



Testimony of Martina Rejsjo
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Before the
House Financial Services Committee's
Task Force on Artificial Intelligence
Hearing entitled, "Robots on Wall Street: The Impact of AI on Capital Markets and Jobs in the
Financial Services Industry."

Thank you Chairman Foster and Ranking Member Loudermilk for the opportunity to testify today on the impact of artificial intelligence (AI) on our capital markets. While many people think of the AI with a cautious eye to the Hollywood extreme of "The Terminator," we at Nasdaq believe strongly that we can use this technology tool-set to target a wholly different prey - the fraudster.

As you know, Nasdaq has extensive experience leveraging technology to operate our markets and markets around the world - protecting market participants and investors. We operate 25 exchanges and six clearinghouses around the globe for equities, options, commodities, power, freight, interest rates, and fixed income trading.

Additionally, Nasdaq's Market Technology department is a separate business unit that develops and sells marketplace technology to hundreds of the world's market infrastructure organizations and market participants, including regulators, exchanges, clearinghouses, central securities depositories and broker dealers globally. These technologies not only include systems such as trading and clearing, but also surveillance technology, known as Nasdaq Market Surveillance. Currently more than 59 marketplaces and 19 regulators globally use this surveillance technology to monitor their ecosystems for market abuse. Since its inception nearly

30 years ago, Nasdaq’s surveillance technology has become the industry benchmark for real-time and T+1 cross-market surveillance platforms. These solutions automate the detection, investigation and analysis of potentially abusive or disorderly trading—whether cross market, cross-asset, and multi-venue—to help improve the overall efficiency of the surveillance organization and reduce cost, even as market complexity and new regulations increase. As part of product development, we have constantly strived to be at the forefront in developing and evolving surveillance-focused visualization tools to simplify the monitoring process by distilling complex information into a single snapshot, resulting in clear guidance on where to focus an investigation.

Regulation at a Glance:

- **750,000+ ALERTS REVIEWED**
- **800 MATTERS REFERRED TO SEC AND FINRA**
- **80,000+ ELECTRONIC TEST SCRIPS RUNNING ACROSS 6 TRADING SYSTEMS TO ENSURE SYSTEM RULE COMPLIANCE**
- **6.7 Billion MESSAGES PER DAY PROCESSED BY NASDAQ’S REAL-TIME REGULATORY SYSTEMS**

As marketplaces become more accessible, the sheer number of market participants continues to rise—expanding the number and types of potential events that surveillance systems need to capture. At the same time, trading behaviors are constantly evolving so compliance teams are spending more time than ever combing through data to investigate abnormal activity.

This increase in players, the ability to deploy manipulative strategies with their own technology, and exponential increase in data quantities can act as the perfect ecosystem for

market manipulators looking to hide amongst the noise. This increased complexity in monitoring across markets and asset classes presents new challenges for surveillance teams relying on pre-conceived parameters and known factors to detect manipulative patterns.

Monitoring in US Markets

Nasdaq North America Surveillance team monitors 3 equity markets, 6 options markets and one futures market with real-time surveillance and post-trade surveillance of unusual market activity. The surveillance department is monitoring the markets for Insider Trading, Fraud and Manipulation, including manipulation through trading—pump and dump—and order book manipulation—spoofing and layering, as well as handling events in the market such as clearly erroneous transactions.

The surveillance program today is using algorithmic coding to detect unusual market behavior running over 40 different algorithms in real-time, looking for market abuse and manipulation. The patterns have sophisticated algorithms that use approximately 35,000 parameters. In addition to real-time surveillance, there are over 150 patterns covering post trade-surveillance, which are used to identify a wide range of potential misconduct. The activity is monitored across equity and options markets, with some market-specific alerts and some alerts encompassing data from all markets.

The team proactively develops tools and procedures to constantly increase the quality of surveillance and to meet changing demands in the market place and we initiate and drive change in regulation.

Pattern Development Today

The manner in which patterns are currently recognized and detected can represent potential challenges in manipulative pattern identification. Since they are based on known factors, which can be a combination of information shared between market places, information from broker dealers, investors and other market participants, it can be difficult to capture new behavior and remain proactive rather than reactive to threats in the market. In addition, pre-defined expectations of what patterns replicate a specific manipulative behavior can often limit alert results, depending on how alert parameters are calibrated. Calibration can also present a challenge when determining the best balance between false positives and true alerts.

Using AI to Enhance Surveillance

The above challenges in alert detection and coding led to a joint collaboration between departments within Nasdaq to gain more insight into potential manipulation scenarios, Nasdaq's Machine Intelligence (MI) Lab, Nasdaq's Market Technology business and Nasdaq US Surveillance Team joined forces to enhance surveillance capabilities with the help of Artificial Intelligence and Transfer Learning:

- **MI Lab:** Nasdaq’s team formed specifically to research the latest trends in artificial intelligence and machine learning and apply those techniques to our own technology across the organization.
- **Nasdaq Market Technology:** One of Nasdaq’s four commercial businesses, Market Technology includes the Nasdaq Market Surveillance offering in its suite of products. Nasdaq’s Surveillance solutions are deployed at 59+ non-Nasdaq exchanges, 19 regulators and 160+ market participants globally.
- **Nasdaq US Surveillance Team:** Monitors Nasdaq’s US exchanges to ensure utmost transparency.

Using AI to detect abnormal behavioral patterns is premised on the notion that manipulative behavior can be identified by signals in the market; that a scheme to defraud market participants often has a specific pattern in how it is executed; and that there is a price rise/decline, an action taken and trading is then restored to norm. This “signaling concept” leads to new ways to look at pattern detection.

New Models for Trading Risk Detection

By leveraging AI to detect potential trading risks, detection models were not tied to static logic or parameters—helping to reduce false positive flags. The teams were able to train the AI machine based on visual patterns of manipulation, with an initial focus on spoofing. The machine was trained with human input via “active learning” and then tested with transfer learning

to expand the scope of the project beyond spoofing. Transfer learning leverages AI to apply a model developed for a specific task as the starting point for a model on a second task. By using transfer learning the more markets and customer data applied to training models, the better

New Capabilities are Making AI More Powerful

Transfer Learning: *New Models from Old Models*

- Rapid Implementation
- Scalable Model Development
- **Detect:** new forms of financial crime in new markets

Human-in-the Loop Learning

- Man-Machine Integration
- Label generation on-the-fly for sparse or unclear classes
- Manage: Human assisted model improvement leads to more signal and less noise in flagged examples

Deep Learning

- Learns invariant representations
- Uses 'hidden layer' in find increasingly complex relationships
- Can learn any function, including highly nonlinear ones

models can be for new markets. Models can be transferred between markets or events, and then further improved with analyst feedback.

By working across Nasdaq's Market

Surveillance Technology team, MI Lab and

MarketWatch team, the group was able to benefit from

piloting the latest innovations for release within our

technology business and provide real-time feedback for

developers. By using Deep Learning and Human in the

Loop techniques, the cross-business team started to train

new models for detecting market abuse. The underlying

neural network technology was based on Convolutional Networks, augmented with Human in the Loop processes with continuous training.

The Results

During the testing and implementation phases of market transfer from Commodities to US Equities for spoofing detection, initial experiments indicated usable results with 95% fewer

examples than typically required. The project pilot is ongoing and the detection efficacy of current models is either similar or better than the comparison model. The teams are jointly gathering comparative statistics for fine tuning and application to other markets around the world.

Impact on Surveillance Function

The inclusion of AI into the detection function will allow the surveillance department to focus the effort on in-depth investigations on potential manipulative behavior instead of triaging a high number of false positives. Let me be clear, the human input is still of primary critical importance both in analyzing the output from the surveillance system, but also in continuously training the machine to produce more and more accurate output. The AI depends on the “human-in-the-loop” learning that relies on analysts sharing their expertise with the machine - there has to be a feedback loop built into the system to continuously refine the output. AI will be at the center of next generation surveillance technology, focusing on adaptive detection models with the input from the analysts, empowering surveillance teams with faster, smarter and more accurate monitoring capabilities, ultimately aimed at maintaining market integrity.

The massive, and in many cases exponential, growth in market data is a significant challenge for surveillance professionals. Billions of messages pass through a larger marketplace’s systems on an active day. In addition, market abuse attempts have become more sophisticated, putting more pressure on surveillance teams to find the proverbial needle in the



(data) hay-stack. Although automated surveillance systems have vastly improved real-time monitoring capabilities and resources are stretched to the maximum, we cannot allow parameters for potential market abuse to go undetected. To this end, exchanges and market participants alike need to optimize their efforts by employing multiple methods of detection. This means constantly evolving how we adopt and leverage new technologies to better surveil trading activity. By incorporating AI into our monitoring systems, we are sharpening our detection capabilities and broadening our view of market activity to safeguard the integrity of our country's markets. In the future, Nasdaq sees an opportunity to leverage transfer learning to apply models across markets and additional manipulative behaviors. With added data and analytics, the models will continue to be enhanced. Moving forward, AI will play a key role in detecting manipulative behaviors that would otherwise undermine our markets.

Other AI Projects

Surveillance is a critical use-case for AI, but Nasdaq is looking to apply it to other Self-Regulatory obligations and areas of our business where we can deploy this powerful tool. For example, we are also using a version of AI in the listings business to leverage machine learning to facilitate the compliance review of public company filings. We use Natural Language Processing (NLP) to review issuer's 8-K filings—the AI will flag certain sentences and words and send it to the listing analyst. We estimated that Nasdaq's regulatory analysts spent about 60% of their workday reviewing the more than 48,000 SEC filings submitted by Nasdaq-listed companies each year. While the compliance tracking platform effectively evaluates securities for



compliance with quantitative requirements (number of shares outstanding), it has limited ability to facilitate the qualitative elements of an analyst's review (equity offerings or investigations).

Nasdaq's listing qualifications team is utilizing cloud-based text analytics tools to embed NLP technology into the compliance tracking software and train it to process, flag and prioritize filings that require manual review. Automation of this process will save compliance analysts considerable time combing through filing narratives to investigate deficiencies—enhancing the integrity of the market.

In closing, we are convinced that this use-case for AI will benefit investors and the resiliency of the U.S. and other markets that we serve. We appreciate the opportunity to testify on these important issues. I am happy to answer your questions.