Application of Quantitative Techniques in Securities Lending

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Agenda

Application of Quantitative Techniques in Securities Finance

Securities Finance & State Street Associates

Securities Lending Overview

Capturing Short Sell Market Price Pressures with Quantitative Models

Applying Models and Algorithmic Trading Strategies

Conclusion
Who We Are: State Street Associates & Securities Finance

Research
- Closely aligned with latest academic findings
- Robust modeling by top academics and quants
- Experience using alt data and novel techniques

Securities Finance

Business
- First-hand information on needs from clients or trading
- Knowledge of market dynamics driving data variation
- Focus on decision-making based on consuming data and analytics

Securities Finance Research

A collaboration that is greater than the sum of its parts:
- Streamlined flow from idea generation through model development
- Quick iteration cycles between academic and business insights
- Diverse perspectives from different angles
- Translation and validation of quantitative models from a business perspective
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What is Securities Lending?
Securities Lending Sample Transaction

- Securities Lending is a capital markets product where participants generate revenue by temporarily transferring *long positions* in a collateralized transaction, to a borrower.
- Lender transfers legal ownership of securities while retaining rights of beneficial ownership.
- Borrowers are contractually obligated to return the securities upon recall by the lender.

Illustration by State Street Global Markets
Digitalization of Securities Lending Market has Increased Complexity

- Market regulations following the 2008 Financial Crisis significantly reduced leverage in Equity Markets
- These constraints on bank balance sheets have accelerated automation and optimization of financial resources
- More recently, the Securities Lending market has seen significant digitization
- This recent digitalization has increased market complexity and the need for efficient decision making
- To tackle this need, we have integrated intelligent pricing algorithms onto the trading desk and developed quantitative models for optimization

Electronic Trading is the majority of STT’s Agency lending’s daily transaction volume and slightly above half of trade value

Source: State Street Global Markets
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SF/ SSA Collaborating on Multiple Quantitative Projects

Sound Bites

• **Summary:** Weekly analytical pieces that provide a view into securities lending market and MKT MediaStats’ indicators for a highlighted company

• **Application:** Highlight a company to watch due to its interest with short sellers and strong media signals

Earnings Outlook

• **Summary:** Leverage stock loan market information and MKT Media Stats to predict excess returns post earnings announcements

• **Application:** Inform the Securities Lending desk and clients of price pressures leading up to company earnings announcements

Short Sell Market Measure

• **Summary:** Developed a model to capture market dynamics in short sell information at a single stock level

• **Application:** Capture price pressure for cross-section of US equities exposed to Securities Lending-relevant shocks
Short Sell Market Measure Approach

Background & Motivation

Universe Selection

Short Sell Model

Short Sell Indicator Series
Motivation

- Securities lending is a source of asset-level data for equity strategies but with thousands of securities and dozens of potential input variables

Our solution:

- Short Sell Market Measure, to capture price pressure for cross-section of US equities exposed to Securities Lending-relevant shocks
Securities Lending as an Alternative Data Source

Why is the data additive?
• Non-standard
• Can be informative beyond standard factors

Where is the data from?
• Vendors aggregating across sources

Example Data Fields

Borrow rate

Cost to borrow a specific security

Short Utilization

Number of shares on loan / number of available shares

Short Interest

Number of shares on loan / number of shares outstanding in the market
Short Sell Market Measure is inspired by academic findings

Stocks that are heavily shorted tend to underperform
• Short sellers may be informed
• Performance holds even net of fees

Shorting demand is an important predictor of stock returns
• Directional market equilibrium shocks identified by “price quantity pairs”
• Demand increase = increase in loan fee + increase in utilization

Securities lending information can also correlate with positive price movements
• Constrained supply of stocks to borrow can inform long side of portfolio
• From conceptual standpoint, securities lending information can also point toward short squeezes

See, for instance, Cohen et al (2007)
Securities lending-relevant universe restriction

Model should perform best on stocks that are most driven by securities lending market.

However, how to define potential stocks of interest to short sellers?

Try to identify Hard-to-Borrow stocks

Multiple ways to restrict stock universe for modeling

- Variety of potential inputs:
  - Fees
  - Utilization
  - Borrower/lender distributions
- Combination of factors, lags, and deltas
- Thresholds vs. predictive models

Value-add in security selection step alone: Stronger signal-to-noise
Model-derived daily indicator used in rolling backtest

Filters & cleaning

Single stock excess return measure

Pooled, rolling regression

Indicator & portfolio construction

Daily returns & stats recorded
Short Sell Market Indicator hypothetical performance

Equal-weighted daily long/short portfolios using top decile/bottom decile of Short Sell Market Indicator among model-defined “Hard to Borrow” securities. Robustness test against weekly hold for period through end of 2016 indicated an 11% annualized return and information ratio of 0.90.


Data for illustrative purposes only.
Short Sell Market Indicator performs relative to benchmarks

<table>
<thead>
<tr>
<th></th>
<th>Strategy</th>
<th>Double Sort (HTB Filter)</th>
<th>Double Sort (Full Sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annualized Return</strong></td>
<td>17%</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Std. Dev.</strong></td>
<td>15%</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Sharpe Ratio</strong></td>
<td>1.1</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td><strong># Stocks Traded / Day</strong></td>
<td>~100</td>
<td>~100</td>
<td>~600</td>
</tr>
</tbody>
</table>

Equal-weighted daily long/short portfolios using top decile/bottom decile of Short Sell Market Indicator among model-defined “Hard to Borrow” securities. “Double sort” refers to sorting on fee quintiles and size quintiles, for restricted “(HTB)” sample or full sample of broad U.S. equities.

In summary …

• Movements in securities lending markets can be predictive of excess returns

• We build an indicator that captures market pressures in the securities lending space

• We leverage academic findings, market knowledge, and quant techniques

• The indicator is additive and robust beyond simple sorts on raw data or universe restriction alone
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Algorithmic Trading In Securities Finance

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Algorithmic Trading In Securities Finance
Algorithmic Trading in State Street Agency Lending

**Develop a comprehensive analytical view of the trade-offs in the Securities Lending market**

**Create a quantitative framework for tactical and strategic pricing of lending transactions**

**Build and maintain the market microstructures for electronic execution**
Algorithmic Lending Rates – Pricing Process

1. Data Sourcing
   - Aggregation of transaction level lending rates
   - Corporate action & alt-data

2. Proprietary Algorithm
   - Construct a lending rate for the next new transaction (at the asset/collateral level)

3. Pricing Distribution
   - Disseminate lending rates through electronic trading venues
   - Use market feedback to refine pricing
Electronic Execution – Market Microstructures

Borrowers convey demand preferences not only through lending rates but their collateral preference.

Majority of trading throughput occurs in early morning hours through electronic negotiations.
Borrower bid activity includes information on short-medium term needs and preferences.

Expansion of collateral profiles creates more avenues of trade expansion.
Research – Modeling “Hard-to-Borrow” Securities

• A security is defined as HTB when *high borrower demand* and *tightening supply* create a highly favorable negotiating posture for asset lenders and often corresponds to higher lending rates.

• **Majority** of program revenues are generated from securities that are HTB; while only being around a quarter of loan volumes.

• Accurately predicting these events provides an opportunity to *capture additional revenue*.

• It is **crucial to predict** HTB events for two reasons:
  
  1. It is difficult to increase rates with borrowers once securities are lent out.

  2. Need to have inventory once security is “HTB” to take advantage of higher fees.

• If the business can accurately predict these events, there is **opportunity** to capture more revenue.
Research – HTB Event Prediction Engine

• Our goal was to produce a **HTB event prediction engine**

• Started with a standard **Ordinary Least Squares Regression (Linear)**
  – Initial inputs chosen based on market intuition
  – Served well in **categorizing** securities as HTB, but not predicting the exact event

• To improve accuracy we leveraged more advanced methods: **K Nearest Neighbors Model (Categorical)**
  – OLS confirmed inputs are significant and additive

• Data Specification
  – **Sources**: IHS Markit & Bloomberg
  – **Asset Universe**: MSCI ACWI Index
  – **Coverage Period**: January 1, 2012 to February 21, 2019 (~ 7 years)

• Performance measured against accuracy to own definitions of “HTB” and the trade-offs of false negatives & false-positives
  – For trading use-case, would rather **falsely categorize HTB** rather than vice versa
Research – K-Nearest Neighbors Infrastructure & Mechanics

**Prediction Infrastructure**

1. Q: Is this HTB?

2. Pull in training data & their known classes

3. Predict via majority vote of neighbors

**High-level mechanics**

- Predict via majority vote of neighbors
- HTB Event (0/1)
- Training Days: 260 days rolling
- Nearest Neighbors: $K=15$
- Testing Period: 2013-2018 (1450 trade days)

- Predicted Variable
- Lagged Value Weighted Fees (VWAF)
- Lagged Utilization

Source: State Street Global Markets
### Research – Lessons from modeling, by impact & type

<table>
<thead>
<tr>
<th><strong>High Impact</strong></th>
<th><strong>Moderate Impact</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall model</strong></td>
<td><strong>Modeled Variable Type</strong></td>
</tr>
<tr>
<td>HTB score vs. movement into HTB</td>
<td>HTB score very persistent, which means predicting score will underweight the predictiveness of deltas (fees, util) on entering HTB</td>
</tr>
<tr>
<td><strong>Specificity vs. Sensitivity</strong></td>
<td>i.e., “False positive” vs. “False neg.”</td>
</tr>
<tr>
<td>When choosing model for desk, overall “accuracy” may be less important than types of errors being made; may be more tolerant of “False pos.” than “False neg.” for inventory mgmt.</td>
<td></td>
</tr>
<tr>
<td><strong>K-nn</strong></td>
<td><strong>Sparsity</strong></td>
</tr>
<tr>
<td>HTBs rare; need to re-sample</td>
<td>K-nn’s take majority vote of neighbors; need to properly sample HTB events to ensure anything is captured as HTB</td>
</tr>
<tr>
<td><strong>Winsorization</strong></td>
<td>Treat right-tailed inputs (fees, util)</td>
</tr>
<tr>
<td>Particularly with nearest neighbors calculated on multiple dimensions, need to ensure large values are winsorized</td>
<td></td>
</tr>
<tr>
<td><strong>OLS</strong></td>
<td><strong>Restriction to Relevant Types</strong></td>
</tr>
<tr>
<td>GCs, Warms, HTBs?</td>
<td>Modeling 0’s often uninformative; focus on warms/HTBs for those relevant to what we try to capture</td>
</tr>
<tr>
<td><strong>Categorical vs. Continuous</strong></td>
<td>Inputs: categorical or continuous?</td>
</tr>
<tr>
<td>Relies on some market knowledge/intuition. We found that market cap varies substantially (continuously) but matters more in “buckets”.</td>
<td></td>
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Model Results
OLS and kNN results for ~7 year period (Jan 2012 and Feb 2019), trained with 260 day look back period

| Method: First predict HTB score, then categorize based on mapped score |

\[
HTBSCORE_{i,t} = \beta_1 INPUT1 + \beta_2 \Delta INPUT1 + \beta_3 INPUT2 + \beta_4 \Delta INPUT2 + \beta_5 INPUT3 + \beta_6 INPUT4 + \beta_7 INPUT5 + \beta_8 \Delta INPUT5 + \beta_9 INPUT6 + \epsilon_{i,t}
\]

<table>
<thead>
<tr>
<th>OLS</th>
<th>Hit Rate (HTB events)</th>
<th>4%</th>
<th>False pos.</th>
<th>27%</th>
<th>False neg.</th>
<th>97%</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>kNN</th>
<th>Hit Rate (HTB events)</th>
<th>68%</th>
<th>False pos.</th>
<th>10%</th>
<th>False neg.</th>
<th>32%</th>
</tr>
</thead>
</table>

- Use same inputs as above
- Use HTB event start (indicator) on LHS
- 15 nearest neighbors
Conclusion

• As the Securities Lending industry continues to digitalize, there will be many more opportunities to apply the lessons learning in the electronification of other financial markets

• The collaboration between researchers and the business allows for unique, relevant, and robust application of advanced quantitative techniques

• The over-the-counter Agency Lending market is a particularly fascinating venue for this innovation which can have profound impacts on funding markets
Thank you – and feel free to be in touch!

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