# Time-series momentum on SPY

**Strategy evaluated** · Development · Sample 2020-03-05 14:30:00+00:00 to 2024-12-31 14:30:00+00:00

N/A marks an undefined or missing value. Return and risk fractions are shown as percentages. The JSON evidence preserves the original precision of the results.

## Assessment limits

**Survivorship bias.** Not assessed. Evidence on historical universe membership is missing.

**Look-ahead bias.** Not assessed. The report does not verify when signals became available.

**Multiple testing.** DSR and PBO cannot be assessed from the evidence supplied.

**Costs and execution.** Gross and net returns were reconciled with recorded costs. Cost sensitivity and actual execution were not assessed.

**Use of AI.** The engine computes the metrics. Use of AI in strategy development was not assessed.

**Advice.** This report does not constitute investment advice.

## Performance and risk

**Absolute performance · Strategy and benchmark**

| Metric | Strategy | Benchmark |
|---|---|---|
| Annualized arithmetic return<br>`annual_return_arithmetic` | 14.0973% | 12.6078% |
| Annualized volatility<br>`annual_volatility` | 12.5345% | 19.0974% |
| Periods per year<br>`annualization` | 252 | 252 |
| Annualized compound return (CAGR)<br>`cagr` | 14.2342% | 11.367% |
| Calmar<br>`calmar` | 0.95767 | 0.3990405 |
| Excess kurtosis<br>`excess_kurtosis` | 2.879638 | 10.70211 |
| Alias for the share of positive periods<br>`hit_rate` | 47.6543% | 55.9671% |
| Maximum drawdown<br>`max_drawdown` | -14.8634% | -28.4857% |
| Periods from the previous peak to recovery<br>`max_drawdown_recovery_periods` | 190 | 563 |
| Periods to the maximum drawdown trough<br>`max_drawdown_underwater_periods` | 102 | 233 |
| Observations<br>`n_obs` | 1215 | 1215 |
| Share of positive periods<br>`positive_period_rate` | 47.6543% | 55.9671% |
| Annual risk-free rate<br>`risk_free_annual` | 2% | 2% |
| Sharpe<br>`sharpe` | 0.9666875 | 0.5564868 |
| Skewness<br>`skewness` | -0.2689278 | -1.130101 |

**Absolute performance · Strategy and benchmark**

| Metric | Strategy | Benchmark |
|---|---|---|
| Sortino<br>`sortino` | 1.391046 | 0.7485818 |
| Cumulative return<br>`total_return` | 89.9591% | 68.0477% |

**Active performance · Strategy versus benchmark**

| Field | Value |
|---|---|
| Annualized active return<br>`active_return_annual` | 1.4895% |
| Periods per year<br>`annualization` | 252 |
| Benchmark Sharpe ratio<br>`benchmark_sharpe` | 0.5564868 |
| Beta<br>`beta` | 0.119408 |
| Correlation with the benchmark<br>`correlation` | 0.1819284 |
| Information ratio<br>`information_ratio` | 0.07143844 |
| Annualized Jensen alpha<br>`jensen_alpha_annual` | 10.848% |
| Observations<br>`n_obs` | 1215 |
| Annualized regression alpha<br>`regression_alpha_annual` | 12.5918% |
| Annual risk-free rate<br>`risk_free_annual` | 2% |
| Strategy Sharpe ratio<br>`strategy_sharpe` | 0.9666875 |
| Annualized tracking error<br>`tracking_error_annual` | 20.8501% |

## Statistical uncertainty

**Strategy · Sharpe ratio interval · block bootstrap**

| Field | Value |
|---|---|
| Replications attempted<br>`attempted_repetitions` | 1000 |
| Block length<br>`block_length` | 11 |
| Lower interval bound<br>`ci_lower` | 0.102261 |
| Upper interval bound<br>`ci_upper` | 1.899451 |
| Confidence level<br>`confidence` | 95% |
| Lower-tail probability<br>`lower_probability` | 2.5% |
| Observations<br>`n_obs` | 1215 |
| Point estimate<br>`point_estimate` | 0.9666875 |

| Strategy · Sharpe ratio interval · block bootstrap | |
|---|---|
| **Field** | **Value** |
| Replications<br>`repetitions` | 1000 |
| Seed<br>`seed` | 20261116 |
| Standard error<br>`standard_error` | 0.4396189 |
| Status<br>`status` | evaluated |
| Replications with no defined estimate<br>`undefined_repetitions` | 0 |
| Upper-tail probability<br>`upper_probability` | 97.5% |
| Valid replications<br>`valid_repetitions` | 1000 |

| Strategy · Mean excess return · HAC | |
|---|---|
| **Field** | **Value** |
| Annualized estimate<br>`annualized_estimate` | 12.117% |
| Annualized standard error<br>`annualized_standard_error` | 5.30947% |
| Estimate per period<br>`estimate` | 0.0480832% |
| Weighting kernel<br>`kernel` | bartlett |
| Lags<br>`lags` | 6 |
| Observations<br>`n_obs` | 1215 |
| Two-sided p-value (normal)<br>`p_value_two_sided_normal` | 0.02248084 |
| Standard error<br>`standard_error` | 0.0210693% |
| Status<br>`status` | evaluated |
| t-statistic<br>`t_stat` | 2.282144 |

Benchmark · No uncertainty estimate supplied.

| Active performance · Information ratio interval · block bootstrap | |
|---|---|
| **Field** | **Value** |
| Replications attempted<br>`attempted_repetitions` | 1000 |
| Block length<br>`block_length` | 11 |
| Lower interval bound<br>`ci_lower` | -0.9016823 |
| Upper interval bound<br>`ci_upper` | 0.9892556 |
| Confidence level<br>`confidence` | 95% |

| Active performance · Information ratio interval · block bootstrap | |
|---|---|
| **Field** | **Value** |
| Lower-tail probability<br>`lower_probability` | 2.5% |
| Observations<br>`n_obs` | 1215 |
| Point estimate<br>`point_estimate` | 0.07143844 |
| Replications<br>`repetitions` | 1000 |
| Seed<br>`seed` | 20261116 |
| Standard error<br>`standard_error` | 0.4665693 |
| Status<br>`status` | evaluated |
| Replications with no defined estimate<br>`undefined_repetitions` | 0 |
| Upper-tail probability<br>`upper_probability` | 97.5% |
| Valid replications<br>`valid_repetitions` | 1000 |

| Active performance · Mean active return · HAC | |
|---|---|
| **Field** | **Value** |
| Annualized estimate<br>`annualized_estimate` | 1.4895% |
| Annualized standard error<br>`annualized_standard_error` | 9.16247% |
| Estimate per period<br>`estimate` | 0.00591071% |
| Weighting kernel<br>`kernel` | bartlett |
| Lags<br>`lags` | 6 |
| Observations<br>`n_obs` | 1215 |
| Two-sided p-value (normal)<br>`p_value_two_sided_normal` | 0.8708607 |
| Standard error<br>`standard_error` | 0.036359% |
| Status<br>`status` | evaluated |
| t-statistic<br>`t_stat` | 0.1625653 |

## Subperiods and robustness

Additional metrics · No evidence supplied.

## Verification and configuration

| Engine checks | |
|---|---|
| **Field** | **Value** |
| Schemas valid<br>`schema_valid` | Yes |
| Evidence hash valid<br>`hash_valid` | Yes |
| Signature verified<br>`signature_verified` | No |
| Confirmatory provenance verified<br>`confirmatory_provenance_verified` | No |
| `reconciliation.tolerance` | 1e-09 |
| Status<br>`reconciliation.status` | reconciled |
| Metric paths checked<br>`reconciliation.checkedPathCount` | 96 |
| Hash bindings valid<br>`hash_bindings_valid` | Yes |
| Metrics reconciled<br>`metrics_reconciled` | Yes |
| Simulations reproduced<br>`simulations_reproduced` | Yes |
| `kernelVersion` | 1.1.0 |

Decision thresholds · No evidence supplied.

| Engine configuration | |
|---|---|
| **Field** | **Value** |
| `allowPositional` | No |
| Periods per year<br>`annualization` | 252 |
| Annualization method<br>`annualizationMethod` | declared by StrategyTrace.frequency.periodsPerYear |
| `calendar` | XNYS |
| Annual risk-free rate<br>`riskFreeAnnual` | 2% |
| `timezone` | UTC |
| Block length<br>`uncertainty.blockLength` | 11 |
| Confidence level<br>`uncertainty.confidence` | 95% |
| `uncertainty.hacLagPolicy.kind` | sample-size-bartlett-v1 |
| Replications<br>`uncertainty.repetitions` | 1000 |
| Seed<br>`uncertainty.seed` | 20261116 |
| Expected calendar hash<br>`uncertainty.timeBasis.expectedEndsHash` | `e36965a88c2312234cb3d61c38be5ef036451312cead5a27da3802b05aec831f` |
| `uncertainty.timeBasis.kind` | session-grid |

# Monte Carlo

### Observed path

| Field | Value |
|---|---|
| Longest losing streak (periods)<br>`longestLosingStreak` | 6 |
| Longest stretch below the peak (periods)<br>`longestUnderwaterStreakPeriods` | 189 |
| Maximum drawdown magnitude<br>`maximumDrawdown` | 14.8634% |
| Ruin threshold reached<br>`ruined` | No |
| Terminal wealth (multiple)<br>`terminalWealth` | 1.899591 |
| Share of periods below the peak<br>`timeUnderWaterFraction` | 73.8272% |
| Cumulative return<br>`totalReturn` | 89.9591% |

### Circular block bootstrap

| Metric | Minimum | Mean | Maximum | Quantiles |
|---|---|---|---|---|
| Longest losing streak (periods)<br>`longestLosingStreak` | 5 | 7.048 | 12 | 5% = 6 · 50% = 7 · 95% = 9 |
| Longest stretch below the peak (periods)<br>`longestUnderwaterStreakPeriods` | 67 | 299.864 | 1134 | 5% = 116 · 50% = 266 · 95% = 612 |
| Maximum drawdown magnitude<br>`maximumDrawdown` | 7.00618% | 14.831% | 33.147% | 5% = 9.19348% · 50% = 13.8877% · 95% = 23.1155% |
| Probability of reaching the ruin threshold<br>`ruinProbability` | | 0% | | |
| Terminal wealth (multiple)<br>`terminalWealth` | 0.9437853 | 1.974673 | 4.54145 | 5% = 1.279659 · 50% = 1.904241 · 95% = 2.916415 |
| Share of periods below the peak<br>`timeUnderWaterFraction` | 73.0041% | 87.5057% | 98.6831% | 5% = 80.4897% · 50% = 87.572% · 95% = 94.4856% |
| Cumulative return<br>`totalReturn` | -5.62147% | 97.4673% | 354.145% | 5% = 27.9659% · 50% = 90.4241% · 95% = 191.642% |

### Return-order permutation

| Metric | Minimum | Mean | Maximum | Quantiles |
|---|---|---|---|---|
| Longest losing streak (periods)<br>`longestLosingStreak` | 5 | 7.246 | 14 | 5% = 5 · 50% = 7 · 95% = 10 |
| Longest stretch below the peak (periods)<br>`longestUnderwaterStreakPeriods` | 81 | 293.417 | 695 | 5% = 150 · 50% = 270.5 · 95% = 516 |
| Maximum drawdown magnitude<br>`maximumDrawdown` | 8.18625% | 15.6996% | 29.5843% | 5% = 10.7681% · 50% = 15.1478% · 95% = 22.2981% |
| Probability of reaching the ruin threshold<br>`ruinProbability` | | 0% | | |
| Share of periods below the peak<br>`timeUnderWaterFraction` | 83.0453% | 88.9207% | 91.9342% | 5% = 86.9136% · 50% = 88.9712% · 95% = 90.6214% |

### Simulation settings and bindings

| Field | Value |
|---|---|
| `simulationSchemaVersion` | strateva-simulation-evidence/v2 |
| `engineVersion` | 0.9.0 |

| Simulation settings and bindings | |
|---|---|
| **Field** | **Value** |
| `kernelVersion` | 1.1.0 |
| `observationCount` | 1215 |
| `strategyTraceHash` | `0f34bf934d1fc9503a13ad530b354c3b36d97da060d91aa46bc37be0d94fb678` |
| `contentHash` | `60deca13eddc8c0254c1786fda54fbd219b2f880dba093dc0847d66753c3d1a9` |
| Block length<br>`configuration.blockLength` | 11 |
| Initial wealth<br>`configuration.initialWealth` | 1 |
| `configuration.quantiles` | 5% · 50% · 95% |
| Replications<br>`configuration.repetitions` | 1000 |
| Ruin threshold (share of initial wealth)<br>`configuration.ruinWealthFraction` | 50% |
| Seed<br>`configuration.seed` | 20261116 |
| `classic.method` | CIRCULAR_MOVING_BLOCK_BOOTSTRAP |
| `classic.sampling` | WITH_REPLACEMENT |
| `permuted.method` | FISHER_YATES_RETURN_ORDER_PERMUTATION |
| `permuted.sampling` | WITHOUT_REPLACEMENT |
| Terminal wealth (multiple)<br>`permuted.terminalWealth` | 1.899591 |
| Terminal wealth invariant<br>`permuted.terminalWealthInvariant` | Yes |

## Provenance and traceability

| Evidence and input hashes | |
|---|---|
| **Field** | **Value** |
| `bundleSchemaVersion` | strateva-evidence-bundle/v3 |
| `artifactId` | `urn:strateva:strategy-trace:0f34bf934d1fc9503a13ad530b354c3b36d97da060d91aa46bc37be0d94fb678` |
| `engineVersion` | 0.9.0 |
| `kernelVersion` | 1.1.0 |
| `generatedAt` | 2026-11-17T13:21:53Z |
| `contentHash` | `fecb86e7fa717eb2e6b6b60218686b8e76c1e871bb854c988c361cb1107082dd` |
| Benchmark return series hash<br>`inputHashes.benchmarkReturns` | ed9a30f81b9a783deee0afe05cce7a743c454359cc86fc0add02f17e100d9de4 |
| Strategy return series hash<br>`inputHashes.strategyReturns` | d0ef8bf2a854125cf2916c4553761f58b1b49ce6108a35c9c724c283cb59448f |

| Evidence and input hashes | |
|---|---|
| **Field** | **Value** |
| `lineage` | strategyTrace:0f34bf934d1fc9503a13ad530b354c3b36d97da060d91aa46bc37be0d94fb678 · scope:991872c47e81d6aebf7be3c06f41829bb0f439f6c89f9459d8c964ae772d9a31 · artifact:5fdd45866ba03f865588182c0154d26ddca54f6f7899912b3384d5ac6f0c332c · data:425ebe693844bdfe759fdd57ef3aa8414f1e147cb485e7c24eec6ab70209a728 |

| Provenance statement | |
|---|---|
| **Field** | **Value** |
| `claim` | development |
| `containerImageDigest` | N/A |
| `engineCommit` | N/A |
| `freezeHash` | N/A |
| `runId` | N/A |

Evidence signature · No evidence supplied.

| StrategyTrace · Identity, frequency, conventions and benchmark | |
|---|---|
| **Field** | **Value** |
| `traceSchemaVersion` | strateva-strategy-trace/v1 |
| `engagementId` | eng-8f3dfd3f |
| `runId` | tsmom-evidence |
| `generatedAt` | 2026-11-17T13:21:53Z |
| `scopeContentHash` | `991872c47e81d6aebf7be3c06f41829bb0f439f6c89f9459d8c964ae772d9a31` |
| `artifactContentHash` | `5fdd45866ba03f865588182c0154d26ddca54f6f7899912b3384d5ac6f0c332c` |
| `dataContentHash` | `425ebe693844bdfe759fdd57ef3aa8414f1e147cb485e7c24eec6ab70209a728` |
| `frequency.barInterval` | 1d |
| Periods per year `frequency.periodsPerYear` | 252 |
| `frequency.calendar` | XNYS |
| `frequency.sourceTimezone` | America/New_York |
| `conventions.returnType` | SIMPLE |
| `conventions.returnUnit` | FRACTION |
| `conventions.timestampMeaning` | UTC_PERIOD_END |
| `conventions.turnover` | SUM_ABSOLUTE_POSITION_CHANGES |
| `conventions.exposure` | FRACTION_OF_EQUITY |
| `conventions.costs` | RETURN_FRACTION |
| `benchmark.kind` | SERIES |
| `benchmark.symbol` | URTH |
| `contentHash` | `0f34bf934d1fc9503a13ad530b354c3b36d97da060d91aa46bc37be0d94fb678` |

| Notes included in the evidence | |
|---|---|
| **Field** | **Value** |
| `disclosures` | The engine recomputed the metrics from verified StrategyTrace net returns. · Monte Carlo has its own hash. It affects criteria only if preregistered for that purpose. |