

# Artificial Intelligence and High-Skilled Work: Evidence from Analysts

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AI & ML in Finance

# Motivation

- AI is a powerful form of automation that improves prediction and exploration and enables human-like actions.
  - Many applications, making AI the most important general-purpose technology of this era (Bynjolfsson and McAfee, 2014).
  - Despite the pandemic, both 2020 and 2021 set records for AI investment. \$75 billion invested in AI and 1 in 3 CEOs surveyed by McKinsey said they increased AI investments.
- But the emergence of AI raises questions about the future of work and what it will look like.
  - Rich literature on previous other technologies (Bresnahan et al., 2002; Autor et al., 2003; Bessen et al., 2019, Humlum, 2019).
  - Yet AI may be fundamentally different, especially for high-skilled workers (Acemoglu and Restrepo, 2019).

## Research Question

**“With 80% of the data in the world created in the last two years, judgment matters more than ever. Technology is a complement to sound judgment and knowledge, not a substitute.”**

– Joyce Chang, Global Head of Research, J.P. Morgan

**RQ:** Given that AI can automate core production tasks, what are the implications for incumbent workers traditionally tasked with such work?

**Stock analyst context:** advantage is unlike job vacancies or other metrics, we know details of how AI is being used for financial analysis (e.g., data abundance, computational ease, etc.). This deep-dive on a single profession allows for a rich description of what is happening.

## Preview of Main Findings

- 1 **AI does not fully replace analysts but it does change the job and reduce the total number of analysts.**
- 2 **Substitutes:** There are fewer analysts per stock: more leave, fewer enter, and those that stay shift coverage to stocks requiring more soft skills.
- 3 **Complements:** Analysts turn to their soft skills. They increase meetings with management and institutional investors and change the type of questions they ask on earnings calls.
- 4 **Prediction quality:** The consensus forecast improves but heterogeneous response by individual analysts. Also, mixed evidence on effort.
- 5 **Compensation:** For analysts' compensation, some indirect evidence consistent with decreased compensation.

# Background on AI in Asset Management

# Investors Using AI to Do What Analysts Do

Rapidly expanding set of FinTechs synthesizing many data sources and using AI to make investment recommendations.



# Data Is Hard to Process without AI Help



# All Investors Must Rely on AI to Process the Alt Data

Evidence from FinTechs shows that investors rely on AI signals.

**TIPRANKS** Type: Expert Name or Stock  Research Tools Smart F

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**SMART SCORE**

The Smart Score harnesses value from each of the 8 data sets to create a powerful rating that unites all of TipRanks' unique stock insights. The Smart Score is measured and updated on a daily basis.

**8 OUTPERFORM**

1 2 3 4 5 6 7 8 9 10

**MORE RESOURCES**

- See Top Smart Score Stocks New
- About Smart Score & Performance

**Smart Score 8 Factors Overview for FB**

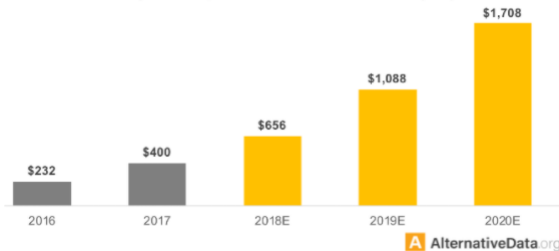
In total we have discovered 8 unique factors that each improve the odds of stock-picking success. For as strong as these factors are individually, they work even better when combined together to create the Smart Score. See details on each below. Then click on any of the 8 sections to find even more useful information on those factors.

<b>ANALYST RATINGS</b> CONSENSUS <b>Strong Buy</b> Average Price Target: \$236.00 <a href="#">Detailed Analysis &gt;</a>	<b>BLOGGER OPINIONS</b> SENTIMENT <b>Bullish</b> FB Sentiment 83% Sector Average 67% <a href="#">Detailed Analysis &gt;</a>	<b>HEDGE FUND ACTIVITY</b> TREND <b>Decreased</b> By 1.57M Shares Last Quarter. <a href="#">Detailed Analysis &gt;</a>	<b>INSIDER ACTIVITY</b> TREND <b>N/A</b> Currently Not Enough Data Available <a href="#">Detailed Analysis &gt;</a>	
<b>TIPRANKS INVESTORS</b> SENTIMENT <b>Very Negative</b> Last 7 Days ▼ 0.16% Last 30 Days ▼ 1.16% <a href="#">Detailed Analysis &gt;</a>	<b>NEWS SENTIMENT</b> LAST 7 DAYS <b>Neutral</b> Bullish 54% Bearish 46% <a href="#">Detailed Analysis &gt;</a>	<b>TECHNICALS</b> SMA <b>Positive</b> 20 days / 200 days	<b>FUNDAMENTALS</b> MOMENTUM <b>10.84%</b> 12 Months Change	
			<b>RETURN ON EQUITY</b> <b>20.3%</b> Trailing 12 Months	<b>ASSET GROWTH</b> <b>29.59%</b> Trailing 12 Months

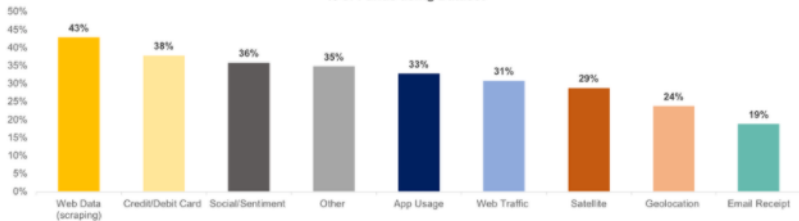


# Majority of Asset Managers Rely on AI and Alt Data

Total Buy-side Spend on Alternative Data (\$m)



% of Funds using Dataset



# Factors Influencing AI Adoption by Finance

- 1. Data abundance:** more things being quantified, so larger search space for ML predictors (e.g., twitter, satellite images).
- 2. Computing ease:** Data processing is less costly. As processor power and cloud resources rapidly increased, insights from NLP can go live fast (e.g., don't read news, just have AI-bot process).
- 3. Algorithmic improvements:** Easier to train a model, especially for stable results, enhancing out-of-sample predictions.
- 4. Data integrity:** Data quality enhanced as a streamlined process ensures garbage-in-garbage-out is limited
- 5. Competition:** Startups bringing AI to market, so incumbents can't afford not to
- 6. Accessible talent:** Open-source AI tools makes hiring talent less costly as reliance on firm-specific systems is lower

# FinTechs and AI Are Changing Asset Management

- Research shows the information signals that FinTech firms provide improve price informativeness
- Thus, even for those ignoring AI and sticking to fundamental analysis, their job is harder because there are fewer novel trading ideas out there.
- This reduction in residual variance could have even broader trading/asset pricing implications
  - Some investments rely on diffuse risk, so these may need to be approached differently
  - When everyone uses AI, this could lead us closer to a no-trade future or a future where idiosyncratic memes that introduce unexpected variance dominate.

# AI and High-Skilled Work

# How is AI's Impact on Labor Potentially Different?

**Robots:** substitute for manual tasks up to a threshold  
(**low-skilled**)

- Example: Amazon warehouse robots, cleaning robots
- Graetz and Micahles (2018), Acemoglu and Restrepo (2019)

**Software:** substitute for routine, back-office tasks with low stakes  
(**medium-skilled**)

- Example: billing software
- Autor, Levy, Murnane (2003), Acemoglu and Autor (2011)

**AI:** substitute for non-routine, core production tasks  
(**high-skilled**)

- Example: image recognition, stock predictions, writing reports
- Brynjolfsson et al. (2018), Webb (2020), Autor et al. (2021)

# Sell-side Analysts' Job in Detail

- Sell-side security analysts produce investment information
  - Research reports
  - Earnings estimates
  - Stock holding recommendations (e.g, Buy or Hold)
- Unique insights are valuable, so analysts' efforts go toward uncovering new info and/or proprietary angles
- Typical U.S. analyst is part of a cost center
  - Employer's profit indirectly via trades
  - Analyst comp is related to "abnormal trading volume"
  - The value the analyst brings to clients is based on (i) accuracy, (ii) access to firms' management, and (iii) soft information gathered

# What Analyst Tasks Can Machines Do?

- Analysts' jobs are considered **above average** for replacement by AI according to SML (Brynjolfsson et al., 2018).
- **Analysts' tasks that AI can do:** processing alt data useful for short-term predictions, updating valuation models, writing reports
- **Analysts' tasks that AI can't do:** economic interpretability of predictions and knowledge of long-term trends, explaining findings to clients, and gathering soft information

# Interview Details from Analysts

## Has entry into and exit from the job changed as a result of AI?

**Entry:** Yes, brokers seek atypical backgrounds (tech, healthcare, etc.). The “Wall Street” glass ceiling is broken.

**Exit:** Yes, given every company has some tech angle, analysts get exposed to aspects of business outside their core. This opens door to corporate and IR roles rather than just analyst roles.

**Is AI changing the nature of the job?:** Yes, but there is more nuance.

**Mega, large caps:** AI is pretty accurate at prediction for these stocks with a few well-established metrics that everyone has the data for.

**Small and mid-cap:** AI is less accurate for these stocks. There are still too many variables that are not well populated and valuable insights that come from legwork rather than data.



## Interview Details from Analysts (2)

### Is AI pushing forecasts to shorter or longer horizons?

- No, forecast horizon depends on who the primary clients of the bank are.

### Will AI replace you?

- No, it will just change the nature of the work. Autopilot never replaced pilots, it just changed their job.
- AI is complementary. AI may set the risk parameters, then our “ear to the street” will help pick between three stocks.

# Analysts' Skills from Investors' Perspective

How much does product (stock signal) vs. process (explaining the black box) matter?

WHAT INVESTORS REALLY WANT							
For a 12th year running, industry knowledge was deemed the most important sell-side equity research attribute, according to participants in the 2009 All-America Research Team survey. Stock selection was considered the least important of the 12 attributes investors were asked to rate on a scale of 1 to 10 (1 being most important).							
OVERALL RANK	ATTRIBUTE	RANK BY U.S. EQUITIES UNDER MANAGEMENT					
		\$75 BILLION OR MORE	\$30 BILLION TO \$74.99 BILLION	\$10 BILLION TO \$29.99 BILLION	\$5 BILLION TO \$9.99 BILLION	\$1 BILLION TO \$4.99 BILLION	LESS THAN \$1 BILLION
1	Industry knowledge	1	1	2	2	1	1
2	Integrity/professionalism	2	2	3	1	3	2
3	Accessibility/responsiveness	3	3	1	3	1	3
4	Management access	4	4	4	4	4	4
5	Special services	5	5	5	5	5	5
6	Written reports	6	6	6	6	6	7
7	Financial models	8	8	7	8	7	8
8	Useful & timely calls & visits	7	9	8	7	8	9
9	Idea generation	9	7	9	9	8	6
10	Research delivery	10	10	10	10	10	10
11	Earnings estimates	11	11	11	11	11	12
12	Stock selection	12	12	12	12	12	11

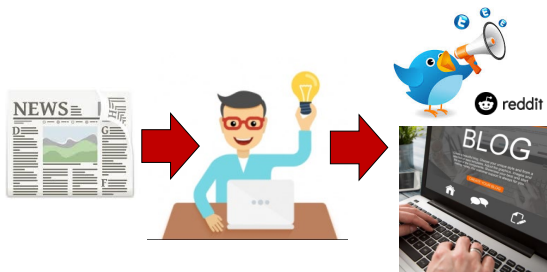
# What Does Data from All Analysts Show?

# Data for AI in Analyst Context

- Proxy for data abundance using the quantity of social media data processed for a given stock in a quarter (i.e., # of posts).
  - Apple, Facebook, and Tesla get disproportionate attention (100x relative to names like Starbucks or Coca-Cola).
  - Data abundance matters even if analysts don't pay attention to it since it makes it harder for them to bring "value" to clients (i.e., unique trading angles).
- Proxy for computational ease using by using SEC download data to identify the crawlers processing SEC filings.
- Proxy for remaining AI using employer investment in FinTech/AI firms and data licensing.

# Short Headline Length as an IV for Data Abundance

- Short news headlines attract attention, ultimately leading to more social media posts about a specific stock (e.g., GME).



- Headline length quasi-random since advertisement sales determine headline length editor uses.
- Separate out changes in data abundance from good (random) and bad (non-random) variation to estimate effect.

# Exclusion Restriction and Relevance of Instrument

- **Selection bias:** Do editors use short headlines for good companies? No, evidence suggests headline length does not vary with stock characteristics.
- **Selection bias:** Do editors use short headlines for more important news? No, evidence suggests headline length is orthogonal to news content.
- **Relevance:** Worry no info in 100th iteration of same idea on social media.
  - Growing literature in finance documenting “crowd wisdom” in social media posts (Da and Haung 2018, Cookson and Niessner, 2020, Grennan and Michaely, 2020, Da et al., 2020).
  - We find significant increase in social media posts about a stock following a short newspaper headline. This holds even for “smart” posts.

# Testing Substitutes Hypothesis

## IV Test of Number of Analysts Per Stock

- Fewer analysts per stock when social media data is abundant
- Controls include 20+ stock and news characteristics
- Std. errors clustered at the stock level

	Analysts per stock	
<b>Data abundance: # social media posts</b>	<b>-0.084***</b>	<b>-0.109*</b>
	<b>(0.018)</b>	<b>(0.062)</b>
Easy compute: # crawlers downloading 10-ks	-0.033***	-0.015***
	(0.004)	(0.006)
Additional stock controls	Y	Y
Year fixed effects	Y	Y
Industry fixed effects	Y	Y
Stock fixed effects	N	Y
First-stage $F$ statistic	177.5	108.6
$t$ -statistic on IV	13.3	10.4
Stock-quarter observations	91,304	91,125



## Extensive Margin: Analyst Quits Job

- Lower analysts per stock appears to be coming from quits, especially accurate analysts.
- Analyst controls include experience, reputation, and workload.
- Std. errors clustered at the analyst level.

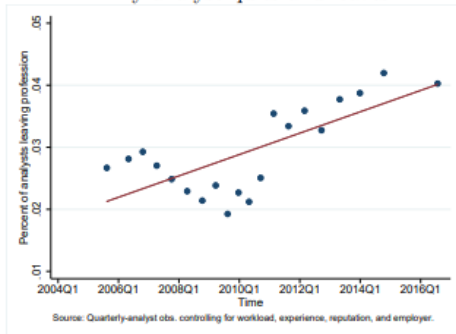
	Analyst quits		Accurate analyst quits	
<b>Data abundance</b>	<b>0.029**</b>	<b>0.029*</b>	<b>0.054***</b>	<b>0.041**</b>
	<b>(0.014)</b>	<b>(0.016)</b>	<b>(0.017)</b>	<b>(0.019)</b>
Easy compute	0.009	0.015*	0.004*	0.021**
	(0.007)	(0.008)	(0.002)	(0.010)
AI/data acquisitions	-0.008**	-0.009*	-0.010**	-0.009**
	(0.004)	(0.005)	(0.005)	(0.005)
Controls	Y	Y	Y	Y
Employer FE	N	Y	N	Y
Industry & Year FE	Y	Y	Y	Y
First-stage <i>F</i> statistic	2135.9	1400.7	2135.9	1400.7
<i>t</i> -statistic on IV	46.2	39.1	46.2	39.1
Analyst-quarter observations	73,778	73,735	73,778	73,735

## Robustness: Results hold across many tests

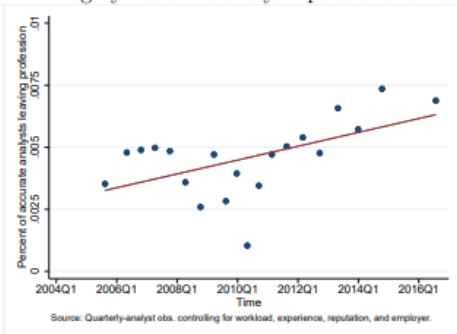
- Using different cuts of the sample (e.g., IQR)
- Using different thresholds for accuracy
- Using different lag structures
- Using different definitions for data abundance: only idiosyncratic social media data
- Placebo test using randomly assigned data abundance
- Using instrument constructed from multiple newspapers

# Analyst Departure Rates Higher Than in Past

## Any analyst quits and leaves



## Highly accurate analyst quits and leaves

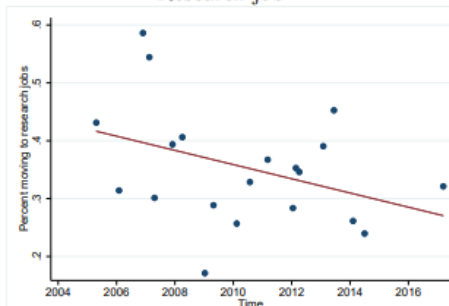


# Where Do Analysts Go?

- For a random sample of 900+ analysts that quit their job between 2004 and 2016, we searched LinkedIn to find them. Full breakdown as follows:
  - Buy-side research (15.8%)
  - Corporate finance role (16.1%)
  - Asset management (19.6%)
  - Investor relations (9.3%)
  - Same firm, different role (9.3%)
  - FinTech (4.8%)
  - Entrepreneurship (9.1%)
  - Consulting (7.0%)
  - Corporate strategy (5.3%)
  - Other (3.8%)
- **Bottom line:** Talent is leaving. Many stay in research but some shift to other skills.

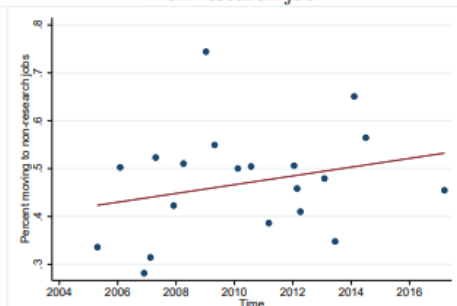
# Analyst Increasingly Depart for Non-research Roles

## Research job



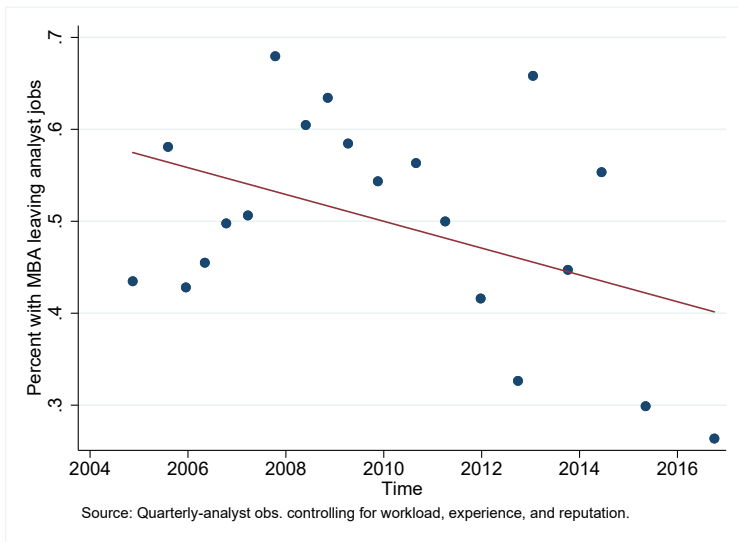
Source: Quarterly-analyst obs. controlling for workload, experience, and reputation.

## Non-research job



Source: Quarterly-analyst obs. controlling for workload, experience, and reputation.

# Non-MBA, Socially Disconnected Analysts Depart



# AI and Analyst's Next Job

- Analysts more exposed to AI are less likely to take a research role and more likely to take a non-research role (e.g., investor relations).

	Research job (1)	Non-research job (2)	FinTech job (3)
Data abundance	-0.134*** (0.054)	0.182** (0.081)	-0.016 (0.046)
First-stage $F$ statistic	47.5	47.5	47.5
$t$ -statistic on IV	6.9	6.9	6.9
Analyst observations	452	452	452
Additional analyst controls	Y	Y	Y
Year FE	Y	Y	Y

## Intensive Margin: Initiates Stock Coverage

- Analysts are less likely to initiate coverage on stocks with high data abundance.
- Full set of stock, analyst, and news content controls.

Dep. var. = initiate stock coverage	(1)	(2)
<b>Data abundance</b>	<b>-0.043***</b>	<b>-0.066***</b>
	<b>(0.014)</b>	<b>(0.028)</b>
Controls	Y	Y
Industry FE	Y	Y
Analyst FE	Y	N
Stock FE	N	Y
Year FE	Y	Y
First stage <i>F</i> -statistic	76.8	54.0
<i>t</i> -statistic on IV	8.8	7.4
Analyst-stock-quarter obs.	244,210	244,975



## Intensive Margin: Stops Covering Stock

- Analysts are more likely to stop covering stocks with high data abundance.
- Full set of stock, analyst, and news content controls.

Dep. var = stops stock coverage	(1)	(2)
<b>Data abundance</b>	<b>0.018***</b>	<b>0.090***</b>
	<b>(0.006)</b>	<b>(0.029)</b>
Controls	Y	Y
Industry FE	Y	Y
Analyst FE	Y	N
Stock FE	N	Y
Year FE	Y	Y
First stage <i>F</i> -statistic	108.7	72.4
<i>t</i> -statistic on IV	10.4	8.5
Analyst-stock-quarter obs.	632,962	633,225

# Summary: Substitution Hypotheses

- AI substitutes for high-skilled labor
  - (i) Career switching, especially among top talent
  - (ii) Stock coverage moves away from high-AI stocks

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- AI substitutes for high-skilled labor
  - (i) Career switching, especially among top talent
  - (ii) Stock coverage moves away from high-AI stocks
- Consistent with a rich literature on other tech (Lin, 2011, Acemoglu and Restrepo, 2017, Graetz and Michales, 2018, Bessen et al., 2019, Koch et al., 2019, Humlum, 2020).
- Nuance in this literature between early adopters vs. non-adopters, where ultimately, non-adopters lose employees as they reallocate to early adopters.
- Importantly, we see that with AI, where adoption is dictated by data and external competition, even top firms (adopting AI internally) are experiencing substitution.

# Testing Complementary Tasks Hypothesis

# Bring in Novel Data for Testing Soft Skills



**S&P  
Capital IQ**

# Textual Analysis of Analyst's Question Content



$x_1$  vector with count of each word  
used in an analyst question

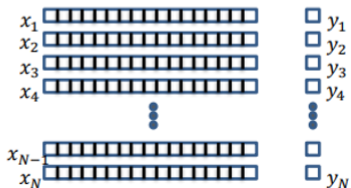


$y$ , associated 0/1 label  
easy-to-measure topic

vs.

hard-to-measure topic

Then, generalize to *all*  
analysts questions



# Analysts' Focus On Earnings Call

Evidence from earnings calls suggests AI proxies associated with increased efforts, especially toward complex/intangible topics.

	Total questions (1)	Question length (2)
<i>Panel A. Analyst questions</i>		
<b>Data abundance</b>	<b>0.082**</b> (0.042)	<b>0.088**</b> (0.043)
	Easy-to-measure (1)	Hard-to-measure (2)
<i>Panel B. Question content</i>		
<b>Data abundance</b>	<b>-0.095*</b> (0.051)	<b>0.104*</b> (0.060)
Controls	Y	Y
Stock FE	Y	Y
Year FE	Y	Y
First-stage <i>F</i> statistic	131.5	207.1
<i>t</i> -statistic on IV	11.5	14.4
Stock-quarter obs.	55,057	55,260

## Analysts' Focus Shift to In-Person Meetings

- Evidence from meetings suggests AI proxies associated with increased focus on social skills.

	Total analyst meetings (1)	Meetings with management (2)	Meetings with institutional investors (3)
<b>Data abundance</b>	<b>0.137***</b> (0.016)	<b>0.121***</b> (0.017)	<b>0.139***</b> (0.015)
<b>Easy compute</b>	<b>0.027**</b> (0.013)	<b>0.034***</b> (0.014)	<b>0.050***</b> (0.020)
Controls	Y	Y	Y
Industry FE	Y	Y	Y
Employer FE	Y	Y	Y
Year FE	Y	Y	Y
First-stage <i>F</i> statistic	1699.0	1699.0	1699.0
<i>t</i> -statistic on IV	41.2	41.2	41.2
Analyst-quarter obs.	72,112	72,112	72,112



## Analysts' Earnings Forecasts

- Within stock-analyst pairs over time, data abundance and computational ease weakly associated with higher quality reports.
- Bold forecast consistent with both strategic (i.e., seeking attention) and effort mechanism.

	Dependent variable =				
	As % of consensus		As % of stock price		Bold forecast
	Accuracy	Bias	Accuracy	Bias	
	(1)	(2)	(3)	(4)	(5)
Data abundance	0.140*	-0.100	0.062	-0.121**	0.143**
	(0.072)	(0.065)	(0.039)	(0.050)	(0.064)
Easy compute	0.004	-0.007	0.008*	-0.010*	-0.006
	(0.008)	(0.007)	(0.005)	(0.005)	(0.006)
Controls	Y	Y	Y	Y	Y
Year, Industry, Broker FEs	Y	Y	Y	Y	Y
Analyst-by-stock fixed effects	Y	Y	Y	Y	Y
First-stage <i>F</i> statistic	71.3	71.3	71.8	71.8	71.8
<i>t</i> -statistic on IV	8.4	8.4	8.5	8.5	8.5
Analyst-stock-quarter observations	594,129	594,129	625,639	625,639	597,281

# Findings: Complementary Tasks and Product Quality

- AI complements soft-skill tasks
  - (i) earnings call questions transition from rote to complex ideas
  - (ii) shift to more meetings with management and investors
- AI linked to product quality improvements
  - (i) likely from soft-skill effort but cannot rule out strategic motives.
  - (ii) also likely long-term consequences from work force changes.

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- AI linked to product quality improvements
  - (i) likely from soft-skill effort but cannot rule out strategic motives.
  - (ii) also likely long-term consequences from work force changes.
- Consistent with AI enhancing capabilities rather than replacing them (Bessen et al. 2019, Acemoglu and Restrepo, 2019).
- Supports the increased importance of non-cognitive skills in the labor market (Heckman and Kautz, 2012, Castex and Dechter, 2014, Deming, 2017).

# Implications for Compensation

- While compensation data is unavailable for analysts, their incentive pay is linked to directing trades through their employer.
- A common proxy in the literature is to look at the excess returns and trading volume around recommendations.



# Market Reaction Suggests Lower Compensation

- Data abundance is associated with lower excess trading, which suggests lower pay.

Market reaction	Dep. var. = Excess Returns		Dep. var. = Excess Volume	
	[0,1]	[0,5]	[0,1]	[0,5]
<b>Data abundance</b>	<b>-0.24%***</b>	<b>-0.27%***</b>	<b>-0.47***</b>	<b>-0.034*</b>
	<b>(0.05%)</b>	<b>(0.05%)</b>	<b>(0.10)</b>	<b>(0.19)</b>
Time FE	Y	Y	Y	Y
Analyst FE	Y	Y	Y	Y
Recommendation obs.	39,454	39,454	39,454	39,454

# Conclusion

# Conclusion

**RQ:** Given that AI is a technology likely to change many industries, what are the implications for incumbent workers traditionally tasked with AI-type work?

**Equity analyst results:** suggest the future of work for these high-skilled workers will focus on their soft skills as analytic advantages decline. Some analysts, especially talented ones, will leave the profession. The changes in talent may offset some of the initial improvements in product quality.

**Limitations:** while sell-side analysts share characteristics with many high-skilled workers and finance was an early adopter of AI, the patterns we document may not generalize beyond this setting.

Thank you!