

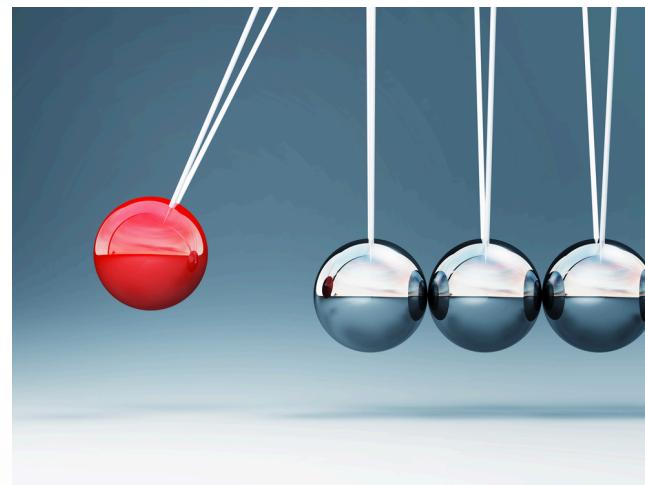
# Momentum Strategies in Intraday Trading

Matthew Creme, Raphael Lenain, Jacob Perricone, Ian  
Shaw, Andrew Slottje

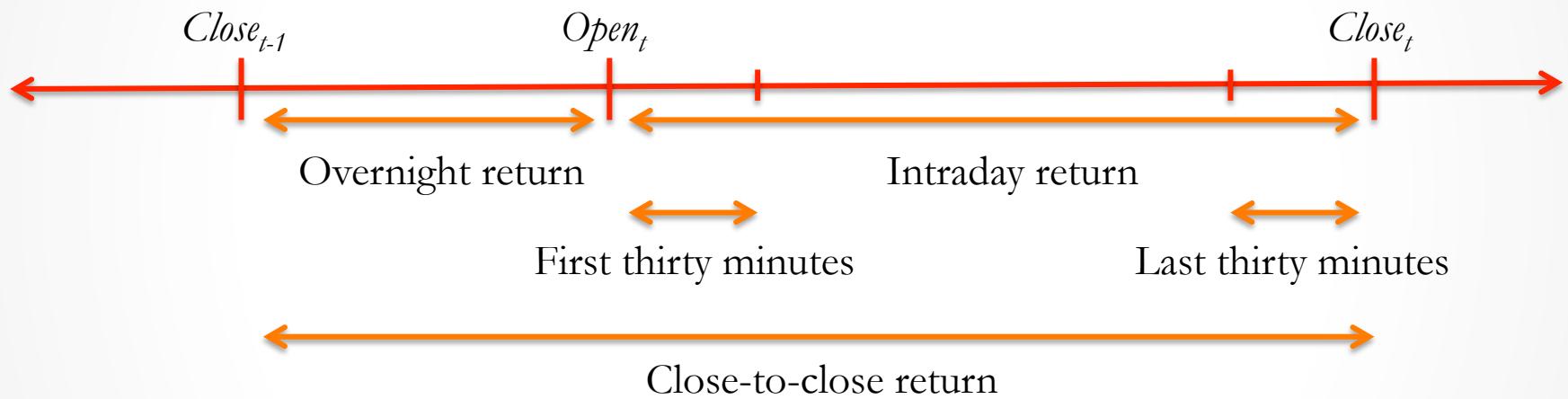
MIRAJ Alpha  
MS&E 448

# Origin of momentum strategies

- Long-term: Jegadeesh and Titman (1993)
  - Rank stocks into deciles based on returns
  - Buy the top decile, sell the bottom decile
  - Results: Winners with six-month lag generate abnormal returns for a year (and thereafter lose this return)

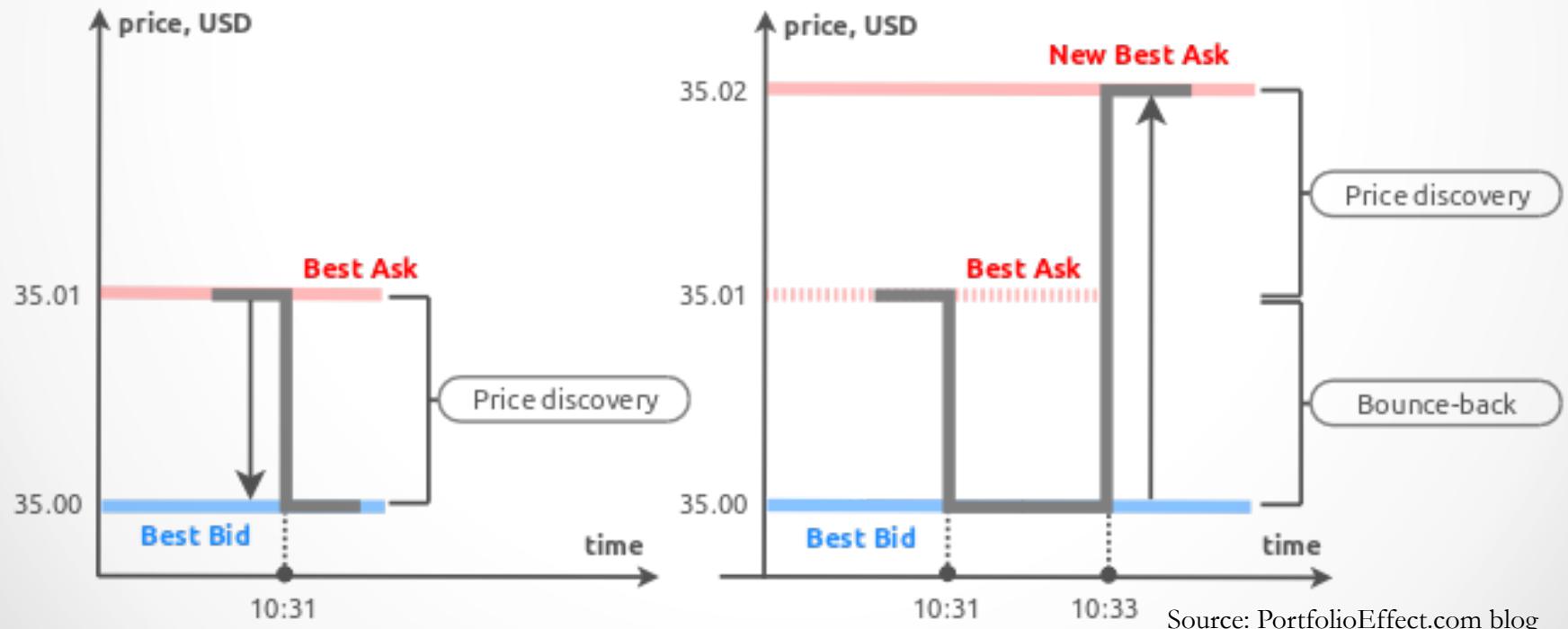


# Context: Return timeline



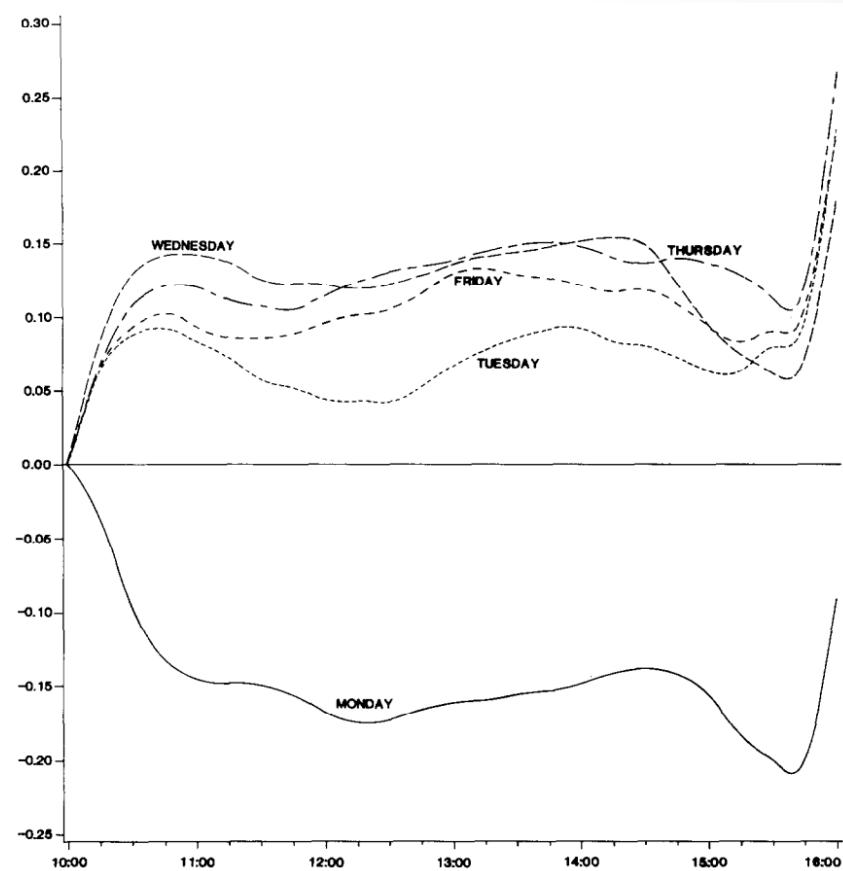
# Context: Bid-ask bounce

- Potential explanation for the negative correlation on overnight and intraday returns
- Consider a stock that closes at the bid and opens at the ask



# Intraday effects

- Intraday studies in the 1980s:  
Wood et al. (1985); Smirlock  
(1985)
  - Harris (1986): predictable  
patterns in returns through  
the day. Prices rise on all  
mornings but Monday
  - Potentially due to market-  
maker inventory control
  - Persistent despite  
expansive literature



# Starting point: Results from the literature

## Similar experiments:

- Gao et al. (2014) prove statistical correlation in first thirty/last thirty returns on the SPY
- Branch and Ma (2012) prove overnight/intraday correlation within equities returns and with SPY

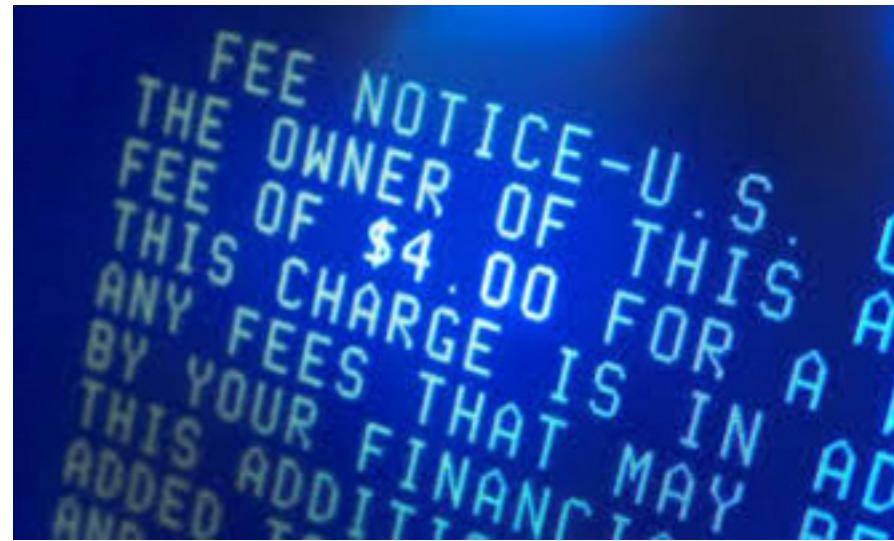
## Additional findings:

- High volatility correlates with strong momentum effects: Zhang (2006) and Gao et al.
- Half-hour returns predict later performance in those intervals: Heston et al. (2010)
- Correlations with size and institutional ownership: Israel and Moskowitz (2013), Hong et al. (2000), Branch and Ma



# Objective

- Develop an intraday momentum strategy that withstands transaction costs



# Challenges

- Empirical challenges
- Statistical predictability does not imply profitability - Komarov (2017)
- Ongoing debate about whether transaction costs will prevent profits
  - Double bind: if they don't, the excess returns should get arbitraged away

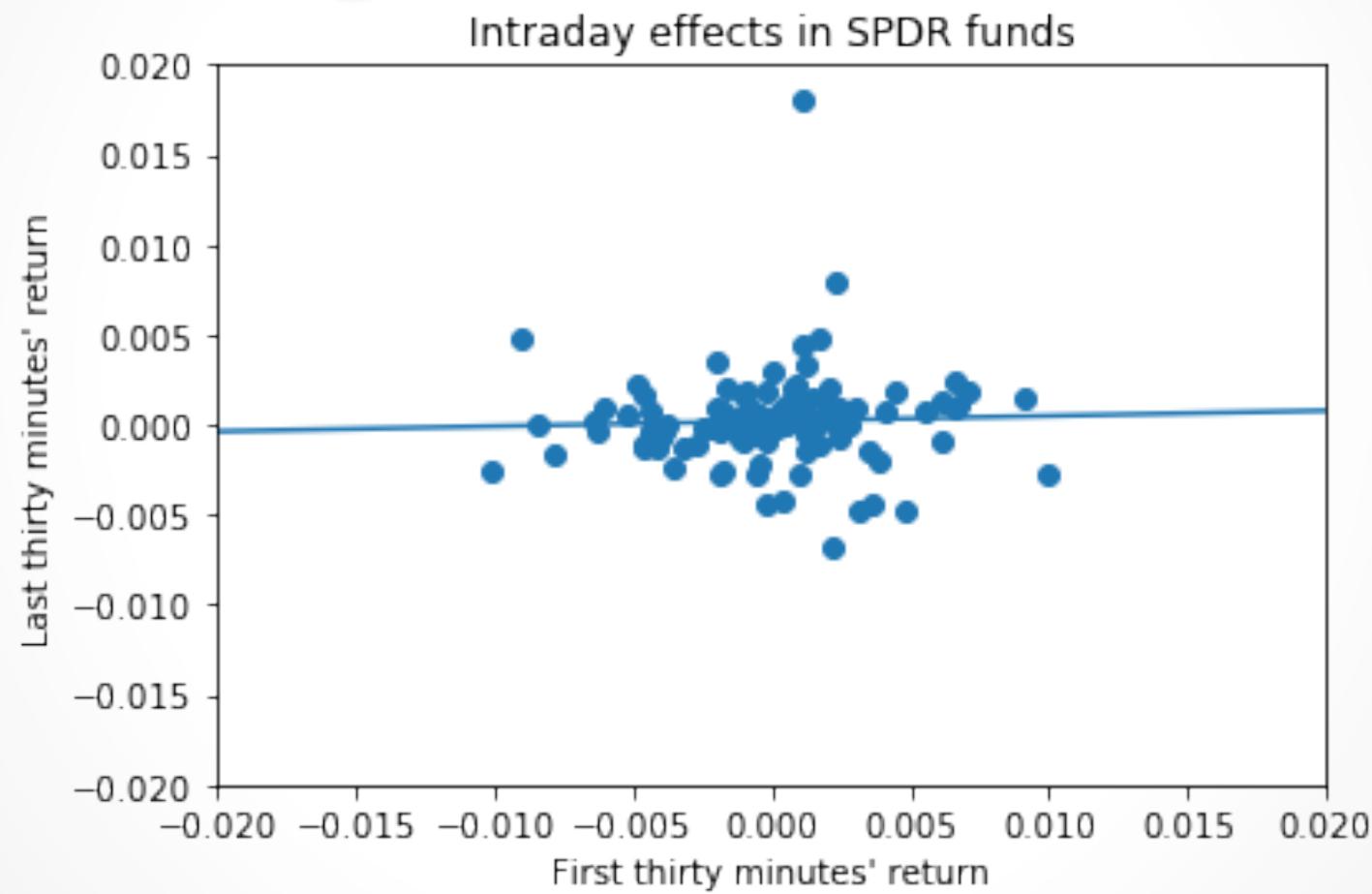


# Preliminary exploration: Google Finance

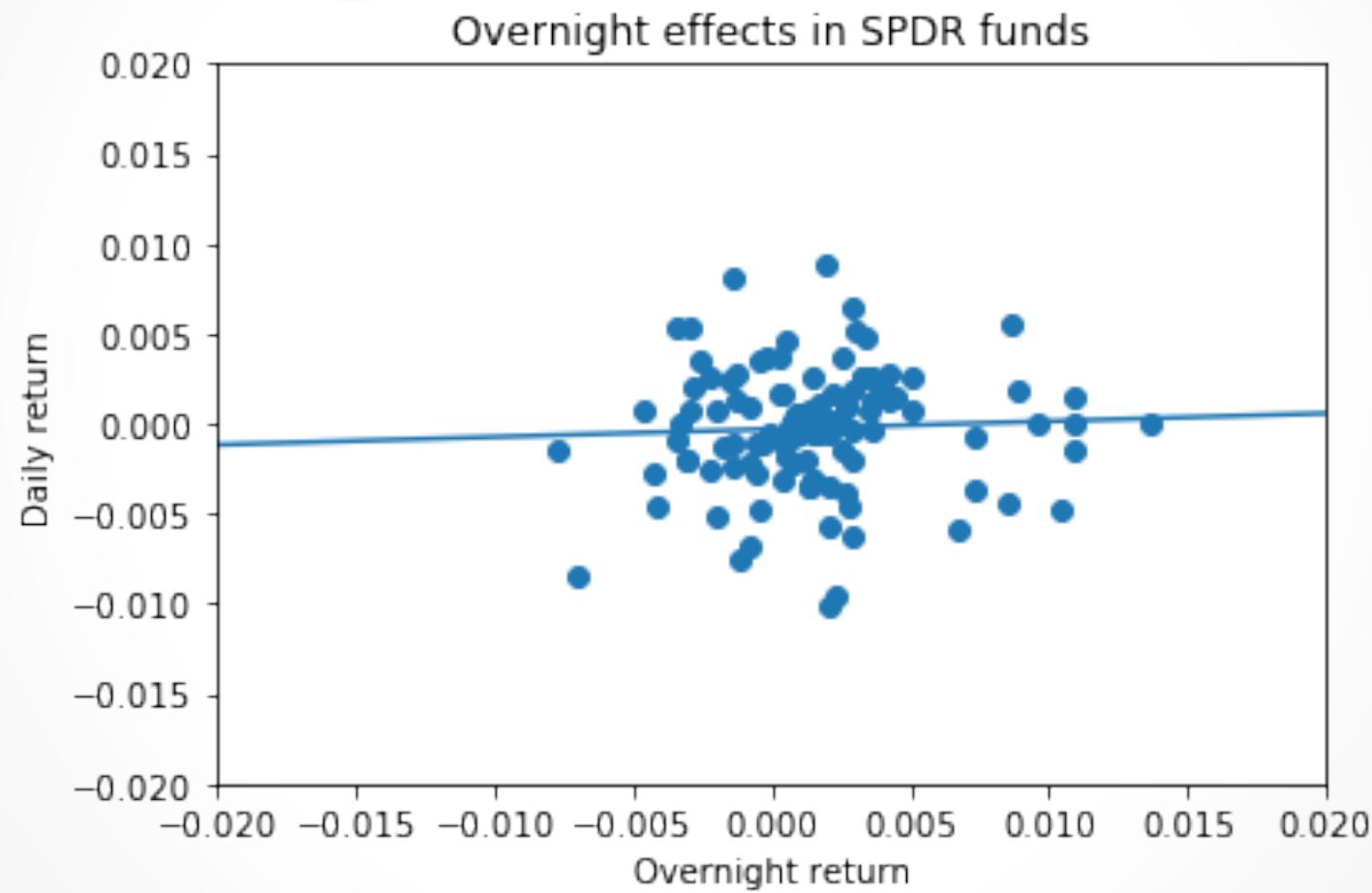
- Investigation of sector-specific ETF dynamics called for in the MS&E 448 final paper of Chiquone et al. (2015)
- Used intraday data publicly available on Google Finance
- Downloaded all available intraday historical prices for SPDR exchange funds and ran analytics in Python
- 14 days, 10 ETFs (XTL intraday data was sparse)



# Google Finance results



# Google Finance results



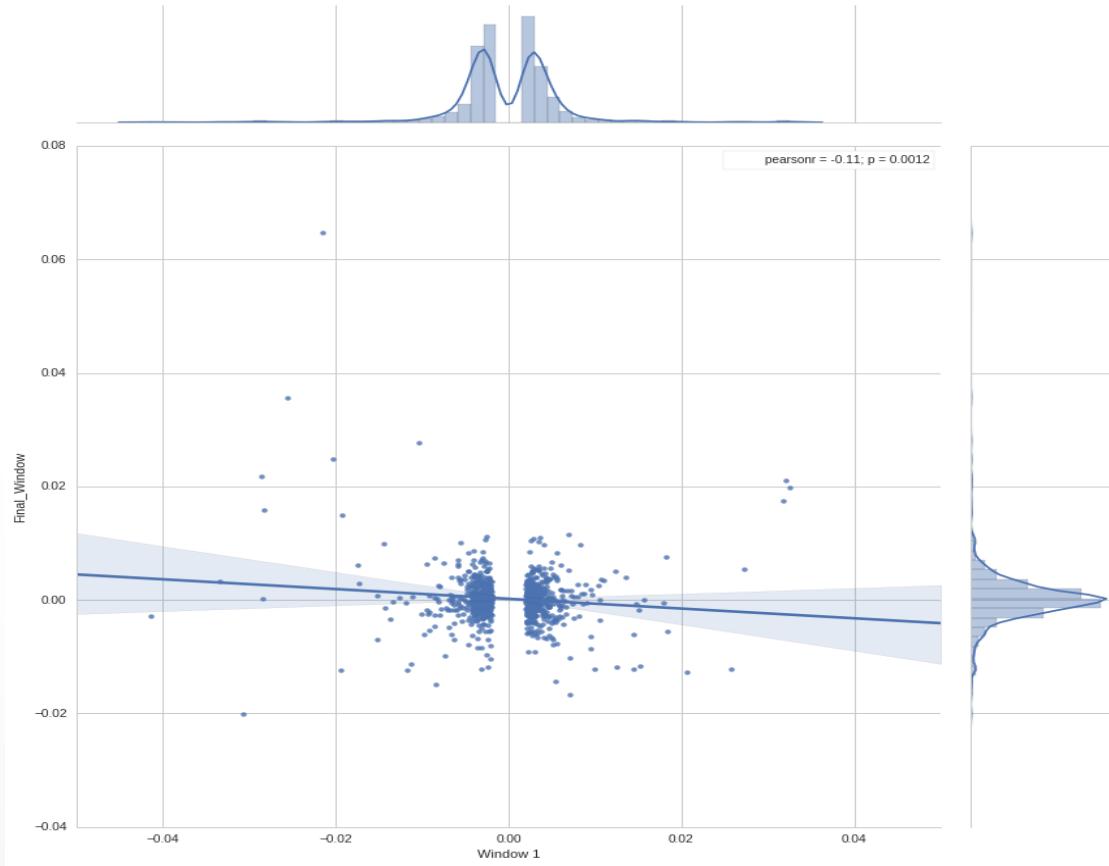
# Google Finance analysis

## Analysis:

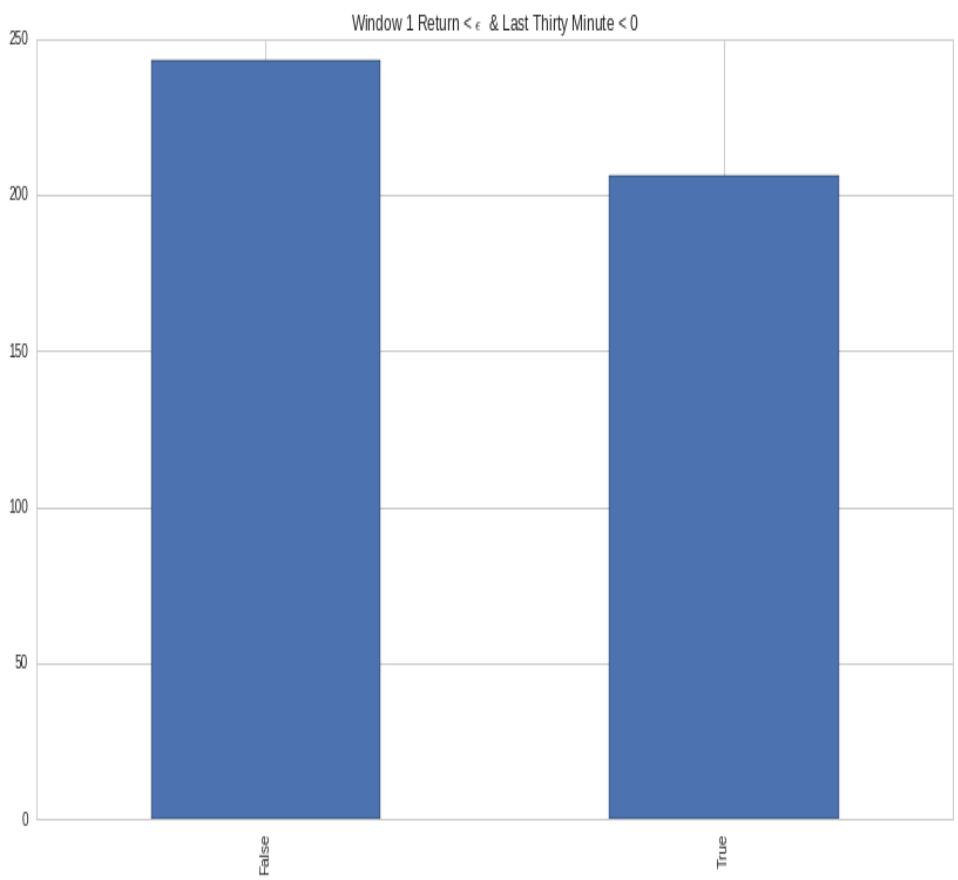
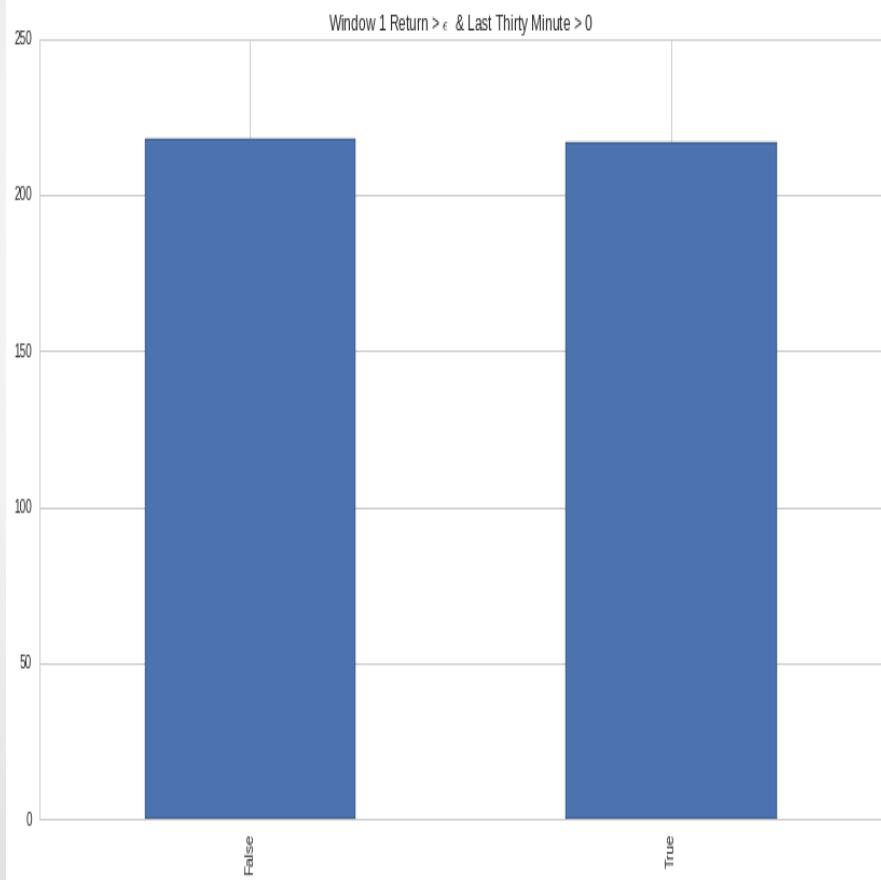
- Low  $R^2$  and correlation coefficients
- Suggests arbitrageurs may have disappeared this effect from the markets
- But dataset is very limited
- Effect may also be attenuated in ETF prices from use of futures in SPDR pricing (Branch and Ma)
- Working on getting more intraday hard data from online providers to confirm these effects

# Onto Quantopian: Preliminary analysis

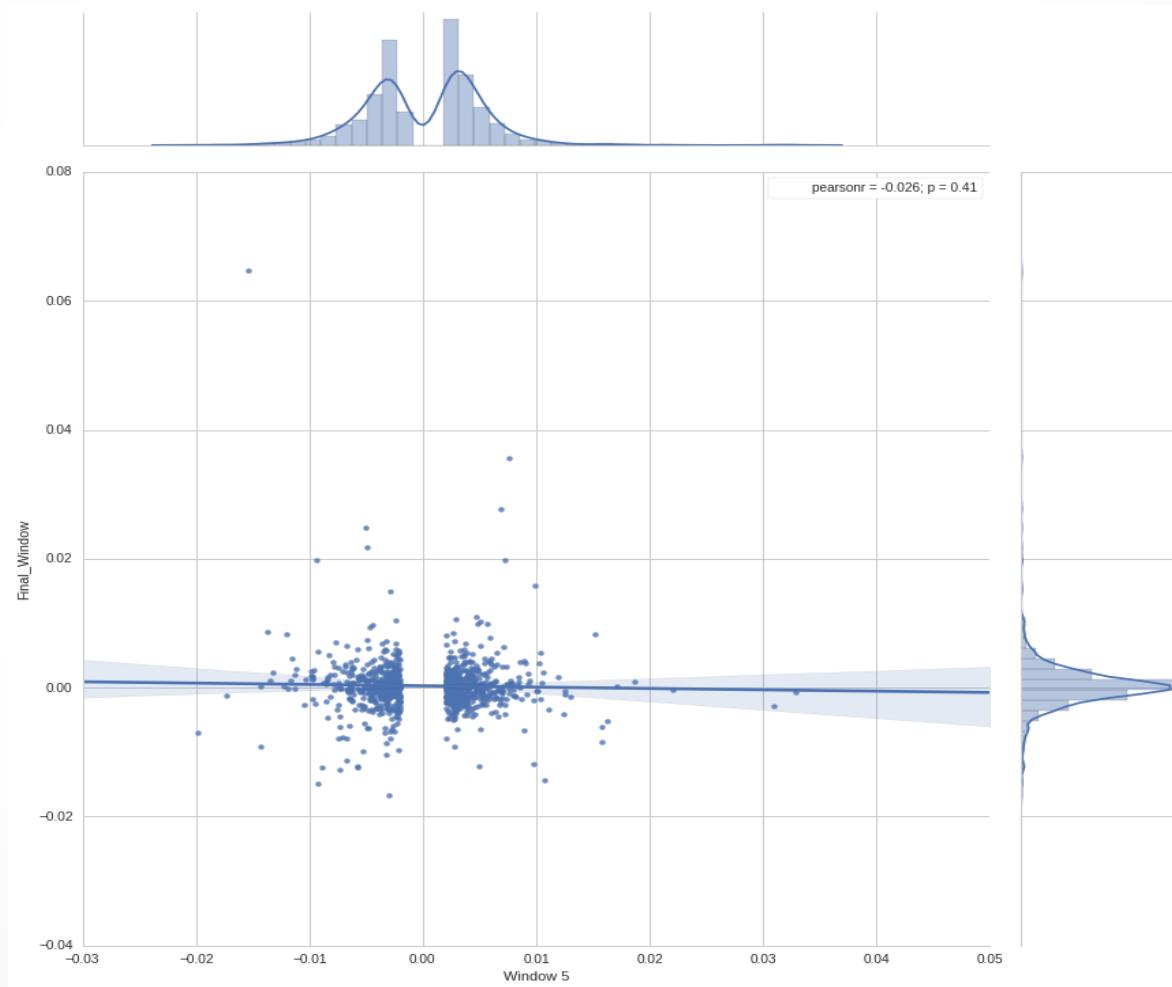
- Pulled SPY data in Quantopian over 2002 – 2014
- Looked at intraday correlations over half-hour intervals



# Success rate

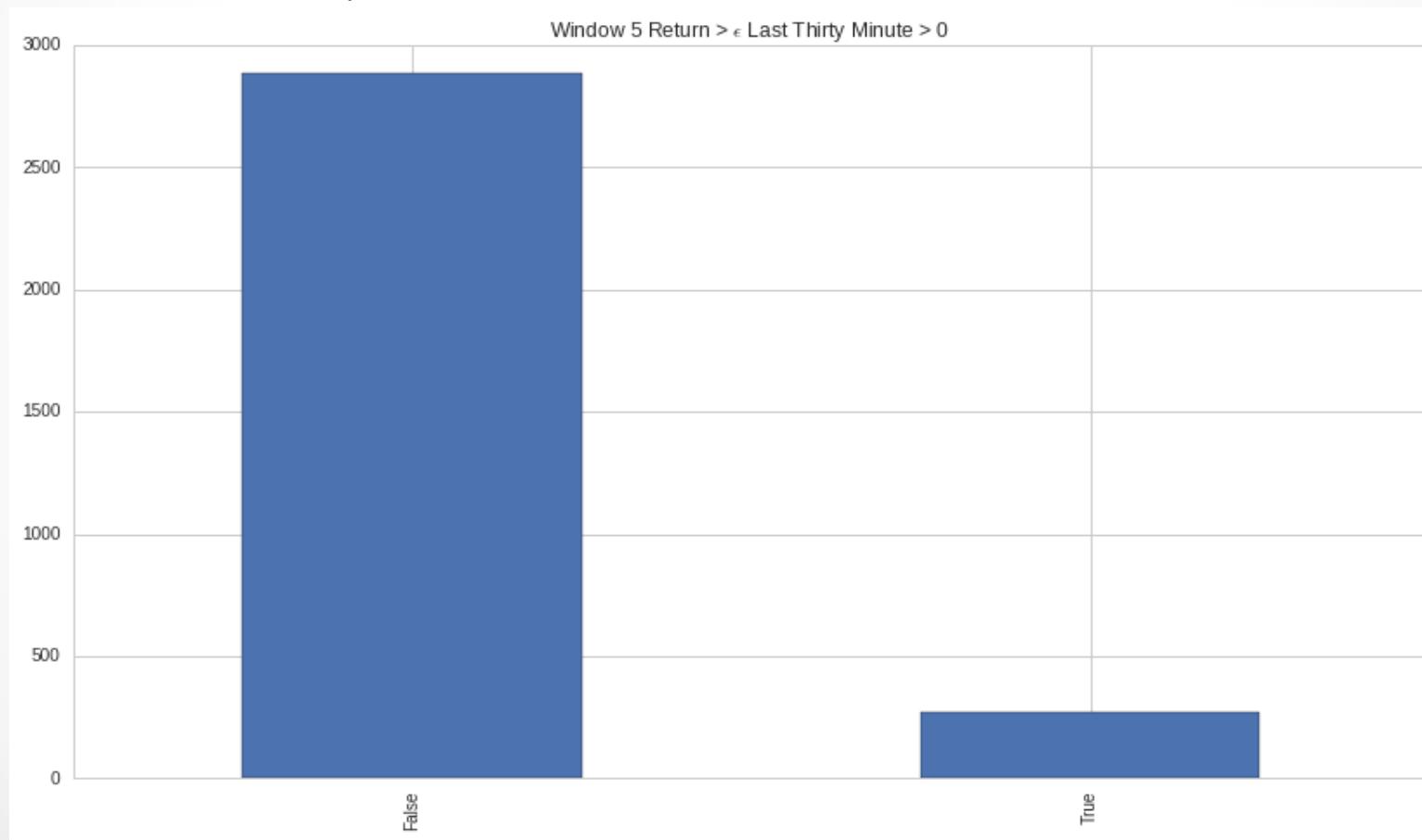


# Comparison with midday window

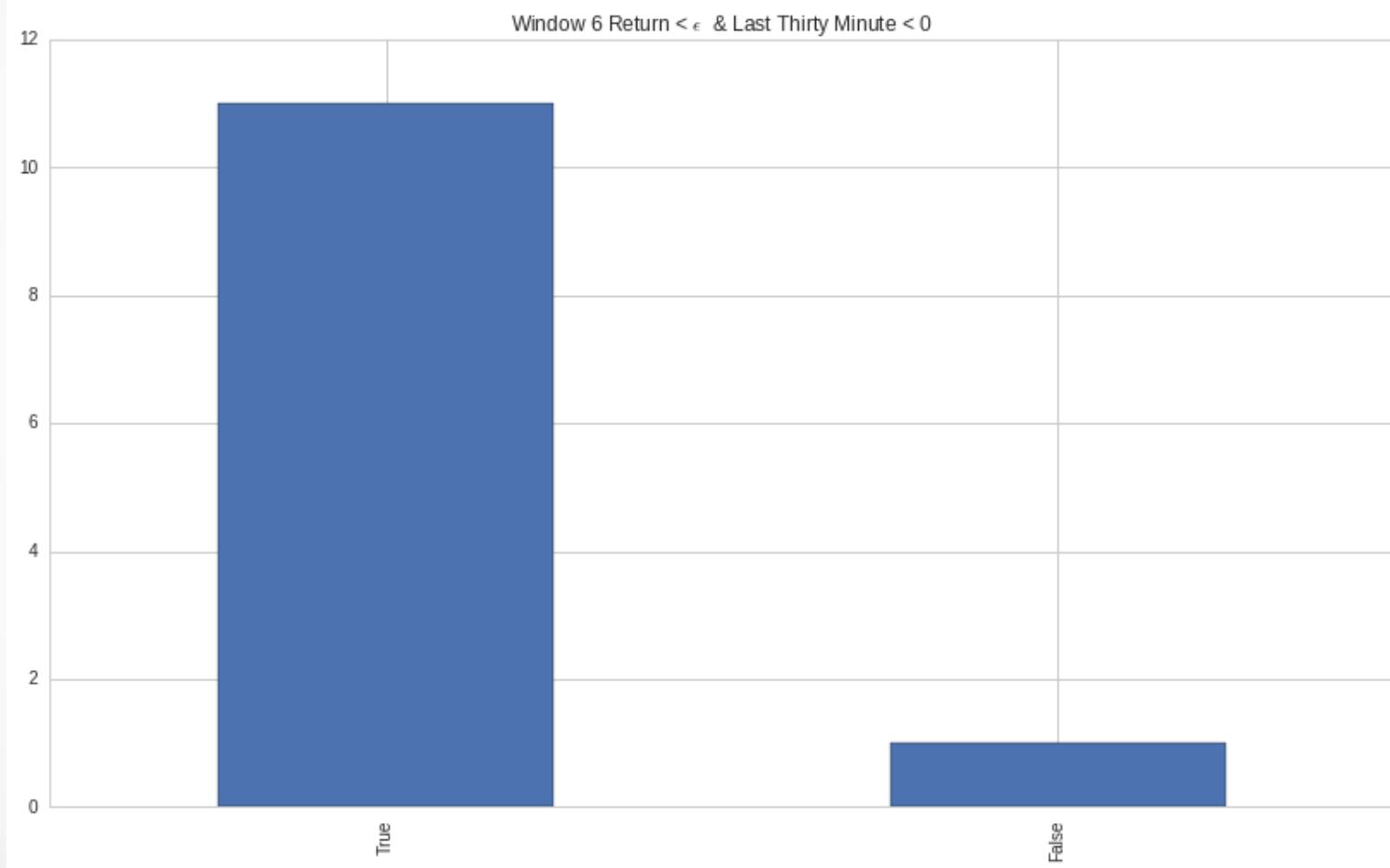


# Midday window success rate

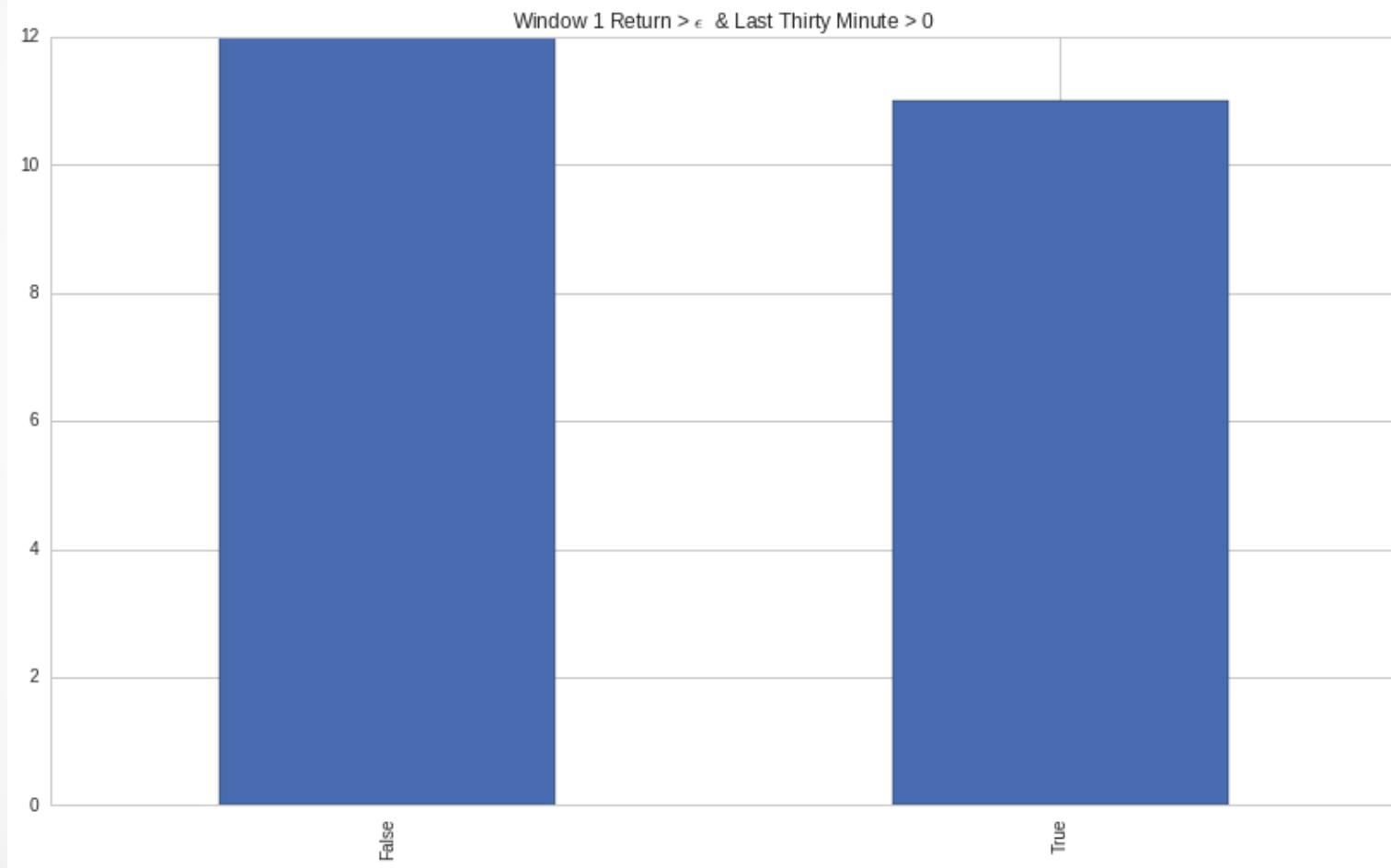
- Substantially lower success rate



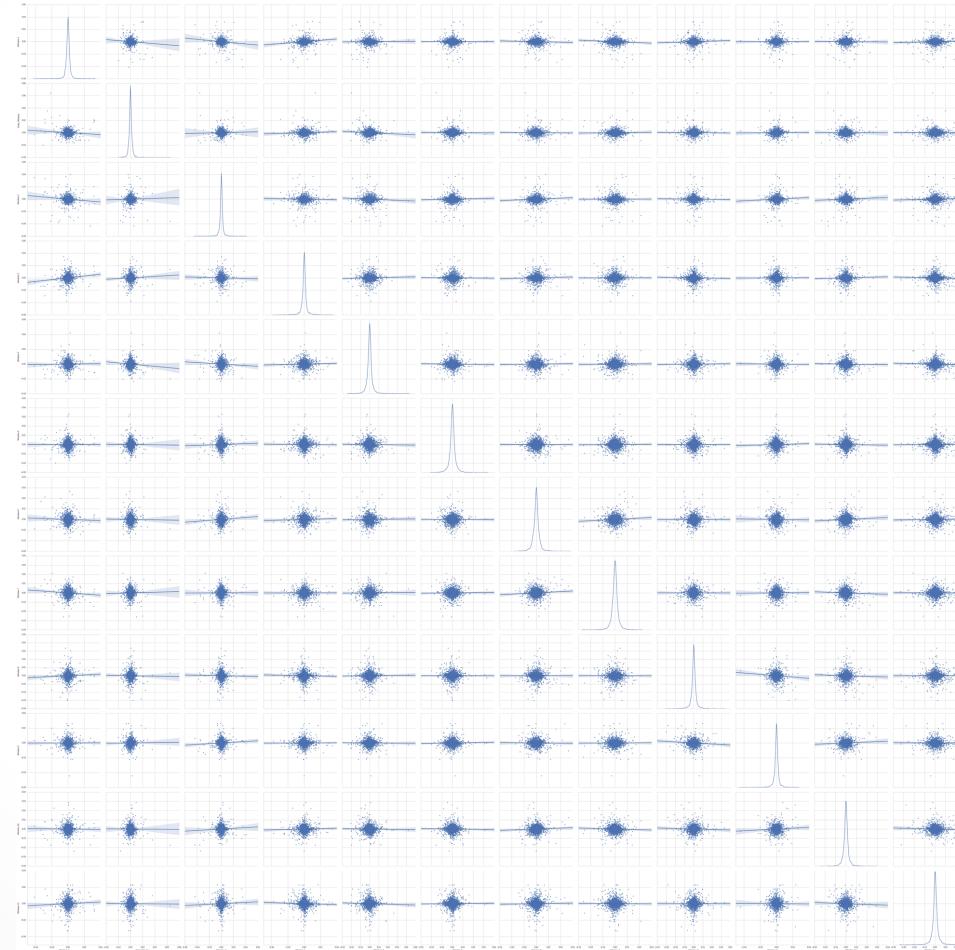
# Results with higher epsilon

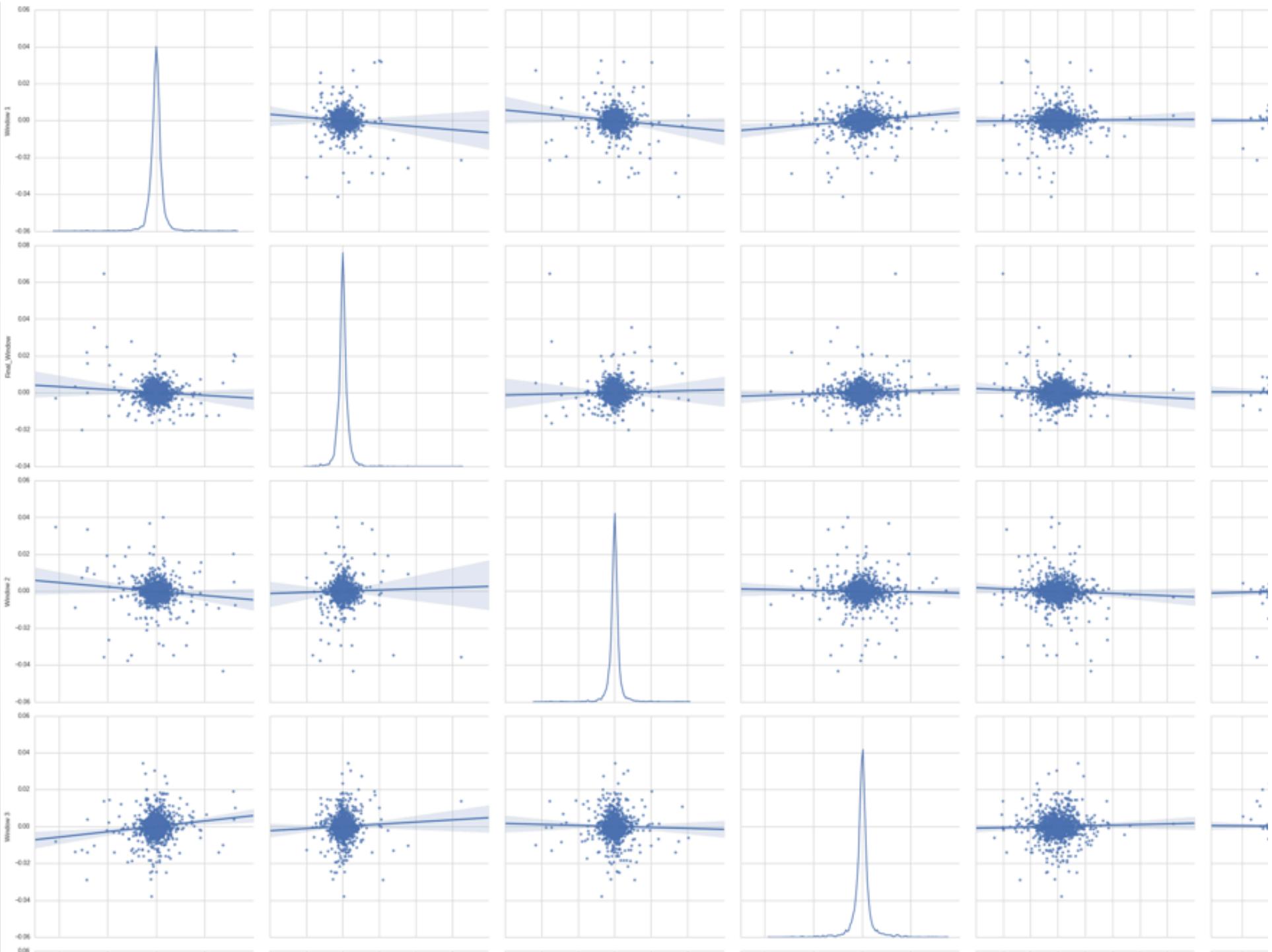


# Results with higher epsilon



# Correlation chart





# Preliminary analysis: Findings

- This signal does not appear to be very strong
  - Correlations are low
  - P-values are high
- Inconsistencies comparing first 30/last 30 with midday windows
- We will need richer data in order to harness this trend to make profitable trades

# Quantopian backtesting

- Looked in the timeframe 2010-2013
- Universe of stocks: U.S. market top 100 by volume
- Strategy: if first 30 and penultimate 30 minutes are positive, go long; short if both negative. Close positions each day
- Initial results:



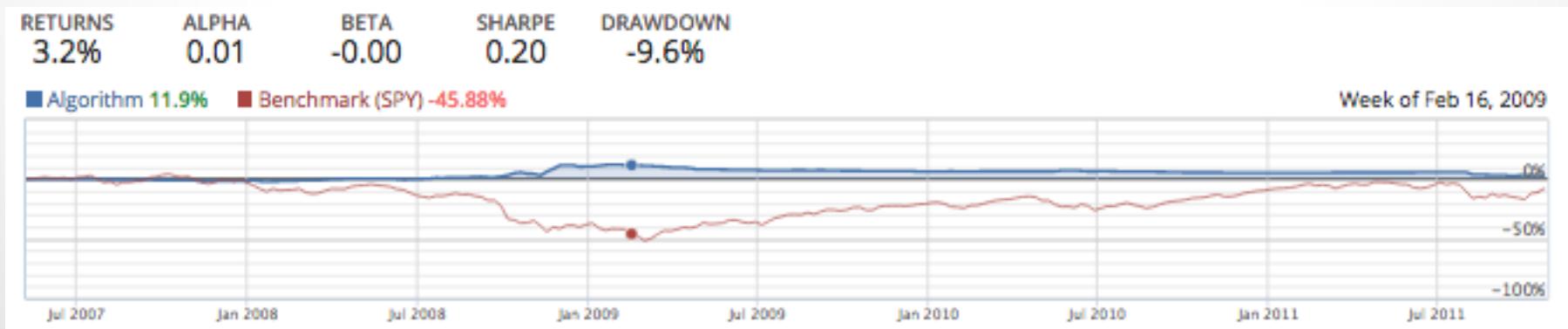
# Backtest results

- Our first try at a Quantopian strategy had consistent annual losses
- Attributable to trading restrictions on the portfolio that didn't let us buy and sell at the times we wanted. Hard to take advantage of liquidity effects when we had to sell off at the end of each day.
- We finessed it a bit and backtested on the S&P from 2010-2013.  
This gave:



# Intraday and the VIX

- We know that intraday momentum effects are strongest in high-volatility regimes
- So we run our strategy only when the VIX is over 20, and look at 2007 through 2013
- This strategy allows us to make money when the market crashes in 2008



# Signal boosting with Inferess

- Can also boost signal by controlling for investor sentiment
  - We were able to obtain no longer publically available data from Inferess
  - Cleaned and organized it
  - Uploaded to Quantopian to find matching stock prices
  - Difficulty: 6 million stock price lookups takes a long time on their platform
  - Plan to run machine learning classification on the stocks' movement over various time periods following the time of these signals (article publication time)
- •

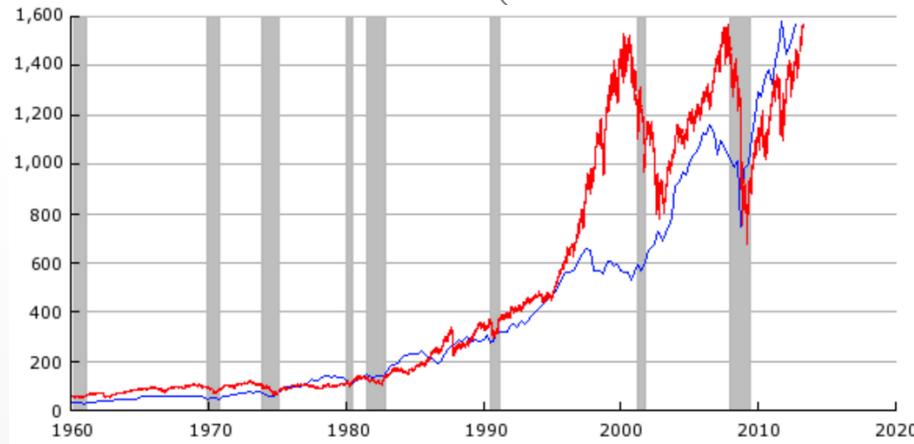
# Signal boosting with Inferess

symbol	Time	Negative Confidence	Positive Confidence	Negative Words	Positive Words	Total Words	start_price	after 30 minutes	after 2 hours	next day	next week
HME	2011-05-03 11:41:13.307000-04:00	0.005250	0.873000	12	54	1727	62.98	63.035	62.325	62.540	62.110
CYH	2011-05-03 11:41:30.127000-04:00	0.125163	0.584108	0	3	270	29.23	29.240	29.230	29.170	31.020
DMRC	2011-05-03 11:41:32.799000-04:00	0.005250	0.873000	1	19	447	26.41	26.350	26.260	26.130	27.290
IF SIA	2011-05-03 11:40:53.188000-04:00	0.021142	0.791267	24	32	926	18.65	18.650	18.600	18.648	19.390
XRX	2011-05-26 10:02:03.890000-04:00	0.005250	0.873000	9	37	1254	9.79	9.840	9.875	10.110	10.015



# Backtest results

- Intraday momentum trading does not appear to be profitable, especially once we account for transaction costs
- We had limited success constraining these trades to high-volatility regimes
- We saw success in times when we knew the market would be volatile, but the same strategy did not produce profits in times of market stability. We would need an additional strategy to run when the market is more stable (most of the time)



Source:  
St. Louis Fed

# Challenges

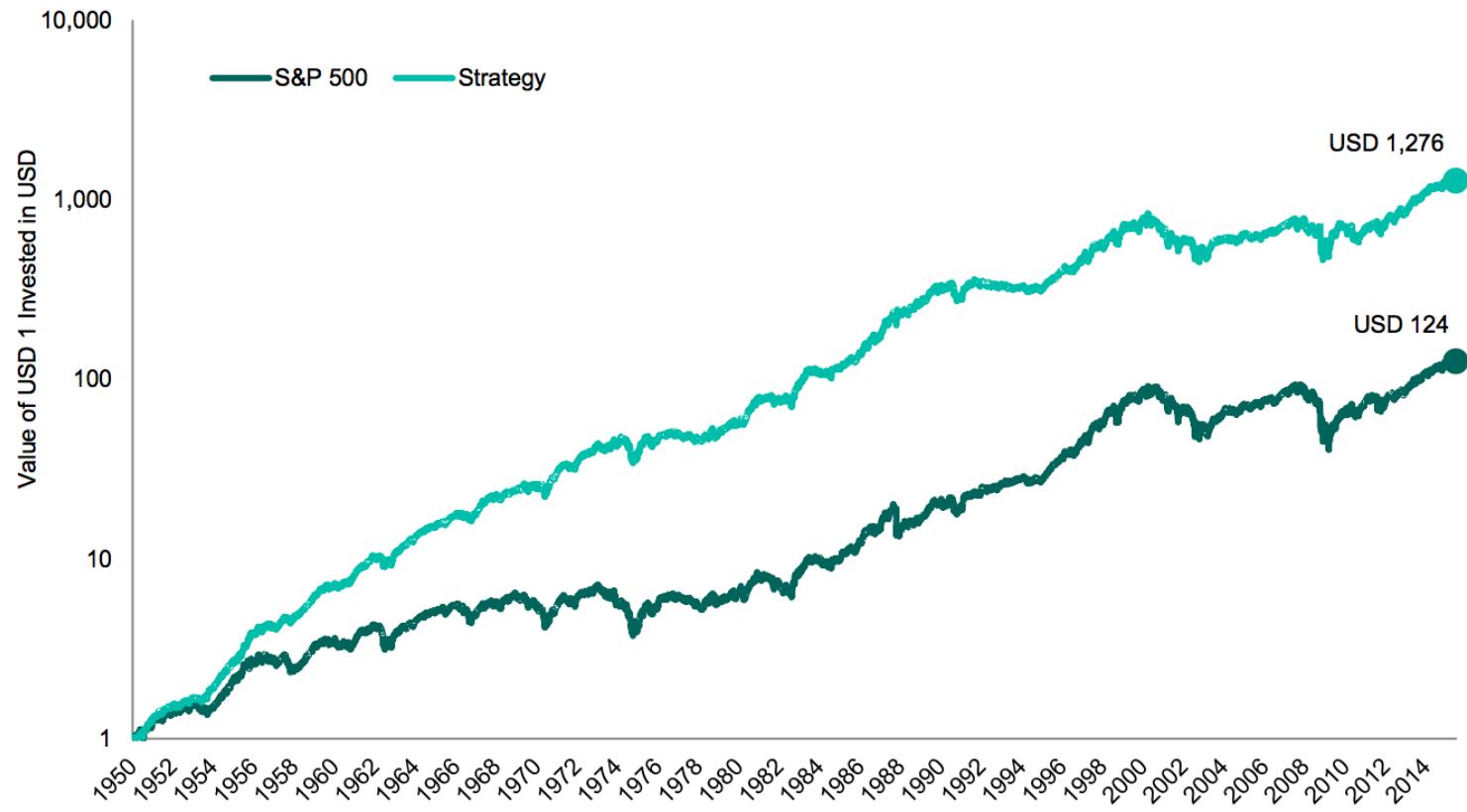
- Difficult to take advantage of foreknowledge of end-of-day effects due to limited liquidity
- Quantopian limits the ability to import large outside datasets: makes it difficult to develop intuition or check precision
- VIX reflects investors' anticipated volatility, not recent volatility
- Data selection issues:
  - Top 100 stocks induce obvious biases
  - Q1500 (Quantopian liquid data) suffer survivorship bias

# Next steps: Tactical

- Get more data
  - More historical pricing: Bloomberg, Barchart
  - Investigate extant analysis to optimize next moves strategically
- Expand analytical breadth
  - Deploy Inferess data to boost signals
  - Can perform overnight analysis with daily data
  - Consider and compare more timeframes, trade frequencies
  - Expand dataset analysis and visualization beyond ETFs: haven't examined cross-correlation in stocks (called for in Gao et al.)
- Continue working on familiarity with the Quantopian platform to deal with logistical issues

# Has intraday momentum gone? It's happened before:

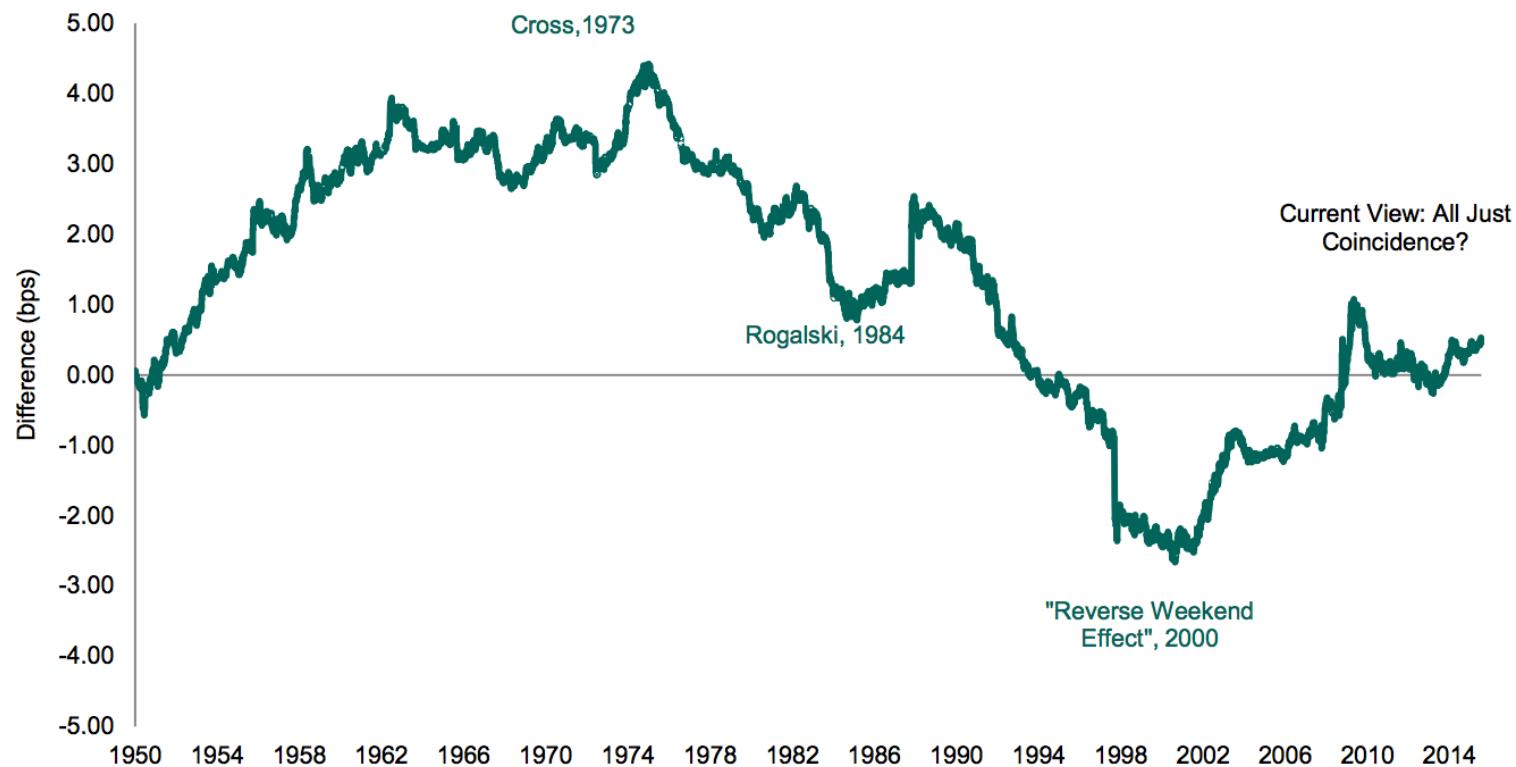
**Exhibit 1: Exploiting the Weekend Effect in U.S. Equities**



Source: S&P Dow Jones Indices October 2015 paper

# A “disappearing anomaly”

**Exhibit 2: What a Difference a Day Makes**



# Next steps: Strategic

*“Knowledge of the fact differs from knowledge of the reason for the fact” – Aristotle*

- Ways to build in resilience to transaction costs and liquidity challenges:
  - 1) Integration into other strategies
    - There are many known “anomalies” like the first 30/last 30 effect; we can look at combining other such anomalies and incorporating them into strategies
    - Risk of data mining is real: momentum strategies don’t work in Japan (Fama, 2015)

# Next steps: Strategic

- Ways to build in resilience to transaction costs and liquidity challenges:
  - 2) Constrain to profitable regimes
    - Like our VIX strategy
    - Risk of insufficient profitability
    - Combine with (1):
      - Trade first 30/last 30 when volatility is high, and run a stat arb strategy when the market is more stable
      - Trade a long-term momentum strategy and use first 30/last 30 price movements to determine trade times
  - 3) Outsource to scikit-learn