

## OCTOBER 2020—GLOBAL FINANCIAL STABILITY REPORT

**Firms' Environmental Performance and the COVID-19 Crisis —  
Online Annexes 5.1–5.4****CONTENTS**

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## Online Annex 5.1. Data Sources

Online Annex Table 5.1.1. Data Sources		
Variable	Description	Source
<b>Macroeconomic and Financial Variables</b>		
Exchange Rate	The exchange rate used to convert balance sheet items into US dollars	Refinitiv Datastream
Global Economic Activity	Industrial production index for OECD economies and six non-OECD economies (Brazil, China, India, Indonesia, the Russian Federation and South Africa)	Updated series from Baumeister and Hamilton (2019)
Global Oil Inventories	Constructed as in Baumeister and Hamilton (2019)	U.S. Energy Information Administration
Oil Price	Spot oil price: West Texas Intermediate (US dollars per barrel)	Haver Analytics
Output Gap	Output gap, constant prices in national currency, percent	IMF, World Economic Outlook
Real Gross Domestic Product	Gross domestic product, constant prices in national currency	IMF, World Economic Outlook
Short-Term Nominal Interest Rate	Short-term deposit rate	IMF, World Economic Outlook
US Consumer Price Index	US consumer price index for all urban consumers: all items	Federal Reserve Bank of St. Louis
VIX	CBOE Volatility Index	Refinitiv Datastream
World Oil Production	World oil production measured in thousands of barrels of oil per day	US Energy Information Administration
<b>Firm-Level Variable</b>		
Cash and Short-Term Investments	The sum of cash and short-term investments	Refinitiv Datastream
Cash Dividends	The total common and preferred dividends paid to shareholders of the company	Refinitiv Datastream
Date of Incorporation	The date the company was incorporated	Refinitiv Datastream
Debt-to-Asset Ratio	The ratio of total debt relative to total assets, where total debt represents all interest bearing and capitalized lease obligations and is the sum of long- and short-term debt	Refinitiv Datastream
Dividends per Share	Total dividends per share declared during the calendar year for US corporations and fiscal year for non-US corporations; includes extra dividends declared during the year	Refinitiv Datastream
EBIT	The earnings of a company before interest expense and income taxes. It is calculated by taking the pre-tax income and adding back interest expense on debt and subtracting interest capitalized.	Refinitiv Datastream
Interest Coverage Ratio (EBIT relative to interest expense)	Interest expense represents the total amount of interest paid by a bank or other financial company.	Refinitiv Datastream
Market Capitalization	Current total market value of a company based on current price and current shares outstanding.	Refinitiv Datastream
Operating Income Before Depreciation and Amortization	The operating income of a company before depreciation and amortization expenses have been deducted.	Refinitiv Datastream
Ratings	Long-term issuer rating.	Standard & Poor's
Total Assets	The sum of total current assets, long-term receivables, investment in unconsolidated subsidiaries, other investments, net property plant and equipment and other assets.	Refinitiv Datastream

**Online Annex Table 5.1.1. Data Sources (concluded)**

<b>Other Indicators</b>		
Carbon Dioxide (CO <sub>2</sub> ) Emission	Estimated global historical carbon dioxide emission; estimated change in global daily carbon dioxide emission in 2020.	The Global Carbon Project; Le Quére and others (2020)
Carbon Price	Settlement price of futures contracts on CO <sub>2</sub> EU allowances traded at the Intercontinental Exchange.	Refinitiv Datastream
Climate Change Commercial Risk/Opportunities	Measures a company's awareness that climate change can represent commercial risks and/or opportunities.	Refinitiv Datastream
Climatic Disaster Classified by IMF	Six types of natural disasters related to climate change: floods, droughts, landslides, wildfires, storms, and extreme temperature.	The Emergency Events Database, EM-DAT
Coverage of National Carbon Pricing Schemes	Coverage of greenhouse gases by a carbon pricing scheme as share of total emissions within a jurisdiction.	IMF and the World Bank
Emissions Category Score	This score measures a company's commitment and effectiveness towards reducing environmental emission in the production and operational processes.	Refinitiv Datastream
Enforcement of Environmental Regulations	Executive Opinion Survey: "How would you assess the enforcement of environmental regulations in your country? (1 = very lax; 7 = among the world's most rigorous)".	World Economic Forum
Environmental Investments Initiatives	Binary variable providing the answer to the question: "Does the company report on making proactive environmental investments or expenditures to reduce future risks or increase future opportunities?".	Refinitiv Datastream
Environmental Score	The Refinitiv Asset4 Environmental Pillar Scores are based on 68 metrics covering three environmental categories: resource use, emissions, and innovation. Category scores are calculated using a rank scoring methodology. The environmental scores are calculated from a weighted average of the category scores, where the category weights vary by industry.	Refinitiv Datastream
Environmental Policy Stringency Index	A country-specific and internationally comparable measure of the stringency of environmental policy; it covers 33 countries.	Organization for Economic Co-operation and Development
ESG Score	Overall company score based on the self-reported information in the environmental, social, and corporate governance pillars.	Refinitiv Datastream
Management Score	Measures a company's commitment and effectiveness towards following best practice corporate governance principles.	Refinitiv Datastream
Resource Use Category Score	Reflects a company's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management.	Refinitiv Datastream
Sautner Climate Change Physical Exposure	The variable is equal to 1, if the transcript contains a climate change physical-related bigram (of a set developed by the authors), and to 0, otherwise.	Sautner and others (2020)
Sautner Climate Change Regulation Exposure	The variable is equal to 1, if the transcript contains a climate change regulation-related bigram (of a set developed by the authors), and to 0, otherwise.	Sautner and others (2020)
Stringency of Environmental Regulations	Executive Opinion Survey: "How would you assess the stringency of your country's environmental regulations? (1 = very lax; 7 = among the world's most stringent)".	World Economic Forum
Total CO <sub>2</sub> Equivalent Emissions to Revenues	Total CO <sub>2</sub> and CO <sub>2</sub> equivalents emission in tones divided by net sales or revenue in US dollars.	Refinitiv Datastream

## Online Annex 5.2. Financial Constraints and Firms' Environmental Performance

### *Explaining Environmental Scores with Financial Constraints*

#### **Empirical Approach:**

The following model is estimated to evaluate the linkages between financial constraints and environmental performance (environmental score):

$$E_{i,s,c,t} = \alpha_s + \gamma_c + \lambda_t + \beta_1 \text{Constraints}_{i,t-1} + \mu' X_{i,t-1} + \varepsilon_{i,s,c,t} \quad (1)$$

Where  $i$  is a firm,  $s$  is a sector,  $c$  is the economy and  $t$  is time (year).  $E_{i,s,c,t}$  is the environmental score from Refinitiv and in the range of 0 (low performance)-100 (high performance).  $\alpha_s$ ,  $\gamma_c$ , and  $\lambda_t$  are sector, country, and time fixed effects, respectively. The choice of the fixed effects specification follows Dyck and others (2019), who use this dataset for cross-country analysis of firms' environmental and social responsibility. Sectors correspond to the 69 industries from the Global Industry Classification Standard.  $X_{i,t-1}$  are firm-level controls: the logarithm of total assets and earnings before interest and taxes. The variable  $\text{Constraints}_{i,t-1}$  is one of the following five firm-level financial constraints, commonly used in the literature, and defined as a dummy variable (equal to one if the firm is financially constrained and zero otherwise) except for size which is defined as a continuous variable:<sup>1</sup>

- Size is the logarithm of total assets. The sign of this variable is reversed such that higher values indicate smaller firms;<sup>2</sup>
- Dividends: a firm is constrained if it does not pay dividends;
- ICR: a firm is constrained if its interest coverage ratio is below one;
- Ratings: a firm is constrained if it is not rated according to Standard and Poor's and has a positive debt-to-asset ratio;<sup>3</sup>
- KZ score: a firm is constrained if its Kaplan-Zingales score is above the median of the Kaplan-Zingales score distribution.

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<sup>1</sup> There is an extensive literature evaluating how financial constraints affect firm behavior, using firm size, firm payout, ratings, or indices based on linear combinations of observable firm characteristics as measures of financial constraints (Almeida, Campello, and Weinback 2004; Duchin, Ozbas, and Sensoy 2010). However, Farre-Mensa and Ljungqvist (2016) argue that listed firms classified as constrained by standard financial constraint proxies have no difficulties in raising debt, suggesting that results based on such measures might have to be interpreted cautiously.

<sup>2</sup> The rationale for using size as a measure of financial constraints is that small firms are typically young and less well known, hence more vulnerable to capital market imperfections (Almeida and others (2004)).

<sup>3</sup> This approach is akin to Duchin and others (2010), who consider firms as unconstrained if they have zero debt and no rating.

The dataset comprises about 7,000 listed firms from 62 economies for which environmental scores are available.<sup>4</sup> The estimation frequency is annual, and the sample extends from 2002 to 2019. Standard errors are clustered at the firm-level.

### Robustness Analysis:

To control for additional factors that could influence the links between financial constraints and environmental performance, a range of robustness checks have been performed:

- Alternative definitions of the financial constraint variables: defining that a firm is constrained if its total assets are below the median of the firm size distribution by total assets, the KZ score as a continuous variable, whether a firm's long-term issuer rating is below investment grade according to Standard and Poor's, and the long-term issuer rating;
- Alternative definitions of the dependent variable: the two sub-categories of the environmental score directly related to climate change, the emissions and resource use subcategories, as well as firms' carbon intensity;
- Using firm age as an additional firm-level control variable;
- Alternative specification of fixed effects: firm-level, country-year, or industry-year fixed effects;
- Country fixed effects are replaced by climate policies: country-specific environmental policies obtained from the OECD's environmental policy stringency index or information from the World Economic Forum survey regarding the strictness and enforcement of environmental laws;
- The use of a balanced panel of firms, starting from 2005 or 2010.

The original conclusions are robust to these changes.

### *Explaining Firms' Environmental Investment Decisions with Financial Constraints*

#### Empirical Approach:

The specification of the probit model is the following:

$$P(I_{i,s,c,t} = 1) = \Phi(\alpha_s + \gamma_c + \lambda_t + \beta_1 \text{Constraints}_{i,t-1} + \mu' X_{i,t-1}) \quad (2)$$

Where  $\Phi$  is the cumulative distribution of the normal function and  $I_{i,s,c,t}$  is a binary variable that indicates whether firm  $i$ , in sector  $s$ , economy  $c$  undertakes environmental investments in year  $t$ .<sup>5</sup>  $\alpha_s$ ,  $\gamma_c$ , and  $\lambda_t$  are

<sup>4</sup> Refinitiv's firm-level environmental scores are obtained using 68 metrics covering three environmental categories: resource use, emissions, and innovation. Category scores are calculated using a rank scoring methodology to evaluate firms' environmental performance relative to all other firms each year. Firms' overall environmental scores are then calculated from a weighted average of the category scores, where the category weights vary by industry.

<sup>5</sup> Specifically, it is the answer to the following question that is one of the metrics of the Emissions category of the Refinitiv's environmental score: "Does the company report on making proactive environmental investments or expenditures to reduce future risks or increase future opportunities? (i) investment made in the current fiscal year to reduce future risks and increase future opportunities related to the environment; (ii) investments made in new technologies to increase future opportunities; (iii) treatment of emissions (e.g., expenditures for filters, agents); (iv) installation of cleaner technologies.

sector, country, and time fixed effects, respectively.  $Constraints_{i,t-1}$  is one of the five firm-level financial constraints defined above, and  $X_{i,t-1}$  are the same firm-level controls as in the previous analysis (the logarithm of total assets and earnings before interest and taxes).

The dataset comprises about 7,000 listed firms from 48 economies.<sup>6</sup> The estimation frequency is annual, and the sample extends from 2002 to 2019. Standard errors are clustered at the firm-level.

### Robustness Analysis:

Several checks have been performed to assess the robustness of this analysis:

- Alternative definitions of the financial constraint variables: defining a firm as constrained if its total assets are below the median of the firm size distribution by total assets, the KZ score as a continuous variable, whether a firm's long-term issuer rating is rated below investment grade according to Standard and Poor's, and the long-term issuer rating;
- Country fixed effects are replaced by climate policies: country-specific environmental policies obtained from the OECD's environmental policy stringency index or information from the World Economic Forum survey regarding the strictness and enforcement of environmental laws;
- To circumvent the incidental parameters problem that may arise in non-linear panel data models, replacing fixed effects by macroeconomic and financial control variables: the lagged country-specific output gaps, the lagged price of oil (the logarithm of the WTI) and the lagged VIX;
- The use of a balanced panel of firms, starting from 2005 or 2010.

The original conclusions are robust to these changes.

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<sup>6</sup> The number of economies drops in this analysis, since firm coverage is very low for several emerging market and developing economies.

## Online Annex 5.3. Firms' Environmental Performance, Financial, Economic, and Oil Market Shocks

### Empirical Approach

The following model is estimated to evaluate the dynamic responses of environmental performance (environmental score) to financial, economic, and oil market shocks:

$$E_{i,s,c,t+h} = \alpha_s + \gamma_c + \beta^h shock_t + \delta^h Firm\ controls_{i,t-1} + \gamma^h Macro\ controls_{t-1} + \epsilon_{i,s,c,t+h} \quad (1)$$

Where  $i$  is a firm,  $s$  is a sector,  $c$  is the economy and  $t$  is time (year).  $h$  denotes the horizon of the projection.  $E_{i,s,c,t}$  is the environmental score from Refinitiv.  $\alpha_s$  and  $\gamma_c$  are sector and country fixed effects, respectively. Sectors correspond to the 69 industries from the Global Industry Classification Standard. Firm-level controls are the logarithm of total assets and earnings before interest and taxes. The macroeconomic controls include the price of oil (logarithm of the WTI), country-specific output gaps and the VIX.<sup>7</sup> The shocks are obtained as follows:

- Financial shock: The annual average of the VIX is used directly in the regression;
- Economic shock: The domestic economic shock is the change in the annual output gap obtained from the World Economic Outlook database;
- Oil market shocks: The oil supply and oil consumption demand shocks are obtained from the structural VAR model of Baumeister and Hamilton (2019). The shocks are derived from the median of the posterior distribution of the relevant parameters.<sup>8</sup> The shocks are aggregated at an annual frequency by taking an average of the monthly values over the calendar year.<sup>9</sup> Historical decompositions of the price of oil indicate that oil price fluctuations in early 2020 were predominantly driven by demand factors: the world economic activity shock and the oil consumption demand shock explained 75 percent of the drop in the price of oil on average from February to April 2020 (Figure 5.3.1).

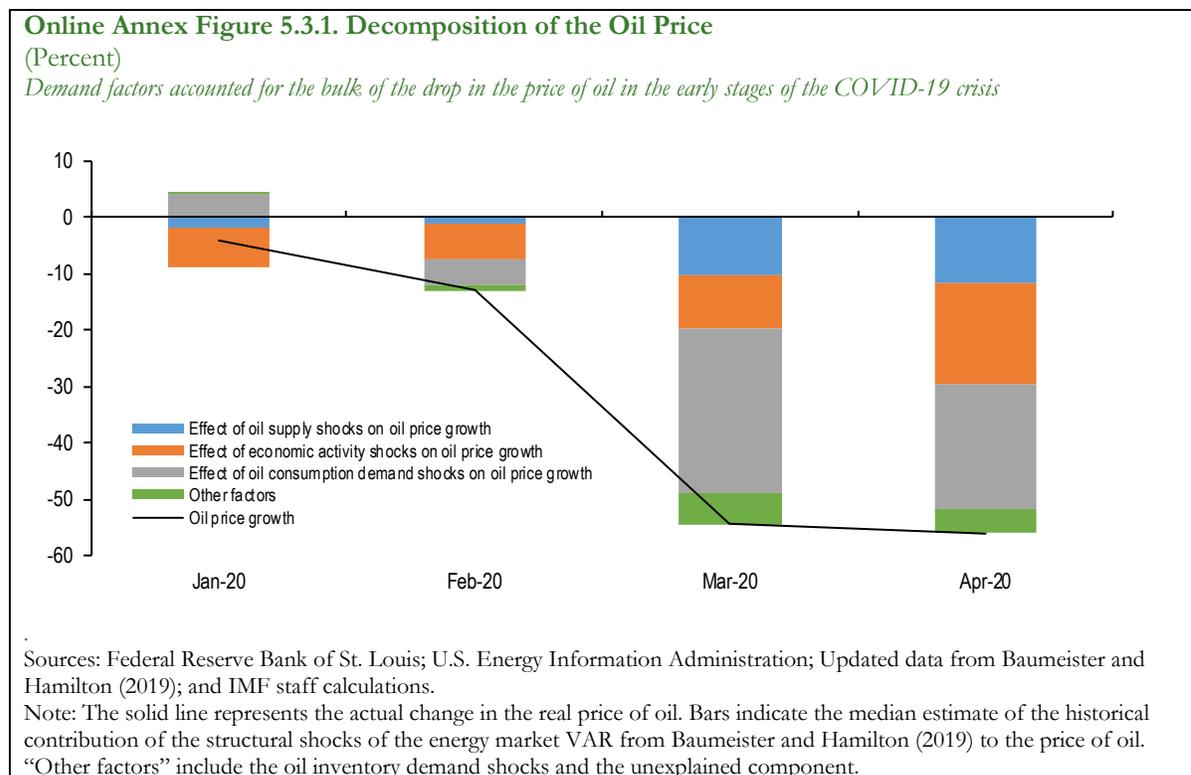
The dataset comprises about 6,900 listed firms from 53 economies. The estimation frequency is annual, and the sample extends from 2002 to 2019. Standard errors are clustered at the firm-level.

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<sup>7</sup> When the shock is defined in terms of the output gap, it is not included as a control variable.

<sup>8</sup> We are grateful to Christiane Baumeister for making available the structural shocks from the energy market VAR of Baumeister and Hamilton (2019).

<sup>9</sup> We exclude from this analysis the oil inventory demand shock (also referred as a "speculative demand shock" in the oil market literature), since this shock plays a limited role in explaining oil price fluctuations and it leads to a fall in world economic activity in the VAR model of Baumeister and Hamilton (2019). Contractionary world economic activity shocks, which lead to a fall in environmental scores, are also excluded from this analysis for brevity.



## Robustness Analysis

To control for additional factors that could influence the links between financial, economic activity, oil market shocks and environmental performance, a range of robustness checks have been performed:

- Alternative definitions of the dependent variable: the two sub-categories of the environmental score directly related to climate change, the emissions and resource use subcategories;
- Alternative specification of fixed effects: firm-level fixed effects;
- Alternative definition of financial stress shocks: An autoregressive model of order one for the monthly VIX is estimated over the period extending from January 1990 to December 2019 instead of using directly the VIX. The monthly residuals of that regression are aggregated at an annual frequency by taking an average of the monthly values over the calendar year;
- Alternative definitions of the economic shocks: global economic shocks defined from the forecast error for current year global GDP growth from the IMF’s April World Economic Outlook, and the global economic activity shock from Baumeister and Hamilton (2019);
- A dummy variable for the years 2008 and 2009 to control for the severe impact of the global financial crisis for firms’ environmental performance.

The original conclusions are robust to these changes.

## Online Annex 5.4. Climate Change and Disaster Indices

### Index Construction

Firm-level exposure to climate change may materialize as physical risk, such as climatic disasters, or transition risk, e.g. through the impact of regulation aimed at reducing climate change. Both may have positive or negative effects on firms, depending among other things on the products or services that firms produce. For example, a renewable energy firm may benefit from a higher carbon tax whereas fossil fuel energy producers may be harmed.

By using textual analysis on Earnings Call Transcripts of 4,109 firms from 46 economies over the period 2004–2020, two firm-level indices are constructed to measure the exposure to these risks and opportunities.

First, the *climate change discussion index* is constructed based on a dictionary of climate change-related terms composed of phrases included in four climate change glossaries (Intergovernmental Panel on Climate Change, IPCC; the United States Environmental Protection Agency; the United Nations; and the British Broadcasting Corporation, BBC). Each earnings call transcript is assigned a value of one if it contains any phrase included in the dictionary, and zero otherwise.<sup>10</sup> Second, the *climate disaster discussion index* is constructed in a similar way but using climatic disaster terms obtained from various sources.

Online Annex Tables 5.4.2 and 5.4.3 show all the climate change and climate disaster phrases included in the two dictionaries, together with the percentage of transcripts in which each phrase appears, respectively.

#### Online Annex Table 5.4.1. Economies and Number of Firms

United States (2246), United Kingdom (304), Canada (260), Australia (203), Germany (129), France (112), Switzerland (77), Japan (74), Italy (69), Brazil (47), Spain (45), Sweden (45), Taiwan Province of China (41), Russia (38), Finland (34), Korea (34), Norway (33), New Zealand (31), Netherlands (30), Turkey (28), Denmark (26), Mexico (22), Belgium (21), Poland (18), Hong Kong SAR (16), Israel (14), Philippines (14), Indonesia (9), Ireland (9), Thailand (9), Austria (7), Portugal (7), United Arab Emirates (6), Argentina (5), Qatar (5), Chile (3), Colombia (2), Egypt (2), Kuwait (2), Saudi Arabia (2), Czech Republic (1), Hungary (1), Morocco (1), Oman (1), Pakistan (1), Peru (1).

Sources: FactSet; and IMF staff calculations.

<sup>10</sup> Only the Management Discussion Section of the transcripts is analyzed but results are robust to including the Q&A section as well. All results are robust to assigning to each transcript a value equal to the share of its sentences containing climate change-related terms.

**Online Annex Table 5.4.2. Climate Change Related Terms and Percentage of Transcripts Including Them**

Emissions (3.272%), renewable energy (1.964%), energy efficiency (1.864%), co2 (1.517%), electric vehicle (0.8426%), environmental impact (0.7252%), climate change (0.5626%), wastewater (0.5255%), greenhouse gas (0.4803%), sustainable development (0.4128%), biofuel (0.4081%), carbon footprint (0.373%), alternative energy (0.3407%), opec (0.3353%), fossil fuels (0.2921%), carbon dioxide (0.2003%), renewable resources (0.1794%), energy star (0.1484%), glacier (0.145%), clean technology (0.1342%), carbon capture (0.1194%), iceberg (0.1119%), global warming (0.1072%), bunker fuels (0.0978%), air pollution (0.0964%), carbon price (0.0924%), carbon neutrality (0.0883%), energy security (0.0863%), carbon intensity (0.0829%), ozone (0.0809%), greenhouse gases (0.0789%), bioenergy (0.0748%), zero carbon (0.0708%), biodiversity (0.0519%), food security (0.0452%), municipal solid waste (0.0391%), international energy agency (0.0384%), tundra (0.031%), Paris agreement (0.0303%), reforestation (0.0283%), carbon market (0.0276%), clean coal technology (0.0269%), climate risk (0.0249%), biomass fuels (0.0249%), fuel switching (0.0249%), cap and trade (0.0236%), carbon offsetting (0.0236%), nitrous oxide (0.0202%), weather risk (0.0195%), Kyoto protocol (0.0188%), deforestation (0.0188%), environmental plan (0.0188%), O<sub>3</sub> (0.0155%), anthropogenic (0.0148%), climate target (0.0134%), carbon sequestration (0.0128%), climate system (0.0114%), clean development (0.0114%), biosphere (0.0107%), climate neutrality (0.0087%), blue carbon (0.008%), weather-resistant (0.008%), ipcc (0.008%), soil moisture (0.0074%), troposphere (0.0074%), climate model (0.006%), greenhouse effect (0.004%), green infrastructure (0.004%), carbon sink (0.004%), umbrella group (0.0033%), n<sub>2</sub>o (0.0033%), Montreal protocol (0.0033%), removal unit (0.0026%), climate variability (0.0026%), sea ice (0.0026%), geosphere (0.002%), climate projection (0.002%), decarbonisation (0.002%), thermal expansion (0.002%), geoeengineering (0.002%), unfccc (0.0013%), fluorinated gases (0.0013%), albedo (0.0013%), enhanced weathering (0.0013%), stern review (0.0013%), carbon budget (0.0013%), black carbon (0.0013%), southern oscillation (0.0013%), geological sequestration (0.0013%), integrated water resources management (0.0006%), sulfate aerosols (0.0006%), ice core (0.0006%), fluorocarbons (0.0006%), earth system model (0.0006%), world climate conference (0.0006%), carbon cycle (0.0006%), carbon leakage (0.0006%), climate services (0.0006%), enteric fermentation (0.0006%), ultraviolet radiation (0.0006%), conference of the parties (0.0006%), united nations environment programme (0.0006%), global average temperature (0.0006%), soil carbon (0.0006%), risk weather (0.0006%).

Sources: FactSet; Intergovernmental Panel on Climate Change, IPCC; the United States Environmental Protection Agency; the United Nations; the British Broadcasting Corporation, BBC; and IMF staff calculations.

**Online Annex Table 5.4.3. Climate Disaster Related Terms and Percentage of Transcripts Including Them**

Hurricane (4.746%), flood (2.362%), drought (0.8642%), severe weather (0.8224%), adverse weather (0.6409%), tsunami (0.4209%), wildfire (0.4176%), extreme weather (0.3717%), severe winter weather (0.3177%), tornado (0.2833%), cyclone (0.2064%), typhoon (0.2044%), lightning (0.1936%), blizzard (0.1646%), snowstorm (0.1544%), windstorm (0.1079%), heat wave (0.0971%), monsoon (0.0924%), thunderstorm (0.0539%), inundation (0.0505%), snowpack (0.0472%), whirlwind (0.0296%), adverse winter weather (0.0222%), severe rain (0.0182%), storm surge (0.0148%), weather extreme (0.0121%), firestorm (0.0101%), extreme climate (0.0074%), tropical cyclone (0.0074%), severe snow (0.0053%), sea level rise (0.0033%), extreme rain (0.0033%), extreme precipitation (0.0026%), severe summer weather (0.0013%), extreme snow (0.0006%), sea level change (0.0006%).

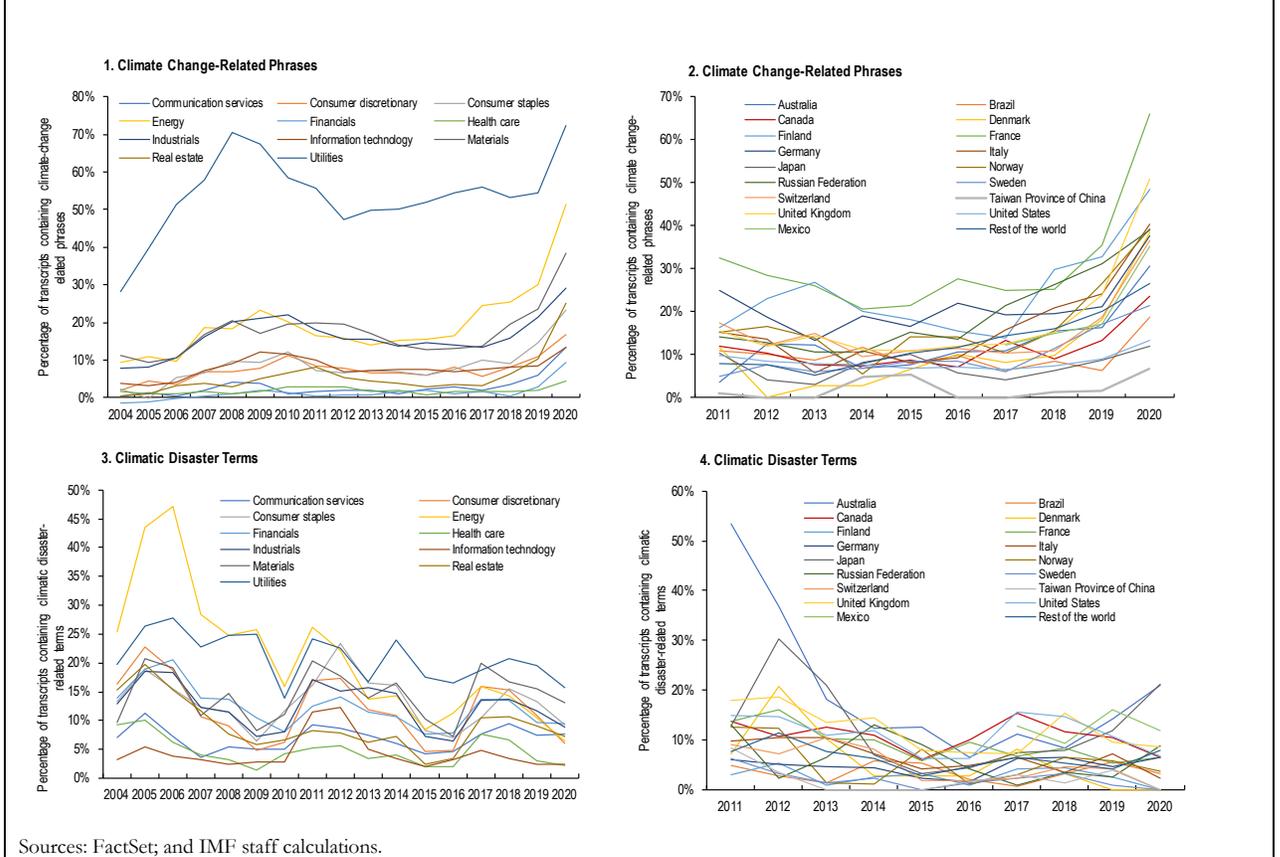
Sources: FactSet; and IMF staff calculations.

**Recent Trends**

Looking at the constructed indices, there seems to be a sharp increase in corporate discussions involving climate change-related topics in the last few years, and especially during the COVID-19 pandemic, across sectors and countries. No such increase is observed in climatic disasters-related discussions, suggesting that firms’ awareness of physical risks has generally remained stable over the last decade. The steady uptick in climate change-related discussions since 2016 suggests that the Paris Agreement has affected awareness about regulatory risk and opportunities related to climate change.<sup>11</sup>

<sup>11</sup> These trends are robust to using a constant set of firms across time.

Online Annex Figure 5.4.1. Evolution of Country and Sector-Level Climate Change and Disaster Indices



### Index Validation

To better understand the dimensions of climate change captured by the indices, they are regressed against proxies for climate change opportunities (firms’ self-disclosed climate change commercial opportunities, firms’ environmental score), climate change transition risk (firms’ carbon intensity, firms’ self-disclosed climate change commercial risks)<sup>12</sup>, and climate change physical risk (a dummy equal to 1 if there was a climatic disaster in the country of the firm’s headquarter in the quarter prior to the conference call). Results are shown in Online Annex Table 5.4.4.<sup>13</sup>

Firms that discuss climate change-related topics are more likely to have climate change commercial risks/opportunities and higher environmental scores as well as higher emissions intensity, suggesting that the *climate change discussion index* captures both firms’ awareness of climate change risks and opportunities. The index is not correlated with climatic disaster events, which suggests it does not capture short-term physical risk.

In contrast, the *climate disaster discussion index* does capture short-run physical risk as measured by the occurrence of climatic disaster events in the previous quarter. The *climate disaster discussion index* is also

<sup>12</sup> The variables used as proxies for climate change risk and opportunities are obtained from Refinitiv DataStream. Online Annex 5.1 contains their descriptions.

<sup>13</sup> Results are generated using linear regressions and are robust to using the probit model.

positively correlated with climate-change related opportunities, though to a lower extent than the *climate change discussion index* when considering the environmental score.<sup>14</sup>

**Online Annex Table 5.4.4. Correlations with Measures of Climate Change Opportunities and Risk**

Dependent variable: <i>Climate change discussion index</i>									
Climate Change Commercial Risks/Opportunities	0.046***	0.021***							
	-0.004	-0.003							
Environmental Score			0.056***	0.038***					
			-0.004	-0.003					
Direct Emissions / Assets					0.082***	0.015**			
					-0.011	-0.006			
Disaster Classified by IMF (t-1)							0.005	-0.004	
							-0.008	-0.008	
Constant	0.1	-0.087**	0.092	-0.077*	0.025	-0.117*	-0.008	-0.075***	
	-0.069	-0.04	-0.063	-0.046	-0.072	-0.067	-0.021	-0.018	
Observations	88,025	87,839	87,242	87,057	33,224	33,203	117,165	113,984	
R-squared	0.041	0.149	0.045	0.155	0.075	0.184	0.018	0.126	
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Sector FE	No	Yes	No	Yes	No	Yes	No	Yes	
Size Control	No	Yes	No	Yes	No	Yes	No	Yes	
Firm Cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Dependent variable: <i>Climate disaster discussion index</i>									
Climate Change Commercial Risks/Opportunities	0.027***	0.017***							
	-0.003	-0.003							
Environmental Score			0.015***	0.010***					
			-0.003	-0.003					

<sup>14</sup> Results from Online Annex Table 5.4.4 are robust to controlling for management scores.

**Online Annex Table 5.4.4. Correlations with Measures of Climate Change Opportunities and Risk (concluded)**

Direct Emissions / Assets					0.022***	0.003			
					-0.005	-0.005			
Disaster Classified by IMF (t-1)							0.023***	0.020***	
							-0.007	-0.007	
Constant	0.032	-0.022	0.014	-0.037	-0.035	-0.063	-0.032	-0.061*	
	-0.04	-0.026	-0.038	-0.024	-0.07	-0.066	-0.023	-0.034	
Observations	88,025	87,839	87,242	87,057	33,224	33,203	117,165	113,984	
R-squared	0.059	0.078	0.055	0.077	0.058	0.08	0.05	0.074	
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Sector FE	No	Yes	No	Yes	No	Yes	No	Yes	
Size Control	No	Yes	No	Yes	No	Yes	No	Yes	
Firm Cluster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	

Sources: Emergency Events Database (EM-DAT); FactSet; Refinitiv DataStream; and IMF staff calculations.

Note: Disaster Classified by IMF is a dummy variable equal to one if a large climatic disaster event took place on the country where the firm's headquarter is located. Large climatic disasters are classified according to April 2020 GFSR Chapter 5. Size is measured as firms' total assets. Firm Cluster means that standard errors are clustered at the firm-level.

The constructed indices also compare well with similar indices developed in the literature. For example, Sautner and others (2020) also construct indices based on earnings call transcripts.<sup>15</sup> The *climate change discussion index* tracks closely their regulatory and opportunities climate change exposure measures whereas the *climate disaster discussion index* tracks their physical exposure measure (Online Annex Figure 5.4.2).

### Additional Results and Robustness Tests

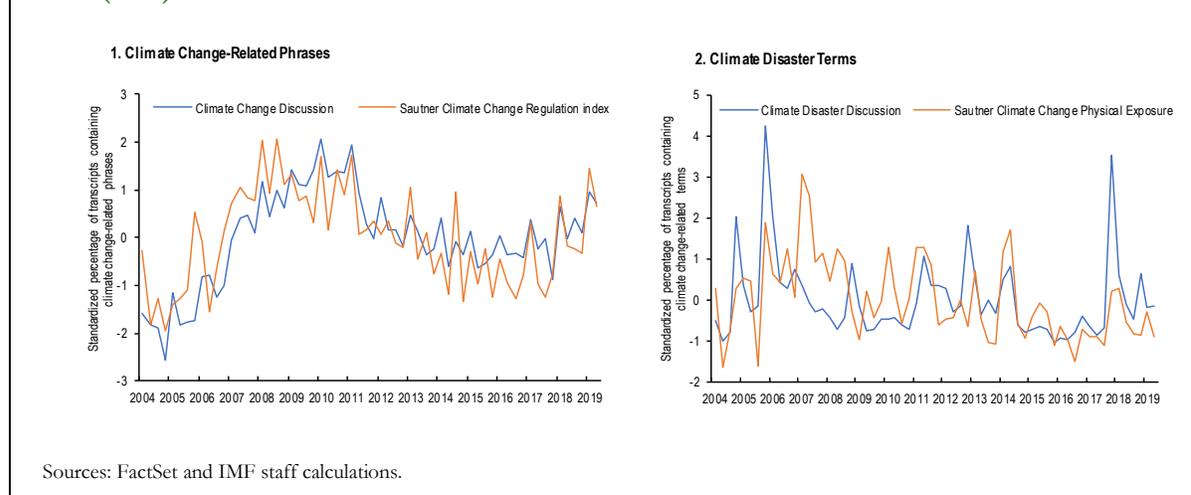
To assess other firm characteristics that tend to be associated with climate change-related discussions, the impact of firms' management quality is analyzed. Both the *climate change discussion index* and the *climate disaster discussion index* are positively correlated with firms' management quality, suggesting that better managed firms are more likely to be aware of both possible climate change risks and opportunities. This result holds when controlling for transcript length.

In addition, as a robustness check, for each of the previously analyzed dictionaries, a version of the indices is created in which the transcripts receive a value of one if they contain a phrase from the dictionary appearing together in the same sentences with the word "risk", the word "uncertainty", or any of their synonyms. Results

<sup>15</sup> The difference lies in the construction of the dictionaries: Sautner and others (2020) start from a small set of bigrams that are related to climate change and its sub-categories, and use an adaptation of a machine learning algorithm developed by King and others (2017) to produce a larger set of bigrams related to each sub-topic.

are very similar to the ones presented in the box and this annex. Similarly, results are robust to assigning each transcript a value equal to the share of sentences that contain both a phrase from the dictionary and a risk or uncertainty synonym.

**Online Annex Figure 5.4.2. Climate Change and Disaster Indices Compared with Sautner and others (2020)’s Measures**



**Online Annex Table 5.4.5. Are Better Managed Companies More Aware of Climate Change and Disaster Risks and Opportunities?**

	Dependent variable: <i>Climate change discussion index</i>				Dependent variable: <i>Climate disaster discussion index</i>				
ESG Score	0.036***	0.029***			ESG Score	0.015***	0.013***		
	-0.004	-0.003				-0.003	-0.003		
Management Score			0.020***	0.007***	Management Score			0.017***	0.012***
			-0.003	-0.003				-0.003	-0.002
Constant	0.078	-0.087*	0.051	-0.116**	Constant	0.014	-0.034	0.004	-0.045**
	-0.064	-0.047	-0.062	-0.045		-0.038	-0.024	-0.034	-0.02
Observations	87,273	87,087	87,273	87,087	Observations	87,273	87,087	87,273	87,087
R-squared	0.033	0.152	0.026	0.147	R-squared	0.055	0.077	0.056	0.077
Year-Quarter FE	Yes	Yes	Yes	Yes	Year-Quarter FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Country FE	Yes	Yes	Yes	Yes
Sector FE	No	Yes	No	Yes	Sector FE	No	Yes	No	Yes
Size Control	No	Yes	No	Yes	Size Control	No	Yes	No	Yes
Firm Cluster	Yes	Yes	Yes	Yes	Firm Cluster	Yes	Yes	Yes	Yes

Sources: FactSet; Refinitiv DataStream; and IMF staff calculations.

Note: Size is measured as firms’ total assets. Firm Cluster means that standard errors are clustered at the firm-level.

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