Volatility Surface Skew for Forecasting Equity Returns

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October 21, 2024

Presentation Overview

1. Introduction

- Can we use Skews in Volatility Surfaces to predict equity returns?
- Quick reference to the key findings of the paper

2. Methodology

- How we are constructing skews
- Data used and backtesting period

3. Backtesting Results

- Factor Assessment
- Portfolio results

Summary of the paper

Implied Skewness and Stock Returns

Model-Free Implied Skewness (MFIS) is positively related to future stock returns, contradicting previous studies. High MFIS stocks outperform low MFIS stocks by 45 basis points per month.

Misvaluation Insight

MFIS reflects stock misvaluation. Overvalued stocks tend to have more negative skewness, predicting a correction in their prices, which drives the MFIS-return relation.

Arbitrage Risk and Price Correction

The speed of misvaluation correction depends on arbitrage risk. Stocks with lower arbitrage risk correct faster, with more rapid changes in MFIS for these stocks.

Summary of the Paper

Model-Free Implied Skewness (MFIS)

$$\text{MFIS}(t,\tau) = \frac{e^{r\tau}W(t,\tau) - 3\mu(t,\tau)e^{r\tau}V(t,\tau) + 2\mu(t,\tau)^3}{\left(e^{r\tau}V(t,\tau) - \mu(t,\tau)^2\right)^{3/2}}$$

where:

$$V(t,\tau) = \text{Model-Free Implied Variance}$$
$$W(t,\tau) = \text{Cubic Contract}$$
$$\mu(t,\tau) = \text{Mean of Risk-Neutral Distribution}$$

Robust Return Predictability

A portfolio strategy based on MFIS, with monthly rebalancing, delivers significant excess returns, demonstrating the predictive power of MFIS for short-term stock performance.

Key Reasons for Using Skewness (MFIS)

1. Forward-Looking Information

MFIS captures option traders' future expectations, offering insights not yet reflected in stock prices.

2. Misvaluation Detection

MFIS identifies over- and under-valued stocks, signaling potential price corrections.

3. Faster Information Incorporation

Option markets may reflect information faster than equity markets, making skewness a timely indicator.

4. Comprehensive Measure

MFIS uses all available options data, providing a model-free, full-scope view of risk-neutral distribution skewness.

Steps for Constructing Skew

Skew Calculation Process

- Obtain options data for expiries before and after 30 days.
- Perform SABR calibration for both expiries to model the implied volatility smiles.
- Use linear interpolation of cumulative variance between the two expiries to derive the volatility smile for a constant 30-day tenor.
- Calculate the 30-day skew as:

$$\text{Skew} = \text{30-Day Call Vol (25 Delta)} - \text{30-Day Put Vol (-25 Delta)}$$

Data Sources

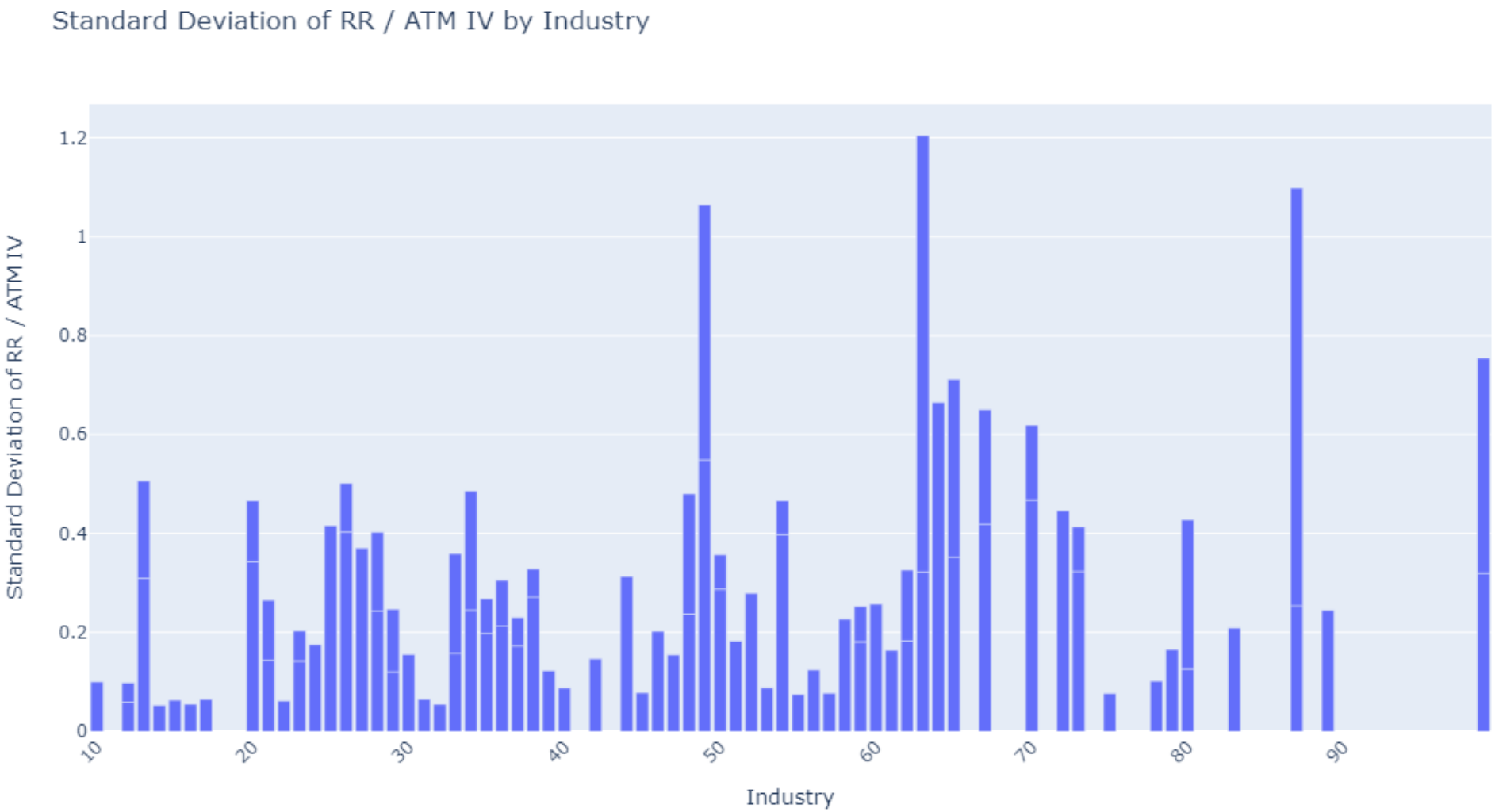
Category	Details
Stock Universe	Constituents of the S&P 500
Equity Prices and Industry Sector	Sourced from CRSP (Center for Research in Security Prices)
Options Data	Sourced from OptionMetrics
Main Tools Used	pandas, numpy, sklearn

Table: Overview of Data Sources and Tools

Portfolio Construction Steps

- **Data Preparation:** Collected historical stock data and calculated the skew.
- **Factor Neutralization:** Neutralized exposures relative to the market to eliminate biases.
- **Exposure Clipping:** Applied winsorization to clip extreme factor exposures, reducing the impact of outliers.
- **Weight Assignment:** Assigned portfolio weights directly based on final factor exposures.
- **Daily Rebalancing and Transaction Costs:** Rebalanced the portfolio daily.

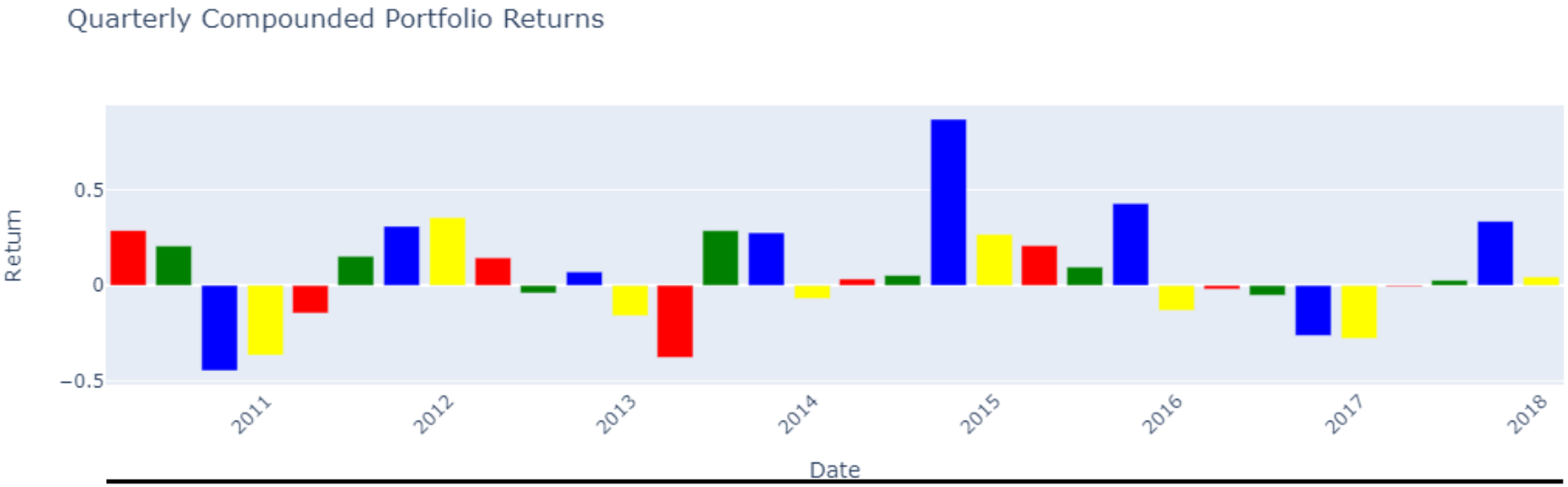
Neutralization: Market v/s Industry



Backtesting Results: Cumulative Return vs. Time

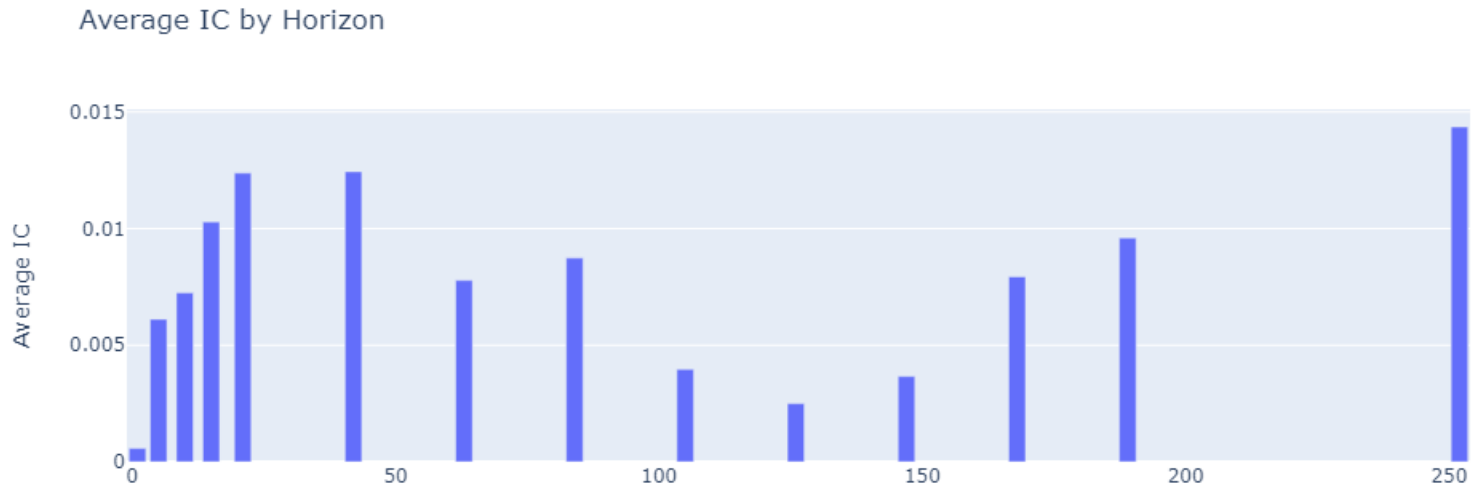
Metric	Expected Return (E)	Standard Deviation (std)	Sharpe Ratio
Value	12.02%	18.45%	0.65

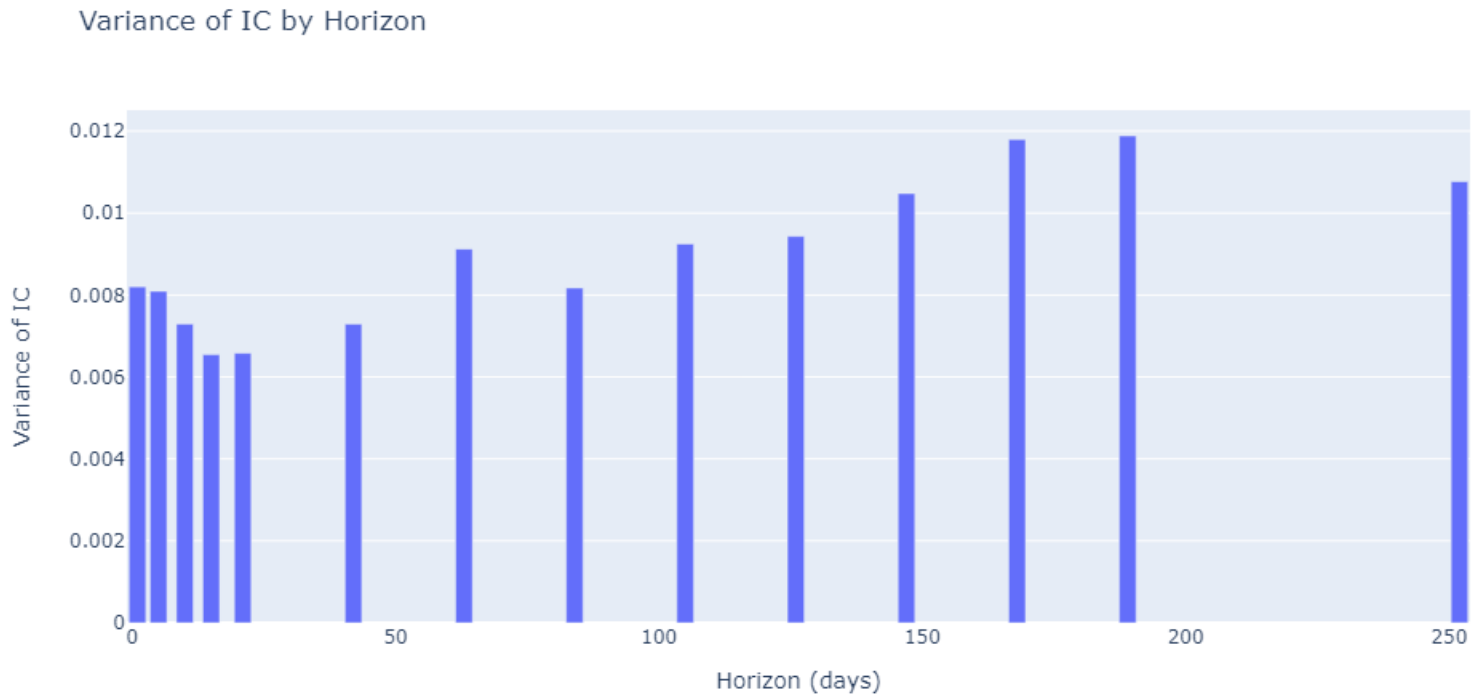
Backtesting Results: Seasonality



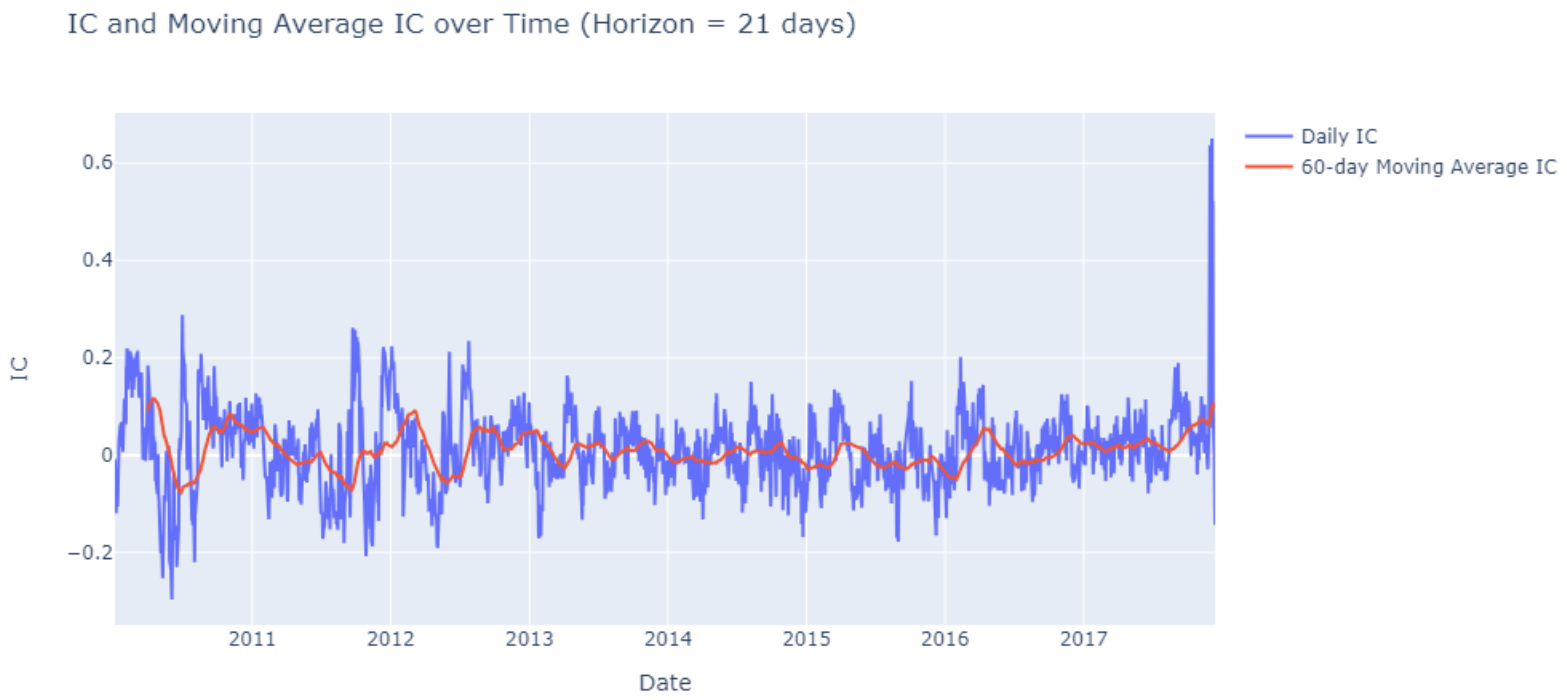
Year	Annual Return	Annual Volatility	Sharpe Ratio
2010	-0.4520	0.2241	-2.0174
2011	0.7492	0.1735	4.3189
2012	-0.0089	0.1820	-0.0492
2013	-0.0469	0.1889	-0.2483
2014	1.5774	0.2267	6.9581
2015	0.6468	0.1771	3.6526
2016	-0.5036	0.1270	-3.9663
2017	0.4251	0.1262	3.3692

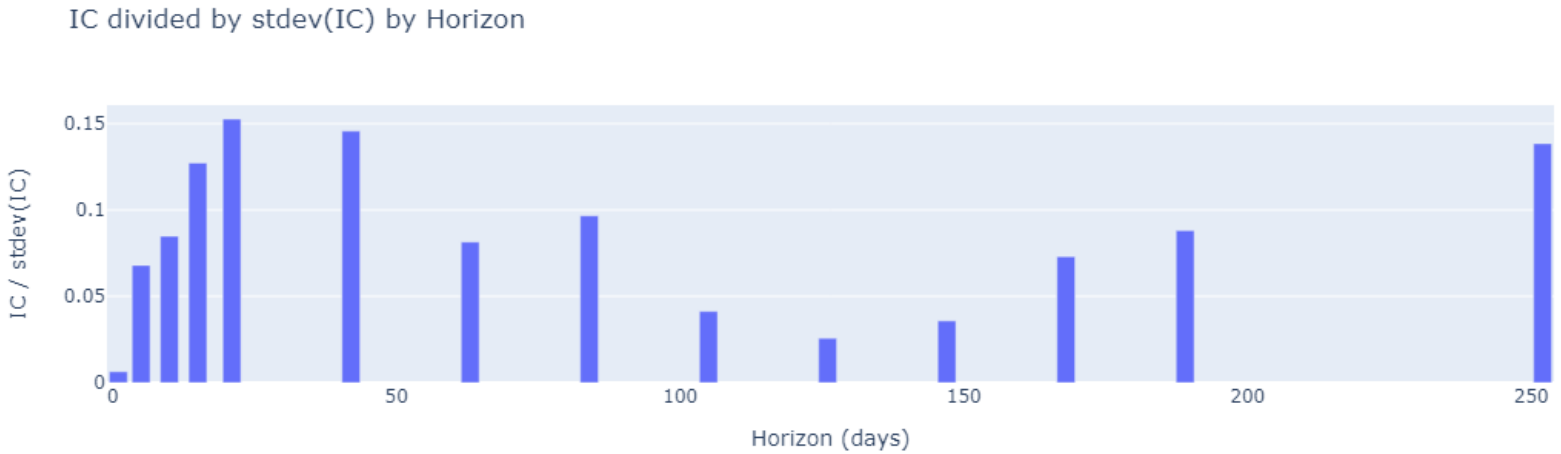
IC Backtesting Results: Insights



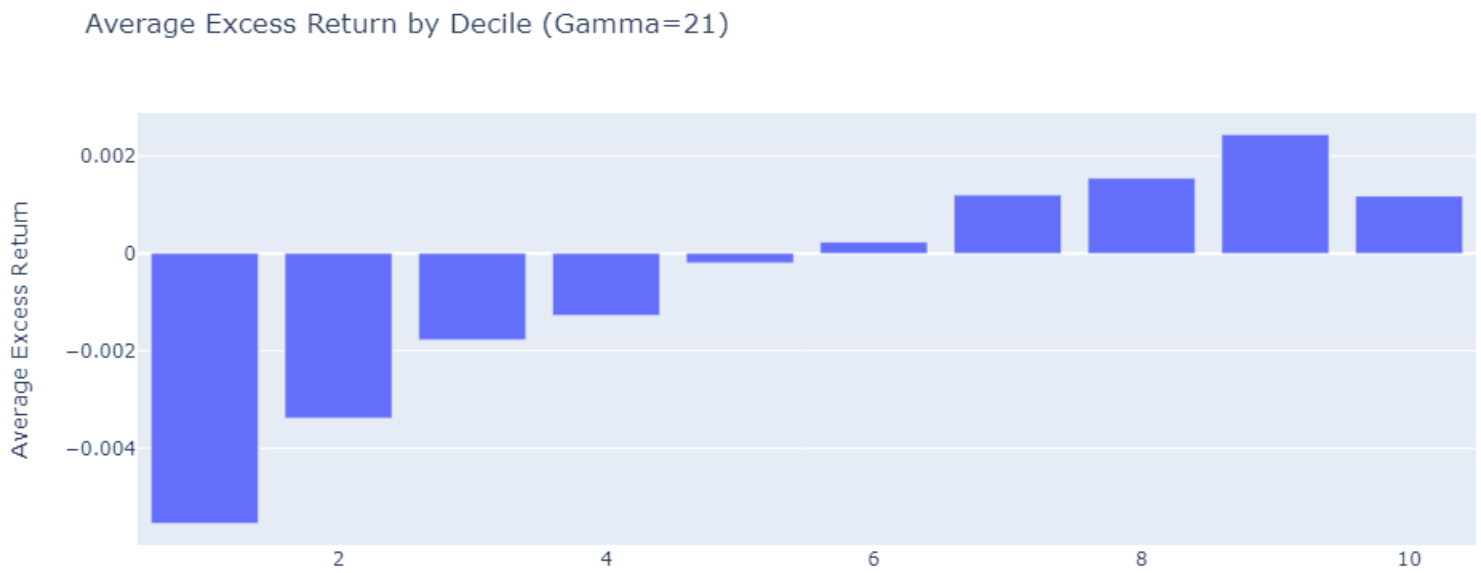


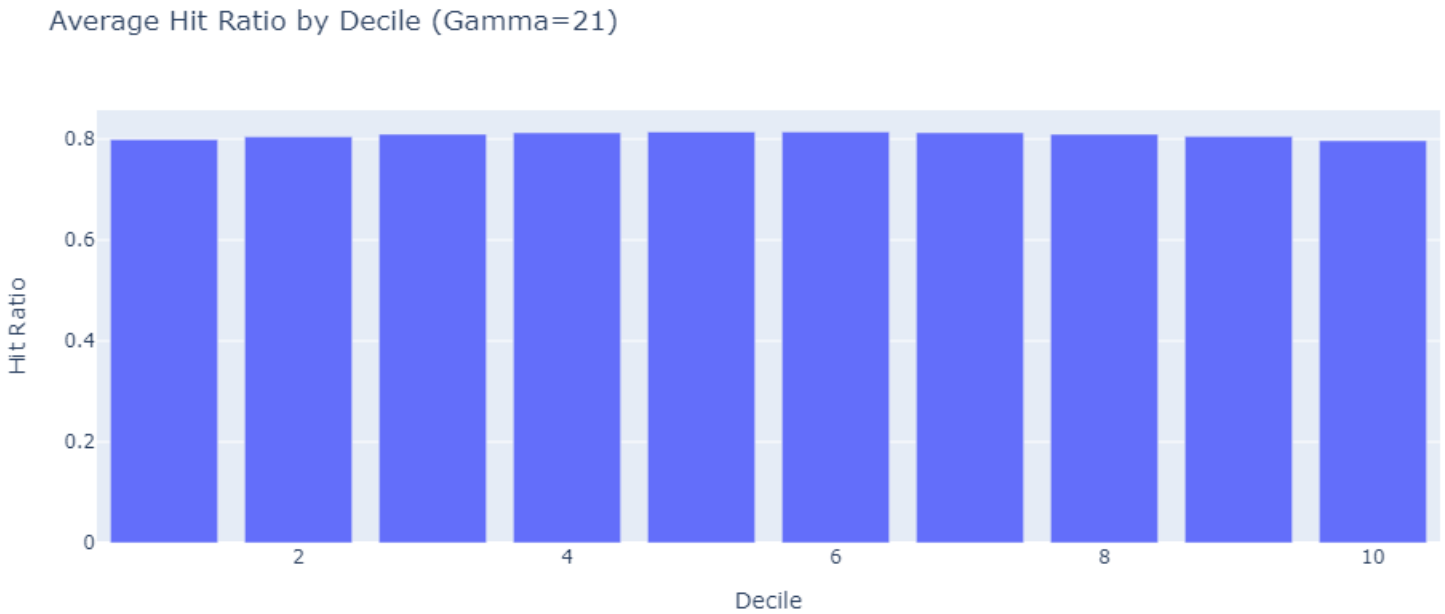
Backtesting Results: Insights



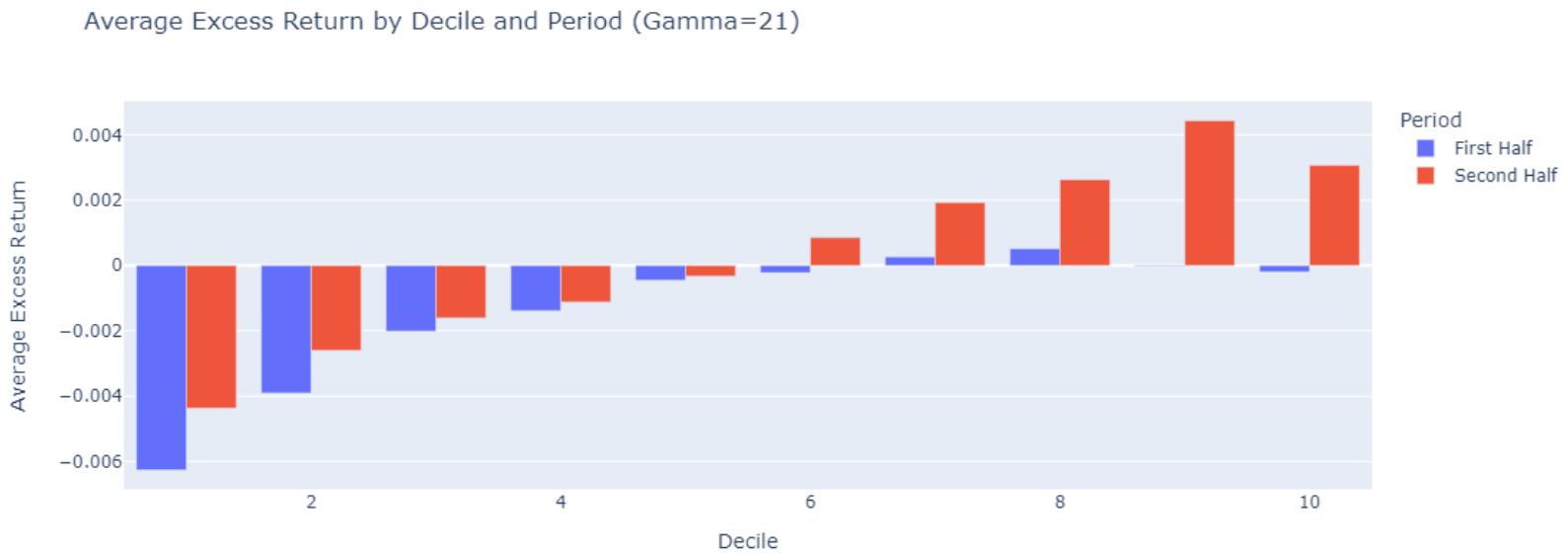


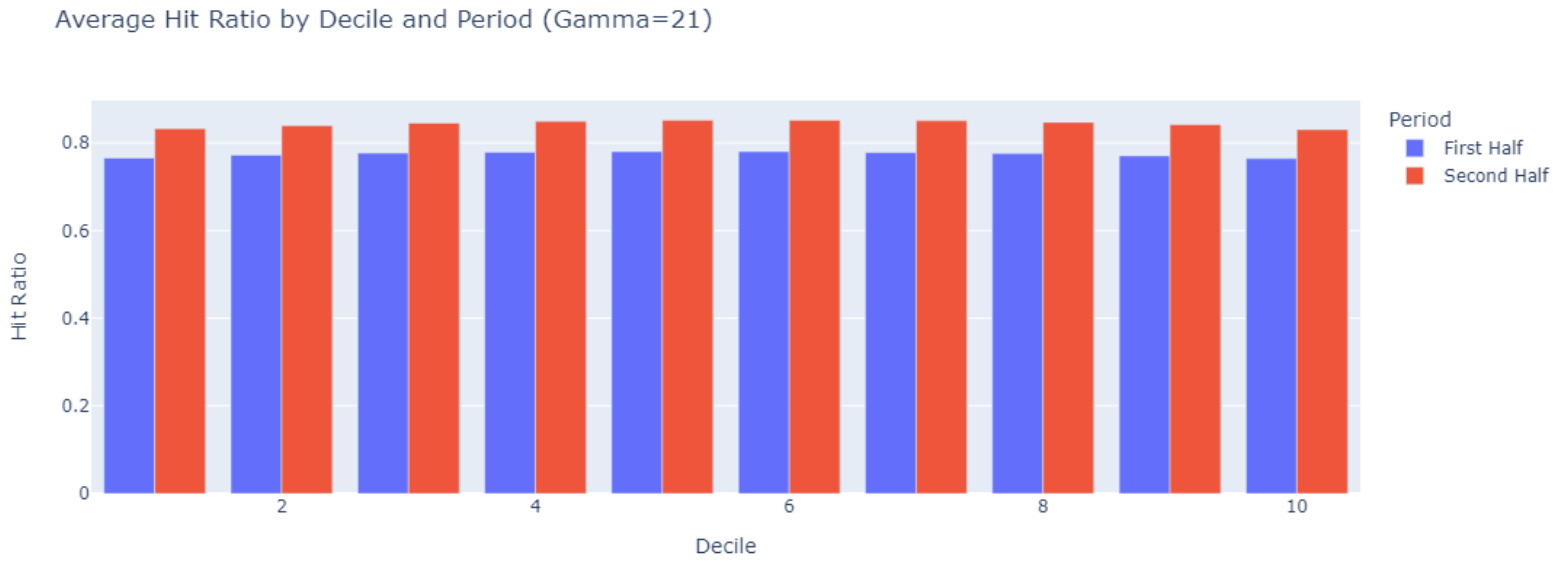
Backtesting Results: Decile Analysis (Gamma = 21)





Backtesting Results: Decile Analysis





T-statistics by Decile and Period (Gamma = 21)

Decile	First Half			Second Half		
	Avg ER	Std ER	t-stat	Avg ER	Std ER	t-stat
1	-0.006258	0.011130	-17.637	-0.004370	0.010781	-12.728
2	-0.003902	0.006989	-17.513	-0.002599	0.006401	-12.748
3	-0.002009	0.006203	-10.157	-0.001608	0.005583	-9.043
4	-0.001389	0.005818	-7.491	-0.001120	0.005307	-6.629
5	-0.000448	0.005664	-2.479	-0.000325	0.005216	-1.956
6	-0.000224	0.006055	-1.160	0.000854	0.005950	4.507
7	0.000268	0.006091	1.382	0.001929	0.005957	10.166
8	0.000515	0.006548	2.468	0.002628	0.006836	12.072
9	-0.000022	0.007817	-0.089	0.004432	0.007592	18.332
10	-0.000198	0.010314	-0.601	0.003068	0.008202	11.747

Table: T-statistics by Decile and Period (Gamma = 21)

Analysis of Returns

Stock	Skewness	Kurtosis	Hitrate (%)
Portfolio	-0.294	7.11	55.7

Chart of the hitrate over time

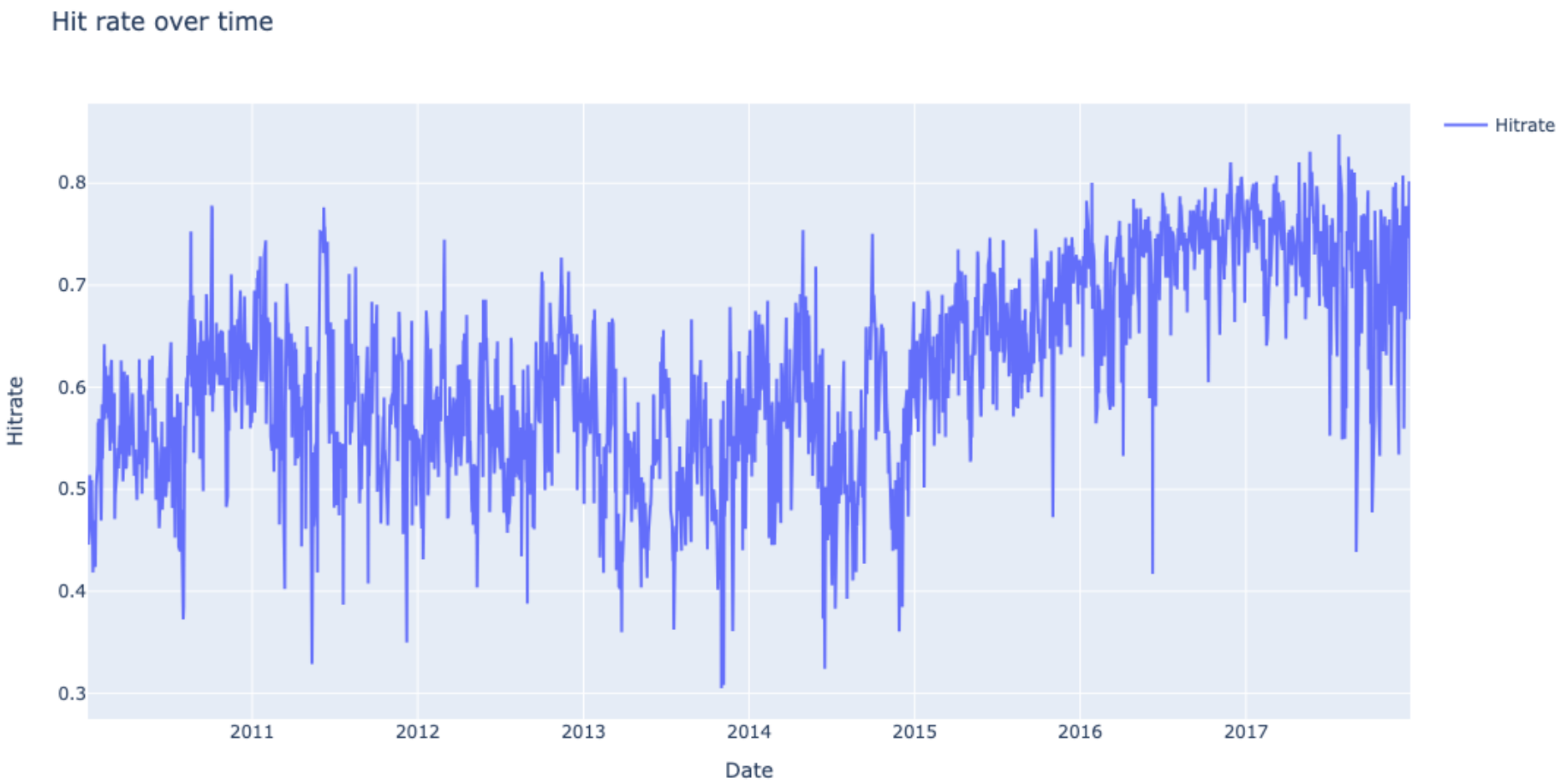


Figure: Hitrate over time

Conclusion

- Volatility surface data can be used to forecast equity returns.
- Industry normalization is causing issues and is not beneficial for the backtest.
- The results are very promising for predicting on the shorting side but not as effective on the long side.

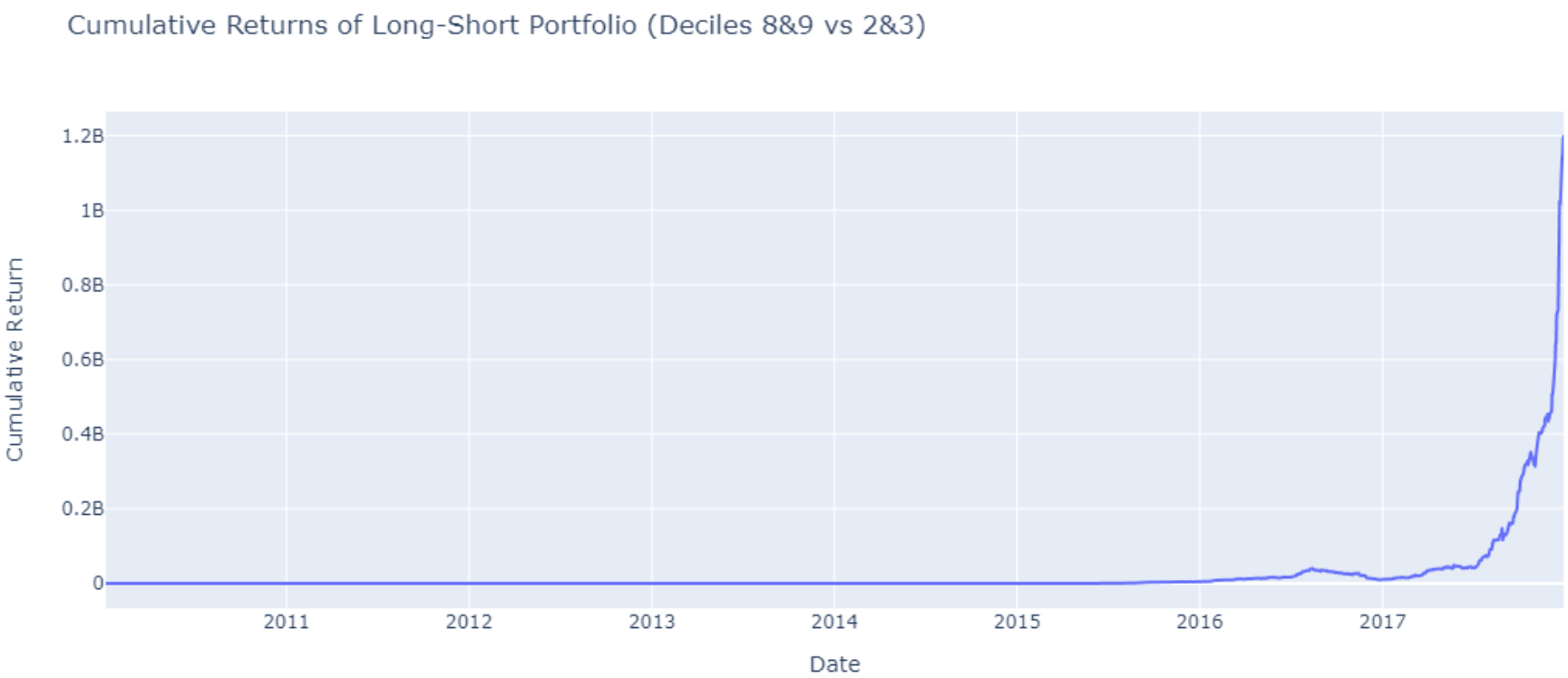
Next steps

- Mean-variance optimization was implemented, but issues were encountered when running it over the entire period.
- The Diderot & Wolf method for covariance matrix estimation was implemented, but encountered issues during execution.
- Consider signals from the volatility surface for shorter expirations, as market makers are possibly more active and need to hedge.

Sources

- Equity Data from CRSP
- Options Data from Optionmetrics
- Risk-Neutral Skewness: Return Predictability and Its Sources by G. Rehman & Z. Vilkov
- Dedorit & Wolf : A Well-Conditioned Estimator for Large-Dimensional Covariance Matrices

Backtesting Results: Cumulative Return vs. Time



Metric	Expected Return (E)	Standard Deviation (std)	Sharpe Ratio
Value	509.31%	54.34%	9.37