

Climate Change, Analyst Forecasts, and Market Behavior

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Motivation

- An emerging literature in whether climate change affects firm performance.
- Sell-side equity analysts play a crucial role in financial markets.
- Analysts should provide earnings forecasts that reflect the potential impact of climate change. **But do they?**
 - Not all analysts can see the link between climate change and firm performance.
 - **guess: analysts located in areas where firms are more affected by climate change are more likely to understand how climate change affects firm performance.**

Question

- Face large temp increase, how analyst forecast firm performance?
 - High sensitive firm area analysts issue **lower** forecasts relative to the consensus.
 - High sensitive firm area analysts are more **accurate**.
- Why high-TS area analysts' less optimistic forecasts is accurate?
 - **High-TS firms** contribute above result.
 - High-TS firms' earnings are negatively affected by large temp increases.
- How market react to **forecast revisions**?
 - No stronger reaction: investors do not anticipate high-TS area analyst's accuracy.
 - High-TS firms with more High-TS analysts: higher earnings surprises, higher CAR and weak PEAD for earnings announcements.

Contribution

- contributes to literature that how climate change affects financial outcomes.
 - Hugon & Law(2019): unusually warm climate negatively affect firm earnings.
 - extend using **temp sensitivities**.
- contribute to the literature that factors that affect analyst forecast.
 - limited attention (Dong & Heo,2016),extreme negative events (Cuculiza, 2020) ...
 - analysts anticipate temp extremes affect part of earnings shocks.(Bobeia, 2019)
 - extend: **how to understand the affect and adjust forecasts**
- contribute to the literature that how political beliefs affect financial decisions.
 - affect mutual fund managers, retail investors' portfolio, firms' CSR policies (Hong& Kostovetsky, 2012; Ke, 2020; Giuli & Kostovetsky, 2014).
 - find:local political beliefs affect analysts' view of climate change & earnings.

Design: Q1

Estimate Firm_level Temp Sensitivity

$$r_{j,t} - r_{f,t} = \alpha_j + \beta_j(r_{mkt,t} - r_{f,t}) + \theta_j Temp\ Anomaly_t + \epsilon_{j,t}$$

rolling window

15Y(180M), $\geq 10Y$

avg temp in t -

avg temp in past 30 years

top quintile of θ_j (q5) as **high temp-sensitivity firms** in t.

top quintile of $\hat{\theta}$ (VW- θ_j of U.S. states) **high TS states.**

Exogenous: Facing Large Temp Extreme:

$$Temp\ Anomaly_t > avg(Temp\ Anomaly_t), 1.96$$

treated month t

t-3	t-2	t-1	t	t+1	t+2	t+3
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treated group: High TS state analysts;
control: others

DID : affect analyst forecast

DID : affect analyst forecast analyst i at t is in H-TS state & issue forecast in $t=[0,3] \rightarrow 1$

$$Relative\ Optimism_{i,j,t} = \alpha + \beta HTSA_{i,t} + \gamma X_{i,j,t} + \delta_{analyst} + \iota_{firm} + \zeta_{time} + \epsilon_{i,j,t}$$

analyst i in t forecast for firm j > control group consensus forecast $\rightarrow 1$

$$PMAEF_{i,j,t} = \alpha + \beta HTSA_{i,t} + \dots PMAEF_{i,j,t} = \frac{AFE_{i,j,t} - \overline{AFE}_{j,t}}{\overline{AFE}_{j,t}}$$

$\overline{AFE}_{j,t}$ is the median absolute error for firm j at t .

$X_{i,j,t}$: Forecast Horizon,
No.Companies, Firm Experi
ence, General Experience,
Broker Size, All Star,
No. Industries. Lagged AFE

Design: Q2

- less optimistic, accurate——High TS state analyst understand climate risk well
- To further pin down: High ST firm v.s. other firm
- Risk? large increases in temperature affect firm performance.

$$Earning_{j,t+1} = \alpha + \beta \text{Temp.Lnc.}_{1 \text{ year } j,t} + \gamma X_{j,t} + \iota_{firm} + \zeta_{time} + \epsilon_{i,j,t}$$

- $\text{Temp.Lnc.}_{1 \text{ year } j,t} = 1$ if the fiscal-year-end-date for a firm is within 1 year (12 months) after a large temp increase
- $X_{j,t}$ includes firm characteristics and local economic measures.

Design: Alternative Explanations

- Large Temperature Increases and State-Level **Political Affiliations**.
 - McCright & Dunlap(2011): liberals and Democrats are more likely to express concern about climate change than conservatives and Republicans.
 - X : (dummy:liberal, $H-ST=1$; conservatives, $H-ST=0$) \times TF(issue in $t=[0,3]$).
 - Y : Relative optimism; PMAEF.
- Large Changes in Temperature and **Bold Forecasts**.
 - Clement and Tse(2005): analysts systematically issue bold forecasts, regardless of the direction, with private information.
 - Y : Bold Revision =1 when $forecast_t > or < (con_forecast \& own_forecast)_{t-1}$.

Design: Q3 Market Reaction

- If **investors** anticipate for these analysts to be more accurate?
 - X : Forecast Revision($forecast_{i,j} - pre_forecast_{i,j}$) $\times HTSA$,
 - Y : three-day market-adjusted excess return centered on the revision date.
- After earnings announcement reaction?
 - Unexpected Earning
 - X : $HTSA(F) \times High\ TS$, $HTSA(F) = 1$ if the firm belongs to the highest H-ST analysts following and the earnings announcement occurs in $t=[0,3]$
 - Y : Unexpected Earning (UE), $Earning_t - E(Earning_t)$
 - Stock market reaction
 - X : $HTSA(F) \times High\ TS \times UE$
 - Y : CAR[-1.1], PEAD[2,60]

Data

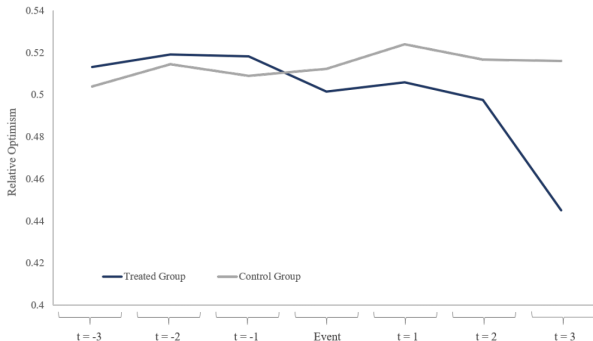
- Temperature Data.National Centers for Environment Information (NCEI)
- Analyst Forecasts:Thomson Reuters' Institutional Brokers Estimate System (I/B/E/S)
- Equity Data: CRSP and COMPUSTAT.
- Sample period is from 1996 to 2017.

Results: relative optimistic

	Large Temperature Increase			Large Temperature Decrease		
	(1)	(2)	(3)	(4)	(5)	(6)
HTSA	-0.026*** (-3.28)	-0.046*** (-2.90)	-0.041** (-2.82)	-0.014 (-1.50)	-0.004 (-0.44)	-0.009 (-0.83)
Forecast Horizon	-0.001 (-0.76)	-0.001 (-0.63)	-0.002 (-1.02)	0.000 (0.20)	0.001 (0.32)	0.001 (0.39)
No. Companies	-0.010 (-0.32)	0.038 (0.67)	0.037 (0.57)	-0.000 (-1.40)	-0.002*** (-3.22)	-0.003*** (-3.40)
Firm Experience	0.004 (1.71)	0.005 (1.66)	0.003 (0.90)	0.002 (0.38)	0.003 (0.37)	0.006 (0.73)
General Experience	-0.007* (-1.99)	-0.017 (-1.53)	-0.009 (-0.72)	-0.000 (-0.02)	0.017 (0.93)	0.020 (1.00)
Broker Size	-0.030***	-0.031*	-0.034*	-0.000	-0.000*	-0.001**

- treated analysts are 4.1% more likely to issue a less optimistic forecast face a large temp increase than untreated.

Results: relative optimistic



- diff becomes significant in the third month (t-statistic = 3.59), it takes a couple of months for the effect to be fully reflected in analysts' forecasts.

Results: forecast accuracy

	(1)	(2)	(3)
HTSA	0.077** (2.70)	0.079** (2.69)	0.068** (2.26)
Forecast Horizon	0.037*** (3.74)	0.034*** (3.78)	0.036*** (3.71)
No. Companies	-0.046 (-0.37)	-0.045 (-0.31)	0.310 (0.98)
Firm Experience	0.021 (1.47)	0.021 (1.45)	0.024 (1.66)
General Experience	0.009 (0.58)	0.030 (1.59)	0.005 (0.11)
Broker Size	0.001 (0.03)	-0.002 (-0.06)	-0.023 (-0.53)
No. Industries	-0.015 (-1.14)	-0.021 (-1.26)	-0.018 (-1.01)
All Star	-0.037	-0.041	-0.042

- after large temp increases, analysts in H-ST area forecast more accurate

Results: High-TS Firms

<i>Panel A: Relative Optimism</i>				
	High-TS Firms		Other Firms	
	(1)	(2)	(3)	(4)
HTSA	-0.071** (-2.66)	-0.080*** (-3.47)	-0.032* (-1.85)	-0.026* (-1.73)
Forecast Horizon	0.001 (0.25)	0.004 (0.81)	-0.002 (-1.63)	-0.004* (-1.78)
No. Companies	0.333* (1.78)	0.470* (1.78)	0.094 (1.28)	-0.023 (-0.26)
<i>Panel B: Analyst Forecast Accuracy</i>				
	High-TS Firms		Other Firms	
	(1)	(2)	(3)	(4)
HTSA	0.142*** (3.87)	0.126** (2.63)	0.060 (1.70)	0.056 (1.43)
Forecast Horizon	0.019 (1.61)	0.021 (1.72)	0.041*** (3.55)	0.041*** (4.18)
No. Companies	-0.327	0.852	0.046	0.467

- the results are mostly driven by high-TS firms

Results: Firm Performance

<i>Panel A: Annual Firm Earnings Within A 1-Year Window</i>						
	High-TS Firms		Other Firms		All Firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Temp. Inc. _{.1 year}	-0.015*** (-3.25)	-0.011** (-2.01)	-0.004 (-0.87)	-0.006 (-1.20)	-0.005 (-1.37)	-0.005 (-1.36)
Size		0.020** (2.23)		0.005 (0.58)		0.009 (1.18)
Log(BM)		-0.037*** (-3.14)		-0.051*** (-2.84)		-0.049*** (-3.15)

- lower forecasts that are more accurate for high-TS firms, as these have lower earnings following unusually hot climates.

Alternative Explanations: State-Level Political Affiliations

<i>Panel A: Relative Optimism</i>			
	(1)	(2)	(3)
TF* Democrat	-0.043** (-2.33)	-0.089*** (-4.09)	-0.124*** (-3.51)
Controls	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes
Analyst Fixed	Yes	Yes	Yes
Firm Fixed Effect	No	No	Yes
N	6,451	6,960	6,466
Adj. Rsq.	0.005	0.049	0.119

<i>Panel B: Analyst Forecast Accuracy</i>			
	(1)	(2)	(3)
TF*Democrat	0.100*** (3.30)	0.137*** (3.38)	0.132*** (3.84)
Controls	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes
Analyst Fixed	No	No	Yes
N	7,603	6,241	7,541
Adj. Rsq.	0.004	0.005	0.023

- forecasts made by analysts located in high-TS + Democratic are more accurate

Alternative Explanations: bold forecasts

	Bold Revision		Downward Bold Revision		Upward Bold Revision	
	High-TS Firms	Other Firms	High-TS Firms	Other Firms	High-TS Firms	Other Firms
	(1)	(2)	(3)	(4)	(5)	(6)
HTSA	-0.051 (-1.65)	-0.002 (-0.14)	0.059** (2.27)	-0.018 (-1.30)	-0.053* (-1.79)	0.016 (0.99)
Forecast Horizon	0.030*** (4.07)	0.027*** (7.55)	-0.016 (-1.54)	-0.016** (-2.29)	0.038*** (3.89)	0.043*** (7.07)

- rules-out the potential alternative explanation for our findings that analysts are more accurate because they systematically issue bold forecasts.

Results: Market Reaction——investor

	Dependent Variable: 3-day Market Adjusted Return					
	(1)	(2)	(3)	(4)	(5)	(6)
HTSA	-0.135 (-0.77)	0.028 (0.13)	-0.085 (-0.51)	-0.022 (-0.10)	-0.279 (-0.78)	-0.262 (-0.74)
Forecast Revision	0.735*** (41.10)	0.739*** (38.57)	0.641*** (33.51)	0.648*** (31.70)	0.700*** (25.72)	0.157 (1.17)
HTSA* Forecast Revision	0.016 (0.22)	0.002 (0.02)	-0.001 (-0.02)	-0.012 (-0.15)	-0.156 (-1.47)	-0.146 (-1.39)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	No	No	Yes	Yes	No	No
Analyst Fixed Effect	No	Yes	No	Yes	No	No
Firm*Analyst Fixed Effect	No	No	No	No	Yes	Yes
Controls* Forecast Revision	No	No	No	No	No	Yes
N	47,560	47,079	47,206	46,703	36,561	36,561
Adj. Rsq.	0.069	0.087	0.226	0.225	0.091	0.094

- investors do not consider analysts in high-TS states as more accurate when they issue forecasts following a large increase in temperature

Results: Market Reaction——Unexpected Earnings

	(1)	(2)
HTSA(F)*High TS	0.170*** (4.73)	0.165*** (4.33)
HTSA(F)	0.019 (1.14)	0.019 (1.11)
High TS	0.035* (1.91)	0.034* (1.79)
Log(ME)		0.029** (2.10)
Log(BM)		0.063*** (5.69)
Beta		0.012 (0.77)

- when more treated analysts follow a high-TS firm, their less optimistic forecasts generate a lower consensus forecast-higher unexpected earnings.

Results: Market Reaction——Earnings Announcements

	Dependent Variable: CAR		Dependent Variable: PEAD	
	(1)	(2)	(3)	(4)
HTSA(F)*High TS* UE	1.926*** (4.42)	1.550*** (3.01)	0.045 (0.03)	0.573 (0.38)
HTSA(F)*High TS	0.656* (1.70)	0.687 (1.62)	-0.317 (-0.31)	-0.076 (-0.07)
HTSA(F)* UE	0.296 (1.41)	0.262 (1.12)	0.250 (0.42)	1.282* (1.89)
High TS* UE	0.759*** (5.88)	0.726*** (5.38)	0.002 (0.01)	0.012 (0.03)
HTSA(F)	-0.149 (-1.04)	-0.107 (-0.64)	-0.937** (-2.31)	-0.974** (-2.14)

- stronger CAR, weaker PEAD——market incorporates the information contained in the earnings announcement faster

New ideas

- 是否可以迁移到中国；是否可以使用温度波动（二阶）作为 X ；或者替换温度为新闻气候指标；
- 中介变量分析师预测可以换为投资者感知、投资者情绪……

Thanks!