

**ROBOTS ON WALL STREET: THE IMPACT
OF AI ON CAPITAL MARKETS AND JOBS
IN THE FINANCIAL SERVICES INDUSTRY**

HEARING
BEFORE THE
TASK FORCE ON ARTIFICIAL INTELLIGENCE
OF THE
COMMITTEE ON FINANCIAL SERVICES
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**ROBOTS ON WALL STREET:
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SERVICES INDUSTRY**

Friday, December 6, 2019

U.S. HOUSE OF REPRESENTATIVES,
TASK FORCE ON ARTIFICIAL INTELLIGENCE,
COMMITTEE ON FINANCIAL SERVICES,
Washington, D.C.

The task force met, pursuant to notice, at 9:42 a.m., in room 2128, Rayburn House Office Building, Hon. Bill Foster [chairman of the task force] presiding.

Members present: Representatives Foster, Cleaver, Casten, Adams, Garcia of Texas; Loudermilk, Hollingsworth, and Riggleman.

Also present: Representative Himes.

Chairman FOSTER. The Task Force on Artificial Intelligence will now come to order.

Without objection, the Chair is authorized to declare a recess of the task force at any time. Also, without objection, members of the full Financial Services Committee who are not members of this task force are authorized to participate in today's hearing.

Today's hearing is entitled, "Robots on Wall Street: The Impact of AI on Capital Markets and Jobs in the Financial Services Industry."

The Chair will now recognize himself for 5 minutes for an opening statement.

First off, thank you all for joining us today for what should be a very interesting hearing of this task force. Today, we are looking at exploring how artificial intelligence (AI) is being deployed in capital markets, from automated trading, to portfolio allocation, to investment management decisions.

We are also going to consider how the use of this technology is changing the nature of work in financial services, rendering some jobs obsolete and changing the skill sets needed to excel in others.

It would not be much of an exaggeration today to say that Wall Street, quite literally, is run by computers. Long gone are the days where traders would be screaming orders on the floor of the New York Stock Exchange and financial analysts would use TI calculators and pore over the ticker tape and financial statements to glean insights into a company's value.

I actually hear about those days from the limo driver who takes me back, who used to be a floor trader on the Merc.

Today, trades are automated and orders are executed in milliseconds or microseconds. Passive exchange-traded funds (ETFs) have proliferated, relying on algorithmic models to ensure the fund's holdings of shares are properly weighted to whatever index or benchmark it is tracking. Quantitative hedge funds, or quant funds, use algorithms that scour all sorts of market data to find the stocks that have the most price momentum or the highest dividends or look for correlations in the market and in the external data feeds to provide the most value for investors.

And I think it is very notable that a lot of the shakeup that we are seeing in those markets is really a reflection of, sort of, the winner-take-all nature of digital economies—that any digital business, purely digital business is a natural monopoly, and as more of finance becomes digitized, you are going to see more and more of the rewards go to a smaller and smaller number of dominant players. And I would like to emphasize, that doesn't mean they are evil; it is just simply a natural reflection of the nature of the digital marketplace.

Other asset managers may use algorithms to perform complex research and analysis in real-time on big data sets. This could include scouring of social media sites, satellite information, internet traffic, online transactions, and just about anything else you can think of. This is, I guess, good in terms of having the market reflect all known data, but there are abusive corners. For example, imagine what it would be worth if you had a 10-second early look at Trump's Twitter feed, how much money you could make trading off that, for example.

The three types of computer-managed funds—index funds, ETFs, and quant funds—make up about 35 percent of the approximately \$31 trillion American public equities market. Human managers, such as traditional hedge funds and other mutual funds, manage just 24 percent of the market.

The rise of the so-called computerization of our stock markets has a number of benefits. The costs of executing trades has gone way down, sometimes to zero dollars, and there is more liquidity in the market. Passive funds charge less than 1 percent of assets under management each year, while active managers often charge 20 times that much.

It certainly creates additional questions as well, however, as in the 2010 flash crash. And the more recent mini flash crashes have shown algorithmic trading can sometimes cause unpredictable consequences that create market volatility. It can also exacerbate information asymmetry between different types of investors, as firms with more and faster access to enormous data sets are able to obtain a competitive advantage.

Another broader question is how these developments are impacting the nature of jobs in the financial services industry. A recent Wells Fargo research report estimated that technological efficiencies would result in about 200,000 job cuts over the next decade in the U.S. banking industry. While these cuts will certainly affect back-office, call-center, and customer-service positions, the pain will be widespread. Many front-office workers, such as bankers,

traders, and financial analysts, could also see their head count drop by almost a third, according to a McKinsey & Company report released earlier this year.

The report also found that 40 percent of existing jobs at financial firms could be automated with current technology. So, if you spend your whole day staring at a big screen, and particularly if you are receiving a large paycheck, your job will be at risk.

Understanding the skills that will be needed to excel in the financial services industry of tomorrow and how we can encourage these skills is one of the issues that we must tackle head-on and tackle early. In a world where many functions can be done by automated AI models, what role does that leave for humans?

So, I very much look forward to hearing from our witnesses on these issues.

With that, I would like to recognize the ranking member of the task force, my friend from Georgia, Mr. Loudermilk, for 5 minutes.

Mr. LOUDERMILK. Thank you, Mr. Chairman.

And I want to thank each of our witnesses who are here today. Thank you for taking the time to be here to discuss this issue. While the rest of America is fixated on other things going on here, this is something that may not resonate on the major networks, but it is something that is very important, and has an impact on our lives, positively but also potentially negatively, and it is important that we look into this.

And, as you know, today, the task force will examine the intersection between technology and the capital markets. In recent years, there have been many technological developments, including the adoption of artificial intelligence and automation, that have re-defined and reshaped trading and investing.

The first trades on the New York Stock Exchange were made in the late 1700s using a manual, paper-intensive process. For many years, buyers and sellers communicated about orders over the phone. Today, trading and investing are done on digital platforms, and investors can trade securities from virtually anywhere in the world using modern technology.

Electronic trading has benefited the markets in many ways. It has been positive for investors by leading to lower overhead and transaction costs, which has contributed to record investment returns over the last decade.

Several major asset management firms now offer zero-percent commissions, which means investors can buy and sell stocks essentially for free and can capture more of the growth of their investments. This would not be possible without electronic trading.

Digital trading platforms also provide investors with access to low-cost financial research and advice 24 hours a day using robo-advisors.

Electronic trading also makes markets more efficient by allowing faster searches for prices, better processing of large sets of data, and more transparent price information. The proliferation of technology can also lower firms' barriers to entry, foster more competition, improve risk management, and increase market access for investors.

In addition to these core benefits, there are many other cases of companies using AI to improve efficiencies in the capital markets

in unique ways. For example, some clearing companies are using AI to optimize the settlement of trades and enhance cybersecurity and fraud detection. Some self-regulatory organizations are also using AI in regtech and market surveillance.

While there are many benefits to electronic trading, it can also present new challenges.

One challenge, which is at the forefront of our discussion today, is the disruption of the job market. While the rise of automated trading has displaced many floor traders, job opportunities in fields like code writing, cloud management, telecommunications, fiber optics, and data analysis are growing.

There is some concern that high-frequency trading can contribute to volatility, but new evidence suggests that high-frequency trading does not increase volatility and can actually improve liquidity. There is also some concern that firms that don't have the latest technology could be competed out of the markets.

It is important to keep in mind that not all types of electronic trading are the same, and I look forward to learning more from the witnesses about the differences between automated trading, algorithmic trading, high-frequency trading, and computer trading.

Finally, I look forward to exploring the legislative and regulatory issues in this space. One issue that I think needs to be addressed is the protection of source code, because algorithms are traders' core intellectual property. They must be protected.

We passed a bill out of this committee and the House on a bipartisan basis last Congress to ensure that the Securities and Exchange Commission issues a subpoena before obtaining these algorithms, rather than getting them through routine exams. Mr. Chairman, I hope that we will be able to work together on a bill this Congress.

I thank you, and I yield back.

Chairman FOSTER. Thank you.

And, today, we are welcoming the testimony of Dr. Charlton McIlwain, vice provost for faculty engagement and development, and professor of media, culture, and communication at NYU; Dr. Marcos Lopez de Prado, professor of practice at the Engineering School, Cornell University, and chief investment officer of True Positive Technologies; Ms. Rebecca Fender, CFA, senior director, Future of Finance Initiative at the Chartered Financial Analyst Institute; Ms. Kirsten Wegner, chief executive officer of the Modern Markets Initiative; and Ms. Martina Rejsjo, head of Nasdaq market surveillance, Nasdaq Stock Market.

Witnesses are reminded that your oral testimony will be limited to 5 minutes, and without objection, your full written statements will be made a part of the record.

Dr. McIlwain, you are now recognized for 5 minutes to give an oral presentation of your testimony.

STATEMENT OF CHARLTON MCILWAIN, VICE PROVOST, FACULTY ENGAGEMENT AND DEVELOPMENT, AND PROFESSOR OF MEDIA, CULTURE, AND COMMUNICATION, NEW YORK UNIVERSITY (NYU)

Mr. MCILWAIN. Chairman Foster and Ranking Member Loudermilk, thank you for inviting me to testify.

While my written remarks cover four key areas, my oral remarks focus on two: the implications of automation on the workforce; and mitigating algorithmic discrimination and bias.

We have ample reason to be concerned about automation's future in the financial services sector. First, the financial services sector is ripe for automation and algorithm-driven innovation. Second, the fintech sector is on the rise. Third, a large number of workers will likely be displaced in the financial services sector even if automation and AI development is projected to create new types of jobs.

If all of this is true, then the cause for concern is clear. It lies with the fact that African Americans and Latinx workers, in particular, are already vastly underrepresented in the financial services sector workforce.

African Americans, Hispanics, and Asians make up only 22 percent of the financial services industry workforce. African-American representation in the financial services sector, at both entry-level and senior-level jobs, declined from 2007 to 2015. Less than 3.5 percent of all financial planners in the U.S. are Black or Latinx. African Americans make up just 4.4 percent and Hispanics just 2.9 percent of the securities subsector. Asians make up just 2.8 percent of the central banking and insurance subsectors.

My point is simple: Racial groups that are already extremely underrepresented in the financial services industry will be most at risk in terms of automation and the escalation of fintech development. This is especially true given the vast underrepresentation of African Americans and Latinx in the adjacent technology sector workforce.

If we are to mitigate the likelihood that automation will disproportionately and negatively affect those already underrepresented in the financial services industry, we must plan ahead long into the future rather than allowing the market to run its course towards predictable outcomes.

Now, to the subject of deterring algorithmic bias. Certainly, one way to mitigate against algorithmic bias is to develop best practices for constructing and deploying algorithmic systems and providing more oversight from industry, government, and nongovernmental bodies who are able to assess how such systems are used and the outcomes they produce.

This includes technical solutions that make algorithms more transparent and auditable and mitigate against potential biases before such systems gain widespread use rather than trying to simply correct their effects once their damage is done.

But I want to emphasize that, especially when it comes to mitigating the potential disparate outcomes that biased algorithms might have on individuals and communities of color, simple reliance on technical fixes by technologists is not a complete solution.

I want to end by drawing on the wisdom of Bayard Rustin, a former civil rights leader who had a sophisticated understanding of computerized automation and algorithmic systems as they existed in his time. He said, "Today, the unskilled and semi-skilled worker is the victim, but cybernation invades the strongholds of the American middle class as once-proud white-collar workers begin sinking into the alienated world of the American underclass. And as the new poor meets the old poor, we find out that automation is a

curse. But it is not the only curse. The chief problem is not automation but social injustice itself.”

Take as a final example the findings from a recent National Bureau of Economic Research study, titled, “Consumer-Lending Discrimination in the FinTech Era.” Their researchers sought to determine whether an algorithmic system could reduce discrimination in mortgage lending as compared to traditional face-to-face lending processes.

Their findings were mixed. Yes, the algorithmic system discriminated 40 percent less than the traditional process, but that also meant that the process still discriminated against a large number of Black and Latinx loan applicants. Further, even though the algorithmic system did not, on balance, discriminate in terms of loan approval, it did discriminate against Black and Latinx users in terms of price.

One of the key conclusions of the study states that both fintechs and face-to-face lenders may discriminate in mortgage issuance through pricing strategies. We are just scratching the surface of the role of pricing strategy discrimination in the algorithmic area of data use.

In short, algorithmic lending may reduce discrimination relative to face-to-face lenders, but algorithmic lending is not, alone, sufficient to eliminate discrimination in loan pricing. Even with the aid of a fair, accurate, and transparent algorithmic system, racial discrimination persists.

Thank you again for allowing me the opportunity to contribute to these proceedings.

[The prepared statement of Mr. McIlwain can be found on page 66 of the appendix.]

Chairman FOSTER. Thank you.

Dr. Lopez de Prado, you are now recognized for 5 minutes to give an oral presentation of your testimony.

STATEMENT OF MARCOS LOPEZ DE PRADO, PROFESSOR OF PRACTICE, ENGINEERING SCHOOL, CORNELL UNIVERSITY, AND CHIEF INVESTMENT OFFICER, TRUE POSITIVE TECHNOLOGIES

Mr. LOPEZ DE PRADO. Thank you, Chairman Foster, Ranking Member Loudermilk, and distinguished members of this task force. It is an honor to be asked to contribute to this committee today.

As a result of recent advances in pattern recognition, supercomputing, and big data, today, machine-learning algorithms can perform tasks that until recently only expert humans could accomplish.

An area of particular interest is the management of investments, for two reasons. First, some of the most successful hedge funds in history happen to be algorithmic. The key advantage of algorithmic funds is that their decisions are objective, reproducible, and can be improved over time. The second advantage is that the automation enables substantial economies of scale and cost reductions. Automated tasks include ordered execution, portfolio construction, forecasting, credit rating, and fraud detection.

Financial AI creates a number of challenges for the over 6 million people employed in the finance and insurance industry, many

of whom will lose their jobs, not because they will be replaced by machines but because they have not been trained to work alongside algorithms. The retraining of these workers is an urgent and difficult task.

But not everything is bad news. As technical skills become more important in finance than personal connections or privileged upbringing, the wage gap between genders, ethnicities, and other classifications should narrow. In finance, too, math could be a great equalizer.

Retraining our existing workforce is of critical importance; however, it is not enough. We must make sure that the talent that American universities help contribute and develop remains in our country. The founders of the next Google, Amazon, or Apple are this very morning attending a math or engineering class at one of our universities. Unlike in the past, odds are these future entrepreneurs are in our country on a student visa and that they will have a very hard time remaining in the United States unless we help them. Unless we help them, they will return to their countries of origin with their fellow students to compete against us.

On a different note, I would like to draw your attention to two practical examples of regtech—that is, the application of machine-learning algorithms to regulatory oversight.

A first embodiment of regtech is the crowdsourcing of investigations. One of the most challenging tasks faced by regulators is to identify market manipulators among oceans of data. This is literally a very challenging task, like searching for a needle in a haystack.

A practical approach is for regulators to enroll the help of the data science community, following the example of talent competitions or the Netflix Prize. Accordingly, regulators could anonymize transaction data and offer it to the worldwide community of data scientists, who would be rewarded with a portion of the fines levied by regulators against wrongdoers. The next time that financial markets experience something like the flash crash, this tournament approach could lead to a faster identification of potential market manipulators.

A second embodiment of regtech is the detection of false investment products. Academic financial journals are filled with false investment studies as a consequence of backtest overfitting. Financial firms offer online tools to overfit backtests, and even large hedge funds fall constantly for this trap, leading to investor losses.

One solution is to require financial firms to record all the backtests involved in the development of a product. With this information, auditors and regulators could compute the probability that the investment strategy is overfit, and this probably could be reported in the funds' promotional material.

Finally, I would like to conclude my remarks with a discussion of bias. Yes, machine-learning algorithms can incorporate human biases. The good news is we have a better chance at detecting the presence of biases in algorithms and measure that bias with greater accuracy than on humans. The reason is that we can subject algorithms to a batch of randomized, controlled experiments, and we will calibrate those algorithms to perform as intended. Algorithms can assist human decision-makers by providing a baseline rec-

ommendation that humans can override, thus exposing biases in humans.

As algorithmic investing becomes more prevalent, Congress and regulators can play a fundamental role in helping reap the benefits of this technology while mitigating its risks.

Thank you for the opportunity to contribute to this hearing, and I look forward to your questions.

[The prepared statement of Dr. Lopez de Prado can be found on page 53 of the appendix.]

Chairman FOSTER. Thank you.

Ms. Fender, you are now recognized for 5 minutes to give an oral presentation of your testimony.

**STATEMENT OF REBECCA FENDER, CFA, SENIOR DIRECTOR,
FUTURE OF FINANCE INITIATIVE, CHARTERED FINANCIAL
ANALYST (CFA) INSTITUTE**

Ms. FENDER. Chairman Foster, Ranking Member Loudermilk, and members of the task force, thank you for inviting me to testify here today. My name is Rebecca Fender, and I am the senior director of the Future of Finance Initiative at the CFA Institute, which is our thought leadership platform.

CFA Institute is the largest nonprofit association of investment professionals in the world, with 170,000 CFA charterholders in 76 countries. CFA Institute is best known for its Chartered Financial Analyst designation, the CFA Charter, which is a rigorous, three-part, graduate-level exam. To earn the designation, charterholders must also have at least 4 years of industry experience.

CFA Institute is a nonpartisan organization and seeks to be a leading voice on global issues of transparency, market efficiency, and investor protection.

Earlier this year, CFA Institute published a paper on the investment professional of the future, examining the changing roles and changing skills of the industry in the next 5 to 10 years. Among the CFA Institute members and candidates we surveyed, 43 percent think the role they perform today will be substantially different in 5 to 10 years' time. And it was greater than 50 percent among financial advisors, traders, and risk analysts. Another 5 percent do not think their role will exist by then.

One of the catalysts is technology. CFA Institute sees the impact of technology on jobs in the investment industry as a pyramid. At the foundation, we have basic applications. Everyone will need to learn to do things differently, and they must be more comfortable using and understanding technology. Some people will face tech substitution, but many more will have their roles adapted. In the middle, there are specialist applications, where technology will enhance work. And at the top, there are hyperspecialist roles that will be less common but very valuable. This includes roles at quant firms and AI labs.

CFA Institute believes the key to this evolution is ongoing learning. Our exam curriculum now includes material about machine learning. And among the members and candidates we surveyed in our recent report, 58 percent have interest in data-analysis coding languages, like Python and R. Similarly, data visualization and

data interpretation are areas that more than half have expressed interest in.

In terms of the role of artificial intelligence in the investment industry, the organizing principle we see is: artificial intelligence plus human intelligence, or AI+HI.

In these middle and top levels of that technology hierarchy, investment management and technology teams work together. AI techniques can augment human intelligence to free investment professionals from routine tasks and enable smarter decision-making. Investment professionals will spend less time finding and entering data and more time ensuring models are consistent with how markets work. AI unlocks the potential of unstructured data and can identify patterns in information more efficiently than humans. AI can amplify an investment team's performance but cannot replicate its creativity.

In our recent paper, "AI Pioneers in Investment Management," authored by my colleague, Larry Cao, we have identified three types of AI in big-data applications that are emerging in investment management: first, the use of natural language processing, computer vision, and voice recognition to efficiently process text, image, and audio data; second, the use of machine-learning techniques to improve the effectiveness of algorithms used in investment processes; and third, the use of AI techniques to process big data, including alternative and unstructured data, for investment insights.

We find that relatively few investment professionals, about 10 percent, are currently using AI and machine-learning techniques in their investment processes. However, here are a few examples from our case studies of what the AI pioneers are doing.

First, Goldman Sachs' sell-side research team is better able to analyze national concrete companies supplying the construction industry by using geospatial data of 9,000 U.S. quarries that each act as local businesses.

Second, the data science team at American Century Investments studied psychology textbooks to determine patterns of deception in children and criminals. They then applied machine learning to these patterns in their earnings calls to determine where spin, omission, obfuscation, and blame are being used.

Finally, Bloomberg has had a sentiment analysis product available since 2009 which analyzes the potential effect of news stories on valuations. They process 2 million documents a day through their machine-learning platform. This was alternative data used only by hedge funds at first, but now many of their clients use it.

Just as the investment industry is beginning to employ greater technology, regulators can look at new data in the world of regtech. This speed and volume of data presents a new surveillance challenge. Regulators will need to have the tools and resources to keep pace with changes.

Thank you again for the opportunity to testify today, and I look forward to your questions.

[The prepared statement of Ms. Fender can be found on page 34 of the appendix.]

Chairman FOSTER. Thank you.

Ms. Wegner, you are now recognized for 5 minutes to give an oral presentation of your testimony.

**STATEMENT OF KIRSTEN WEGNER, CHIEF EXECUTIVE
OFFICER, MODERN MARKETS INITIATIVE (MMI)**

Ms. WEGNER. Thank you, Chairman Foster, Ranking Member Loudermilk, and members of the AI Task Force. It is an honor to discuss the role of automation of the markets and our deployment of artificial intelligence in the financial services industry and our future workforce.

I am Kirsten Wegner, chief executive officer of Modern Markets Initiative. We are an education and advocacy organization comprised of automated trading firms. We operate in over 50 markets globally and, together, employ over 1,600 people. Our advisory board, which is half women, promotes responsible innovation, including advancing a diverse workforce in our industry.

Over the past decades, we have seen automated trading leading to much of the replacement of the exchange-floor-based intermediaries you see in 1980s Wall Street movies. Technology, as you have noted, has reduced the cost of trading for the average investor by more than half over the past decade, both in direct trading costs and in savings through tighter bid-ask spreads.

So if you are an investor in a 529 college savings plan, a pension fund, or a 401(k), then you have benefited from today's low-cost trading and all of the dependable liquidity that we see in the markets. And studies have shown that over a lifetime of savings, investors have 30 percent more in their bank accounts as the result of the automation.

Now, as we look ahead, there are four points that I want to discuss here in the oral testimony.

First, global competition to adopt the latest AI technologies will make human decision-making more efficient in terms of speed, processing time, depth of data, and it is going to confirm more efficiencies and cost savings for U.S. investors across-the-board. Already, competition in the markets has resulted in near-zero-commission online trading from Fidelity, Charles Schwab, and Robinhood, and we have seen a rise in the ETF industry from those efficiencies. Similarly, automated trading has brought down overall trading costs to a fraction of the price from decades ago.

Second, we can expect to see a proliferation of regtech as AI becomes increasingly valuable for individual firms and regulators to police the markets more efficiently. AI functionality in regtech includes monitoring, reporting and compliance, and processing of regulatory filings; loan origination processing; detection and reporting of illegal and irregular trading; and detection of cyber risk.

And, notably, I want to point out that through public-private partnerships, firms can play a role in working with a regulator to share those limited resources in AI and to share cutting-edge technology. Since 2017, several Modern Markets Initiative members have welcomed the opportunity to work together with FINRA in public-private partnerships. We are contributing our know-how while welcoming deploying artificial intelligence together to surveil the markets.

So automated trading firms are incentivized to detect bad actors, because we, too, can be the victims of fraud. And as bad actors become more sophisticated globally, it is absolutely vital that financial regulators have the funding resources so they, too, have the technological capacity and access to AI and automated technologies to be a strong and effective cop on the beat.

Third, as AI technology matures, we can expect increased demand for high-quality, robust data, including alternative data, to provide what I call the crude oil for the engines of AI. This entails large quantities of complex data that humans alone cannot digest. So I think we are going to see policy questions arise around this proliferation of data; I think it was already noted, questions of competition and antitrust in the digital marketplace. We are going to see increasing discussion of intellectual property rights and ownership rights of that data and questions of access to that data and the cost of data.

I think alternative data has been successful in helping establish a credit history for the underbanked. That is one positive. But I think we need to continue discussions surrounding algorithm bias. And, in my prepared testimony, I have noted next steps, including industry-led initiatives, to share best practices, utilize ethics officers, and regtech approaches.

And, last, I want to talk about the future of the workforce. AI and automation can and should be a tool rather than a replacement for humans. Some jobs will disappear, and others will grow. Areas of growth we can expect to see are in the computer occupations, jobs related to the transmission, storage, security, privacy, and integrity of data, the fiber-optics industry. They are all going to be fueling the AI economy.

There is massive existing demand for qualified technological talent across virtually all sectors of our economy, particularly in the financial sector. The current baseline participation for women, and particularly women of color, is something that leaves room for substantial improvement, and that is something we are focused on. And a skilled workforce for tomorrow's Wall Street is only as good as the companies that are there to invest in technology.

I thank you for your time.

[The prepared statement of Ms. Wegner can be found on page 89 of the appendix.]

Chairman FOSTER. Thank you.

And, Ms. Rejsjo, you are now recognized for 5 minutes to give an oral presentation of your testimony.

STATEMENT OF MARTINA REJSJO, VICE PRESIDENT, NASDAQ MARKETWATCH

Ms. REJSJO. Thank you, Chairman Foster and Ranking Member Loudermilk, for the opportunity to testify on the impact of AI on our capital markets.

Many people associate AI with high-tech and movies such as "The Matrix," and "Terminator," but we at Nasdaq strongly believe that we can use this technology 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 to

protect participants and investors. We operate 25 exchanges and 6 clearinghouses around the globe. And we sell marketplace technology—trading, clearing, and surveillance systems—to hundreds of the world’s markets, regulators, exchanges, clearinghouses, and broker-dealers.

Our internal surveillance department is monitoring the markets for insider trading, fraud, and manipulation, as well as handling real-time events in the market. The accessibility of the markets and the increase in players with the ability to deploy manipulative strategies using their own technology and the exponential increase in data quantities can act as the perfect ecosystem for market manipulators to hide amongst the noise. This increased complexity in monitoring presents new challenges for the surveillance team relying on preconceived parameters and known factors to detect manipulative patterns.

Our surveillance program is using algorithmic coding to detect unusual market behavior, running over 40 different algorithms in real-time, utilizing over 35,000 parameters. In addition to real-time surveillance, there are over 150 patterns covering post-trade surveillance to identify a wider range of potential misconduct. The team proactively develops tools and procedures to increase the quality of surveillance and to meet changing demands in the markets.

But with the manner in which patterns are currently recognized, relying on known factors to describe behavior, it can be difficult to capture new behavior and to remain proactive rather than reactive to threats in the market.

In addition, predefined expectations of what patterns look like can often limit alert results, depending on how alert parameters are calibrated. Calibration also presents a continued challenge when determining the best balance between false positives and true alerts.

These challenges led to a calibration between the Nasdaq Machine Intelligence Lab, Nasdaq’s market technology business, and the Nasdaq U.S. Surveillance Team, to enhance surveillance capacities with the help of artificial intelligence.

Using AI to detect abnormal behavior patterns is based on the notion that manipulative behavior can be identified by signals in the markets, that a scheme to defraud market participants often has a specific pattern to it. There is a price rise or decline, an action is taken, and the trading is then back to normal. So, this signaling concept leads to new ways to look at pattern detection.

By leveraging AI, detection models are not tied to static logic or parameters. We are able to train the AI machine based on visual patterns of manipulation, and we started to look at this spoofing pattern.

The machine must then further train with human input, and then transfer learning was used to expand the scope of this project beyond spoofing. Transfer learning leveraged AI to apply a model developed for a specific task at the starting point for a model on the second task.

By using deep-learning and human-in-the-loop techniques, the new models for detecting market abuse with our initial spoofing ex-

amples indicated usable results with 95 percent fewer examples than typically required.

The inclusion of AI into the detection function will allow us to focus the effort on in-depth investigations of potential manipulative behavior instead of triaging a high number of false positives.

But, to be clear, the human input is still of critical importance, both in analyzing the output from the surveillance system but also in continuously training the machine to produce more and more accurate outputs.

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

By incorporating AI, we are sharpening our detection capabilities and broadening our view of market activity to safeguard the integrity of our financial markets.

Surveillance is a critical use case for AI, but Nasdaq is also looking to apply it in other businesses. For example, we are using a version of AI, natural language processing, in the listings business to facilitate the compliance review of public company filings.

In closing, we are convinced that this use case for AI will benefit investors and the resiliency of the U.S. market and the other markets that we serve.

Thank you for the opportunity to testify, and I am happy to answer your questions.

[The prepared statement of Ms. Rejsjo can be found on page 80 of the appendix.]

Chairman FOSTER. Thank you.

And I will now recognize myself for 5 minutes for questions.

I should also mention to the Members present, it looks like the latest estimate for votes is now 11:30, so we may, in fact, have time for a second round of questions for Members who are interested. We will have to play it by ear.

Dr. Lopez de Prado, you note in your testimony that today, data vendors offer a wide range of data sets—and I think other witnesses mentioned that—things that were not available a couple of years ago. And not only the data itself but the processing power to analyze it and the real-time delivery of that data is becoming more and more important to successfully trade on it.

Could you just illuminate for us what are some of the more interesting data sets that you now see being used?

Mr. LOPEZ DE PRADO. Certainly. It is a combination of data sets. On one hand, we have access now to credit card transactions, geolocation data, satellite images, transcriptions from earning calls, engineering data, and data from engineering processes like exploration and production companies that allow us to better estimate where the wells are for extraction of oil or fracking—all sorts of data.

Keep in mind, please, that 80 percent of all data recorded today was generated over the past 3 or 4 years. Going back to history, going back to Mesopotamia, there is a lot of data around, data that we aren't even aware of but is just being scraped from websites and such.

So all of this data can be used to understand what is the psychology of people, what is the state of mind of people, understanding people are more inclined today to take risks or to, for instance, relocate their assets to fixed income instead of stocks; trying to understand from news articles, as one of my colleagues mentioned, what are the narratives associated with particular companies.

The amount of data today is staggering, and this is only going to increase because the storage of data is becoming cheaper every day and the processing power is increasing. So, this is definitely a trend that is not going to stop.

Chairman FOSTER. Yes. And as I think I mentioned in my opening remarks, that has a danger of driving monopoly, the returns to scale—because you get more correlations to look at with your AI if you have the full range of data.

And so, this will naturally cause those smaller players in the market to be less effective, and less profitable. And I think, that is probably what you are seeing in high-frequency trading, the consolidation that you are seeing there.

Now, is there any way around this? And how hard should we lean against the natural tendency to monopoly here in financial trading?

Mr. LOPEZ DE PRADO. There are two schools of thought in this regard.

Number one, there are a number of academics who believe that this consolidation is not necessarily negative, in the sense that the few survivors that are able to consolidate, for instance, high-frequency trading, today are operating like utilities. They are not making the kind of returns that they were able to obtain 9 years or 10 years ago. Essentially, what happens is that they break even. These technologies are becoming so expensive that they have to spend this time and money in order to achieve a profit that is dwindling.

There are a number of academics who believe that, actually, consolidation is not necessarily negative. There is, on the other hand, of course, the problem that a small number of operators could have a grip on the market, and it also could cause a domino effect if one of them fails to provide liquidity.

So, there is a need to strike a balance between, on one hand, preventing too much consolidation, and on the other hand, also favoring competition between these operators.

Chairman FOSTER. Yes. Ms. Wegner, you mentioned that this actually netted out—or, at least, electronic trading generally netted out very positively for someone's retirement account, that it actually, because of the lower bid-offer spreads and transaction costs, that, actually, it was—I think you quoted 30 percent—

Ms. WEGNER. Correct.

Chairman FOSTER. —more in your retirement account as a result of this.

So, similarly, when AI is widely deployed, if it is very effectively deployed, in principle we get a more efficient capital allocation across our country. And so is, actually, the best strategy to let a small number of very dominant players have access to all the data sets to get a more efficient economy?

Ms. WEGNER. Yes. I think it is absolutely—

Chairman FOSTER. Or are we better off just letting a thousand flowers bloom?

Ms. WEGNER. Sure. I think it is absolutely vital that we encourage policies that promote strong competition in this space. And with high-frequency trading and automated trading, we have seen such fierce competition over the past decade or two that we are approaching near-zero latency speed, we are approaching the speed of limits of—

Chairman FOSTER. But also more monopolization. I think my time is up here, but this is something I intend to return to—

Ms. WEGNER. Sure, absolutely.

Chairman FOSTER. —if we get a chance here.

Ms. WEGNER. I am happy to respond.

Chairman FOSTER. Thank you all.

I now yield 5 minutes to the ranking member, Mr. Loudermilk.

Mr. LOUDERMILK. Thank you, Mr. Chairman.

Ms. Wegner, as you know, the SEC has experienced some cybersecurity difficulties, especially in the 2016 EDGAR data breach. I think it is important for the SEC to only obtain proprietary trading algorithms, if absolutely necessary, with a subpoena. So I was wondering if you could discuss why it is important for source code to be protected?

Ms. WEGNER. Sure. That is a very good question.

The real lifeblood of automated trading and the, kind of, secret sauce is the source code—that is the valuable intellectual property that the different firms are competing against each other with, not just domestically but globally. And just like a self-driving car company needs to keep its algorithms and source-code intellectual property protected from misappropriation, so do algorithmic traders rely on government protection for their intellectual property.

There was a proposal a number of years ago to perhaps collect IP source code and put that in a government repository just in case it was needed. That never came to light, but it is still something we are absolutely educating policymakers on. This should be, I think, a bipartisan area of interest, to ensure that we have a globally competitive marketplace that protects intellectual property rights.

Mr. LOUDERMILK. I appreciate that from my time in the military working in intelligence. We had a principle we lived by because of the sensitivity of the data that we collected and maintained, which was, “If you don’t need something, don’t keep it,” which means you don’t have to protect what you don’t have.

And my concern is how vulnerable the industry becomes, because, quite frankly, the government tends to be the weakest link when it comes to data security in some aspects. So, I think obtaining that source code is not only just a violation of the privacy right of the business, the coder, but it could also be a national security risk.

Ms. WEGNER. I think that is right. If bad actors were able to breach the source code, it would be presenting an opportunity for manipulating the markets or cyber risks. So it is absolutely vital that we protect the intellectual property rights of source code.

Mr. LOUDERMILK. Thank you.

Ms. Fender, the adoption of artificial intelligence in electronic trading can disrupt the job market and displace floor traders, but technologies also create a need for more workers in other fields.

Today, we have about a million people working in the airline industry, but in the early 1900s, The Washington Post led with a headline that said, “Man Will Never Fly and Shouldn’t,” and part of their argument was the displacement of people in the job market.

Could you touch on the job fields that are growing because of the use of AI in the capital markets space?

Ms. FENDER. Yes. Thank you.

As you noted, there are many ways that jobs are changing, and adaptation is really the key.

We surveyed industry leaders, the people who are doing the hiring, and we asked, “What are the most important skills going forward? Maybe it is not necessarily in the job description. What are the skills underlying who will succeed in the future?”

And they talked about something called T-shaped skills. This is an idea that, if you think about the letter “T,” you have the vertical bar where there is deep subject-matter expertise and a horizontal bar where you can cut across different disciplines.

And if you think about fintech, we have big risk if there is “fin” over here and “tech” over here, and they aren’t talking. So, the ability to connect the two is where there is a lot of opportunity.

These are the innovators. This is an area where you will see more research needing to be done so that we understand what the trends are.

And the key thing is that people have to ask the right questions. Firms are realizing you have to think about the return on investment (ROI) of gathering this data. And many of the machine-learning people will say a large percentage of the data isn’t that useful. So you have to be smart about how to do that and start the process with investment professionals.

Mr. LOUDERMILK. Okay. So, what you are getting at is not all the jobs are going to be just as deep intellectual, being able to code and understand algorithms and all that, but there are ancillary jobs that come about because of the development, is that a fair statement?

Ms. FENDER. Yes, definitely. We don’t think, for example, that all CFA charterholders need to become programmers, but we think they are going to have data scientists on their teams, and they are going to need to speak the language and work together.

Mr. LOUDERMILK. Okay.

Ms. Rejsjo, I want to talk about the use of artificial intelligence in fraud detection. I view cybersecurity as the biggest challenge that we face in this nation, from a business, government, and personal perspective.

Can you touch on quickly—I’m running out of time—how algorithms are used to detect unusual market behavior?

Ms. REJSJO. Yes. As I said, we really rely on the algorithm coding to pick up on the unusual patterns that we see. Everything needs to be compared to something that is usual, right? So we program things to pick up on the unusual things based on historical comparison on specific stocks, how they have been trading in the

past. So that is what we do already and we have done for a long time.

The new thing here—

Mr. LOUDERMILK. Thank you.

Chairman FOSTER. At this point, I think we will leave that hopefully to your next round of questioning.

The gentlewoman from North Carolina, Ms. Adams, is now recognized for 5 minutes.

Ms. ADAMS. I thank the Chair very much for putting this hearing together. We appreciate it.

And, also, those of you who have come to testify, thank you very much for your comments and for your work.

Automation technologies, which enable the transfer of tasks from human labor to machines, affect approximately 6.4 million workers employed in the financial services industry. Specific industries like credit lending and capital markets are being affected by AI, as human tasks involving data analysis, decision-making, and compliance are replaced by machine-learning robots. This shift in job automation could predict which jobs in financial services will be replaced and what new jobs could be created.

Ms. Wegner, specifically examining loan underwriting compared to the traditional methods of meeting a loan application in person, to what extent does AI replace or augment the work done by loan officers, credit counselors, or other credit underwriters?

Ms. WEGNER. That is a very good question.

In the consumer lending context, I think it is very important that AI is the tool for humans when they are extending credit and extending loans, that there are systems in place to ensure that there isn't any sort of algorithmic bias. And, in my prepared testimony, I noted some suggestions. Our members are not engaged in the consumer lending context, but we have our own insight.

I think that loan companies, individually or collectively, could employ ethics officers to ensure that there isn't algorithmic bias in the lending context. I think it is important that industry members share lessons learned as they explore how they are democratizing access to credit and finding the most efficient ways to extend that credit.

I think it is really vital that we act now to make sure, as we are building out this system, that we minimize the risk for algorithmic bias in consumer lending. I think it is very vital.

Ms. ADAMS. Thank you, ma'am.

Is the U.S. properly equipped to remain competitive in the financial services workforce?

This question is to Dr. Lopez de Prado and to Ms. Fender.

Mr. LOPEZ DE PRADO. The U.S. is the leader in the financial services industry today. My concern is that this leadership is being challenged by the fact that: first, we are not investing as much in AI as other countries; and second, the fact that we are educating our competitors.

In my remarks, I mentioned that I am very concerned that the innovators of the future are attending today a class in our universities but they will not be allowed to stay. And, as a result, yes, we are very competitive, and this ability to train these skills is going to turn against us if we are not able to retain this talent.

Ms. ADAMS. Okay.

Ms. FENDER?

Ms. FENDER. We have seen that—again, it is early days for how this changes our industry, with only about 10 percent actually using these techniques. But what we are seeing is that firms are doing AI labs, they are doing innovation hubs. They realize that this is something they need to be proactive about.

And so we are seeing—out of our case studies, we had a criteria that things in our case studies had to actually be in practice. There is a lot of talk out there, but things that are actually in practice, five of the nine are here in the U.S.

Ms. ADAMS. Great. Thank you.

Dr. McIlwain, are we adequately teaching the skills needed for the jobs of the future?

Mr. McILWAIN. Thank you for the question.

I think we are adequately teaching those skills; I think the question is, who has access to that teaching?

And so, when we think about underrepresentation of certain individuals and members of the workforce who are not getting the types of education that are needed for the jobs that may be coming online as a result of automation and AI development—and so I think, if we are to have a full pipeline of folks who are able to receive what it is that we teach in our colleges, universities, even high schools and younger, then we have to be more proactive about making sure that all people have access to that teaching and that information.

Ms. ADAMS. No one left behind.

Mr. McILWAIN. Absolutely.

Ms. ADAMS. Okay. I appreciate that.

I am going to yield back, Mr. Chairman. Thank you very much.

Chairman FOSTER. Thank you.

The gentleman from Indiana, Mr. Hollingsworth, is now recognized for 5 minutes.

Mr. HOLLINGSWORTH. I appreciate each of you being here today, and I appreciate the chairman for holding this hearing. This is an important topic, something I have been really passionate about since arriving here in Congress.

And, Dr. Lopez de Prado, I appreciate your comments, because what you have touched on is something that I have been an ardent believer in for a long time, which is that the big arm of the Federal Government isn't going to stop the growth of this technology, isn't going to cease the investment in AI either here or around the world. And while we can shape the context by which that technology flows, we are not going to dam up and stop that technology.

And so, when people say job losses may result on account of this, there is a lot of fear and a lot of desire to put an end to that and to stop that, but I like how you referenced a lot of training and retraining that may need to happen—training individuals who are graduating from school to ensure they have the skills that are necessary in a 21st-Century workplace, but also ensuring that those who are already in the workplace have the opportunity to get the retraining to continue their competitiveness. And as we see further growth and development in AI, it will require more and more fre-

quent retraining to stay ahead of that, to stay relevant in that field. That is a very competitive field, right?

But the second thing you touched on is something I am even more ardent about. We educate a lot of kids in this country. We do higher education in this country better than anywhere else in the world. We bring a lot of talent into this country. We invest a lot in those kids, and then we politely ask them to leave at the end of their tenure here, right? That is embarrassing, that is idiotic, that is stupid, and I hate that.

I want to find a way to attract talent into this country and retain talent into this country, not because I believe it is a zero-sum game but because I believe that this country can provide a crucible for technological development that you can't find elsewhere in the world. And I think that technology will benefit humankind over all the world in the long run, and I want to make sure we do that.

So, I really appreciate you touching on those topics, and I really appreciate that investment of time.

Ms. Wegner, I know that you have a source-code event coming up. Today? Tomorrow?

Ms. WEGNER. This afternoon.

Mr. HOLLINGSWORTH. This afternoon, to talk about source code again. And I really appreciate you continuing to educate a lot of people about how important that is. Where I go, all the way across the district in Indiana, I hear more and more about how much technology, how much investment, how much IP is in things that aren't readily seen, either in business processes, in the source code, in the technology underpinning automation itself. And so I know how important that is, and I really appreciate you bringing that to light.

All that being said, I wanted to ask Ms. Rejsjo a question that is maybe a little bit far afield from what we are talking about today.

I had some people in my office earlier this week who were very complimentary, frankly, of Nasdaq surveillance services. They were very complimentary—they were public companies—and how, when something seems amiss in the markets, Nasdaq was very quick to pick up the phone and say, "Something seems amiss. Let's figure out what is going on here."

One of the things that is very important back home is biotech. A lot of biotech firms are based in Indiana. People don't know that. We are trying to get the word out about it. They are concerned about market manipulation, specifically with regard to short-selling. And they are promoting this idea that there should be more disclosure around short-selling, similar to many long positions.

Now, they came in and said that disclosure around short-selling would really help us, as a firm, better understand those that might have interests adverse to us, because we can't really track that right now. But the counter-argument that they made was, gosh, Nasdaq seems to be doing a really good job of figuring out when there is potential manipulation.

I wondered if you might touch on that. Is disclosure in short-selling something that would benefit the market, something that would benefit these firms? Or do you feel like you have enough of the ability to track potential market manipulation on the back end?

And, again, I am not pejorative against short-sellers. I just want to make sure that it is legitimate action, not market manipulation. I wonder if you might comment on that in the last minute.

Ms. REJSJO. I think disclosure is a big part of surveillance.

Mr. HOLLINGSWORTH. Yes.

Ms. REJSJO. Information is always needed to understand what is happening.

Mr. HOLLINGSWORTH. Okay.

Ms. REJSJO. I do think that what we have today is sufficient. As you say, we have a lot of patterns that are detecting manipulation such as short-selling, or, I might say, the troublesome part of short-selling.

Mr. HOLLINGSWORTH. Right.

Ms. REJSJO. I mean, short-selling is legal, right?

Mr. HOLLINGSWORTH. Right. Of course.

Ms. REJSJO. So it is really to detect what is then being—how it is used in an abnormal way or in a sort of manipulative kind of way.

Mr. HOLLINGSWORTH. Yes. So you feel like you can detect the activity that would be illegal or abnormal or different adequately. The question is, what do we do with it after that point, is maybe where we should focus public policy attention? Is that fair?

Ms. REJSJO. Yes. But to be fair, also, there are other parts within Nasdaq that handle more of the policy questions.

Mr. HOLLINGSWORTH. Okay.

Ms. REJSJO. But for me as a surveillance practitioner, I do think that the disclosure we have and the tools we have to monitor the markets are—

Mr. HOLLINGSWORTH. Are adequate.

Ms. REJSJO. Yes.

Mr. HOLLINGSWORTH. Great. I think that is an important question. Because when they were in my office, I think that is the question: Where do we need to focus public policy attention? And perhaps it is beyond surveillance, and focus more on some of the penalties or some of the actions that happen with the enforcement agencies.

With that, I will yield back.

Chairman FOSTER. Thank you.

And I am very encouraged that one of the areas of bipartisan agreement here is the insanity of this business of awarding people their Ph.D.s and pushing them back on an airplane.

And so that is one of the reasons I was proud to introduce, this session of Congress, H.R. 4623, the Keep STEM Talent Act of 2019, designed to—it is a rifle shot to just exactly solve this problem. And I really look forward to my colleagues' support on this.

And now, I recognize the gentlewoman from Texas, Ms. Garcia, for 5 minutes.

Ms. GARCIA OF TEXAS. Thank you, Mr. Chairman. And thank you again for holding this hearing.

And thank you to all the witnesses. Good morning, and welcome.

I wanted to focus on a couple of issues that some of you have already talked about. Like Ms. Adams, I am particularly concerned about jobs. My district is in Houston, and is 77 percent Latino. It is also working-class, so we are always concerned about jobs. I am

encouraged that you all seem to have the consensus that, although there will be some job displacement, there will be new jobs created.

My main concern, of course, is whether or not we do have the skill sets, Mr. McIlwain, to transfer those skills or to make sure that we can fill those jobs. Because, in the end, that is what really matters to families in my district.

But I am also concerned with automation and the difference between AI and automation, and how it can work together, specifically in the area of regulatory compliance.

Ms. FENDER, in your experience, has AI and automation affected institutions' regulatory compliance? Is it improving? Is it still a work in progress? Or how are we doing?

Ms. FENDER. Thank you. That is a very good question. And, again, I think it is about—it is still kind of early to know. We hear so much about what is coming, and yet—so compliance areas are growing in firms clearly. And now we have more and more data, and regulators are going to be able to have the same sort of data.

The question is, is there a greater risk, maybe, of insider information now? You collect more data, and people can see lots of different patterns out there. And if they see that and can trade on it before the market, then you have challenges for the SEC, I think, in terms of Reg FT and so forth.

Ms. GARCIA OF TEXAS. Okay.

Ms. Wegner, can that be used to simplify and ensure regulatory compliance with the Federal agencies in charge of supervising the capital markets.

Ms. WEGNER. Sure. I think, as the data sets become more complex, as you just alluded to, I think it is going to be vital that the regulators have the resources to have their own AI, either independently of the companies, or together with the companies through public-private partnerships as the bad actors become more sophisticated, and we are talking about global bad actors. We need a strong cop on the beat here in the U.S. And I think it is very important that the private sector work together with regulators to ensure that they have those resources, and that Congress really ensures that the SEC and the CFTC have the resources they need, because the systems are becoming much more complex and regtech is evolving, but needs to keep up with the pace of that technology.

Ms. GARCIA OF TEXAS. I think that is a big concern of this committee, those bad actors, as you have described them.

So how can AI assist us with anti-money-laundering compliance's suspicious activity reporting? Are we prepared for that? I know we did a codel to several countries. And things are getting more and more sophisticated, and it seems like the bad actors have more money and better things, to find ways to hide the money. Do we have what we need to detect it and to ensure that we can catch it?

Ms. WEGNER. It is vital that we focus on this. And I would say Haimera Workie, who is the new head of innovation at FINRA, has an excellent group. They just established themselves this year. They are a fantastic resource. They are working together with other regulators, with private sector participants to gather information about best practices, and to really make sure we have the best

technology. This is 100 percent something we need to be focused on.

Ms. GARCIA OF TEXAS. In your opinion, do you think that our regulators and our oversight entities are well-prepared in this arena, or what else should we be doing?

Ms. WEGNER. I think we need to be investing in technology. There is always room for more technology with the regulatory agencies. I think MIDAS at the SEC has been a very positive example of the SEC using very sophisticated technology to surveil the markets, but I think this is a constantly evolving space, as everyone here has noted. We have to just keep very much on our tiptoes on this, and keep on investing in this area.

Ms. GARCIA OF TEXAS. Okay.

Ms. Fender, did you want to add something?

Ms. FENDER. I think the more data we have, the more complex it gets, right? And one of the other things that we are really concerned about is the investor protection side too.

If bad data goes into these models, they can be marketed in many different ways. And so, disclosures are really important. Understanding your clients, understanding where the money comes from, and understanding what clients are really getting all kind of goes together.

Ms. GARCIA OF TEXAS. Thank you. Thank you, both of you. And I yield back.

Chairman FOSTER. Thank you. The gentleman from Virginia, Mr. Rigglesman, is recognized for 5 minutes.

Mr. RIGGLESMAN. Thank you, Mr. Chairman. I want to thank all of the witnesses for being here today. I am so happy that all of you are here, so I am not showing any favoritism. I would particularly like to welcome Ms. Fender from the CFA Institute, which is located in my district in Charlottesville, Virginia. The CFA Institute provides a host of resources for professionals who work in the financial services industry, who are among the most qualified and adhere to the highest codes of standards in the financial industry. I am honored to have such a distinguished group reside in the Fifth District. Although Ms. Fender is not a constituent herself, her organization employs many of them, so I am thrilled to see you here today. Welcome, and welcome to all of you.

I will start with you, Ms. Fender. You probably knew that was going to happen. Can you talk about how CFA is adapting the charter to these AI and machine-learning innovations in the investment industry?

Ms. FENDER. Thank you very much. And I'm pleased to be here representing Virginia.

The CFA Institute is really the global standard for investment practitioners. The people who have our credential are the portfolio managers for your 401(k). They are the chief investment officers at the public pension funds. They are the people who are really safeguarding the financial futures of so many people. And so, it is imperative for us to keep up-to-date on what we teach. I mentioned earlier in my testimony that we just added machine learning into our curriculum. And this is a significant indication that we are seeing the market change. And we need to prepare people.

We have a group called our practice analysis team. And they are out there all the time going to these conferences, figuring out what is the next thing that people need to know, because global demand for investment management is growing, and especially for those who really combine both competence and ethics.

Mr. RIGGLEMAN. There really is a reason I asked that question. My prior job, and we talked about monopolization of the data and things of that nature. I wanted to monopolize as much data as I could for data interactions when looking at sort of critical infrastructure analysis when I worked for the Office of the Secretary of Defense. We had about 40 people looking at this, so we had to look at all data, multi domain across stovepipes, and see how that actually includes that data or to analyze or aggregate that data, consolidate it, aggregate it, analyze it, and then execute using that data based on how we templated human behavior.

So looking at AI and ML rules, I guess that I will start with Ms. Rejsjo, I am going to ask a few of these, because this is the exciting part for me, is the technology part. When we did this, we had multiple data sets that people had never seen before. We talked about the challenges of data. We had multiple data sets. We had data we had never sort of aggregated, and combined with other data sets.

So we thought we had the right answer, and we found out we didn't, in trying to template human behavior analysis. Do you think that is something you are going to see more of in the future, is that there won't be a human in the loop, and there will be more sort of human templating, or machine-learning rules to sort of mimic what human behavior does with certain rule sets? Do you think we are going to see more and more of that, taking humans out of the loop, looking at actually any type of analysis, or fraud, or anything of that nature?

Ms. REJSJO. I think that we are a long way from that. I think that for now, the way that we do it is really to have the data that we have. For us, it is really much more the order and trade data that we already have and that we analyze. Now, we are just applying a new technique to give us a better overview that is not that parameter-driven. But for us, still, I really think that the human in the loop is the way to go, because there is much more analysis that needs to be applied after the output has come. And I think that is going to be there for a while.

Mr. RIGGLEMAN. It is interesting that you said that. We actually thought we could take the human out of the loop in some of our processes, and found out it was not a good idea, with some of the things that we did. I see some heads nodding back there. We tried to do that.

Dr. Lopez de Prado, you were talking about, there could be some advantages to sort of aggregating as much data in one place as we can, right? And then looking in the gaps of that data. That is the thing I have been trying to wrap my arms around. My whole job was not competition. It was to monopolize all the data. And then to use competition to give us the best algorithmic solutions that we could first for first, second, and third order effects of what happened to a specific part of the network.

This is a tough question, because to be this objective in 40 seconds is going to be probably ridiculous. But when you are looking

at this, do you think—and I know this is a tough question—with all the proprietary technologies out there, do you think there will be a voluntary sharing of that data if we find something that is very good, across multiple sets? So, for example, another company, do you think we will have that type of sharing for proprietary solutions based on algorithmic types of analysis? Do you think that will ever happen? Or do we think we have to sort of force that to happen when we monopolize that kind of data, if that makes sense.

Mr. LOPEZ DE PRADO. Are you referring to sharing these technologies—

Mr. RIGGLEMAN. Yes.

Mr. LOPEZ DE PRADO. In private and public companies?

Mr. RIGGLEMAN. Yes.

Mr. LOPEZ DE PRADO. When you look at the NASA model, actually, there has been a lot of transfer of IP between the agency and various contractors. So that could be a model that could work for the CFTC and the SEC. In particular, in my remarks I mentioned the crowdsourcing of investigations, how the companies or private participants could establish tournaments to help agencies identify market manipulators.

Mr. RIGGLEMAN. Thank you very much. And I yield back the balance of my time.

Chairman FOSTER. Thank you.

The gentleman from Illinois, Mr. Casten, is recognized it for 5 minutes.

Mr. CASTEN. Thank you, Mr. Chairman. And thank you all so much for being here today.

Back in my prior life, I had a head of engineering who had a theory that I have yet to prove wrong. He said, every advance in technology gives us more precision and less knowledge. This was a guy who started with slide rules, where he had to know the order of magnitude of his answer. And now, he got 16 significant digits, and can never remember whether it was millions or billions. And, of course, in my lifetime, we have gone from foldable maps to GPS that can give me the exact latitude and longitude. And I can't tell you whether I am north, south, east, or west of where I started.

AI has always struck me as sort of putting that acceleration on steroids. At one point, I built a genetic algorithm to predict the revenues of our utility business, and it was amazing. I cut our revenue forecast variance by 90 percent, and I have no idea how it worked.

And that is the power and the frustration. I mention that because I think most of you have talked about the consumer benefit that comes when we get all these AI algorithms out in the markets, and we get lower trading costs, lower bid ask spreads. And that is all terrific.

A lot of you have also talked about bad actors and we can put up monitoring for that and that is also great. The concern I have is this tension between the transparency of the model, and whether the model can actually effectively replicate a bad actor that we don't understand, because it is fairly easy for me to imagine the trading algorithm that is tracking a bunch of data and has figured out how to bet on one country invading another and making money. I can imagine a trading algorithm that is looking at

changes in currency flows for illegal activity that is not in itself illegal, but is arbitraging some spread that results from that.

So Ms. Wegner, I wonder if you would comment on that tension between transparency and algorithm robustness? And to what degree we have or need regulatory tools to stipulate where we sit on that continuum?

Ms. WEGNER. Sure. I think transparency is absolutely vital. I think it is also very vital that regulators and the exchanges have the resources that, if they note any sort of irregularity in the markets, they can immediately identify that. And to the question of whether or not one needs to get source code, if there is a detection of some sort of illegal or irregular activity, then the regulator requests—

Mr. CASTEN. But if I could just clarify, first, would you agree that the more transparent the algorithm, potentially the less powerful the algorithm?

Ms. WEGNER. I think to the extent that the algorithm is not subject to intellectual property rights, that transparency is absolutely vital. If we are talking about intellectual property rights in this source code of algorithm, that is proprietary information that if it was—

Mr. CASTEN. By transparency, I am not referring to whether or not the public has access to the algorithm. I am referring to whether or not our human brains can understand how the algorithm works. I could give you the genetic algorithm I wrote. You couldn't understand what it is doing.

Ms. WEGNER. Sure. That question becomes more complicated in the machine-learning context, especially. You point to an interesting question, as the commands become self-acting in a way, they are basing their analysis on the existing data sets. I don't think we are totally there yet, but I think that is something we definitely need to explore, what does our policy answer to, because that is an interesting balance.

Mr. CASTEN. This question is for you, but really for all of the panelists. I think thinking about that problem before it gets there, because it strikes me that there will be pressure for every trading firm to develop the most powerful algorithms, which, by definition, at some level, are going to be the ones that we have the least ability to unpack and understand.

Ms. WEGNER. I think this is an important question that the industry should get together on and share their best practices, how do you balance that push for trade?

Mr. CASTEN. For anybody who thinks they have a great answer in this, number one, how should we do that? And number two, to what degree do we need to coordinate internationally? Because even if we do everything in our country, since all of these markets are so interlinked, is this a U.S. problem, or is this an international problem? Does anybody have thoughts on that?

Mr. LOPEZ DE PRADO. If I may, this is a very important distinction. Black boxes in finance tend to be less reliable than transparent solutions, particularly in finance, because we are dealing with problems where the signal-to-noise ratio is very low. Unlike, for instance, in astrophysics research, why is the signal-to-noise ratio low in the finance world because of competition, because of ar-

bitrage? Otherwise, everybody would be able to extract profits from the market. So because of that, when we deploy black box solutions in finance, the solutions can identify patterns that are not real, they are just balancing the noise and confound these patterns with these noise patterns with actual signal, leaving to investment studies that will fail. So one solution would be for an investor to understand very carefully when a product is based on a black box solution as opposed to a transparent machine-learning solution.

Mr. CASTEN. Thank you. I yield back. I would welcome any of your comments. If you have any follow-up in writing, please share.

Chairman FOSTER. As I mentioned, we are likely to have another round for Members who are interested here.

The gentleman from Missouri, Mr. Cleaver, who is also the Chair of our Subcommittee on National Security, International Development and Monetary Policy, is recognized for 5 minutes.

Mr. CLEAVER. Thank you, Mr. Chairman. And I really appreciate you calling this hearing and we appreciate all of you giving us your time.

I don't know how we are going to deal with AI and human beings. Long before we had flip phones, Captain Kirk had one, and long before we had the smartwatches, Mr. Spock had one. And a lot of attention is always paid to Hollywood, particularly in science fiction, and the military, our own military.

So a lot of people have their eyes on a fearful future, as it relates to AI. And to be straight, I am one of those, I am conflicted. I know we can't hold back the wind. It is inevitable that we are going to see more and more of this in the future. And I am not sure that we ought to try to hold it back. But to the degree that we can control it, that is what I think we ought to do. And that is where I am concentrating most of my answers.

Dr. McIlwain, first of all, thank you for being here. But I am wondering how inclusive this new technology is right now, and what can we do to make sure that in the future, every component of our great mosaic in the United States is a part of it?

Mr. MCILWAIN. Thank you for that question, and I share a little bit of your fear, because what we know persists as technology changes, as technological advances are made is that some people, and typically, the same groups of people, are left out, left behind, disadvantaged. And so, even as technology is unpredictable, some of those exclusions are very much predictable.

I think those exclusions are present in our current market, as most of the folks in this panel have at least alluded and nodded to; that is, when we look at our technology sector, those who are prepared to be part of that sector, those who are currently working, building the technologies of today and tomorrow are tremendously unrepresentative of our full democracy of all the citizens of our country. And I think representation makes a tremendous difference. I think the place we are in today with respect to some of the inequalities and devastations that technologies, AI and automation included, have wreaked, because not everyone has been included in the decision-making about what technologies will be built, why, for what purposes, who they will advantage and disadvantage.

So I think moving forward, we have to change that. That is, we have to invest strategically in building a more inclusive workforce in these sectors that are growing. That is the technology sector and the financial sector as well.

Mr. CLEAVER. What do you think we should do, or any of you do right now, if we—we have young people interested in and committed to the future, and AI is an inevitable part of it. What should they do next week? What should young people be doing? How should we direct young people right now, who are scientifically gifted? What should we do?

Ms. WEGNER. I think we need to promote responsible innovation. I know our members support trying to get out there to the middle school students geographically across the country, a diverse population of people, and get them interested in STEM fields. I think there is a lot of opportunity for companies to partner with some of the public schools in a geographically diverse part of the country and help fund that, and just recruit now. Kids get interested in these fields from a young age. And we just have to get in there early and make sure that people see role models at the firms that we promote those public-private partnerships.

Mr. CLEAVER. My time is up, so thank you very much. Thank you, Mr. Chairman.

Chairman FOSTER. Thank you.

And, I guess, we have time for a brief second round of questions here.

We have had sort of two different narratives that have been going on here. One is the, sort of, optimistic narrative of the—well, I guess the T-shaped skills or machine intelligence, human intelligence paring, albeit second, augmented human intelligence. And then we also have the sort of intermediate way of transfer learning, where you would actually use one field of expertise and transfer what was learned there to another field thereby replacing multiple machine parings. An example of that was the example from the geniuses at Goldman who were analyzing satellite imagery of quarry activities to predict cement pricing, and so on in the future; and then, potentially, using transfer learning so that knowledge could be transferred to copper mining or whatever else it was.

On the other hand, there is an alternative narrative that you just aggregate all the data you can, and just say, I want a general purpose, learning, trading algorithm to look at all satellite data and look for all market correlations. And that would detect not only the cement market, it would look at the parking lots of Toys R Us to predict that Toys R Us was going bankrupt because they didn't have many cars on Black Friday.

And so this sort of thing could be written once and deployed to replace tens of thousands of machine-human pairings on here, and, obviously, with much, much smaller labor input and need for humans. So which of the two narratives is going to end up winning, and how is it going to net out for human participation in this? Anyone who wants to tackle that tar baby?

Ms. FENDER. I can start, and just say that one of the foundational concepts in investing is that correlation is not necessarily causation. And so, we have a lot of data and we can see these patterns, but you need a human to ask, what is the right

question? I mention also the example of going through the news stories with Bloomberg. And they said, the key question there was to go through the news article and not say, what do we think the author of this article wanted to get across, but what do we think people are hearing?

So there are a lot of nuances really about how this is going to play out. And that is why, again, having sort of the collective intelligence and diverse perspectives is going to be important.

Chairman FOSTER. Dr. Lopez de Prado?

Mr. LOPEZ DE PRADO. Yes. I think that the two narratives have some part of truth. I think in the short term, we have reasons to be worried in terms of the transfer of knowledge, and the potential displacement that will occur as these technologies are more broadly deployed. But I think in the long term, we have reasons to be optimistic, because the next generation would be better prepared than our generation, or previous generations. It is very important that we give equal access to education. It is very important that we encourage kids to learn how to program, participate in math and engineering classes, and that we form the flexible workforce, a workforce that in the future, we don't know what these technologies will do in 20 years, that they are able to engage proactively.

Chairman FOSTER. Is there a danger that this is going to squeeze all profitability out of financial services? That if you had complete knowledge of everything, and very efficient algorithms immediately trading on that knowledge, the 30 percent improvement in your retirement savings, all of that money used to end up in the pockets of people with nice homes in Oyster Bay, and that is sort of the nature of things. And it may be that when we get this much more efficient economy with extensive deployment of AI, just the total amount of money left to be extracted will continue to go down the same way high-frequency trading is sort of suffering that decline in margins.

Mr. LOPEZ DE PRADO. One view, if I may, is that, in fact, having such a perfect market is not necessarily bad for society, meaning that the day that we go to our financial adviser and we receive the same treatment that we receive when we go to the doctor essentially, there is a product goal of, this is what you need to invest to achieve your retirement goals. I think that is a good outcome.

Ms. WEGNER. And as we see greater efficiencies, global advisors and other more efficient, I would say, asset managers, we will be able to deploy that efficiency to the masses. But I think it also raises a global competition question, because we are not just talking about competition domestically, we are talking about internationally, and we are not going to stop time all across the world, right? Other countries are innovating in AI. So it is inevitable we are going to be competing in that space and we want to keep the U.S. markets the envy of the world, I think.

Chairman FOSTER. So if the future of financial advising is conversations with Alexa, I guess it comes down to, is the objective that a function that the AI running Alexa is maximizing, is that Amazon's profit? Or is it some linear combination of Amazon's profit and diversity inclusion, a secure retirement rather than steering people into products that are profitable for Amazon?

Ms. WEGNER. Right. I think the vital part here is, as you mentioned, we have competition, that there is not too much aggregation of power in one entity. We need to have policies that promote robust competition amongst, let's say, the robo advisors that make sure that data is accessible at competitive prices, so there is not a barrier to entry. This is going to be, I think, an exciting space where a Financial Services Committee meets a Judiciary Committee on antitrust issues, and meets a Commerce Committee. Finance is becoming more technology, and technology is becoming more finance. So, those are the right questions.

Chairman FOSTER. Thank you. And I will yield 5 minutes to the ranking member.

Mr. LOUDERMILK. Thank you, Mr. Chairman.

Ms. Rejsjo, I would like to go back and kind of continue our conversation that we were talking about, cybersecurity, and using AI, and fraud. And I wasn't managing that time very well before, so could you explain further how Nasdaq is using AI in fraud detection?

Ms. REJSJO. Yes, I think it is important, just to start, that—I mean, the future is here, right? We have billions of data points. It is a massive amount of data that needs to be analyzed to capture anything that is fraudulent or manipulative in the market. So, we have that environment already. And what we have been doing so far is deploying algorithmic coding to sort of be able to process all of this data very fast. Our real-time surveillance is picking up on unusual behavior within seconds after it has happened in the market.

So there is, really, a fast and efficient way to go through the data, but as it is growing and exponentially growing, there is the need, of course, to continue to invest in other ways of looking at it, where AI then comes in. It is a broader approach, and it doesn't have to be those parameters specific that we are today, so we can capture more things that are more sophisticated. Because as we have been talking about, it is not only us using this technique, the participants in the market are using it as well. So I think it is important for us to match their technology with our technology, when we are look at the types in the market with the behavior.

Mr. LOUDERMILK. Thank you.

Dr. Lopez de Prado, can you touch on the differences between automated trading, algorithmic trading, high frequency trading, and computer trading, how they are not all the same and what differentiates each of those?

Mr. LOPEZ DE PRADO. Yes. Algorithmic trading consists of following some rules. A computer follows some rules in order to achieve a particular outcome. It does not require machine learning. Machine learning is the learning of patterns from a set of data with us directing that learning. Essentially, what happens is, you give to an algorithm a data set, and the data set identifies the pattern we were not aware of. So, that is machine learning.

What was the third one?

Mr. LOUDERMILK. The automated trading and high frequency.

Mr. LOPEZ DE PRADO. Yes. Well, high frequency trading is algorithmic trading at a fast speed. It can happen with or without machine learning, so in the earliest stages, 2005, the high frequency

trading or core without intelligence. Today, what we see is liquidity providers, market majors, hedge funds, deploy high frequency solutions with machine learning embedded.

Mr. LOUDERMILK. Thank you.

Ms. Wegner, we have had some discussion on the cost savings that have resulted from AI and automation in the capital markets. Do you see that these efficiencies are a significant reason behind the record returns investors have enjoyed in the last decade?

Ms. WEGNER. This has definitely contributed to the returns, every reduced incremental cost of trading adds up with compounding interest over time. So as the markets become more efficient, investors are going to have more in their pocketbooks, whether half of America invested in a 529 plan or otherwise for the net positive.

Mr. LOUDERMILK. Okay. Thank you.

I have no further questions, Mr. Chairman. I yield back.

Chairman FOSTER. Thank you. The gentleman from Missouri is recognized for 5 minutes.

Mr. CLEAVER. Thank you, Mr. Chairman.

I am interested in, how do we do planning now for the future? For example, we just updated our anti-money-laundering deal, or the Bank Secrecy Act. And I am sitting here now, and I introduced the bill, so I have been feeling pretty good about myself until you guys came up today. And I am thinking, why did we go through all of that? Because the bad guys are out there trying to figure out how they can exploit whatever we pass legislatively. How do you see an AI involved in anti-money-laundering efforts, like the legislation that we hope the Senate will take up during our lifetime? Is there any way you think that can play a role, that AI can play a role in our money laundering bills or how we are trying to reduce it? We know we are probably never going to eliminate it.

Mr. LOPEZ DE PRADO. This is a gargantuan problem. We have to tackle tremendous amounts of data, terabytes of data, and identify this needle in the haystack. I think a practical solution is for regulators to work together with data scientists, with the entire community, and crowdsource these problems. We need to anonymize this data, and give this data to the community so that the community help us enforce the law. Of course, they could be rewarded with part of the fines levied against wrongdoers, but I think that is a very doable approach, given: number one, how difficult it would be for the agencies to develop the kind of techniques that the wrongdoers are developing for bad purposes; and number two, the amounts of data that we need to parse through.

Mr. CLEAVER. We had the Treasury Secretary before our committee yesterday. I, of course, didn't even raise this issue. We have an agency, FinCEN, which is an investigatory part of Department of the Treasury. So, I am here wondering what they are doing to try to keep up with the technology, and what challenges they are going to face in the future. And you all have destroyed almost everything I was proud of, but we appreciate you coming here anyway. Thank you very much.

I yield back, Mr. Chairman.

Chairman FOSTER. Thank you. I would like to thank our witnesses for their testimony today.

The Chair notes that some Members may have additional questions for this panel, which they may wish to submit in writing. Without objection, the hearing record will remain open for 5 legislative days for Members to submit written questions to these witnesses and to place their responses in the record. Also, without objection, Members will have 5 legislative days to submit extraneous materials to the Chair for inclusion in the record.

This hearing is now adjourned.

[Whereupon, at 11:05 a.m., the hearing was adjourned.]

A P P E N D I X

December 6, 2019

Testimony to the House Committee on Financial Services Task Force on Artificial Intelligence

Hearing: “Robots on Wall Street: The Impact of AI on Capital Markets and Jobs in the Financial Services Industry”

December 6, 2019

Submitted by Rebecca Fender, CFA

Senior Director, Future of Finance at CFA Institute

Chairman Foster, Ranking Member Loudermilk, and Members of the task force, thank you for inviting me to testify today. My name is Rebecca Fender, and I am the Senior Director of the Future of Finance, which is the thought leadership platform for CFA Institute.

CFA Institute is the largest non-profit association of investment professionals in the world with 170,000 CFA charterholders in 76 countries. CFA Institute is best known for its Chartered Financial Analyst designation (the CFA charter) – a rigorous three-part graduate-level exam. To earn the designation, charterholders must also have four years of investment industry work experience. CFA Institute is a non-partisan organization and seeks to be a leading voice on global issues of transparency, market efficiency, and investor protection.

The following testimony comes from two of our recent publications and relates to the anticipated impact of technology and artificial intelligence on the investment industry in the coming years.

- Section I comes from the May 2019 paper *Investment Professional of the Future*.¹
- Section II comes from the paper *AI Pioneers in Investment Management*,² by Larry Cao, CFA, Senior Director, Industry Research, based on interviews with investment industry practitioners around the world and from different areas of investments, mostly in April and May 2019.

Section I: Investment Professional of the Future

As the investment industry undergoes accelerating change, the investment professional of the future must adapt and embrace new challenges and opportunities for career success. This report considers how investment industry roles, skills, and careers are evolving to shape the attributes of the investment professional of the future. We look out over the next 5–10 years and define investment professionals as those who are influential in investment allocation decisions in such areas as investment strategy, portfolio construction, and trading—areas that encompass portfolio managers and research analyst roles.

Inputs to the report include 3,800+ respondents to a global survey of CFA Institute members and candidates, 130+ respondents to a global survey of industry leaders on trends regarding the world of work in investment management, and 100+ participants in industry roundtables and individual interviews, including investment professionals, human resources and learning and development professionals, university program faculty, and executive recruiters.

¹CFA Institute, *Investment Professional of the Future* (Charlottesville, VA: CFA Institute, 2019).

<https://futureprofessional.cfainstitute.org/>.

²CFA Institute, *AI Pioneers in Investment Management* (Charlottesville, VA: CFA Institute, 2019).

www.cfainstitute.org/en/research/industry-research/ai-pioneers-in-investment-management.

Highlights

- **Adaptability is essential:** 89% of industry leaders agree that “Individuals’ roles will be transformed multiple times during their careers; adaptability and lifelong learning will be the most essential skills.”
- **Change is anticipated:** 43% of investment professionals think the role they perform today will be substantially different in 5–10 years’ time.
- **AI+HI becomes the norm:** Significant professional roles at the investment firms of the future will include investment roles, technology roles, and innovation roles. We use the shorthand “AI+HI” to denote the interaction of artificial intelligence (AI) and human intelligence (HI). For certain interactions, the combined model adds more value than either component alone because it leverages the benefits of both, instead of technology obscuring the favorable human elements. We cite ethical orientation, transparency, communication, empathy, tacit knowledge, and trust interaction as the key human elements that technology cannot (yet) reproduce.
- **T-shaped skills are valued:** T-shaped professionals have both domain-specific specialist knowledge (the vertical bar of the “T”) and wider professional connections, understanding, and organizational perspective (the horizontal bar of the “T”). The keys to their success are readiness to adapt to changing environments and the ability to go beyond their own field and work across disciplines. These skills are acquired from combining traditional learning with experience learning (i.e., learning by doing). Innate to effectiveness in a T-shape is being at ease with technology. Industry leaders rank the importance of skill categories for successful investment professionals in the next 5–10 years as follows: T-shaped skills (49% rank these first), leadership skills (21%), soft skills (16%), and technical skills (14%). The mix of the skills needed varies over career paths.
- **The ability to work with technology is a differentiator:** The type of “skill” required for investment teams will remain predominantly investment skills. Professionals on investment teams who understand the basics of AI, data science, and technology, however, can be expected to be far more effective than someone with similar investment skills but no exposure to such technologies. This does not mean that the majority of CFA charterholders will need to become programmers or statisticians. Quite the contrary, they will need to sharpen their investment skills even more as routine tasks will increasingly be performed by machines. Just 6% of members and candidates say they are proficient in data analysis coding (Python, R, MATLAB, etc.), but 58% have interest in gaining this skill. Similarly, data visualization and data interpretation are areas that more than half expressed interest in. Experience and judgment around data interpretation will become especially important for those with analytical skills.

A. How Much Existing Investment Professional Roles Will Change

In this time of significant change in the industry, we asked CFA Institute members and candidates how much they think the role they currently hold will change in the next 5–10 years. The results are summarized in **Exhibit 1**. Overall, 43% of respondents say they expect their role to be significantly different. In addition, 5% of respondents say their role is unlikely to exist in 5–10 years. The ones with the greatest anticipated change, however, are not core investment roles but rather those doing IT in finance (80% say their role will substantially change or cease to exist). The three roles most likely to cease to exist are sales agents and traders (both 11%) and performance analysts (19%). Among the latter

group, much time is currently spent gathering data from unintegrated sources, so it is true that upcoming significant changes could relieve performance analysts of some of the tedious parts of their role, freeing up time for more judgment and analysis.

Exhibit 1

Leaving aside any personal circumstances or your expected career progression, how different, if at all, do you think the role of a(n) [CURRENT OCCUPATION] will be in 5-10 years' time?	I expect it to be substantially different	I do not think the role I perform today will exist in 5-10 years.
Total	43%	5%
Information Technology	77%	3%
Trader	51%	11%
Financial Adviser/Planner/Wealth Manager	54%	4%
Accountant or Auditor	49%	9%
Risk Analyst/Manager	54%	3%
Performance Analyst	31%	19%
Research Analyst, Investment Analyst, or Quantitative Analyst	45%	4%
Credit Analyst	44%	3%
Investment Consultant	45%	1%
Relationship Manager/Account Manager	40%	6%
Portfolio Manager	39%	3%
Investment Strategist	36%	5%
Chief Executive Officer (CEO)	30%	0%
Chief Investment Officer (CIO)	24%	1%

SOURCE: CFA INSTITUTE MEMBERS AND CANDIDATES SURVEY

B. The Most Valuable Roles in the Future and How They Relate to Technology

There is consensus among the practitioners we interviewed and our survey respondents that technology will be the dominant driver for change in investment management and an increasingly essential element of work for almost all investment professionals. Barbara Petitt, CFA, head of curriculum and learning experience for CFA Institute, said, "As technology becomes the lingua franca, investment professionals must become literate in a language that is not their own and be able to ask the right questions. Asking the right questions is and remains a key competency for our profession."

As the industry moves to an AI+HI model, investment teams of the future will fulfill three main functions (investment, technology, and innovation) in eight types of

Exhibit 2

SIGNIFICANT TYPES OF ROLES AT INVESTMENT FIRMS OF THE FUTURE	
Investment	Investment decision maker Investment researcher Private wealth manager
Technology	Data scientist Applications engineer
Innovation	Investment thinking and process innovator Knowledge engineer Innovation facilitator

roles, as shown in **Exhibit 2**, at the investment firms of the future.³

Investment decision-making roles are typically undertaken by chief investment officers and portfolio managers, depending on the size and structure of the firm. Investment research is predominantly provided by research analysts. Private wealth managers are generalists who also serve a relationship function with their clients. These roles exist today, but as seen in **Exhibit 1**, many investment professionals expect them to change significantly. Among wealth managers, 54% expect the role to be substantially different, compared with 45% of research analysts and 39% of portfolio managers.

Data scientist roles are increasingly present at investment organizations. These professionals are the architects and the applications engineers are the builders; they work together to develop and implement the technology components of the investment process.

Innovators focus on improving the existing investment process. A key role innovators play in the face of technology disruption is to facilitate the collaboration between investment and technology teams. One will find investment thinking and process innovators both among senior researchers in the industry and at leading research universities. Knowledge engineers are subject matter experts who identify key industry trends and emerging investment expertise. They focus on gathering insights from the innovators and sharing it with the rest of the investment professionals. Innovation facilitators play a similar role to private wealth managers except that they operate in the innovation space.

C. How Individuals Will Increasingly Differentiate Themselves by Their Ability to Work with Technology

Collaboration to apply technology, as discussed earlier, involves human intelligence in training, explaining, and sustaining roles (ensuring the technology works safely and ethically). It involves the machine in amplifying, interacting, and replicating roles (reproducing human skills). The roles are complementary in all cases—their effectiveness is present only when there is some AI+HI combination.

Investment professionals of the future will increasingly differentiate themselves by their ability to work with technology to enhance their quality of work generally and performance levels more specifically. The need and ability to work with technology translates into different requirements for the three functions of investment, technology, and innovation highlighted above.

The type of skill required for investment teams, which includes the majority of CFA charterholders, will remain predominantly investment skills. Professionals on investment teams who understand the basics of AI, data science, and technology can be expected to be far more effective than someone with similar investment skills but no exposure to such technologies. We must emphasize that we do not think this means that the majority of CFA charterholders will need to become programmers or statisticians. We also doubt that investment professionals in general are committed to such a development. Quite the contrary, we think professionals need to continue to sharpen their investment skills because routine tasks will increasingly be performed by machines. Experience and judgment will become more important in the more-complicated tasks that often carry greater impact and higher risk.

³This discussion benefited from the future professional roles section in Richard Susskind and Daniel Susskind, *The Future of the Professions: How Technology Will Transform the Work of Human Experts* (Oxford, United Kingdom: Oxford University Press, 2015).

The big data opportunity in portfolio management is additive in nature. Unstructured data analysis today is the equivalent of going where people have not been before (i.e., uncovering previously hidden information). In addition to annual reports and conference call transcripts, the explosion of data in today's world has put a vast amount of new information at the disposal of investment professionals, including such alternative data as social media, satellite images, customer and cargo traffic information captured with sensors, and web scraping. In this way, analysts can gain knowledge without physically being present. In other words, information is stored and transmitted in the form of images and written and spoken languages. AI and big data technologies will enable analysts to have access to a vast amount of public information, much of which was not available to investors before. This shift is often referred to as going beyond the "data tap" (i.e., Form 10-K data being periodically dripped out) to the "data lake" (i.e., constant access to constantly growing publicly and privately accessible data). The challenge now is for the analyst to create value by making sense of this massively expanded data and integrating them into portfolio construction. It speaks to the human roles in training, explaining, and sustaining and machine roles in amplifying, interacting, and replicating.

The most important skillset on a growth trajectory for innovation professionals is T-shaped skills. Innovation professionals are subject matter experts, but the key to success will be their readiness to adapt to changing environments and their ability to go beyond their own field and work across disciplines. We would argue innovation professionals in investment firms need to be grounded in both investment and technology, so they can communicate effectively with technology and investment professionals, respectively.

In practice, we expect investment teams and technology teams to collaborate closely in shared team space. We believe this is the most effective institutional approach to foster T-shaped skills across teams and for organizations to get the most out of professionals with T-shaped skills.

D. How Firms Can Navigate and Harness Technology

We have categorized the effects of technology into three levels, shown in **Exhibit 3**.

1. The basic applications in technology require all professionals to do things differently, ensuring technology improves task execution in amplifying, interacting, and replicating (replacing tasks and sometimes displacing human roles).
2. The specialist applications in technology will be in enhancing different things where investment teams and technology teams collaborate closely in shared team space and to foster T-shaped team skills.
3. The hyper-specialist applications in technology are derived from data science evolution and its spin-offs in new and different things like training, explaining, and sustaining (ensuring safe and accurate tech deployment). While many of these individuals will not be investment trained, the best will be.

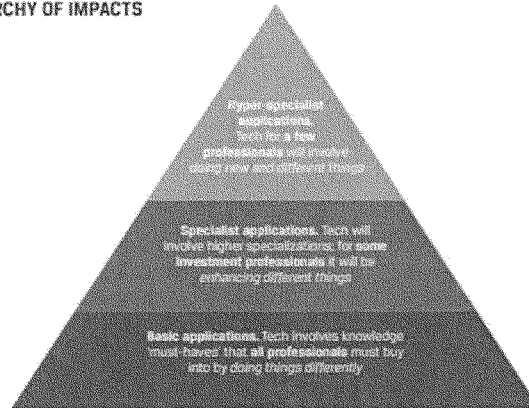
What is different? There is a wholesale shift occurring in people plus technology models for the industry. That shift will evolve and accelerate.

What is the same? Professionals have always had to respond to new technologies. Recall the impact the desktop computer had on the investment industry.

What advice can we offer to the investment professional of the future? Build tech-savvy skills (i.e., understanding and using technology effectively) and make sure it serves you, not the other way around.

Exhibit 3

TECHNOLOGY HIERARCHY OF IMPACTS



Section II: AI Pioneers in Investment Management

Will robots replace human investment managers? As the investment industry stands on the cusp of arguably its greatest technological transformation, we set out to understand the current state of adoption of artificial intelligence (AI) and big data applications in investment management and to exemplify where and how such technologies can be put to use.

Highlights

- We identify three types of AI and big data applications in investment management: (1) using natural language processing (NLP), computer vision, and voice recognition to efficiently process text, image, and audio data; (2) using machine learning (ML), including deep learning, techniques to improve the effectiveness of algorithms used in investment processes; (3) using AI techniques to process big data, including alternative and unstructured data, for investment insights.
- According to a CFA Institute survey, relatively few investment professionals are currently using AI/big data techniques in their investment processes. Most portfolio managers continue to rely on Excel and desktop market data tools; only 10% of portfolio manager respondents have used AI/ML techniques in the past 12 months.
- We identify five major hurdles to successful adoption of AI and big data in investment processes: cost, talent, technology, leadership vision, and time. Investment firms will need to substantially overcome the five hurdles to reach the top of the FinTech pyramid.

- Powerful FinTech will be the result of collaboration between *Fin* (financial institutions) and *Tech* (technology companies). Successful firms will be centered on T-shaped teams that combine investment expertise, innovation, and technology application across investment strategies or processes.

Key Takeaways

- The decision to use AI and big data techniques should be benchmarked against the performance of traditional techniques. Firms should determine whether the potential additional alpha capture is worth the additional cost and complexity of applying AI and big data.
- A machine is only as intelligent as the data it learns from. The more comprehensive the training data, the more generalized the machine will process new events, thereby mitigating common pitfalls like overfitting.
- ML techniques are more suited to systematic strategies (including rules-based, quantitative strategies), and unstructured and alternative data are typically used more by discretionary (active) managers.
- Niche, sector-specific data sets are of more relevance to a fundamental analyst or portfolio manager searching for alpha than a systematic manager.
- The effective use of such data sets could provide one of the biggest opportunities for a besieged active management sector.
- AI and big data are no panacea; they cannot solve every investment problem. For example, only a small proportion of big data can generate meaningful signals; reliably extracting signal from noise is difficult.

A. Applying AI and Big Data in Investments: Challenges and Opportunities

In the words of numerous industry heavyweights, AI is the new electricity. The *Economist* magazine championed the slogan, “Data is the new oil.”⁴ We discuss in this section how some firms are taking advantage of frontier powers in investment management.

AI: NLP, computer vision, and voice recognition

Researchers have made tremendous strides in building the ultimate “seeing, hearing, and understanding” machine in recent years.⁵ In the case of natural language processing (NLP), computer vision, and voice recognition programs, AI is used to capture text, audio, and imagery from a variety of public sources and internal/vendor databases. Examples include transcribing analyst conference calls and extracting data from issuer filings for valuation models. In most cases, the program automates what is traditionally a manual and repetitive task performed by an analyst. We expect to see these types of applications being used more and more in the industry; they broaden the investment professionals’ reach and improve efficiency by combing through multiple data sources and combining them into one platform.

Such programs also increase human capacity by freeing time otherwise spent on manual work. Junior analysts used to spend much of their research time finding and entering information. These routine and

⁴See www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data.

⁵See Larry Cao, “Artificial Intelligence, Machine Learning, and Deep Learning: A Primer,” *Enterprising Investor* blog (13 February 2018): <https://blogs.cfainstitute.org/investor/2018/02/13/artificial-intelligence-machine-learning-and-deep-learning-in-investment-management-a-primer/>.

repetitive activities will likely become the first to be taken over by AI programs, which have a natural advantage in this type of work.

AI: Machine learning (ML) and deep learning (DL)

More sophisticated programs will further process the information harvested from various sources to generate signals to inform the investment decision-making process. This often requires sophisticated AI techniques, such as ML and DL.

Machine learning is a general term for computing methods and algorithms that allow machines to uncover patterns without explicit programming instructions.⁶ ML programs inform themselves how to interpret inputs and predict outputs.⁷ Deep learning is a type of ML that is based on artificial neural networks (a type of learning modeled on the human brain).

DL algorithms are often applied to improve the results of NLP, computer vision, and voice recognition programs. They can also help extract useful information from large piles of data. For example, these algorithms can infer certain key words from conference call transcripts or identify sentiment from unstructured data, such as social media. Such information can then be translated into trading signals or, more simply, alerts for human analysts and portfolio managers to process.

ML and DL programs are also popular with quantitative (systematic) managers who often find it helpful to apply these techniques in order to improve the effectiveness of their quantitative processes. There are several cases in the report that illustrate this point.

Traditional statistics and econometrics are based on techniques first developed a couple of centuries ago, and their applications in finance often involve linear regression models. These linear models are effective in many situations. However, at least some of the complexities in the real world may be better captured using ML techniques because of their ability to handle contextual and nonlinear relationships, which can often arise in finance. For example, ML techniques may be more effective than linear regressions in the presence of multicollinearity (where explanatory variables are correlated).⁸ In these cases, ML and DL techniques provide investment managers with additional toolkits that can give them an edge.⁹

Big data: Alternative data and unstructured data

Data scientists define big data with four Vs: volume, variety, veracity, and velocity.¹⁰ The terms often used in the investment circles are “alternative data” or “unstructured data.”

Alternative data refers to data from sources that are not currently used or not yet mainstream. In comparison to structured data, which is data that are digitized and stored in relational databases,

⁶K.C. Rasekhschaffe and R.C. Jones, “Machine Learning for Stock Selection,” *Financial Analysts Journal*, vol. 75, no. 3 (Third Quarter 2019).

⁷Cao, “Artificial Intelligence, Machine Learning, and Deep Learning” (2018).

⁸See Rasekhschaffe and Jones (2019).

⁹For suggested further reading on machine learning, including types of ML algorithms and their applications, see the CFA Institute Refresher Reading on “Machine Learning” (2020 Curriculum), available to CFA Institute members and charterholders at www.cfainstitute.org/en/membership/professional-development/refresher-readings/2020/machine-learning.

¹⁰See www.ibmbigdatahub.com/infographic/four-vs-big-data.

unstructured data refers to data that are often in text, image, or voice formats and are not readily processable. Alternative data and unstructured data are related and yet not quite the same. Alternative data is often unstructured when first discovered, and unstructured data is usually not used by mainstream investors, making it alternative.

Examples of alternative data/unstructured data often used in the investment world today include satellite images, earnings conference call recordings and transcripts, social media postings, consumer credit and debit card data, and e-commerce transactions.

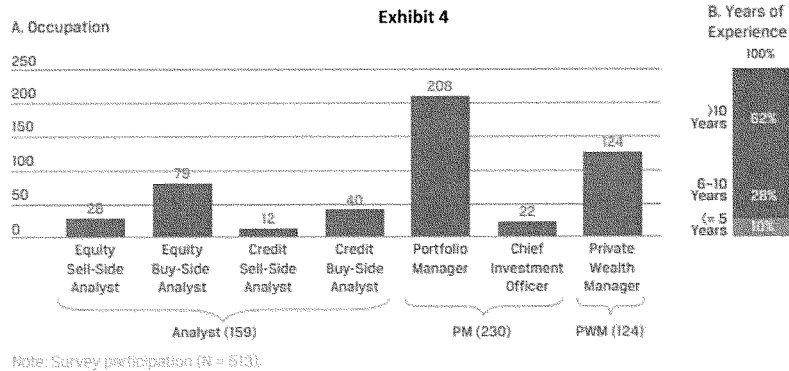
Finding the new data source that generates alpha has become the next arms race among some analysts and investment managers, much like how managers have traditionally competed to find the unturned stone in the public markets. In a way, extracting signals from big data is simply an extension of what analysts used to do—visiting stores to check out customer traffic, for example. Now some of them use satellite images or sensor information of the parking lot to infer the same information. The new techniques offer efficiency gains; an analyst can cover a lot more stores in much less time using satellite imagery or sensor data.

Alternative data tends to be niche and is more popular with fundamental managers running discretionary portfolios who use these data as one input in the investment decision-making process. Some of the cases included in this report provide real-world examples of how alternative and unstructured data are being used.

B. Where Does the Industry Stand in terms of Applying AI and Big Data?

CFA Institute conducted a survey to understand the state of adoption of different technologies in the workflows of analysts, portfolio managers, and private wealth managers. This section provides some of the pertinent findings to illustrate the industry landscape regarding AI technologies and to set in context the specific case studies that follow.

The survey was sent to a randomized sample of CFA Institute charterholder members in March 2019, and there were a total of 734 respondents (52% from the Americas, 18% from Asia Pacific, 30% from



Europe, Middle East and Africa). Respondent occupations spanned equity and credit analysis, portfolio management, chief investment officers, and private wealth management, as shown in **Exhibit 4**.

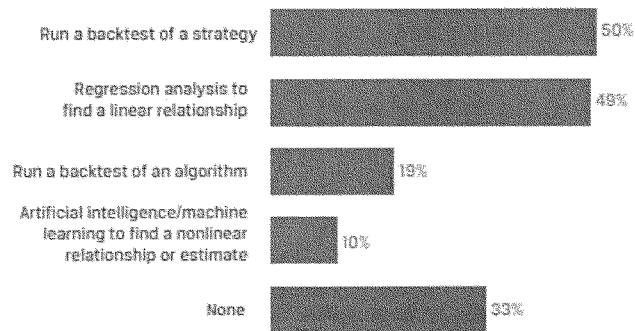
The professional experience of the respondents ranged from new entrants to those with more than 10 years of experience.

The survey results indicate that few investment professionals are currently using programs typically utilized in ML techniques, including coding languages such as Python, R, and MATLAB. Most portfolio managers continue to rely on Excel (indicated by 95% of portfolio manager respondents) and desktop market data tools (three quarters of portfolio manager respondents) for their investment strategy and processes.

Moreover, as the results in **Exhibit 5** illustrate, only 10% of portfolio manager respondents have used AI/ML techniques in the past 12 months, and the number of respondents using linear regression in investment strategy and process outnumbers those using AI/ML techniques by almost five to one.

Exhibit 5: Statistical Techniques Used in Investment Strategy and Process

Portfolio Manager: Which of these have you used in the past 12 months for investment strategy and process?

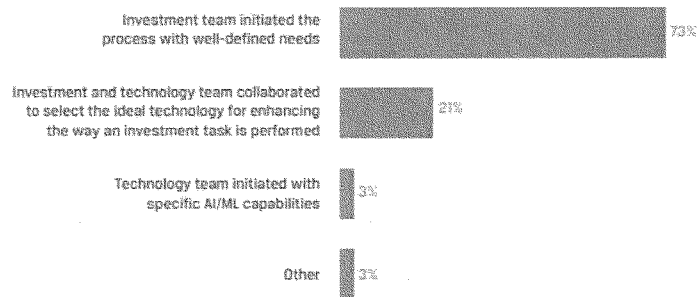


Note: Survey participation (N = 230).

At the organizational level, the extent of collaboration between investment and technology teams remains relatively low, as shown in **Exhibit 6**. This suggests further integration may be needed to realize process efficiencies as these technologies take hold.

Exhibit 6: Organizational Responsibilities for Investment Strategy and Process

Portfolio Manager: Which option below most accurately describes your organization's process for investment strategy and process?



Note: Survey participation (N = 230).

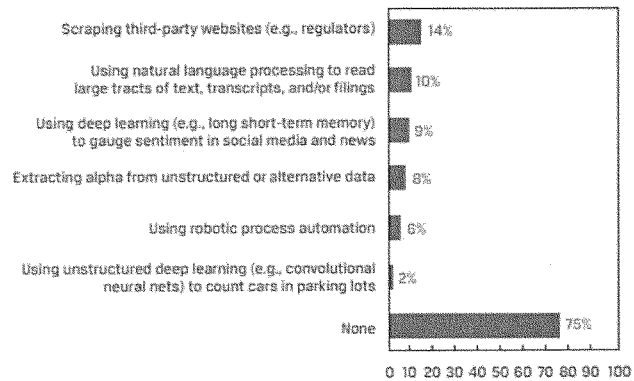
The prevalence of AI/ML techniques in trading strategies is also low, according to the survey: 69% of portfolio manager respondents report not using any AI/ML techniques for creating trading algorithms in the past 12 months. Those professionals who are using these techniques indicate a wide range of use cases, including arriving at buy or sell decisions based on various input variables (15%), building signals (14%), and determining sentiment based on NLP (10%), among several others.

A similar result emerges in Panel A of **Exhibit 7**, which shows that three-quarters of analyst respondents are not using AI/ML techniques for industry and company analysis. Of those who are, the two most popular techniques cited are scraping third-party websites (cited by 14% of respondents) and using NLP (cited by 10% of respondents). In comparison, 40% of respondents cited using linear regression for industry and company analysis (not shown).

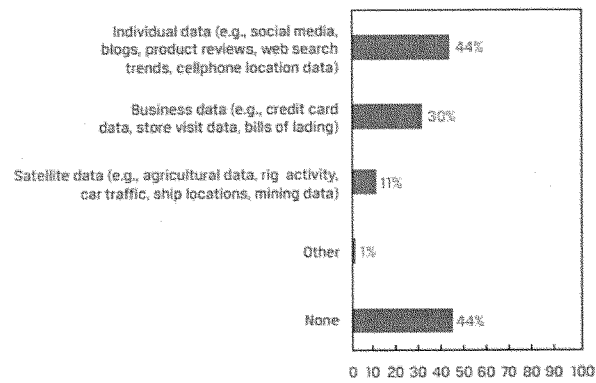
Using unstructured and alternative data for industry and company analysis is more popular than using AI/ML techniques among investment professionals. As illustrated in Panel B of **Exhibit 7**, 44% of analyst respondents report using individual data, such as social media, product reviews, and web search trends, in the past 12 months while only 11% have used satellite imagery. One caveat of these results, however, is that they do not allow us to infer how often or how extensively these data sources are being used in industry and company analysis. A significant number of professionals, 44%, report not using these data.

Exhibit 7: AI/ML Techniques vs. Unstructured/Alternative Data for Industry and Company

A. Analyst: Which of the following artificial intelligence/machine learning use cases have you performed in the past 12 months for industry and company analysis?



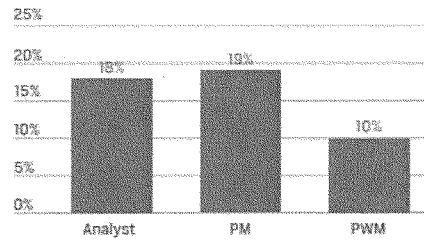
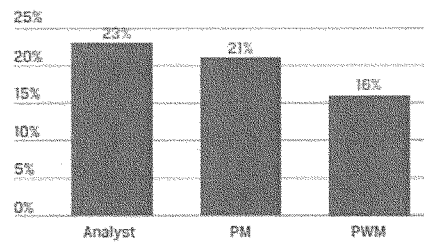
B. Analyst: What type(s) of unstructured and/or alternative data have you used for your industry and company analyses in the past 12 months?



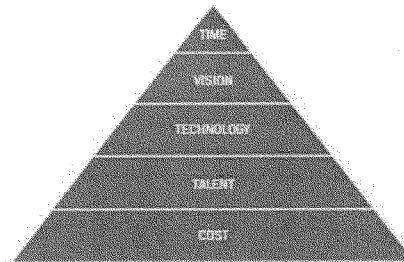
Note: Survey participation (N = 169).

In sum, these results suggest that the investment industry is in the very early stages of adoption of AI techniques and related technologies, and few professionals are currently using AI/big data techniques in their daily investment processes.

However, approximately one fifth of analysts and portfolio managers report participating in AI/big data training, as illustrated in **Exhibit 8**.

Exhibit 8: AI/ML vs. Data Analytics Training**A. AI/ML Training Done in the Last 12 Months****B. Data Analytics Training Done in the Last 12 Months**

Overall, given the low current utilization of AI and big data techniques coupled with the large number of practitioners undergoing training in these fields, the industry seems poised to undergo significant growth in the coming years.

C. Challenges in Applying AI and Big Data: The FinTech Pyramid**Exhibit 9: The FinTech Pyramid**

So, what is holding investment professionals and investment firms back from realizing the full power of AI and big data? We have identified five major hurdles, which are described next in increasing order of difficulty.

Hurdle #1: Cost

Financial institutions are not strangers to huge IT budgets, but launching AI and big data capability can involve significant upfront cost as well as ongoing maintenance costs.

The high cost can at least in part be attributed to the new data sets that enable these technologies and that have been catching the industry's attention.¹¹ Identifying, cleansing, and making sense of these data sets is no small feat, which is why one prominent economist believes that small firms will find it increasingly difficult to compete in the age of AI and big data.¹²

Hurdle #2: Talent

College graduates with basic programming and statistics training, not to mention those with advanced degrees in AI or related fields, are already very popular with employers in the age of AI. Yet this is only part of the story.

There is a real advantage of working at one of the top technology companies that employs and invests significantly in AI. Google, Microsoft, Baidu, and Alibaba are some of the names that come to mind. Much of the latest and greatest developments in AI are taking place at these companies, and the small number of employees involved in these projects have become a rare breed who have access to knowledge and skills not currently taught yet in the top schools around the world.

What further complicates matters is that it seems very few of the top AI talents are actually looking to work in the investment industry. Maybe AlphaGo and driverless cars are innately more exciting for AI scientists. Either way, obtaining talent appears at least a degree harder than managing the cost.

Hurdle #3: Technology

We are at the beginning of the AI revolution, and technology is still fast evolving. This creates significant challenges for those investing in AI applications because the risk of being leapfrogged by a latecomer is significant. Staying current with the latest developments is a real challenge for most investment professionals and organizations, barring a privileged few. Having a sizeable budget and top talent are prerequisites to staying ahead of the pack.

Similarly, in the alternative data space, the exploration of new data sources is in its relative infancy. There are many new data vendors entering the field, and extracting useful signals from the avalanche of data remains challenging.

Hurdle #4: Vision

There will likely be sweeping changes in the investment industry driven by advances in AI and big data technologies in the coming decades. These technological changes have to be managed from the top of organizations for them to fully penetrate the business while efficiently deploying resources.

¹¹See, for example, www.cnn.com/2017/11/28/making-millions-from-the-data-hidden-in-plain-sight.html.

¹²www.nytimes.com/2018/01/12/business/ai-investing-humans-dominating.html.

As noted in *Investment Firm of the Future*, IT deployment in investment firms has been substantially reactive to date, with firms trying to marshal technology to capture efficiencies in the face of legacy issues.¹³ Firms will need to focus on proactively developing the skills and procuring the systems to stay competitive. Strategic vision, leadership commitment, and collective ownership of IT deployment will be essential for firms to succeed in the future.

Hurdle #5: Time

Any progress, no matter how small, often takes a significant investment of time, among other things. This is simply a fact of life when you are on the frontier of development.

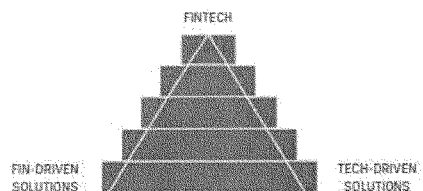
Every firm wants to be the first at turning over a rock and uncovering useful information, but exploring ways to increase alpha and integrating the new approaches into existing investment processes take time. Even in the most advanced markets and at firms where the most sophisticated technologies have been in deployment for many years, most big data projects still require a lot of time and effort to prepare the data and make them fit for purpose. Patience and persistence are necessary, and even then, many projects will not succeed. Time remains one of the toughest challenges to overcome, and success does not happen overnight.

Current state of play and the road map to the top of the pyramid

Investment firms will need to substantially overcome the five hurdles (i.e., use the latest AI and big data technologies to solve core investment problems) to reach the top of the pyramid, where *Fin* meets *Tech*. But ascent to the top requires a collaborative approach; overcoming each hurdle requires consideration of both Fin and Tech dimensions.

Conceptually, this is illustrated in **Exhibit 10**. In the Fin corner, investment solutions tend to be driven by quants who come from a finance background. By and large, these types of solutions rely on existing data sets and do not rely heavily on alternative data, saving time and effort in identifying relevance (separating signal from noise) and testing and cleansing data. At the same time, they may not benefit from new information from alternative data and the latest technical breakthroughs in NLP, computer vision, and voice recognition, for example.

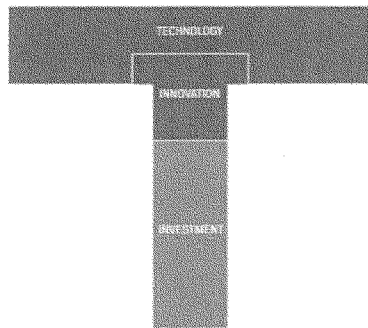
Exhibit 10: Where Fin Meets Tech



¹³CFA Institute, *Investment Firm of the Future* (Charlottesville, VA: CFA Institute 2018): 10–11.

Also in the Fin corner are some discretionary managers experimenting with new data sources that they come across. What is often missing is the overall strategy of systematically leveraging new technologies to gather and process new information that will feed into the investment process, creating an edge.

Exhibit 11: T-Shaped Team



In the Tech corner, solutions are typically driven by technologists coming from outside the investment world. The architects and their teams tend to have in-depth knowledge of the latest AI and big data technologies and can create the fanciest wizardry that leverages the latest technology. Often, they are not built with a specific business objective or end user profile in mind and cannot be easily incorporated into the investment process of an established investment firm.

Introducing AI and big data into investments may be the single most significant change to the investment

process that investment professionals will experience in their careers. Given the complexity illustrated by the FinTech pyramid, it will take many iterations to get everything right and reach the top of the pyramid. The important takeaway is the need to take a collaborative approach and expect to ascend the pyramid step by step. There is no shortcut.

D. Making It Happen: T-Shaped Teams

The FinTech pyramid highlights the strategic imperatives of applying AI and big data in investments. The T-shaped team concept we introduce in this section provides an operational and organizational approach to making it happen.

We discussed in *Investment Professional of the Future*¹⁴ the increasing importance for individual investment professionals to acquire T-shaped skills. T-shaped professionals have both domain-specific specialist knowledge and wider professional connections, understanding, and organizational perspective. In addition, T-shaped teams have a broad and deep collective intelligence and benefit from a collaborative culture and cognitive diversity.

In the context of AI and big data in investments, we can apply the concept of T-shaped teams. The combination of skills and collective intelligence gathered through investment expertise and technology application across investment strategies or processes is an example of a T-shaped team in this area. We also emphasize a third aspect of T-shaped teams in this context—namely, the role of innovators in connecting investment and technology teams, requiring such professionals to be particularly strong in T-shaped skills. The small T in the overall T-shape shown in **Exhibit 11** illustrates this aspect.

Under this framework, roles in the investment function are not substantially different from what we observe in the industry today, but that may not be true for the technology function. The technology

¹⁴CFA Institute, *Investment Professional of the Future* (Charlottesville, VA: CFA Institute, 2019).
www.cfainstitute.org/en/research/survey-reports/investment-professional-of-the-future

function in future investment teams will likely require different skill sets than those required today. In particular, data scientists, in addition to computer engineers, will become important.

The third function, innovation, is of critical importance, because its main function is to facilitate collaboration between the investment and technology functions, something that the industry has not had a strong track record to date. Innovators may have the title of researcher, strategist, product manager, or business developer. The lack of appreciation for this function is evidenced by the fact that professionals serving the roles often sit in different departments at different firms. Some sit in the investment or technology departments but must have a keen understanding of their counterparts' business to be effective collaborators. Strategists and product managers, for example, may take on the role because they have a better understanding of the big picture than the specialists from the investment and technology functions.

As noted in "FinTech and the Future of Financial Services," powerful FinTech will be the result of collaboration between powerful Financial institutions and powerful Tech (nology companies).¹⁵ The argument is true not only from a strategic perspective but also from an operational and organizational perspective.

In the early stage of collaboration, T-shaped teams are typically small in scale and often exist only on an informal, project-specific basis. As operations mature, T-shaped teams become more commonplace and are more permanent features of the organizational structure. The complexity of the issues at hand requires organizational commitment, which can be best identified by the number (and effectiveness) of the T-shaped teams an organization supports.

E. AI in Practice: Examples from Our Case studies

Below are a few examples from our case studies of how AI is processing these large and complex data sets:

- First, Goldman Sachs' sell-side research team is better able to analyze national concrete companies supplying the construction industry by using geospatial data of 9,000 U.S. quarries that each act as local businesses.
- Second, the data science team at American Century Investments studied psychology textbooks to determine patterns of deception in children and criminals. They then applied machine learning to these patterns so they can recognize them in earnings calls to find where information might be purposely omitted and to determine where spin, obfuscation, and blame are being used and communicated.
- Finally, Bloomberg has had a sentiment analysis product available since 2009, which analyzes the potential effect of news stories on valuations. They process 2 million documents a day through their machine learning platform. This was alternative data used only by hedge funds at first but now many of their clients use it.

¹⁵Larry Cao, "FinTech and the Future of Financial Services," in *Fintech 2017: China, Asia, and Beyond* (Charlottesville, VA: CFA Institute 2017). Available in Chinese at www1.hkex.com/dailynews/investment/article/1313726/.

F. Implications for Regulators

Just as the investment industry is beginning to employ greater technology, regulators can look at new data in the world of “regtech.” We see several potential regulatory concerns and challenges related to AI.

1. One is the ability of SEC monitoring and enforcement to keep up with insider information and Reg FD data that makes its way undetected through the vast AI “vacuum.” The speed and volume of data collected present a new surveillance challenge for both compliance departments and regulators.
2. Regulators will need to have the tools and resources to recognize when investment products are marketed using faulty or inaccurate data that subject investors to higher risks. Application of these tools will help regulators apply and enforce existing regulations calling for full and fair disclosure of investment strategies and methodologies.
3. Regulators should consider how firm cultures adapt to increasingly tech-informed investing. Most successful AI pioneer firms seek broad input when designing new products and processes, and having diverse perspectives can reduce the risk of building biases into models.

G. Outlook and Word of Caution

We believe in the power of the “AI + HI” model—that is, most tasks are and will remain best handled using both AI and human intelligence, and the collective power of the two is superior to either element on its own.¹⁶ The path of adoption begins with routine, rudimentary tasks such as capturing information from texts and images, producing reports, and populating spreadsheet models, where AI has some advantage over human beings in the breadth of information they can process at high speeds. Analysts are then free for higher-value tasks that require more experience and judgment.

It is not a race between humans and machines. The competition ultimately is among “AI + HI” teams, and the stronger teams that effectively harness and combine both elements will outlast the weaker ones. The successful investment teams of the future will excel in collective intelligence through cognitive diversity (artificial and human) and T-shaped skills.

Despite the important role they will play in the investment industry, AI and big data are no panacea. In some situations, additional information (big data) can add alpha, and in others, enhanced algorithms (ML) may detect previously undiscovered patterns. Still, AI and big data certainly won’t provide all the answers investors need or want.

One of the challenges ML techniques face, for example, is that they work better in the test environment (i.e., based on the training data set) and may not always respond appropriately to new situations in the real world. This is the problem of overfitting—where algorithms perform well in sample but poorly out of sample. AI may work for AlphaGo, where all the rules are set. The ever-changing investment world, however, presents more difficulties. In addition, at least some of the ML programs for business are more like a black box; users do not have access to the logic behind ML actions. As a result, some of the features captured by the programs have no causal relationship with the variables the models try to predict.

¹⁶See Larry Cao, *Fintech 2018: The Asia Pacific Edition* (Charlottesville, VA: CFA Institute, 2018) and CFA Institute, *Investment Professional of the Future* (Charlottesville, VA: CFA Institute, 2019).

As technology and understanding progress, these challenges may be overcome, but as of now, we should put the power of AI and big data in perspective when embarking on a journey to explore the unknown.

Based on our research, including interviews and conversations with academics and practitioners in both investments and technology, we can conclude that

1. AI and big data have the potential to bring about the most significant change to the investment management industry that current professionals will experience in their careers.
2. Successful investment firms of the future will start to strategically plan their integration of AI and big data techniques into their investment processes now.
3. Successful investment professionals will understand and exploit the opportunities brought about by these new technologies and applications, enabled by collaborative organizational cultures, cognitive diversity, and T-shaped teams.

Testimony before the

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON FINANCIAL SERVICES**

TASK FORCE ON ARTIFICIAL INTELLIGENCE

regarding

**“Robots on Wall Street: The Impact of AI on Capital Markets and
Jobs in the Financial Services Industry”**

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Testimony of Dr. Marcos López de Prado, Cornell University
before the U.S. House of Representatives Committee on Financial Services
Task Force on Artificial Intelligence
regarding
“Robots on Wall Street: The Impact of AI on Capital Markets and
Jobs in the Financial Services Industry”
December 6, 2019

Congressman Foster, Ranking Member Loudermilk, thank you. It is an honor to be asked to testify today before your Committee. The following remarks constitute my personal opinion, and do not necessarily represent the views of the organizations listed in my affiliation.

I am a professor of practice at Cornell University, where I teach machine learning courses at the School of Engineering. Between the years 2011 and 2018, I was a research fellow at Lawrence Berkeley National Laboratory (U.S. Department of Energy), where I conducted research on the use of supercomputers for the analysis of financial Big data. Concurrently with my academic research, over the past 20 years I have held senior executive positions at some of the largest asset managers in the world. I therefore offer my testimony as an academic with a deep practical understanding of the state of the art in the financial industry.¹

I have divided this testimony into four sections, which discuss: (1) several types of automation currently being deployed in capital markets and the financial sector, and how they affect decision-making; (2) how machine learning² (ML) and automation can help and hurt

¹ For further information, please visit www.QuantResearch.org

² Throughout this testimony I focus on the subset of AI that deals with modelling data, known as machine learning.

workers by disruption of the current and future financial services workforce; (3) what “RegTech” is and how ML can be deployed to help regulators better supervise financial institutions; and (4) algorithmic bias.

1. The rise of algorithmic finance

As a consequence of recent advances in pattern recognition, big data and supercomputing, ML can today accomplish tasks that until recently only expert humans could perform. An area of particular interest is the management of investments, for several reasons. First, some of the most successful investment funds in history happen to be algorithmic. A key advantage of algorithmic funds is that their decisions are objective, reproducible, and can be improved over time. A second advantage is that algorithms can be automated, leading to substantial economies of scale and cost reductions. A third advantage is that algorithmic investments address the all-important concern of conflicts of interest, which are so pervasive among financial institutions.

For the above reasons, today the great majority of financial firms increasingly offer some form of algorithmic products. According to studies, more than 34% of the total hedge fund assets under management are currently invested using algorithmic strategies, for over \$1 trillion dollars (Preqin [2018]).³ This figure does not include factor-based mutual funds and exchange traded funds offered to retail investors, so the total assets of algorithmic-managed investments could be close to \$2 trillion.

While there has been substantial hype around the application of ML to financial problems, there have also been remarkable successes on a wide range of use cases (López de Prado [2018,

³ <https://www.ft.com/content/f17528bc-ec16-11e7-8713-513b1d7ca85a>

2019a]).⁴ Examples of ML automation that have replaced humans, or have the potential to replace humans in the short terms, include the following:

- **Order execution:** algorithms are responsible for the lion share of transactions in electronic markets. Since the enactment of Reg NMS in 2005, these algorithms have fully automated the jobs of tens of thousands of execution traders worldwide. Market makers and position takers have adopted this technology, not only because of its speed and scalability, but also because of its ability to process in real time large amounts of microstructural information, leading to better outcomes (Easley et al. [2013]).
- **Pricing, risk management, pattern recognition:** ML algorithms are particularly powerful at modeling complex non-linear interactions between variables. Knowledge graphs uncover hidden connections between securities that are not obvious to human experts. Regime switch algorithms detect changes in patterns, which require the recalibration of models. Banks are using ML algorithms to price their structured products, and manage their risks, with material improvement over traditional valuation methods (Buehler et al. [2019]).
- **Portfolio construction, bet sizing, asset allocation:** ML algorithms have also proven their ability to build better investment portfolios compared to classical quantitative methods (López de Prado [2019b]), and avoid behavioral biases in bet sizing (López de Prado [2018]). Eventually, we can expect that ML algorithms will be involved in the allocation of tens of trillions of dollars, replacing human discretion and the more traditional econometric methods (López de Prado [2019c]).

⁴ <https://ssrn.com/abstract=3365271>

In other areas, ML is presently best used to enhance and support the role of human experts:

- **Credit ratings, scoring, fraud detection:** ratings agencies routinely use ML algorithms to monitor the credit worthiness of debt issuers, and recommend revisions when they detect material changes in companies' ability to meet their obligations.⁵ Credit card companies, insurance companies and banks use ML algorithms to flag transactions that are potentially fraudulent.⁶
- **Sentiment extraction, recommender systems:** algorithms classify tens of thousands of news articles a day, and help determine whether particular stocks are the subject of positive or negative narratives. Recommender systems suggest stocks that could benefit from specific narratives spreading through the media (Sohangir et al. [2018]).

2. Algorithms and jobs: challenges and opportunities

Financial firms employ tens of thousands of analysts to model financial datasets. This silo approach made sense in the past, because financial data was largely proprietary and datasets were small. Today, data vendors offer a wide range of datasets that were not available a couple of years ago. As a result, some technology firms have begun to distribute this data and crowdsource the jobs of data analysts through tournaments.

In a tournament, an organizer proposes an investment challenge (e.g., the forecasting of stock prices) and distributes the data needed to solve this challenge to a crowd of data scientists. Because tournament organizers use their knowledge of financial markets to narrowly define the investment problem, tournament participants can work on this problem, even if they lack

⁵ <https://bit.ly/33yWPnC>

⁶ <https://www.fico.com/blogs/5-keys-using-ai-and-machine-learning-fraud-detection>

financial knowledge and they are not employees of financial companies (López de Prado and Fabozzi [2019]).

The tournament approach has the potential to disrupt some of the highest paying jobs in finance. For example, asset managers could crowdsource their entire research function, by organizing tournaments where millions of data scientists from outside the financial sector participate. Insurance companies could crowdsource their actuarial models.

Financial ML creates a number of challenges for the 6.14 million people employed in the finance and insurance industry, many of whom will lose their jobs, not necessarily because they are replaced by machines, but because they are not trained to work alongside algorithms.⁷ The retraining of these workers is an urgent and difficult task. But not everything is bad news. Minorities are currently underrepresented in finance.⁸ As technical skills become more important than personal connections or privileged upbringing, the wage gap between genders, ethnicities and other classifications should narrow. The key is to ensure equal access to technical education. In finance, too, math could be “the great equalizer.”

Retraining our existing workforce is of paramount importance, however it is not enough. We must make sure that America retains the talent it develops. The founders of the next Google, Amazon or Apple are this very morning attending an engineering or math course at one of our Universities. Unlike in the past, odds are that these future entrepreneurs are in our country on a student visa, and that they will have a very hard time remaining in the United States after their

⁷ <https://datausa.io/profile/naics/finance-insurance>

⁸ According to the Board Center for Financial Planning, less than 3.5% of all the 80,000 Certified Financial Planners (CFPs) in the United States are black or latino. The situation is likely worse in asset management firms. <https://prn.to/2PcBaNc>

graduation. Unless we help them stay, they will return to their countries of origin with their fellow students, to compete against us in the near future, hindering our competitive advantage.⁹

3. RegTech

The term RegTech refers to the collection of technologies in general, and ML technologies in particular, that assist and support the functions specifically assigned to regulatory agencies, such as financial oversight, preservation of market integrity and prosecution of market manipulators. The applications of ML in this space are very diverse. In this testimony I will focus on two examples that I believe are implementable in the short term.

3.1. Crowdsourcing the detection of market manipulators

One of the most challenging tasks faced by regulators is to spot the actions of market manipulators among oceans of data. This is, quite literally, like searching for a needle in a haystack. A practical approach is for regulators to enroll the help of the data science community, following the example of Kaggle competitions, or the Netflix prize.

Between 2006 and 2009, Netflix held a tournament to improve their movie recommender algorithms. Data scientists received a training set containing information regarding over 100 million ratings contributed by almost half a million users. The data was anonymized, to protect the privacy of Netflix customers. The winning team improved Netflix's forecasting power by about 10%, and received a prize of \$1 million.¹⁰

Following this example, regulators could anonymize transaction data, and offer it to the worldwide community of data scientists, who would be rewarded with a portion of the fines

⁹ <https://www.svcip.com/>

¹⁰ <https://www.netflixprize.com/assets/rules.pdf>

levied by regulators against wrongdoers. The next time that financial markets experience a “flash crash,” the tournament approach could lead to a faster identification of potential market manipulators.¹¹

3.2. Detection of false investment products

A pervasive mistake in financial research is to take some data, and simulate the historical performance of alternative variations of an investment algorithm, until a false positive result comes out. This methodological error is known as “backtest overfitting,” and it is so notorious among statisticians that we consider it scientific fraud (Bailey et al. [2014]). Academic financial journals are filled with such pseudo-discoveries. Financial firms offer online tools to overfit backtests, and even large hedge funds constantly fall into this trap, leading to investor losses.¹²

Years ago, financial firms realized that peer-reviewed journal articles were an extremely effective marketing tool, and a way to circumvent SEC rules against false advertising (Fabozzi and López de Prado [2018]). This has led financial firms to launch investment products based on overfit backtests, with great commercial success followed by disappointing performance.

Although there are no laws specifically prohibiting funds based on overfit backtests (yet), investors may have a legal case against this widespread investment malpractice that professional associations of mathematicians have deemed unethical. Such offenders are abusing the public trust earned by *bona fide* scientists. As legal analysts and regulators learn more about these unethical or negligent practices, laws and regulations should be passed to finally curtail some of these abuses.

¹¹ <https://www.bloomberg.com/news/articles/2015-04-22/mystery-trader-armed-with-algorithms-rewrites-flash-crash-story>

¹² An intuitive explanation of backtest overfitting can be found in this video:
https://youtu.be/4oBMvIQ_sxs

One solution is to require financial firms to record all backtests carried out in the development of a product. With this information, auditors and regulators can apply ML techniques to compute the probability that the strategy is overfit, and this probability could be reported in the funds' promotional material (Fabozzi and López de Prado [2018], López de Prado [2019d]). In other experimental fields, like in medical research, logging all trials is standard operating practice.

A second solution is to require that financial firms disclose in their promotional materials whether their product is based on flawed academic publications, that is, peer-reviewed papers where the authors failed to disclose the full extent of the experiments conducted. This makes sense, because backtest overfitting constitutes scientific malpractice, and funds should be held responsible when this malpractice costs investors their savings.

A third solution is to require financial firms to conduct their research following the protocol of ML tournaments. In ML tournaments, researchers only have access to a portion of the data. Because part of the data is remains hidden, researchers cannot overfit their backtests. Tournaments offer a viable alternative to the traditional backtesting paradigm (López de Prado and Fabozzi [2019]).

4. Algorithms and bias

Financial professionals are confronted with conflicts of interest every day: in granting a loan, classifying a company, recruiting talent, predicting earnings, forecasting inflation, etc. When these individuals are asked to make judgment calls, there is a risk that they fail to comply with their fiduciary duties, or that they impose their biases on others.

In some situations, investors may be better served when a machine makes the calls, based on facts learned from hard data. Furthermore, machines will comply with the law, always, when programmed to do so.

This does not mean that algorithms will make flawless decisions. When trained incorrectly, ML algorithms can incorporate human biases. The good news is, we have a better chance at detecting the presence of biases in algorithms, and measure that bias with greater accuracy than on humans, because we can subject algorithms to a batch of blind randomized controlled experiments. It is easier to monitor and improve an algorithmic decision process than one relying entirely on humans. Algorithms can assist human decision-makers by providing a baseline recommendation that humans can override, thus exposing potential biases in humans.

As algorithmic investing becomes more prevalent, Congress and regulators can play a fundamental role in helping reap the benefits of financial AI, while mitigating its risks.

Thank you for the opportunity to contribute to this hearing. I look forward to answering your questions.

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Biography

Dr. Marcos López de Prado is the CIO of True Positive Technologies (TPT), and Professor of Practice at Cornell University's School of Engineering. He has over 20 years of experience developing investment strategies with the help of machine learning algorithms and supercomputers. Dr. López de Prado launched TPT after he sold some of his patents to AQR Capital Management, where he was a principal and AQR's first head of machine learning. He also founded and led Guggenheim Partners' Quantitative Investment Strategies business, where he managed up to \$13 billion in assets, and delivered an audited risk-adjusted return (information ratio) of 2.3.

Concurrently with the management of investments, between 2011 and 2018 Dr. López de Prado was a research fellow at Lawrence Berkeley National Laboratory (U.S. Department of Energy, Office of Science). He has published dozens of scientific articles on machine learning and supercomputing in the leading academic journals, is a founding co-editor of *The Journal of Financial Data Science*, and SSRN ranks him as the most-read author in economics. Among several monographs, Dr. López de Prado is the author of the graduate textbooks *Advances in Financial Machine Learning* (Wiley, 2018), and *Machine Learning for Asset Managers* (Cambridge University Press, forthcoming).

Dr. López de Prado earned a PhD in financial economics (2003), a second PhD in mathematical finance (2011) from Universidad Complutense de Madrid, and is a recipient of Spain's National Award for Academic Excellence (1999). He completed his post-doctoral research at Harvard University and Cornell University, where he is a faculty member. In 2019, Dr. López de Prado received the 'Quant of the Year Award' from *The Journal of Portfolio Management*. For more information, visit www.QuantResearch.org

Statement by

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before the

Task Force on Artificial Intelligence

of the

Committee on Financial Services

U.S. House of Representatives

December 6, 2019

Chairman Foster and Ranking Member Loudermilk, thank you for inviting me to testify about “Robots on Wall Street: The Impact of AI on Capital Markets and Jobs in the Financial Services Industry.” My remarks provide background on the role and implications of automation and algorithmic systems on the financial services workforce, and I offer an opinion on how we might mitigate the negative impacts of such systems, in particular for those underrepresented in the financial services sector.

My name is Dr. Charlton McIlwain. I currently serve as a Vice Provost at New York University. I am a tenured Full Professor in the Department of Media, Culture, and Communication at New York University, where I have been a faculty member for nineteen years. I offer testimony today in my capacity as a professor and researcher, and my testimony today in no way represents the view or position of the institution I serve.

I started my academic career almost twenty years ago researching how racial discrimination is produced, and how it impacts our electoral politics, specifically how racial dynamics in our electoral system often undermine our country’s principles of representation, equality, and equal opportunity. My expertise in this area has afforded me the opportunity to serve as an expert witness in two federal court cases. These cases have some bearing on my remarks today. Each of those cases focused on how financial service providers – mortgage lenders more specifically – targeted Black and Latinx homebuyers as a market for predatory mortgage products.¹

¹ I worked with Relman, Dane & Colfax, PLLC and South Brooklyn Legal Services, in the case of Saint-Jean v. Emigrant, United States District Court for the Eastern District of New York, case# 1:11-cv-02122 (involving racial targeting and housing discrimination); and for South Brooklyn Legal Services in the case of Barkley, et al. v. United Homes, et al., United States District Court for the Eastern District of New York, case #s 04-CV-875 (KAM), 05-CV-187 (KAM), 05-CV-4386 (KAM), 05-CV-5302 (KAM), 05-CV-5362 (KAM), 05-CV-5679 (KAM) (involving racial targeting and housing discrimination).

For the past ten years I have devoted my efforts to researching and illuminating the ways that Internet platforms and automated and algorithmic systems impact these same racial dynamics. I research how such systems may discriminate against, and disparately impact, individuals and communities of color. For instance, I have published work such as *Racial Formation, Inequality and the Political Economy of Web Traffic*. I am also a historian of technology, exemplified most recently in my new book *Black Software*² which, among other features, highlights the devastating outcomes resulting from automation, beginning in the 1960s, African Americans' persistent underrepresentation in the technology workforce, as well as highlighting the ways that African Americans have used computing technology and the Internet to advance their own economic, social and political interests. In 2017, I founded the Center for Critical Race & Digital Studies, a research center and network of experts who seek to better understand the ways that new technologies impact and are impacted by communities of color.

Key Questions

I have been asked to supply information about and insight into: (1) the types of automation currently being deployed in capital markets and the financial sector, and how that affects decision-making; (2) how AI and automation can help and hurt workers by disruption of the current and future financial services workforce; (3) what "regtech" is and how AI can be deployed to help regulators better supervise financial institutions; and (4) ways to deter algorithmic bias. I will do my best to address these points from my expertise as a historian of technology, a social scientist studying algorithmic systems and decision making, and my focus on the implications of these technologies on marginalized communities, particularly communities of color.

² Charlton D. McIlwain (2019) *Black Software: The Internet & Racial Justice, From the Afronet to Black Lives Matter*, New York: Oxford University Press.

Financial Sector Automation

I use the term “automation” to refer to the application of computing technology (generally software-based) to control the execution of business processes, transactions and consumer services, with little human intervention. Automation is certainly not new in concept or application and is utilized across a wide range of industries and sectors of our economy. This means that the opportunities, anxieties, complications and implications of automation are also not new and provide evidence from the past that can provide us insight into what we should be concerned about now and in the future with regard to how increased automation will affect new sectors such as the financial services industry. I use the term “artificial intelligence” at its most basic level, to refer to software that: utilizes human-designed algorithms to rapidly process and analyze large volumes of data, utilizes data analytics to predict outcomes, then utilizes those predictions to inform and/or determine decisions. Automation and artificial intelligence might be separate or paired products and processes.

For example, a bank may automate the home loan application process by developing an app (a term I will use to distinguish the technology from the process of applying for something) that allows me to utilize my smartphone to supply the necessary information. The app may be designed to connect to and draw information from other databases and use the information I supply as an applicant (such as my social security number, address, etc.) to automatically verify my identity, and pull into my mortgage application additional information such as my credit bureau scores and/or reports. The automation aspect of this application, which arguably makes application submission and processing more efficient for both the bank and me, the individual applicant, could end there. At that point the information gathered could be turned over to a human loan officer to further process and make a loan decision.

Additionally, however, the bank may utilize a software application that uses key variables supplied/generated from the app (for example my credit score, annual income, and the amount of other debt) to compare to a larger database of loan applicants. That data would be analyzed to predict whether I am at low enough risk for defaulting on my loan, in which case I would be approved for a mortgage. If I posed high enough risk, my application would be rejected. This would be done by constructing an algorithm that predetermines what data variables will be utilized to model varying levels of risk (credit score, annual income, and amount of other debt), and how each of these variables will be weighted (e.g., credit score might be weighted highest, followed by income, followed by debt). Further, even if I meet a minimum risk threshold, a separate algorithm might be utilized to determine pricing, that is, how much I will pay in interest on the loan. This algorithm might automatically and positively correlate my risk score with the loan price (such that the higher my acceptable risk, the higher the loan price), based on a different algorithm that seeks to maximize potential profits for the bank. The end result of this automated, algorithmic product is a decision to reject my loan application or approve my application at a particular price point.

The example above (credit risk scoring) is but one of many that fall under the now colloquial category called “fintech.” These are automated and algorithmic applications that seek to maximize consumer access to, interaction with, and benefits from the financial sector. A sample of additional examples include:

1. Fraud Prevention apps that, for example, a bank might use to algorithmically profile a consumer based on their past purchasing patterns, then alert the bank and the consumer about deviations from that pattern, prompting the consumer to verify whether they made and/or authorized a specific transaction;

2. High Frequency Trading apps that use algorithms to analyze market information and execute trades at high speeds to maximize potential profits or gain other advantages in the market;
3. Personalized Banking apps that automate routine consumer banking transactions such as paying bills or sending automated reminders that bill payments are due/overdue, or that provide personal finance apps that use algorithms to help a user track or forecast spending, etc.

Impact of Automation on Financial Sector Workers

The actual and perceived impact of computer driven automation has been a key labor and civil rights concern since its rise to prominence in the late 1950s and early 1960s. Two principles, advanced by labor and civil rights leaders from that time period – individuals who were no stranger to this legislative body – continue to be relevant to this day as a guide and framework for understanding how automation might impact workers in general, and have a disparate impact on African American and other racially and socioeconomically marginalized citizens in our society. Labor leader A. Philip Randolph suggested that automation should be guided by principles of inclusion, one that mitigates against the disparate positive and negative impacts of technology. This, he asserted, would be possible by making sure that we prepared the workforce for new jobs that could be produced by automation. He said,

The great masses of the people should not be required to bear the brunt of the impact of this great automation revolution which is shaking the world. But what can be done about it? You cannot destroy the machine, you cannot stifle the invention of various geniuses in the world. Then what is to be done? We must reduce the hours of work, we must shorten the workday, the workweek, the workmonth, in order to make new jobs. For instance, in

our own field, if the Brotherhood of Sleeping Car Porters can win the fight for the forty-hour week we will make one thousand new jobs.

Ahead of what later became President John F. Kennedy's Manpower and Development Training Act of 1962, and motivated by early concerns about automation, Congressman Adam Clayton Powell, Jr. framed how the outcomes from automation would be influenced by the more overarching presence of racial discrimination. He said:

I shall not quote statistics. To do so would be a waste of your time and that of my staff. We know that the Afro-American is the last-hired, first-fired. We know that he pays a tax on being black, which makes him the lowest wage earner in this Nation. We know that he is quarantined, regardless of ability and education, so that his highest achievement can be the attainment of only creature comforts. We know that he composes the largest number of unemployed in this Nation today. We know that the new era of automation does not include him. We know that Government—local, State and Federal—rigidly excludes him or gives him token consideration at high levels and mass menial jobs at low levels.³

As we reflect on our current moment and the future of automation in the financial services sector, Randolph and Powell's principles give us ample reason to remain concerned. Why? First, the financial services sector is ripe for automation and algorithm-driven innovation. A 2017 McKinsey Global Institute study estimated that fifty percent and upwards of key financial/insurance service sector tasks (specifically those involving data/document collection

³ Charlton D. McIlwain (2019), *Black Software: The Internet & Racial Justice, from the Afronet to Black Lives Matter*.

and processing) are at risk of being automated.⁴ McKinsey also forecasted that “machines will do up to 10 to 25 percent of work across bank functions.”⁵

Second, the fintech sector is on the rise. Both companies and consumers recognize its efficiencies and conveniences. For example, Ernst & Young’s annual survey of fintech adoption, has shown a 16% to 64% increase in fintech adoption among consumers and small and medium size enterprises, between 2015 and 2019.⁶

Third, large numbers of workers will likely be displaced in the financial services sector (as well as others), even if automation and AI development is projected to create new types of jobs. As two Brookings Institution researchers put it, “Robots kill jobs. But they create jobs, too”.⁷ If the financial services sector is ripe for automation, if increased adoption and development of fintech increases the propensity for automation, and if automation is likely to displace significant numbers of workers, then the cause for concern is clear. It lies with the fact that African Americans and Latinx workers in particular, are already vastly underrepresented in the financial service sector workforce. Government Accountability Office analysis of Equal Employment Opportunity Commission (EEOC) data showed that African Americans, “Hispanics,” and Asians make up only 22% of the financial service industry workforce. African American representation in the financial services sector (both entry and senior level jobs)

⁴https://www.ncci.com/Articles/Pages/II_Insights_QEB_Impact-Automation-Employment-Q2-2017-Part1.aspx

⁵<https://www.mckinsey.com/industries/financial-services/our-insights/the-transformative-power-of-automation-in-banking>

⁶ https://www.ey.com/en_us/financial-services/eight-ways-fintech-adoption-remains-on-the-rise

⁷ <https://www.brookings.edu/blog/up-front/2019/03/18/robots-kill-jobs-but-they-create-jobs-too/>

declined from 2007 to 2015.⁸ Less than 3.5% of all financial planners in the U.S. are Black or Latinx.⁹ According to the EEOC, African Americans make up just 4.4% and Hispanics just 2.9% of the securities subsector, and Asians make up just 2.8% of the central banking and insurance subsectors. Further, the EEOC concluded each subsector in the financial industry has a large portion of establishments where the chances of moving into management are “unfavorable to women, African Americans, Hispanics and Asians when compared to white males. Entry into management may be a particular concern for Asians.”¹⁰

My point is simple. Racial groups that are already extremely underrepresented in the financial services industry will be most at risk in terms of automation and the escalation of fintech development. This is especially true given the vast underrepresentation of African Americans and Latinx in the adjacent technology sector workforce. There, African Americans and Hispanics represent only 4% and 7% respectively of all workers, 2% and 5% respectively of managers, and 1% and 3% respectively of executives.¹¹ Further, automation’s displacement patterns are likely to mirror the same disparities found during other forms of economic and workforce downturns. For instance, “Even though the poverty gap between blacks and whites has narrowed, a Pew study released last year found that blacks were still at least twice as likely as whites to live in poverty or be unemployed.”¹²

⁸ Highlights of GAO-18-64. 2017. Financial Services Industry. Trends in Management Representation of Minorities and Women and Diversity Practices, 2007-2015.

⁹<https://centerforfinancialplanning.org/wp-content/uploads/2018/10/Racial-Diversity-in-Financial-Planning.pdf>

¹⁰ <https://www.eeoc.gov/eeoc/statistics/reports/finance/index.html>

¹¹ <https://github.com/cirlabs/Silicon-Valley-Diversity-Data>

¹²<https://www.cnn.com/2017/05/05/opinions/empathy-gap-in-viewing-black-poverty-and-pain-tanzina-vega/index.html>

I close this section with another statement by one of our civil rights forbears, Bayard Rustin, who had one of the most sophisticated understandings at the time of computerized automation and its workforce implications. In his essay, *Automation and the Negro*, Rustin emphasized that the only hope we have to curb the devastating effects of automation on the black workforce is to plan deliberately for the inevitability of job displacement brought on by automation. If we are to mitigate the likelihood that automation will disproportionately and negatively affect those already underrepresented in the financial services industry, we must plan ahead, long into the future, rather than allowing the market to run its course toward predictable outcomes. Such planning requires developing an agenda that focuses on better understanding the potential effects of automation on the workforce. But it also means developing an agenda for how the public and private sector, higher education institutions and others will set and implement specific goals for educating and retraining the existing workforce. It also means committing to develop and fully utilize those who come through a more robust pipeline of underrepresented workers into the financial and technology sectors. The stagnant representation of people of color in both the financial services and technology sectors demonstrates our need to do something above and beyond the status quo.

“Regtech”

Regtech products help monitor regulatory and compliance processes within the financial and other industries. A recent report by Deloitte¹³ identified 347 regtech companies worldwide actively developing such solutions across five regulatory areas including: regulatory reporting, risk management, identity management, compliance, and transaction monitoring.

¹³ <https://www2.deloitte.com/lu/en/pages/technology/articles/regtech-companies-compliance.html>

The most important characteristic of regtech is that they are a combination of automated and algorithmically-driven systems. As such, they provide the potential to improve the financial industry regulatory landscape. But they are, by no means, a panacea. Whether automated and algorithmically driven technologies are developed to serve consumers, produce financial profits for businesses, help industry comply with regulatory mandates, or help government regulate the financial sector, they are susceptible to biases that may produce tangible harms on citizens, and potentially disparate harms on certain groups.

Such biases generally become part of algorithmic systems by relying on data that is inaccurate, unrepresentative, or sourced from unreliable datasets. It also comes from algorithms that draw incorrect inferences from data, especially when that data is aggregated from multiple, disparate datasets and sources. Biases potentially become part of such systems when the variables and weighting of variables is not transparent, obscuring how algorithms draw connections between variables and draw inferences from large bodies of data to drive decisions. This problem is further exacerbated when we cannot trace (audit) the ways that an algorithm processes data that leads to apparent disparate outcomes, or when there is no “human in the loop” to monitor and scrutinize the outputs of algorithmic systems, at the very least to verify whether or not it actually accomplishes what it was designed to produce.

The Michigan Integrated Data Automated System (MiDAS) is one of the most recent and high-profile examples of how an algorithmic system utilized by a government agency, can produce tangible harms. In this case, the likely reliance on inaccurate and corrupt data to help detect unemployment fraud misidentified, accused, and commenced punitive financial actions against more than 34,000 Michigan residents. In this case, the algorithm that powered MiDAS misidentified potential fraud 85% of the time, resulting in devastating financial outcomes for

those falsely accused by the algorithmic system. Further, the system allowed for no human review or verification before it commenced punitive actions against those accused.¹⁴

Deterring Algorithmic Bias

I want to conclude my remarks by briefly addressing the very important question about what we can do to deter algorithmic bias. Certainly, one course of action is to develop best practices for constructing and deploying algorithmic systems and providing more oversight from industry, government, and non-governmental bodies who are able to assess how such systems are used and the outcomes they produce. As cited above, this includes “technical” solutions that make algorithms more transparent and auditable to mitigate against potential biases *before* such systems gain widespread use, rather than trying to simply correct their effects once their damage is done.

But I want to emphasize that, especially when it comes to mitigating the potential disparate outcomes that biased algorithms might have on individuals and communities of color, simple reliance on “technical” fixes by technologists is not a complete solution. I argue that algorithmic bias, algorithmic discrimination, is not merely a financial issue. It is a civil rights issue. I want to end by again drawing on the wisdom of Bayard Rustin, who said of his time,

Today the unskilled and semiskilled worker is the victim, but cybernation [an early term used in part to refer to algorithmic processes] invades the strongholds of the American middle class as once-proud white-collar workers begin sinking into the alienated world of the American underclass. And as the new poor meets the old poor, we find out that automation is a curse. But it is not the only curse. The chief problem is not automation, but social injustice itself.

¹⁴<https://spectrum.ieee.org/riskfactor/computing/software/michigans-midas-unemployment-system-algorithm-alchemy-that-created-lead-not-gold>

Rustin's point, as applied to our current situation, is this. While we must do all that we can to make algorithmic systems fairer, more accurate, and more transparent, we cannot expect that such actions will remedy a central problem, which is social and racial injustice and discrimination. Take, as a final example, the findings from a recent National Bureau of Economic Research study titled, "Consumer-Lending Discrimination in the FinTech Era." There researchers sought to determine whether an algorithmic system could reduce discrimination in mortgage lending as compared to traditional face-to-face lending processes. Their findings were mixed. Yes, the algorithmic system discriminated 40% less than the traditional process. But that also meant that the process still discriminated against a large number of Black and Latinx loan applicants. Further, even though the algorithmic system did not, on balance, discriminate in terms of loan approval, it did discriminate against Black and Latinx users in terms of what they had to pay for their loans. One of the key conclusions of the study states that

Both FinTechs and face-to-face lenders may discriminate in mortgage issuance through pricing strategies. We are just scratching the surface in the role of pricing strategy discrimination in the algorithmic area of data use. In short, algorithmic lending may reduce discrimination relative to face to face lenders, but algorithmic lending is not alone sufficient to eliminate discrimination in loan pricing.¹⁵

Even with the aid of a fair, accurate, and transparent algorithmic system, racial discrimination persists, the result of what can only be ascribed to systemic and structural racial discrimination that has plagued this sector throughout our history.

¹⁵ Bartlett, R., Morse, A., Stanton, R., & Wallace, N. (2019). *Consumer-lending discrimination in the FinTech era* (No. w25943). National Bureau of Economic Research.

What does this mean for us? It means that beyond our technical fixes, we must urge technologists and all of those who have a hand in developing and regulating algorithmic systems not to take a race-blind approach to solving the problems of algorithmic bias and discrimination. It means we must, as a general rule, demand that technologists, researchers, regulators, and others who have a stake in these systems specifically understand and determine how such systems will impact citizens based on racial group demographics. Finally, we must continue to do what we can to curb the underlying problem of racism. Such an approach must be ongoing, systemic and institutionalized.

Thank you again for allowing me the opportunity to contribute to these proceedings.



Testimony of Martina Rejsjo
Head of Nasdaq Surveillance North America Equities
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' to 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.

WRITTEN TESTIMONY OF KIRSTEN WEGNER
CHIEF EXECUTIVE OFFICER, MODERN MARKETS INITIATIVE

BEFORE THE TASK FORCE OF ARTIFICIAL INTELLIGENCE
UNITED STATES HOUSE COMMITTEE ON FINANCIAL SERVICES

HEARING ON "ROBOTS ON WALL STREET: THE IMPACT OF AI ON CAPITAL MARKETS AND
JOBS IN THE FINANCIAL SERVICES INDUSTRY"

DECEMBER 6, 2019

Introduction

Thank you Chairwoman Waters, Ranking Member McHenry, Chairman Foster and Ranking Member Loudermilk, and the distinguished members of the Task Force, it is a personal honor to be here to discuss the role of automation and Artificial Intelligence (AI) in the financial services industry, our capital markets and future of the workforce.

I am Kirsten Wegner, Chief Executive Officer of Modern Markets Initiative, an education and advocacy organization comprised of automated trading firms. Together, our firms trade in over 50 markets globally and employ 1600 people. Our Advisory Board, made of half women, promotes responsible innovation, including advancing leadership opportunities for a diverse workforce.ⁱ

The Rise of Automation in Trading

Over the past few decades, we've seen computerization of our capital markets, including the rise of automated traders, taking the place of the exchange-floor based traders depicted in 1980s Wall Street movies.ⁱⁱ So too have we seen the proliferation of automated trading systems available to retail investors, where at the click of a button, and in many cases for free, the average investor can buy and sell stocks in a fraction of a second.

It is now beyond debate that our technology has reduced the cost of trading for the average investor, both in direct trading costs and savings through tighter bid ask spreads.ⁱⁱⁱ Investors in 529 college savings plans, 401ks, pension funds, and university endowments have benefited from what are now the best markets ever when it comes to low cost trading and dependable liquidity.^{iv} Specifically, over a decade, automation of the electronic intermediaries has brought down trading costs by 50 percent,^v and yielded 30 percent more in lifetime savings for investors.^{vi}

Future Automation and Rise of AI

As the pace of technology continues to quicken and companies continue to innovate, we can anticipate further growth in automation and AI in these areas:

- **Asset management industry** –AI will likely be used by robo-advisors and others for “Know Your Customer” services to understand risk tolerance, investment goals, and to help humans make more informed decisions, and deliver performance results in an increasingly competitive and global industry.
- **“Regtech” space** – AI will be used to deliver more detailed, accurate, and timely reporting and compliance functionality, likely at cost-savings.
- **Fraud Detection and Cyber-Defense** –AI will be in demand for faster, and more accurate detection, surveillance, and reporting of domestic and international bad actors to protect the capital markets and public.

Key Take-Aways

As we step back and look more broadly at the future of AI and further automation in our capital markets, I would like to discuss four key take-aways.

1. GLOBAL COMPETITION IN AI AND AUTOMATION DRIVING EFFICIENCIES, COST SAVINGS IN DECISION-MAKING

Today the U.S. is the place where international companies come to list, and where international investors come to invest. As further automation and AI capacity emerges, U.S. companies will need to innovate and invest in leading technology to continue to compete in a global marketplace. It is anticipated that this competition to adopt the latest AI technologies will make human decision making more efficient in terms of speed, processing time, depth of data, and will confer further efficiencies and cost savings for all U.S. investors. Already, competition in the markets has resulted in near-zero commission online trading from Fidelity, Charles Schwab and Robinhood. Similarly, automated trading has brought overall trading costs down to a fraction of the price from decades ago.

As we look ahead, we can see AI and competition on pricing to further deliver savings to investors in the form of robo-advisors, ETFs, and other areas of our capital markets.^{vii} Moreover, it will be vital for U.S. financial firms to continue to innovate to compete in a global economy and keep America’s capital markets the world leader.

2. ROBOCOP: AI FOR SURVEILLANCE, CYBER SECURITY, AND FRAUD DETECTION

Second, artificial intelligence will become of increasing value for firms and regulators to police against cyber-risk, irregular trading, illegal speculation and fraud, and we can anticipate an expansion of an area known as “regtech.”

Through public-private partnerships, private firms can play a role in working with regulators to share resources on AI and cutting edge technology. For example, since 2017, several Modern Markets Initiative members have welcomed the opportunity to work together with FINRA in a private-public partnership, contributing their private sector know-how, to deploy artificial intelligence to surveil the market.^{viii} Automated trading firms are incented to detect bad actors as they, too, can be victims of fraud.

Further, “Regtech,” is a growing space in which companies offer technology to other companies and regulators to help humans manage decision-making and processes for regulatory purposes. It is often faster, more efficient and comes with a cost savings to better deploy the limited government resources of regulators. Examples of regtech include:

- Monitoring, reporting, and compliance of regulatory filings
- Loan origination processing, in the lending space
- Processing of filings received by regulators
- Help for regulators to identify misconduct and illegal trading through regulatory filings or other data.^{ix}

As bad actors become more sophisticated, it is vital that financial regulators have the funding resources, technological capacity, and access to AI and automated technologies to be a strong and effective cop on the beat.^x

3. DATA: THE FUEL OF AI; DEMAND FOR ALTERNATIVE DATA

As the technology for AI systems matures, we can expect to see an increased demand for high quality, robust data – including alternative data, used to obtain insight into the investment process – to provide the crude oil for the engines of AI.^{xi} This will entail large quantities of data, including alternative data, too vast and complex for humans, alone, to digest.

Policy questions in the future are likely to arise regarding:

- integrity of alternative data sets and algorithms used to process data, including nondiscrimination in consumer finance fields such as mortgages and lending
- cost of data and access to such data
- intellectual property rights, ownership rights, and privacy rights of data
- competition and antitrust questions related to data ownership^{xii}

A positive discussion point on usage of alternative data has centered on helping establish credit history for the underbanked.^{xiii} This is an example of responsible innovation that policy-makers should encourage.

Notably, algorithmic bias is an area for which you have invited discussion. Academic research has been conducted on questions of potential risk in algorithmic bias, even unintentionally, to be modeled into statistical analysis regarding consumer lending, for example: mortgage origination, credit scoring, consumer lending, and other areas.^{xiv} Generally, I think it is vital that industry participants share information with one another on addressing this issue, mitigating against risk of discrimination, establishment best practices, and, where applicable, consider use of ethics officers collectively (within the “regtech space”) or individually within firms to mitigate against algorithmic bias.

4. FUTURE OF WORKFORCE: JOBS LOST, JOBS GAINED, INCLUSION

Worries of robots replacing humans have been around since the start of the century – and the fear of automation replacing workers has been around since the beginning of the industrial revolution.^{xv}

What I can tell you is this: AI and automation can and should be a *tool*, rather than a *replacement*, for humans.^{xvi} Some jobs will disappear, and others will grow. We can expect to see declines in: office support,^{xvii} administrative/compliance, and manual trading.^{xviii}

We can expect to see growth in “computer occupations,” anticipated to increase by 12% in the next decade.^{xix} We will see growth in jobs related to the transmission, storage, security, privacy, and integrity of data that fuels the AI economy.

There is a massive demand in virtually all sectors of our economy, particularly in the financial sector, for qualified technology talent.^{xx} To ensure that a diverse and

prepared workforce share in the up-side of growth of AI, public policy makers and private sector employers should consider the following:

- Promote private-public educational partnerships for STEM fields, beginning in middle school, in geographically diverse regions nationwide to engage and encourage youth to explore careers in technology and programming.^{xxi}
- Educational institutions should consider offering two-year degrees in technology fields, in addition or alternative to four year degrees, to reduce student debt obligations and allow students to enter the STEM workforce.^{xxii}
- Public-private apprenticeships for summers between high school and college, in the areas of STEM, to expose and recruit women and minorities to these fields.^{xxiii}
- Investment in reskilling current employees, supporting mobility and job rotation to growth areas.^{xxiv}
- Promote women and minorities in leadership in the private sector and government.^{xxv}

Notably, the current baseline of participation of women, and in particular women of color, in the financial sector leaves room for substantial improvement and it is vital that policymakers include diversity as part of discussions over responsible innovation.^{xxvi} According to The Institute for Women's Policy Research on AI, social policy is needed for access to training and employment, as well as social policy to improve equity going forward, such that women, and in particular minority women, may enter "high tech" occupations such as software engineering.^{xxvii}

Conclusion

A skilled workforce for tomorrow's Wall Street is only as good as companies there to invest in technology and AI and hire more employees. Lawmakers should promote policies that encourage responsible private sector innovation, reward innovative companies and allow the U.S. capital markets to remain a global leader in the innovation economy.

I appreciate the opportunity to present my views to the Committee today and I look forward to answering any questions you may have.

###

ⁱ Established by MMI in Q4 2017, the MMI Advisory Board is dedicated to promoting core values and mission, with one of our five core stated goals since then of “promoting women in technology/innovation.” See <https://www.modernmarketsinitiative.org/leadership>.

ⁱⁱ See 1980s floor-based traders in popular culture movies such as *Wall Street* (1987), *Trading Places* (1983), and *Dealers* (1989). There have been specialists, or market intermediaries, at the exchanges since their establishment, providing an intermediary role between a buyer and a seller, matching the so called “bid” or price one is willing to buy a stock, and an “ask” or the price one is willing to sell a stock. Thus, we have the so-called “bid-ask” spread that the intermediaries match. With a human on an exchange as intermediary, in 1988 the bid-ask spread such that a market maker netted four cents in profit for every share they traded. With electronic intermediation through HFT – with humans programming computers, rather than humans on a trading floor – the bid-ask spread such that by 2010 electronic intermediaries were making 0.07 of a cent per trade, or 50 times less than humans on the trading floors. See Harold S. Bradley and Robert E. Litan “*Choking the Recovery: Why More Companies Aren’t Going Public And Unrecognized Risks Of Future Market Disruptions*,” (Nov. 8, 2010)(The authors found that in 1988, the typical market maker netted about four cents in profit for every share traded. In contrast, the typical HFT today reportedly nets 7/100 of a cent or less for every share traded. In short, the HFTs are willing to work for 98 percent less than what the average market maker of yesteryear made.)

ⁱⁱⁱ Academic literature, studies, statements on the cost savings benefits of automation of the markets to investors:

- Vincent Van Kervel and Albert J. Menkveld, “*High-Frequency Trading around Large Institutional Orders*” (Jan 29, 2016) (HFT provides liquidity for six hours to large buy side orders, to their benefit, and in doing so challenges the belief that HFT profits from quick “electronic front-running.” This prolonged period of HFT leaning reduces institutional trading costs by 39% and by extension all the individual investors they represent.”)
- Hal Scott, “*Why U.S. Investors are Better Off Today*,” Washington Times, (January 21, 2016). (Vanguard estimates that the shift from the old market structure to today’s automated market structure has reduced trading costs by 35-60 percent, resulting in a 32% greater yield for long-term investors.)
- “*Remarks* of Chairman Timothy Massad before the Global Exchange and Brokerage Conference (New York),” (June 3, 2015), Speech of Former CFTC Chair Tim Massad, (“Numerous studies – including the recently released UK Foresight HFT project – have shown that transaction costs for both retail and institutional traders decreased substantially with the growth of high-frequency trading.”)
- Barbara Novick, et al., “*US Equity Market Structure: An Investor Perspective*,” Blackrock Viewpoint, (April 2014)([Electronic market making] brings tangible benefits to our clients through tighter spreads.”)
- Terrence Hendershott, Charles Jones, Albert J. Menkveld, “*Does algorithmic trading improve liquidity?*” *Journal of Finance*, VOL. LXVI, NO. 1, (February 2011), 66(1):1-33 (lead article). Finalist, Smith-Breeden best paper prize.
- Charles Jones, Erik Sirri, “*Examining the Main Street benefits of our modern financial markets*” (March 2010) Center for Capital Markets Competitiveness, U.S. Chamber of Commerce. (“Lower trading costs and retirement savings - Our markets help investors manage their financial well-being and retirement needs. Lower trading costs mean investors can keep a bigger part of their nest eggs. Twenty years ago, buying a few hundred shares of stock would have taken several minutes and could have easily cost over \$100. Today, this trade can happen in seconds with the click of a mouse and is likely to cost less than \$10.”...Our modern financial markets enable the real economy and are fundamental to our nation’s economic prosperity. It is critical that policymakers understand that our markets are increasingly global and investors and companies have a choice of where to turn for their financial needs.”)

^{iv} For further information on automated trading and liquidity, including in times of volatility, please see:

- Prof. Terrence Hendershott, Haas School of Business University of California at Berkeley, Ryan Riordan, Department of Economics and Business Engineering Karlsruhe Institute of Technology, “*Algorithmic Trading and Information*” (August 18, 2009), (algorithmic trading “contributes more to the discovery of the efficient price than human trading. Contrary to conventional wisdom we find no evidence of AT behavior that would contribute to volatility beyond making.”);

Austin Gerig, Division of Economic and Risk Analysis U.S. Securities and Exchange Commission, David Michayluk, Finance Discipline Group University of Technology, Sydney, [Division of Economic and Risk Analysis \(DERA\) – Automated Liquidity Provision](#), (The authors create a model showing how automated HFT liquidity providers set more efficient prices, increase informed and decrease uninformed traders' transaction costs, and have no effect on volatility).

- "HFT Supplies Dependable Liquidity During Market Volatility," Modern Markets Initiative, (February 16, 2018) at <https://www.modernmarketsinitiative.org/latest-news/2018/12/14/hft-supplies-dependable-liquidity-during-market-volatility>.
- "Market volatility ensures a larger role for FinTech in 2019," Kirsten Wegner, The Hill (January 9, 2019)
- Comerton-Forte, C., Hendershott, T., Jones, C. M., Moulton, P. C., & Seasholes, M. S. (2010). "Time variation in liquidity: The role of market-maker inventories and revenues". (The authors show that market-maker balance sheet and income statement variables explain time variation in liquidity, suggesting liquidity-supplier financing constraints matter).

^v Menkveld, Albert J., "The Economics of High-Frequency Trading: Taking Stock" (June 1, 2016). Annual Review of Financial Economics, Volume 8, Forthcoming. Available at SSRN: <https://ssrn.com/abstract=2787542> (In the decade of migration to electronic trading and HFT arrival, transaction cost decreased by over 50% for both retail and institutional investors.)

^{vi} April 21, 2010: Vanguard Comment letter on SEC Concept Release on Equity Market Structure ("...we conservatively estimate that transaction costs have declined 50 bps, or 100 bps round trip. For example, if an average actively managed equity mutual fund with a 100% turnover ratio would currently provide an annual return of 9%, the same fund would have returned 8% per year without the reduction in transaction costs over the past decade. Today's investor with a 30 year time horizon would see a \$10,000 investment in such a fund grow to approximately \$132,000 in 30 years, compared to approximately \$100,000 with the hypothetical return of 8% associated with the higher transaction costs. Thus, any analysis of "high frequency trading" must recognize the corresponding benefits that long-term investors have experienced through tighter spreads and increased liquidity.")

^{vii} In April 2019, FINRA formed an "Office of Innovation" to conduct thoughtful research on the current and potential applications of AI on financial services industry. Haimera Workie, the inaugural chair of this group, is an excellent resource for information on general questions of impact of fintech and AI on the capital markets. See <https://www.finra.org/media-center/news-releases/2019/finra-forms-office-financial-innovation-announces-haimera-workie-head>.

^{viii} Market Surveillance Advisory Group in FINRA's Special Notice (March 21, 2017) (Notice announces the establishment of group to work with FINRA on initiatives to utilize artificial intelligence and technology to detect bad actors, e.g. spoofers and others, and report to FINRA; several MMI member firms are participants).

^{ix} "See Financial institutions have been making limited headway in cutting the cost of complying with increasing post-crisis regulation. That may be changing." PWC, <https://www.pwc.com/us/en/industries/financial-services/research-institute/top-issues/regtech.html>

^x Regulators can work with FINRA and SROs to build better, multi-layered approaches to detecting market disruption, to enhance kill switches, and deter market disruptions. Discussed by the SEC in 2013, a "kill switch" is a mechanism "pursuant to which one or more limits could be established by a trading venue so that if a participant exceeded those limits, the trading venue could stop accepting incoming orders from the participant³⁰ — in essence, a "kill switch" that would stop further trading." See "Addressing Market Instability through Informed and Smart Regulation, Commissioner Luis A. Aguilar, U.S. Securities and Exchange Commission." at <https://www.sec.gov/news/speech/2013-spch022213a.htm>. Since then, exchanges such as NASDAQ and NYSE have implemented kill switches as a way to safeguard against market disruption.

^{xi} See Deloitte: “[Alternative data for investment decisions: Today’s innovation could be tomorrow’s requirement](#)” See also “Why investors want alternative data,” Z., W. The Economist. (August 22, 2016)(“An explosion of data, which has revolutionised industries like health care and advertising already—is at last making itself felt in finance. A cottage industry is springing up to provide investors with data of a kind that will not show up on everybody else’s terminal: these are means for measuring a company’s performance that do not rely on solely on financial statements or company reports. The providers are themselves a disparate group, pumping out databases ranging from satellite imagery to social-media posts. Though their businesses may look utterly different on the surface, as vendors of data all are competing in the same space. Recent advancements in machine-learning have made it possible for companies to efficiently parse through millions of satellite images a day. Some data providers are now studying pictures of the car parks of big-box retailers to estimate sales, while others are looking at farmland to estimate corn yields.”)

^{xii} Testimony of Nicol Turner Lee, Fellow, Center for Technology Innovation, Brookings Institution, House Financial Services Committee Hearing on “Perspectives on Artificial Intelligence: Where We Are and the Next Frontier in Financial Services” (June 26, 2019).

^{xiii} “To Bank the Unbanked, Start Using Alternative Data,” Rodrigo Sanabria (August 14, 2018), Center for Financial Inclusion.

^{xiv} “Consumer-Lending Discrimination in the FinTech Era” Bartlett *et al* (November 2019), U.C. Berkeley, at <https://faculty.haas.berkeley.edu/morse/research/papers/discrim.pdf>.

^{xv} “Robots have been about to take all the jobs for more than 200 years. Is it really different this time?” Louis Anslow (May 16, 2016) (Noting, in relevant part, “Technology has always triggered fears of mass unemployment.... The same persistent fear has been playing out in the pages of newspapers for the last century: In 1921, The New York Times featured a book review titled “Will Machines Devour Man?,” In 1940s, “Does Machine Displace Man in the Long Run?...In the 1980s, “A Robot is After Your Job.”)

^{xvi} “Artificial Intelligence, Automation, and the Economy,” Executive Office of the President (December 20, 2016) at <https://obamawhitehouse.archives.gov/sites/whitehouse.gov/files/documents/Artificial-Intelligence-Automation-Economy.PDF> (“CEA has identified four categories of jobs that might experience direct AI-driven growth in the future. Employment in areas where humans engage with existing AI technologies, develop new AI technologies, supervise AI technologies in practice, and facilitate societal shifts that accompany new AI technologies will likely grow.”)

^{xvii} “Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation,” McKinsey Global Institute (December 2017) .

^{xviii} “Five Million Jobs by 2020: the Real Challenge of the Fourth Industrial Revolution,” World Economic Forum (Jan. 18, 2016) (Noting, “The Fourth Industrial Revolution, combined with other socio-economic and demographic changes, will transform labour markets in the next five years, leading to a net loss of over 5 million jobs in 15 major developed and emerging economies. Skills and jobs displacement will affect every industry and geographical region, but losses can be offset by job growth in key areas.”)

^{xix} “Computer Systems Analyst: Job Outlook,” U.S. Department of Labor, Bureau of Labor Statistics (2019)

^{xx} “How to Protect Workers From Job-Stealing Robots: President Obama’s chief economist argues that, with the right policies, artificial intelligence can be boon to the labor market, not a threat,” Jason Furman, The Atlantic (September 21, 2016).See also “Notes From the AI Frontier Modeling the Impact of AI on the World Economy,” McKinsey Global Institute (September 2018) (“ Based on early evidence, our average simulation shows around 70 percent of companies adopting at least one of these types of AI technologies by 2030, and less than half of large companies may be using the full range of AI technologies across their organizations. In the aggregate, and netting

out competition effects and transition costs, AI could potentially deliver additional economic output of around \$13 trillion by 2030, boosting global GDP by about 1.2 percent a year.”).

“Notes From the AI Frontier Modeling the Impact of AI on the World Economy.” McKinsey Global Institute (September 2018) (“Based on early evidence, our average simulation shows around 70 percent of companies adopting at least one of these types of AI technologies by 2030, and less than half of large companies may be using the full range of AI technologies across their organizations. In the aggregate, and netting out competition effects and transition costs, AI could potentially deliver additional economic output of around \$13 trillion by 2030, boosting global GDP by about 1.2 percent a year.”).

^{xxi} I am the result of a public-private partnership in STEM in the 1990s at [TJHSST](#). These types of models in the public school system, including the [Bronx High School of Science](#) and [Benjamin Banneker Academic High School](#), might be encouraged. A more diverse workforce can be established through partnerships with school groups and on-campus recruiting for internships at the high school as well as college levels to increase diversity headcount.

^{xxii} “Technology is changing jobs. Here’s how community colleges are responding.” Emily Arnim (November 13, 2019) (“As the artificial intelligence (AI) revolution transforms what work will look like in the future, community college leaders must take the lead in reskilling our workforce.”)

^{xxiii} “Employment and Jobs: Automation and a Changing Economy: The Case for Action, Pollack, Fitzpayne, and McKay, (April 2, 2019) The Aspen Institute (noting, “Investments in education, training, and the social safety net, along with a social contract between employers and workers that provided workplace benefits and protections, have helped mitigate automation’s negative impacts in the past and helped workers succeed in the changing economy.”)

^{xxiv} “How to Protect Workers From Job-Stealing Robots: President Obama’s chief economist argues that, with the right policies, artificial intelligence can be boon to the labor market, not a threat,” Jason Furman, The Atlantic (September 21, 2016) (Noting, in relevant part, “there is no economic reason that the United States cannot address inequality and increase employment while enjoying even higher levels of technology and productivity than seen today. What matters is how labor-market institutions—such as job-training programs, relocation assistance, licensing regimes, and so on—cope with these changes, support the creation of new jobs, and successfully match workers to them.”).

^{xxv} “Women in Financial Services: Quick Take,” Catalyst (May 21, 2019) (noting that Only 19.4% of executive and senior-level professionals are women in the US securities industry); policies aimed at improving these numbers should be implemented by private sector.

^{xxvi} “Closing the gap: Leadership perspectives on promoting women in financial services,” by Stacey Chin, Alexis Krivkovich, and Marie-Claude Nadeau; (September 2018), McKinsey Report, See Exhibit 1

^{xxvii} Institute for Womens’ Policy Research: [Women, Automation, and the Future of Work](#), Hegewisch *et al.* (March 13, 2019) “Women are more likely than men to work with computer and digital media but remain substantially underrepresented in the highest paid tech jobs, the jobs that require the highest knowledge and use of computers and digital media and that produce the technology of the future. Encouragingly, the number of women in such jobs has increased, particularly for women of color; time trends, however, also show that overall these occupations are becoming even more male-dominated because men’s employment in high tech fields has grown faster than women’s. This report reminds us of women’s historical role in the development of computing; working with computers and digital media is a much more integral part of most women’s work, than it is of most men’s. Many women are already digitally literate—the challenge is to help them move into fields where their digital skills can be developed and returns on those skills are higher and more secure than in the fields where women are now concentrated”



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December 6, 2019

Chair Bill Foster
 Ranking Member Barry Loudermilk
 Honorable Members
 House Financial Services Committee Task Force on Artificial Intelligence
 2129 Rayburn House Office Bldg.
 Washington, DC 20515

Via email

Dear Chair, Ranking Member, and Members:

On behalf of more than 500,000 members and supporters of Public Citizen, we offer the following submission relevant to the hearing titled “Robots on Wall Street: The Impact of AI on Capital Markets and Jobs in the Financial Services Industry.”

As the Task Force reviews the role of Artificial Intelligence in financial services, you will hear from a witness representing the high frequency trading (HFT) industry. Public Citizen believes computer trading can play a constructive role in our markets. However, high frequency trading can and has led to serious disruptions. For example, Treasury Secretary Mnuchin referenced HFT as a culprit in December 2018 stock market turbulence.¹ We support a tax on trades, in part, to address these disruptions. We have published reports showing that there will be negligible to no impact on average investors. Our most report on that topic is attached.

Because the integrity of information is important to your policy-making, we also include here a recent report that highlights duplicitous, misleading, facile studies produced by HFT allies that allege serious financial injury from such a tax. We expect specious claims will again be ventilated at this hearing. We also attach this report.

We ask that you please include our reports in the hearing record.

For questions, please contact Susan Harley at sharley@citizen.org, or Bartlett Naylor at bnaylor@citizen.org.

Sincerely,

Public Citizen

¹ Mark Decambre, *Mnuchin thinks there's a simple reason the Dow is poised for its worst December since 1931*, MARKETWATCH (Dec. 19, 2018) <https://www.marketwatch.com/story/mnuchin-has-a-simple-reason-why-the-dow-is-poised-for-its-worst-december-since-1931-2018-12-18>

AUG ANNUAL FTT COST

INCOME LEVELS	MEDIAN INCOME	COST/ YEAR*
01-19%	\$ 15,100	\$ 4
20-39%	\$ 31,400	\$ 9
40-59%	\$ 52,700	\$ 13
60-79%	\$ 86,100	\$ 25
80-89%	\$136,000	\$ 57
90-100	\$260,200	\$155

*Cost to retirement accounts. Only a small minority of Americans own stocks outside of retirement accounts.

A Progressive Tax With Beneficial Effects

A Small Levy on Financial Transactions Would Steer Clear of Struggling Americans, Raise Meaningful Revenue, and Possibly Retire An Abusive Wall Street Industry

September 16, 2019



Acknowledgments

This paper was written by Taylor Lincoln, Research Director of the Congress Watch division of Public Citizen, and edited by Susan Harley, deputy director of Congress Watch.

About Public Citizen

Public Citizen is a national non-profit organization with more than 500,000 members and supporters. We represent consumer interests through lobbying, litigation, administrative advocacy, research, and public education on a broad range of issues including consumer rights in the marketplace, product safety, financial regulation, worker safety, safe and affordable health care, campaign finance reform and government ethics, fair trade, climate change, and corporate and government accountability.



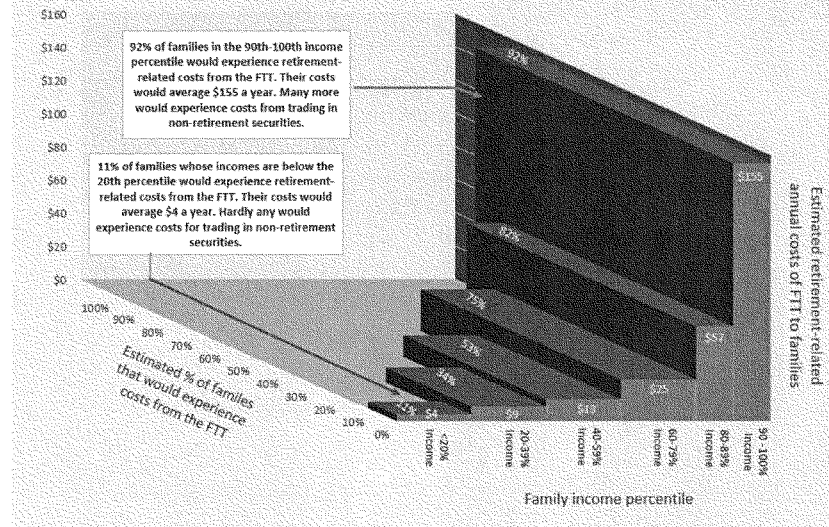
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TAKEAWAYS

A small tax on financial transactions, such as a one-tenth of 1 percent levy on the purchase of stocks and bonds, would likely end the viability of high-frequency trading while raising consequential sums for the U.S. Treasury. Opponents of this proposal have claimed it would hinder the ability of middle-class families to save for retirement. In contrast, we conclude that the costs of a modest financial transaction tax (FTT) would be little to nothing for middle-income families and would be easily manageable for average families in top income bracket.

- **Only about half of U.S. families would likely experience any costs at all from a financial transaction tax.** Because only about half the families in the United States have retirement accounts and very few of the families lacking retirement accounts likely own non-retirement securities, about half the families in the country would likely experience no costs at all from a financial transaction tax.
- **An FTT could actually save families money.** Incentives posed by an FTT could result in families saving more money than their costs from the tax. That is primarily because existing overhead and transaction costs that mutual fund investors already pay dwarf their potential costs from the FTT. An FTT would encourage mutual funds to reduce the rate with which they buy and sell stocks. This would not only reduce costs that consumers experience from an FTT, but would yield additional savings in reduced mutual fund overhead and non-FTT transaction costs.
- **An FTT would be progressive.** An average family in the lowest fifth of family incomes (median 2016 earnings of \$15,100 a year) that has a retirement account would experience estimated costs of about \$4 a year from a one-tenth of 1 percent FTT, according to Public Citizen's estimate. An average middle-income family (median income: \$52,700) that has a retirement account would experience about \$13 in annual costs. Families in the top 10 percent of incomes (median income: \$260,200) would experience about \$155 in average costs relating to their retirement accounts, while many would owe additional taxes for trading stocks outside of retirement accounts. [Figure on next page shows the prospective effects of the tax on retirement accounts by income group.] Costs based on estimates issued by the Investment Company Institute, discussed later in this report, would be somewhat higher, but still modest, and similarly progressive in relation to income groups.

Projected Percentages of Families That Would Experience Retirement-related Costs From 0.1% Financial Transaction Tax, and What Their Costs Would Be, By Income Percentile



INTRODUCTION

Unlike on purchases of most goods, there is no tax on purchases of stocks, bonds or other securities.¹ Over the years, policy advocates and public officials have put forth various proposals to institute a small levy on these transactions.²

Such proposals might appeal to those who wish to create a more progressive tax system, raise money for public investments, reduce the federal deficit, or deter high-frequency, computer algorithmic trading.

A financial transaction tax,³ or FTT, would inherently be targeted toward people of greater means. That is because it would be assessed only on those who have investments in the stock market, and roughly in proportion to the size of investors' assets. Stock ownership is closely correlated with wealth.

Such a tax has the potential to raise meaningful amounts of revenue. The Wall Street Tax Act introduced by Sen. Brian Schatz (D-Hawaii) and Rep. Peter DeFazio (D-Ore.)⁴ – which would tax the sale of most stocks, bonds and derivatives at one-tenth of 1 percent – is similar to a proposal that the congressional Joint Committee on Taxation last year estimated would raise \$777 billion over a decade.⁵

An FTT also would discourage high-frequency trading. This is a strategy, memorialized in Michael Lewis's best-selling book "Flash Boys," that involves buying and selling securities in intervals of milliseconds based on computer algorithms. High-frequency trading is estimated to account for more than half of stock trades.⁶

High-frequency trading may pose a risk to ordinary investors because the phenomenon of computers acting on other computers' signals could trigger a runaway chain reaction, causing a stock market meltdown. High-frequency traders have been blamed in part for the 2010 "flash crash," in which the Dow Jones Industrial Average lost about 10 percent of its value in 10 minutes for no apparent reason.⁷

¹ At present, there is a very small fee on transactions that resembles a tax but is not technically a tax. Brokerages often charge a fee, typically less than 10 cents per trade, to cover regulatory fees that they must pay to the Securities and Exchange commission. See, for example, *Fees to Consider before Your Sell Your Stock*, FINANCIAL WEB (viewed on Jan. 23, 2014), <http://bit.ly/1hPdmY9>.

² Aside from a financial transaction tax or Wall Street tax, proposals to tax financial transactions have been labeled a Tobin Tax, after Nobel-prize winning economist James Tobin, and the Robin Hood tax, after the folklore hero.

³ Proposals to institute small levies on financial transactions also have been labeled a Tobin Tax, after Nobel-prize winning economist James Tobin, and the Robin Hood tax, after the folklore hero.

⁴ Wall Street Tax Act of 2019, S. 647 (introduced on March 5, 2019), <http://bit.ly/2MUKnvB> and Wall Street Tax Act of 2019, H.R. 1516 (introduced on March 5, 2019), <http://bit.ly/2XZrrgm>. Separately, Sen. Bernie Sanders (I-Vt.) and Rep. Barbara Lee (D-Calif.) have introduced legislation, the Inclusive Prosperity Act of 2019, that would tax stock trades at 0.5 percent. The analysis in this report is limited to the Wall Street Tax Act because Joint Committee on Taxation has provided an assessment on the amount of revenue that would be raised by a proposal similar to that bill.

⁵ Press release, Sen. Brian Schatz, Sen. Schatz, Rep. DeFazio Introduce New Legislation to Tax Wall Street, Address Economic Inequality (March 5, 2019), <http://bit.ly/2XZsm0i> and *Impose a Tax on Financial Transactions*, CONGRESSIONAL BUDGET OFFICE (Dec. 13, 2018), <http://bit.ly/2XZcCu4>.

⁶ Gregory Meyer, Nicole Bullock and Joe Rennison, *How High-Frequency Trading Hit a Speed Bump*, FINANCIAL TIMES (Jan. 1, 2018), <https://on.ft.com/2MVw89U>.

⁷ Andrei Kirilenko, Albert S. Kyle, Mehrdad Samadi, Tugkan Tuzun, *The Flash Crash: High-Frequency Trading in an Electronic Market*, JOURNAL OF FINANCE (forthcoming) (last revised March 10, 2018), <http://bit.ly/2lqmXdm>.

Setting aside the potential of high-frequency traders to infuse risk into the stock market, the strategies they employ are simply unfair. High-frequency traders enjoy advantages that enable them to receive information and complete orders a split-second sooner than others. This allows them to profit at the expense of other traders.

A financial transaction tax would presumably suffocate the high-frequency trading industry because the tax would largely correlate with trading volume, and high volume is the oxygen of high-frequency trading.

Critics of an FTT, such as mutual fund industry representative Investment Company Institute, have predicted that the tax would hurt all investors “especially middle-income Americans workers saving for retirement.”⁸

We find this claim to be unfounded.

By our calculations, an average middle-income family that has a retirement account would experience only about \$13 a year in costs from the proposed FTT. (Most families would not pay the tax directly; instead, mutual funds would pay it, and then presumably pass their costs on to their customers.) If we apply the Investment Company Institute’s estimates, we conclude that the same average middle-income family would experience about \$13 to \$35 in annual costs from the tax, depending on the family’s mix of investments.

Meanwhile, any costs from the tax would apply only to families that have retirement accounts or other securities. About half of U.S. families do not have retirement accounts, and available data indicate that families without retirement accounts are unlikely to own non-retirement securities. Therefore, about half of U.S. families likely would not experience any costs at all from an FTT.

The effects of the tax would be somewhat different for upper-income Americans, although hardly onerous. About 90 percent of families in the top 10 percent of incomes (median 2016 earnings: \$260,200) have retirement accounts. They would experience an average of about \$155 a year in costs relating to their retirement accounts from an FTT by our estimate, and between \$202 and \$564 if the estimates published by the Investment Company Institute are applied. Many in this income strata – unlike those in other income bands – own stocks and other securities outside of retirement accounts and would owe taxes for trading in those assets, as well.

Notably, these estimates do not take into account the near certainty that incentives created by the financial transaction tax would depress trading activity. This would result in actual FTT costs for investors that are lower than those estimated based on current trading volumes. A reduction in trading motivated by the implementation of an FTT would have the salutary effect of reducing mutual fund overhead costs and transaction costs that hinder investors’ returns.

Taking these factors into account, it is quite possible that ordinary families would experience net savings after an FTT begins because their savings from reduced trading activity by their funds would exceed the costs that families experience from an FTT.

⁸ Letter from Investment Company Institute CEO Paul Schott Stevens to U.S. Sen. Chris Van Hollen (D-Md.) (March 16, 2016), <http://bit.ly/2YQ8snP>.

I. AVERAGE ANNUAL RETIREMENT ACCOUNT COSTS RESULTING FROM THE FTT FOR A MIDDLE INCOME FAMILY WOULD RANGE FROM \$13 TO \$35

Opponents of a modest financial transaction tax have said that it would hurt ordinary families. In this report, we take a close look at the costs that families could expect to experience from a 0.1 percent financial transaction tax. By two methodologies, including one that applies industry estimates, we reach a conclusion that costs to most families would somewhere between trivial and nonexistent.

As stated in the introduction, our estimates do not take into account the near certainty that incentives posed by the tax would dampen stock trading volume, which would result in lower financial transaction taxes than projected in this report, and would yield ancillary savings for consumers.

In both of the methodologies, we estimated the costs to families' retirement accounts from a financial transaction tax according to families' income levels. We focused on retirement accounts because relatively few American families own stocks or other securities that are not held in retirement accounts.

Public Citizen Methodology

We estimated the costs to families from the financial transaction tax by taking the median retirement account size by family income level, as reported by the Federal Reserve, and assuming that families contribute 9.9 percent of their income to their retirement accounts annually. This is the median rate of contribution to retirement accounts, as reported by mutual fund company Vanguard in its most recent annual report on retirement savings. This contribution rate takes into account both employee and employer-financed portions.⁹

We assumed that families would invest in mutual funds with 32 percent annual turnover, the industry average. Mutual fund turnover – which regards the frequency with which funds buy and sell the securities that make up their portfolios – stands to be the primary cause of costs to retirement accounts from an FTT.

We assumed that the FTT would result in costs to family retirement accounts in two ways, each of which concern costs that would be paid by mutual funds and passed on to consumers:

1. Costs relating to mutual funds' purchase and sale of securities

When a mutual fund buys shares of stocks or bonds to change its portfolio or it purchases securities by reinvesting dividends, those purchases would be taxed. We assume that those taxes would be passed on to consumers.

2. Costs relating to consumers' purchases and sales of mutual fund securities

When consumers purchase shares of a mutual fund security, they would not be taxed on the purchase itself under Wall Street Tax Act because new issues of a security are excluded from the tax, and a mutual fund offering would count as a new issue. But consumers' purchases of a mutual fund security could require the mutual fund to purchase the underlying stocks that make up the mutual fund offering. For instance, if the mutual fund's portfolio consisted of all the stocks in the S&P 500, the mutual fund would need to own those underlying stocks to

⁹ *How America Saves 2019*, VANGUARD (2019), <https://vgi.vg/2LOHOFt>.

populate its fund offering. To the extent that the mutual fund experiences more incoming investment than withdrawals, the fund would need to purchase additional stocks on the open market. Those purchases would be taxed.

We are not able to estimate how frequently a fund would need to purchase new shares, as opposed to simply filling orders with the shares freed up by other customers' withdrawals. In this report, to offer a broad interpretation of potential costs to consumers, we assume that the fund would need to purchase new shares each time consumers contribute to their retirement accounts. This assumption almost certainly exaggerates the frequency with which funds would need to purchase shares.

Eventually, families cease to make contributions to their retirement accounts and begin making withdrawals. When families sell shares of mutual funds back to mutual fund management companies, those sales would count as purchases for the mutual fund, and would be taxed under the proposed FTT. Again, we assume that mutual fund companies would pass those costs on to their customers.

For simplicity, calculations for this report assume that families would withdraw funds at the same rate that they previously contributed funds. Therefore, we assume that families that are withdrawing funds from their retirement account would experience the same annual costs from the FTT as those making contributions at the corresponding income levels.

In reality, a family's annual rate of withdrawal would likely differ from its annual rate of contributing. But even if our methodology has significantly underestimated the rate of withdrawal, the effect on our overall conclusion on costs resulting from the FTT would not likely be significant for most families. That is because most of the costs from an FTT would result from mutual funds buying and selling their portfolio securities, rather than from consumers exchanging mutual fund shares.

In this report, we estimate that average families below the 80th income percentile that are withdrawing funds from their retirement account would experience between about \$1.50 and \$9 in average annual costs from a 0.1 percent FTT associated with their sales of mutual fund shares. Thus, even if families' actual rates of withdrawal proved to be three-times greater than our estimate, they would only experience only about \$27 a year in costs for these withdrawals at the high end. By our estimate, families in the top 10 percent of incomes would experience about \$25 a year in average annual costs relating to purchases and sales. Thus, they would experience about \$75 a year in sales-related costs if their actual rate of withdrawals were three-times greater than our methodology assumes.

• • •

Combining factors 1 and 2, described above, households with retirement accounts that have incomes in the lowest 20 percent (median 2016 income: \$15,100) would experience an average of about \$4 a year in annual costs from the FTT. But only about one-tenth of these households have a retirement account, and even fewer own non-retirement securities. Therefore, nearly 90 percent of households with incomes in the lowest 20 percent would likely experience zero costs due to a financial transaction tax.

Only about half the families in the middle-income band (median 2016 income: \$52,700) have a retirement account. They would pay an average of about \$13 per year in financial

transaction taxes relating to their retirement account by our methodology. The 47 percent of families in this income band that do not have a retirement account would pay zero, unless they hold stocks or other securities in non-retirement accounts. Only a small percentage of middle-income families own non-retirement securities, and those that do are likely among those that also have retirement accounts.

More than 90 percent of families in the top 10 percent of income (median 2016 income: \$260,200) have a retirement account. They would pay an average of about \$155 annually in financial transaction taxes relating to their retirement account, according to our methodology. A significant percentage of families in this income band also would owe taxes for trading in other securities. [Table 1]

Table 1: Estimated Costs From Financial Transaction Tax by Income Bracket (Public Citizen methodology)

Income Percentile	Median Income	Pct. of Population in Income Percentile With Retirement Account	Median Retirement Account Size	Estimated Annual Contribution or Sale*	FTT Costs for Retirement Accounts Based on Fund Turnover**	FTT Costs Relating to Family Contributions or Sales	Total FTT-related costs
Less than 20	\$15,100	11.3	\$7,800	\$1,495	\$2.50	\$1.49	\$3.99
20–39.9	\$31,400	33.6	\$17,000	\$3,109	\$5.44	\$3.11	\$8.55
40–59.9	\$52,700	53.1	\$25,000	\$5,217	\$8.00	\$5.22	\$13.22
60–79.9	\$86,100	75.2	\$51,000	\$8,524	\$16.32	\$8.52	\$24.84
80–89.9	\$136,000	82.2	\$136,000	\$13,464	\$43.52	\$13.46	\$56.98
90–100	\$260,200	91.9	\$403,000	\$25,760	\$128.96	\$25.76	\$154.72

Source: Public Citizen analysis of Federal Reserve 2016 Survey of Consumer Finances.

* Based median contribution rate of 9.9 percent on income, inclusive of employer and employee contributions, as reported by Vanguard for 2018.¹⁰ ** Assumes 32 percent turnover, the weight-adjusted industry average, according to the Investment Company Institute.¹¹

Alternative Methodology: Public Citizen Application of Investment Company Institute Calculations

The methodology above could overestimate the cost of the FTT because it assumes that mutual funds would always purchase component stocks on the open market whenever their customers buy new mutual fund shares. It could underestimate costs because it assumes that retirement savers maintain a “buy and hold” strategy and do not shift their retirement investments from one fund to another. To offer another perspective, we also cross-referenced estimates by the Investment Company Institute on the costs of an FTT against income-sorted retirement account data.

The Investment Company Institute estimated the potential costs of a 0.1 percent FTT by looking backwards at mutual funds’ actual activities in 2018. The ICI has only issued its top line findings, not its underlying data. The ICI explained in communications with Public Citizen that the group’s estimates were derived by looking at aggregate data on mutual funds’ sales and purchases, which the vast majority of mutual funds privately provide to the ICI.

The ICI calculated that a 0.1 percent FTT would have resulted in investors in index mutual funds experiencing annual costs of 0.05 percent of their total investment in 2018. The ICI

¹⁰ *Id.*

¹¹ 2019 *Investment Company Fact Book*, INVESTMENT COMPANY INSTITUTE (2019), <http://bit.ly/2Y55A6U>.

estimated that investors in average mutual funds (aggregating index funds and actively managed funds) would have experienced FTT-related costs of 0.14 percent of their investment from the FTT in 2018.¹²

When cross-referenced with Federal Reserve data, these estimates lead to a conclusion that families in the middle-income band that have retirement accounts would experience average annual costs relating to the FTT of about \$13 if they invested solely in index funds and \$35 a year if they invested in a blend of funds that represent a composite of index and actively managed funds. [Table 2]

Table 2: Estimated Costs From Financial Transaction Tax by Income Bracket (Public Citizen Application of Investment Company Institute Calculations)

Income Percentile	Median Income	Pct. of Population in Income Percentile With Retirement Account	Median Retirement Account Size	ICI Estimate of 0.1% FTT Tax Effect on Index Mutual Fund Returns	ICI Estimate of 0.1% FTT Tax Effect on Average of Mutual Funds Returns (Index and Active)	Annual Costs to Retirement Investors in Index-only Funds	Annual Costs to Retirement Investors in Average Mutual Funds (Index and Active)
Less than 20	\$15,100	11.3	\$7,800	-0.05%	-0.14%	\$3.90	\$10.92
20–39.9	\$31,400	33.6	\$17,000	-0.05%	-0.14%	\$8.50	\$23.80
40–59.9	\$52,700	53.1	\$25,000	-0.05%	-0.14%	\$12.50	\$35.00
60–79.9	\$86,100	75.2	\$51,000	-0.05%	-0.14%	\$25.50	\$71.40
80–89.9	\$136,000	82.2	\$136,000	-0.05%	-0.14%	\$68.00	\$190.40
90–100	\$260,200	91.9	\$403,000	-0.05%	-0.14%	\$201.50	\$564.20

Source: Public Citizen analysis of data issued by the Investment Company Institute and Federal Reserve 2016 Survey of Consumer Finances.

There are some reasons to believe the costs projected in Table 2 are higher than retirement savers should expect. Michael Edesess, an economist, investment strategist and author of books offering investment advice for consumers, commented in an op-ed in *Bloomberg* that consumers' sales and purchases of mutual fund shares in 2018 were unusually large, a factor that would have resulted in higher-than-usual projected FTT costs.¹³

Also, there is evidence that costs from an FTT would be lower for retirement investors than average investors. That conclusion requires a quick summary of the data that mutual funds report. Mutual funds charge their customers fees for their overhead costs that they report as "expense ratios." Funds' expense ratios vary widely and roughly correlate with the frequency with which funds buy and sell stocks in their portfolios. Such buying and selling is reported as their annual "turnover."

¹² Paul Schott Stevens, president and CEO of the Investment Company Institute, letter to Sen. Chuck Grassley, Sen. Ron Wyden, Rep. Richard Neal and Rep. Kevin Brady (March 14, 2019), <http://bit.ly/33FXtkN>. Note: Stevens wrote that a 0.14 percent increase in cost would result in increased overall costs of 31 percent for retirement investors in mutual funds. The 31 percent figure has been widely cited by opponents of the proposal. But it is misleading unless put into context. The fees (officially known as the "expense ratio" costs) covering the average retirement mutual fund investment at the time the letter was written, according to the ICI, were 0.45 percent, or 45 cents for every \$100 invested. An increase of 0.14 percent to those costs would indeed represent a 31 percent increase, but it would be 31 percent of a very small number.

¹³ Michael Edesess, *The Case for a Financial Transaction Tax*, BLOOMBERG (June 20, 2019), <https://bloom.bg/2ZDtawv>. (Public Citizen provided a draft of this report to Edesess and incorporated some of his comments.)

Money in 401(k) retirement accounts is invested in funds that have expense ratios about 25 percent lower than the industry average, according to data that the ICI has separately published.¹⁴ Funds with lower expense ratios typically have lower turnover. Funds that have lower turnover will experience lower FTT costs. These facts suggest that retirement accounts would experience lower FTT costs than investors on the whole.

An additional way that the ICI may have overestimated costs from the proposed FTT concerns how sales of securities should be treated. The ICI's calculations assumed that mutual funds would experience FTT costs both on purchases and sale of securities, the ICI told Public Citizen. The Wall Street Tax Act would tax purchases only.¹⁵ The ICI told Public Citizen that it assumed that the market would, in essence, adjust to require sellers to share in FTT costs. This assumption warrants additional review. The public and policymakers could better evaluate the ICI's calculations if it published its underlying math and methodology.¹⁶

II. THE COST OF AN FTT FOR TRANSACTIONS OUTSIDE OF RETIREMENT ACCOUNTS WOULD BE ZERO FOR MOST FAMILIES

Here, we look at the likelihood of families owing financial transaction taxes due to holdings of securities outside of retirement accounts. Among families below the 80th income percentile, no more than 26 percent hold stock or mutual fund investments. In the 60th to 79th income percentile 13.8 percent of families own stocks and 12.5 percent own pooled investments, which include mutual funds, according to data provided by the Federal Reserve. [Table 3] It is not possible to determine from this data to determine the degree to which the owners of stocks overlap with owners of pooled investments. Because many of the families

¹⁴ *The Economics of Providing 401(k) Plans: Services, Fees, and Expenses*, INVESTMENT COMPANY INSTITUTE (2019), <http://bit.ly/2GRIVZs> and *2019 Investment Company Fact Book*, INVESTMENT COMPANY INSTITUTE (2019), <http://bit.ly/2Y55A6U>.

¹⁵ Wall Street Tax Act of 2019, S. 647 (introduced on March 5, 2019), <http://bit.ly/2MUKnvB> and Wall Street Tax Act of 2019, H.R. 1516 (introduced on March 5, 2019), <http://bit.ly/2XZrrgm>.

¹⁶ Shortly before this report was published, mutual fund company Vanguard issued a paper that claimed a 0.1 percent FTT would result in a 1.09 percent reduction in annual returns for investors. This estimate was nearly 8 times higher than the estimate put forth by the Investment Company Institute, and it should be viewed with extreme skepticism. In its paper, Vanguard said that FTT costs to consumers would result from increased transaction costs due to fund turnover (presumably taxes) and by the FTT's impact on "market spreads and liquidity" (which likely refers to increased bid-ask spreads, a concept that is discussed later in this paper). Vanguard's paper provides no substantive data, such as the rate of fund turnover or the amount of change to bid-ask spreads it assumed in its model. The paper does say that its estimates are based on investments in a "small-capitalization active equity fund." Selecting such a fund for its model was a strange methodological choice for Vanguard to make, and one that was most likely made to arrive at about the highest possible projected FTT costs. Vanguard is best known as the pioneer of index funds, which have very low annual turnover. For instance, the Vanguard "total stock market index" – which mirrors the entire stock market and has the most assets of any mutual fund in the world – has annual turnover of just 3 percent. Vanguard's "strategic small-cap equity fund," an actively managed small-capitalization fund such as the one Vanguard refers to in its paper, has annual turnover of 88 percent. This rate is nearly 30 times higher than that of its flagship index fund, and would profoundly affect projected FTT costs. But, even if Vanguard assumed an 88 percent turnover rate in its model, that would not come close to explaining the whopping total costs Vanguard claims. By our calculations, annual turnover of 88 percent would result in reduced returns of about 0.1 percent under the proposed FTT. That is less than a tenth of Vanguard's estimated total cost. The rest of Vanguard's cost conclusions, according to the skeletal methodological details the company provides, apparently were derived from an assumption that bid-ask spreads would widen dramatically. As we discuss in Section IV of this report, we believe that it is doubtful that implementation of an FTT would result in expansions of bid-ask spreads that would affect investors' returns much at all. We asked Vanguard for details on the assumptions it made in its model. The company did not provide a substantive response by the time this report was issued.

that own stocks are probably among those that own pooled investments, the percentage holding one type or the other (or both) is likely significantly less than 26 percent.

The percentage of families holding securities outside of retirement accounts rises with income level. In the 90th to 100th income percentile, 46 percent hold stocks and 37 percent hold investments in pooled investment funds. Again, the dataset provides no window into the degree of overlap of these two universes.

Because families' trading practices, unlike mutual funds, are not publicly disclosed and likely vary greatly, it would be difficult to arrive at a *typical* stock-holding family to estimate the effects of an FTT. We can, however, offer some snapshots.

If a middle-income family possessed the median value of stocks and pooled investments for its income band, and if it traded 10 percent of its portfolio in the course of a year, it would owe about \$6 in financial transaction taxes annually for these trades. If it traded 30 percent of its portfolio, it would owe about \$18 in financial transaction taxes. If it traded 50 percent, it would owe about \$30. Note that, at most, only 16 percent of families in the middle-income band (the 40th to 60th percentile of annual incomes) own securities outside of retirement accounts. Therefore, no more than 16 percent could owe any financial transaction taxes for trading non-retirement securities.

Meanwhile, if a family in the 90th to 100th percentile held the median level of both stocks and pooled investments for families in that income band, it would owe about \$58 a year in annual financial transaction taxes if it traded 10 percent of its portfolio, \$173 if it traded 30 percent, and \$288 if it traded 50 percent, [Table 4]

Table 3: Value of Stocks and Pooled Investments Held By U.S. Families by Income Percentile (Non-Retirement Accounts)

Income Percentile	Stocks		Pooled Investment Funds (includes mutual funds)	
	Median Pct. Holding	Median Value	Median Pct. Holding	Median Value
Less than 20	3.9	\$7,500	1.6	\$20,000
20–39.9	6.0	\$15,000	3.2	\$90,000
40–59.9	10.5	\$8,200	5.4	\$50,000
60–79.9	13.8	\$12,000	12.5	\$61,000
80–89.9	25.1	\$21,200	17.6	\$120,000
90–100	45.9	\$125,000	37.3	\$450,500

Source: Federal Reserve 2016 Survey of Consumer Finances.

Table 4: Snapshot of Prospective FTT Costs to Families Trading Securities Outside of Retirement Accounts

Income Percentile	Combined Median Value of Stocks and Pooled Investments	Maximum Pct. of Families That Own Such Investments	Annual FTT Costs for Families That Own Median Level of Both Stocks and Pooled Investments at 10 Pct. Annual Turnover	Annual FTT Costs for Families That Own Median Level of Both Stocks and Pooled Investments at 20 Pct. Annual Turnover	Annual FTT Costs for Families That Own Median Level of Both Stocks and Pooled Investments at 30 Pct. Annual Turnover
Less than 20	\$27,500	5.5	\$2.75	\$8.25	\$13.75
20–39.9	\$105,000	9.2	\$10.50	\$31.50	\$52.50
40–59.9	\$58,200	15.9	\$5.82	\$17.46	\$29.10
60–79.9	\$73,000	26.3	\$7.30	\$21.90	\$36.50
80–89.9	\$141,200	42.7	\$14.12	\$42.36	\$70.60
90–100	\$575,500	83.2	\$57.55	\$172.65	\$287.75

Source: Federal Reserve 2016 Survey of Consumer Finances.

III. CONSUMERS AND FUNDS COULD MORE THAN OFFSET THE COSTS OF AN FTT BY ALTERING INVESTMENT STRATEGIES

The estimates above do not account for incentives created by the FTT to trade less, which would result in families experiencing lower costs from an FTT than shown in these projections. A reduction in trading by mutual funds would likely provide an extra benefit to consumers because it would also reduce non-FTT costs that hinder rates of return.

Mutual funds experience significant transaction costs when they buy and sell stocks. These costs include administrative fees (analogous to “commissions” that consumers pay); costs regarding the discrepancy between what buyers are offering and sellers are demanding (known as the “bid-ask” spread, which is discussed later in this report); and costs relating to the effect on a stock’s price of a fund making large quantity purchases or sales (known as the “price impact” or “market impact”).

In a 2014 report, we cited three estimates of costs associated with mutual fund transactions. They ranged from 0.4 percent to 0.8 percent of the value of each transaction.¹⁷ If one accepts the midpoint of those estimates, that means investors’ essentially lose 0.6 percent of the value of every transaction a fund makes. Because a fund’s sale of a stock is usually coupled with a purchase of about equal value, each change to a mutual fund’s portfolio, in effect, hits investors with an invisible cost equal to 1.2 percent of the amount in question. Mutual funds, on average, replace about one-third of their portfolios annually. This leads to a conclusion that the average annual hidden costs to consumers from mutual funds’ turnover of their portfolios is about 0.4 percent (*i.e.*, one-third of 1.2 percent is 0.4 percent).

Mutual funds also charge their investors official costs, which are reported as “expense ratios,” to cover the fund’s overhead expenses.¹⁸ The average expense ratio for all mutual funds in 2018 was 0.55 percent of the amount of capital invested.¹⁹

These figures suggest that investors experience an average reduction in returns from turnover and expense ratios of nearly 1 percent annually (*i.e.*, 0.4% plus 0.55% = 0.95%). That far exceeds potential costs from the proposed financial transaction tax.

Common sense suggests that a financial transaction tax would give mutual funds an incentive to be more judicious about their trading to avoid hindering returns. Evidence from studies on the effects of trading costs on trading volume supports this conclusion.

A researcher for the International Monetary Fund in 2011 reviewed studies that tabulated 20 empirical findings on how changes to transaction costs affected trading volume.²⁰ In most cases, higher trading costs were associated with reduced trading volume. In about half the cases, the percent reduction in trading volume was the same or greater than the percent increase in trading costs. That means that in about half the cases, traders ended up paying the same or less in total transaction costs even though costs for individual transactions were increased.

¹⁷ Taylor Lincoln, *A Matter of Perspective*, PUBLIC CITIZEN (March 12, 2014), <http://bit.ly/2XSrtK3>.

¹⁸ *Expense Ratio*, MORNINGSTAR (viewed on Jan. 27, 2014), <http://bit.ly/11jfpq>.

¹⁹ *2019 Investment Company Fact Book*, INVESTMENT COMPANY INSTITUTE (2019), <http://bit.ly/2Y55A6U>.

²⁰ Thornton Matheson, *Taxing Financial Transactions*, IMF WORKING PAPER (2011), <http://bit.ly/1KDCCGvK>.

Incentives from an FTT will likely cause turnover to decline, reducing the prospective FTT costs and yielding ancillary savings from reduced transactions. The tax could prompt funds to reduce trading enough that reduced transaction costs could more than compensate for the tax.

Families also could reduce their FTT costs – as well as other costs – by choosing lower-cost funds. One way consumers can enjoy lower transaction costs and expense ratio fees is to invest in index funds – sometimes called passive investment funds – which consist of a basket of stocks in a certain universe, such as the S&P 500. Index funds contrast with actively managed funds, in which managers choose securities that they believe will outperform the market. Index funds tend to have much lower turnover and expense ratios than actively managed funds.

Studies have consistently shown that, over time, index funds outperform the bulk of actively managed funds. The chief explanation for this is that actively managed funds need to achieve higher returns to overcome their higher expense ratios and transaction costs. This is difficult to accomplish over the long term.²¹

IV. FACTORS THAT COULD INCREASE OR DECREASE COSTS OF AN FTT THAT ARE NOT DISCUSSED ABOVE

There are some additional factors that this report does not attempt to quantify that could result in greater costs or savings to consumers. Although these topics have been the subject of much speculation on the potential effects of an FTT, we believe the impact of these factors would be minimal for ordinary investors.

Increase in bid-ask spreads

If the FTT led, as intended, to the demise of the high-speed trading industry, that would likely result in a modest increase in bid-ask spreads. Bid-ask spreads represent the difference between the highest price that a buyer is willing to pay for a stock and the lowest price a seller is willing to accept. Market makers – who act as middlemen between buyers and sellers – buy at the bid price and sell at the ask price. To draw an analogy, a broker who buys and sells concert tickets for a living might offer to buy (bid for) tickets for \$25 and then sell them (ask) at \$30. The ticket broker would pocket the difference.

The spreads for stock transactions are much smaller and have fallen to minuscule levels in recent decades. From the latter half of the 1990s through 2004, as Internet trading took hold, bid-ask spreads for high-volume stocks were reduced by an order of magnitude, from about 0.2 percent to about 0.02 percent of the value of a stock offering.²² This period straddled the 2001 change from markets pricing stocks in fractions of a dollar (such as one-sixteenth of a

²¹ See, for example, Kent Thune, *Index Funds vs. Actively-Managed Funds*, THE BALANCE (June 2, 2019), <http://bit.ly/2Ywxb5i>.

²² See, for example, Terry Hendershott, Charles M. Jones, Albert J. Menkveld, and Matthew O'Brien, *Does Algorithmic Trading Improve Liquidity?* THE JOURNAL OF FINANCE (February 2011), <http://bit.ly/2M8wQ25>.

dollar) to pennies. Subsequently, pricing in fractions pennies was introduced. The change to decimal pricing enabled tighter bid-ask spreads.²³

From 2004 until 2011 – the period of the greatest expansion in high-frequency trading²⁴ – bid-ask spreads for large stocks tightened by another order-of-magnitude, according to data cited in a 2011 speech prominent British economist Andrew G. Haldane.²⁵

Experts attribute much of the reduction in bid-ask spreads over recent decades primarily to advances in technology that more efficiently match buyers and sellers, as well as the introduction of more granular pricing.²⁶ But the expansion of high-frequency trading – which creates a glut of buyers and sellers – also likely played a role in shrinking bid-ask spreads.

An end to high-frequency trading could result in a modest widening of bid-ask spreads. But even if bid-ask spreads returned to levels that existed before the rise of high-frequency trading, costs to ordinary families would be minimal. A return to 0.02 percent bid-ask spreads, which was roughly the average in 2004, would equal only 2 cents per \$100 traded.

Demise of High-Frequency Trading Could Result in Non-HFT Traders Obtaining Better Prices

A factor that could save consumers money from an FTT is that the end to high-frequency trading would put conventional mutual funds on equal footing with other traders. This would end the practice of non-high frequency traders being consigned to accepting disadvantageous prices in their securities transactions. As Michael Edesess wrote in his *Bloomberg* op-ed, referenced above, the “lightning trades” by high-frequency firms come at the expense of “whales,” like mutual and pension fund traders, who are left to watch desirable offers disappear before they can act on them.²⁷ Ending the “lightning trades” could result in mutual and pension funds obtaining more favorable prices on the market, benefiting American consumers.

Fallout From FTT Could Cause Mutual Funds to Charge Lower Fees

Also among the factors that could save consumers money from an FTT are that the tax could increase competition within the financial services industry to lower prices. If the FTT put the high-speed trading industry out of business and dampened conventional trading activity, that would likely result in reduced business for the financial services sector. Common sense economic theory holds that those who remained in business would be inclined to lower their prices wherever possible to retain a share of the shrinking market. Therefore, it is

²³ Matthew O'Brien, *Everything You Need to Know About High-Frequency Trading*, THE ATLANTIC (April 11, 2014), <http://bit.ly/2YS3ibc> and Ben Walsh, *Do stocks really trade for fractions of a penny? Sort of*, REUTERS (Nov. 18, 2013), <https://reuters/31zmvQF>.

²⁴ Computerized trading has existed since the 1980s. The greatest expansion of high-frequency trading appears to have occurred from about 2004 to 2010. See, for example, Michael J. McGowan, *The Rise Of Computerized High Frequency Trading: Use And Controversy*, DUKE LAW & TECHNOLOGY REVIEW (2010), <http://bit.ly/2ZFLfGo> and Daniel Cross, *The Rise of High-Frequency Trading: A Brief History*, TRADERHQ.COM (July 1, 2015), <http://bit.ly/2yKek7C>.

²⁵ Andrew G. Haldane, *The Race to Zero*, Address to the International Economic Association Sixteenth World Congress, in Beijing (July 8, 2011), <http://bit.ly/2TiwiHQ>.

²⁶ See, for example, Charles M. Jones, *A Century Of Stock Market Liquidity And Trading Costs* (May 22, 2002), <http://bit.ly/2yPYFnm> and Josh Bivens and Hunter Blair, *A Financial Transaction Tax Would Help Ensure Wall Street Works for Main Street*, ECONOMIC POLICY INSTITUTE (July 28, 2016), <http://bit.ly/30tLXHD>.

²⁷ Michael Edesess, *The Case for a Financial Transaction Tax*, BLOOMBERG (June 20, 2019), <https://bloom.bg/2ZDtawv>.

conceivable that mutual funds might in essence absorb some of the cost from an FTT, instead of passing it on to their customers, to compete for market share.

CONCLUSION

A financial transaction tax, such as the one proposed in the Wall Street Tax Act, has the potential to raise meaningful amounts of revenue with minimal impact on ordinary Americans. Even its prospective effect on average families in the top income tier is not particularly onerous.

Slamming the breaks on high-speed trading would good for just about all Americans except for those who benefit by treating Wall Street like a casino. Faced with the prospect of less action, Wall Street's croupiers will warn of harms to ordinary Americans from an FTT. Evaluators of those forecasts should consider the industry's incentives.

Those who endorse the concept of a more progressive tax code, meanwhile, should find much to like in a financial transaction tax because it would apply roughly proportionately to families' holdings in securities, and those holdings disproportionately belong to the wealthiest Americans.

Critics of proposed public investments – such as those to improve the nation's health, increase access to education, and address climate change – often base their opposition on affordability grounds. A financial transaction tax would offer a way to make a down payment on long-term investments in the nation's welfare that would be paid almost entirely by those who clearly can afford it.



**Warning: How Industry Rigged the Data
to Attack Financial Transaction Taxes**

October 10, 2019



Acknowledgments

This paper was written by Taylor Lincoln, Research Director of the Congress Watch division of Public Citizen, and edited by Susan Harley, Deputy Director of Congress Watch.

About Public Citizen

Public Citizen is a national non-profit organization with more than 500,000 members and supporters. We represent consumer interests through lobbying, litigation, administrative advocacy, research, and public education on a broad range of issues including consumer rights in the marketplace, product safety, financial regulation, worker safety, safe and affordable health care, campaign finance reform and government ethics, fair trade, climate change, and corporate and government accountability.



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In recent years, several proposals have been put forth to implement a tax of a fraction of a percentage point on the purchase of stocks, bonds and derivatives to fund public investments and to curtail the practice of high-frequency trading.¹

Public Citizen recently issued a report concluding that a 0.1% financial transaction tax (FTT) would cost an average middle-income family about \$13 a year if the family has a retirement account.² For the roughly 50% of families that lack retirement accounts, the cost would likely be zero. The report separately applied cost estimates on a 0.1% FTT issued by the Investment Company Institute (ICI), which represents mutual funds. Applying the industry group's estimates yielded a conclusion that the average costs to middle-income families would be about \$13 to \$35 a year, depending on the family's mix of investments.³

These are hardly alarming costs. But interests representing the financial industry have put forth a much different narrative.

Financial industry interests in September issued at least four papers claiming that proposed taxes on financial transactions would seriously harm ordinary Americans. These papers have portrayed proposed FTTs as an attack on "Main Street" and poison for Americans' retirement accounts. Three of the four organizations issuing papers have lobbied against the FTT.⁴ (Public Citizen has lobbied in favor of the proposal.⁵)

Industry groups have only occasionally issued studies on the FTT in the past. The spate of industry papers arriving at similar findings and employing similar rhetoric, along with overlaps in the membership and principals associated with the various groups, suggests that these papers were part of an orchestrated industry campaign.

The conclusions put forth in these industry papers are not credible. A close look shows that each relied on assumptions that conflict with real world data or omitted key details of its methodology, altogether. To the extent that these papers include descriptions of their methodologies, each suffers from two chief flaws:

- First, the papers use models that assume that the average churn, or turnover, of mutual fund holdings is much greater than it currently is. This is important because much of the cost to investors from an FTT would result from mutual funds' turnover of their portfolios.

¹ See, for example, Wall Street Tax Act of 2019, S. 647, <http://bit.ly/2MUKnvB>, and H.R. 1516, <http://bit.ly/2XZrrgm>, and Inclusive Prosperity Act of 2019, S. 1587, <http://bit.ly/2IDxdGt>, and H.R. 2923, <http://bit.ly/2pj2tfd>. Note, the United States had a financial transaction tax from 1914 to 1965. In its latter years, this tax was similar to some recent proposals. Critics of financial transaction taxes have cited repeal of the measure as evidence that it did not work as intended. In reality, the FTT was eliminated as part of a massive tax overhaul bill that ended all sorts of excise taxes. See, John D. Morris, *Senate-House Conferees Agree on a \$4.6 Billion Excise Tax Cut*, THE NEW YORK TIMES (June 16, 1965).

² Taylor Lincoln, *A Progressive Tax With Beneficial Effects*, PUBLIC CITIZEN (Sept. 16, 2019), <http://bit.ly/2nLu8Vj>.

³ *Id.*

⁴ See lobbying disclosure records maintained by the secretary of the Senate. These reports rarely disclose whether lobbying entities advocate for or against proposals. Based on their public statements, we assume in this report that the entities mentioned have lobbied against the FTT.

⁵ *Id.*

Choosing an unrealistically high turnover rate to forecast FTT costs would be like assuming that everybody drives a gas guzzling SUV when predicting an average person's fuel costs.

- Second, these papers ignore the likelihood that incentives from an FTT would reduce trading and, therefore, result in lower FTT costs down the road than recent turnover data suggest. Interestingly, two of the industry papers do say that an FTT would reduce trading volume. But they only discuss reduced trading in the context of their claims that the tax would not generate the anticipated levels of revenue. These papers' forecasts on costs to consumers are based on assumptions that trading will continue at the current pace. This is a clear inconsistency that almost certainly reflects motivations by the reports' authors to cast the FTT in an unfavorable light, rather than to educate the public.

Industry Papers Criticizing Financial Transaction Tax Released in September 2019

Organization Issuing report on FTT	Mutual fund turnover rate in model to project costs	Group's funding source	Group has lobbied on the FTT?
U.S. Chamber of Commerce	63%	Does not disclose. Despite its claims to represent millions of businesses, the Chamber's tax forms in recent years have revealed that the majority of its funding comes from fewer than 100 donors. ⁶	Yes
Modern Markets Initiative	67%	Modern Markets was founded, and is funded, by four firms engaged in high-frequency trading. ⁷	Yes
Vanguard	Does not disclose. But a Vanguard fund matching the description of the unnamed fund the firm reported that it used in its model has turnover of 88%.	Corporation is funded by revenue from its business.	Yes
Committee on Capital Markets Regulation	N/A. Report did not contain original findings.	Reports that it is funded by "contributions from individuals, foundations, and corporations." Public Citizen asked the Committee if it would provide more specific information. We did not receive a response.	No

⁶ See, for example, Dan Dudas, *The Gilded Chamber 2.0*, PUBLIC CITIZEN (2016), <http://bit.ly/2nefjkz>, and Sam Jewler, *The Gilded Chamber*, PUBLIC CITIZEN (2014), <http://bit.ly/2ng7t3J>.

⁷ E-mail from Modern Markets Initiative CEO Kirsten Wegner to author, Sept. 30, 2019, and study of the four firms that are listed as MMI founders on MMI's web site.

U.S. Chamber of Commerce

On Sept. 16, 2019, the U.S. Chamber of Commerce issued a report on the FTT that it commissioned Georgetown University finance professor James J. Angel to write. The report said that a 0.5% financial transaction tax, as proposed by U.S. Sen. Bernie Sanders (I-Vt.), would result in an average retirement investor accruing about \$20,000 less over 46 years.⁸

The Chamber report's calculation assumes FTT costs would result from mutual funds' turnover of their assets. But its model assumes a turnover rate that does not hold up to scrutiny.

The Chamber report assumes that the hypothetical retirement saver would be invested in funds with an annual turnover rate of 63%, which the report says is the "average turnover of a domestic stock fund," according to the mutual fund analysis firm Morningstar.⁹ This is an inaccurate statement. The article from which the Chamber report author obtained the 63% figure clearly stated that the number applied only to "managed domestic stock funds."¹⁰ The Morningstar number did not take into account index funds.

The Chamber's omission of the word "managed" in its description of the 63% figure is significant because managed funds often have much higher turnover than index funds. Index funds now have about as much money invested in them, if not more, than actively managed funds.¹¹

The problems with the Chamber's use of the 63% figure do not end there. The figure reflects a *simple average* turnover of all actively managed U.S. mutual funds, according to Morningstar Research Manager Michael Laske, who issued the figure. That means the figure does not take into account the value of assets invested in each fund. The *asset-weighted average* turnover of managed funds, which does factor in the value of assets each funds holds, is 38%, Laske told Public Citizen.¹²

An asset-weighted average turnover provides much better insight into the costs that an average investor could expect. To draw a hypothetical example, if there were two mutual funds in the world and 99% of mutual fund assets were invested in one fund and 1% in the other, the average investor's experience would correlate much more closely with the fund containing 99% of the assets, not the average of the two. [The response of the author of the U.S. Chamber report is in the footnote below. In some respects, the response appears to validate, rather than allay, concerns we raise about using a turnover figure that ignores index funds.¹³]

⁸ James J. Angel, *Financial Transaction Taxes: A tax on investors, taxpayers, and consumers*, U.S. CHAMBER OF COMMERCE (summer 2019), <http://bit.ly/2lCOVtx>. Note: Angel's estimates regarded costs to consumers relating to stock transactions. The legislative proposal he analyzed calls for much lower rates of transaction for purchases of bonds and derivatives.

⁹ *Id.*

¹⁰ Troy Segal, *Turnover Ratio Definition*, INVESTOPEDIA (March 25, 2019), <http://bit.ly/2nRRUPJ>.

¹¹ Dawn Lim, *Index Funds Are the New Kings of Wall Street*, THE WALL STREET JOURNAL (Sept. 18, 2019), <https://on.wsj.com/2m7cHON>.

¹² Michael Laske, e-mail to author, Sept. 26, 2019.

¹³ Public Citizen sent Chamber report author James J. Angel a summary of our assessment of flaws with the turnover figure he used in his report. We offered to print his response verbatim if he chose to provide one. We also asked if he would correct the error that the Chamber report misstated the universe covered in the 63% mutual fund turnover rate reported by Morningstar's research manager. Angel did provide a response to Public Citizen but did not address our observation that his report mischaracterized the Morningstar figure as including all mutual funds when, in fact, it did not take index funds into account. Here is Angel's response: "Your concern is with the turnover figure, which I

The Investment Company Institute, which represents mutual funds, reported that the asset-weighted average turnover for all mutual funds (i.e., including index funds) in 2018 was just 32%, barely half of the 63% number the Chamber used.¹⁴ This means that if the Chamber report's model were updated to include more accurate turnover data, the FTT costs that it would forecast would be only about half as high as its report concludes.

In reality, turnover levels will likely be even lower in the future, especially if an FTT is implemented. Mutual fund turnover rates are steadily declining. The average asset-weighted annual mutual fund turnover rate from 1984 to 2018 was 56%, which is 75% higher than it was in 2018.¹⁵

Implementation of any FTT would almost certainly hasten the decline in mutual fund turnover rates simply because it would create a disincentive to trade. This would especially be true for the 0.5% FTT on stocks that the Chamber report analyzed because that rate is at the high end of legislative proposals. Therefore, even plugging in the most recent mutual fund turnover rate of 32% would probably yield an exaggerated estimate of FTT costs.

One portion of the Chamber report trumpets that an FTT would result in reduced trading. Such reduced trading, the report says, means that "the amount of revenue raised will be far less than estimated."¹⁶ But if trading activity is depressed, that would also mean that mutual fund turnover would be reduced and, hence, FTT costs to investors would be lower. The Chamber report ignores this factor in its forecast of costs from an FTT. Instead, it assumes that fund turnover will continue at the current rate, which, as discussed above, the Chamber report also mischaracterizes.

Modern Markets Initiative

Modern Markets Initiative (MMI) issued a report in September that forecast that a 0.5% FTT rate on stocks would impose onerous costs on retirement accounts, university endowments, families' college savings plans, pension plans and retirees.¹⁷

MMI was founded by high-frequency trading firms and represents the high-frequency trading industry.¹⁸ Its advisory board includes James J. Angel, author of the U.S. Chamber of Commerce report discussed above.¹⁹

obtained from Morningstar, a respected statistical source. You assert that the turnover figure should be weighted based on fund assets, which skews the number based on a small number of extremely large index funds. The majority of funds offered in 401(k) plans are actively managed, not indexed, so using the simple rather than weighted average is appropriate for illustrating the potential lifetime impact on a worker. The other primary assumptions used in the analysis are quite conservative and tend to reduce the estimated tax hit (i.e. \$1,500/year investment, 5% compounding return)."

¹⁴ 2019 *Investment Company Fact Book*, INVESTMENT COMPANY INSTITUTE (2019), <http://bit.ly/2Y55A6U>.

¹⁵ *Id.*

¹⁶ James J. Angel, *Financial Transaction Taxes: A tax on investors, taxpayers, and consumers*, U.S. CHAMBER OF COMMERCE (summer 2019), <http://bit.ly/2ICOVtx>.

¹⁷ *A Study on the Effects of a Retirement Tax / Financial Transaction Tax on Retirement Security, College Savings and University Investment*, MODERN MARKETS INITIATIVE (September 2019), <http://bit.ly/2niRDVr>.

¹⁸ *About page for Modern Markets Initiative* (viewed on Sept. 27, 2019), <http://bit.ly/2ncLYAq>.

¹⁹ *Leadership*, MODERN MARKETS INITIATIVE (viewed on Sept. 27, 2019), <http://bit.ly/2nJYpUu>.

The MMI report suffers from the same flaws as the U.S. Chamber of Commerce report: it assumes a mutual fund turnover rate that is out of line with actual data and its projections on the FTT's cost to families fail to take into account the likelihood that the FTT would reduce trading activity.

Most of the report's calculations on the costs to families were based on an unsourced assumption of a 67% annual turnover rate for mutual funds, which the report characterizes as the average. MMI later explained in response to a question from Public Citizen that this turnover assumption was derived by averaging three figures on mutual fund turnover.²⁰ Examination shows that each of these three figures was flawed as a measure of turnover rates that average investors should expect.

- One of the figures (86%) was the simple average turnover rate reported by the Investment Company Institute for 2015.²¹ This statistic is flawed because it is several years old, which matters because mutual fund turnover has declined since then. More importantly, it's not weighted for the value of assets invested in each fund. The ICI report from which this number was drawn explains why a simple average is not the best lens. In the sentence after reporting the 86% simple average, the ICI wrote "however, mutual fund shareholders tend to invest in equity funds with much lower turnover rates, as reflected in the lower industrywide *asset-weighted* average turnover rate of 44%."²² [emphasis added] As noted above, the ICI reported that the asset-weighted average fell to 32% in 2018.²³
- A second figure was the 63% turnover rate reported by Morningstar's research manager for actively managed domestic funds.²⁴ As described above, use of this figure is flawed as a predictor of expected costs for average investors because it does not include index funds and because it is a simple average, not a weighted average.
- The third figure cited was a reference in a blog by a financial investor on the web site *ETF Trends*. The blog said that median turnover for mutual funds is "about 50 percent."²⁵ The blog author does not describe the source of this statistic, so it is impossible to assess its credibility. More importantly, median turnover rates embody many of the same problems as simple averages when it comes to projecting the costs of an FTT on an average investor. While a median offers the benefit of diminishing the effects of outliers, it does not take into account the amount of money invested in given funds the way that an asset-weighted average does.

Similar to the claims in the U.S. Chamber of Commerce report cited above, MMI's report expresses a prediction that an FTT would result in reduced trading volume.²⁶ But, as with the Chamber report, the MMI report only invokes reduced trading in the context of a prediction that an FTT would not yield as much revenue as expected. It does not take the anticipated reduction in trading volume into

²⁰ E-mail from Modern Markets Initiative CEO Kirsten Wegner to author, Sept. 19, 2019.

²¹ *The Economics of Providing 401(k) Plans: Services, Fees, and Expenses, 2015*, INVESTMENT COMPANY INSTITUTE (July 2016), <http://bit.ly/2marxEJ>.

²² *Id.*

²³ *2019 Investment Company Fact Book*, INVESTMENT COMPANY INSTITUTE (2019), <http://bit.ly/2Y55A6U>.

²⁴ Troy Segal, *Turnover Ratio Definition*, INVESTOPEDIA (March 25, 2019), <http://bit.ly/2nRRUPJ>.

²⁵ Rusty Vanneman, *ETF Analysis: Don't Forget Portfolio Turnover*, ETF TRENDS (Dec. 27, 2016), <http://bit.ly/2mmityV>.

²⁶ The MMI report says that the FTT has "a proven track record of failure in the jurisdictions in which it has been tested," in part due to its effect of "reducing trading volume by 50 to 80%."

account in its forecast of FTT costs to investors. Reduced trading would, of course, reduce FTT costs, as well as other transaction-related costs. [MMI's response is in the footnote below.²⁷]

Vanguard

The mutual fund company Vanguard issued a paper in September claiming that a 0.1% FTT would reduce investors' returns by a staggering 1.09% a year.²⁸ (Note: the 0.1% proposed tax on stock trades that Vanguard's paper assessed is only one-fifth as large as the 0.5% proposed tax assessed in the U.S. Chamber of Commerce and MMI reports, above.) Costs to investors from a 0.1% FTT, Vanguard claimed, would require the "everyday investor to work roughly two-and-a-half years longer before retiring."²⁹

The Vanguard paper appears to be riddled with even greater methodological flaws than the U.S. Chamber of Commerce and Modern Markets Initiative reports discussed above. This is in part because the Vanguard paper appears to rely on an assumed mutual fund turnover rate that is even further removed from reality than those used in the Chamber and MMI papers. Worse, even if one accepts its assumption of an abnormally high mutual fund turnover rate, the Vanguard paper still fails to account for the vast majority of costs that it forecasts for an FTT.

The Vanguard paper provides scant information about the methodology underlying its conclusions. But it does divulge that its calculations are based on an investment in "a small capitalization active equity fund."³⁰ Vanguard's decision to use an actively managed fund in its model should strike any reader with a casual familiarity of mutual funds as highly suspicious. Vanguard, of course, is famous for its pioneering role in developing low-cost, low-turnover *index* funds, which are the opposite of the type it chose for this paper.

Vanguard's paper does not disclose the exact fund or turnover rate it used in its model. But Vanguard's "Strategic Small-cap Equity Fund,"³¹ which is the kind of fund the company says it modeled its FTT calculations on, has annual turnover of 88%.³² Vanguard's Total Stock Market Index Fund (its flagship index fund and often reported as the biggest mutual fund in the world) has

²⁷ Public Citizen submitted a summary of these criticisms to Kirsten Wegner, the CEO of Modern Markets Initiative, and offered to print her response verbatim in this report. Wegner did respond, though she did not address the substance of the issues we raised on the method by which MMI arrived at a turnover figure to plug into its model. Here is Wegner's response: "Modern Markets Initiative (MMI) is pleased to provide open and transparent information on MMI's Financial Transaction Tax (FTT) calculations and why it is a retirement tax on hard working Americans at all levels of income trying to save for the future. MMI's turnover calculation of 0.67 for a mutual fund in a 401k plan was arrived at utilizing three publicly available data points: 0.86 from ICI, 0.63 from Morningstar, and 0.5 from ETF Trends. Further, as noted in MMI's report in footnote 13, MMI provides a calculation where a turnover to be calculated at 0.5 turnover rate, to highlight that impact of an FTT even utilizing the most modest data point would still arrive at over \$40,000 lifetime impact out of a portfolio of \$80,000 invested in the stock market (subject to the 50 basis point tax). MMI's footnote includes a hypothetical calculation for an investor with \$100,000 saved over 40 years, of which 20% is invested in bonds and 80% (or \$80,000) in equities subject to the 50 basis point tax; this calculation notes a 0.5 turnover rate (e.g. conservative, less than the 0.67 average mutual fund rate), such that \$40,000 of the stocks are subject to the FTT a year; that had that \$200+ been invested rather than tax, the participant would retire with an extra \$45,717 after 40 years."

²⁸ *Main Street investors at risk*, VANGUARD (September 2019), <http://bit.ly/2nbYFLW>.

²⁹ *Id.*

³⁰ *Id.*

³¹ See, Vanguard Strategic Small-Cap Equity Fund, <https://vgi.vg/2n9zIRb>.

³² Vanguard Strategic Small-Cap Equity Fund Investor Shares, Yahoo Finance! (profile), <https://yhoo.it/2n9ALAB>.

turnover of just 3%.³³ In other words, Vanguard apparently chose to base its estimates on a fund with about 30 times higher turnover than the type of fund the company is best known for.

Vanguard's Total Stock Market Index has about \$827 billion invested in it.³⁴ That's more than 500 times greater than its Strategic Small-cap Equity Fund, which has just \$1.4 billion in assets (both figures as of Oct. 8, 2019).³⁵ This discrepancy casts further doubts on the legitimacy of Vanguard's decision to use a fund like its Strategic Small-cap Equity Fund to predict FTT costs for ordinary investors.

Vanguard's paper explains that its cost estimate for a 0.1% FTT takes into account two costs: 1. "transaction costs that would be incurred due to fund turnover" and 2. "the estimated impact the FTT would have on market spreads and liquidity."³⁶

Even plugging in a fund turnover rate as high as 88% would only account for an annual reduction in returns of about 0.09% under a 0.1% FTT. That is less than a tenth of the costs that Vanguard's paper forecasts for the FTT.

That leaves "market spreads and liquidity," the second factor Vanguard cites in its explanation of FTT costs, to explain the vast majority of costs that Vanguard claims would result from a 0.1% FTT. This factor presumably refers to a theory that reduced trading from an FTT could increase the discrepancy (or spreads) in the prices that buyers and sellers offer in stock transactions.

Bigger market spreads do result in higher transaction costs, but the gradations can be so small that increases are not likely to have a meaningful effect on ordinary investors. Vanguard's paper provides no details on how much its authors expect market spreads would expand under an FTT. It is almost inconceivable, however, that spreads could expand anywhere near enough to account for the staggering costs that the Vanguard paper forecasts for a 0.1% FTT.

Market spreads have generally fallen over time and have shrunk to microscopic levels (on the order of 0.002%)³⁷ in the past decade. Some attribute this tightening to the rise of high-frequency trading, which creates a glut of buyers and sellers. But if spreads reverted to their level in the early-2000s, which was before high-frequency trading took off, the extra costs to investors would still be tiny.³⁸ Spreads began to shrink markedly earlier than that, when the advent of Internet trading greatly increased the efficiency of matching buyers and sellers. But even if spreads reverted all the way back to pre-Internet, early-1990s levels, the increased costs to investors would still only account for a fraction of the costs that Vanguard projects for the FTT.³⁹

³³ Vanguard Total Stock Market Index Fund Investor Shares, Yahoo Finance! (profile), <https://yhoo.it/2njuceH>.

³⁴ *Id.*

³⁵ Vanguard Strategic Small-Cap Equity Fund Investor Shares, Yahoo Finance! (profile), <https://yhoo.it/2n9ALAB>.

³⁶ *Main Street investors at risk*, VANGUARD (September 2019), <http://bit.ly/2nbYFLW>.

³⁷ See, for example, Andrew G. Haldane, *The Race to Zero*, Address to the International Economic Association Sixteenth World Congress, in Beijing (July 8, 2011), <http://bit.ly/2TiwiHQ>.

³⁸ See, for example, Terry Hendershott, Charles M. Jones, Albert J. Menkveld, and Matthew O'Brien, *Does Algorithmic Trading Improve Liquidity?* (June 2008) (Slides), <http://bit.ly/2mkW1Dq>.

³⁹ *Id.*

Public Citizen asked Vanguard's communications staff several times for details on the assumptions and methodology underlying the findings of the company's paper, such as the turnover rate and the extent of change in market spreads that the paper assumed. We did not receive a substantive response.

We did learn in the course of this research that Vanguard produced at least one previous study on the FTT, in 2015. That study, according to a *New York Times* article that referenced it, arrived at a conclusion that a 0.1% FTT could reduce returns by up to 1.62% annually, an even more mind-boggling conclusion than the recent Vanguard paper claimed.⁴⁰

The *New York Times* article included details about the 2015 study that provide insight into the strategically misleading nature of Vanguard's methodology. The article said that Vanguard's projected 1.62% cost would occur in the case of "an actively managed mutual fund that buys small stocks."⁴¹ This is the type of fund Vanguard plugged into its model in its recent paper. Vanguard's 2015 paper concluded that costs for an actively managed fund that buys large stocks would be just 0.58%, according to the *Times*.⁴²

The significantly lower costs for large-stock funds likely explains why Vanguard did not include calculations for such funds in its recent paper. Meanwhile, the *Times* article reported that Vanguard's "index funds would probably suffer less" under the FTT. But, tellingly, the *Times* reported that "the company did not run those numbers."⁴³

Observers should look upon Vanguard's FTT conclusions regarding all types of funds with great skepticism, especially if the company continues to keep secret the details on how it reached its conclusions. But the company's mere choice to focus on actively traded funds and ignore index funds should suffice to reveal its true purposes in issuing these papers.

The Committee on Capital Markets Regulation

The Committee on Capital Markets Regulation published an 18-page report in September forecasting all manner of harms from an FTT. The Committee is a 501(c)(3) nonprofit group that consists of 35 individuals, most of whom are high ranking officials at financial institutions and a few of whom are associated with esteemed universities, including Harvard and Columbia.⁴⁴

Hal Scott, the president and CEO of the Committee and an emeritus professor at Harvard Law School,⁴⁵ was paid \$500,000 by the Committee in 2018 for 30 hours of work per week, according to the Committee's tax form for that year.⁴⁶ Co-chair Glenn Hubbard is a former chairman of the

⁴⁰ Ron Lieber, *A Tax to Curb Excessive Trading Could Be a Boon to Returns*, THE NEW YORK TIMES (Oct. 2, 2015), <https://nyti.ms/2nwx9sO>. (Public Citizen asked Vanguard to send us its 2015 study. We did not receive a response.)

⁴¹ *Id.*

⁴² *Id.*

⁴³ *Id.*

⁴⁴ *Financial Transaction Taxes*, COMMITTEE ON CAPITAL MARKETS REGULATION (September 2019), <http://bit.ly/2ne6GA1>.

⁴⁵ Hal S. Scott, *Nomura Professor of International Financial Systems, Emeritus*, HARVARD LAW SCHOOL (viewed on Sept. 27, 2019), <http://bit.ly/2nQ4eQk> and Committee on Capital Markets Regulation Form 990 (2018), <http://bit.ly/2mp54TJ>.

⁴⁶ Committee on Capital Markets Regulation Form 990 (2018), <http://bit.ly/2mp54TJ>.

White House Council of Economic Advisers under President George W. Bush and former dean of the Columbia University Business School, where he still serves as a professor and dean emeritus.⁴⁷

The Committee's report on the FTT did not include original findings or claims but, instead, summarized those that others have put forth. The Committee's report relayed three findings on prospective FTT costs that it attributes to other organizations. The report characterized those findings as much more substantive and official than they actually were.

The three claims outlined in the Committee's report were:

- The Committee reported that a 0.1% FTT could, according to the American Retirement Association, "reduce an American's retirement savings by as much as 3% over their working life."⁴⁸ The footnote cites to an opinion piece and indicates "(quoting the CEO of the American Retirement Association, Brian Graff)."⁴⁹ In reality, there are no quotation marks around the words in question in the opinion piece, nor does the opinion piece indicate that the author is paraphrasing Graff. A literal reading would indicate that the analysis belonged to the author of the opinion piece, not Graff, although the proximity of the words to those that did quote Graff could lead a reader to infer that the author was putting forth Graff's thinking. The unquoted words, in turn, impute costs to an FTT based on an Obama-administration report on an entirely different topic.⁵⁰ No additional elaboration or detail is provided. The American Retirement Association has reported lobbying on the financial transaction tax (presumably against it) in 2019.⁵¹
- The Committee reported that the Securities Industry and Financial Markets Association (SIFMA) "estimates that '[a] typical mutual fund investor will have to save an additional \$600 per year...or work an additional two years to achieve his/her retirement goals.'"⁵² What work, if any, SIFMA did as an organization to arrive at that estimation is unclear from the Committee's report. The quotation in the Committee's report cites to a June 13, 2019, opinion piece that was written by SIFMA CEO Kenneth E. Bentsen Jr.⁵³

It appears that the claims in Bentsen's op-ed did not originate with anybody at SIFMA. We pasted the relevant portion of Bentsen's op-ed into an e-mail to a SIFMA spokeswoman and asked the source of Bentsen's claim, particularly the culminating sentence of the opinion piece that said costs from an FTT could reduce returns by up 1.62% annually. A SIFMA spokeswoman told Public Citizen by e-mail that the source of Bentsen's conclusion

⁴⁷ *Id.* and Glenn Hubbard, GLENNHUBBARD.NET (viewed on Oct. 4, 2019), <http://bit.ly/2MbHJhr>.

⁴⁸ *Financial Transaction Taxes*, COMMITTEE ON CAPITAL MARKETS REGULATION (September 2019), <http://bit.ly/2ne6GA1>.

⁴⁹ *Id.*

⁵⁰ Nevin Adams, *Financial Transaction Tax Attacks Retirement Savings*, AMERICAN SOCIETY OF PENSION PROFESSIONALS & ACTUARIES (March 26, 2019), <http://bit.ly/2n9XInf>. See, also, *About ASPPA*, AMERICAN SOCIETY OF PENSION PROFESSIONALS & ACTUARIES (viewed on Sept. 27, 2019), <http://bit.ly/2nkAD0E>.

⁵¹ Lobbying disclosure records maintained by the secretary of the Senate. See, for example, <http://bit.ly/2nQ90NK>.

⁵² *Financial Transaction Taxes*, COMMITTEE ON CAPITAL MARKETS REGULATION (September 2019), <http://bit.ly/2ne6GA1>.

⁵³ Kenneth E. Bentsen Jr., *The Facts Don't Support the FTT*, SIFMA (June 13, 2019) (archived version), <https://web.archive.org/web/20190915045346/https://www.sifma.org/resources/news/the-facts-dont-support-the-fft/>, <http://bit.ly/2nnV39k>.

was the 2015 Vanguard study that is referenced earlier in this paper.⁵⁴ We asked SIFMA's spokeswoman if she could send us a copy of the Vanguard study. We did not receive a response.

In fact checking for this report, we attempted to confirm that the words in Bentsen's June 13, 2019, opinion piece matched those in the Committee's report. We located the opinion piece, which was still dated June, 13, 2019. But, mysteriously, the language that is cited in the Committee of Capital Markets report was not there. We then discovered that all of the language in the paragraph from Bentsen's June 13, 2019, opinion piece that the Committee's report cited has been updated to reflect the claims in the paper that Vanguard released in September 2019 (discussed above).⁵⁵

- The third cost forecast in the Committee's report is that "BlackRock estimates that a 10 basis-point FTT would cause investors to lose \$2,300 in expected returns on a \$10,000 investment in its global equity fund over ten years."⁵⁶ The Committee's report does not cite BlackRock as the source of this claim but, rather, a 2013 article in *The New York Times* by Steven Solomon, a professor at the University of California, Berkeley.⁵⁷ Public Citizen was unable to obtain any document or statement by BlackRock that referred to such a finding. Public Citizen inquired to the Committee and to BlackRock in search of BlackRock's work, but to no avail. Because we were unable to locate any documentation for the claim that the Committee report attributes to BlackRock, we are unable to assess its credibility. [The president of the Committee indicated to Public Citizen that the Committee relied on Solomon's article, not BlackRock, for the findings it attributed to BlackRock. The Committee president's full response is in the footnote.⁵⁸]

⁵⁴ E-mail from SIFMA's Lindsay Gilbride to author (Sept. 30, 2019).

⁵⁵ Kenneth E. Bentsen Jr., *The Facts Don't Support the FTT*, SIFMA (June 13, 2019) (updated version), <http://bit.ly/2nnV39k> and *Main Street investors at risk*, VANGUARD (September 2019), <http://bit.ly/2nbYFLW>.

⁵⁶ *Financial Transaction Taxes*, COMMITTEE ON CAPITAL MARKETS REGULATION (September 2019), <http://bit.ly/2ne6GA1>.

⁵⁷ Steven Davidoff Solomon, *In Wall St. Tax, a Simple Idea but Unintended Consequences*, THE NEW YORK TIMES (Feb. 26, 2013), <https://nyti.ms/358D2h3>.

⁵⁸ Public Citizen submitted questions by e-mail regarding the Committee's report to Harvard University emeritus law professor Hal Scott (who is the president and CEO of the Committee), to Columbia University professor and Columbia Business School Dean Emeritus Glenn Hubbard (who is a co-chair of the Committee) and to Committee on Capital Markets Regulation Executive Director John Gulliver. Among other questions, we asked these leaders if they were comfortable that the Committee did sufficient due diligence to confirm that the figures its report imputed to SIFMA, the American Retirement Association and BlackRock are credible. We also asked them if the Committee would correct its claim in its report that "SIFMA" arrived at various conclusions on an FTT, given that those conclusions did not originate with SIFMA. We did receive a response from Hal Scott, but his response did not address the substantive issues we raised. In his e-mail, Scott appears to indicate that finding that the paper attributes to BlackRock was actually the finding of a professor articulated in the *New York Times*. Contradictorily, however, Scott maintained that the Committee report's description is accurate. Here is his response: "Throughout the Committee's 14 page report we explain the key factors that form the methodological basis for econometric studies of FTTs. These factors include the direct cost of the tax on retirees and investors, negative impact on market liquidity and increase in the cost of raising capital for U.S. companies and the U.S. government. Additionally, the paragraph that you reference in your October 2 email correctly attributes estimates of the impact of an FTT on retirees and investors to the CEO of SIFMA, the CEO of the American Retirement Association and Berkeley Professor Steven Solomon. However, as to the statement by the CEO of SIFMA, we cite to a June 13, 2019 statement that has since been updated. In fact, we should reference a related July 29, 2019 statement." [Scott's e-mail did provide that July 29, 2019 statement.]

SIFMA's CEO and a BlackRock representative are members of the Committee on Capital Markets Regulation.⁵⁹ Glenn Hubbard, a co-chair of the Committee, is on the board of BlackRock.⁶⁰ Also on the Committee is the managing director of high-frequency trading firm Hudson River Trading. Hudson River Trading was one of the founders of the Modern Markets Initiative, which wrote one of the other reports attacking financial transaction taxes, as discussed above.⁶¹

Conclusion

The industry groups that have put forth reports attacking financial transaction taxes clearly are self-interested. Their suggestions that they are motivated by concerns for retirees or "Main Street" should be ignored.

The financial industry, if nothing else, has professionals at its disposal who are expert at modelling and making precise calculations. They are capable of getting their facts right. These groups' reliance on inaccurate data and mystery methodologies to arrive at their conclusions on the potential costs of FTT proposals should prompt evaluators to look upon every assertion made in these reports with great skepticism.



⁵⁹ Members, COMMITTEE ON CAPITAL MARKETS REGULATION (viewed on Sept. 27, 2019), <http://bit.ly/2mMomYUDB>.

⁶⁰ Co-chairs and President, COMMITTEE ON CAPITAL MARKETS REGULATION (viewed on Oct. 2, 2019), <http://bit.ly/2nWndZT>.

⁶¹ About page for Modern Markets Initiative (viewed on Sept. 27, 2019), <http://bit.ly/2ncLYAq>.