Price of clean air: Evidence from Chinese ESG mutual funds

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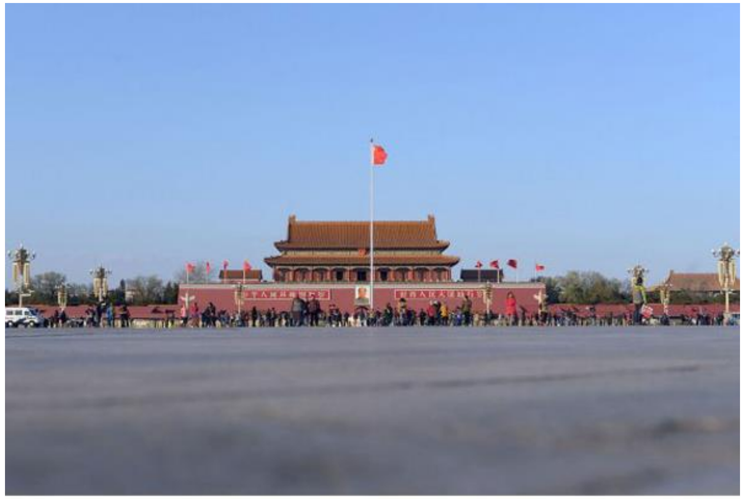
Motivation

- Air pollution can be an important non-financial consideration in investment decisions.
    - China is one of the most polluted countries.
    - As the Chinese government's efforts to improve air quality, investors are increasingly aware of the importance of sustainability.

- Previous studies link China's air pollution to investor behaviors.
    - Li et al. (2019 JFE), Huang et al. (2020 MS): air pollution affects investors' mood and significantly increases the disposition effect.

- We argue that air pollution affects investor preference and investment choice to create environmental change.
    - Combating air pollution has become a critical social norm (Becker, 1957; Arrow, 1972; Hong and Kacperczyk, 2009) in China.



Source: China Daily Asia, "*Beijing sees first red alert over smog*" By Zheng Jinran (December 7, 2015)

Research Questions

- Our research question:
  - *Do Chinese ESG funds underperform conventional funds?*
  - *Do investors are willing to pay for environmental impact? How much?*

- Unlike ESG or SRI investing, impact investors are willing to forgo financial returns for non-pecuniary benefits.
  - Barber et al. (2021, JFE) study impact funds and show that investors accept 2.5–3.7 ppts lower IRRs.

- Our paper is different from previous study in that we
  (1) suggest that ESG funds act as impact investments in a specific circumstance (high air pollution period), and,
  (2) thus, sacrifice financial returns in exchange for clean air.

Hypotheses development

- There are competing hypotheses regarding ESG funds' future performance.
  - Underperform conventional funds because their screening process constrains the investment universe (Renneboog et al., 2008, 2011).
  - Outperform conventional funds because ESG screens may eliminate poorly managed firms with underperforming stocks (Edmans, 2011; In et al., 2019).
  - Nevertheless, most literature shows that SRI funds perform similarly to conventional funds (Renneboog et al., 2008, 2011) or significantly underperform (El Ghoul and Karoui, 2017).
- Barber et al. (2021) investors are willing to accept lower financial returns for impact investing.
  - Willingness-to-pay (WTP) models investors accept 2.5–3.7 ppts lower IRRs ex ante for impact funds.

H1: *ESG funds* ***underperform*** *conventional funds following the* ***high air pollution period****.*

Data: ESG and non-ESG sample

- Base fund sample: China’s open-end equity and equity-oriented hybrid funds (2014-2020).
  - Obtain from CSMAR: fund TNA, age, turnover, expense, fund return on a quarterly basis

- ESG funds
  - Identified 127 pan-ESG mutual funds by the Syntao Green Finance and China SIF (as of October 2020).
  - The number (% TNA) of ESG funds was 11 (1.4%) in 2014 and has increased to 42 (6.6%) in 2020.
  - Environmental fund accounts for the highest majority of ESG funds to pursue environmental sustainability.

Table 1. ESG and Non-ESG sample construction

Panel A. Summary of Pan-ESG equity mutual funds

Year	Number of funds					TNA (in billion RMB)					ESG funds (%) of all equity funds	
	ESG	E	S	G	Other	ESG	E	S	G	Other	By number of funds	By TNA
2014	11	6	2	1	2	9.51	1.50	0.77	0.12	7.13	2.24	1.37
2015	16	11	2	1	2	25.75	17.13	4.87	0.05	3.69	2.58	3.17
2016	26	21	2	1	2	29.13	25.85	3.01	0.16	0.11	2.67	2.76
2017	32	27	2	1	2	32.94	26.64	3.84	0.20	2.26	2.60	2.90
2018	38	33	2	1	2	24.29	20.06	2.51	0.05	1.67	2.70	3.06
2019	42	37	2	1	2	34.14	29.43	2.73	0.11	1.87	2.62	3.08
2020	42	37	2	1	2	107.71	102.30	1.96	0.26	3.19	2.59	6.55

Data: ESG and non-ESG sample

- Matching Non-ESG funds
  - Propensity score matching methodology (fund TNA, fund family TNA, fund return, fund family return, alpha, and expense ratio)
  - Conduct a 3:1 nearest neighbor matching, results in **38 ESG funds** and **109 non-ESG funds**.
  - After matching, the average fund size, age, flows, and performance of the ESG funds are similar to those of the non-ESG funds.

Table 1. ESG and Non-ESG sample construction

Panel B. Fund sample before matching							
	Mean	Std.Dev	Median	Mean	Std.Dev	Median	t-statistic
	ESG funds (n=786)			Conventional funds (n=29,439)			Difference
LnTNA	5.844	1.680	5.794	5.654	1.771	5.763	2.95***
lnAge	3.837	0.639	3.861	3.921	0.685	3.932	-3.39***
Expense	0.019	0.045	0.015	0.032	0.105	0.015	-3.42***
Volatility	0.014	0.007	0.013	0.013	0.007	0.012	7.30***
Flow	0.795	7.694	-0.041	1.634	11.115	-0.046	-2.05***
Return	0.056	0.144	0.035	0.048	0.124	0.030	1.78*
Perf	0.519	0.307	0.520	0.499	0.287	0.499	1.87*
CAPM Alpha	0.025	0.075	0.020	0.021	0.065	0.015	1.65*
3-factor Alpha	0.011	0.070	0.011	0.006	0.055	0.007	2.45**
4-factor Alpha	0.018	0.070	0.013	0.011	0.055	0.009	3.55***
Pane C. Fund sample after matching							
	ESG funds (n=667)			Non-ESG funds (n=1,669)			Difference
LnTNA	5.762	1.689	5.550	5.766	1.735	5.854	-0.05
lnAge	3.893	0.598	3.892	3.911	0.629	3.892	-0.65
Expense	0.020	0.048	0.015	0.019	0.046	0.014	0.25
Volatility	0.014	0.007	0.013	0.013	0.006	0.012	4.40***
Flow	0.861	8.159	-0.042	1.025	9.032	-0.044	-0.40
Return	0.058	0.142	0.038	0.056	0.127	0.038	0.29
Perf	0.521	0.302	0.522	0.520	0.289	0.540	-0.06
CAPM Alpha	0.025	0.074	0.020	0.026	0.067	0.021	-0.35
3-factor Alpha	0.010	0.069	0.011	0.011	0.055	0.009	-0.09
4-factor Alpha	0.017	0.069	0.012	0.016	0.055	0.011	0.55

Data: Air Quality Index

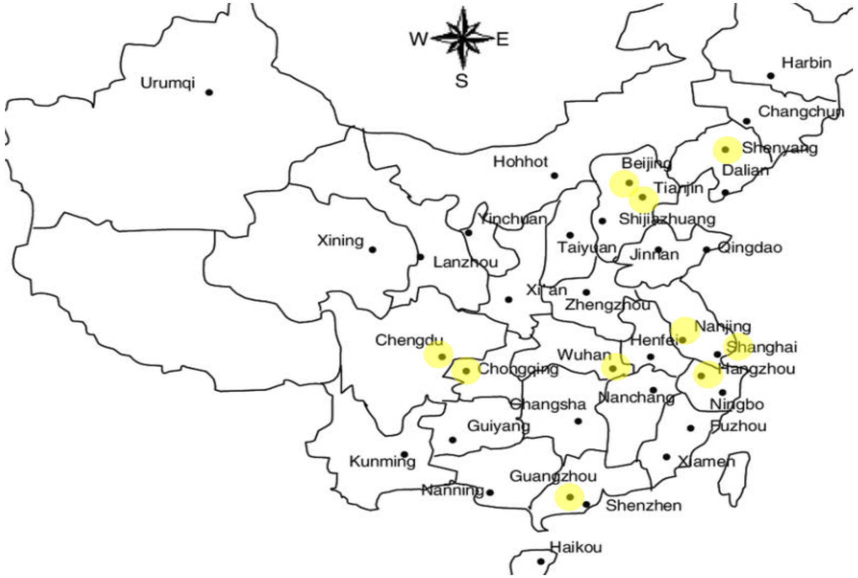
- World Air Quality Index (www.aqicn.org) with an open data framework.
  - Since 2014, has provided city-based daily concentrations of air pollutants such as PM2.5, PM10, nitrogen dioxide, etc.
  - PM2.5: can enter the bloodstream, directly affect human health

- Construct AQI_PM at a quarterly frequency:

$$AQI_t = \sum_{i=1}^{10} AQI_{i,t}$$

  - 10 largest cities: **Beijing, Chengdu, Chongqing, Guangzhou, Hangzhou, Nanjing, Shanghai, Shenyang, Tianjin, and Wuhan.**
    1. by population
    2. tier 1 and tier2 cities to consider the extent of economic and financial development
    3. exclude adjacent cities within one province to consider geographical distribution.

Source: www.aqicn.org



Data: Air Quality Index

Air Quality Index - Particulate Matter	
301 – 500	Hazardous
201 – 300	Very Unhealthy
151 – 200	Unhealthy
101 – 150	Unhealthy for Sensitive Groups
51 – 100	Moderate
0 – 50	Good

- Identify high (low) air pollution periods based on the median value of the sample period.
  - Assuming that AQI affects aggregate investor preference, use the nationwide time-series variation in AQI.
- China was exposed to unhealthy air quality.
  - The average AQI was 123 μg/m3.
  - high AQI periods: average 141.7 μg/m3, max. value of 173.4 μg/m3 , mostly issuing “red alert.”
  - low AQI periods: average 105.5 μg/m3

Table 2. Summary statistics of AQI

Panel A. PM2.5 level (μg/m3) by cities					
City	Mean	Std.Dev	Median	Min	Max
Beijing	123.599	26.291	116.237	87.098	187.289
Chengdu	132.028	25.878	129.967	76.835	182.100
Chongqing	125.409	26.786	128.383	71.989	177.767
Guangzhou	95.887	20.835	92.600	58.576	137.411
Hangzhou	127.963	23.912	127.811	87.120	169.644
Nanjing	123.573	25.766	121.315	76.511	176.811
Shanghai	107.000	17.552	105.319	79.580	135.167
Shenyang	127.166	29.665	119.102	82.380	188.101
Tianjin	130.758	25.144	127.200	93.696	189.011
Wuhan	142.430	30.373	136.209	90.275	209.900
Panel B. PM2.5 level (μg/m3) of AQI measure					
AQI	123.602	23.327	120.218	81.896	173.437
High *AQI* period	141.687	16.278	141.352	120.634	173.437
Low *AQI* period	105.516	12.675	107.594	81.896	119.803
Difference (t-statistics)	36.171***	(6.560)			

Empirical analysis

(1) Air pollution and Fund future performance → Panel regression

(2) Ex-ante willingness-to-pay estimation → develop a discrete choice model

(3) Ex-post performance estimation → estimate portfolio alpha

(5) Robustness tests

Empirical results (H1)

- To examine the future performance of ESG funds following the high air pollution period, we use the following regression model:

$$\boldsymbol{Alpha_{i,t}} = \alpha + \beta_1 ESG_i + \beta_2 \boldsymbol{ESG_i} * \boldsymbol{AQI_{t-1}^{High}} + \beta_3 AQI_{t-1}^{High} + \gamma Controls_{i,t-1} + \varepsilon_{i,t+1}$$

  - $Alpha_{i,t}$: the future risk-adjusted performance of fund i in quarter t based on the CAPM, Fama and French's (1993) three-factor model, and Carhart's (1997) four-factor model, respectively.
  - ESG_i: a dummy variable equal to one if a fund i is the ESG fund.
  - AQI_{t-1}^{High} : a dummy variable equal to one if the quarter t-1 lies in the high air pollution periods and zero otherwise.
  - The control variables include fund size, age, expenses, fund return volatility, and past fund flows.
  - We adjust standard errors for clustering at the time level.

Empirical results (H1)

Table 4. AQI and future performance of ESG funds

Alpha =	Excess Return		CAPM Alpha		3-factor Alpha		4-factor Alpha	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$AQI^{High}{}_{t-1} * ESG$		-0.023**		-0.019**		-0.018*		-0.012
		(-2.12)		(-2.24)		(-1.98)		(-1.32)
$AQI^{High}{}_{t-1}$		-0.081**		-0.024*		-0.020*		-0.022*
		(-2.15)		(-1.73)		(-1.84)		(-2.05)
ESG	-0.005	0.005	-0.004	0.004	0.001	0.008	0.003	0.008
	(-0.66)	(0.47)	(-0.69)	(0.53)	(0.22)	(1.14)	(0.60)	(1.04)
$LnTNA_{t-1}$	-0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.002*
	(-0.59)	(0.07)	(0.79)	(1.13)	(1.38)	(1.57)	(1.65)	(1.77)
$LnAge_{t-1}$	0.002	-0.000	-0.001	-0.002	-0.004**	-0.005**	-0.003	-0.004
	(0.51)	(-0.10)	(-0.55)	(-1.00)	(-2.14)	(-2.58)	(-1.24)	(-1.70)
$Expense_{t-1}$	-0.099*	-0.076	-0.086***	-0.077***	-0.090***	-0.082***	-0.084***	-0.076***
	(-1.91)	(-1.48)	(-3.01)	(-2.80)	(-3.63)	(-3.36)	(-4.02)	(-3.56)
$Volatility_{t-1}$	4.394	4.390	2.042**	2.044***	-0.648	-0.646	-0.674	-0.673
	(1.27)	(1.52)	(2.35)	(2.82)	(-0.60)	(-0.61)	(-0.82)	(-0.79)
$Flow_{t-1}$	0.000	-0.000	0.000***	0.000**	0.000*	0.000	0.000*	0.000
	(0.33)	(-0.49)	(2.94)	(2.26)	(2.02)	(1.38)	(1.72)	(1.10)
$Intercept$	-0.002	0.029	0.003	0.013	0.032**	0.041**	0.030*	0.039**
	(-0.04)	(0.58)	(0.17)	(0.77)	(2.13)	(2.76)	(1.90)	(2.52)
Observations	2175	2175	2175	2175	2175	2175	2175	2175
R-squared	0.049	0.150	0.041	0.086	0.014	0.061	0.014	0.060

→ Support H1: *ESG funds* ***underperform*** *conventional funds following the* ***high air pollution period****.*

Empirical results (ex-ante WTP)

- If ESG investors derive their utility primarily from non-financial considerations and care less about financial performance than conventional investors, we expect that they are willing to sacrifice returns.
- We develop a discrete choice model following Barber et al. (2021). We begin with a random utility model in which investors face a binary choice of whether to invest in fund i:

$$y_i^* = f(\mathbb{E}[r_i], X_i, AQI, e_i)$$

  - $\mathbb{E}[ri]$ represent the expected return
  - Xi is the observable vector of nonprice fund characteristics such as fund size, age, and expense
  - AQI represents the air quality index that enters into the investment decision of the environmentally-conscious investors
  - ei is an error term representing unobserved attributes

Empirical results (ex-ante WTP)

- We use logit estimation with the base sample of equity mutual funds.
- The dependent variable is assigned one of two outcomes: 1 = invest in ESG funds (ESG fund has positive fund inflows) and 0 = not invest in ESG funds. The probability that we observe $y_i = 1$ is given by:

$$\Pr[y_i = 1] = \alpha + \boldsymbol{\beta} * \mathbb{E}[r_i] + \gamma' * X_i + \boldsymbol{\delta} * AQI + \varepsilon_i$$

  - $\mathbb{E}[ri]$ is the quarterly expected returns calculated by the CAPM, Fama and French's (1993) three-factor model, and Carhart's (1997) four-factor model.
  - Xi is a vector of fund attributes, including fund size, age, and expenses at quarter-end immediately preceding the investment.
  - AQI is the standardized value of AQI in the quarter immediately preceding the investment.

- The WTP for ESG funds is derived from the equation as follows:

$$WTP == -\frac{\partial \mathbb{E}[r]}{\partial AQI} = -\frac{\left(\frac{\partial \Pr[y=1]}{\partial AQI}\right)}{\left(\frac{\partial \Pr[y=1]}{\partial \mathbb{E}[r]}\right)} = -\frac{\delta}{\beta}$$

Empirical results (ex-ante WTP)

Table 5. Ex-ante willingness-to-pay estimation

Expected return =	using daily returns in the last three months			using monthly data in the previous 36 months		
	CAPM model	3-factor model	4-factor model	CAPM model	3-factor model	4-factor model
	(1)	(2)	(3)	(4)	(5)	(6)
$Expected\ return_t$	-1.585	-1.295	-1.213	-1.192	-3.076	-1.951
	(-1.63)	(-1.60)	(-1.58)	(-0.42)	(-1.52)	(-1.30)
$LnTNA_{t-1}$	-0.040***	-0.040***	-0.041***	-0.039***	-0.039**	-0.039***
	(-2.66)	(-2.68)	(-2.70)	(-2.59)	(-2.57)	(-2.62)
$LnAge_{t-1}$	0.245***	0.247***	0.246***	0.242***	0.242***	0.244***
	(6.50)	(6.53)	(6.52)	(6.43)	(6.43)	(6.47)
$Expense_{t-1}$	2.331***	2.329***	2.327***	2.342***	2.341***	2.340***
	(4.29)	(4.28)	(4.28)	(4.30)	(4.30)	(4.30)
AQI_{t-1}	0.056**	0.059**	0.060***	0.056**	0.050**	0.053**
	(2.39)	(2.56)	(2.58)	(2.36)	(2.11)	(2.24)
$Intercept$	1.729***	1.726***	1.727***	1.726***	1.727***	1.726***
	(11.32)	(11.30)	(11.31)	(11.30)	(11.31)	(11.31)
WTP estimate (%)	3.533	4.556	4.946	4.698	1.625	2.717
Observations	26476	26476	26476	26476	26476	26476
Pseudo R-squared	0.0064	0.0063	0.0063	0.0064	0.0063	0.0063

- WTP estimate = 3.5% (= 0.056/1.585) in Column (1)
- Overall, investors are willing to give up 1.6%-4.9% of ESG funds for clean air.

Empirical results (ex-post alpha)

- Following the methodology in Nofsinger and Varma (2014), we calculate a separate risk-adjusted abnormal return of the high AQI and low AQI periods.
- The model specification with Carhart's (1997) four-factor model is as follows:

$$r_t - r_{f,\mathrm{t}} = \alpha_{Low}\boldsymbol{LowAQI_t} + \alpha_{High}\boldsymbol{HighAQI_t} + \beta_{MKT}(r_{mkt,\mathrm{t}} - r_{f,\mathrm{t}}) + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{UMD}UMD_t + \varepsilon_t$$

  - r_t : the monthly return on an equally weighted portfolio of funds in month t
  - $r_{f,\mathrm{t}}$: the risk-free rate
  - $r_{mkt,\mathrm{t}}$: the value-weighted market index return
  - $HighAQI_t(LowAQI_t)$: a dummy variable that is equal to one if the previous three-month rolling average of monthly AQI is above (below) the median value and zero otherwise.
  - SMB_t: the difference in returns between a small-cap portfolio and a large-cap portfolio
  - HML_t : the difference in returns between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks
  - UMD_t : the difference in returns between a portfolio of past 12-month winners and a portfolio of past 12-month losers.

Empirical results (ex-post alpha)

Table 6. Ex-post fund performance and factor loadings

Panel A. Alpha during the entire period			
	CAPM Alpha	3-factor Alpha	4-factor Alpha
ESG funds	4.784	4.465	4.261
	(1.04)	(1.42)	(1.41)
Non-ESG funds	5.079	4.813**	4.653**
	(1.43)	(2.49)	(2.62)
Difference	-0.295	-0.347	-0.391
	(-0.15)	(-0.17)	(-0.20)

Panel B. Alpha during the separate high and low AQI period						
	Low AQI			High AQI		
	CAPM	3-factor	4-factor	CAPM	3-factor	4-factor
ESG funds	13.805**	12.158***	11.015***	-4.404	-3.358	-2.580
	(2.21)	(2.93)	(2.69)	(-0.69)	(-0.87)	(-0.71)
Non-ESG funds	9.689**	8.387***	7.461***	0.383	1.178	1.808
	(2.14)	(3.69)	(3.43)	(0.07)	(0.41)	(0.70)
Difference	4.115	3.771	3.554	-4.787**	-4.536*	-4.388*
	(1.32)	(1.27)	(1.18)	(-2.09)	(-1.98)	(-1.92)

- Alphas for the ESG funds are not significantly different from the conventional fund alphas.
- Following the low AQI periods, the ESG fund alpha is not significantly different from the non-ESG fund alpha.
- Following the high AQI periods, the ESG funds significantly underperform 4.4 to 4.8% the non-ESG funds.

Robustness tests

(1) Alternative specification of AQI

- $AQI\_hq_{i,t-1}^{High}$: a dummy variable equal to one if the value of the PM2.5 index of the city where the respective fund i's headquarters is located is above the median cross-sectional value in quarter t-1.
- Results are not changed.

(2) Supply-side fund managers' decisions

- The environmental concerns can affect fund managers' decisions and motivate them to create new ESG funds.
- $ESGInception_{j,t} = \Lambda(LnFamTNA_{j,t}, NumFamInception_{j,t}, NumESGInception_t, ESGReturn_t) + \varepsilon_{j,t}$
- AQI does not affect the fund manager's inception decision (supply-side channel).

(3) Ex-post alpha: inclusion of ESG factor

- To further investigate fund performance and exposure to an ESG factor, we include ESG factor.
- ESG funds have significantly higher exposure to the ESG factor than non-ESG funds.
- ESG funds underperform their conventional matching funds following the high air pollution periods.

(4) DID tests on funds' future performance

- To mitigate a potential endogenous concern, we use the difference-in-difference analysis on funds' future performance.
- On January 1, 2016, the Chinese New Air Prevention and Control Law came into effect to curb greenhouse gas emissions.
- The governmental actions to implement the New Air Law may reduce air pollution and may cause a decrease in the underperformance of ESG funds.

Summary: empirical results

- This study shows that Chinese ESG funds act as impact investments and thus sacrifice financial returns in exchange for clean air.

- During the high air pollution period,
  - the flow-performance relationship of ESG funds becomes weaker
  - investors are likely to invest in ESG funds, ESG funds underperform conventional funds following the high air pollution period.

- ESG investors may sacrifice their return for clean air,
  - willing to pay 1.6%-4.9% on the ex-ante basis
  - yield 4.4%-4.8% lower risk-adjusted abnormal returns than non-ESG based on the ex-post alpha estimation.

Contribution

- To the best of our knowledge, this is one of the pioneering studies that relate air pollution to ESG mutual funds in China.
    - Taking a holistic approach to the overall assessment of **flows** and **performance**.
    - Extends the literature on ESG investor behaviors in **emerging markets**.

- We provide new evidence that investors are **willing to pay** for environmental impact and ESG funds act as impact investment products during high air pollution periods.
    - Provide ex-ante WTP and ex-post fund alpha calculations.

Appendix

Robustness test (1): alternative specification of AQI

- $AQI\_hq_{i,t-1}^{High}$: a dummy variable equal to one if the value of the PM2.5 index of the city where the respective fund i's headquarters is located is above the median cross-sectional value in quarter t-1.
- Consistent with the results in Table 3, further support H1.

Table 7. AQI and Flow-performance relationship: alternative specifications of AQI

	ESG funds	Non-ESG funds	All funds
	(1)	(2)	(3)
$Perf_{i,t-1} * AQI\_hq^{High}{}_{i,t-1} * ESG_i$			-5.509**
			(-2.26)
$Perf_{i,t-1}$	2.164	2.142***	2.108***
	(1.60)	(2.91)	(3.10)
$Perf_{i,t-1} * AQI\_hq^{High}{}_{i,t-1}$	-5.861**	-0.565	-0.544
	(-2.26)	(-0.47)	(-0.45)
$AQI\_hq^{High}{}_{i,t-1}$	3.813**	0.013	-0.018
	(2.10)	(0.02)	(-0.02)
$LnTNA_{i,t-1}$	-1.694***	-2.037***	-1.954***
	(-2.97)	(-3.73)	(-4.54)
$LnAge_{i,t-1}$	2.034***	1.268*	1.419**
	(3.01)	(1.96)	(2.74)

Robustness tests (2): supply-side decisions

- The environmental and sustainability concerns can affect fund managers' supply-side decisions and motivate them to create new ESG funds.

$$ESGInception_{j,t} = \Lambda(LnFamTNA_{j,t}, NumFamInception_{j,t}, NumESGInception_t, ESGReturn_t) + \varepsilon_{j,t}$$

- $ESGInception_{j,t}$: a dummy variable equal to one when a fund family j has inception of an ESG fund in a given quarter t and zero otherwise.
- $LnFamTNA_{j,t}$: the natural logarithm of fund family TNA in quarter t.
- $NumFamInception_{j,t}$: the number of any mutual fund inception by fund family j in quarter t.
- $NumESGInception_t$: the number of ESG fund inception in the whole market in quarter t.
- $ESGReturn_t$: the equal-weighted return of ESG funds in a 12-month period ending at the end of the quarter t.

Robustness tests (2): supply-side decisions

Table 8. Determinants of ESG fund inception

Panel A. Descriptive statistics (n=871)

	Mean	Std.Dev	Median	Min	Max
$ESGInception_{j,t}$	0.031	0.173	0.000	0.000	1.000
$LnFamTNA_{j,t}$	8.645	1.923	9.195	-2.429	11.614
$NumFamInception_{j,t}$	1.447	0.876	1.000	1.000	8.000
$NumESGInception_t$	1.437	1.846	1.000	0.000	6.000
$ESGReturn_t$	0.157	0.305	0.084	-0.240	0.891

Panel B. Logit regression

	Coefficient	Walt test value (z)
AQI_{t-1}	3.566	1.51
$LnFamTNA_{j,t}$	0.546*	1.67
$NumFamInception_{j,t}$	0.112	0.32
$NumESGInception_t$	-0.208	-1.24
$ESGReturn_t$	1.691**	2.53
Intercept	-26.967**	-2.48
Observations	871	
Pseudo R-squared	0.151	

- AQI does not affect the fund manager's inception decision (supply-side channel).
- However, family fund size and the equal-weighted return of ESG funds are positively associated with the new inception of ESG funds.

Robustness tests (3): ex-post alpha- inclusion of ESG factor

- To further investigate fund performance and exposure to an ESG factor, we include $ESGt$ factor.
- $ESGt$: the excess return of the ESG benchmark index.
- We use the value-weighted return of the indices of CNI EP Index (index code: 399358), CNI CSR Index (index code: 399369), and CNI Corporate Governance Index (index code: 399322)

Table 10. Fund performance and factor loadings: including ESG style factor

	Alpha		MKT	SMB	HML	UMD	ESG	R-sq
	Low AQI	High AQI						
ESG funds	8.629***	-3.217	0.314*	0.213***	-0.533***	0.256***	0.647***	0.941
	(2.68)	(-0.97)	(1.84)	(2.70)	(-8.69)	(5.62)	(3.49)	
Non-ESG funds	6.639***	1.588	0.641***	0.115**	-0.492***	0.194***	0.223**	0.967
	(3.09)	(0.65)	(6.77)	(2.23)	(-9.18)	(6.52)	(2.13)	
Difference	1.990	-4.806**	-0.326**	0.098	-0.041	0.062	0.424***	0.346
	(0.85)	(-2.02)	(-2.46)	(1.64)	(-1.09)	(1.54)	(3.07)	

- ESG funds have significantly higher exposure to the ESG factor than non-ESG funds.
- ESG funds underperform their conventional matching funds following the high air pollution periods.

Robustness tests (4): DID tests on funds’ future performance

- To mitigate a potential endogenous concern, we use the difference-in-difference analysis on funds’ future performance.
- On January 1, 2016, the Chinese New Air Prevention and Control Law came into effect to curb greenhouse gas emissions.
- We use the following specification:

$$Alpha_{i,t} = \alpha + \beta_1 ESG_i * Post_{t-1} + \beta_2 ESG_i + \beta_3 Post_{t-1} + \gamma' Contols_{i,t-1} + \varepsilon_{i,t}$$

- $Alpha_{i,t}$: the future risk-adjusted performance fund i in month t based on the Carhart’s (1997) four-factor model
- ESG_i : a dummy variable equal to one if the fund is the ESG fund
- $Post_t$: a dummy variable equal to one if month t is in the period after the law came into effect (2016-2017) and zero if month t is in the period before the law (2014-2015)
- $Controls_{i,t}$ includes fund size, age, expenses, fund return volatility, and past fund flows

Robustness tests (4): DID tests on funds' future performance

Table 9. Diff-in-diff tests on the air pollution law enactment

Panel B. Multivariate specification		
	(1)	(2)
$ESG_i * Post_{i,t-1}$	0.0052**	0.0055**
	(2.06)	(2.07)
ESG_i	-0.0049**	-0.0045**
	(-2.34)	(-2.08)
$Post_{i,t-1}$	0.0118***	0.0111***
	(8.34)	(7.59)
$LnSize_{i,t-1}$		0.0009**
		(2.57)
$LnAge_{i,t-1}$		-0.0025***
		(-2.79)
$Expense_{i,t-1}$		-0.0132
		(-1.40)
$Volatiltiy_{i,t-1}$		-0.0481***
		(-3.10)
$Flow_{i,t-1}$		0.0000
		(0.28)
Intercept	-0.0111***	-0.0035
	(-9.66)	(-0.81)
Observations	2684	2452
R-squared	0.048	0.063

- The governmental actions to implement the New Air Law may reduce air pollution and may cause a decrease in the underperformance of ESG funds.

Robustness tests (4): DID tests on funds’ future performance

- To differentiate the impact investing hypothesis from the regulation hypothesis, we compare the underperformance of ESG vs. non-ESG funds that took place before the regulatory shutdown (the pre-law period) to the underperformance of ESG vs. non-ESG funds that took place after the regul atory shutdown (the post-law period). The DID test results show that first, a larger difference in u nderperformance is found between the two sets of pre-law period (5.851% (t-statistic = 2.35)), an d second, insignificant difference during the post-law period (0.065% (t-statistics = 0.045)). Thus, t he DID results support the impact investing hypothesis more than the regulation hypothesis beca use, during the pre-law period, ESG funds significantly underperform the non-ESG funds.

Robustness tests (4): DID tests on funds' future performance

Panel A. Univariate specification		
	Alpha	(t-statistic)
Pre-law period		
ESG (Treated)	-19.17	-
Non-ESG (Control)	-13.32	-
Diff	-5.851**	(-2.350)
Post-law period		
ESG (Treated)	0.887	-
Non-ESG (Control)	0.822	-
Diff	0.065	(0.045)
Diff-in-diff	5.916**	(1.961)
Observations	2787	
R-squared	0.0469	