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When Machine Comes to Town: Fund Evaluation with Artificial Intelligence

Grace Fan (SMU)

Xi Kang (Vanderbilt University)

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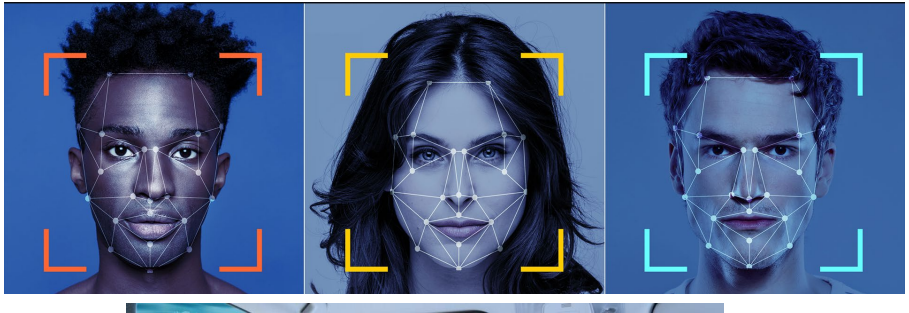
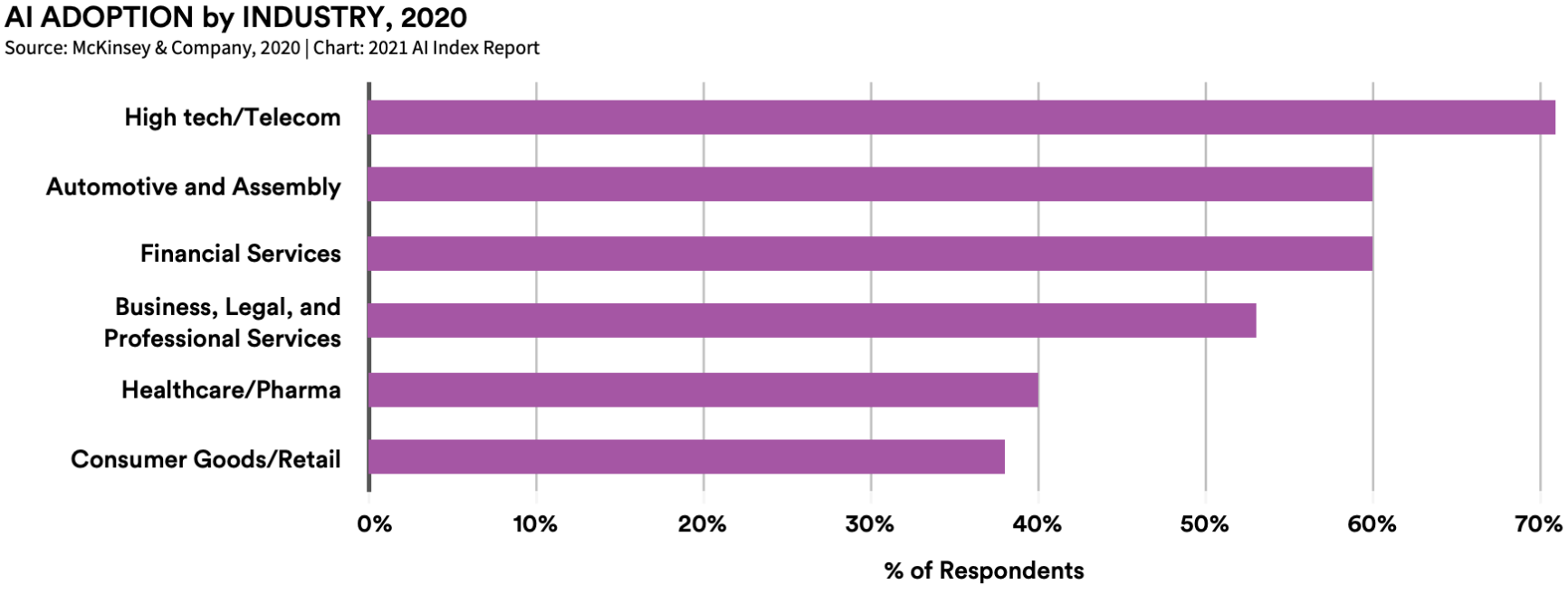
Artificial intelligence:

- Not a new technology; recent achievements driven by the advances in machine learning
- Definition: The use of algorithms to detect patterns in vast volumes of data and help make predictions.



AI Adoption in the Financial Industry



Research Question

- How does AI adoption affect the financial industry?
  - The financial research industry
- Whether, and how does AI help financial workers improve their performance?

Setting and Results Overview

Setting: a financial research firm that adopted AI to **expand mutual fund coverage**

- Analyst-rated funds → still rated by analysts
- Uncovered funds → rated by AI

Results overview:

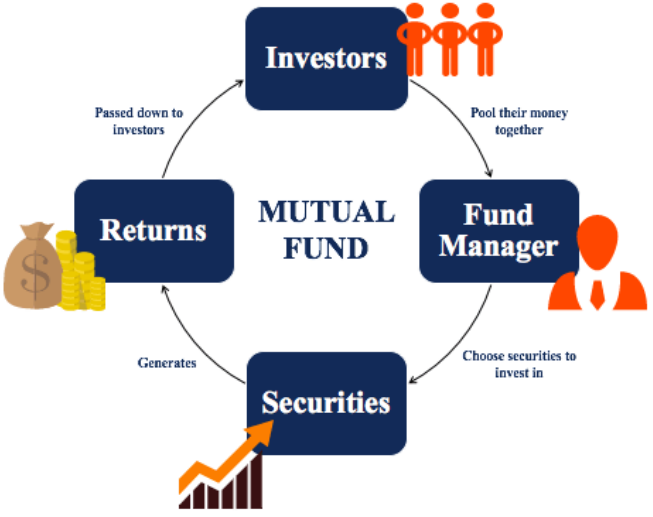
- Fund analysts provide better fund ratings after AI adoption
  - They also provide more objective analyst reports

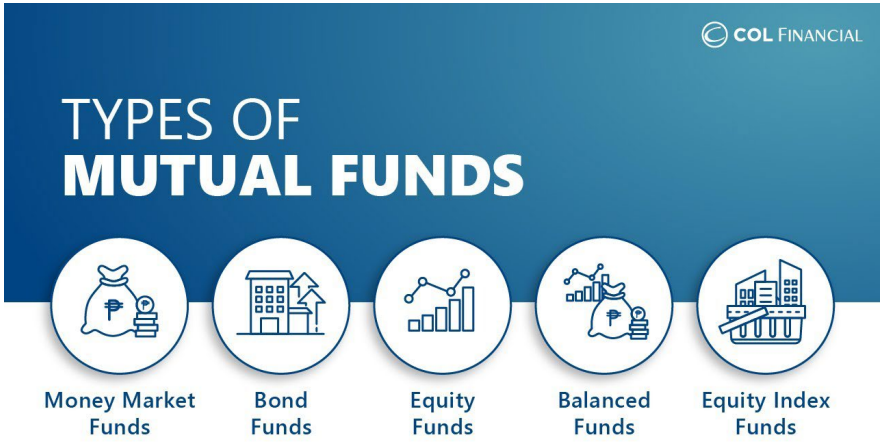
- The improvement is through two channels:
  - The disciplinary channel: AI helps reduce analysts' biases stemming from social connection
  - The learning channel: AI significantly increases available information of benchmark funds

- Heterogeneity in the impact of AI:
  - Fund analysts with longer tenure and higher past performance experience larger improvement in rating quality

The US Mutual Fund Industry

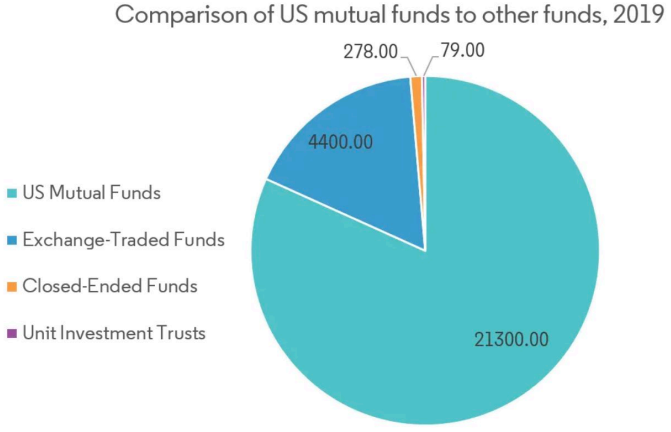
- **Mutual fund:** a company that pools money from many investors and invests the money in securities such as stocks, bonds, and short-term debt. (SEC, 2021)





The US Mutual Fund Industry (Continued)

- Massive in size:
  - **7,481** registered Mutual Funds by April 2021
  - **USD 26.96 trillion** of net assets
  - **40%** of the global mutual fund market



- Important investment for individual investors:
  - **46.2%** of the households in the United States hold investments in mutual funds (Mordor Intelligence, 2021)

- Investors rely heavily on **Morningstar ratings** (Sirri and Tufano, 1998; Gruber, 1996, and Goetzmann and Peles 1997)
- Morningstar ratings affect the likelihood of fund managers' turnover (Barron and Ni, 2013)
- The quality of Morningstar ratings matters

Morningstar Mutual Fund Analyst Ratings (Human Ratings)

- The largest independent financial research company
- Evolved from backward-looking star ratings (1986-1998) to forward-looking analyst ratings (1999-)
- Fund analysts conduct research, interview with the fund managers, and provide ratings on mutual funds

People	Process	Performance	Parent	Price
How talented are the fund's managers and analysts? Do the experience and resources match the strategy?	What is the fund's strategy and does management have a competitive advantage enabling it to execute the process well and consistently over time?	Is the fund's performance pattern logical given its process? Has the fund earned its keep with strong risk-adjusted returns over relevant time periods?	What priorities prevail at the firm? Stewardship or salesmanship?	Is the fund a good value proposition compared with similar funds sold through similar channels?

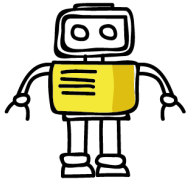
Pillar Ratings

Gold Silver Bronze

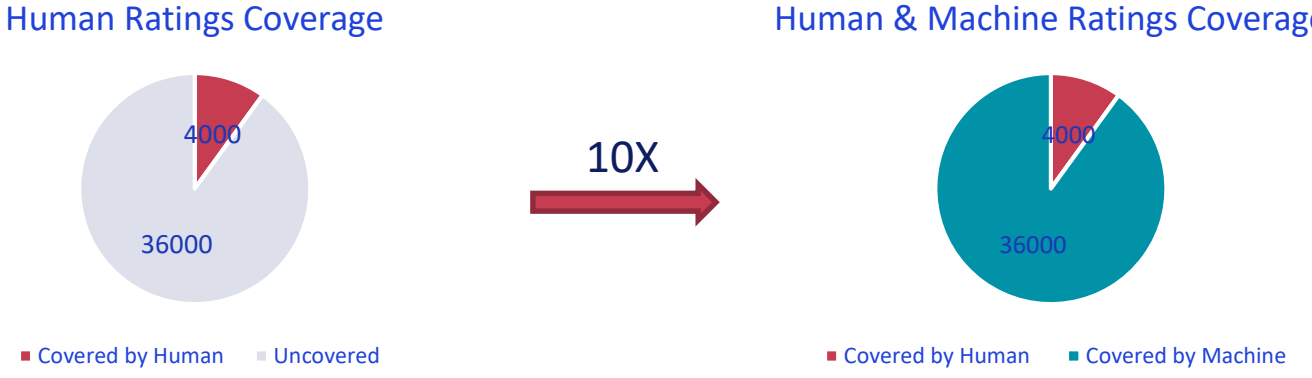
Neutral Negative

Overall Rating

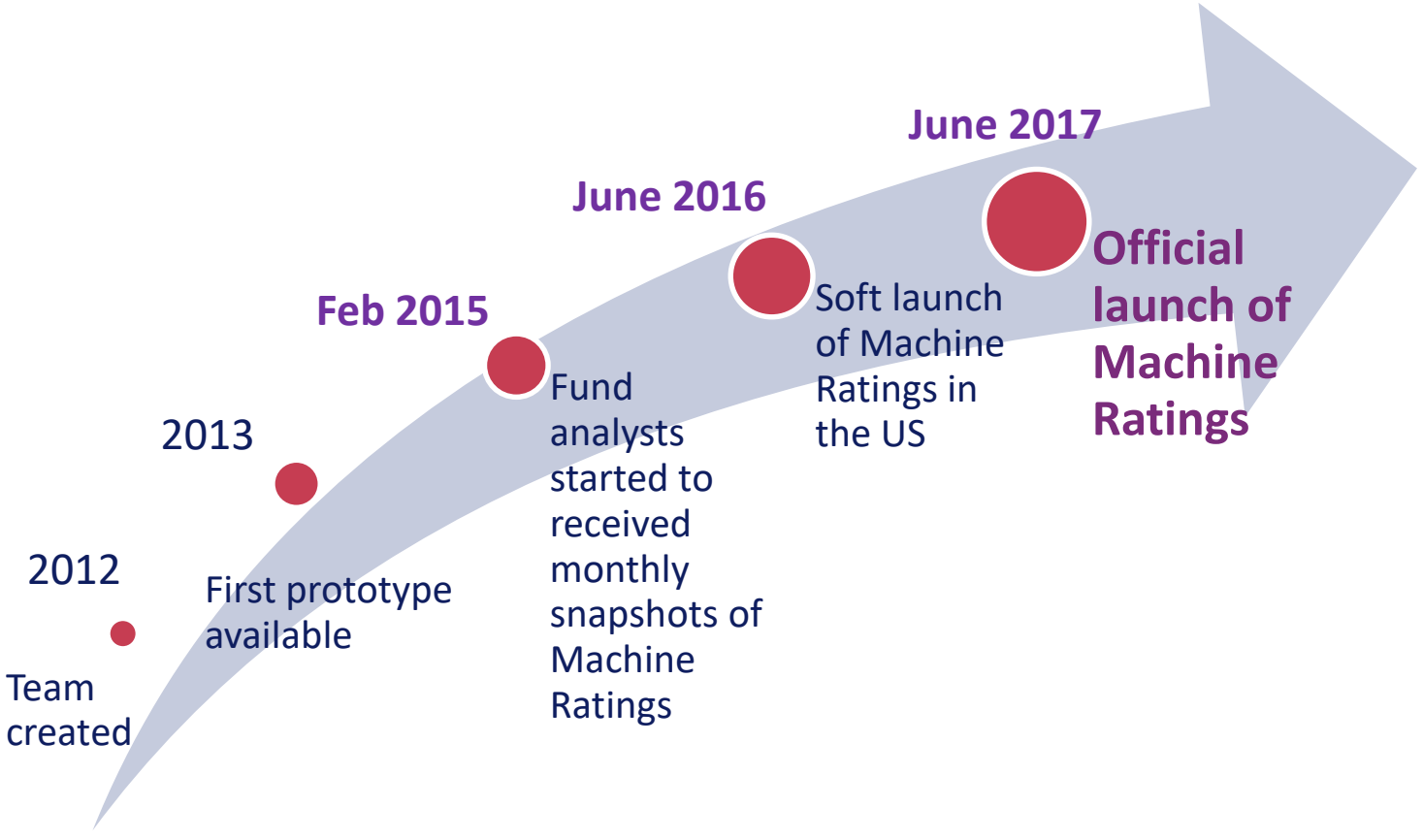
Introduction of Morningstar Quantitative Ratings (Machine Ratings)



- Morningstar Quantitative Ratings
  - Developed using a random forest machine learning algorithm with 180+ inputs
  - Intended to mimic analysts' evaluation outcomes
  - Only cover funds that are **NOT** covered by analysts



Introduction of Machine Ratings

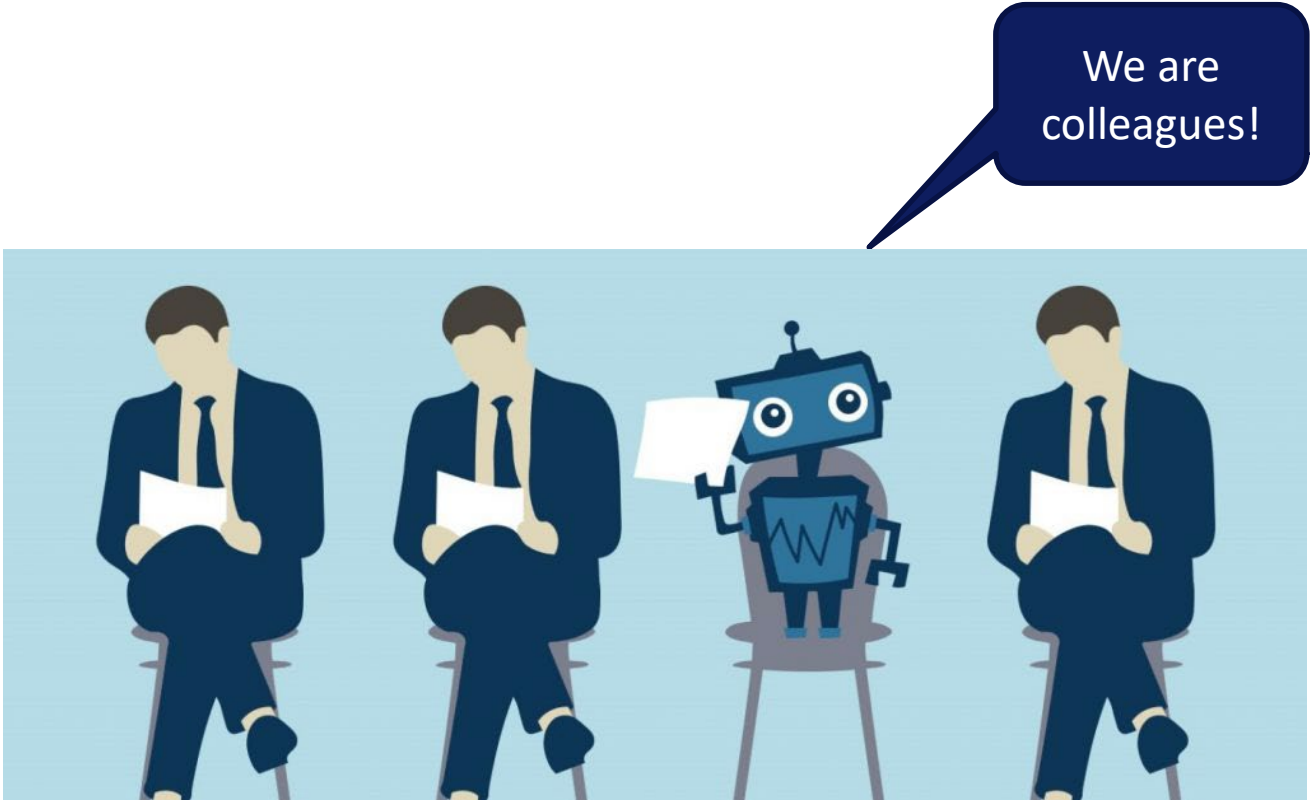


Prior Research on the effect of new technologies

- Research on technology adoption
  - the effects of technologies are less a function of the technologies themselves than of their use (Barley, 1986; DeSanctis & Poole, 1994; Kling, 1991; Orlikowski, 1992)
  - Technology adoption induces workers to **adapt**, often in unexpected ways outside of the design purpose (Anthony, 2021; Beane & Orlikowski, 2000; Orlikowski, 2000; Orlikowski & Scott, 2008; Troyer, 2018)

- Research on career concerns
  - AI can be perceived as a threat and raises career concerns (Brougham & Haar, 2018)
  - Career concerns motivates workers to **pay more effort** in order to secure their job (Gibbons & Murphy, 1992; Holmström, 1999; Aghion et al., 2013; Galasso & Simcoe, 2011; Hong et al., 2000)
  - Workers may be **motivated to change**

RQ1: Does the adoption of AI affect fund analysts' performance?



Data and Sample

- Sample period: January 2011 to October 2019
  - Sample ends in Oct 2019 due to methodology change by Morningstar
- Morningstar Human & Machine Ratings, and analyst reports: Morningstar Direct
- Mutual fund data: Morningstar Direct & CRSP Mutual Fund
  - Fund size, monthly returns, front/rear load, expense ratio…
  - 2,213 unique funds/11,136 fund-share classes in the US
  - Survivorship bias-adjusted
- Fund managers' information:
  - Age, tenure, gender, education background
  - Manually collected from Morningstar
  - 1,147 unique managers
- Fund analyst information:
  - Tenure, gender, education background (identity-encrypted)
  - Proprietary source from Morningstar research team
  - 300 unique analysts

Human Ratings

Gold Silver Bronze

Neutral Negative

People
How talented are the fund's managers and analysts? Do the experience and resources match the strategy?

Process
What is the fund's strategy and does management have a competitive advantage enabling it to execute the process well and consistently over time?

Performance
Is the fund's performance pattern logical given its process? Has the fund earned its keep with strong risk-adjusted returns over relevant time periods?

Parent
What priorities prevail at the firm? Stewardship or salesmanship?

Price
Is the fund a good value proposition compared with similar funds sold through similar channels?

Overall Rating

Scale	Score
Gold	5
Silver	4
Bronze	3
Neutral	2
Negative	1
Under review	Excluded
Not Rateable	Excluded

Pillar Ratings

Scale	Score
Positive	3
Neutral	2
Negative	1

Results: Quality of Human Ratings After AI Adoption

POST: June 2017 When the Machine Ratings are officially launched

Results are consistent if we look at **POST-February 2015**

VARIABLES	(1) $FRET_{1Y}$	(2) $FRET_{1Y}$	(3) $FRET_{1Y}$	(4) $FRET_{1Y}$	(5) $FRET_{1Y}$	(6) $FRET_{1Y}$
MS_Overall×POST	**0.688****					
	(2.51)					
MS_People×POST		**0.127***				
		(1.99)				
MS_Parent×POST			**1.945*****			
			(3.55)			
MS_Price×POST				**1.057****		
				(2.07)		
MS_Process×POST					0.087	
					(0.11)	
MS_Performance×POST						0.256
						(0.49)
POST	-2.441	-7.438*	-9.663***	-0.133	-6.465**	-2.885
	(-1.46)	(-1.85)	(-3.32)	(-0.06)	(-2.25)	(-1.06)
Constant	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y
Fund-ShareClass FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	187,079	187,079	187,079	187,079	187,079	187,079
R-squared	0.411	0.410	0.411	0.411	0.410	0.410
Adj. R-squared	0.379	0.379	0.380	0.379	0.379	0.379

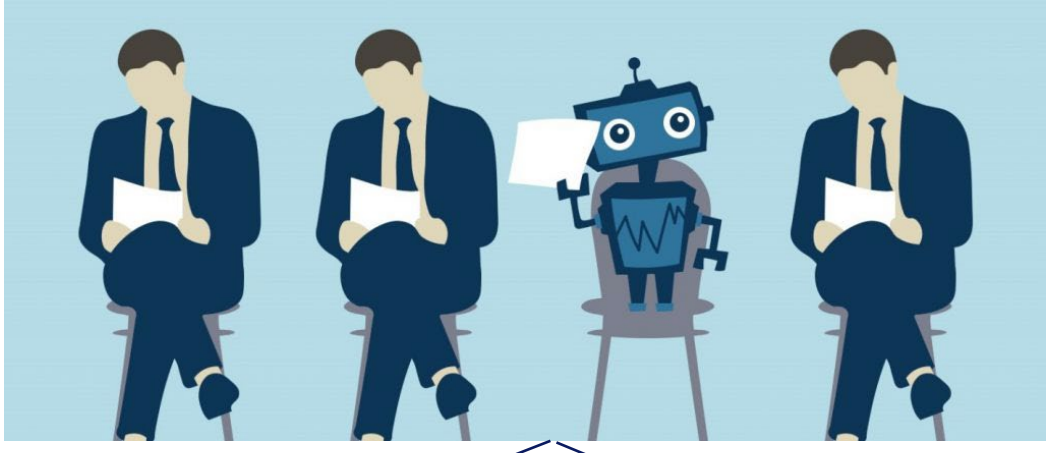
Controls:

- Lagged return
- Fund age & size
- Expense ratio
- Lagged fund flow
- Manager tenure and gender
- Analyst tenure and gender

Net Cash Inflows After AI Adoption

VARIABLES	(1) $FRET_{1Y}$	(2) $FRET_{1Y}$	(3) $FRET_{1Y}$	(4) $FRET_{1Y}$	(5) $FRET_{1Y}$	(6) $FRET_{1Y}$
MS_Overall×POST	0.028**					
	(2.32)					
MS_People×POST		0.096***				
		(3.72)				
MS_Parent×POST			0.035			
			(1.33)			
MS_Price×POST				0.046*		
				(1.80)		
MS_Process×POST					-0.000	
					(-0.01)	
MS_Performance×POST						0.026*
						(1.67)
POST	0.178***	0.004	0.182**	0.148*	0.270***	0.203***
	(3.47)	(0.06)	(2.51)	(1.98)	(3.57)	(4.22)
Main Effects & Constant	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y
Fund-ShareClass FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	187,079	187,079	187,079	187,079	187,079	187,079
R-squared	0.777	0.575	0.758	0.759	0.759	0.758
Adj. R-squared	0.770	0.575	0.757	0.758	0.758	0.758

RQ2: How does the adoption of AI improve fund analysts' performance?



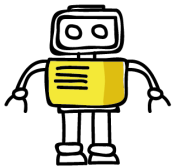
Disciplinary Channel

Learning Channel

Disciplinary Channel

Human Limitations:

- Bias towards socially-connected individuals (Westphal, 1999; Bradley, Gokkaya, and Liu, 2020; Gu et al., 2019)
- Such biases even exist for sophisticated professional workers:
  - CEOs, Board members
  - Financial analysts
  - Judges
  - …
- Fund analysts might favor fund managers with similar background and to avoid conflicts



- The introduction of Machine can discipline the fund analysts to:
  - Reflect on their biases
  - Exert more efforts in their jobs

Analyst: (The algorithm) made me realize some of my biases … I think it's driving us to be more consistent, silo each rating criterion, and avoid double counting.

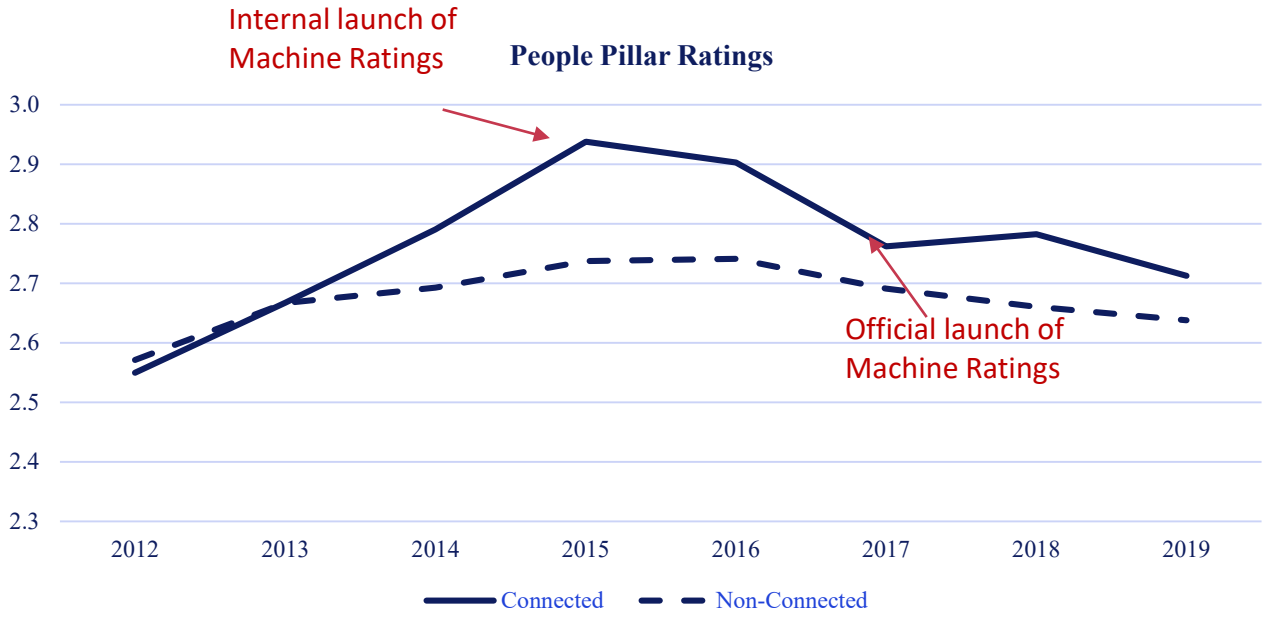
Results-Disciplinary Channel

Using a proprietary dataset of fund analysts' and fund managers' information

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MS_Overall	MS_People	MS_Parent	MS_Price	MS_Process	MS_Performance
CONNECTED×POST	**-0.232****	**-0.089****	**-0.130***	0.001	-0.049	-0.086
	(-2.22)	**(-2.72)**	**(-2.03)**	(0.01)	(-0.82)	(-1.27)
CONNECTED	0.150**	0.050*	0.077*	-0.016	0.012	0.040
	(2.24)	(1.82)	(1.93)	(-0.31)	(0.28)	(0.74)
POST	-0.002	0.026**	0.004	0.011	-0.027**	-0.023*
	(-0.18)	(2.48)	(0.22)	(1.19)	(-2.26)	(-1.86)
Constants & Controls	Y	Y	Y	Y	Y	Y
Fund-ShareClass FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	187,079	187,079	187,079	187,079	187,079	187,079
R-squared	0.650	0.541	0.650	0.545	0.532	0.455
Adj.R-squared	0.647	0.536	0.647	0.541	0.527	0.450

Results are consistent when using manager FE, analyst FE, and analyst-fund FE

Results-Disciplinary Channel-People Pillar Ratings



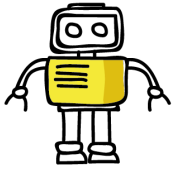
Results-Disciplinary Channel-Ratings Quality

VARIABLES	Connected (1) $FRET_{1Y}$	Non-Connected (2) $FRET_{1Y}$	Connected (3) $FRET_{1Y}$	Non-Connected (4) $FRET_{1Y}$
MS_Overall×POST	2.728*	1.490***	2.367**	0.716***
	(1.85)	(3.05)	(2.43)	(2.99)
Diff Connected-Non-Connected		**1.222*** **		**1.541*** **
Main Effects & Constant	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Fund-ShareClass FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	2,852	190,962	2,868	190,778
R-squared	0.584	0.381	0.585	0.381
Adj. R-squared	0.548	0.364	0.549	0.364

Learning Channel

Human Limitations:

- Limited attention and energy
- Human resources are scarce and expensive
  - Only a selected set of funds are covered
  - Lack of evaluations for benchmark funds/peer funds



- Humans can “learn” from the machine by :
  - Comparing their evaluations of funds with benchmark funds covered by the machines
  - Analysts learn from peers, and having access to benchmark information can lead to improved performance (Graham, 1999; Trueman, 1994; Welch, 2000; Kumar, Rantala and Xu, 2021)

Results: The Learning Channel

% of funds in the same MS Category that have Machine ratings

VARIABLES	(1) $FRET_{1Y}$	(2) $FRET_{1Y}$	(3) $FRET_{1Y}$	(4) $FRET_{1Y}$	(5) $FRET_{1Y}$	(6) $FRET_{1Y}$
MS_Overall×CoverageIncrease	0.765***					
	(4.12)					
MS_People× CoverageIncrease		0.771				
		(1.59)				
MS_Parent× CoverageIncrease			1.676***			
			(3.75)			
MS_Price×CoverageIncrease				0.871**		
				(2.21)		
MS_Process× CoverageIncrease					0.637	
					(1.31)	
MS_Performance×CoverageIncrease						0.394
						(0.97)
CoverageIncrease	-3.314*	-2.128	-4.582**	-2.414	-1.673	-1.160
	(-1.98)	(-1.29)	(-2.51)	(-1.26)	(-1.00)	(-0.71)
Main Effects & Constants	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y
Fund-ShareClass FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	187,079	187,079	187,079	187,079	187,079	187,079
R-squared	0.373	0.372	0.373	0.372	0.372	0.372
Adj. R-squared	0.340	0.338	0.340	0.339	0.338	0.338

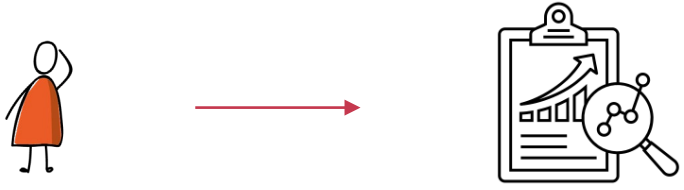
Results: Analyst report

- Until the end of 2017, Margie Patel was running this fund in her decisive style, based on macro and industry-allocation decisions and security selection in high yield and equity. However, the fund adopted a multimanager sleeve approach in January 2018 and increased its neutral allocation to equities to 35% from 25%. The fund uses a custom benchmark of 35% Russell 1000 Index and 65% BofAML U.S. High Yield Cash Pay Index.

- The fund's People Pillar rating has been Average since the departure of the former management team in September 2018. Managers Tim Cunneen and Dan Adler resigned in September 2018, while another named manager, Dan Dektar, left the firm in March 2018.

----Sample analyst report, 2018

Additional Results: Analyst Report Characteristics



	Full Sample	Full Sample
VARIABLES	(1) Polarity	(2) Subjectivity
CONNECTED ×POST	-0.016*	-0.013*
	(-1.69)	(-1.77)
CONNECTED	0.007	0.013*
	(0.95)	(1.90)
POST	-0.003	0.001
	(-1.34)	(0.24)
Controls and Constant	Y	Y
Fund-ShareClass FE	Y	Y
Year FE	Y	Y
Observations	10,237	10,237
R-squared	0.725	0.723
Adj.R-squared	0.632	0.630

Additional test: Heterogeneous Impacts

Tenure:

- Algorithm aversion is more salient among experts with more experience (Allen & Choudhury, 2021)
- Experts tend to rely more on their own judgment than the advice generated by an algorithm (Dietvorst, Simmons, & Massey 2015, Logg, Minson, & Moore, 2019)
- But more senior analysts might have more connections with fund managers and more pressured to maintain a good relationship with them

Past performance:

- High performers may have higher ability to assess algorithm's predictions
- The ability to assess and evaluate the ML algorithm is associated with performance (Allen & Choudhury, 2021; Tong et al., 2021)

Additional test: Heterogeneous Impacts- Tenure

	Disciplinary Channel				Learning Channel	
	Experienced Analyst	Junior Analyst	Experienced Analyst	Junior Analyst	Experienced Analyst	Junior Analyst
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MS_Overall	MS_Overall	MS_People	MS_People	$FRET_{1Y}$	$FRET_{1Y}$
CONNECTED ×POST	-0.164	-0.229*	-0.233**	-0.008		
	(-0.98)	(-1.84)	(-2.11)	(-0.25)		
CONNECTED	0.104	0.170**	0.172**	-0.012		
	(0.95)	(2.02)	(2.16)	(-0.57)		
POST	0.014	-0.021*	0.012	0.029***		
	(0.91)	(-1.73)	(0.86)	(2.72)		
MS_Overall ×CoverageIncrease					0.014***	-0.006
					(4.61)	(-0.44)
MS_Overall					0.000	0.034
					(0.02)	(1.36)
CoverageIncrease					-0.002	0.004
					(-0.24)	(0.93)
Diff Experienced-Junior		**0.065***		**-0.225****		**0.020***
Fund FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	84,897	102,182	84,897	102,182	84,897	102,182
R-squared	0.896	0.892	0.818	0.829	0.373	0.412
Adj. R-squared	0.892	0.888	0.811	0.822	0.350	0.390

Additional test: Heterogeneous Impacts- Ability

	Disciplinary Channel				Learning Channel	
	High Performer	Low Performer	High Performer	Low Performer	High Performer	Low Performer
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	MS_Overall	MS_Overall	MS_People	MS_People	$FRET_{1Y}$	$FRET_{1Y}$
CONNECTED ×POST	-0.306*	0.028	-0.402**	-0.079		
	(-1.77)	(0.36)	(-2.29)	(-1.01)		
CONNECTED	0.040	-0.033	0.090	0.149**		
	(0.46)	(-0.26)	(1.50)	(2.72)		
POST	-0.001	-0.050*	-0.010	0.003		
	(-0.02)	(-1.88)	(-0.39)	(0.26)		
MS_Overall ×CoverageIncrease					0.026***	0.020***
					(5.19)	(6.42)
MS_Overall					(7.69)	(2.15)
					0.026***	0.020***
CoverageIncrease					-0.184***	-0.038
					(-3.49)	(-1.71)
Diff High-Low		**0.334*** **		**-0.032** **		**0.006***
Fund FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	91,133	95,946	91,133	95,946	91,133	95,946
R-squared	0.919	0.918	0.839	0.845	0.488	0.491
Adj. R-squared	0.904	0.903	0.807	0.817	0.387	0.399

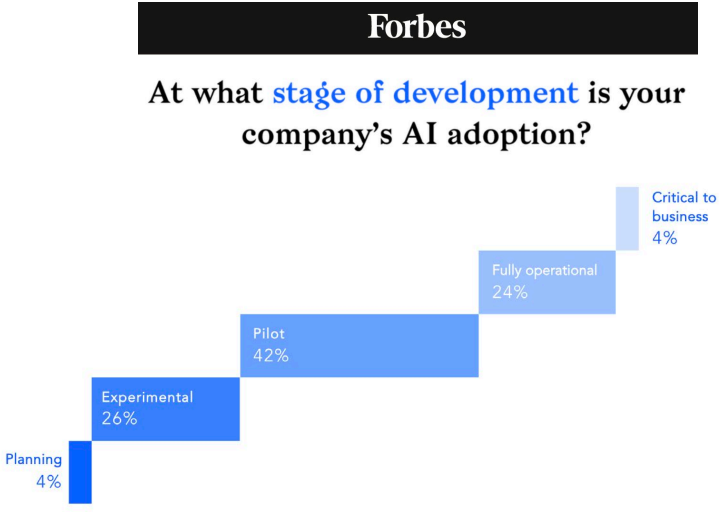
Conclusion

- Introduction of AI to generate Machine Ratings **improve** Human Ratings' quality
  - Human ratings can better predict funds' future returns and attract more fund flows
- Analysts (especially those connected with fund managers) provide more objective and less positive analyst reports
- Two channels that could explain such improvement:
  - **Disciplinary channel** → AI can help reduce human biases
  - **Learning channel**→ AI can provide more benchmark information
- The effects of AI vary by fund analysts' tenure and ability

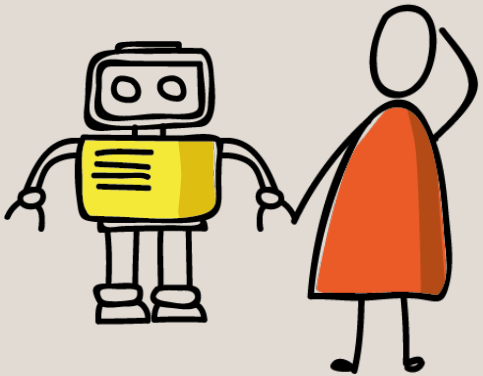
Contribution

- The impact of AI adoption on the efficiency of financial market and the mutual fund industry
- The sources of biases of fund analyst and ways to mitigate them
- The broader literature of the impact of AI on labor market (Frey & Osborne, 2017; Mann & Puttmann, 2017; Agrawal et al., 2019; Gruber et al., 2019)

- Lots of interests to adopt
- Early stage of adoption
- We can help the business leaders and the future employees who work with AI colleagues understand what is ahead of them



Thank you!



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Pillar Ratings' Change After AI

	(1)	(2)	(3)	(4)	(5)
VARIABLES	MS_People	MS_Parent	MS_Price	MS_Process	MS_Performance
POST	-0.016	0.074***	-0.096***	-0.136***	-0.038*
	(-0.78)	(3.62)	(-3.67)	(-5.87)	(-1.72)
Controls	Y	Y	Y	Y	Y
Category FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	190,628	190,628	190,628	190,628	190,628
R-squared	0.107	0.159	0.124	0.138	0.131

Human Pillar Rating Quality After AI Adoption

VARIABLES	(1) FRet12M	(2) FRet12M	(3) FRet12M	(4) FRet12M	(5) FRet12M
MS_People×POST	**1.200***				
	(2.17)				
MS_People	-0.574				
	(-1.03)				
MS_Parent×POST		-0.440			
		(-1.48)			
MS_Parent		0.298			
		(0.76)			
MS_Price×POST			-0.517**		
			(-2.44)		
MS_Price			0.397		
			(1.43)		
MS_Process×POST				**0.905***	
				(1.88)	
MS_Process				-0.792	
				(-1.86)	
MS_Performance×POST					**1.054***
					(2.19)
MS_Performance					-0.860*
					(-1.88)
Controls	Y	Y	Y	Y	Y
Category FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Observations	184,824	184,824	184,824	184,824	184,824
R-squared	0.125	0.123	0.126	0.126	0.127
Adj. R-squared	0.125	0.122	0.126	0.126	0.126