Artificial Intelligence and High-Skilled Work: Evidence from Analysts

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  - Rich literature on other technologies (Bresnahan et al., 2002; Autor et al., 2003; Bessen et al., 2019, Humlum, 2019; Koch et al., 2019).
  - Yet AI may be fundamentally different, especially for high-skilled workers (Acemoglu and Restrepo, 2019). Further, high-tech adoption usually made by incumbent firms yet not for AI.

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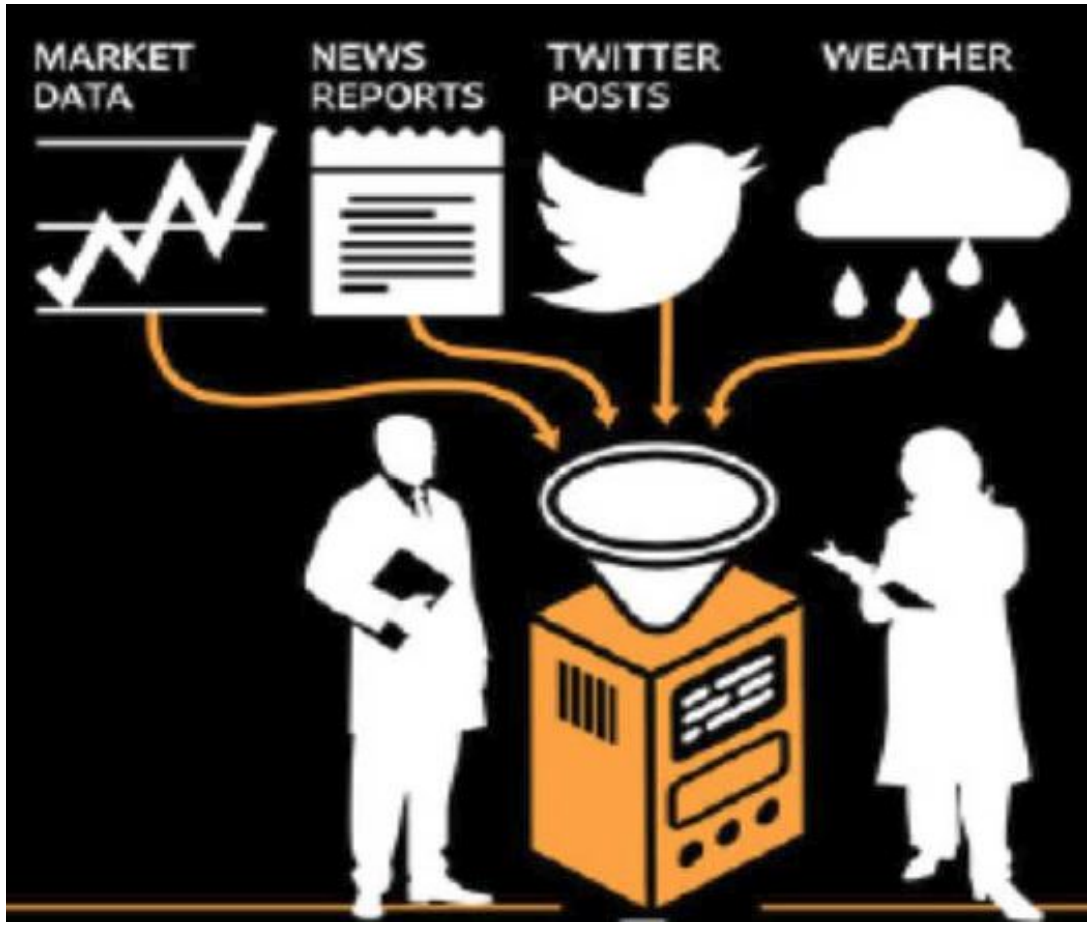
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Stock analyst context: advantage is well-defined prediction problem (i.e., forecast stock price/earnings), detailed data about performance and tasks requiring both soft and hard skills, and meaningful variation in AI intensity.

Many Firms Using AI to Do What Analysts Do

Rapidly expanding set of FinTechs streamlining and synthesizing many data sources relevant for investment recommendations.



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Product quality: Do analysts change the quality of their work product (i.e., earnings forecast)? If so, what economic channel is driving this change (e.g., effort vs. strategic change)?

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3. **Product quality:** Quality improves. Increased effort and strategic motives play a role.

4. **Implications:** For overall efficiency gains, evidence consistent with substitution effect offseting some of the individual efficiency gains. For overall earnings, some indirect evidence consistent with decreased earnings for analysts.

Background

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- Company's public relations, reports to S.E.C.
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- Buy-side analysts (e.g., typically work for active mutual funds, hedge funds, etc.)
- Credit rating agencies
- Newspaper and other media outlets
- Indirectly (customers, twitter, satellite images, etc..)

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- Analysts issue Upgrades and Downgrades of recommendations when their valuations are different from that of the market
- Given that new information is valuable to investors, analysts' efforts go toward uncovering new information and/or a different proprietary angle on the company

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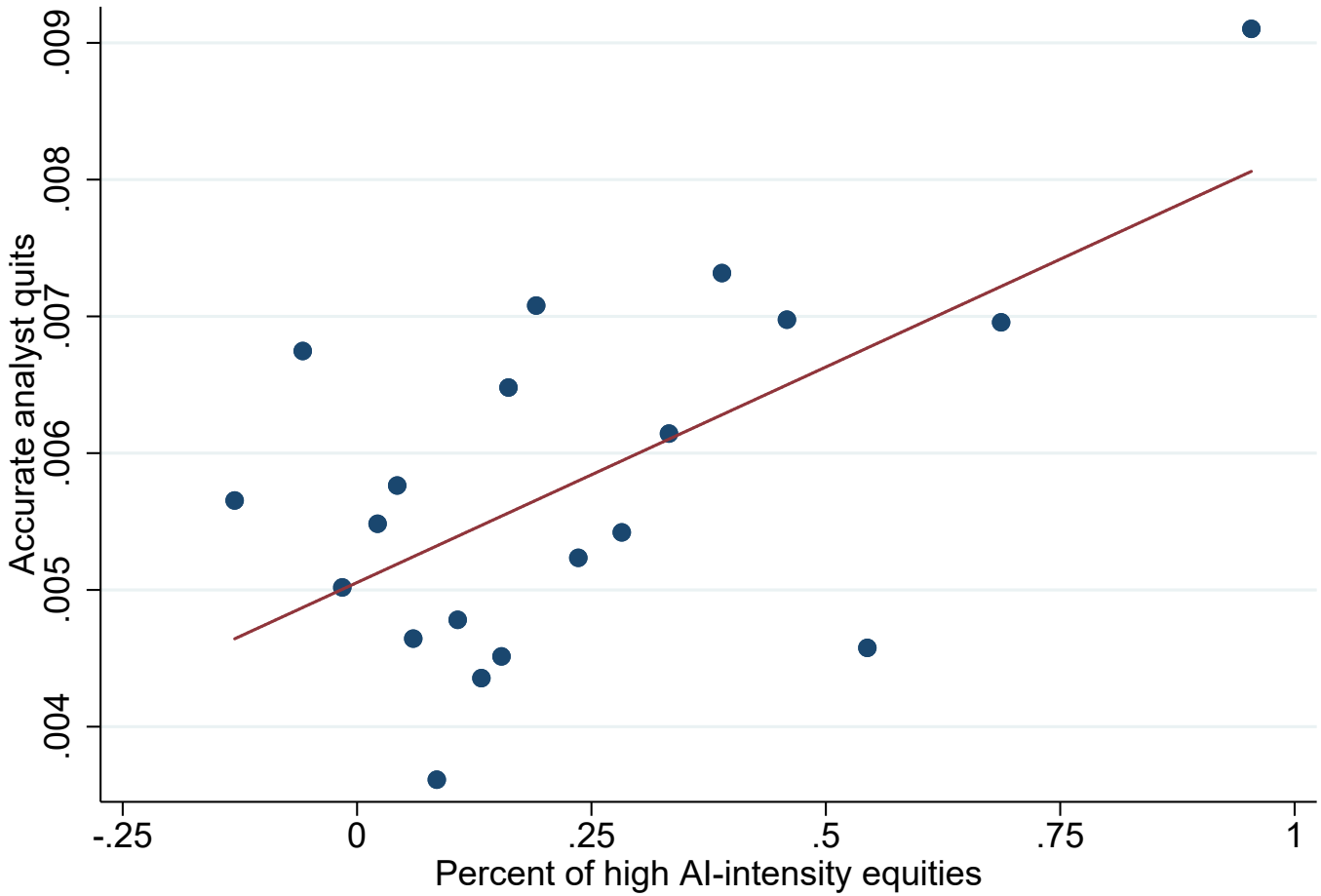
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- The "value" is based on (i) accuracy of forecasts and recs, (ii) access to firms' management, and (iii) soft information

Consequences of AI: From All-Star to Jobless?!





Accurate Analyst Quitting vs. AI Intensity



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

Empirical Strategy

Roadmap of Empirical Strategy

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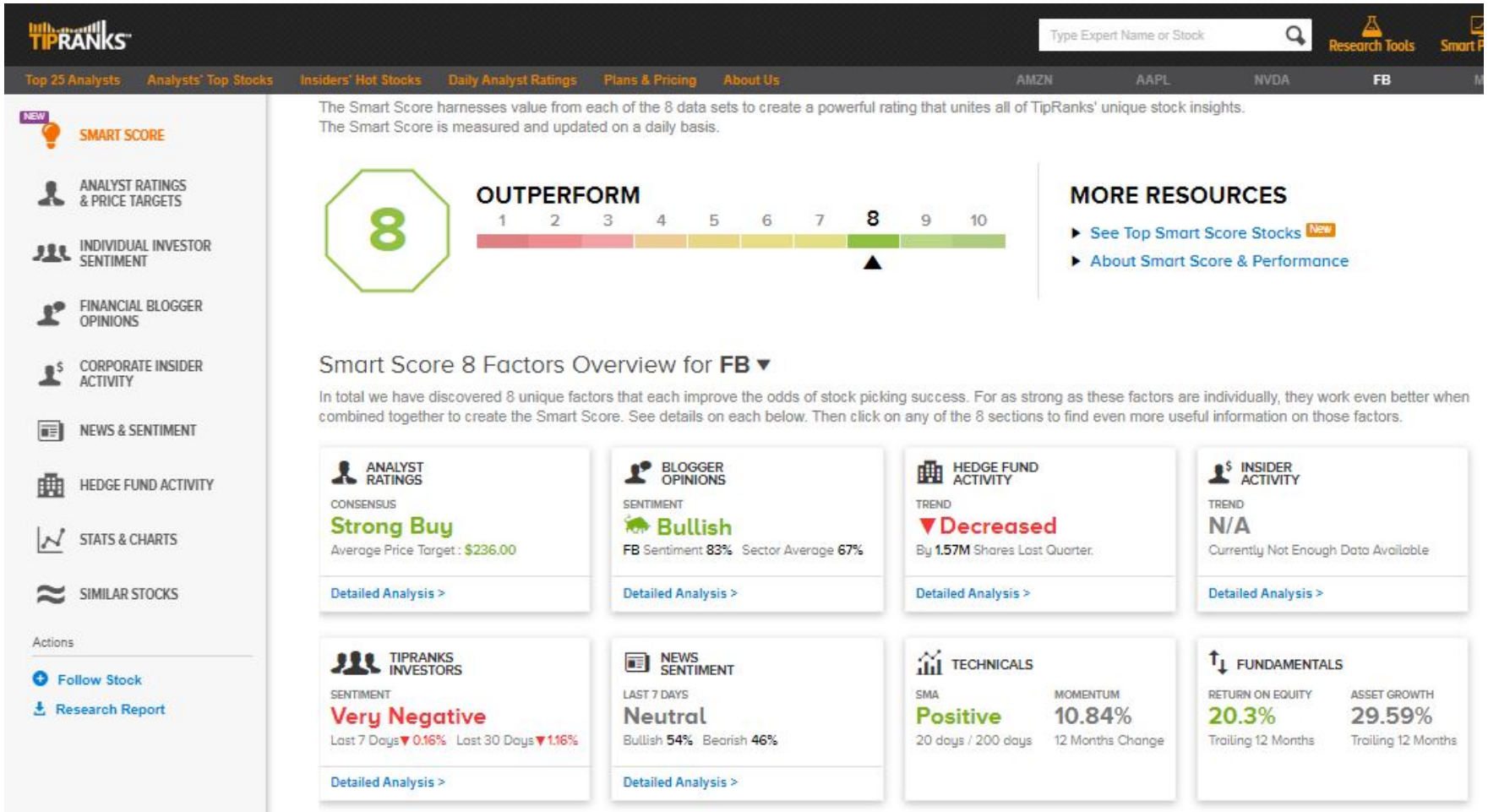
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- Relevance Condition

FinTech's AI-Powered Tools Provide Valuable Insights



Measure of AI Intensity

- AI intensity is the quantity of social media data TipRanks processes for a given stock in a quarter.
  - To put in perspective, Apple, Facebook, and Tesla get disproportionate social media attention (100x relative to household names like Starbucks or Coca-Cola).
  - Our sample covers 2010-2017. Social media data being processed roughly tripled over this time period.
- AI intensity matters to analysts even if they don't pay attention to social media.
  - Why? Social media produces "crowd wisdom" which is incorporated into prices via trades. So even if analysts don't pay attention to social media, they will "feel the pressure" because it will be harder for them bring "value" to clients (i.e., unique trading angles on a stock).

Linking AI Intensity to Analyst's Jobs

We analyze data at three levels: i = stock, j = analyst, $b = employer$, t = quarter

1. Analyst level:

$$Quits_{jt} = \beta High_AI_portfolio_{jt} + \Gamma X_{jt} + \kappa_b + \delta_t + \epsilon_{jt}$$

2. Analyst-stock level:

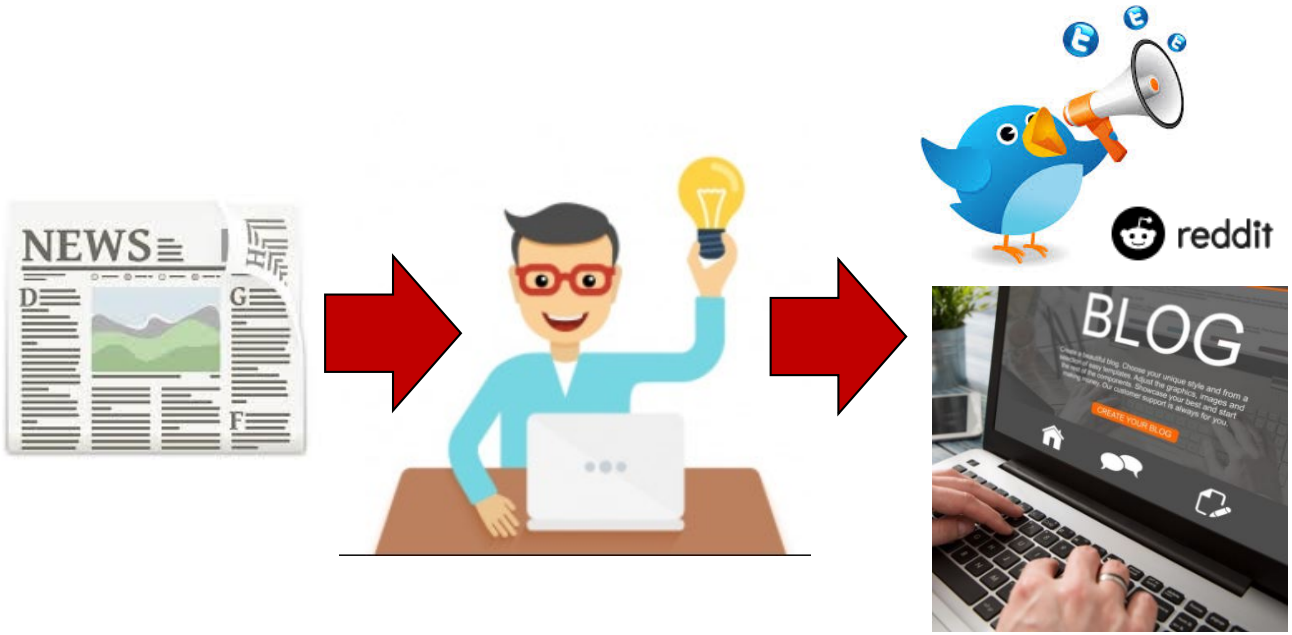
$$Accurate_Forecast_{ijt} = \beta AI_Intensity_{ijt} + \Gamma X_{ijt} + \theta_i + \alpha_j + \delta_t + \epsilon_{ijt}$$

3. Stock level:

$$Meetings_{it} = \beta AI_Intensity_{it} + \Gamma X_{it} + \theta_i + \delta_t + \epsilon_{it}$$

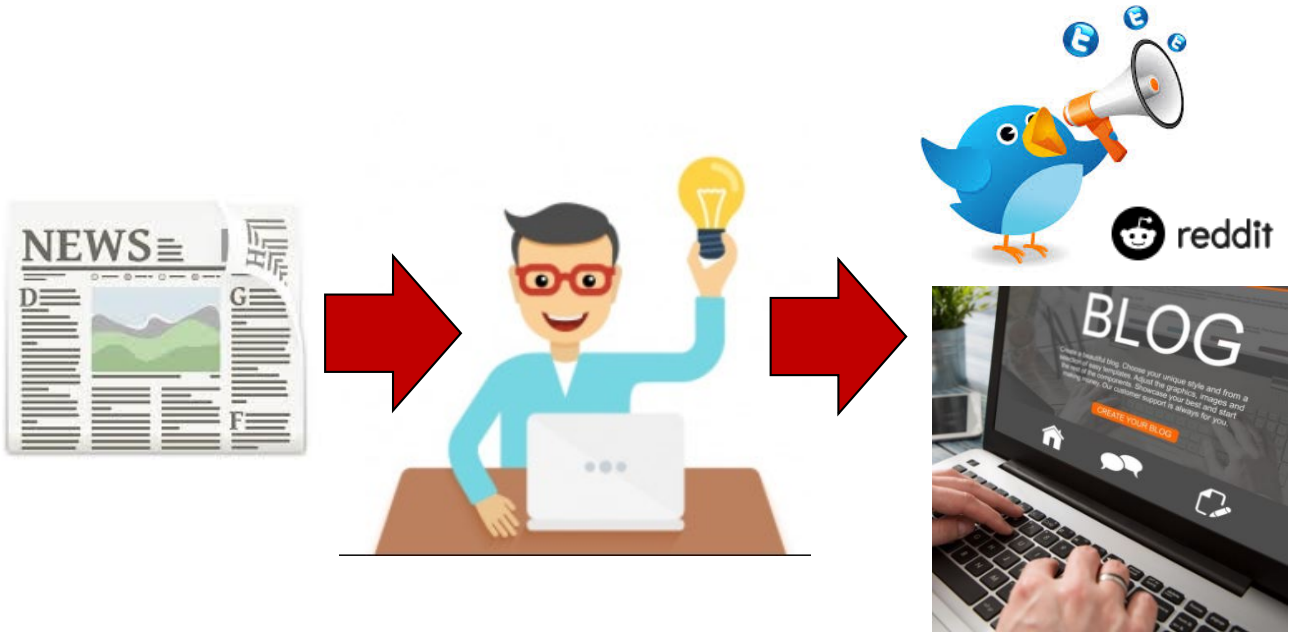
Short Headline Length as an IV for AI Intensity

- Short news headlines attract attention, ultimately leading to more social media posts.



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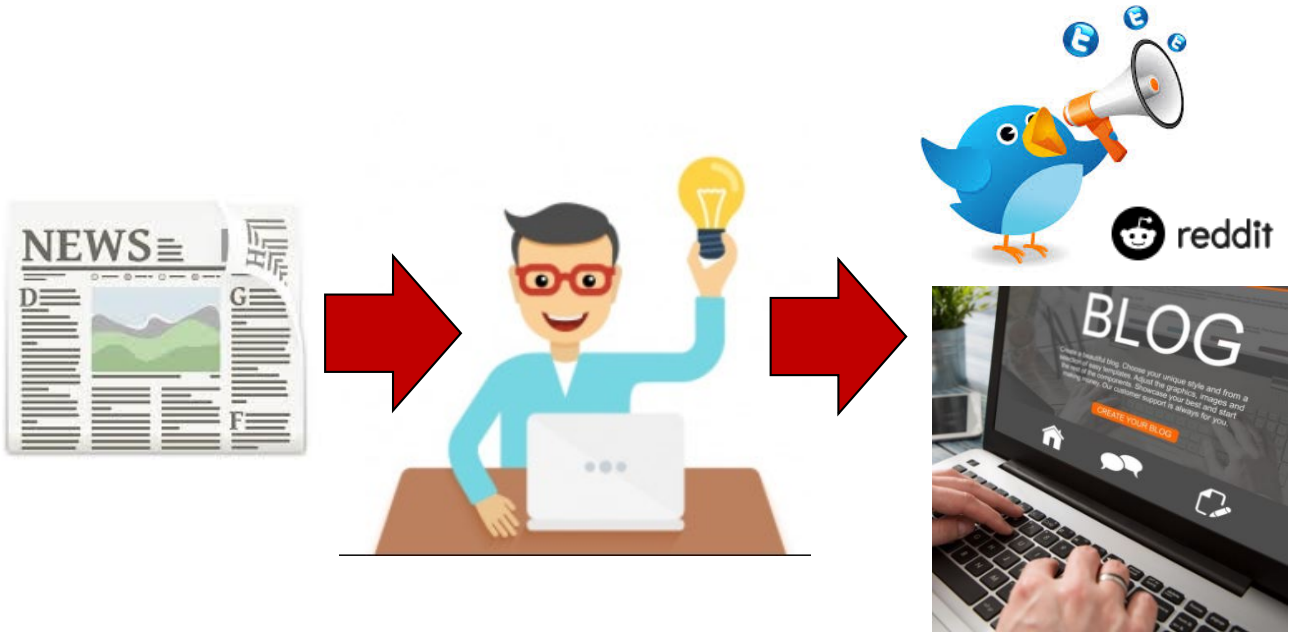
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- Identification comes from incremental changes in social media data induced by short headlines.

Seemingly Random Variation in Headline Length

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  - Wells Fargo Cuts Bank Sales Goals After $185m Fine for Fake Accounts
  - Wells Fargo Fined $185m Over Unauthorized Accounts That Harmed Customers
  - Wells Fargo to Pay $185 Million to Settle Allegations Its Workers Opened Fake Accounts
  - Wells Fargo Settled Over Its Bogus Accounts, but It Still Faces a Fight From Customers and Ex-Employees
  - Wells Fargo Fired 5,300 Workers for Improper Sales Push, the Executive in Charge Is Retiring With $125 Million

Exclusion Restriction and Headline Instrument (1)

- Worry that editor may exhibit selection bias by using short headlines for good companies. But evidence suggests headline length does not vary with stock characteristics.

	Dep. var. = Headline length
Log Market-to-Book	0.00
	(0.00)
Profitability	-0.53
	(0.77)
ROE	0.01
	(0.00)
Momentum	1.32*
	(0.79)
Firm Size	-0.02
	(0.05)
Adjusted R^2	0.1%
Observations	7,538,452

Exclusion Restriction and Headline Instrument (2)

- Worry that editor may exhibit selection bias by using short headline on more important news, but again, evidence suggests headline length orthogonal to news content.

Value-relevant events	Dependent variable = Headline length					
Any key event	0.22	-0.08				
	(0.29)	(0.10)				
Positive earnings surprise			-0.20	-0.39		
			(0.34)	(0.27)		
Negative earnings surprise			-0.83	-0.34		
			(0.76)	(0.54)		
Non-earnings event					0.42	0.13
					(0.31)	(0.10)
Firm controls	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y
Firm FE	N	Y	N	Y	N	Y
Adjusted R^2	9%	23%	9%	23%	9%	23%
Observations	431,710	431,240	431,710	431,240	431,710	431,240

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- Is the short headline shock transient or more permanent? Both.

Testing Substitutes Hypothesis

Extensive Margin: Analyst Quits Job

- Analysts, especially highly skilled analysts, are more likely to quit when they cover more high-AI-intensity stocks.
- Point estimate suggests similar economic magnitude to work experience.
- Controls include work experience, reputation, and workload.

	Dep. var. =	
	Quits	Accurate and quits
% of stocks with high AI intensity	**0.028***	**0.068****
	(0.016)	**(0.021)**
Controls	Y	Y
Broker FE	Y	Y
Year FE	Y	Y
First-stage F statistic	1442.0	1442.0
t-statistic on IV	38.0	38.0
Analyst-quarter obs.	73,796	73,796

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  - Asset management (14.3%)
  - Investor relations (12.0%)
  - Same firm, different role (10.3%)
  - FinTech (7.4%)
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  - Other (4.0%)
- **Bottom line:** Talent is leaving. Many stay in research but some shift to other skills.

Intensive Margin: Initiates Stock Coverage

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

Dep. var. = initiate stock coverage	(1)	(2)
AI intensity	**-0.040*** **	**-0.073*** **
	(0.014)	**(0.028)**
Controls	Y	Y
Analyst FE	Y	N
Stock FE	N	Y
Year FE	Y	Y
First stage *F*-statistic	76.4	54.1
t-statistic on IV	8.7	7.4
Analyst-stock-quarter obs.	244,214	244,979

Intensive Margin: Stops Covering Stock

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

Dep. var = stops stock coverage	(1)	(2)
AI intensity	**0.017*** **	**0.079*** **
	(0.006)	**(0.026)**
Controls	Y	Y
Analyst FE	Y	N
Stock FE	N	Y
Year FE	Y	Y
First stage *F*-statistic	108.7	72.4
t-statistic on IV	10.4	8.5
Analyst-stock-quarter obs.	632,962	633,225

Robustness: Zero-First-Stage Test

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- **Subsample**: stocks in the lowest decile of market capitalization. Even if they have a short headline, little social media following to begin with so won't go viral.
- **Findings:** For the zero-first-stage subsamples, we see no effect. For the remaining subsamples, we see significant effects. Supports exclusion restriction assumption.

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- Importantly, we see that with AI, where adoption is dictated by data and external competition, even top firms (adopting AI internally) are experiencing employee loss.

Testing Complementary Tasks Hypothesis

Bring in Novel Data for Testing Soft Skills



S&P
Capital IQ

Analysts' Focus On Earnings Call

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

Panel A. Analyst questions	Total questions (1)	Question complexity (2)
AI intensity	**0.082****	**0.088****
	(0.042)	**(0.043)**
Panel B. Question content	Easy-to-measure (1)	Hard-to-measure (2)
AI intensity	**-0.095***	**0.104***
	(0.051)	**(0.060)**
Controls	Y	Y
Stock FE	Y	Y
Year FE	Y	Y
First-stage *F* statistic	131.6	187.0
t-statistic on IV	11.5	13.7
Stock-quarter obs.	55,049	55,252

Analysts' Focus Shift to In-Person Meetings

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

	Total analyst meetings (1)	Meetings with management (2)	Meetings with investors (3)
% of stocks with high AI intensity	**0.137*** **	**0.114*** **	**0.167*** **
	(0.016)	**(0.017)**	**(0.015)**
Controls	Y	Y	Y
Broker FE	Y	Y	Y
Year FE	Y	Y	Y
First-stage *F* statistic	1470.0	1470.0	1470.0
t-statistic on IV	38.3	38.3	38.3
Analyst-quarter obs.	72,112	72,112	72,112

Analysts' Earnings Forecasts

- Within stock-analyst pairs over time, AI intensity 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
	Accuracy	Bias	Accuracy	Bias	forecast
	(1)	(2)	(3)	(4)	(5)
AI intensity	**0.145****	**-0.129****	**0.067***	**-0.126****	**0.126***
	(0.073)	**(0.059)**	**(0.039)**	**(0.050)**	**(0.065)**
Controls	Y	Y	Y	Y	Y
Analyst-by-stock FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
First-stage F statistic	71.7	71.7	72.0	72.0	71.7
t-statistic on IV	8.5	8.5	8.5	8.5	8.5
Analyst-stock-quarter obs.	564,173	564,173	593,433	593,433	564,173

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- Consistent with AI enhancing capabilities rather than replacing them (Bessen et al. 2019, Acemoglu and Restrepo, 2019).

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  (i) earnings call questions chage toward complex ideas
  (ii) shift to more meetings with management

- AI associated with improved product quality.

  Likely from soft-skill effort but cannot rule out strategic motives.

- 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 (Heckman and Kautz, 2012, Castex and Dechter, 2014, Deming, 2017).

Implications

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  - To think about overall relationship between AI and quality, we aggregate to the stock level and find the change in talent pool offsets individual improvements in product quality.
- AI is happening in a period of growing economic inequality. To inform debates about impact of AI on the wage distribution, we extend our analysis to explore some indirect evidence next.

Market Reaction and Implication for Earnings

- While earnings data is unavailable for analysts, their incentive pay is linked to excess trading.
- Higher AI data intensity is associated with lower excess trading, which suggests lower pay.

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

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Limitations: while sell-side analysts share characteristics with many high-skilled workers, the patterns we document may not generalize beyond this setting.