Close|PSX
High|PSX
Low|PSX
Open|PSX
Volume|PSX
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|PSX
OC_spread|PSX
SMA_5|PSX
EMA_5|PSX
SMA_10|PSX
EMA_10|PSX
SMA_20|PSX
EMA_20|PSX
lag_price_1|PSX
lag_price_2|PSX
lag_price_3|PSX
autocorr_price_1|PSX
autocorr_price_2|PSX
autocorr_price_3|PSX
log_ret|PSX
ret_sq|PSX
ret_abs|PSX
lag_ret_1|PSX
lag_ret_sq_1|PSX
lag_ret_2|PSX
lag_ret_sq_2|PSX
lag_ret_3|PSX
lag_ret_sq_3|PSX
ewma_var|PSX
roll_var_20|PSX
autocorr_ret_1|PSX
autocorr_ret_2|PSX
autocorr_ret_3|PSX
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75


PSX • Adj Close|PSX Price
160
140
120
100
80
60
40
2019
2020
2021
2022
2023
2024
2025
2026


PSX • 30-Day Rolling Volatility
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2019
2020
2021
2022
2023
2024
2025
2026


PSX • Log Return Distribution
Count
300
250
200
150
100
50
0
−0.15
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20
Adj Close|PSX

# SPY • Schema & Missingness

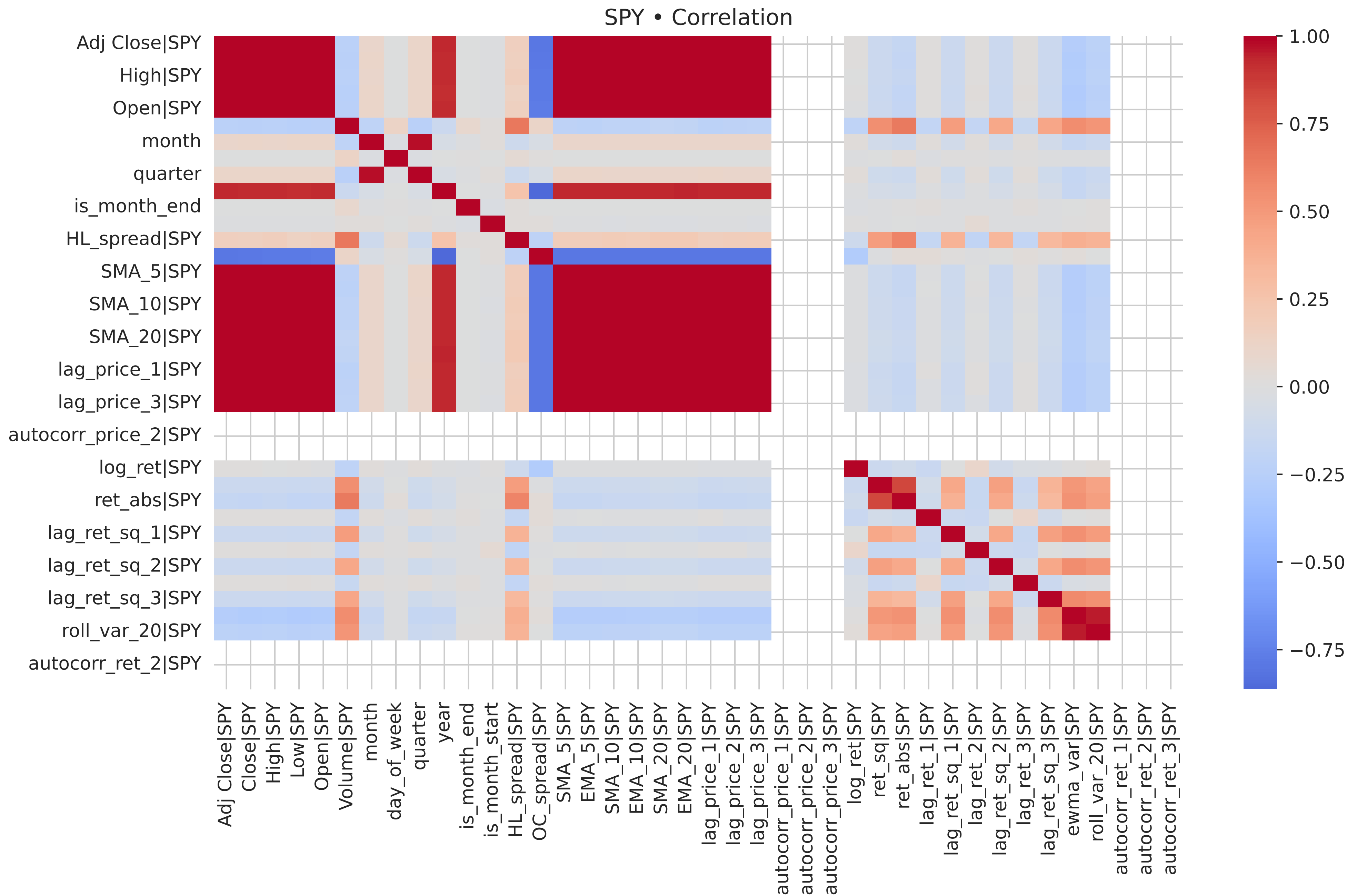
| Column | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|
| Adj Close SPY | float64 | 1790 | 0 | 0.0 | 1773 | 224.9953 |
| Close SPY | float64 | 1790 | 0 | 0.0 | 1751 | 250.18 |
| High SPY | float64 | 1790 | 0 | 0.0 | 1728 | 251.21 |
| Low SPY | float64 | 1790 | 0 | 0.0 | 1740 | 245.95 |
| Open SPY | float64 | 1790 | 0 | 0.0 | 1744 | 245.98 |
| Volume SPY | int64 | 1790 | 0 | 0.0 | 1790 | 126925200.0 |
| month | int32 | 1790 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | int32 | 1790 | 0 | 0.0 | 5 | 2.0 |
| quarter | int32 | 1790 | 0 | 0.0 | 4 | 1.0 |
| year | int32 | 1790 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| HL_spread SPY | float64 | 1790 | 0 | 0.0 | 1361 | 5.26 |
| OC_spread SPY | float64 | 1790 | 0 | 0.0 | 1788 | 20.9847 |
| SMA_5 SPY | float64 | 1790 | 0 | 0.0 | 1790 | 224.9953 |
| EMA_5 SPY | float64 | 1790 | 0 | 0.0 | 1790 | 224.9953 |
| SMA_10 SPY | float64 | 1790 | 0 | 0.0 | 1789 | 224.9953 |
| EMA_10 SPY | float64 | 1790 | 0 | 0.0 | 1790 | 224.9953 |
| SMA_20 SPY | float64 | 1790 | 0 | 0.0 | 1790 | 224.9953 |
| EMA_20 SPY | float64 | 1790 | 0 | 0.0 | 1790 | 224.9953 |
| lag_price_1 SPY | float64 | 1789 | 1 | 0.06 | 1772 | 224.9953 |
| lag_price_2 SPY | float64 | 1788 | 2 | 0.11 | 1771 | 224.9953 |
| lag_price_3 SPY | float64 | 1787 | 3 | 0.17 | 1770 | 224.9953 |
| autocorr_price_1 SPY | float64 | 1790 | 0 | 0.0 | 1 | 0.9993 |
| autocorr_price_2 SPY | float64 | 1790 | 0 | 0.0 | 1 | 0.9987 |
| autocorr_price_3 SPY | float64 | 1790 | 0 | 0.0 | 1 | 0.998 |
| log_ret SPY | float64 | 1789 | 1 | 0.06 | 1788 | -0.0242 |
| ret_sq SPY | float64 | 1789 | 1 | 0.06 | 1788 | 0.0006 |
| ret_abs SPY | float64 | 1789 | 1 | 0.06 | 1788 | 0.0242 |
| lag_ret_1 SPY | float64 | 1788 | 2 | 0.11 | 1787 | -0.0242 |
| lag_ret_sq_1 SPY | float64 | 1788 | 2 | 0.11 | 1787 | 0.0006 |
| lag_ret_2 SPY | float64 | 1787 | 3 | 0.17 | 1786 | -0.0242 |
| lag_ret_sq_2 SPY | float64 | 1787 | 3 | 0.17 | 1786 | 0.0006 |
| lag_ret_3 SPY | float64 | 1786 | 4 | 0.22 | 1785 | -0.0242 |
| lag_ret_sq_3 SPY | float64 | 1786 | 4 | 0.22 | 1785 | 0.0006 |
| ewma_var SPY | float64 | 1789 | 1 | 0.06 | 1789 | 0.0006 |
| roll_var_20 SPY | float64 | 1785 | 5 | 0.28 | 1785 | 0.0004 |
| autocorr_ret_1 SPY | float64 | 1790 | 0 | 0.0 | 1 | -0.1496 |
| autocorr_ret_2 SPY | float64 | 1790 | 0 | 0.0 | 1 | 0.1046 |
| autocorr_ret_3 SPY | float64 | 1790 | 0 | 0.0 | 1 | -0.0403 |

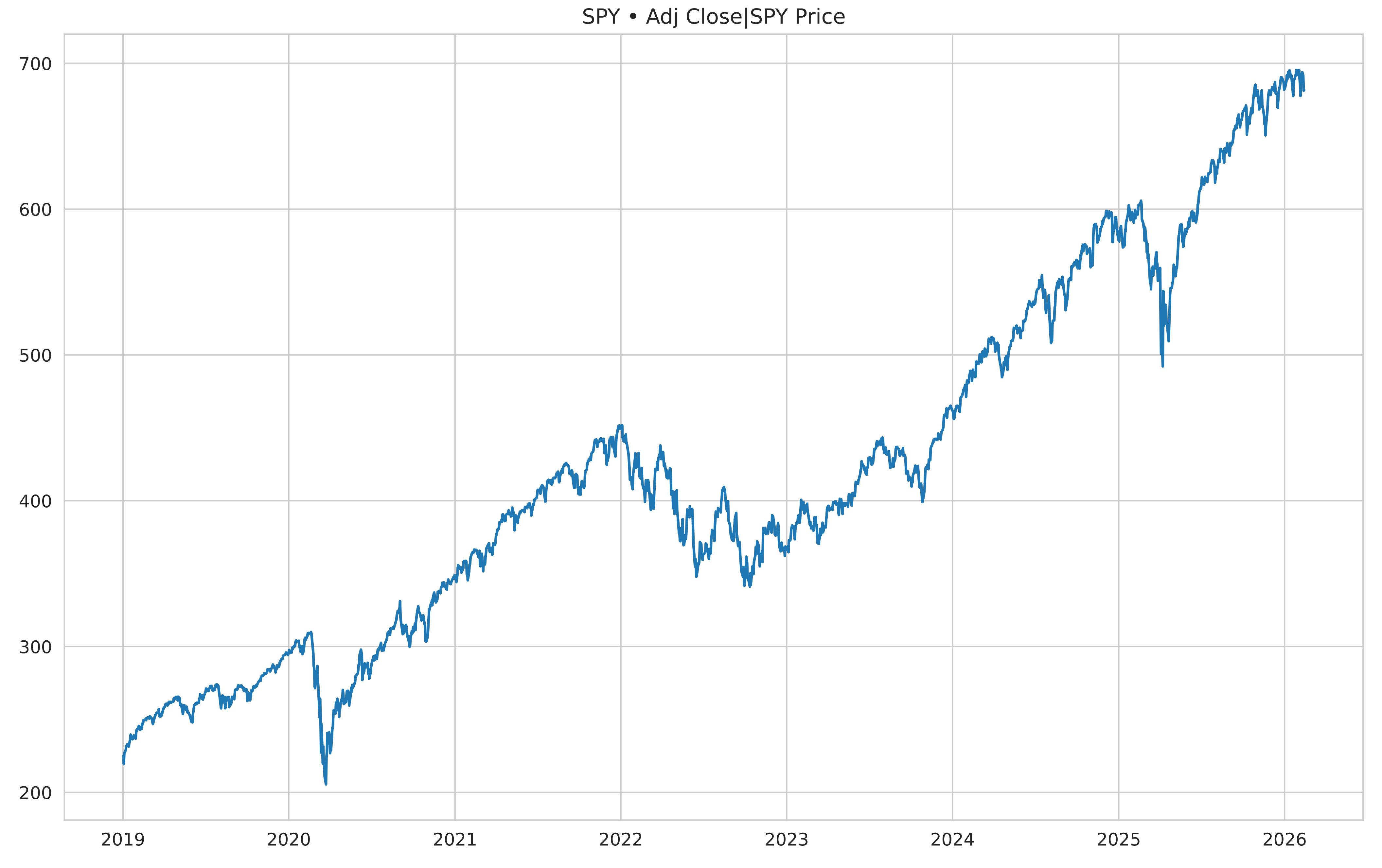
## SPY • Numeric Quality & Ranges

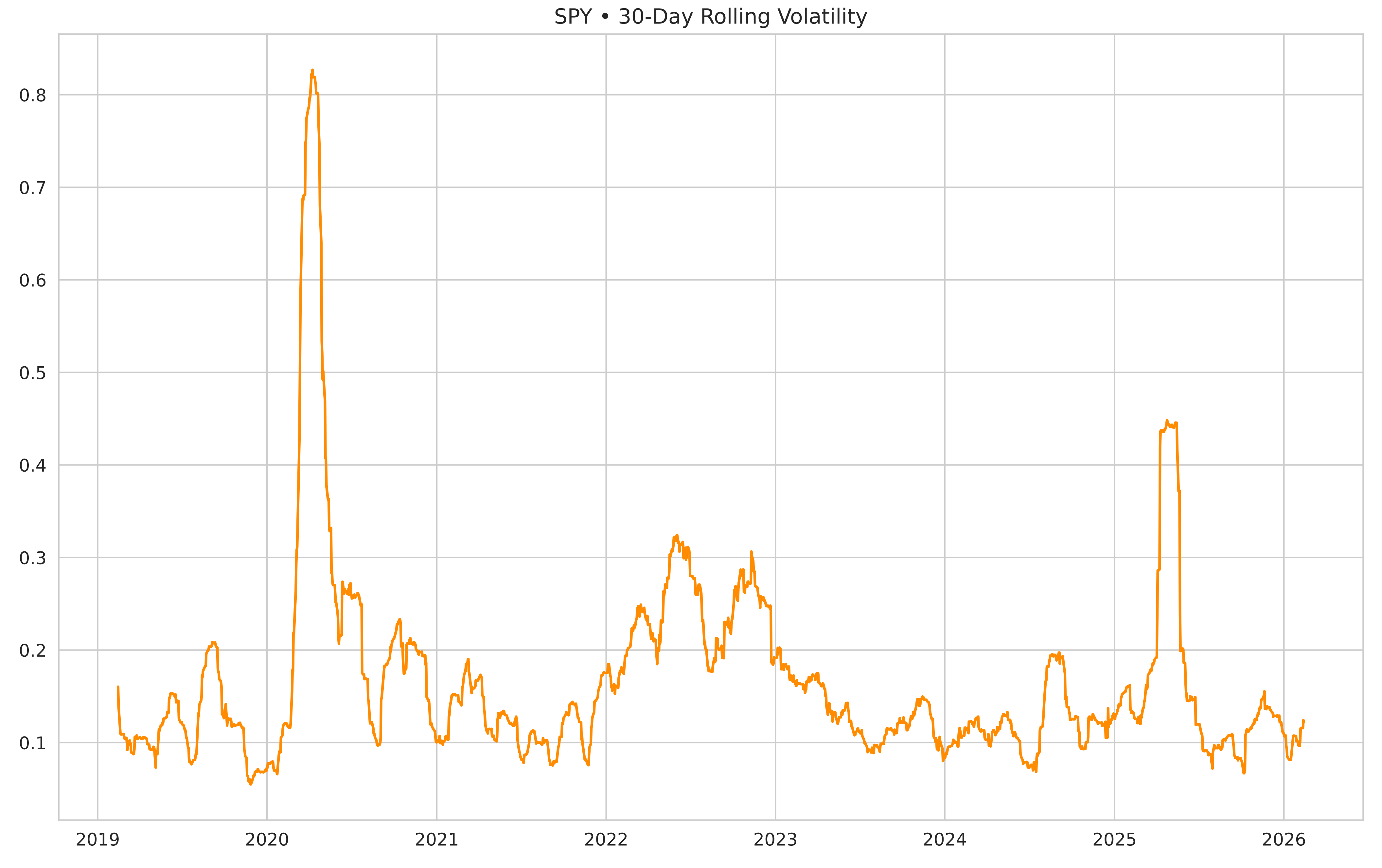
| Column | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close SPY | 1790 | 0 | 0.0 | 0 | 0 | 205.5046 | 232.1112 | 318.736 | 401.1583 | 420.1049 | 508.2999 | 690.3155 | 695.49 | 122.7464 |
| Close SPY | 1790 | 0 | 0.0 | 0 | 0 | 222.95 | 257.3307 | 343.42 | 422.04 | 437.7779 | 518.7875 | 690.3155 | 695.49 | 115.2912 |
| High SPY | 1790 | 0 | 0.0 | 0 | 0 | 229.68 | 258.999 | 345.75 | 424.845 | 440.1732 | 521.67 | 692.3111 | 697.84 | 115.5332 |
| Low SPY | 1790 | 0 | 0.0 | 0 | 0 | 218.26 | 250.83 | 341.245 | 419.305 | 434.9881 | 515.125 | 687.1244 | 693.94 | 114.9776 |
| Open SPY | 1790 | 0 | 0.0 | 0 | 0 | 228.19 | 255.967 | 343.3625 | 422.51 | 437.6871 | 519.2025 | 689.905 | 697.05 | 115.342 |
| Volume SPY | 1790 | 0 | 0.0 | 0 | 0 | 20270000.0 | 30899903.0 | 56136050.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible]5538.2365 |
| month | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4637 | 9.0 | 12.0 | 12.0 | 3.469 |
| day_of_week | 1790 | 0 | 0.0 | 334 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0229 | 3.0 | 4.0 | 4.0 | 1.3995 |
| quarter | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4916 | 3.0 | 4.0 | 4.0 | 1.1233 |
| year | 1790 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0615 | 2024.0 | 2026.0 | 2026.0 | 2.0493 |
| s_month_end | 1790 | 0 | 0.0 | 1731 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.033 | 0.0 | 1.0 | 1.0 | 0.1786 |
| _month_start | 1790 | 0 | 0.0 | 1735 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0307 | 0.0 | 1.0 | 1.0 | 0.1726 |
| _spread SPY | 1790 | 0 | 0.0 | 0 | 0 | 0.59 | 1.11 | 2.88 | 4.29 | 5.185 | 6.415 | 17.4576 | 55.57 | 3.6601 |
| C_spread SPY | 1790 | 0 | 0.0 | 0 | 64 | -50.4435 | -3.4873 | 10.5602 | 18.7881 | 17.5822 | 26.0302 | 32.6587 | 37.439 | 9.3978 |
| SMA_5 SPY | 1790 | 0 | 0.0 | 0 | 0 | 216.1694 | 233.1539 | 318.0796 | 401.3141 | 419.5901 | 508.3417 | 688.2761 | 694.466 | 122.534 |
| EMA_5 SPY | 1790 | 0 | 0.0 | 0 | 0 | 216.5247 | 232.1282 | 317.8146 | 401.5083 | 419.59 | 507.9731 | 688.3838 | 693.6789 | 122.5005 |
| SMA_10 SPY | 1790 | 0 | 0.0 | 0 | 0 | 222.3108 | 229.7634 | 317.1393 | 401.9454 | 418.9441 | 507.5057 | 689.7146 | 691.899 | 122.2692 |
| EMA_10 SPY | 1790 | 0 | 0.0 | 0 | 0 | 224.0191 | 232.3253 | 317.0795 | 401.392 | 418.942 | 507.2322 | 688.5456 | 692.4357 | 122.2064 |
| SMA_20 SPY | 1790 | 0 | 0.0 | 0 | 0 | 222.3108 | 232.0723 | 317.0282 | 399.2532 | 417.6556 | 504.6065 | 688.4005 | 691.197 | 121.7081 |
| EMA_20 SPY | 1790 | 0 | 0.0 | 0 | 0 | 224.484 | 233.6284 | 315.4576 | 399.734 | 417.6454 | 504.5768 | 687.4535 | 690.4923 | 121.6085 |
| _price_1 SPY | 1789 | 1 | 0.06 | 0 | 0 | 205.5046 | 232.1099 | 318.5891 | 400.9716 | 419.9586 | 508.101 | 690.316 | 695.49 | 122.6246 |
| _price_2 SPY | 1788 | 2 | 0.11 | 0 | 0 | 205.5046 | 232.1087 | 318.5849 | 400.9556 | 419.8125 | 507.9475 | 690.3165 | 695.49 | 122.503 |
| _price_3 SPY | 1787 | 3 | 0.17 | 0 | 0 | 205.5046 | 232.1075 | 318.5808 | 400.9397 | 419.6602 | 507.8816 | 689.6822 | 695.49 | 122.3679 |
| _price_1 SPY | 1790 | 0 | 0.0 | 0 | 0 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.0 |
| _price_2 SPY | 1790 | 0 | 0.0 | 0 | 0 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.0 |
| _price_3 SPY | 1790 | 0 | 0.0 | 0 | 0 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.0 |
| log_ret SPY | 1789 | 1 | 0.06 | 2 | 791 | -0.1159 | -0.0348 | -0.0043 | 0.001 | 0.0006 | 0.0066 | 0.03 | 0.0999 | 0.0124 |
| ret_sq SPY | 1789 | 1 | 0.06 | 2 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0001 | 0.002 | 0.0134 | 0.0006 |
| ret_abs SPY | 1789 | 1 | 0.06 | 2 | 0 | 0.0 | 0.0001 | 0.0024 | 0.0056 | 0.0081 | 0.0107 | 0.0449 | 0.1159 | 0.0094 |
| ag_ret_1 SPY | 1788 | 2 | 0.11 | 2 | 791 | -0.1159 | -0.0348 | -0.0043 | 0.001 | 0.0006 | 0.0066 | 0.03 | 0.0999 | 0.0124 |
| ret_sq_1 SPY | 1788 | 2 | 0.11 | 2 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0001 | 0.002 | 0.0134 | 0.0006 |
| ag_ret_2 SPY | 1787 | 3 | 0.17 | 2 | 790 | -0.1159 | -0.0348 | -0.0043 | 0.001 | 0.0006 | 0.0066 | 0.03 | 0.0999 | 0.0124 |
| ret_sq_2 SPY | 1787 | 3 | 0.17 | 2 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0001 | 0.002 | 0.0134 | 0.0006 |
| ag_ret_3 SPY | 1786 | 4 | 0.22 | 2 | 789 | -0.1159 | -0.0348 | -0.0043 | 0.001 | 0.0006 | 0.0066 | 0.03 | 0.0999 | 0.0124 |
| ret_sq_3 SPY | 1786 | 4 | 0.22 | 2 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0001 | 0.002 | 0.0134 | 0.0006 |
| wma_var SPY | 1789 | 1 | 0.06 | 0 | 0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0002 | 0.0002 | 0.0019 | 0.0026 | 0.0003 |
| l_var_20 SPY | 1785 | 5 | 0.28 | 0 | 0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0002 | 0.0001 | 0.0025 | 0.0035 | 0.0004 |
| orr_ret_1 SPY | 1790 | 0 | 0.0 | 0 | 1790 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | 0.0 |
| orr_ret_2 SPY | 1790 | 0 | 0.0 | 0 | 0 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.0 |
| orr_ret_3 SPY | 1790 | 0 | 0.0 | 0 | 1790 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | 0.0 |

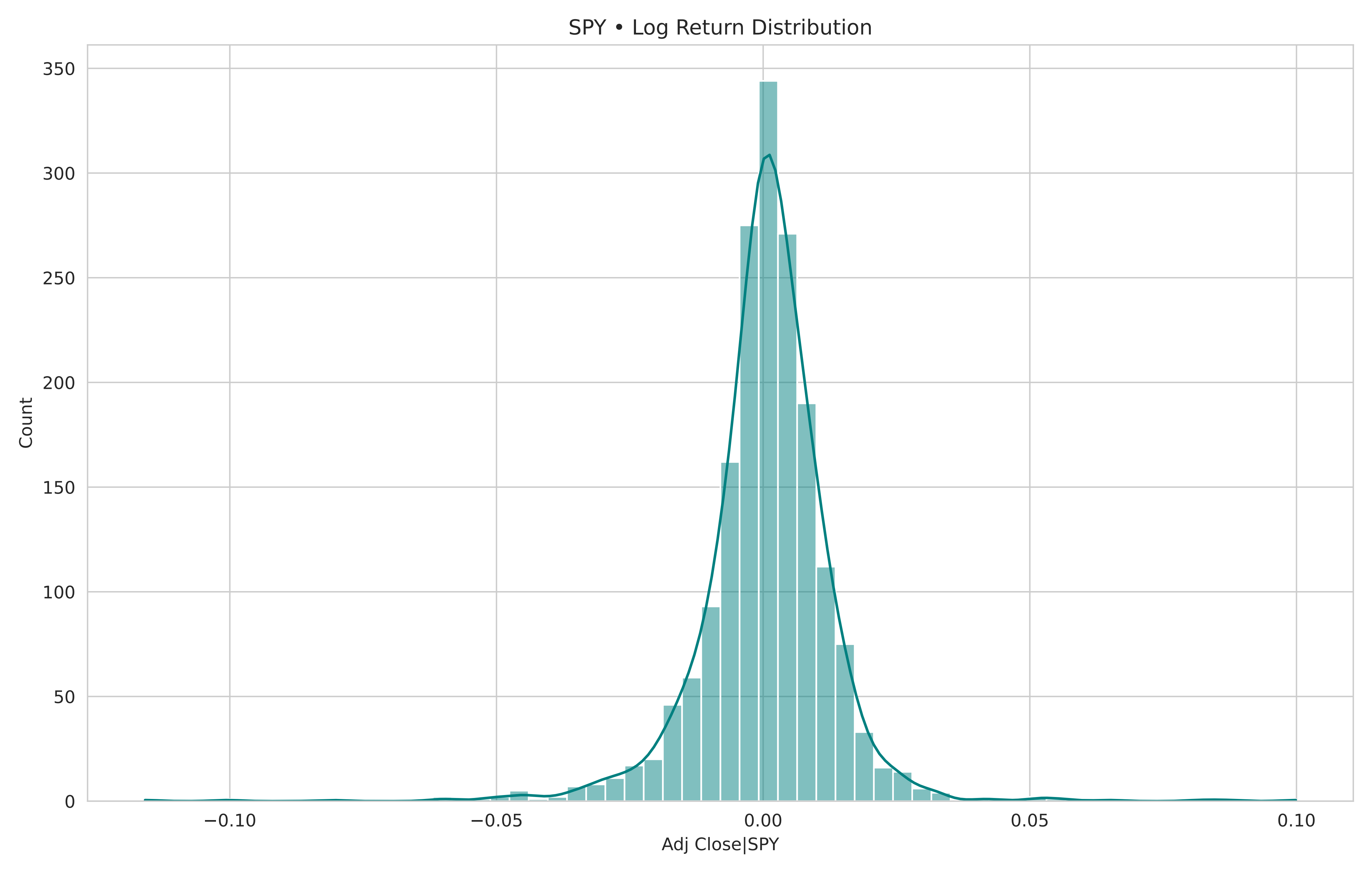
# SPY • Describe

| Variable | | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close | SPY | 1790.0 | 420.1049 | 122.7464 | 205.5046 | 232.1112 | 255.0558 | 318.736 | 401.1583 | 508.2999 | 661.5138 | 690.3155 | 695.49 |
| Close | SPY | 1790.0 | 437.7779 | 115.2912 | 222.95 | 257.3307 | 281.2275 | 343.42 | 422.04 | 518.7875 | 663.4685 | 690.3155 | 695.49 |
| High | SPY | 1790.0 | 440.1732 | 115.5332 | 229.68 | 258.999 | 283.336 | 345.75 | 424.845 | 521.67 | 667.3175 | 692.3111 | 697.84 |
| Low | SPY | 1790.0 | 434.9881 | 114.9776 | 218.26 | 250.83 | 279.1525 | 341.245 | 419.305 | 515.125 | 660.045 | 687.1244 | 693.94 |
| Open | SPY | 1790.0 | 437.6871 | 115.342 | 228.19 | 255.967 | 280.9845 | 343.3625 | 422.51 | 519.2025 | 663.062 | 689.905 | 697.05 |
| Volume | SPY | 1790.0 | 87776779.2738 | 38155538.2365 | 20270000.0 | 30899903.0 | 38738760.0 | 56136050.0 | 71205850.0 | 90600325.0 | 141997715.0 | 242958126.0 | 392220700.0 |
| month | | 1790.0 | 6.4637 | 3.469 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | | 1790.0 | 2.0229 | 1.3995 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | | 1790.0 | 2.4916 | 1.1233 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | | 1790.0 | 2022.0615 | 2.0493 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | | 1790.0 | 0.033 | 0.1786 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | | 1790.0 | 0.0307 | 0.1726 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| HL_spread | SPY | 1790.0 | 5.185 | 3.6601 | 0.59 | 1.11 | 1.49 | 2.88 | 4.29 | 6.415 | 11.8965 | 17.4576 | 55.57 |
| OC_spread | SPY | 1790.0 | 17.5822 | 9.3978 | -50.4435 | -3.4873 | 1.4307 | 10.5602 | 18.7881 | 26.0302 | 29.1181 | 32.6587 | 37.439 |
| SMA_5 | SPY | 1790.0 | 419.5901 | 122.534 | 216.1694 | 233.1539 | 254.7295 | 318.0796 | 401.3141 | 508.3417 | 661.0432 | 688.2761 | 694.466 |
| EMA_5 | SPY | 1790.0 | 419.59 | 122.5005 | 216.5247 | 232.1282 | 254.3892 | 317.8146 | 401.5083 | 507.9731 | 661.4962 | 688.3838 | 693.6789 |
| SMA_10 | SPY | 1790.0 | 418.9441 | 122.2692 | 222.3108 | 229.7634 | 254.2627 | 317.1393 | 401.9454 | 507.5057 | 663.0777 | 689.7146 | 691.899 |
| EMA_10 | SPY | 1790.0 | 418.942 | 122.2064 | 224.0191 | 232.3253 | 253.9595 | 317.0795 | 401.392 | 507.2322 | 662.4078 | 688.5456 | 692.4357 |
| SMA_20 | SPY | 1790.0 | 417.6556 | 121.7081 | 222.3108 | 232.0723 | 253.3678 | 317.0282 | 399.2532 | 504.6065 | 660.0387 | 688.4005 | 691.197 |
| EMA_20 | SPY | 1790.0 | 417.6454 | 121.6085 | 224.484 | 233.6284 | 254.1721 | 315.4576 | 399.734 | 504.5768 | 659.6472 | 687.4535 | 690.4923 |
| ag_price_1 | SPY | 1789.0 | 419.9586 | 122.6246 | 205.5046 | 232.1099 | 255.0526 | 318.5891 | 400.9716 | 508.101 | 661.1883 | 690.316 | 695.49 |
| ag_price_2 | SPY | 1788.0 | 419.8125 | 122.503 | 205.5046 | 232.1087 | 255.0495 | 318.5849 | 400.9556 | 507.9475 | 660.9435 | 690.3165 | 695.49 |
| ag_price_3 | SPY | 1787.0 | 419.6602 | 122.3679 | 205.5046 | 232.1075 | 255.0463 | 318.5808 | 400.9397 | 507.8816 | 660.5581 | 689.6822 | 695.49 |
| rr_price_1 | SPY | 1790.0 | 0.9993 | 0.0 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 | 0.9993 |
| rr_price_2 | SPY | 1790.0 | 0.9987 | 0.0 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 | 0.9987 |
| rr_price_3 | SPY | 1790.0 | 0.998 | 0.0 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 | 0.998 |
| log_ret | SPY | 1789.0 | 0.0006 | 0.0124 | -0.1159 | -0.0348 | -0.0178 | -0.0043 | 0.001 | 0.0066 | 0.0164 | 0.03 | 0.0999 |
| ret_sq | SPY | 1789.0 | 0.0002 | 0.0006 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.002 | 0.0134 |
| ret_abs | SPY | 1789.0 | 0.0081 | 0.0094 | 0.0 | 0.0001 | 0.0004 | 0.0024 | 0.0056 | 0.0107 | 0.0239 | 0.0449 | 0.1159 |
| lag_ret_1 | SPY | 1788.0 | 0.0006 | 0.0124 | -0.1159 | -0.0348 | -0.0178 | -0.0043 | 0.001 | 0.0066 | 0.0165 | 0.03 | 0.0999 |
| g_ret_sq_1 | SPY | 1788.0 | 0.0002 | 0.0006 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.002 | 0.0134 |
| lag_ret_2 | SPY | 1787.0 | 0.0006 | 0.0124 | -0.1159 | -0.0348 | -0.0178 | -0.0043 | 0.001 | 0.0066 | 0.0165 | 0.03 | 0.0999 |
| g_ret_sq_2 | SPY | 1787.0 | 0.0002 | 0.0006 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.002 | 0.0134 |
| lag_ret_3 | SPY | 1786.0 | 0.0006 | 0.0124 | -0.1159 | -0.0348 | -0.0178 | -0.0043 | 0.001 | 0.0066 | 0.0165 | 0.03 | 0.0999 |
| g_ret_sq_3 | SPY | 1786.0 | 0.0002 | 0.0006 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0006 | 0.002 | 0.0134 |
| ewma_var | SPY | 1789.0 | 0.0002 | 0.0003 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0002 | 0.0005 | 0.0019 | 0.0026 |
| oll_var_20 | SPY | 1785.0 | 0.0002 | 0.0004 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0001 | 0.0001 | 0.0004 | 0.0025 | 0.0035 |
| corr_ret_1 | SPY | 1790.0 | -0.1496 | 0.0 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 | -0.1496 |
| corr_ret_2 | SPY | 1790.0 | 0.1046 | 0.0 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 | 0.1046 |
| corr_ret_3 | SPY | 1790.0 | -0.0403 | 0.0 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 | -0.0403 |


SPY • Correlation
Adj Close|SPY
High|SPY
Open|SPY
month
quarter
is_month_end
HL_spread|SPY
SMA_5|SPY
SMA_10|SPY
SMA_20|SPY
lag_price_1|SPY
lag_price_3|SPY
autocorr_price_2|SPY
log_ret|SPY
ret_abs|SPY
lag_ret_sq_1|SPY
lag_ret_sq_2|SPY
lag_ret_sq_3|SPY
roll_var_20|SPY
autocorr_ret_2|SPY
Adj Close|SPY
Close|SPY
High|SPY
Low|SPY
Open|SPY
Volume|SPY
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|SPY
OC_spread|SPY
SMA_5|SPY
EMA_5|SPY
SMA_10|SPY
EMA_10|SPY
SMA_20|SPY
EMA_20|SPY
lag_price_1|SPY
lag_price_2|SPY
lag_price_3|SPY
autocorr_price_1|SPY
autocorr_price_2|SPY
autocorr_price_3|SPY
log_ret|SPY
ret_sq|SPY
ret_abs|SPY
lag_ret_1|SPY
lag_ret_sq_1|SPY
lag_ret_2|SPY
lag_ret_sq_2|SPY
lag_ret_3|SPY
lag_ret_sq_3|SPY
ewma_var|SPY
roll_var_20|SPY
autocorr_ret_1|SPY
autocorr_ret_2|SPY
autocorr_ret_3|SPY
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75


SPY • Adj Close|SPY Price
700
600
500
400
300
200
2019
2020
2021
2022
2023
2024
2025
2026


SPY • 30-Day Rolling Volatility
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2019
2020
2021
2022
2023
2024
2025
2026


SPY • Log Return Distribution
Count
Adj Close|SPY
0
50
100
150
200
250
300
350
−0.10
−0.05
0.00
0.05
0.10

## VLO • Schema & Missingness

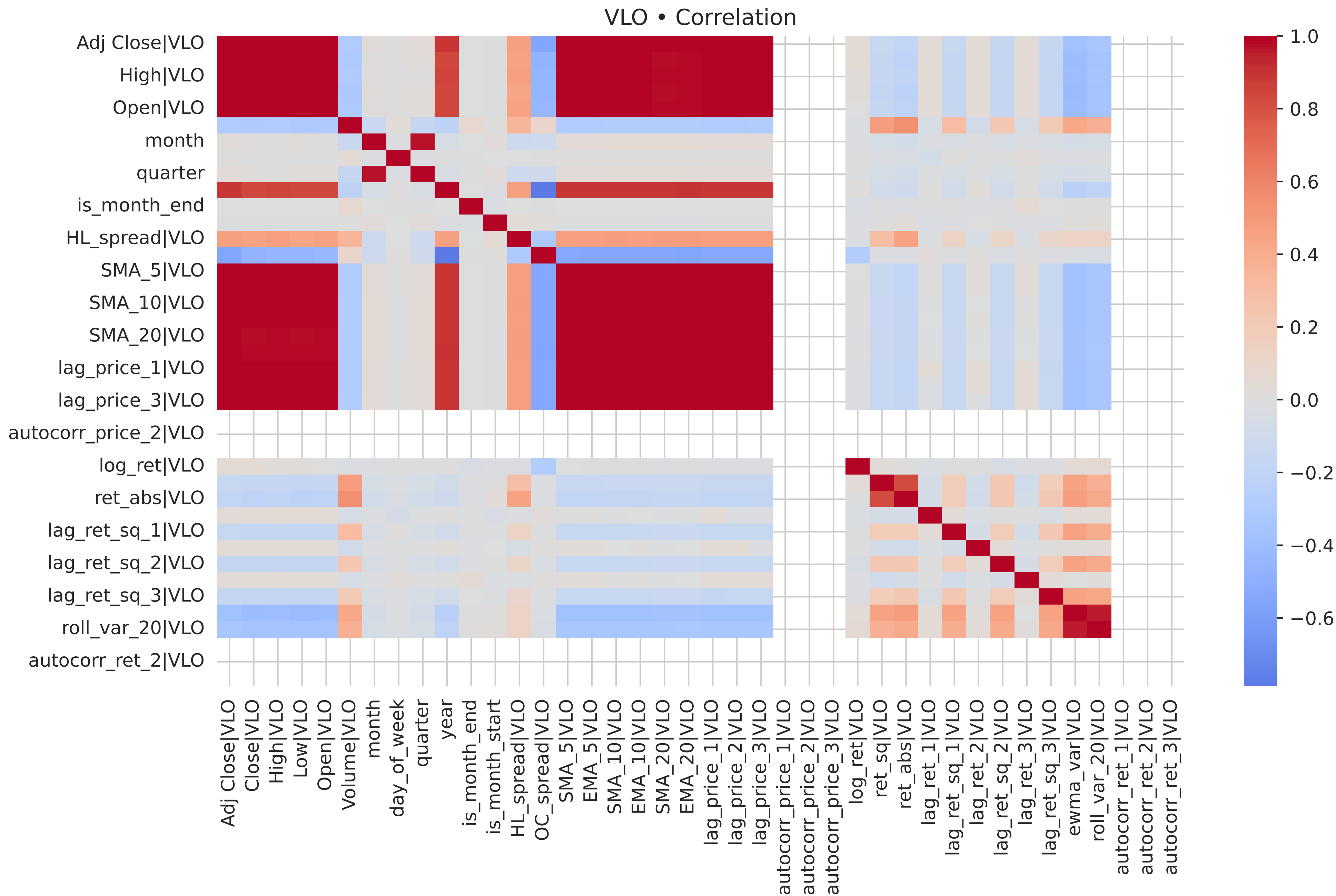
| Column | dtype | non_null | missing | missing_% | unique | sample |
|---|---|---|---|---|---|---|
| Adj Close VLO | float64 | 1790 | 0 | 0.0 | 1761 | 56.3757 |
| Close VLO | float64 | 1790 | 0 | 0.0 | 1641 | 75.56 |
| High VLO | float64 | 1790 | 0 | 0.0 | 1647 | 76.15 |
| Low VLO | float64 | 1790 | 0 | 0.0 | 1650 | 73.17 |
| Open VLO | float64 | 1790 | 0 | 0.0 | 1639 | 73.82 |
| Volume VLO | int64 | 1790 | 0 | 0.0 | 1762 | 4271900.0 |
| month | int32 | 1790 | 0 | 0.0 | 12 | 1.0 |
| day_of_week | int32 | 1790 | 0 | 0.0 | 5 | 2.0 |
| quarter | int32 | 1790 | 0 | 0.0 | 4 | 1.0 |
| year | int32 | 1790 | 0 | 0.0 | 8 | 2019.0 |
| is_month_end | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| is_month_start | int64 | 1790 | 0 | 0.0 | 2 | 0.0 |
| HL_spread VLO | float64 | 1790 | 0 | 0.0 | 1323 | 2.98 |
| OC_spread VLO | float64 | 1790 | 0 | 0.0 | 1790 | 17.4443 |
| SMA_5 VLO | float64 | 1790 | 0 | 0.0 | 1788 | 56.3757 |
| EMA_5 VLO | float64 | 1790 | 0 | 0.0 | 1790 | 56.3757 |
| SMA_10 VLO | float64 | 1790 | 0 | 0.0 | 1789 | 56.3757 |
| EMA_10 VLO | float64 | 1790 | 0 | 0.0 | 1790 | 56.3757 |
| SMA_20 VLO | float64 | 1790 | 0 | 0.0 | 1789 | 56.3757 |
| EMA_20 VLO | float64 | 1790 | 0 | 0.0 | 1790 | 56.3757 |
| lag_price_1 VLO | float64 | 1789 | 1 | 0.06 | 1760 | 56.3757 |
| lag_price_2 VLO | float64 | 1788 | 2 | 0.11 | 1759 | 56.3757 |
| lag_price_3 VLO | float64 | 1787 | 3 | 0.17 | 1758 | 56.3757 |
| autocorr_price_1 VLO | float64 | 1790 | 0 | 0.0 | 1 | 0.9981 |
| autocorr_price_2 VLO | float64 | 1790 | 0 | 0.0 | 1 | 0.9963 |
| autocorr_price_3 VLO | float64 | 1790 | 0 | 0.0 | 1 | 0.9944 |
| log_ret VLO | float64 | 1789 | 1 | 0.06 | 1785 | -0.0182 |
| ret_sq VLO | float64 | 1789 | 1 | 0.06 | 1785 | 0.0003 |
| ret_abs VLO | float64 | 1789 | 1 | 0.06 | 1785 | 0.0182 |
| lag_ret_1 VLO | float64 | 1788 | 2 | 0.11 | 1784 | -0.0182 |
| lag_ret_sq_1 VLO | float64 | 1788 | 2 | 0.11 | 1784 | 0.0003 |
| lag_ret_2 VLO | float64 | 1787 | 3 | 0.17 | 1783 | -0.0182 |
| lag_ret_sq_2 VLO | float64 | 1787 | 3 | 0.17 | 1783 | 0.0003 |
| lag_ret_3 VLO | float64 | 1786 | 4 | 0.22 | 1782 | -0.0182 |
| lag_ret_sq_3 VLO | float64 | 1786 | 4 | 0.22 | 1782 | 0.0003 |
| ewma_var VLO | float64 | 1789 | 1 | 0.06 | 1789 | 0.0003 |
| roll_var_20 VLO | float64 | 1785 | 5 | 0.28 | 1785 | 0.0004 |
| autocorr_ret_1 VLO | float64 | 1790 | 0 | 0.0 | 1 | -0.028 |
| autocorr_ret_2 VLO | float64 | 1790 | 0 | 0.0 | 1 | 0.005 |
| autocorr_ret_3 VLO | float64 | 1790 | 0 | 0.0 | 1 | -0.0176 |

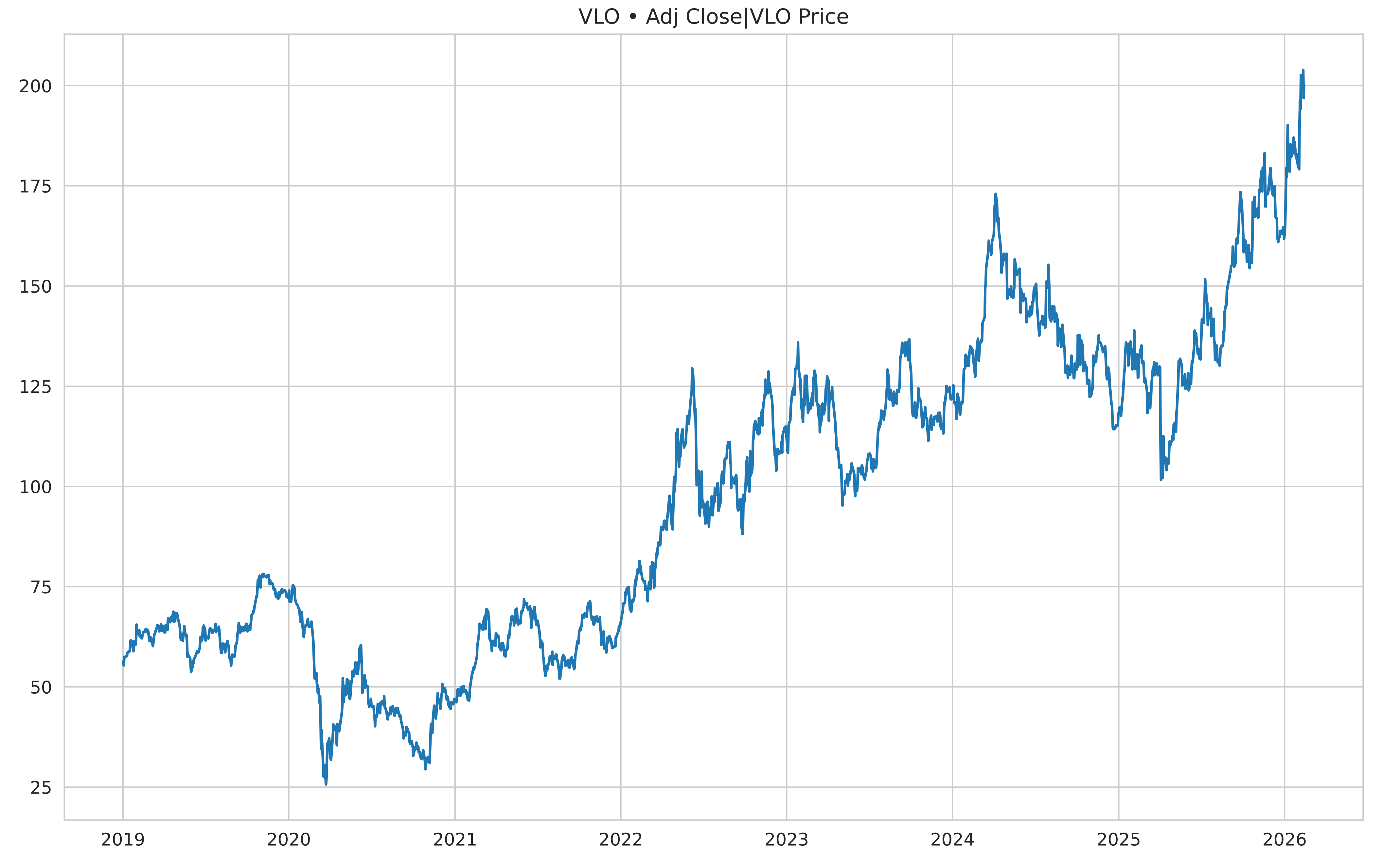
# VLO • Numeric Quality & Ranges

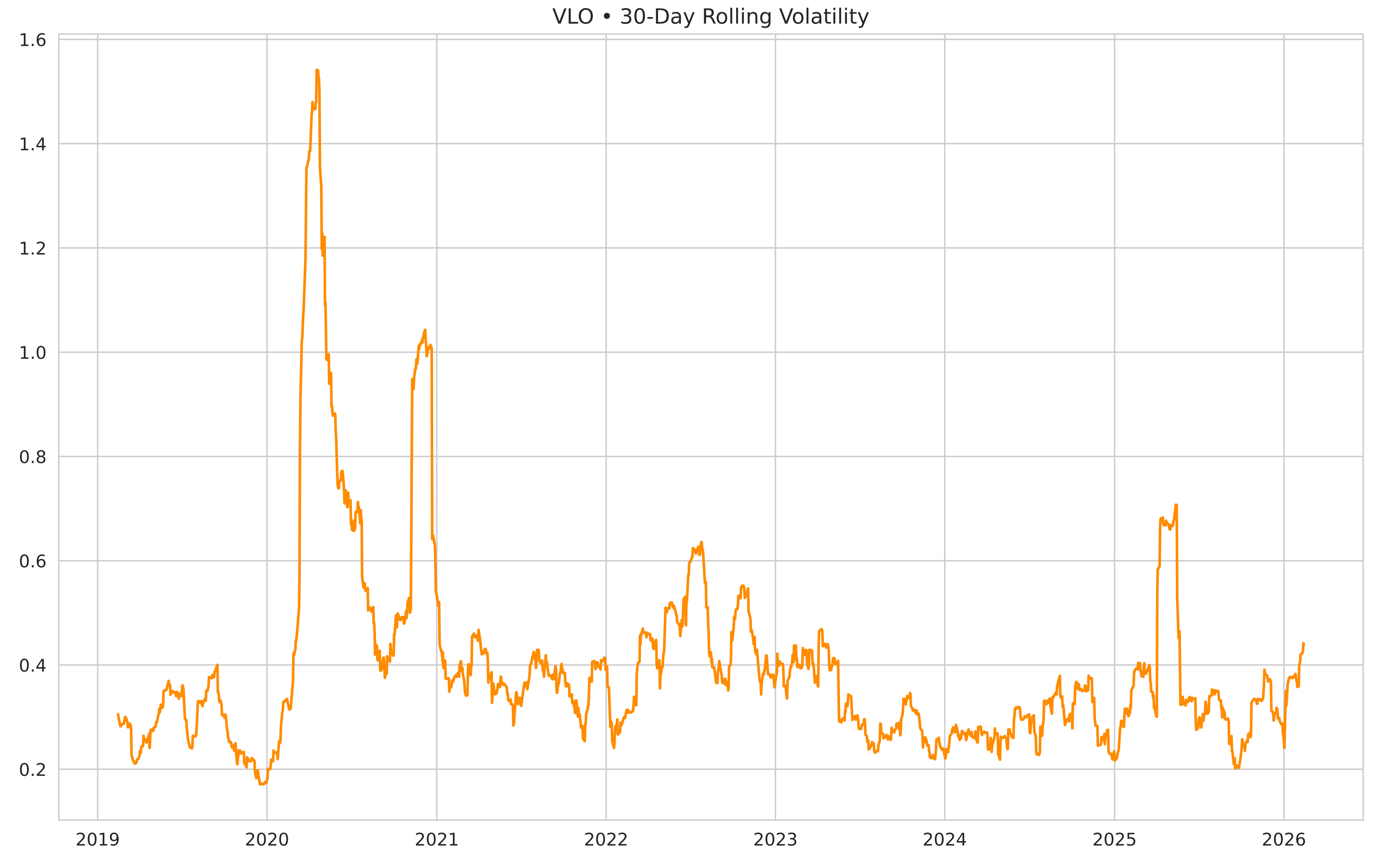
| Column | | non_null | missing | missing_% | zeros | negatives | min | p01 | q1 | median | mean | q3 | p99 | max | std |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dj Close | VLO | 1790 | 0 | 0.0 | 0 | 0 | 25.6788 | 32.2647 | 62.5952 | 100.2655 | 96.9527 | 128.2516 | 182.9285 | 203.92 | 39.4086 |
| Close | VLO | 1790 | 0 | 0.0 | 0 | 0 | 32.62 | 40.1848 | 77.8375 | 110.195 | 107.38 | 134.9875 | 184.0816 | 203.92 | 36.5099 |
| High | VLO | 1790 | 0 | 0.0 | 0 | 0 | 37.31 | 41.3801 | 78.89 | 112.135 | 109.0621 | 136.99 | 187.0626 | 206.77 | 36.9029 |
| Low | VLO | 1790 | 0 | 0.0 | 0 | 0 | 31.0 | 39.1291 | 76.675 | 107.385 | 105.6881 | 133.09 | 181.7241 | 200.51 | 36.0925 |
| Open | VLO | 1790 | 0 | 0.0 | 0 | 0 | 34.79 | 40.4035 | 77.91 | 109.575 | 107.3947 | 135.0 | 184.5698 | 204.08 | 36.5068 |
| Volume | VLO | 1790 | 0 | 0.0 | 0 | 0 | 559800.0 | 1522504.0 | 2765200.0 | 3458100.0 | 3815705.2514 | 4438375.0 | 9928921.0 | 19211600.0 | 1679007.2485 |
| month | | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 3.0 | 6.0 | 6.4637 | 9.0 | 12.0 | 12.0 | 3.469 |
| day_of_week | | 1790 | 0 | 0.0 | 334 | 0 | 0.0 | 0.0 | 1.0 | 2.0 | 2.0229 | 3.0 | 4.0 | 4.0 | 1.3995 |
| quarter | | 1790 | 0 | 0.0 | 0 | 0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.4916 | 3.0 | 4.0 | 4.0 | 1.1233 |
| year | | 1790 | 0 | 0.0 | 0 | 0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2022.0615 | 2024.0 | 2026.0 | 2026.0 | 2.0493 |
| s_month_end | | 1790 | 0 | 0.0 | 1731 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.033 | 0.0 | 1.0 | 1.0 | 0.1786 |
| _month_start | | 1790 | 0 | 0.0 | 1735 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0307 | 0.0 | 1.0 | 1.0 | 0.1726 |
| _spread | VLO | 1790 | 0 | 0.0 | 0 | 0 | 0.8 | 1.0967 | 2.08 | 3.0 | 3.374 | 4.1975 | 9.2422 | 15.73 | 1.7818 |
| _spread | VLO | 1790 | 0 | 0.0 | 0 | 51 | -8.8103 | -1.8231 | 7.1042 | 9.947 | 10.442 | 13.1416 | 22.813 | 24.3871 | 5.7806 |
| SMA_5 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 28.0814 | 32.982 | 62.6133 | 99.9067 | 96.7922 | 127.991 | 182.8538 | 200.878 | 39.2226 |
| EMA_5 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 28.7695 | 33.0943 | 62.6835 | 100.3338 | 96.793 | 128.0443 | 182.5277 | 199.7364 | 39.1943 |
| SMA_10 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 30.6446 | 32.9138 | 62.4654 | 99.913 | 96.5929 | 127.2592 | 182.8395 | 196.5136 | 38.999 |
| EMA_10 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 31.84 | 33.6857 | 62.4802 | 101.1921 | 96.6005 | 127.0069 | 180.9232 | 196.4551 | 38.958 |
| SMA_20 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 32.468 | 33.8304 | 62.3659 | 100.6051 | 96.2264 | 126.4698 | 175.6281 | 189.9207 | 38.6186 |
| EMA_20 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 32.6254 | 35.0865 | 62.2527 | 101.0641 | 96.2362 | 126.564 | 177.2544 | 191.3628 | 38.5438 |
| _price_1 | VLO | 1789 | 1 | 0.06 | 0 | 0 | 25.6788 | 32.2637 | 62.5933 | 100.2048 | 96.895 | 128.2306 | 182.7615 | 203.92 | 39.344 |
| _price_2 | VLO | 1788 | 2 | 0.11 | 0 | 0 | 25.6788 | 32.2627 | 62.5917 | 100.1763 | 96.839 | 128.2102 | 182.3965 | 203.92 | 39.2837 |
| _price_3 | VLO | 1787 | 3 | 0.17 | 0 | 0 | 25.6788 | 32.2618 | 62.5901 | 100.1477 | 96.7791 | 128.1927 | 182.1909 | 202.68 | 39.2129 |
| _price_1 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.0 |
| _price_2 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.0 |
| _price_3 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.0 |
| log_ret | VLO | 1789 | 1 | 0.06 | 5 | 866 | -0.2135 | -0.0731 | -0.0121 | 0.0006 | 0.0007 | 0.0145 | 0.0722 | 0.2716 | 0.028 |
| ret_sq | VLO | 1789 | 1 | 0.06 | 5 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0007 | 0.008 | 0.0738 | 0.0028 |
| ret_abs | VLO | 1789 | 1 | 0.06 | 5 | 0 | 0.0 | 0.0001 | 0.0063 | 0.0132 | 0.0191 | 0.026 | 0.0893 | 0.2716 | 0.0204 |
| ag_ret_1 | VLO | 1788 | 2 | 0.11 | 5 | 866 | -0.2135 | -0.0731 | -0.0121 | 0.0006 | 0.0007 | 0.0145 | 0.0722 | 0.2716 | 0.028 |
| ret_sq_1 | VLO | 1788 | 2 | 0.11 | 5 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0007 | 0.008 | 0.0738 | 0.0028 |
| ag_ret_2 | VLO | 1787 | 3 | 0.17 | 5 | 865 | -0.2135 | -0.0731 | -0.0121 | 0.0006 | 0.0007 | 0.0145 | 0.0722 | 0.2716 | 0.028 |
| ret_sq_2 | VLO | 1787 | 3 | 0.17 | 5 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0007 | 0.008 | 0.0738 | 0.0028 |
| ag_ret_3 | VLO | 1786 | 4 | 0.22 | 5 | 865 | -0.2135 | -0.0731 | -0.0121 | 0.0006 | 0.0007 | 0.0144 | 0.0722 | 0.2716 | 0.028 |
| ret_sq_3 | VLO | 1786 | 4 | 0.22 | 5 | 0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0008 | 0.0007 | 0.008 | 0.0738 | 0.0028 |
| wma_var | VLO | 1789 | 1 | 0.06 | 0 | 0 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0008 | 0.0007 | 0.0066 | 0.0089 | 0.0011 |
| l_var_20 | VLO | 1785 | 5 | 0.28 | 0 | 0 | 0.0001 | 0.0001 | 0.0003 | 0.0005 | 0.0008 | 0.0007 | 0.0069 | 0.012 | 0.0012 |
| orr_ret_1 | VLO | 1790 | 0 | 0.0 | 0 | 1790 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | 0.0 |
| orr_ret_2 | VLO | 1790 | 0 | 0.0 | 0 | 0 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.0 |
| orr_ret_3 | VLO | 1790 | 0 | 0.0 | 0 | 1790 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | 0.0 |

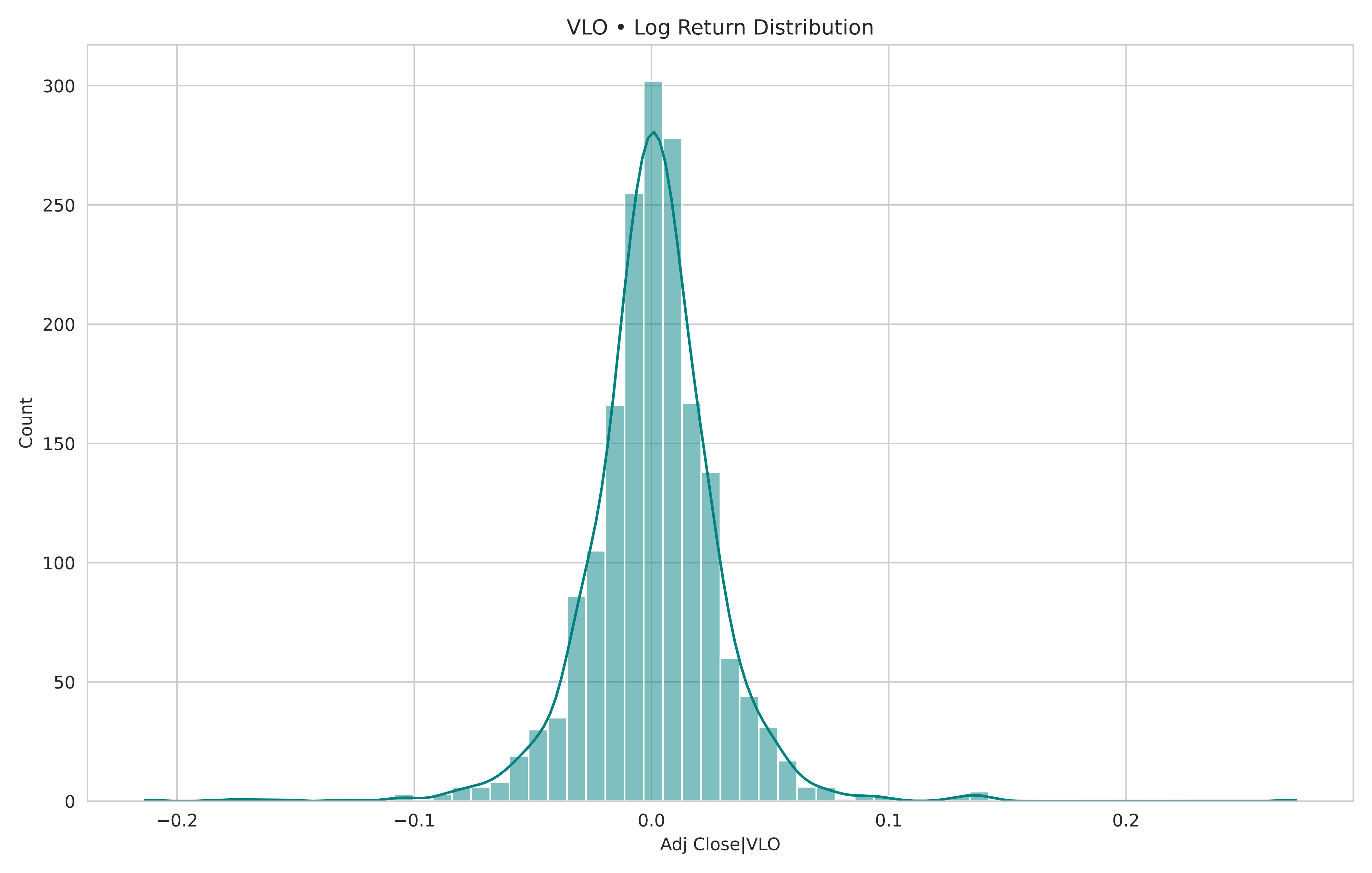
# VLO • Describe

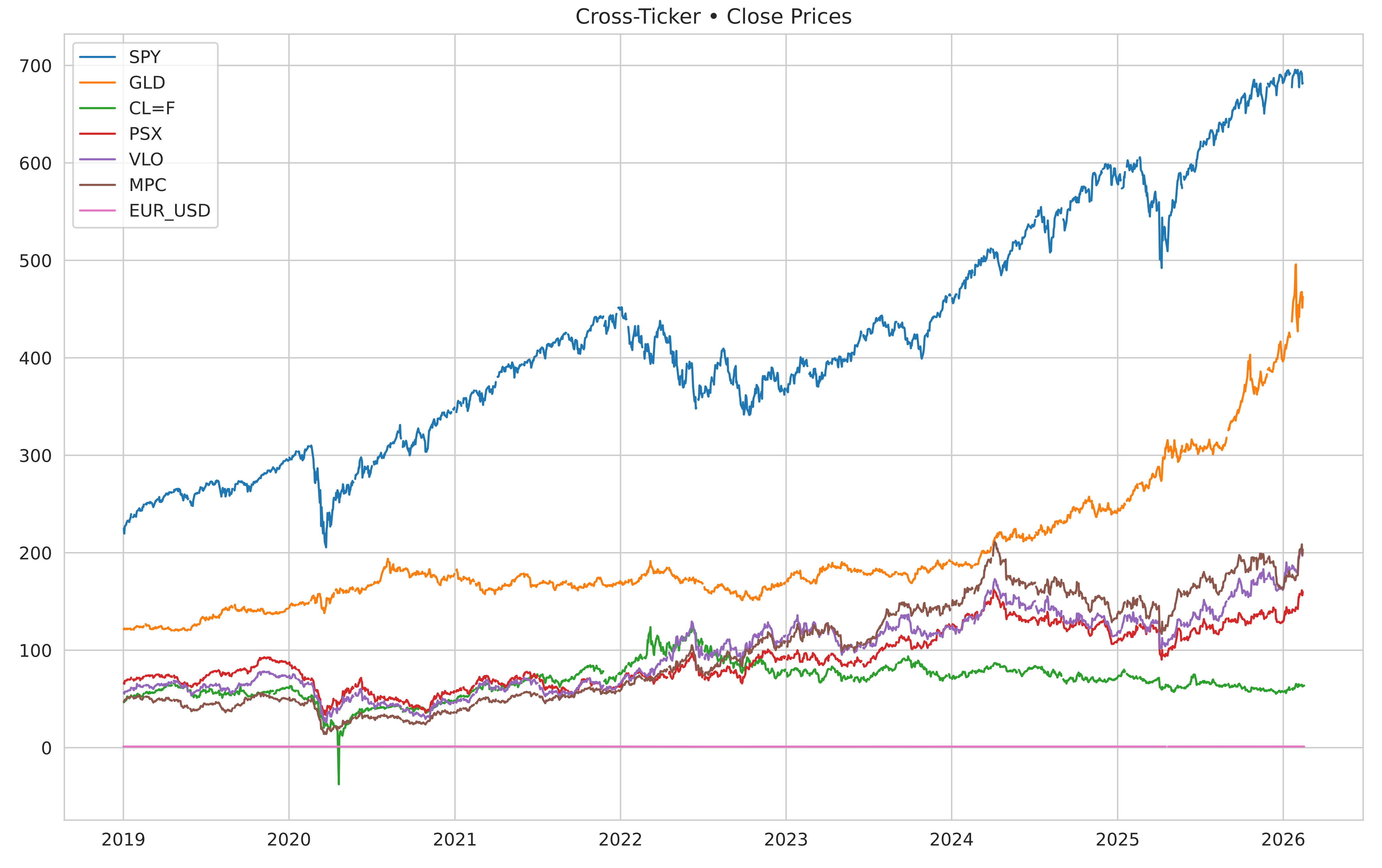
| Variable | | count | mean | std | min | 1% | 5% | 25% | 50% | 75% | 95% | 99% | max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adj Close | VLO | 1790.0 | 96.9527 | 39.4086 | 25.6788 | 32.2647 | 42.5719 | 62.5952 | 100.2655 | 128.2516 | 162.786 | 182.9285 | 203.92 |
| Close | VLO | 1790.0 | 107.38 | 36.5099 | 32.62 | 40.1848 | 52.6035 | 77.8375 | 110.195 | 134.9875 | 167.747 | 184.0816 | 203.92 |
| High | VLO | 1790.0 | 109.0621 | 36.9029 | 37.31 | 41.3801 | 53.8195 | 78.89 | 112.135 | 136.99 | 169.947 | 187.0626 | 206.77 |
| Low | VLO | 1790.0 | 105.6881 | 36.0925 | 31.0 | 39.1291 | 51.6045 | 76.675 | 107.385 | 133.09 | 165.839 | 181.7241 | 200.51 |
| Open | VLO | 1790.0 | 107.3947 | 36.5068 | 34.79 | 40.4035 | 52.727 | 77.91 | 109.575 | 135.0 | 167.9665 | 184.5698 | 204.08 |
| Volume | VLO | 1790.0 | 3815705.2514 | 1679007.2485 | 559800.0 | 1522504.0 | 1974815.0 | 2765200.0 | 3458100.0 | 4438375.0 | 6758665.0 | 9928921.0 | 19211600.0 |
| month | | 1790.0 | 6.4637 | 3.469 | 1.0 | 1.0 | 1.0 | 3.0 | 6.0 | 9.0 | 12.0 | 12.0 | 12.0 |
| day_of_week | | 1790.0 | 2.0229 | 1.3995 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| quarter | | 1790.0 | 2.4916 | 1.1233 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 3.0 | 4.0 | 4.0 | 4.0 |
| year | | 1790.0 | 2022.0615 | 2.0493 | 2019.0 | 2019.0 | 2019.0 | 2020.0 | 2022.0 | 2024.0 | 2025.0 | 2026.0 | 2026.0 |
| is_month_end | | 1790.0 | 0.033 | 0.1786 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| s_month_start | | 1790.0 | 0.0307 | 0.1726 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 |
| HL_spread | VLO | 1790.0 | 3.374 | 1.7818 | 0.8 | 1.0967 | 1.36 | 2.08 | 3.0 | 4.1975 | 6.6955 | 9.2422 | 15.73 |
| C_spread | VLO | 1790.0 | 10.442 | 5.7806 | -8.8103 | -1.8231 | 1.0395 | 7.1042 | 9.947 | 13.1416 | 21.1829 | 22.813 | 24.3871 |
| SMA_5 | VLO | 1790.0 | 96.7922 | 39.2226 | 28.0814 | 32.982 | 42.7734 | 62.6133 | 99.9067 | 127.991 | 163.3123 | 182.8538 | 200.878 |
| EMA_5 | VLO | 1790.0 | 96.793 | 39.1943 | 28.7695 | 33.0943 | 42.751 | 62.6835 | 100.3338 | 128.0443 | 163.2807 | 182.5277 | 199.7364 |
| SMA_10 | VLO | 1790.0 | 96.5929 | 38.999 | 30.6446 | 32.9138 | 43.3508 | 62.4654 | 99.913 | 127.2592 | 163.1491 | 182.8395 | 196.5136 |
| EMA_10 | VLO | 1790.0 | 96.6005 | 38.958 | 31.84 | 33.6857 | 43.3944 | 62.4802 | 101.1921 | 127.0069 | 163.9564 | 180.9232 | 196.4551 |
| SMA_20 | VLO | 1790.0 | 96.2264 | 38.6186 | 32.468 | 33.8304 | 42.8614 | 62.3659 | 100.6051 | 126.4698 | 162.7233 | 175.6281 | 189.9207 |
| EMA_20 | VLO | 1790.0 | 96.2362 | 38.5438 | 32.6254 | 35.0865 | 42.9569 | 62.2527 | 101.0641 | 126.564 | 161.0414 | 177.2544 | 191.3628 |
| g_price_1 | VLO | 1789.0 | 96.895 | 39.344 | 25.6788 | 32.2637 | 42.5708 | 62.5933 | 100.2048 | 128.2306 | 162.6262 | 182.7615 | 203.92 |
| g_price_2 | VLO | 1788.0 | 96.839 | 39.2837 | 25.6788 | 32.2627 | 42.5697 | 62.5917 | 100.1763 | 128.2102 | 162.3332 | 182.3965 | 203.92 |
| g_price_3 | VLO | 1787.0 | 96.7791 | 39.2129 | 25.6788 | 32.2618 | 42.5685 | 62.5901 | 100.1477 | 128.1927 | 161.8939 | 182.1909 | 202.68 |
| rr_price_1 | VLO | 1790.0 | 0.9981 | 0.0 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 | 0.9981 |
| rr_price_2 | VLO | 1790.0 | 0.9963 | 0.0 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 | 0.9963 |
| rr_price_3 | VLO | 1790.0 | 0.9944 | 0.0 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 | 0.9944 |
| log_ret | VLO | 1789.0 | 0.0007 | 0.028 | -0.2135 | -0.0731 | -0.0408 | -0.0121 | 0.0006 | 0.0145 | 0.0408 | 0.0722 | 0.2716 |
| ret_sq | VLO | 1789.0 | 0.0008 | 0.0028 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0007 | 0.0029 | 0.008 | 0.0738 |
| ret_abs | VLO | 1789.0 | 0.0191 | 0.0204 | 0.0 | 0.0001 | 0.0011 | 0.0063 | 0.0132 | 0.026 | 0.0535 | 0.0893 | 0.2716 |
| lag_ret_1 | VLO | 1788.0 | 0.0007 | 0.028 | -0.2135 | -0.0731 | -0.0408 | -0.0121 | 0.0006 | 0.0145 | 0.0408 | 0.0722 | 0.2716 |
| _ret_sq_1 | VLO | 1788.0 | 0.0008 | 0.0028 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0007 | 0.0029 | 0.008 | 0.0738 |
| lag_ret_2 | VLO | 1787.0 | 0.0007 | 0.028 | -0.2135 | -0.0731 | -0.0408 | -0.0121 | 0.0006 | 0.0145 | 0.0408 | 0.0722 | 0.2716 |
| _ret_sq_2 | VLO | 1787.0 | 0.0008 | 0.0028 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0007 | 0.0029 | 0.008 | 0.0738 |
| lag_ret_3 | VLO | 1786.0 | 0.0007 | 0.028 | -0.2135 | -0.0731 | -0.0408 | -0.0121 | 0.0006 | 0.0144 | 0.0408 | 0.0722 | 0.2716 |
| _ret_sq_3 | VLO | 1786.0 | 0.0008 | 0.0028 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0002 | 0.0007 | 0.0029 | 0.008 | 0.0738 |
| ewma_var | VLO | 1789.0 | 0.0008 | 0.0011 | 0.0001 | 0.0002 | 0.0002 | 0.0003 | 0.0005 | 0.0007 | 0.0025 | 0.0066 | 0.0089 |
| oll_var_20 | VLO | 1785.0 | 0.0008 | 0.0012 | 0.0001 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0007 | 0.0024 | 0.0069 | 0.012 |
| corr_ret_1 | VLO | 1790.0 | -0.028 | 0.0 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 | -0.028 |
| corr_ret_2 | VLO | 1790.0 | 0.005 | 0.0 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| corr_ret_3 | VLO | 1790.0 | -0.0176 | 0.0 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 | -0.0176 |


VLO • Correlation
Adj Close|VLO
High|VLO
Open|VLO
month
quarter
is_month_end
HL_spread|VLO
SMA_5|VLO
SMA_10|VLO
SMA_20|VLO
lag_price_1|VLO
lag_price_3|VLO
autocorr_price_2|VLO
log_ret|VLO
ret_abs|VLO
lag_ret_sq_1|VLO
lag_ret_sq_2|VLO
lag_ret_sq_3|VLO
roll_var_20|VLO
autocorr_ret_2|VLO
Adj Close|VLO
Close|VLO
High|VLO
Low|VLO
Open|VLO
Volume|VLO
month
day_of_week
quarter
year
is_month_end
is_month_start
HL_spread|VLO
OC_spread|VLO
SMA_5|VLO
EMA_5|VLO
SMA_10|VLO
EMA_10|VLO
SMA_20|VLO
EMA_20|VLO
lag_price_1|VLO
lag_price_2|VLO
lag_price_3|VLO
autocorr_price_1|VLO
autocorr_price_2|VLO
autocorr_price_3|VLO
log_ret|VLO
ret_sq|VLO
ret_abs|VLO
lag_ret_1|VLO
lag_ret_sq_1|VLO
lag_ret_2|VLO
lag_ret_sq_2|VLO
lag_ret_3|VLO
lag_ret_sq_3|VLO
ewma_var|VLO
roll_var_20|VLO
autocorr_ret_1|VLO
autocorr_ret_2|VLO
autocorr_ret_3|VLO
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6

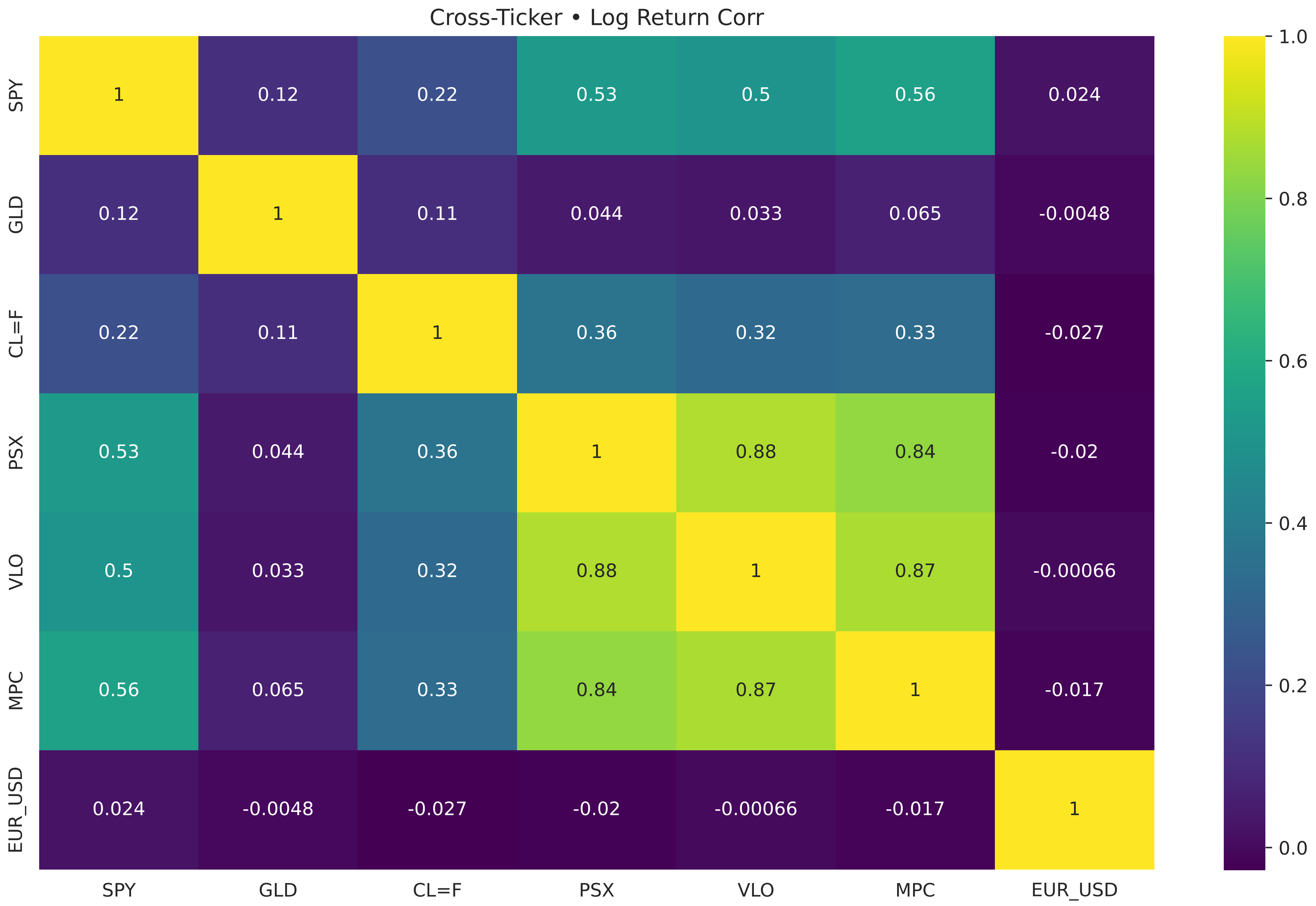

VLO • Adj Close|VLO Price
200
175
150
125
100
75
50
25
2019
2020
2021
2022
2023
2024
2025
2026


VLO • 30-Day Rolling Volatility
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2019
2020
2021
2022
2023
2024
2025
2026


VLO • Log Return Distribution
Count
0
50
100
150
200
250
300
−0.2
−0.1
0.0
0.1
0.2
Adj Close|VLO



Cross-Ticker • Close Prices
SPY
GLD
CL=F
PSX
VLO
MPC
EUR_USD
700
600
500
400
300
200
100
0
2019
2020
2021
2022
2023
2024
2025
2026


Cross-Ticker • Log Return Corr
SPY
GLD
CL=F
PSX
VLO
MPC
EUR_USD
1 0.12 0.22 0.53 0.5 0.56 0.024
0.12 1 0.11 0.044 0.033 0.065 -0.0048
0.22 0.11 1 0.36 0.32 0.33 -0.027
0.53 0.044 0.36 1 0.88 0.84 -0.02
0.5 0.033 0.32 0.88 1 0.87 -0.00066
0.56 0.065 0.33 0.84 0.87 1 -0.017
0.024 -0.0048 -0.027 -0.02 -0.00066 -0.017 1
SPY
GLD
CL=F
PSX
VLO
MPC
EUR_USD
1.0
0.8
0.6
0.4
0.2
0.0