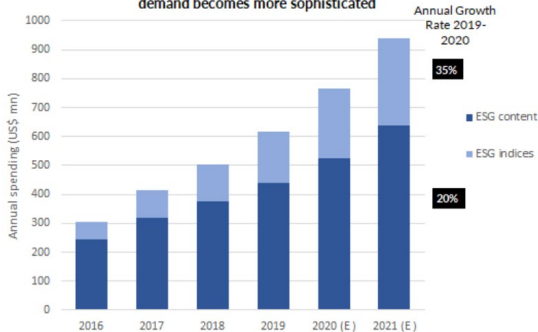# Paying attention to ESG Matters:
Evidence from Big Data Analytics

Wendi Huang, G. Andrew Karolyi and Alan Kwan

May 2021

Motiva...

Spending on ESG data continues to increase rapidly, as customer demand becomes more sophisticated

Source: Opimas estimates

- Risin...

  - T... reports > US$30 tri... ...lwide in 2018
  - ... ...Climate Accord

- Grow...

  - ... ...ecision process
  - ... ...or to understand pe...

- Issues and concerns of ESG data

  - Divergence in the metrics and methodologies among ESG data providers
  - Firm's sustainability disclosures are subject to "greenwashing"
  - There are also serious challenges in obtaining coverage related to ESG issues for smaller companies and for certain regions

Highlights

- **What we do**: Leverage big data analytics to develop novel measure of ESG <u>attention</u> by rank-and-file employees – can judge investors *and* firms

- **Research questions**
  - Can we develop a big data premise to learn more about ESG?
  - Does ESG attention predict firm actions / investor actions?
  - Does ESG attention tell us anything about existing ratings?
  - How much do investors influence firms?

Unique data

- We obtain proprietary business-to-business (B2B) intent data from a leading data provider

  - Intent data captures an online user's interest from his web content consumption (reading news articles, white papers, academic publications...)
  - Map each IP or profile to a firm, where available
  - Map web content consumption to a topic with relevancy score

Dataset coverage
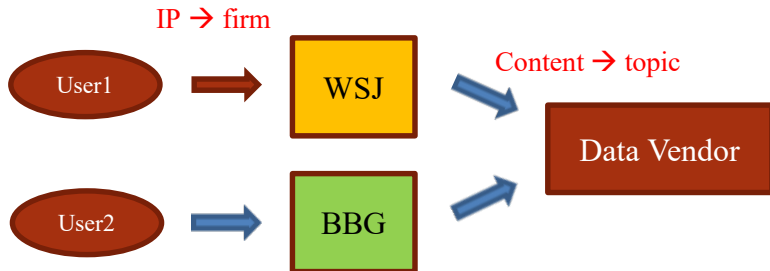
Year	# Topics	# Domains	Daily Consumption Activities Domain-mapped Business-Related Interactions Per Day
2015	2462	1677494	(not available)
2016	2962	1819851	506892107
2017	3589	4303994	686276353
2018	5433	5473714	623016344
2019	6765	6907293	272946594

Technology	Finance	Company	Marketing	Consumer Technology
Hardware Resources	Fixed Annuities	Lockheed Martin (LMT)	Live Streaming	Connected Cars
Salesforce Appexchange	Inversion	Comcast (CCV)	Social Media	Blu-ray
Game Makers	Quantitative Easing (QE)	Earnest	Conversion Rate Optimization (CRO)	Instagram
Google Cloud Messaging (GCM)	NASDAQ	GoFundMe	Holiday Season	iPhone

ESG topics

- ESG topics

  - From the several thousands of topics provided, we hand pick 323 topics most relevant to ESG
  - We classify them into 9 categories and 4 broad categories (Environment, Labor, Social and Governance)

Category Name	# topics
Compliance	18
Corporate Governance	29
CSR	28
Customer Relation	23
Cybersecurity	39
Data and Sensitive Information Protection	40
Environment	46
Equality & Diversity	21
Labor Relation	63
Total	323

ESG topics

Environment	Labor	Compliance	Data and Sensitive Information Protection
Air Pollution	Diversity Recruiting	Accounting Compliance	Data Privacy and Protection
Alternative-Fuel Vehicles	Employee Safety	Business Law	Data Security
Carbon Footprint	Employee Satisfaction	Compliance	Enterprise Application Security
Carbon Management	Equal Employment Opportunity (EEO)	Compliance Management	Information Security
Climate Change	Equal Pay / Comparable Worth	Compliance Training	Internet Security
Emissions	Gender Equality	Global Employment Law	Intrusion Prevention

Unique data --- Topic interest panel

- Weekly index score (primary dataset, long history)
  - Start from May 2015 and still growing
  - "Spike score" for each domain-topic-week
  - Range from 0 to 100
    - 50 means holds steady, >= 50 means increasing interest
- Daily count-measure version (robustness check)
  - For each domain-topic-date, we can observe
    - total record (consumption),
    - total relevancy score
    - and unique users
  - Start from May 2016 and still growing

ESG reading ranked by industry

| Environment	Labor	Compliance	Data and Sensitive Information Protection
Utilities	Educational Services	Finance and Insurance	Finance and Insurance
Mining, Quarrying, and Oil and Gas Extraction	Health Care and Social Assistance	Professional, Scientific, and Technical Services	Professional, Scientific, and Technical Services
Educational Services	Accommodation and Food Services	Administrative, Support Waste Management and Remediation Services	Health Care and Social Assistance
Construction	Management of Companies, Enterprises	Mining, Quarrying, and Oil and Gas Extraction	Accommodation and Food Services
Management of Companies, Enterprises	Administrative, Support Waste Management and Remediation Services	Accommodation and Food Services	Information

Climate Risk Is Investment Risk

As a fiduciary, our responsibility is to help clients navigate this transition. Our investment conviction is that sustainability- and climate-integrated portfolios can provide better risk-adjusted returns to investors. And with the impact of sustainability on investment returns increasing, we believe that sustainable investing is the strongest foundation for client portfolios going forward.

In a **letter to our clients** today, BlackRock announced a number of initiatives to place sustainability at the center of our investment approach, including: making sustainability integral to portfolio construction and risk management; exiting investments that present a high sustainability-related risk, such as thermal coal producers; launching new investment products that screen fossil fuels; and strengthening our commitment to sustainability and transparency in our investment stewardship activities.

Over the next few years, one of the most important questions we will face is the scale and scope of government action on climate change, which will generally define the speed with which we move to a low-carbon economy. This challenge cannot be solved without a coordinated, international response from governments, aligned with the goals of the Paris Agreement.

Firm Attentional Responses to BlackRock's letter
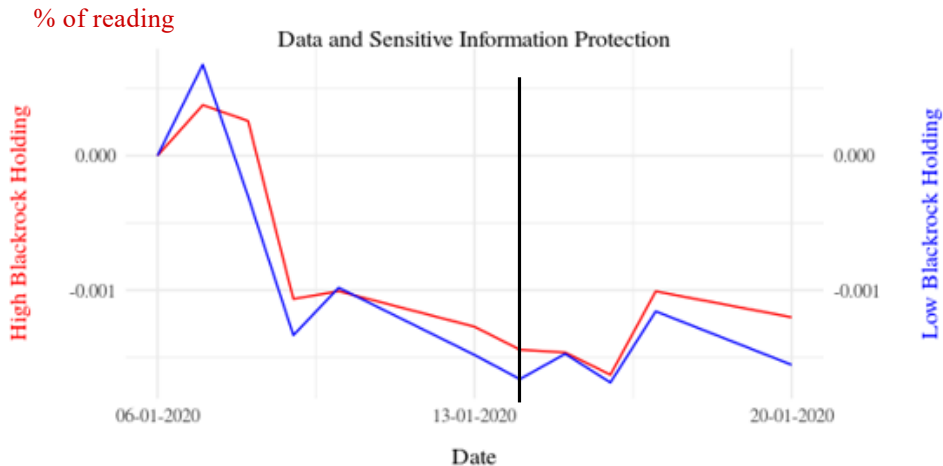
ESG measure

- Measure of ESG attention

$$Spikes^{ESG} = \sum_t \sum_j 1\{Spike\ score_{j,t} \geq 80\}$$

- A toy example

  - Consider a domain-month with 4 weeks and 5 topics
  - The two ESG topics are "Charitable Giving" and "Climate Change", and the three non-ESG topics are "Innovation", "ROA" and "Brand Loyalty"
  - $Spikes^{ESG}$ is 2 and $Spikes^{Not\ ESG}$ is 2

	Charitable Giving	Climate Change	Innovation	ROA	Brand Loyalty
Week1	17	51	24	**80**	NA
Week2	20	69	56	61	31
Week3	21	**83**	78	49	36
Week4	29	**85**	**81**	36	38

Firm-level results

Firm's ESG attention   Firm + year FE

$$ESG\ rating_{i,t} = \boldsymbol{\beta_1} * \mathbf{log}(\mathbf{1} + \boldsymbol{Spikes^{ESG}})_{i,t} + \beta_2 * \log(1 + Spikes^{Not\ ESG})_{i,t} + \mu_i + \varepsilon_t$$

- Does ESG attention → ESG ratings?
  - Positive?
  - Negative relationship?
  - Decompose our ESG attention to different ESG categories

- Real ESG outcomes
  - More upgrade with green technologies from EPA TRI program
  - More worker benefits from Form 5500
  - Less OSHA inspections (unplanned)

- Three ratings
  - MSCI KLD, Refinitiv ASSET4, RepRisk

Real ESG outcomes --- EPA pollution prevention

Sample:	Log(1+ # Green facilities)					
	All	**All**	**Public**	**Refinitiv[Combined]**	**Current RRI**	**KLD1**
	(1)	(2)	(3)	(4)	(5)	(6)
$Log(1+Spikes^{ESG})$	0.020***	0.029***	0.065**	0.042**	0.040**	0.047**
	(0.005)	(0.008)	(0.026)	(0.020)	(0.017)	(0.019)
$Log(1+Spikes^{Not\ ESG})$		-0.010	-0.038			
		(0.008)	(0.026)			
$Score^{ESG}$				0.003	-0.007	-0.001
				(0.014)	(0.020)	(0.021)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,590	14,590	3,597	1,756	2,498	2,375
Adjusted R^2	0.585	0.585	0.448	0.463	0.426	0.443

Real ESG outcomes --- Form5500 Employee benefit

	Contributions divided by firm size				
Sample:	All	All	Refinitiv[Combined]	Current RRI	KLD1
	(1)	(2)	(3)	(4)	(5)
$Log(1+Spikes^{ESG})$	0.030***	0.072***	0.045***	0.017**	0.041***
	(0.005)	(0.014)	(0.008)	(0.008)	(0.008)
$Log(1+Spikes^{Not\ ESG})$		-0.045***			
		(0.013)			
$Score^{ESG}$			0.007	0.007	-0.002
			(0.012)	(0.008)	(0.012)
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Observations	12,200	12,200	5,202	5,494	6,651
Adjusted R^2	0.941	0.941	0.946	0.929	0.943

Real ESG outcomes --- OSHA inspections

Sample:	OSHA inspections per establishments					
	All	**All**	**Public**	**Refinitiv[Combined]**	**Current RRI**	**KLD1**
	(1)	(2)	(3)	(4)	(5)	(6)
$Log(1+Spikes^{ESG})$	-0.013***	-0.039***	-0.043**	-0.023**	-0.030***	-0.019**
	(0.004)	(0.012)	(0.021)	(0.009)	(0.009)	(0.007)
$Log(1+Spikes^{Not\ ESG})$		0.028**	0.022			
		(0.012)	(0.021)			
$Score^{ESG}$				0.016**	0.007	-0.014
				(0.007)	(0.008)	(0.009)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,403	10,403	4,996	1,919	2,708	2,755
Adjusted R^2	0.292	0.293	0.418	0.565	0.484	0.482

Firm-level results --- Refinitiv

	Refinitiv^{Combined}				Refinitiv^{ESG}	Refinitiv^{Contro}
	(1)	(2)	(3)	(4)	(5)	(6)
$Log(1+Spikes^{ESG})$	1.230***	0.483***	1.031**		0.102	1.582**
	(0.212)	(0.166)	(0.422)		(0.203)	(0.686)
$Log(1+Spikes^{Not\ ESG})$			-0.514		0.072	-1.037*
			(0.357)		(0.174)	(0.595)
$Log(1+Spikes^{Environ})$				-0.199		
				(0.296)		
$Log(1+Spikes^{Labor})$				-0.249		
				(0.305)		
$Log(1+Spike^{Social})$				0.754***		
				(0.285)		
$Log(1+Spikes^{Govern})$				0.381		
				(0.292)		
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes					
Firm FE		Yes	Yes	Yes	Yes	Yes
Observations	6,759	6,759	6,759	6,759	6,759	6,759
Adjusted R^2	0.072	0.676	0.677	0.677	0.942	0.395

Firm-level results --- KLD

	$\dfrac{str-con}{\substack{total\ num \\ categories}}$		$\dfrac{str-con}{\max\{1,\ |str|+|con|\}}$		$\dfrac{str-con}{|str|+|con|}$	
	KLD1			**KLD2**	**KLD3**	
	(1)	(2)	(3)	(4)	(5)	(6)
$Log(1+Spikes^{ESG})$	0.749***	-0.032	-0.132	3.577*	5.367**	
	(0.055)	(0.039)	(0.082)	(1.981)	(2.089)	
$Log(1+Spikes^{Not\ ESG})$			0.099	2.006	0.284	
			(0.069)	(1.881)	(1.993)	
$Log(1+Spikes^{Environ})$						1.280
						(1.517)
$Log(1+Spikes^{Labor})$						-1.197
						(1.915)
$Log(1+Spike^{Social})$						1.128
						(1.372)
$Log(1+Spikes^{Govern})$						5.041***
						(1.547)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes					
Firm FE		Yes	Yes	Yes	Yes	Yes
Observations	7,396	7,396	7,396	7,396	5,894	5,894
Adjusted R^2	0.146	0.790	0.790	0.612	0.689	0.690

Firm-level results --- RepRisk

	Current RRI					
	Monthly				**Annual**	
	(1)	(2)	(3)	(4)	(5)	(6)
$Log(1+Spikes^{ESG})$	2.060***	-0.325***	-0.203***		-0.450***	-0.250
	(0.165)	(0.071)	(0.065)		(0.103)	(0.317)
$Log(1+Spikes^{Not\ ESG})$			-0.133**			-0.178
			(0.064)			(0.271)
$Log(1+Spikes^{Environ})$				-0.177***		
				(0.061)		
$Log(1+Spikes^{Labor})$				-0.171***		
				(0.063)		
$Log(1+Spike^{Social})$				-0.181**		
				(0.070)		
$Log(1+Spikes^{Govern})$				-0.109*		
				(0.062)		
Month FE	Yes	Yes	Yes	Yes		
Year FE					Yes	Yes
Industry FE	Yes					
Firm FE		Yes	Yes	Yes	Yes	Yes
Observations	59,413	59,413	59,413	59,413	6,610	6,610
Adjusted R^2	0.100	0.706	0.706	0.706	0.653	0.653

Investor-level results --- trading activity

- More direct evidence

<p align="center" style="color:red">Investor's ESG attention</p>

$$Invest_{i,j,t} = \boldsymbol{\beta_1} * \boldsymbol{ESG\ Rating}_{j,t-1} * \boldsymbol{\log(1 + Spikes^{ESG})}_{i,t} + \emptyset * X_{j,t-1} + \mu_{i,t} + \dots$$

- Investment is defined as follows

$$Invest_{i,j,t} = \log(1 + Holdings_{i,j,t}) - \log(1 + Holdings_{i,j,t-1}(1 + Return_{j,t}))$$

- Control various stock characteristics $X_{j,t-1}$ at last quarter end

  - Stock return, market capitalization, volatility, momentum, profitability, book-to-market

Investor-level results --- trading activity

	Invest			
	KLD1	**Refinitiv^{Combined}**	**Current RRI**	**ΔRRI**
	(1)	(2)	(3)	(4)
$Score^{ESG} \times Log(1+Spikes^{ESG})$	1.200**	1.048**	-0.171	-0.396
	(0.515)	(0.522)	(0.767)	(0.335)
$Score^{ESG} \times Log(1+Spikes^{Not\ ESG})$	-0.487	-0.562	0.408	0.546**
	(0.478)	(0.445)	(0.680)	(0.274)
$Score^{ESG}$	1.690	1.060	-0.995	-2.385***
	(1.540)	(1.294)	(2.348)	(0.716)
$Return$	0.244***	0.555***	0.070*	0.069*
	(0.040)	(0.039)	(0.038)	(0.038)
$Volatility$	-1.303***	-1.305***	-1.100***	-1.091***
	(0.117)	(0.118)	(0.104)	(0.105)
$Log(Market\ Cap)$	24.770***	23.832***	25.807***	26.066***
	(0.947)	(0.903)	(1.070)	(0.962)
$Momentum$	6.677***	9.167***	11.466***	11.305***
	(1.779)	(1.749)	(1.840)	(1.825)
$Gross\ Profitability$	-2.058	-6.510***	1.366	1.661
	(2.250)	(2.120)	(2.158)	(2.219)
$Book\text{-}to\text{-}Market$	8.129***	0.138	7.181***	7.425***
	(1.399)	(1.330)	(1.223)	(1.297)
Investor ×Quarter FE	Yes	Yes	Yes	Yes
Observations	7,053,543	6,045,678	4,818,398	4,818,398
Adjusted R^2	0.262	0.284	0.259	0.259

Investor-level results --- voting on ESG issues

| | Fund vote for ESG | | | | |
| | All | All | All | E&S | Gov |
	(1)	(2)	(3)	(4)	(5)
$Log(1+Spikes^{ESG})$	0.721***	1.183***	1.177***		
	(0.251)	(0.373)	(0.373)		
$Log(1+Spikes^{Not\ ESG})$		-0.541*	-0.534*		
		(0.291)	(0.291)		
$Log(1+Spikes^{Environ})$				0.672*	0.495
				(0.370)	(0.440)
$Log(1+Spikes^{Labor})$				-0.398	0.682
				(0.484)	(0.539)
$Log(1+Spike^{Social})$				-0.491	0.636
				(0.343)	(0.500)
$Log(1+Spikes^{Govern})$				-0.922***	1.160***
				(0.356)	(0.436)
ISS Vote	No	No	Yes	Yes	Yes
Management Vote	No	No	Yes	Yes	Yes
Meeting FE	Yes	Yes	Yes	Yes	Yes
Investor FE	Yes	Yes	Yes	Yes	Yes
Observations	457,454	457,454	457,454	224,333	233,121
Adjusted R^2	0.486	0.486	0.567	0.504	0.548

Joint dynamics --- quarterly reading on each topic

	$1\{Spike^{Firm}\}$					
	All	**All**	**Env**	**Labor**	**Social**	**Gov**
	(1)	(2)	(3)	(4)	(5)	(6)
$1\{Spike^{Top5\,Inv}\}$	5.864***	5.283***	4.879***	4.593***	3.656***	6.446***
	(0.136)	(0.138)	(0.135)	(0.123)	(0.140)	(0.172)
$1\{Spike^{Rest\,Inv}\}$	2.094***	1.459***	1.138***	1.499***	0.966***	1.589***
	(0.073)	(0.070)	(0.091)	(0.072)	(0.069)	(0.079)
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Topic FE		Yes	Yes	Yes	Yes	Yes
Observations	14,251,321	14,251,321	1,932,765	4,889,983	1,882,312	5,546,261
Adjusted R^2	0.037	0.045	0.049	0.038	0.041	0.059

5.864% higher likelihood

Top 5 investors

Other investors

Joint dynamics --- distracted investors

The construction of variable *Distraction* follows Kempf, Manconi, and Spalt (2017)

	$1\{Spike^{Firm}\}$			
	Top 5 Investors		**All investors with sampling**	
	(1)	(2)	(3)	(4)
$1\{Spike^{Inv}\}$	7.141***	7.728***	9.369***	10.902***
	(0.181)	(0.188)	(0.449)	(0.802)
$1\{Spike^{Inv}\} \times$ *Distraction*		-4.701***		-13.353***
		(0.586)		(4.927)
Distraction		-0.121		1.090
		(0.154)		(1.499)
Quarter + Firm + Investor + Topic FE	Yes	Yes	Yes	Yes
Observations	39,588,838	39,588,838	44,703,693	44,703,693
Adjusted R^2	0.040	0.040	0.120	0.120

Measuring each investor's ESG influence

$$I\{Spike_{jqs}\} = \alpha_j + \alpha_q + \alpha_s + \beta * 1\{\{Spike_{qs}^{Inv}\} * 1\{IO_{jq-1}^{Inv} \geq 0.01\}\} + \varepsilon_{jqs},$$

- We interpret β as a measure of "elasticity", which is how sensitive firm's ESG attention is to each investor's attention.

- Then we multiply the elasticity by the average number of stocks that the investor holds at least 1% as the influence measure of each investor, which we call "influence"

- Neither measure is clearly better, so we show results of both influence and elasticity for top investors

Investors ranked by influence	Influence	Investors ranked by elasticity	Elasticity
State Street	336.101	Capital Group	0.178
Blackrock	321.789	J.P. Morgan	0.166
Northern Trust	188.430	State Street	0.158
Dimensional Fund Advisors	165.231	Janus Henderson Investors	0.157
Fidelity Investments	123.338	Invesco	0.156
Invesco	117.936	Voya Financial	0.156
T. Rowe Price	109.236	Two Sigma	0.148
Wellington Management	99.764	T. Rowe Price	0.147
J.P. Morgan	96.262	TIAA-CREF	0.147
Goldman Sachs	81.037	Jennison Associates	0.144
Capital Group	58.060	Goldman Sachs	0.144
Renaissance Institutional	48.747	Blackrock	0.135
Franklin Templeton	44.034	AQR	0.127
Jennison Associates	35.816	Wellington Management	0.126
TIAA-CREF	29.703	American Century Investments	0.126
AQR	28.102	Macquarie Group	0.125
American Century Investments	27.596	Lord Abbett	0.125
AllianceBernstein	27.347	Northern Trust	0.123
Millennium Management	25.353	Century Capital Management	0.118
Two Sigma	25.126	Fiduciary Management Associates	0.118

Conclusion

- Relying on intent data and big data analytics we propose novel measures of ESG attention and obtain the following results

  - Firm's ESG attention is associated with improvements in real ESG outcomes as well as ESG ratings, but different ESG ratings tend to respond in a different way
  - Investor's ESG attention is associated with more ESG friendly ways to trade or vote
  - Investors do value the alignment of ESG attention with holding firms, and there are evidence that investors drive firm's ESG attention

- Contributions

  - To our best knowledge, we are the first to directly measure firm's and investor's attention to ESG, which provides a new angle to measure ESG
  - Evaluate and clarify which existing ESG ratings are good
  - Provide new evidence of interactions between investors and firms on ESG issues

Thanks for listening!