

October 2019

**Application of
Quantitative
Techniques in
Securities Lending**

Yasser El Hamoumi

Travis Whitmore

Agenda

Application of Quantitative Techniques in Securities Finance

Securities Finance & State Street Associates

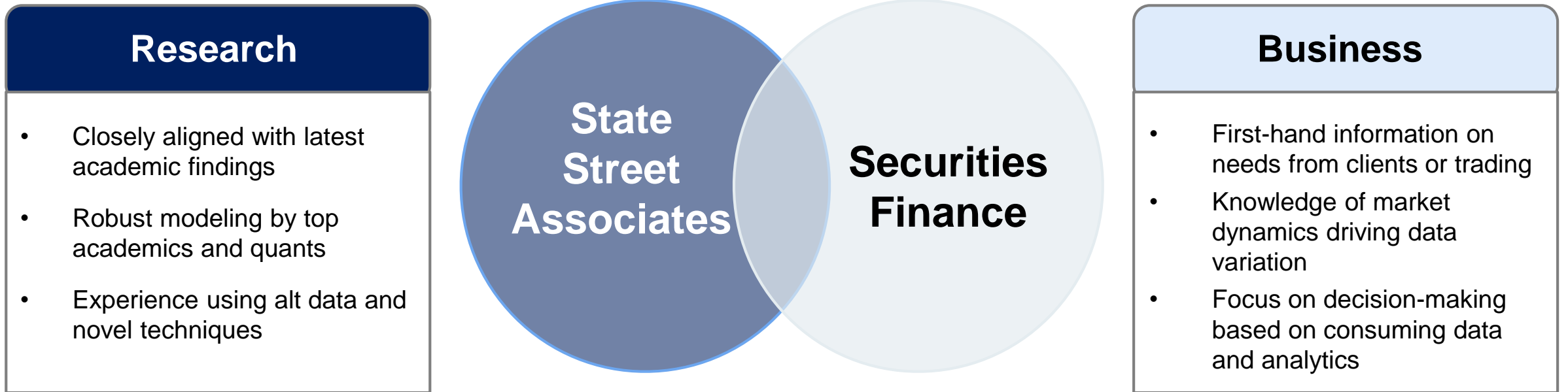
Securities Lending Overview

Capturing Short Sell Market Price Pressures with Quantitative Models

Applying Models and Algorithmic Trading Strategies

Conclusion

Who We Are: State Street Associates & Securities Finance



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

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

What is Securities Lending?

Securities Lending Sample Transaction

- Securities Lending is an 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

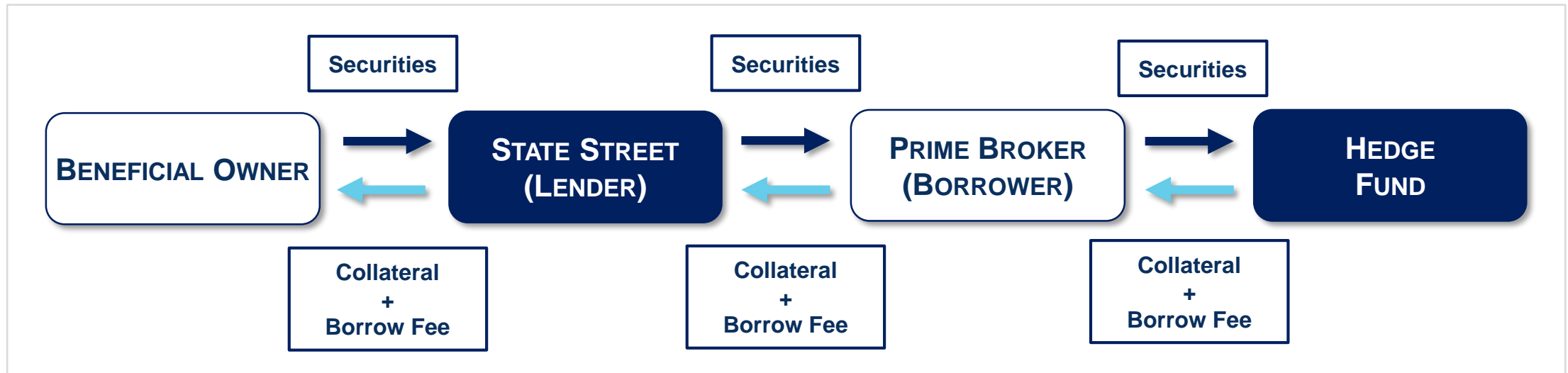
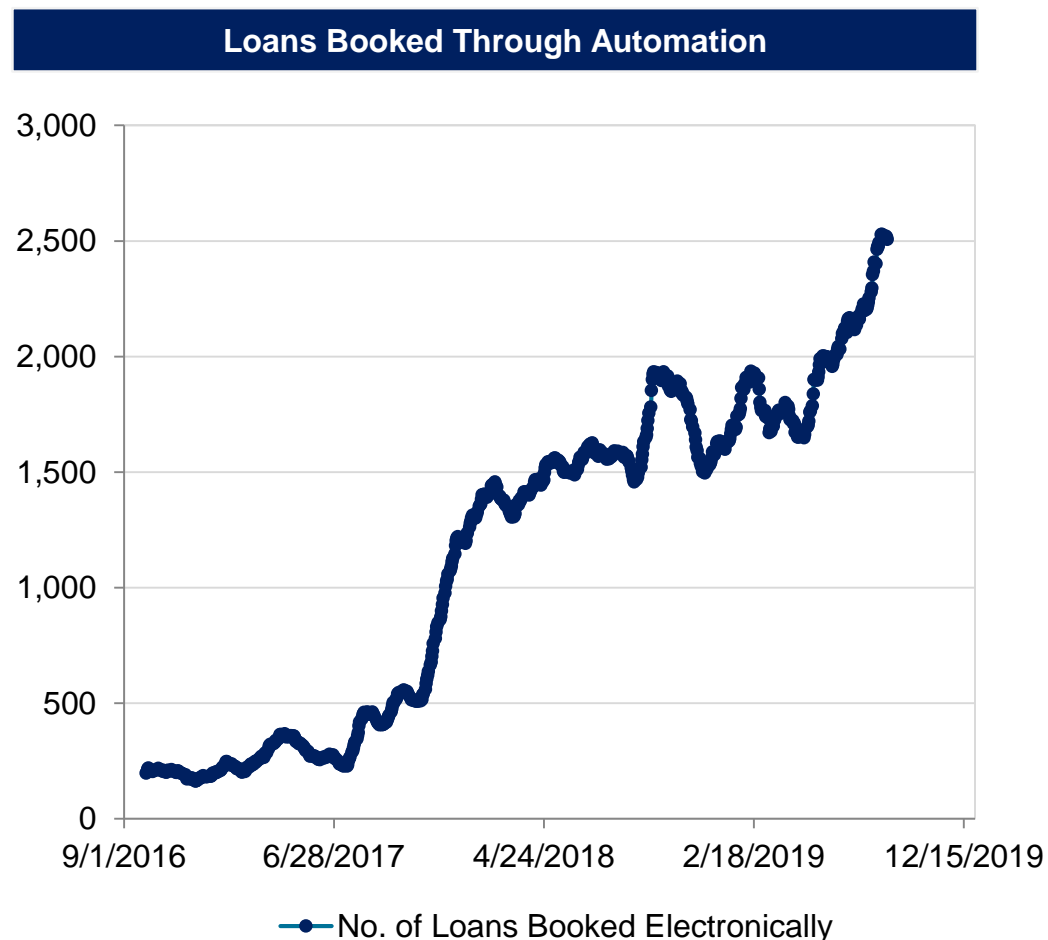


Illustration by State Street Global Markets

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

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

Application Models and Algorithmic Trading Strategies

Conclusion

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

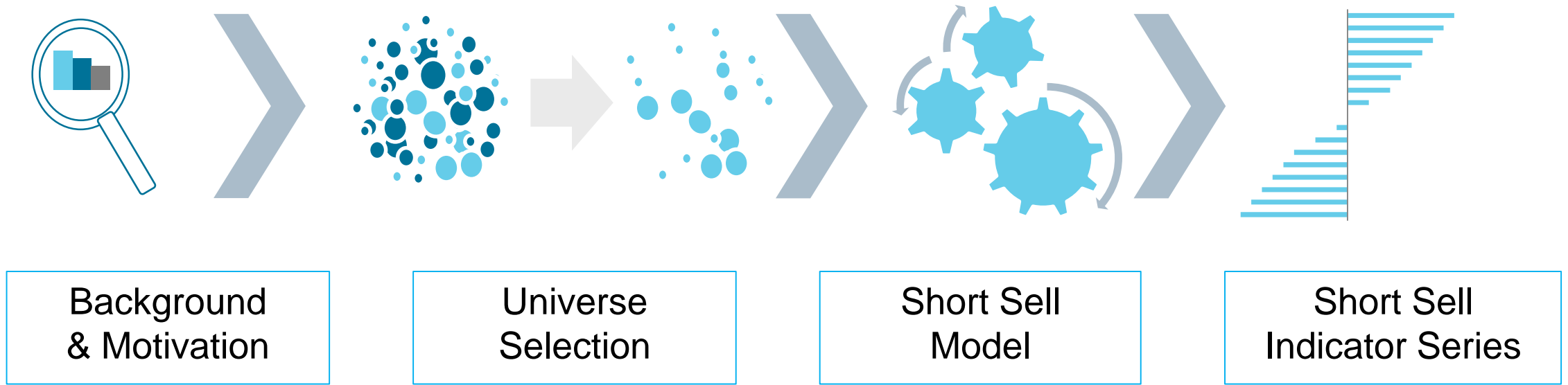
Earnings Outlook

- **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



Motivation

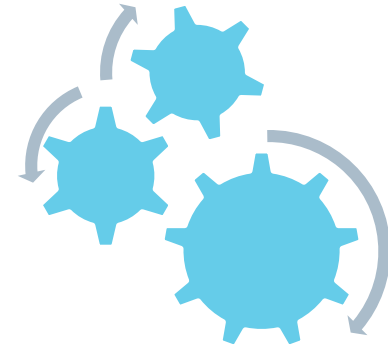
- Securities lending is a source of asset-level data for equity strategies but with thousands of securities and dozens of potential input variables



Which fields to use?



Which securities to focus on?



How to build model?

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

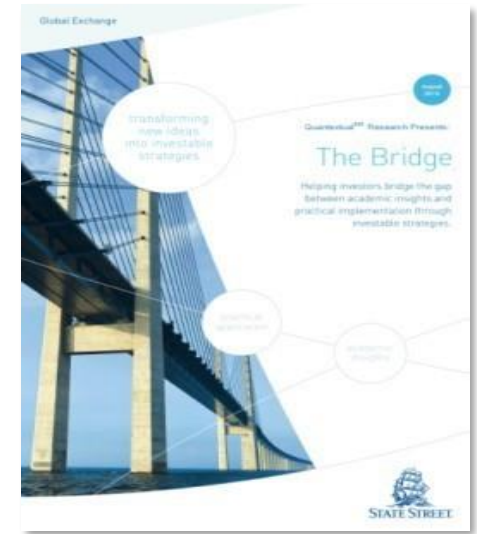
- Short sellers may be informed
- Performance holds even net of fees

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, Asquith and Meulbroek (1996), Desai et al (2002), Boehmer, Jones, and Zhang (2008), Boehmer, Huszar, and Jordan (2010)

See, for instance, Cohen et al (2007)

See, for instance, Miller (1977), Jarrow (1980), Boehme, Danielson, Sorescu (2006), Xu and Liu (2012)

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?

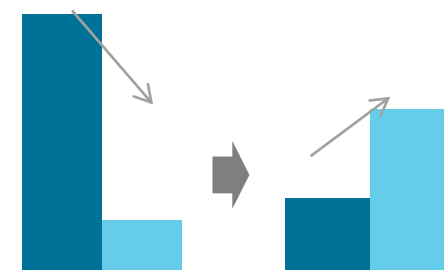
Try to identify Hard-to-Borrow stocks



Multiple ways to restrict stock universe for modeling

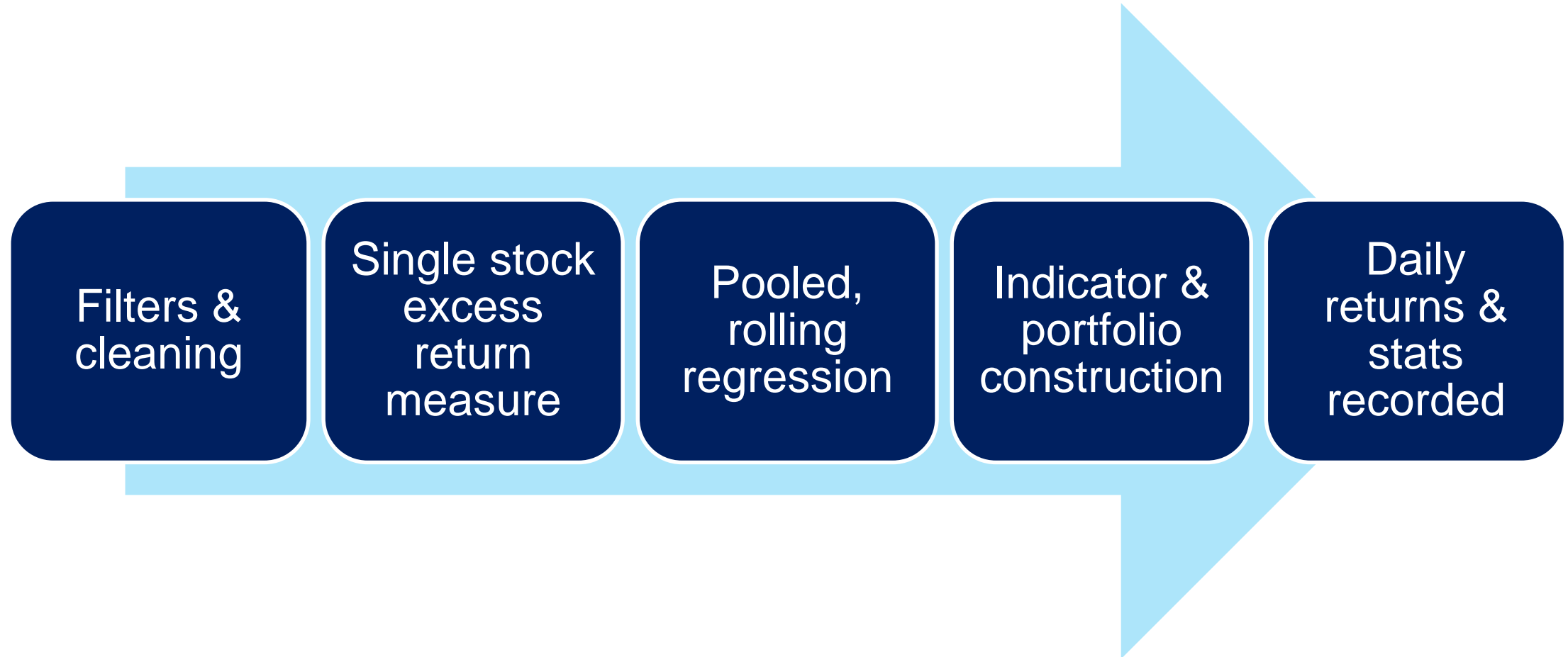
- Variety of potential inputs:
 - Fees
 - Utilization
 - Borrower/lender distributions
- Combination of factors, lags, and deltas
- Thresholds vs. predictive models

Security Selection Signal to Noise

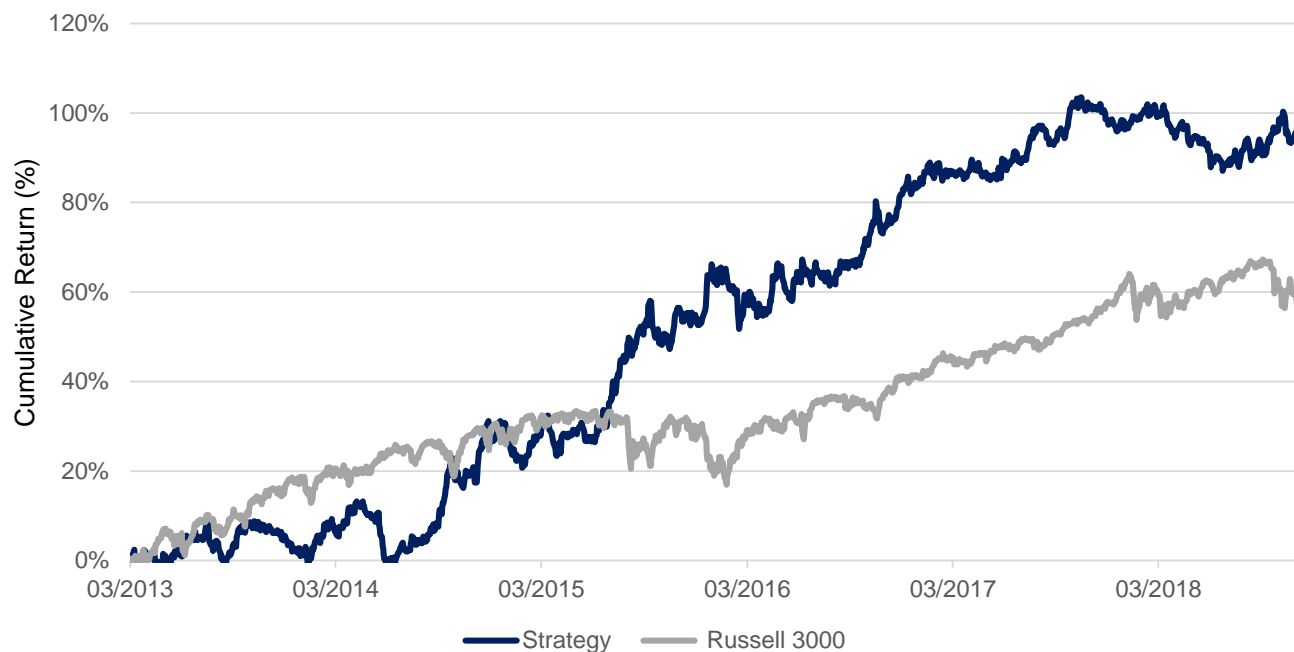
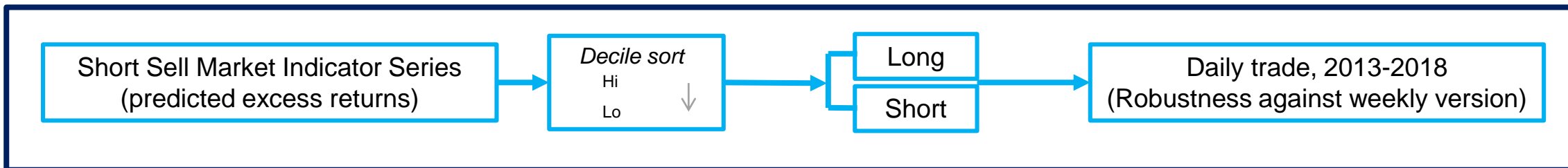


Value-add in security selection step alone:
Stronger signal-to-noise

Model-derived daily indicator used in rolling backtest



Short Sell Market Indicator hypothetical performance

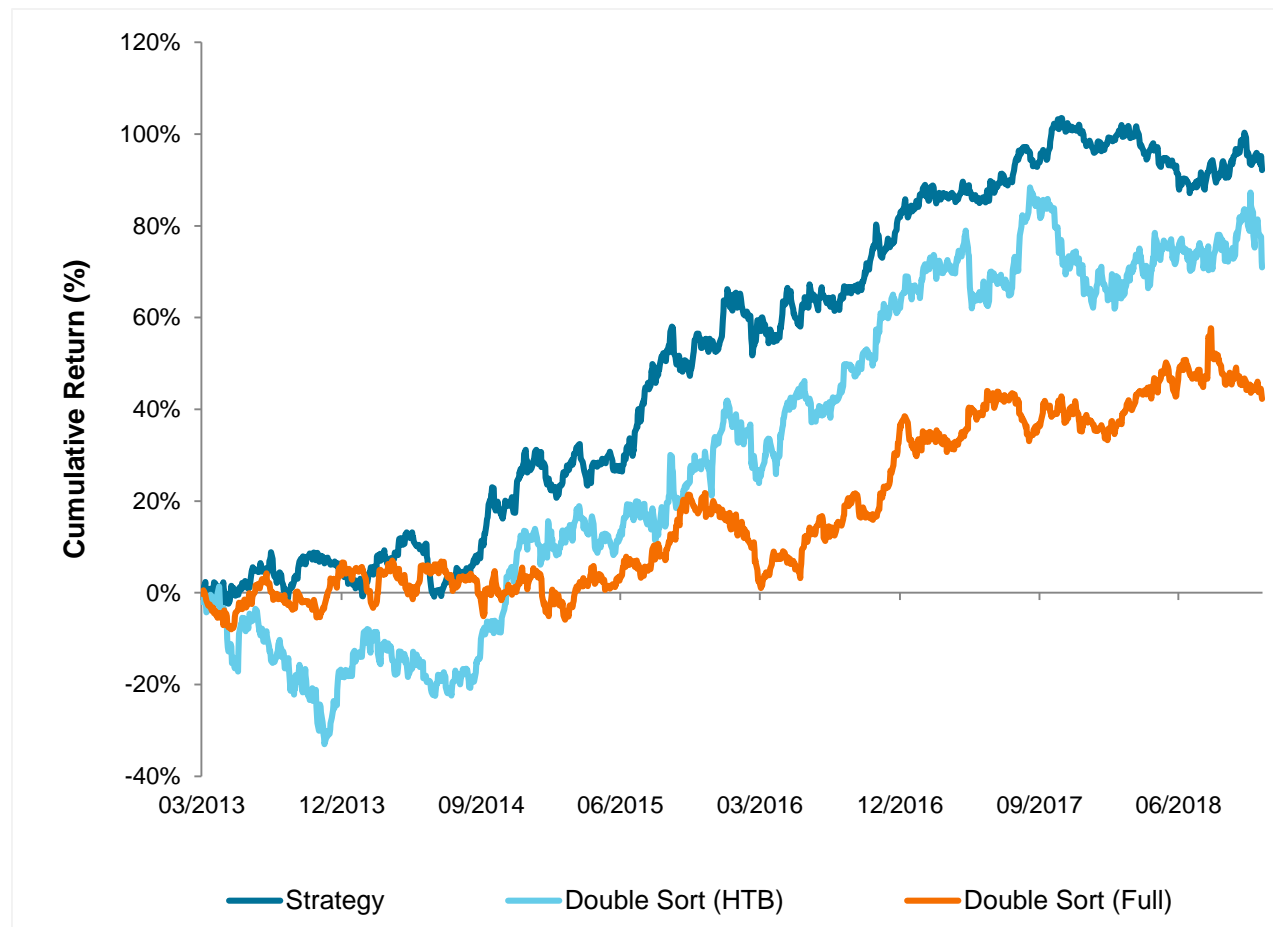


	Strategy
Annualized Return	17%
Std. Dev.	15%
Sharpe Ratio	1.10
# Stocks Traded / Day	~100

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.

Dates: 2013-2018; Sources: State Street Associates, State Street Global Markets, IHS Markit, Thomson Datastream, MSCI, Ken French website. 1-day publication lag included. Data for illustrative purposes only.

Short Sell Market Indicator performs relative to benchmarks



	Strategy	Double Sort (HTB Filter)	Double Sort (Full Sample)
Annualized Return	17%	13%	8%
Std. Dev.	15%	22%	15%
Sharpe Ratio	1.1	0.6	0.5
# Stocks Traded / Day	~100	~100	~600

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.

Dates: 2013-2018; Sources: State Street Associates, State Street Global Markets, IHS Markit, Thomson Datastream, MSCI, Ken French website. 1-day publication lag included.

Data for illustrative purposes only.

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

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

Algorithmic Trading In Securities Finance

Conclusion

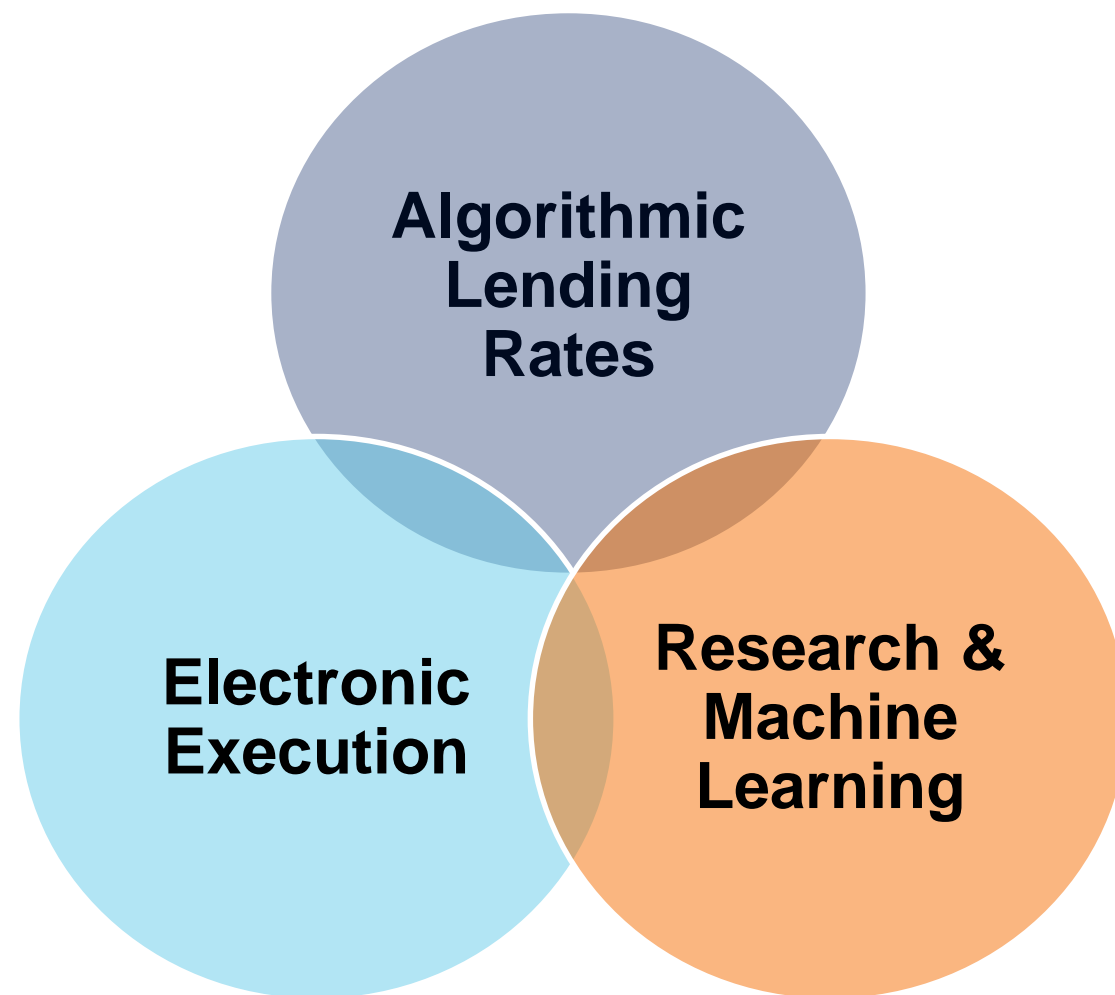
Algorithmic Trading In Securities Finance

Algorithmic Trading in State Street Agency Lending

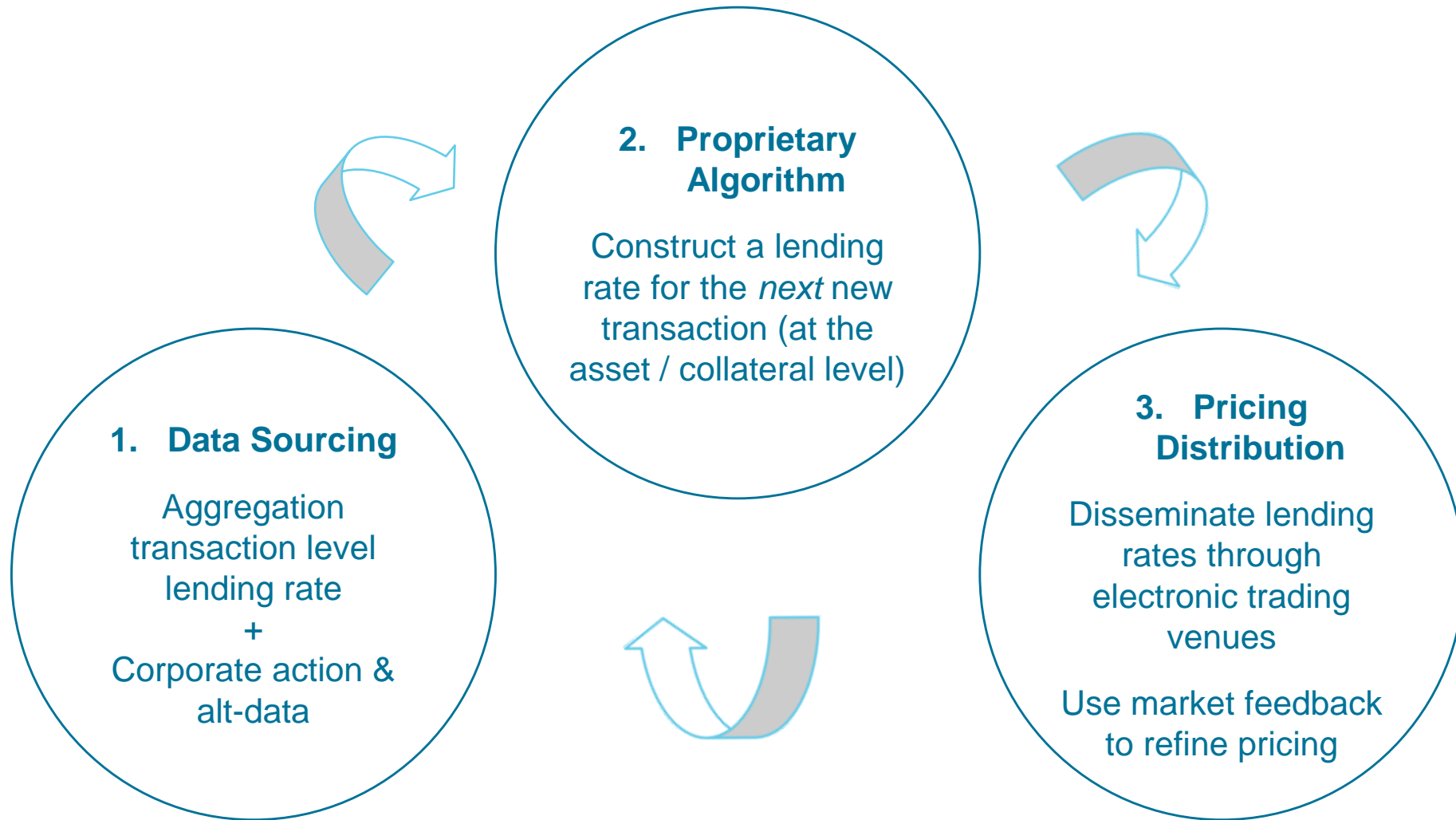
*Develop a comprehensive analytical view
of the trade-offs in the Securities Lending
market*

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

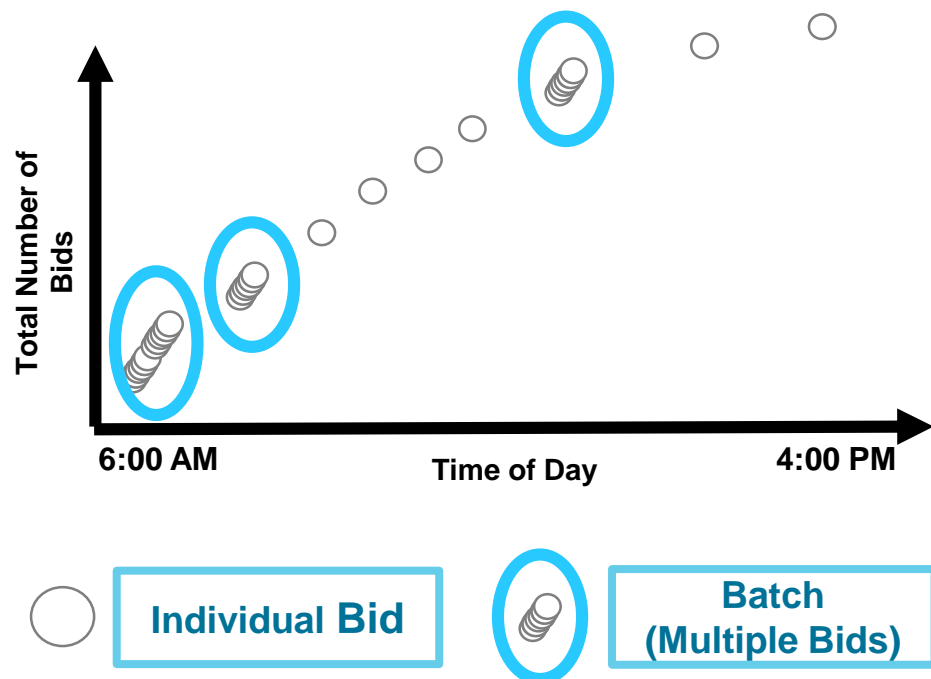
*Build and maintain the market
microstructures for electronic execution*



Algorithmic Lending Rates – Pricing Process

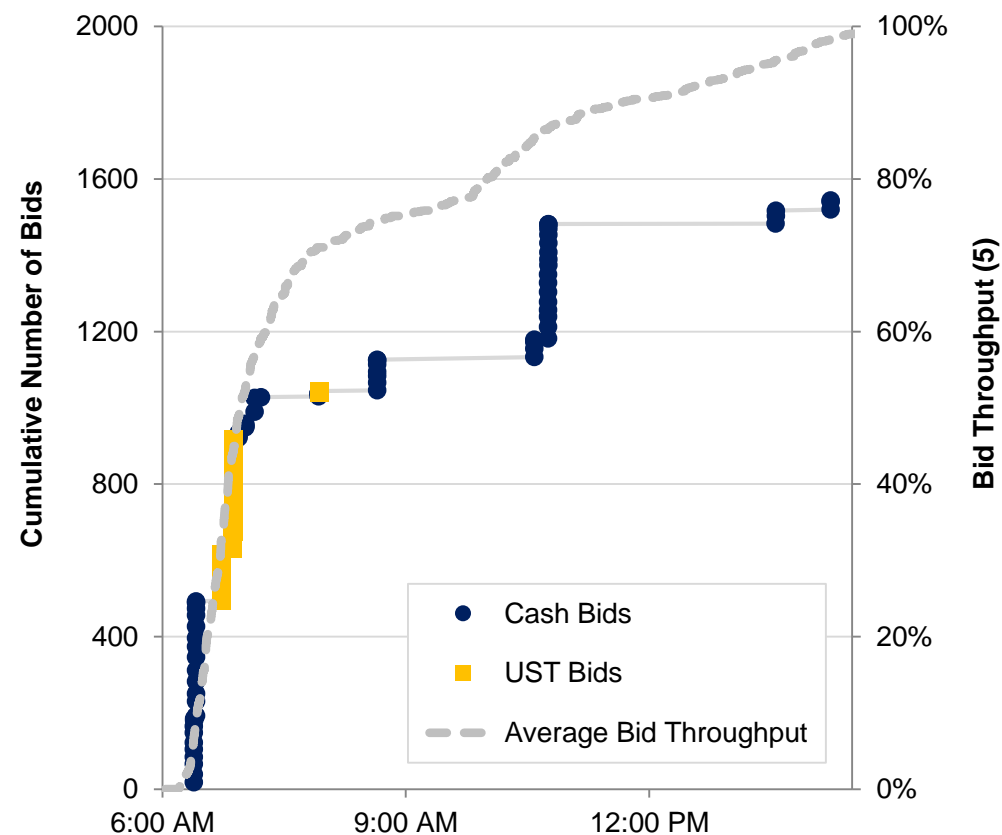


Electronic Execution – Market Microstructures



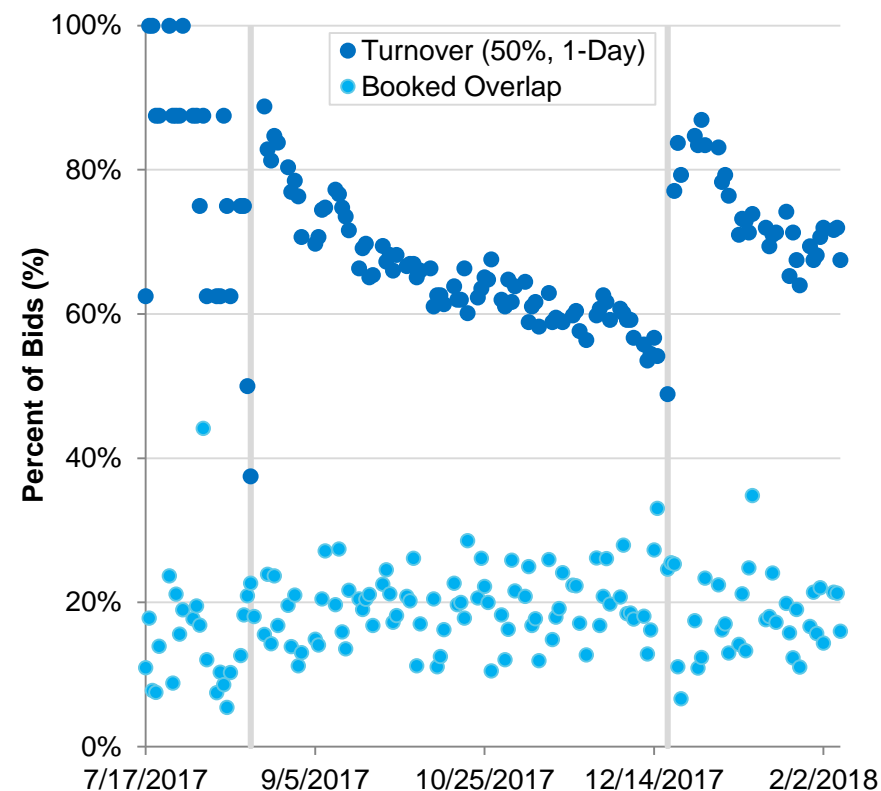
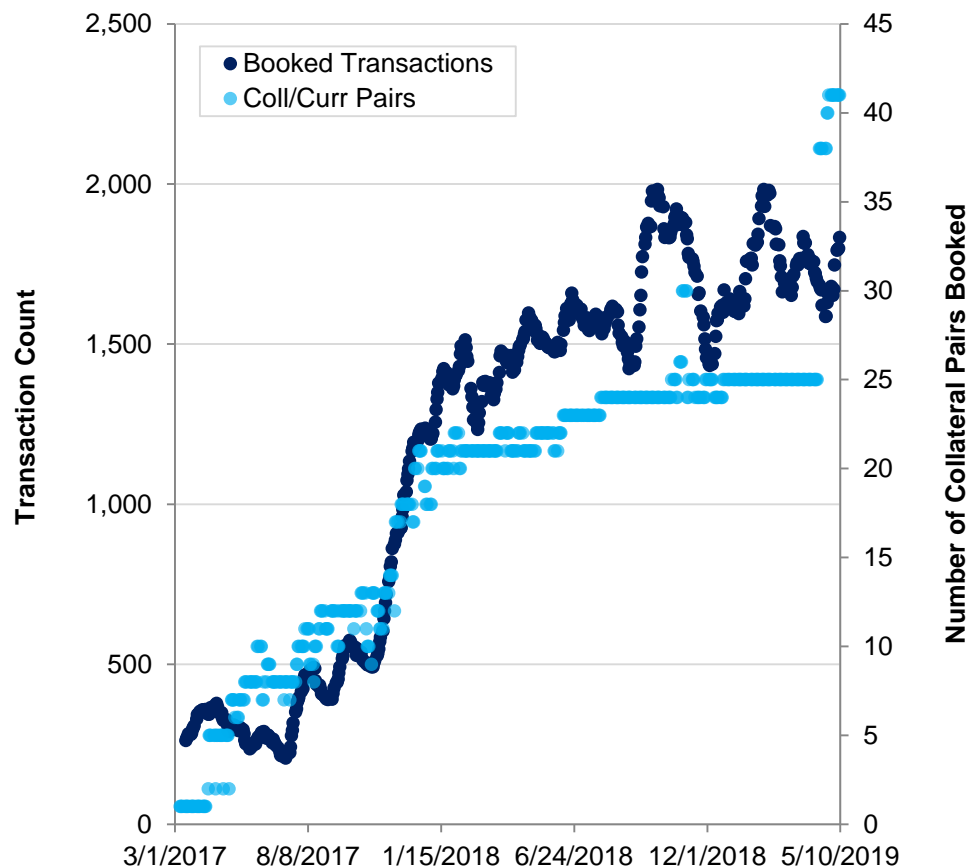
Majority of trading throughput occurs in early morning hours through electronic negotiations

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



Electronic Execution – Market Microstructures

Expansion of collateral profiles creates more avenues of trade expansion



Borrower bid activity includes information on short-medium term needs and preferences

Research – Modeling “Hard-to-Borrow” Securities

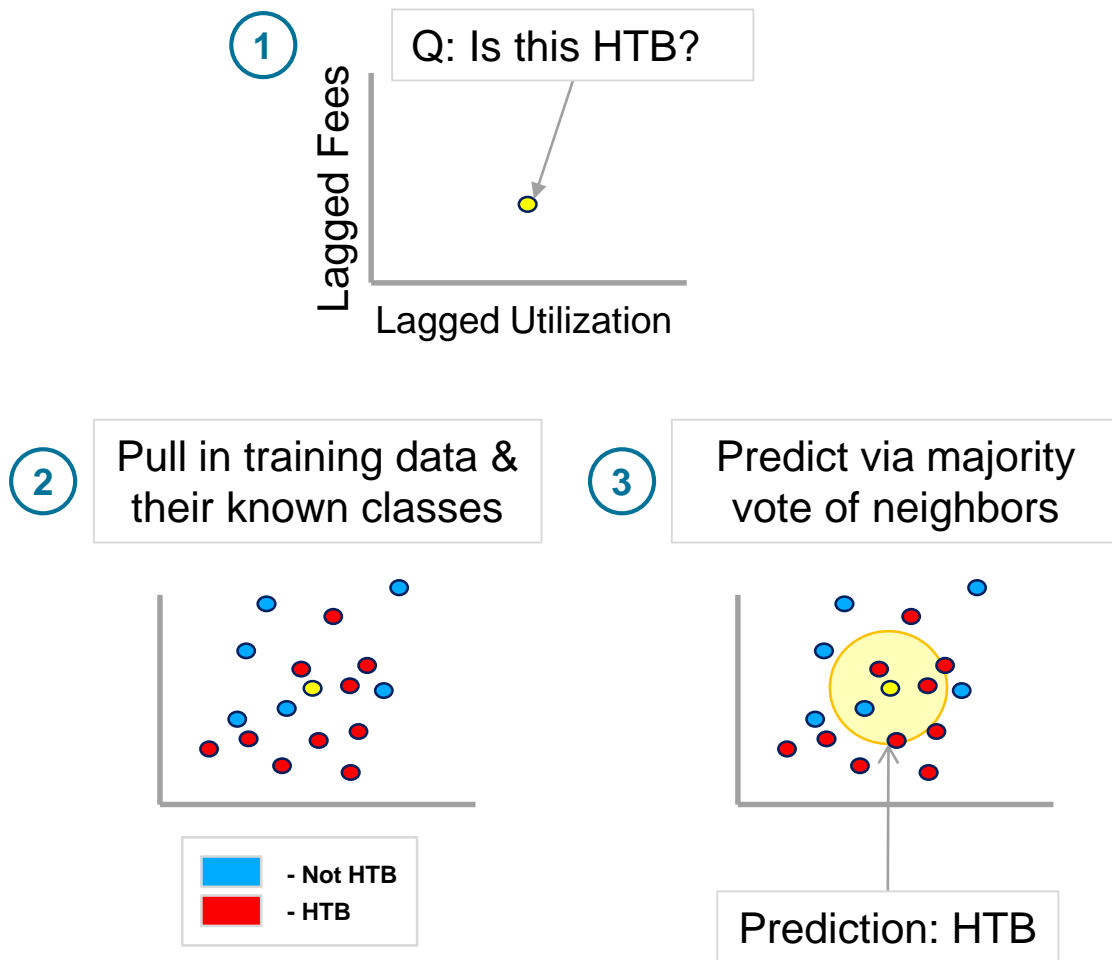
- A security is defined as HTB when **high borrower demand** and **tightening supply** create a highly favorable negotiating posture for asset lenders and often corresponds to higher lending rates
- **Majority** of program revenues are generated from securities that are HTB; while only being around a 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

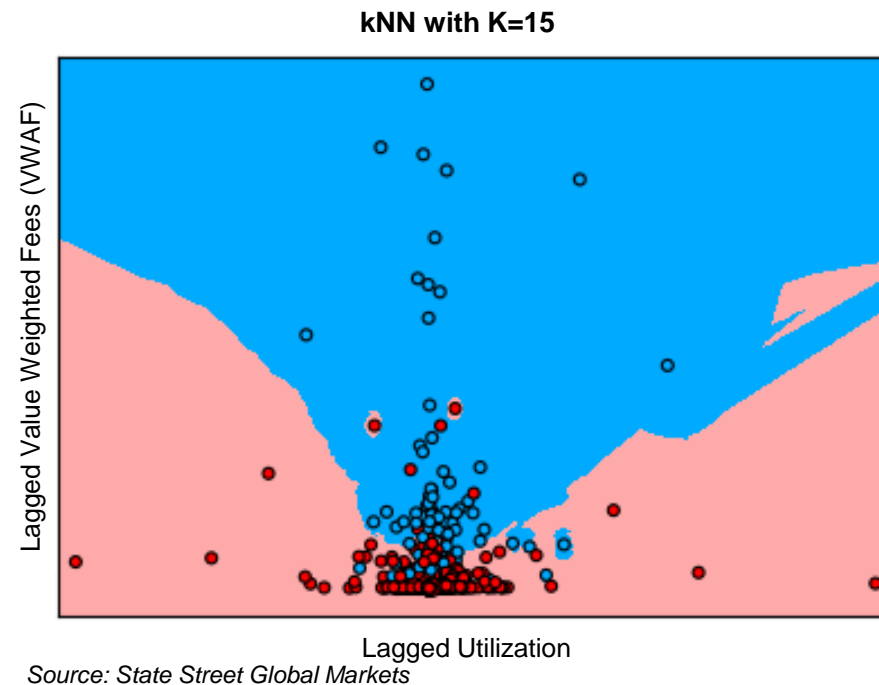
Research – K-Nearest Neighbors Infrastructure & Mechanics

Prediction Infrastructure



Source: State Street Global Markets

High-level mechanics



Predicted Variable	Training Days	Nearest Neighbors	Testing Period
HTB Event (0/1)	260 days rolling	K= 15	2013-2018 (1450 trade days)

Research – Lessons from modeling, by impact & type

High Impact

Moderate Impact

	High Impact	Moderate Impact
Overall model	<p>Modeled Variable Type</p> <p>HTB score vs. movement into HTB HTB score very persistent, which means predicting score will underweight the predictiveness of deltas (fees, util) on entering HTB</p>	<p>Specificity vs. Sensitivity</p> <p>i.e., “False positive” vs. “False neg.” 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.</p>
K-nn	<p>Sparsity</p> <p>HTBs rare; need to re-sample K-nn’s take majority vote of neighbors; need to properly sample HTB events to ensure anything is captured as HTB</p>	<p>Winsorization</p> <p>Treat right-tailed inputs (fees, util) Particularly with nearest neighbors calculated on multiple dimensions, need to ensure large values are winsorized</p>
OLS	<p>Restriction to Relevant Types</p> <p>GCs, Warms, HTBs? Modeling 0’s often uninformative; focus on warms/HTBs for those relevant to what we try to capture</p>	<p>Categorical vs. Continuous</p> <p>Inputs: categorical or continuous? Relies on some market knowledge/intuition. We found that market cap varies substantially (continuously) but matters more in “buckets”.</p>

Agenda

Application of Quantitative Techniques in Securities Finance

Securities Finance & State Street Associates

Securities Lending Overview

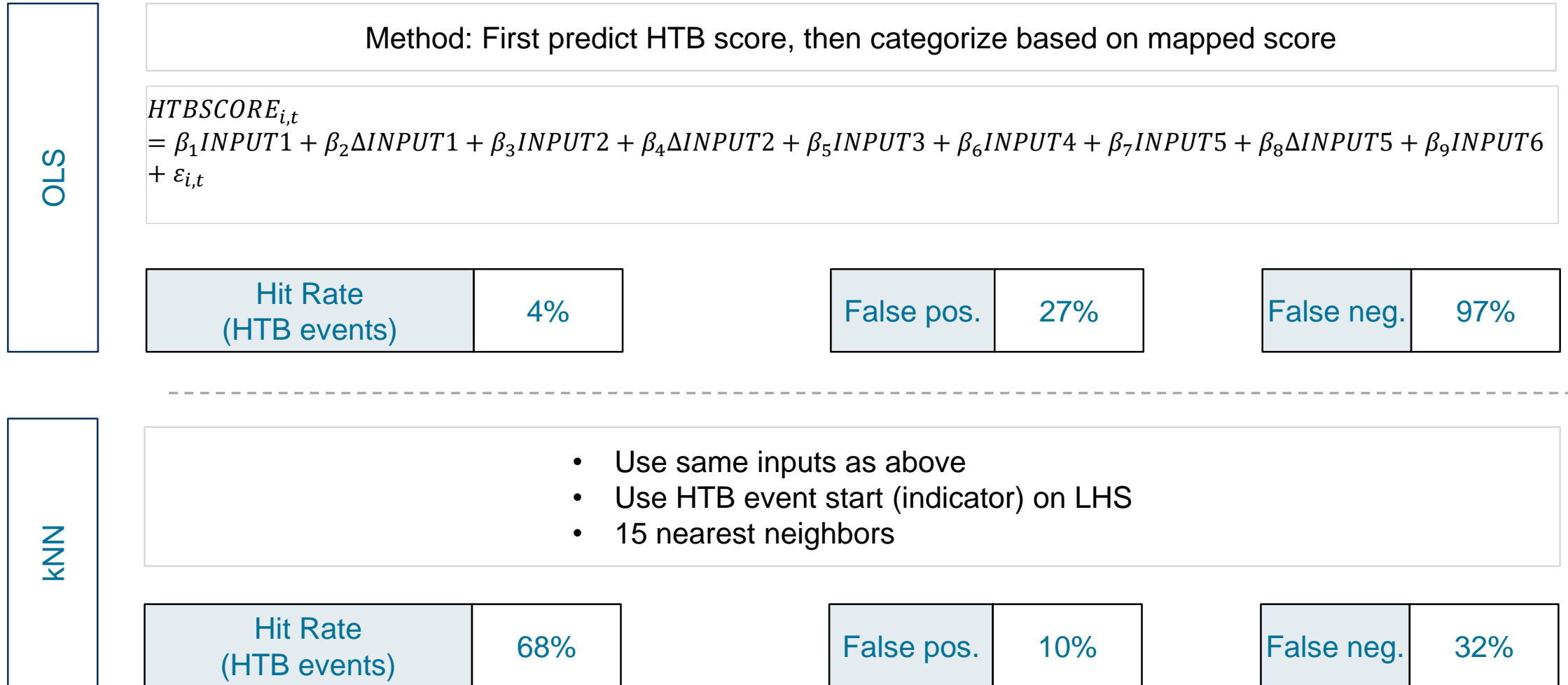
Capturing Short Sell Market Price Pressures with Quantitative Models

Applying Models and Algorithmic Trading Strategies

Conclusion

Model Results

OLS and kNN results for ~7 year period (Jan 2012 and Feb 2019), trained with 260 day look back period



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!



Yasser El Hamoumi
Trading and Algorithmic Strategies,
State Street Securities Finance
YElhamoumi@StateStreet.com



Travis Whitmore
Quantitative Researcher
State Street Associates
twhitmore@statestreet.com

Disclaimers and Important Risk Information

The information provided herein is not intended to suggest or recommend any investment or investment strategy, does not constitute investment advice, does not constitute securities, futures, or swap research, is not market commentary, and is not a solicitation to buy or sell securities, derivatives, foreign exchange or any financial product. It does not take into account any investor's particular investment objectives, strategies or tax status. Clients should be aware of the risks trading foreign exchange, equities, fixed income or derivative instruments or in investments in non-liquid or emerging markets. Derivatives generally involve leverage and are therefore more volatile than their underlying cash investments. Past performance is no guarantee of future results. This communication is not intended for and must not be provided to retail investors. The products and services described in this communication may not be available in all jurisdictions and this communication is not intended for distribution in any jurisdiction where such distribution would be prohibited. The products and services outlined herein are only offered to professional clients or eligible counterparties through State Street Bank and Trust Company, authorized and regulated by the Federal Reserve Board. State Street Bank and Trust Company is registered with the Commodity Futures Trading Commission as a Swap Dealer and is a member of the National Futures Association. Please note that certain foreign exchange business (spot and certain forward transactions) are not regulated. This document is a marketing communication, and the information contained herein has not been prepared in accordance with legal requirements designed to promote the independence of investment research. It is for clients to determine whether they are permitted to receive research of any nature.

The products and services outlined in this document are generally offered in the **United States, Latin America, and Japan**, by State Street Bank and Trust Company. **EMEA:** (i) State Street Bank and Trust Company, London Branch, authorised and regulated by Federal Reserve Board, authorised by the Prudential Regulation Authority, subject to regulation by the Financial Conduct Authority and limited regulation by the Prudential Regulation Authority. Details about the extent of regulation by the Prudential Regulation Authority are available upon request; and/or (ii) State Street Bank International GmbH, authorised by Deutsche Bundesbank and the German Federal Financial Supervisory Authority and, in respect of State Street Bank International GmbH, London Branch, subject to limited regulation by the Financial Conduct Authority and Prudential Regulation Authority. Details about the extent of regulation by the Financial Conduct Authority and Prudential Regulation Authority are available upon request. **Brazil:** The products in this marketing material have not been and will not be registered with the Comissão de Valores Mobiliários - the Brazilian Securities and Exchange Commission ("CVM"), and any offer of such products is not directed to the general public within the Federative Republic of Brazil ("Brazil"). The information contained in this marketing material is not provided for the purpose of soliciting investments from investors residing in Brazil and no information in this marketing material should be construed as a public offering or unauthorized distribution of the products within Brazil, pursuant to applicable Brazilian law and regulations. The products and services outlined in this document are generally offered in **Canada** by State Street Bank and Trust Company. This communication is made available in **Hong Kong** by State Street Bank and Trust Company which accepts responsibility for its contents, and is intended for distribution to professional investors only (as defined in the Securities and Futures Ordinance). This communication is made available in **Australia** by State Street Bank and Trust Company ABN 70 062 819 630, AFSL 239679 and is intended only for wholesale clients, as defined in the Corporations Act 2001. This communication is made available in **Singapore** by State Street Bank and Trust Company, Singapore Branch ("SSBTS"), which holds a wholesale bank license by the Monetary Authority of Singapore. In Singapore, this communication is only distributed to accredited, institutional investors as defined in the Singapore Financial Advisers Act ("FAA"). Note that SSBTS is exempt from Sections 27 and 36 of the FAA. When this communication is distributed to overseas investors as defined in the FAA, note that SSBTS is exempt from Sections 26, 27, 29 and 36 of the FAA. The products and services outlined in this document are made available in **South Africa** through State Street Bank and Trust Company, which is authorized in South Africa under the Financial Advisory and Intermediary Services Act, 2002 as a Category I Financial Services Provider; FSP No. 42671. This communication is made available in **Israel** by State Street Bank and Trust Company, which is not licensed under Israel's Regulation of Investment Advice, Investment Marketing and Portfolio Management Law, 1995. This communication may only be distributed to or used by investors in Israel which are "eligible clients" as listed in the First Schedule to Israel's Regulation of Investment Advice, Investment Marketing and Portfolio Management Law 1995. This communication is made available in **Qatar** by State Street Bank and Trust Company and its affiliates. The information in this communication has not been reviewed or approved by the Qatar Central Bank, the Qatar Financial Markets Authority or the Qatar Financial Centre Regulatory Authority, or any other relevant Qatari regulatory body. This communication is made available in **Malaysia** by State Street Bank and Trust Company, which is authorized and regulated by the Federal Reserve Board. State Street Bank and Trust Company is not licensed within or doing business within Malaysia and the activities that are being discussed are carried out off-shore.

The written materials do not constitute, and should not be construed as constituting: 1) an offer or invitation to subscribe for or purchase securities or futures in Malaysia or the making available of securities or futures for purchase or subscription in Malaysia; 2) the provision of investment advice concerning securities or futures; or 3) an undertaking by State Street Bank and Trust Company to manage the portfolio of securities or futures contracts on behalf of other persons. This communication is made available in **Turkey** by State Street Bank and Trust Company and its affiliates. The information included herein is not investment advice. Investment advisory services are provided by portfolio management companies, brokers and banks without deposit collection licenses within the scope of the investment advisory agreements to be executed with clients. Any opinions and statements included herein are based on the personal opinions of the commentators and authors. These opinions may not be suitable to your financial status and your risk and return preferences. Therefore, an investment decision based solely on the information herein may not be appropriate to your expectations. This communication is made available in **United Arab Emirates** by State Street Bank and Trust Company and its affiliates. This communication does not, and is not intended to, constitute an offer of securities anywhere in the United Arab Emirates and accordingly should not be construed as such. Nor does the addressing of this communication to you constitute, or is intended to constitute, the carrying on or engagement in banking, financial and/or investment consultation business in the United Arab Emirates under the rules and regulations made by the Central Bank of the United Arab Emirates, the Emirates Securities and Commodities Authority or the United Arab Emirates Ministry of Economy. Any public offer of securities in the United Arab Emirates, if made, will be made pursuant to one or more separate documents and only in accordance with the applicable laws and regulations. Nothing contained in this communication is intended to endorse or recommend a particular course of action or to constitute investment, legal, tax, accounting or other professional advice. Prospective investors should consult with an appropriate professional for specific advice rendered on the basis of their situation. Further, the information contained within this communication is not intended to lead to the conclusion of any contract of whatsoever nature within the territory of the United Arab Emirates. This communication has been forwarded to you solely for your information, and may not be reproduced or passed on, directly or indirectly, to any other person or published, in whole or in part, for any purpose. This communication is addressed only to persons who are professional, institutional or otherwise sophisticated investors. This communication is made available in **South Korea** by State Street Bank and Trust Company and its affiliates, which accept responsibility for its contents, and is intended for distribution to professional investors only. State Street Bank and Trust Company is not licensed to undertake securities business within South Korea, and any activities related to the content hereof will be carried out off-shore and only in relation to off-shore non-South Korea securities. This communication is made available in **Indonesia** by State Street Bank and Trust Company and its affiliates. Neither this communication nor any copy hereof may be distributed in Indonesia or to any Indonesian citizens wherever they are domiciled or to Indonesian residents except in compliance with applicable Indonesian capital market laws and regulations. This communication is not an offer of securities in Indonesia. Any securities referred to in this communication have not been registered with the Capital Market and Financial Institutions Supervisory Agency (BAPEPAM-LK) pursuant to relevant capital market laws and regulations, and may not be offered or sold within the territory of the Republic of Indonesia or to Indonesian citizens through a public offering or in circumstances which constitute an offer within the meaning of the Indonesian capital market law and regulations. This communication is made available in **Oman** by State Street Bank and Trust Company and its affiliates. The information contained in this communication is for information purposes and does not constitute an offer for the sale of foreign securities in Oman or an invitation to an offer for the sale of foreign securities. State Street Bank and Trust Company is neither a bank nor financial services provider registered to undertake business in Oman and is neither regulated by the Central Bank of Oman nor the Capital Market Authority. Nothing contained in this communication report is intended to constitute Omani investment, legal, tax, accounting, investment or other professional advice. This communication is made available in **Taiwan** by State Street Bank and Trust Company and its affiliates, which accept responsibility for its contents, and is intended for distribution to professional investors only. State Street Bank and Trust Company is not licensed to undertake securities business within Taiwan, and any activities related to the content hereof will be carried out off-shore and only in relation to off-shore non-Taiwan securities. **Peoples Republic of China ("PRC")**. This communication is being distributed by State Street Bank and Trust Company. State Street Bank and Trust Company is not licensed or carrying on business in the PRC in respect of any activities described herein and any such activities it does carry out are conducted outside of the PRC. These written materials do not constitute, and should not be construed as constituting: 1) an offer or invitation to subscribe for or purchase securities or futures in PRC or the making available of securities or futures for purchase or subscription in PRC; 2) the provision of investment advice concerning securities or futures; or 3) an undertaking by State Street Bank and Trust Company to manage the portfolio of securities or futures contracts on behalf of other persons.

Markit® Financial Information Services. The source data is provided by group participants of Markits® Performance Explorer tool. The data was from a source believed to be reliable, however, neither State Street Bank and Trust Company nor Markit® guarantee the accuracy, adequacy or completeness of the information. SF MK 2019-01.

State Street Global Markets® is a registered trademark of State Street Corporation® used for its financial markets businesses. State Street Associates® is a registered trademark of State Street Corporation, and the analytics and research arm of State Street Global Markets. Please contact your State Street representative for further information.

SSA 2019-08, AdTrax: 2755323.1.1.AM.

© 2019 State Street Corporation – All Rights Reserved