SPY vs Retail Inventories-to-Sales Ratio Analysis

Overview

This analysis explores the relationship between S&P 500 (SPY) price/returns and the Retail Inventories-to-Sales Ratio (RETAILIRSA) using correlation analysis, lead-lag testing, Granger causality, ML predictive models, and regime analysis.

Data Period: January 1993 to September 2025 (393 months)

Qualitative Analysis: Understanding RETAILIRSA

What is the Retail Inventories-to-Sales Ratio?

The Retail Inventories-to-Sales Ratio (RETAILIRSA) measures the relationship between end-of-month inventory values and monthly sales for retail businesses. Published monthly by the U.S. Census Bureau and available through FRED, it indicates how many months of inventory retailers are holding relative to their sales rate.

Key Characteristics:

- **Formula**: Inventory Level / Net Sales
- **Interpretation**: A ratio of 1.5 means retailers hold 1.5 months of inventory relative to sales
- **Historical Range**: Record high of 1.75 (April 1995), record low of 1.09 (June 2021)
- **Current Median**: ~1.49
- **Release Timing**: Mid-month, approximately 6 weeks after the reference month

Market Interpretation and Usage

Economic Signal Interpretation

According to FRED data analysis and TradingView:

Ratio Level	Interpretation
Rising	Retailers overstocked; demand weakening; potential economic slowdown
Falling	Strong consumer demand; supply constraints; economic strength
High (>1.5)	Excess inventory; potential markdowns; margin pressure
Low (<1.3)	Lean inventory; supply chain stress or strong demand

The Bullwhip Effect Connection

The ratio is closely tied to the bullwhip effect - a supply chain phenomenon documented by MIT Sloan where small changes in consumer demand create amplified swings upstream:

> "When businesses notice signs of an impending recession, such as rising inflation, interest rate hikes, and a slowdown in consumer spending, the bullwhip effect may be close behind." - TrueCommerce

The Supply Chain Management Review notes that the "inventory accelerator" concept explains why "when demand decreases, the decline in orders is larger than the decline in sales as firms attempt to reduce their inventory levels."

Role as a Recession Indicator

NetSuite's recession indicators guide identifies inventory levels as a relatively consistent recession signal:

> "In the past three recessions, Total Business Inventories reached 12-, 24-, and 36-month highs within 6 months of the recession's official start."

The self-reinforcing cycle is clear: reduced consumer confidence → lower spending → rising inventories → production cuts → job losses → further confidence decline.

Recent Market Events

2020-2021 Supply Chain Crisis: The record low of 1.09 in June 2021 reflected unprecedented supply chain disruptions combined with stimulus-fueled demand. CNBC reported on how retail inventory misses and subsequent markdowns signaled the market's inflation dynamics.

2022-2023 Inventory Correction: As documented by Tilley Distribution, retailers faced an inventory glut after over-ordering during supply shortages, leading to aggressive discounting and margin pressure.

Key Insights from Literature

Finding	Source	Implication
Rising inventories precede recessions	NetSuite, FocusEconomics	Early warning signal
Ratio spikes within 6 months of recession	Historical analysis	Useful for timing
Bullwhip effect amplifies small demand changes	MIT Sloan	Explains volatility
Record low in 2021 was anomaly	FRED historical data	Context matters
Consumer spending drives inventory cycles	Morningstar	Demand is key driver

Academic and Professional Research

- Rosenberg Research identifies inventory dynamics as one of their key recession-leading indicators
- Advisor Perspectives tracks inventory-related metrics as part of recession monitoring
- FocusEconomics notes that "short-term changes in business inventories can indicate shifts in production and demand and forecast market upturns or downswings"

Limitations as a Stock Market Indicator

1. **Publication Lag**: Data released ~6 weeks after month-end; markets have moved

2. **Sector-Specific**: Retail represents portion of economy; doesn't capture services
3. **Supply Chain Complexity**: Global supply chains complicate interpretation
4. **Structural Changes**: E-commerce and just-in-time practices have lowered "normal" ratios
5. **COVID Distortions**: 2020-2022 created unprecedented volatility in the series

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Key Findings Summary

1. Strong Inverse Level Relationship

- **Correlation: -0.767** between SPY price and RETAILIRSA level
- As SPY rises over time, the Inventories-to-Sales ratio has fallen (supply chain efficiency)
- This is a **spurious correlation** due to opposite secular trends, not a causal relationship

2. Weak Contemporaneous Relationship in Changes

- RETAILIRSA changes have **weak negative correlation** with SPY returns:
  - MoM: -0.105
  - QoQ: -0.129 (strongest)
  - YoY: -0.072
- Interpretation: When retailers build inventory faster, SPY tends to underperform slightly

3. No Predictive Power

- **Granger Causality**: No significant causality in either direction (all p > 0.05)
- **ML Models**: Negative R^2 values indicate RETAILIRSA cannot predict SPY returns
- Best performing model (Lasso, 1-month horizon): R^2 = -0.18 (worse than naive mean)

4. Regime-Based Insights (Most Valuable Finding)

Regime	Mean Monthly Return	Sharpe Ratio	Win Rate
Low Inv/Sales	+1.14%	**1.03**	68.2%
High Inv/Sales	+0.70%	0.51	61.1%
Falling Inv/Sales	+1.09%	**0.98**	64.9%
Rising Inv/Sales	+0.72%	0.52	65.2%
Recession	-1.36%	-0.64	39.3%

Key Insight: SPY performs significantly better when:

- Inventories-to-Sales ratio is **low** (efficient supply chains)
- Inventories-to-Sales ratio is **falling** (improving efficiency)

Detailed Analysis

Correlation Matrix

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                          SPY    RETAILIRSA   MoM     QoQ     YoY   SPY_MoM
SPY_QoQ  SPY_YoY
SPY                     1.000        -0.767  0.007   0.012   0.006    0.069
0.106    0.175
Retail_Inv_Sales_Ratio -0.767         1.000  0.102   0.149   0.240   -0.033
-0.105   -0.118
RETAILIRSA_MoM          0.007         0.102  1.000   0.537   0.315   -0.105
-0.189   -0.066
RETAILIRSA_QoQ          0.012         0.149  0.537   1.000   0.531   -0.129
-0.340   -0.113
RETAILIRSA_YoY          0.006         0.240  0.315   0.531   1.000   -0.072
-0.264   -0.355
```

Observations:

- Strong negative correlation between SPY price and RETAILIRSA level (-0.767)
- Weak negative correlation between RETAILIRSA changes and SPY returns
- RETAILIRSA_QoQ has strongest relationship with SPY_QoQ (-0.340)

Lead-Lag Analysis

Tested lags from -12 to +12 months:

Relationship	Lag	Correlation	P-value	Interpretation
RETAILIRSA_QoQ_Dir	0	-0.138	0.006	Contemporaneous
RETAILIRSA_QoQ	0	-0.129	0.011	Contemporaneous
RETAILIRSA_MoM	0	-0.105	0.039	Contemporaneous

Conclusion: The relationship is primarily **contemporaneous**, not predictive. No significant lead-lag relationships suggest RETAILIRSA doesn't predict future SPY returns.

Granger Causality Tests

Tested if RETAILIRSA Granger-causes SPY returns at lags 1-6 months:

Feature	Best Lag	F-statistic	P-value	Significant?
RETAILIRSA_MoM	2	1.619	0.199	No
RETAILIRSA_QoQ	1	2.101	0.148	No
RETAILIRSA_YoY	4	1.293	0.272	No

Conclusion: RETAILIRSA does **not** Granger-cause SPY returns at any lag tested.

ML Predictive Model Results

Models trained to predict 1-month and 3-month forward SPY returns using lagged RETAILIRSA features:

Horizon	Model	CV R^2	RMSE	MAE
1m	Linear Regression	-0.54	5.25	3.88
1m	Ridge	-0.31	4.88	3.69
1m	Lasso	-0.18	4.64	3.50
1m	Random Forest	-0.25	4.79	3.67
1m	Gradient Boosting	-0.50	5.23	4.08

Top Features (Random Forest):

1. RETAILIRSA_MoM_lag6: 11.2%
2. RETAILIRSA_QoQ_lag3: 9.3%
3. RETAILIRSA_YoY_lag6: 8.8%
4. RETAILIRSA_YoY_lag1: 8.7%
5. RETAILIRSA_QoQ_lag12: 8.5%

Conclusion: All models have **negative R^2**, meaning RETAILIRSA features perform worse than simply predicting the mean return. There is no exploitable predictive relationship.

Regime Analysis

SPY monthly returns segmented by RETAILIRSA regimes:

By Level (High vs Low)

- **Low Inv/Sales** (ratio < median 1.49): Mean return +1.14%, Sharpe 1.03
- **High Inv/Sales** (ratio > median 1.49): Mean return +0.70%, Sharpe 0.51
- **Difference**: +0.44% per month, ~5.3% annualized

By Direction (Rising vs Falling)

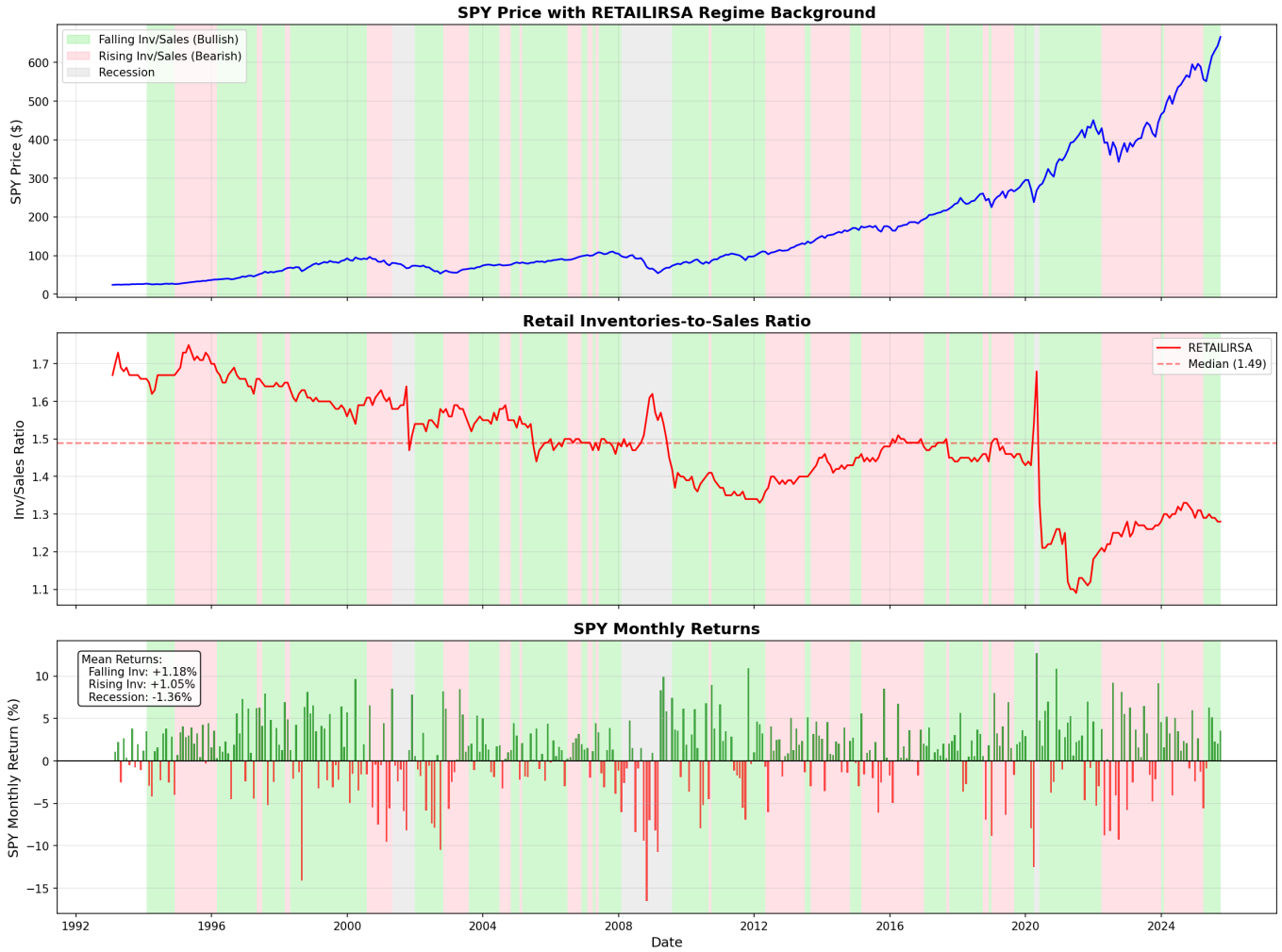
- **Falling Inv/Sales** (YoY < 0): Mean return +1.09%, Sharpe 0.98
- **Rising Inv/Sales** (YoY > 0): Mean return +0.72%, Sharpe 0.52
- **Difference**: +0.37% per month, ~4.5% annualized

Combined with Recession Indicator

- **Expansion + Falling**: Mean +1.16%, Sharpe 1.06 (best regime)
- **Expansion + Rising**: Mean +1.05%, Sharpe 0.89
- **Recession**: Mean -1.36%, Sharpe -0.64 (worst regime)

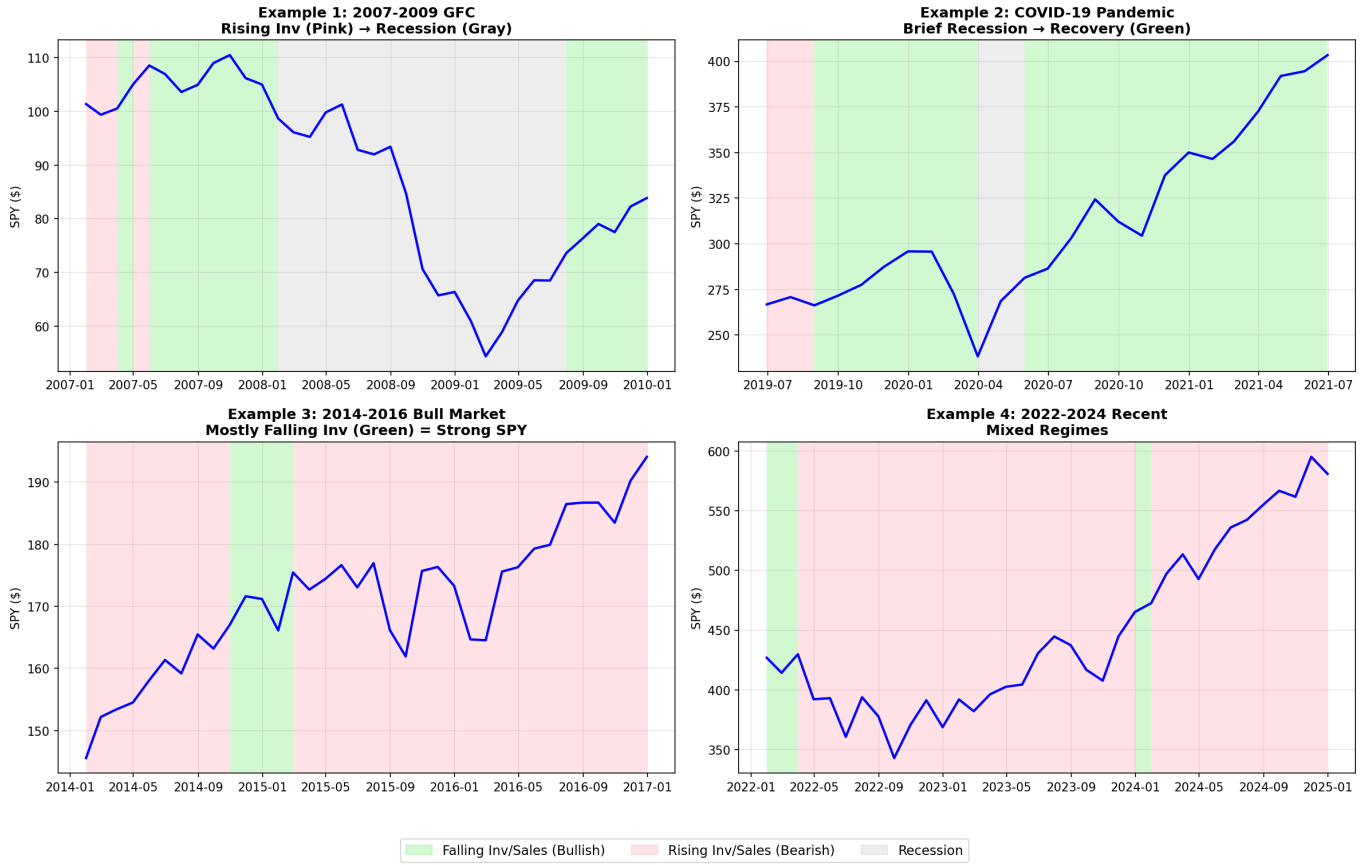
Visualizations

Full Timeline with Regime Background

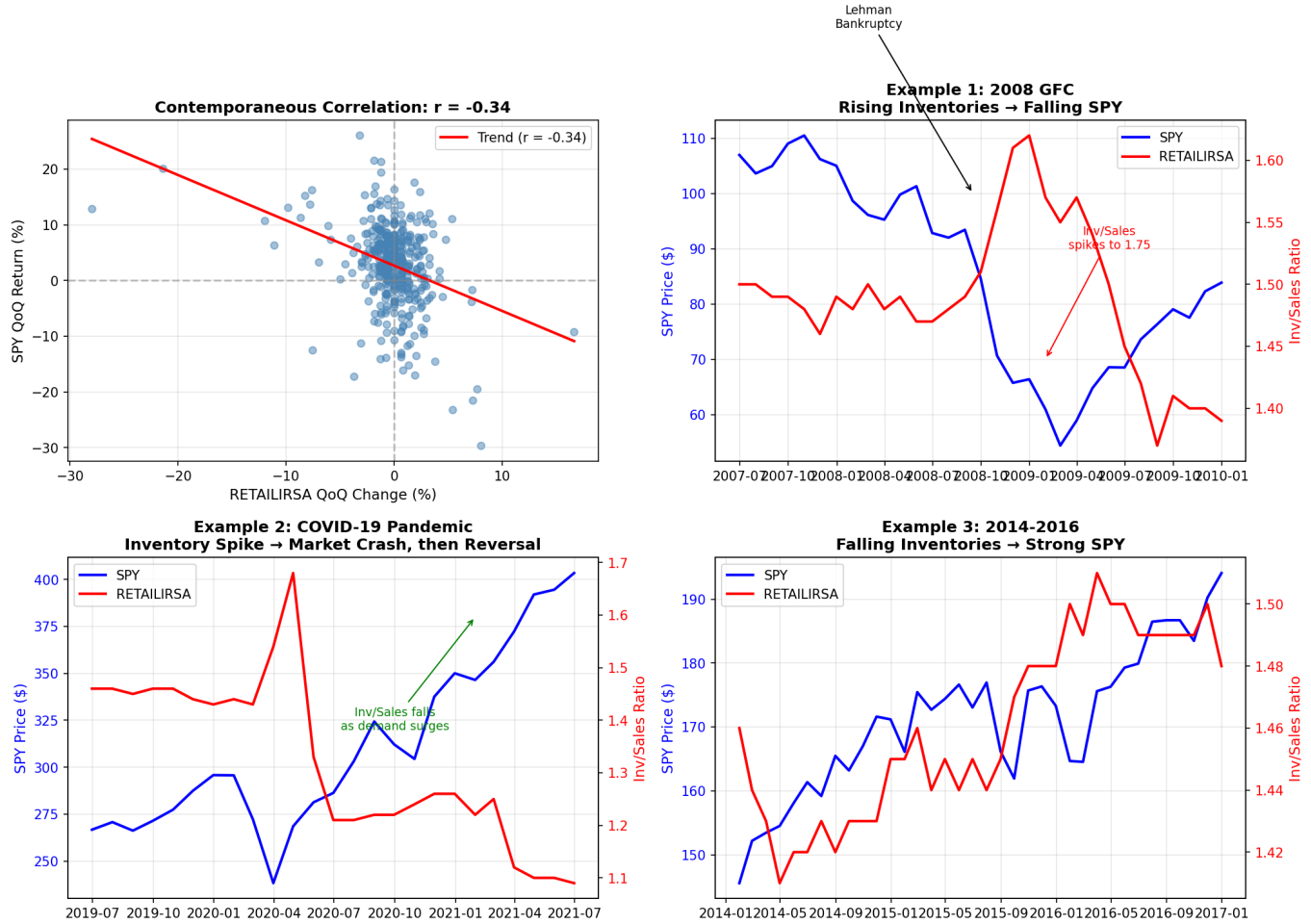


Green = Falling Inventories (YoY < 0), Pink = Rising Inventories (YoY > 0), Gray = Recession

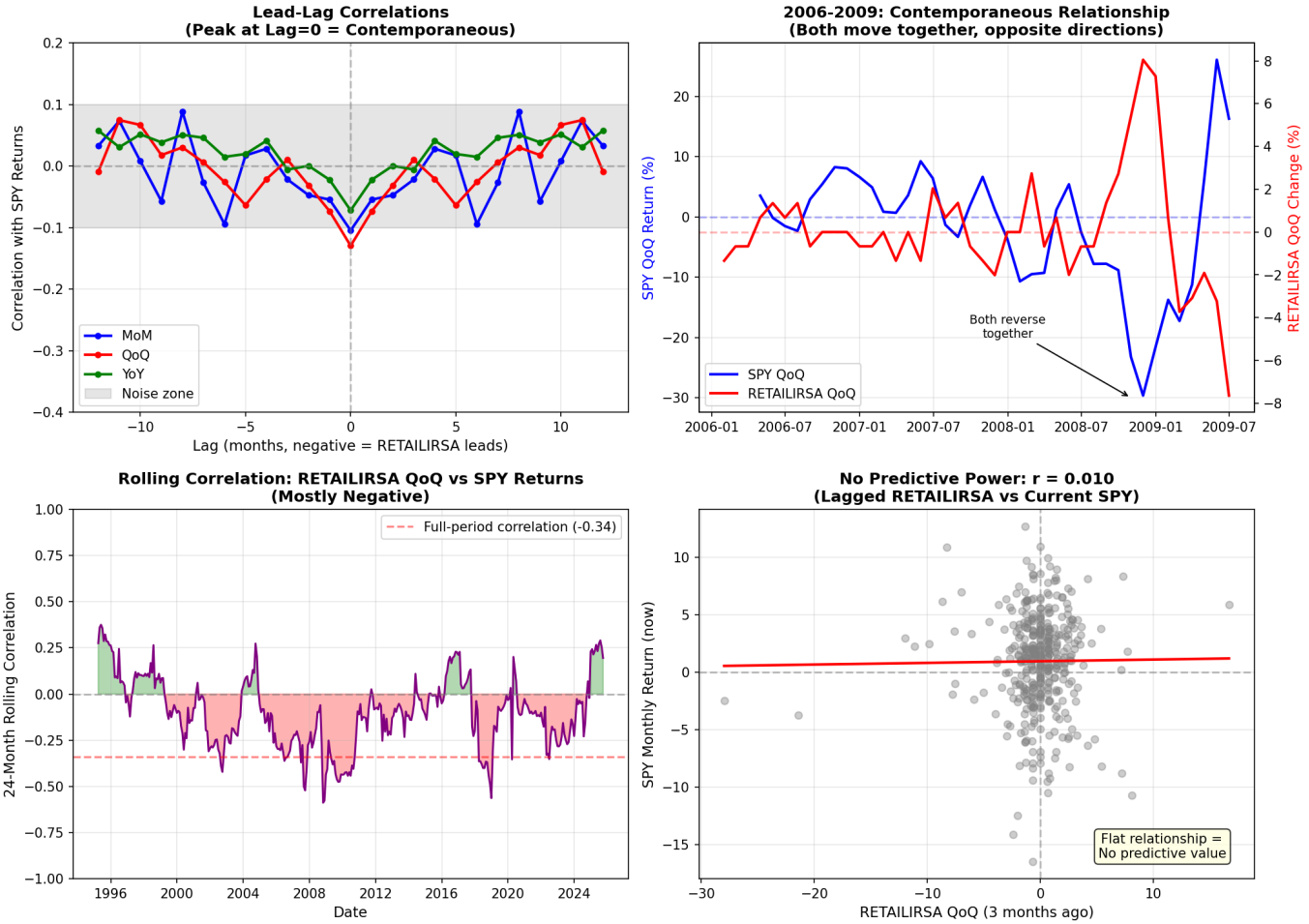
Validated Examples



Correlation Evidence



Lead-Lag Analysis



Economic Interpretation

Why the Inverse Relationship?

The negative correlation between RETAILIRSA changes and SPY returns makes economic sense:

1. **Rising Inventories = Demand Weakness**
   - When retailers build inventory (ratio rising), it often signals weakening consumer demand
   - Products aren't selling as expected, leading to inventory buildup
   - This is bearish for stocks

2. **Falling Inventories = Demand Strength**
   - When inventory-to-sales falls, retailers are selling through inventory faster
   - Indicates strong consumer demand
   - This is bullish for stocks

3. **Supply Chain Efficiency**
   - The secular decline in RETAILIRSA (from 1.75 to 1.28) reflects just-in-time inventory management
   - This structural improvement has coincided with the long-term bull market

Why No Predictive Power?

Despite the contemporaneous correlation, RETAILIRSA lacks predictive power because:

1. **Data is Monthly and Lagged**: RETAILIRSA is released with a 6-week delay
2. **Markets are Efficient**: The information is priced in by release time
3. **Relationship is Weak**: Even contemporaneous correlation is only -0.13
4. **Many Other Factors**: Stock returns are driven by many variables beyond retail inventories

Practical Applications

For Investment Clock Integration

While RETAILIRSA cannot predict SPY returns directly, it can be useful as:

1. **Economic Regime Confirmation**: Rising RETAILIRSA often precedes or coincides with economic slowdowns
2. **Risk Indicator**: High RETAILIRSA levels (>1.5) have historically been associated with lower SPY returns
3. **Recession Warning**: Rapidly rising RETAILIRSA can signal demand destruction

Trading Rules (Based on Regime Analysis)

Simple Rule: Favor stocks when RETAILIRSA YoY < 0 (falling inventories)

- Historical advantage: +4.5% annualized over rising periods
- Win rate: 65% vs 65% (similar)
- Sharpe improvement: 0.98 vs 0.52

Caution: This is a filter, not a timing signal. Use with other indicators.

Files Created

File	Description
`src/ml/retail_spy_analysis/__init__.py`	Package initialization
`src/ml/retail_spy_analysis/relationship_analysis.py`	Analysis functions
`data/spy_retailirsa_regime_background.png`	Full timeline with regime colors
`data/spy_retailirsa_regime_examples.png`	Validated example plots
`data/spy_retailirsa_correlation.png`	Correlation scatter plot
`data/spy_retailirsa_leadlag.png`	Lead-lag analysis plot
`docs/analysis_reports/spy_retailirsa_analysis.md`	This document

Conclusion

RETAILIRSA does not predict SPY returns, but it provides valuable regime context:

1. **Low/Falling inventory ratios** are associated with better SPY performance
2. **The relationship is contemporaneous**, not leading
3. **Use as a filter**, not a signal - combine with other indicators

4. **Recession indicator** adds significant value to the regime analysis

The most actionable insight: Favor equity exposure when RETAILIRSA is falling (YoY < 0) and avoid during recessions.