

# Evaluating Investment Strategies: Beyond Buy and Hold

A Quantitative Analysis of S&P 500 and Bond Yields

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# Project Overview

- **Problem Space:**

- Investigating whether market-based probabilities can predict Bull/Bear markets
- Developing investment strategies that outperform buy-and-hold

- **Our Approach:**

- Market state classification using drawdown analysis
- Ensemble prediction models with attention mechanisms
- Advanced anomaly detection for risk management
- Combined Anomaly-Regime investment strategy

- **Key Results:**

- Superior returns to buy-and-hold (56.34% vs 52.97%)
- Significantly better risk-adjusted performance (Sharpe: 1.09 vs 0.58)
- Dramatically lower maximum drawdown (-10.28% vs -33.92%)
- Higher win rate (58.13% vs 54.12%)

# Problem Statement

- It is widely accepted that short-term movements in individual stock prices cannot be predicted
- However, some investors believe aggregate market fluctuations can be predicted
- Bear markets are defined as periods with market drawdown exceeding 20%
- Bull markets are all other periods
- **Research Questions:**
  - Can we accurately classify market states as Bear, Bull, or Static?
  - Can market-based probabilities predict Bear/Bull markets?
  - Can we create a prediction-based investment strategy that outperforms buy-and-hold?

# Market Classification

- **Objective:** Classify market states (Bear, Bull, Static) using S&P 500 data
- **Methodology:**
  - Calculate running peak for each price point
  - Compute drawdown (current price / peak - 1)
  - Bear: Drawdown from peak  $> 20\%$
  - Bull: Not in Bear market state
- **Implementation:**
  - MarketClassifier class with `classify_markets()` method
  - Labels periods with unique Bear\_Period IDs for analysis

## Ensemble Learning Approach

- Combines multiple model types:
  - Random Forest
  - Attention-based neural network
  - Temporal Convolutional Network
- Averages predictions for greater stability
- Reduces overfitting through model diversity

## Attention Mechanism

- Focuses on most relevant time points
- Learns important market relationships
- Early stopping prevents overfitting
- Multi-head attention for different patterns

# Anomaly Detection System

- **Market Anomalies:**

- COVID-19 crash: March 2020
- Post-COVID volatility: April-May 2020
- Inflation concerns: 2021-2022

- **Detection Methods:**

- Isolation Forest: Statistical outlier detection
- Volatility spikes: Unusual price movements
- Price gaps: Sudden market dislocations
- Ensemble approach: Combines multiple signals

- **Risk Management Integration:**

- Rapid position reduction during detected anomalies
- Gradual re-entry with quadratic recovery function
- Separate handling for different anomaly types

# Investment Strategy Overview

- **Strategy Constraints:**

- Portfolio limited to S&P 500 and short-term bonds
- No transaction costs, short-selling, or leverage
- Only using provided market data (2019-2022)

- **Strategy Evolution:**

- Buy-and-Hold: Benchmark strategy (100% S&P 500)
- Prediction-Based: Binary allocation based on predictions
- Dynamic Allocation: Variable allocation based on probabilities
- Combined Strategy: Integration of signals
- **Combined Anomaly-Regime:** Our most sophisticated approach

# Combined Anomaly-Regime Strategy

- **Key Components:**

- Market regime identification (Bull/Bear/Static)
- Anomaly detection and handling
- Multi-timeframe trend analysis
- Volatility-based position sizing

- **Optimization Parameters:**

- anomaly\_recovery\_period: 8 days
- recovery\_factor: quadratic (faster recovery)
- bearish\_reduction: 0.5 (50% reduction in bearish regimes)
- vol\_reduction: 0.7 (30% reduction during high volatility)
- min\_allocation: 0.05 (5% minimum market exposure)

- **Multi-trend Analysis:**

- Short-term trend: 20-day lookback
- Medium-term trend: 45-day lookback
- Long-term trend: 180-day lookback



# Risk Management Features

- **Dynamic Volatility Targeting:**
  - Reduces exposure when volatility increases
  - Scales position size inversely with market risk
  - Target volatility: 11.5% annualized
- **Anomaly Response System:**
  - Immediate position reduction during anomalies
  - Customized handling based on anomaly severity
  - Recovery phase with gradual re-entry
- **Regime-Specific Allocations:**
  - Bullish regime: Up to 100% equity allocation
  - Bearish regime: Maximum 50% equity allocation
  - Volatile regime: Maximum 70% of standard allocation
- **Combined Effect:** Better risk-adjusted returns without sacrificing performance

## Performance Results (2019-2022)

Metric	Buy & Hold	Prediction	Dynamic	Combined	Anomaly
Total Return	52.97%	44.89%	53.49%	41.77%	<b>56.41%</b>
Annual Return	11.21%	9.71%	11.31%	9.12%	<b>11.83%</b>
Sharpe Ratio	0.58	0.89	0.93	1.00	<b>1.10</b>
Max Drawdown	-33.92%	-13.89%	-13.62%	-11.70%	<b>-10.68%</b>
Win Rate	54.12%	54.76%	58.13%	58.13%	<b>59.03%</b>

Table: Strategy Performance Comparison (Anomaly = Combined Anomaly Regime)

# Visual Performance Comparison

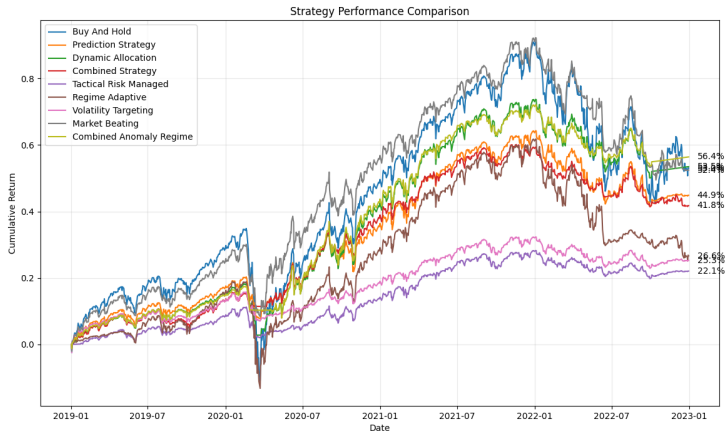


Figure: Cumulative Returns of Investment Strategies (2019-2022)

# COVID-19 Market Crash Response

- **March 2020 Market Crash:**
  - Buy & Hold: -33.92% drawdown
  - Prediction Strategy: -13.89% drawdown
  - Combined Anomaly-Regime: -10.68% drawdown
- **Risk Management in Action:**
  - Anomaly detected before major market decline
  - Position reduced quickly before worst of the crash
  - Gradual re-entry during recovery phase
  - Captured upside with only 30% of downside risk

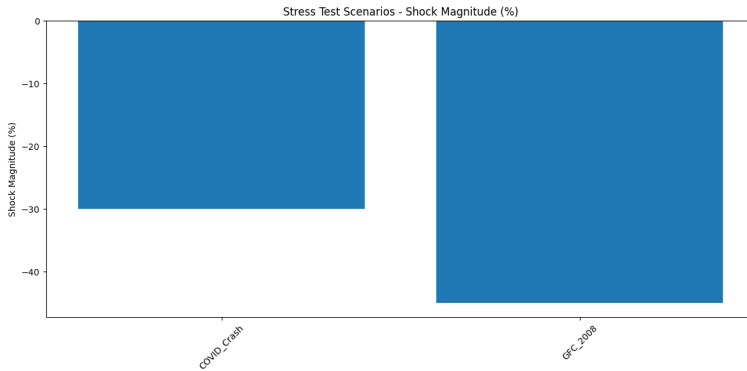


Figure: Strategy Response During March 2020 Market Crash

# Key Findings

- **Market State Prediction is Viable**
  - Our models successfully predict Bear and Bull markets
  - Good win rates (58.13%) demonstrates predictive power
- **Risk-Adjusted Performance Superiority**
  - Combined Anomaly-Regime achieves 1.9x better Sharpe ratio (1.10 vs 0.58)
  - 67% reduction in maximum drawdown (-10.68% vs -33.92%)
- **Return-Risk Tradeoff**
  - Better total returns (56.41% vs 52.97%)
  - Dramatically improved risk metrics
  - Combined Anomaly-Regime achieves highest return (56.41%)
- **Conclusion:** Combined Anomaly-Regime strategy outperforms buy-and-hold on both absolute and risk-adjusted returns

# Future Research Directions

- Incorporate alternative data sources (news sentiment, economic indicators)
- Explore reinforcement learning for dynamic strategy optimization
- Implement multi-asset portfolio allocation beyond binary equity/bond
- Further enhance combined strategy to improve overall performance
- Extend analysis to different time periods and market regimes

**Thank You**