Sustainability Uncertainty Risk Exposure and Stock Returns: Evidence from China

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Abstract. This study examines the impact of sustainability uncertainty risk on Chinese stock returns. We find that lower exposure to sustainability uncertainty risk is significantly associated with stock premiums: stocks with lower exposure to sustainability uncertainty risk outperform those with higher exposure in the following months. The results indicate that this premium does not stem from risk adjustment factors or commonly recognized pricing factors. Additionally, the robustness of this premium can be demonstrated through a series of alternative settings. Finally, we offer some potential explanations for the low-risk exposure premium: sustainability uncertainty risk may reduce corporate profitability and increase corporate investment, leading to lower future stock returns; additionally, sustainability uncertainty risk shocks may increase investor attention, causing investors to prefer purchasing stocks with lower risk exposure to hedge against risk.

Keywords: Sustainability uncertainty risk, Stock cross-sectional returns, Chinese stock market, Investor belief, Company profitability.

1. Introduction

In recent years, sustainability and uncertainty have emerged as two core factors significantly impacting financial markets: As the influence of the United Nations Sustainable Development Goals (SDGs) has steadily grown, sustainability has evolved from a peripheral issue into a central driver of the global economy. The introduction of Environmental, Social, and Governance (ESG) indices provides an effective tool for quantifying corporate sustainability performance. Uncertainty can be measured through specific indicators covering key dimensions such as geopolitical conflicts, pandemic aftereffects, trade policy fluctuations, and regulatory adjustments. These metrics not only help investors pinpoint the sources of market volatility, optimize systemic risk measurement methods, and inform portfolio strategy adjustments, but also serve as crucial benchmarks for quantifying fluctuations in the global political-economic environment and assessing systemic risks. Extensive existing research confirms that both sustainability and uncertainty exert significant impacts on equity markets. However, literature exploring their combined effects remains scarce. Furthermore, uncertainty exhibits direct or indirect bidirectional relationships with each dimension of ESG (environmental, social, governance)[1], underscoring the necessity of investigating their joint effects. This study focuses on the Chinese stock market because this issue is particularly prominent in the Chinese context—China's government-proposed dual goals of “carbon peak and carbon neutrality” have further amplified the interaction between sustainability requirements and policy uncertainty. Chinese enterprises not only face external pressure to enhance ESG performance but also endure uncertainty regarding the timing and strictness of related regulatory policy implementation. In other words, Chinese enterprises face heightened sustainability uncertainty risk. Based on this, this study employs the ESGUI[1] to measure sustainability uncertainty risk, thereby examining the role of exposure to sustainability uncertainty risk in the cross-sectional pricing of Chinese stocks.

This study makes use of the data of every single stock listed on China's main board and growing company market from January 2007 to December 2024. To gauge the sensitivity of stock returns to sustainability uncertainty risk, the ESGUI beta is introduced. In the cross-sectional study, it is found that both market-cap-weighted and equal-weighted portfolios show a low ESGUI beta premium,

namely 0.94% and 0.91% respectively. According to a double-sort portfolio analysis, the forecasting ability of ESGUI beta for future stock returns in the cross-section doesn't come from its intersection with corporation size and market beta. It is discovered via Fama-MacBeth regression that the low ESGUI beta premium can not be accounted for by common pricing factors used as control variables. ESGUI beta has an average slope of -0.33 (-0.26) when taking (or not taking) control variables into account, and its t-statistic is -3.61 (-3.18). Moreover, a series of alternative settings is altered to test the stability of the low ESGUI beta premium. The empirical study has shown that exposure to sustainability uncertainty is a market anomaly and may serve for constructing lucrative zero-portfolios. Meanwhile, this study further elucidates the formation mechanism of the low ESGUI beta premium: Empirical research indicates that sustainability uncertainty risk elevates environmental uncertainty, thereby diminishing corporate sustainability levels and ESG performance. This, in turn, leads to reduced corporate profitability and increased investment scale, ultimately depressing future stock returns. Empirical evidence also indicates that heightened sustainability uncertainty risks heighten investor attention and concerns regarding such risks. This leads investors to favor purchasing stocks with lower risk exposure to hedge against escalating sustainability risks, thereby pushing up the cost of equity for low-beta risk stocks. This logic aligns with the empirical findings of this study—when the aggregate impact of Baidu search volume shocks related to the "sustainable development" theme increases, the cumulative returns of the ESGUI beta long-short portfolio significantly rise.

This study fills the existing research gap by verifying that sustainability uncertainty risk exerts a notable impact on the cross-sectional price of stocks in the Chinese stock market. Additionally, it provides investors with a new perspective on asset allocation, helping them optimize their investment strategies. Meanwhile, the study also puts forward recommendations for future research directions, offering clear guidance for subsequent scholars to further explore related fields. All these contributions collectively enhance the understanding of the relationship between sustainability-related risks and stock market performance in China.

The rest o f this paper falls into five sections: Section 2 is the literature review; Section 3 introduces the data and main variables; Section 4 discusses the empirical results; Section 5 gives possible explanations; and Section 6 makes a conclusion.

2. Literature Review

2.1. ESG and the Stock Market

ESG plays a crucial role in the stock market. The concept of ESG was first proposed by the United Nations Global Compact in 2004 and was systematized in the United Nations Principles for Responsible Investment (PRI) in 2006. In recent years, ESG has garnered widespread attention from various sectors, with many scholars conducting research on its impact on the stock market. Xiong[2] found that stocks with lower ESG risk ratings (green stocks) not only achieve higher returns but also provide better risk protection compared to stocks with higher ESG risk ratings (brown stocks). Capelle-Blancard and Petit[3] demonstrated that, on average, companies facing negative ESG events experience a 0.1% decline in market value, while companies do not benefit from positive announcements on average. Feng et al.[4] examined the relationship between ESG ratings and the risk of stock price crashes, finding a significant negative correlation between Chinese companies at both the statistical and economic levels.

2.2. Uncertainty and the Stock Market

Uncertainty also offers new insights into stock pricing and price forecasting. Uncertainty encompasses various aspects, including indices such as the Climate Policy Uncertainty (CPU), Trade Policy Uncertainty (TPU), and Energy Uncertainty Index (EUI), among others. Many scholars have studied the impact of these indicators on the stock market. Baltussen et al.[5] measured risk uncertainty using the volatility of expected volatility (vol-of-vol), showing that stocks with high risk uncertainty consistently underperformed those with low risk uncertainty by 8% annually. Zhang et al.[6]

confirmed that, after risk adjustment, stocks with low climate policy uncertainty risk exposure had monthly excess returns that were significantly higher than those with high climate risk exposure, ranging from 0.83% to 0.90%. Wang et al.[7] found that the Energy Uncertainty Index has good predictive power for Chinese stock returns, with China's EUI effectiveness leading, followed by global and U.S. EUI effectiveness.

2.3. ESG and Uncertainty

There is a significant interaction between ESG and uncertainty. Wang et al.[8] demonstrated that environmental uncertainty reduces ESG performance by validating the existence of a mediating path. Bin-Feng et al.[9] argue that when environmental uncertainty increases, factors such as financial constraints and industry competition lead to a decline in companies' ESG scores and ESG ratings. Cepni et al.[10] found that during periods of high climate uncertainty, the transmission of shocks between traditional assets and ESG assets significantly decreased, suggesting that ESG investments can provide traditional investors with diversification against climate-driven shocks. Zhang et al.[11] revealed a key aspect of ESG performance, namely its moderating role in the relationship between Economic Policy Uncertainty and investment.

Investor uncertainty regarding ESG impacts stock markets. Avramov et al.[12] calculated the average of all pairwise differences in ESG ratings for the same stock across six major rating agencies (Asset4, MSCI, KLD, etc.) as an ESG uncertainty indicator at the firm level, demonstrating that uncertainty in ESG ratings leads to stocks being perceived as higher-risk assets, resulting in reduced investor demand. Tomtum and Dahl[13] found that when ESG uncertainty is low, ESG ratings are negatively correlated with future stock performance, but this finding no longer holds as uncertainty levels increase. In a single-variable portfolio constructed based on ESG uncertainty, stocks with lower ESG uncertainty perform better than those with higher uncertainty on the London Stock Exchange (LSE).

Compared to previous studies on sustainability uncertainty, this paper differs from those studies in at least three key aspects. First, we focus on the Chinese stock market, which has surpassed the Japanese stock market to become the second-largest stock market globally after the United States. Second, we adopt a cross-sectional perspective, treating sustainability uncertainty exposure as a new asset pricing factor for stock returns. Finally, we introduce a novel ESG-based uncertainty measurement metric—Sustainability Uncertainty (ESGUI). Our research will fill an academic gap in the interaction between sustainability and uncertainty in asset pricing studies, enriching related theories while elucidating its role and mechanisms in the Chinese stock market.

3. Data and Key Variables

3.1. ESGUI Beta

Before constructing the ESGUI beta, we need to perform a series of data preprocessing steps on the raw data, including the China ESGUI Index and the China stock sample. Our stock sample includes all individual stocks listed on the China Main Board and Growth Enterprise Market, covering the time period from January 2007 to December 2024. Following the methodology of Zhang et al. (2023), we excluded the following stocks: 1) stocks listed for less than six months; 2) stocks with fewer than 24 months of trading history over the past five years or fewer than 10 trading days in the most recent month; 3) the bottom 30% of stocks by market capitalization; and 4) stocks subject to special treatment (ST) or special transfer (PT). These screenings ensure our research aligns with general economic principles. Stock data is sourced from the CSMAR database.

To measure sustainability uncertainty, Ongan et al.[1] extracted keywords related to environmental (E), social (S), governance (G), and uncertainty from The Economist Intelligence Unit's monthly country reports, calculated their frequency, divided by the total number of words in the report, and finally summed the results after minimum-maximum standardization. It includes two sub-indices (ESG sub-index and uncertainty sub-index) and several regional indices. We use China's ESGUI

index because it better aligns with China's social realities. We use the moving average residuals of the ESGUI over the past 12 months rather than its raw values to eliminate trends during our study period, prevent spurious regression, and better measure unexpected changes in sustainability uncertainty. Formula (1) describes this process:

$$ESGUI_{\mathrm{t}} = \frac{1}{12}\sum_{i=0}^{11} ESGUI_{t-i} + \varepsilon_{ESGUI,t} \tag{1}$$

where $ESGUI_{\mathrm{t}}$ is the Chinese ESGUI index for month t, and $\varepsilon_{ESGUI,t}$ denotes the moving average (MA) residuals.

We use the ESGUI beta to measure the response of company stock returns to changes in the ESGUI and calculate the ESGUI beta by controlling for market excess returns to separate the information in the ESGUI that is related to market returns. For each stock and each month starting from January 2007, we use the following time series regression with a 48-month rolling window, requiring at least 24 observations:

$$r_{\mathrm{i,t}} = \alpha + \beta_{i,0}\varepsilon_{ESGUI,t} + \beta_{i,1}\varepsilon_{ESGUI,t-1} + \beta_{i,MKT}r_{m,t} + \varepsilon_{i,t} \tag{2}$$

where $r_{i,t}$ is the excess return of stock i in month t, $r_{m,t}$ is the excess market return in month t, $\varepsilon_{ESGUI,t}$ is derived from formula (1), $\varepsilon_{i,t}$ is the error term, and $\beta_{i,MKT}$ is the market beta. We obtain market return data from the CSMAR database and risk-free return data from the RESSET database. The time series regression includes the moving average residuals of ESGUI over the past 12 months, which can accommodate the asynchrony between sustainability uncertainty risk and return measurement. Correspondingly, we extract two-period beta data controlled for market factors to construct the ESGUI beta, which measures the sensitivity of stock returns to sustainability uncertainty risk and is defined as:

$$\beta_{i,ESGUI} = \left|\beta_{i,0} + \beta_{i,1}\right| \tag{3}$$

where $\beta_{i,0}$ and $\beta_{i,1}$ from formula (2). We use an absolute value transformation to ensure that stocks with higher returns under unexpected changes in sustainability uncertainty risk (whether above or below expectations) have higher sustainability uncertainty sensitivity, which also helps us capture the magnitude rather than the direction of this effect.

3.2. Other Variables

Several control variables are also taken into account. They are used to make sure that these typical predictive factors have no effect on the ESGUI beta's prediction performance, thus showing that ESGUI beta is an independent predictive factor. The study applies the natural logarithm to the product of the prior month's closing price and the total outstanding shares to yield the variable of company scale (SIZE). We calculate the ratio of book to market (BM) variable through taking the natural logarithm of the book value of equity divided by the market value of outstanding shares. We construct the illiquidity (ILLIQ) variable using the ratio of monthly average daily absolute stock returns to daily trading volume. The return on equity (ROE) variable is constructed by the company when its net income is divided by the book value of equity. The annual asset growth rate of a company can be used to measure its investment (Investment) variable. These variables are chosen as previous research has verified that, within the Chinese stock market, individual stocks having a high book-to-market ratio, illiquidity, ROE, investment level, and small size exhibit a better performance. These variables are sourced from the CSMAR database.

Panel A of Table 1 lists the descriptive statistics. The values of ESGUI beta, which range from 0 to 279.23, show that the influence of ESGUI on stock returns is highly variable. Since the sample size is large and the 99th percentile and the highest reported values of these variables vary significantly, these variables should be winsorized to prevent outliers from affecting the research outcomes.

In Table 1, Panel B presents the relevant correlation coefficients, where the lower and upper triangles demonstrate the Pearson and Spearman correlation coefficients, respectively. The correlations between these variables are not large, and this shows that, in terms of information provision, ESGUI beta is independent and can offer additional information.

Table 1. Summary statistics

	β_{ESGUI}	β_{MKT}	ME	BM	ILLIQ	ROE	Investment
Panel A: Descriptive statistics							
Mean	2.83	1.13	15.64	-1.33	0.23	0.04	0.14
SD	3.82	0.41	1.09	0.66	44.45	1.52	0.72
Min	0.00	-8.48	11.48	-7.94	0.00	-186.56	-0.97
P1	0.03	0.25	13.83	-3.65	0.00	-0.83	-0.32
Median	1.74	1.11	15.45	-1.24	0.02	0.06	0.07
P99	16.55	2.24	19.10	-0.23	0.22	0.34	1.25
Max	279.23	12.24	21.75	0.39	19814.69	204.69	47.93
Panel B: Correlations							
β_{ESGUI}	1	0.080	0.012	-0.085	-0.017	0.004	0.032
β_{MKT}	0.004	1	-0.048	-0.072	0.006	-0.096	0.019
ME	-0.019	-0.068	1	-0.067	-0.773	0.357	0.233
BM	-0.084	-0.051	-0.051	1	0.075	-0.051	-0.085
ILLIQ	0.003	-0.002	-0.008	-0.006	1	-0.240	-0.188
ROE	-0.017	-0.015	0.018	0.044	-0.004	1	0.425
Investment	0.036	0.018	0.051	-0.013	-0.002	0.014	1

Note: This table reports summary statistics for ESGUI beta and other variables. Panel A reports descriptive statistics, including mean, standard deviation, minimum, 1st percentile, median, 99th percentile, and maximum. Panel B reports correlation coefficients, with the lower triangle showing Pearson correlation coefficients and the upper triangle showing Spearman correlation coefficients, and these variables are winsorized at the 1st and 99th percentiles. The sample period is from January 2011 to December 2024.

4. Empirical Results

4.1. Average and Risk-adjusted Returns of ESGUI Beta Decile Portfolios

In the case of ESGUI beta, the original building time is January 2007 to December 2010. Beginning in January 2011, all stocks are sorted by their ESGUI beta values of the prior month and are then split into ten groups. Stocks with the smallest ESGUI beta are in the first decile, and those with the largest ESGUI beta are in the tenth decile. The study focuses on building a long-short investment portfolio using ESGUI beta by going long on stocks in the first decile and short on those in the tenth decile. To eliminate the effects of heteroskedasticity and autocorrelation, we use Newey and West (1986)-adjusted t-statistics to further ensure the robustness of the results.

In Table 2, the outcomes are reported, and in the first row, we can see the ESGUI beta for every decile. It varies from 0.19 in decile 1 to 7.79 in decile 10. The ESGUI beta shows a significant variation among different deciles, which is a phenomenon akin to what we see in descriptive statistics. We may conclude that when the ESGUI beta increases, portfolio returns decrease since the Spearman correlation coefficients for the market-cap-weighted (Panel A) and equal-weighted (Panel B) portfolios are -0.794 (p-value = 0.006) and -0.952 (p-value = 0.000), respectively. Long-short portfolios specifically obtained significant excess returns. Table 2 presents its findings in two panels. The excess returns obtained using Panel A and Panel B are 0.94% (t-statistic = 3.52) and 0.91% (t-statistic = 4.17), respectively. Moreover, the two panels also show rather steady returns throughout the course of the data period, and their Sharpe ratios are 0.94 and 1.11, correspondingly.

The CAPM model, Fama and French's (1993) three-factor model, and Fama and French's (2015) five-factor model are adopted for calculating the risk-adjusted returns of the ESGUI beta decile portfolios. When looking at the returns of long-short portfolios, it is found that significant alpha values are produced when regressing the returns related to ESGUI beta while keeping these factors under control. As a result, these factor models are unable to account for ESGUI beta.

Table 2. Low ESGUI beta premium

	Low	2	3	4	5	6	7	8	9	High	LMH
β_{ESGUI}	0.19	0.57	0.97	1.39	1.84	2.36	2.98	3.76	4.90	7.79	7.60
Panel A: Value-weight portfolios											
Return A	0.60	0.66	0.45	0.78	0.37	0.48	0.47	0.25	0.10	-0.34	0.94
	(1.30)	(1.30)	(1.09)	(1.61)	(0.87)	(0.98)	(0.91)	(0.52)	(0.21)	(-0.66)	(3.52)
α_{CAPM}	0.19	0.24	0.07	0.37	-0.02	0.05	0.03	-0.18	-0.34	-0.81	1.00
	(1.57)	(2.13)	(0.69)	(3.89)	(-0.20)	(0.45)	(0.25)	(-1.30)	(-1.95)	(-3.31)	(3.69)
α_{FF3}	0.15	0.23	0.07	0.38	-0.01	0.07	0.04	-0.13	-0.33	-0.72	0.87
	(1.21)	(1.98)	(0.67)	(4.08)	(-0.13)	(0.64)	(0.41)	(-1.01)	(-2.43)	(-3.48)	(3.70)
α_{FF5}	0.19	0.26	0.07	0.43	0.01	0.05	0.03	-0.12	-0.33	-0.71	0.99
	(1.43)	(2.13)	(0.64)	(4.39)	(0.08)	(0.50)	(0.31)	(-0.94)	(-2.29)	(-3.41)	(3.86)
Panel B: Equal-weight portfolios											
Return B	0.67	0.55	0.60	0.59	0.52	0.45	0.46	0.31	0.28	-0.24	0.91
	(1.31)	(1.06)	(1.23)	(1.15)	(1.04)	(0.87)	(0.89)	(0.59)	(0.53)	(-0.43)	(4.17)
α_{CAPM}	0.23	0.12	0.17	0.15	0.09	0.01	0.01	-0.14	-0.18	-0.72	0.95
	(1.37)	(0.61)	(0.93)	(0.85)	(0.39)	(0.03)	(0.04)	(-0.62)	(-0.69)	(-2.47)	(4.28)
α_{FF3}	0.05	-0.11	-0.04	-0.01	0.13	-0.02	-0.02	-0.33	-0.36	-0.82	0.84
	(0.05)	(-1.14)	(-0.64)	(-0.61)	(-1.40)	(-2.55)	(-2.30)	(-3.00)	(-3.17)	(-4.72)	(4.30)
α_{FF5}	0.02	-0.09	-0.04	-0.02	-0.15	-0.22	-0.23	-0.34	-0.41	-0.84	0.86
	(0.14)	(-0.84)	(-0.41)	(-0.30)	(-1.43)	(-2.54)	(-2.26)	(-2.93)	(-3.29)	(-4.80)	(4.49)

Note: This table presents the monthly average excess returns and alpha values (in %) of Panel A and Panel B ESGUI beta decile portfolios. Here, 'Low (High)' represents the portfolio with the lowest (highest) ESGUI beta. The strategy of LMH consists of purchasing the portfolio with a low beta and selling the one with a high beta. Each month, all portfolios go through a rebalancing process. In each decile, the average ESGUI beta values of individual stocks are listed in the first row. In each panel, the initial two rows show the average returns in excess and t-statistics. The relevant factor alpha values and associated t-statistics are shown in the last six rows of each panel. The last column displays the difference in factor alpha and average return between the low- and high-beta portfolios. Time period: Jan. 2011-Dec. 2024.

Figure 1 presents the logarithmic cumulative returns (LCRs) of ESGUI Beta, aiming to offer a more direct view of the investment returns from it and to figure out the potential profit. Between January 2011 and December 2024 in the sample period, the investment strategy centered around ESGUI Beta has its cumulative value demonstrating a stable growth pattern, whereas the overall value of the market portfolio suffers a number of substantial drops. As can be seen, Figure 1 demonstrates that a $1 zero-cost investment according to ESGUI Beta can produce a return of either $4.24 (exp (1.4443)) or $4.21 (exp (1.4384)), but the market portfolio only has a return of $1.47 (exp (0.3841)). All in all, this evidence indicates that ESGUI beta may be regarded as a new aspect for investors to take into account and is able to bring about substantial and stable returns.

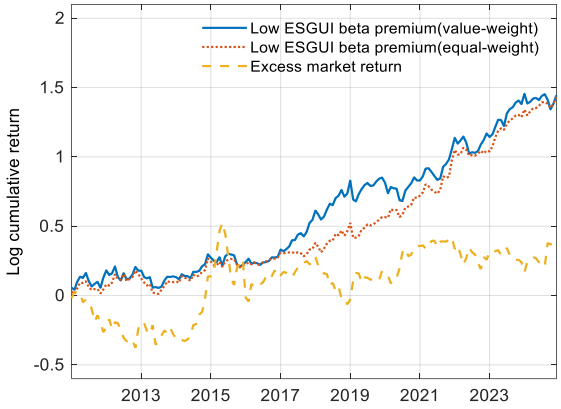

Fig. 1 Low ESGUI beta premium: Cumulative performance

Note: This figure shows the logarithmic cumulative returns of the ESGUI beta long-short portfolio and the market portfolio.

4.2. Double Sorts on ESGUI Beta and Related Variables

We consider that larger companies have greater capacity to expand their global operations through economies of scale and better resources, which may enable them to better diversify risks. To explore whether ESGUI beta provides incremental information regarding market factors and company size, we first rank companies by size or market factors into quintiles, and then within each quintile, rank them by ESGUI beta into quintiles.

In Table 3, Panel A displays the results of the double sorting with respect to ESGUI beta and firm size, whereas Panel B displays the findings with reference to market variables. We find that after the double sorting, excess returns decline significantly as ESGUI beta increases, which is comparable to the outcomes in Section 4.1. Moreover, significant alpha values are obtained when risk-adjusted returns are calculated, which shows that factor models are not sufficient to explain the double-sorted portfolio.

Table 3. Double sorts on ESGUI beta and related variables

	Low	2	3	4	High	Low-High
Panel A: Double sorts on ESGUI beta and size						
Return A	0.62	0.56	0.48	0.46	-0.12	0.74
	(1.32)	(1.28)	(1.06)	(0.92)	(-0.25)	(4.04)
α_{CAPM}	0.20	0.16	0.07	0.03	-0.58	0.78
	(2.38)	(2.37)	(1.20)	(0.26)	(-3.31)	(4.15)
α_{FF3}	0.17	0.16	0.08	0.06	-0.50	0.67
	(1.96)	(2.26)	(1.47)	(0.72)	(-3.40)	(3.87)
α_{FF5}	0.19	0.19	0.09	0.06	-0.51	0.70
	(2.19)	(2.40)	(1.71)	(0.63)	(-3.43)	(3.99)
Panel B: Double sorts on ESGUI beta and market beta						
Return B	0.79	0.81	0.74	0.61	0.30	0.50
	(1.51)	(1.51)	(1.38)	(1.14)	(0.53)	(3.23)
α_{CAPM}	0.35	0.36	0.28	0.15	-0.18	0.53
	(1.35)	(1.41)	(1.04)	(0.54)	(-0.59)	(3.41)
α_{FF3}	0.05	0.07	-0.02	-0.14	-0.42	0.47
	(0.54)	(0.91)	(-0.26)	(-1.50)	(-3.01)	(3.42)
α_{FF5}	0.04	0.08	-0.04	-0.16	-0.44	0.48
	(0.41)	(0.87)	(-0.44)	(-1.73)	(-3.10)	(3.44)

Note: This table presents the monthly average excess returns, alpha values (in %), and t-statistics for dual-sorted investment portfolios sorted by ESGUI beta and firm size (Panel A) and market beta

(Panel B). Stocks are initially grouped into five size quintiles in accordance with their market capitalization and the relevant market beta of the previous month. Then stocks are sorted according to their ESGUI beta to create five quintile portfolios for each size and market beta quintile. Time period: Jan. 2011-Dec. 2024.

4.3. Fama-MacBeth Regressions

To control for multiple factors simultaneously in our analysis, we employ Fama-MacBeth regression to investigate whether the ESGUI beta premium in the Chinese stock market is influenced by other important variables. These variables are the market factors mentioned in Section 3.2, including β_{MKT} ,SIZE, BM, ILLIQ, ROE, and Investment. The monthly cross-sectional regression can be expressed as:

$$r_{i,t+1} = \lambda_t + \lambda_t^{ESGUI}\beta_{i,t,ESGUI} + \lambda_t^{X} X_{i,t} + \varepsilon_{i,t+1} \quad (4)$$

where $r_{i,t+1}$ is the excess return of stock i in month t+1, $\beta_{i,t,ESGUI}$ is the ESGUI beta of stock i in month t, $X_{i,t}$ denotes the empty set or the set of control variables (β_{MKT} , SIZE, BM, ILLIQ, ROE, and Investment), and $\varepsilon_{i,t+1}$ is the error term.

Table 4 presents the time-series average of the slope coefficient along with its t-statistic. The ESGUI beta has an average slope of -0.33 and a t-statistic of -3.38 when no other variables are under control. It shows that during the sample period, if investors carry out investment transactions with a lower ESGUI beta, it will help them reach an annualized Sharpe ratio of 0.96 (3.61/), which is higher than the market-cap-weighted decile long-short portfolio in Section 4.1. Consequently, one can find once more that making investments with a low ESGUI beta premium can lead to considerable and stable returns. As control variables are gradually introduced into the regression equation, the ESGUI beta coefficient drops slightly to -0.30 and -0.26, and at the 1% level, the t-statistic remains significant. This demonstrates that when several control variables are considered simultaneously, the low ESGUI beta premium remains constant, and these ordinary control variables can only account for the low ESGUI beta premium to a small extent. To sum up, it is shown that unexpected alterations in sustainability uncertainty can offer independent incremental data for future cross-sectional returns in the Chinese stock market.

Table 4. Fama-Macbeth regressions

	DepVar.: One-month-ahead excess returns(%)			
	(1)	(2)	(3)	(4)
β_{ESGUI}	-0.33	-0.33	-0.30	-0.26
	(-3.61)	(-3.45)	(-3.47)	(-3.18)
β_{CAPM}		-0.13	-0.12	-0.09
		(-1.30)	(-1.41)	(-1.02)
SIZE			-0.32	-0.11
			(-2.01)	(-0.66)
BM			0.10	0.10
			(1.88)	(1.99)
ILLIQ				0.56
				(5.55)
ROE				0.09
				(1.41)
Investment				0.02
				(0.62)
Adj. R^2	370,399	370,181	370,181	370,181
Number of obs.	0,007	0.021	0.053	0.068

Note: This table reports the results of a Fama-MacBeth regression analyzing the future one-month excess returns of stocks, with ESGUI beta as the explanatory variable and controlling for other

variables [including market beta (β_{MKT}), logarithmic company size (SIZE), log book-to-market ratio (BM), illiquidity index (ILLIQ), return on equity (ROE), and investment growth rate (Investment)]. All independent variables are winsorized at the 1st and 99th percentiles and then standardized to have a mean of zero and a standard deviation of one. The results include the time series average of the slope coefficient and its t-statistic adjusted by Newey and West (in parentheses). The sample period is from January 2011 to December 2024.

4.4. Robustness Checks

variable while other variables are controlled for. The slope coefficient's time-series average and its t-statistic are among the results. Time frame: Jan. 2011-Dec. 2024.

4.4 Robustness checks

Robust test engages in guaranteeing the ESGUI beta premium robustness (Table 5). The operations related to columns one through six are: (1) take the one-year deposit rate from CSMAR as a proxy for the risk-free rate; (2) utilize first-order autoregressive (AR(1)) residuals for the original ESGUI data; (3) deal with the ESGUI raw data by using time trend term residuals; (4) including stocks that are not excluded from ST and PT; (5) retain the bottom 30% of stocks as ranked by market capitalization; (6) employ total market capitalization instead of market capitalization outstanding. Table 5 shows that almost all of the tests yield notably positive returns, which are also similar. So, it can be concluded that the ESGUI beta premium is stable in various situations.

Table 5. Robustness check

	(1)	(2)	(3)	(4)	(5)	(6)
Value-weight Return	0.95	0.76	0.75	0.93	0.88	1.03
	(3.35)	(2.96)	(2.70)	(3.59)	(3.44)	(4.06)
Equal-weight Return	0.69	0.68	0.83	0.90	0.78	0.86
	(2.94)	(3.36)	(4.23)	(4.22)	(3.95)	(3.90)

Note: This table presents the results of the robustness test. The 1st and 3rd lines display the average excess returns, and the 2nd and 4th lines show the t-statistics. Time frame: Jan. 2011-Dec. 2024.

5. Explanations

5.1. Company Profitability

ESGUI beta is related to corporate profitability. First, improvements in sustainability and ESG indicators can enhance corporate profitability. For example, Bodhanwala and Bodhanwala[14] revealed a significant positive correlation between sustainability and corporate performance indicators, and demonstrated that companies implementing sustainable development strategies exhibit stronger profitability and significantly lower debt-to-equity ratios. Kuo et al.[15] studied multinational mining companies and found that higher sustainability leads to higher returns for companies, meaning that multinational mining companies achieve higher profitability efficiency by improving sustainability efficiency. Cesarone et al.[16] found that ESG factors have a positive impact on corporate profitability, and this impact is more pronounced in larger companies. Second, increased uncertainty reduces corporate profitability. For example, Demir[17] found through empirical results based on dynamic panel estimation that increased macroeconomic uncertainty and volatility have a significant negative impact on corporate profitability. Bayar and Ceylan[18] confirmed that macroeconomic uncertainty can influence corporate profitability by affecting corporate decision-making, and that maintaining stable macroeconomic conditions is crucial for corporate profitability, sustainable growth, and reducing unemployment rates. Finally, high-profitability firms generate higher future stock returns than low-profitability firms[19][20].

Combining the above with the literature in Section 2.3, it can be inferred that when ESGUI beta increases, firm uncertainty rises, ESG indicators decline, leading to reduced firm profitability, and

ultimately resulting in lower future stock returns for the company. Additionally, the Pearson correlation coefficient between ESGUI beta and return on equity (ROE) is significantly negative at the 1% level (unreported), further confirming this point.

5.2. Company Investment Situation

ESGUI beta can reflect a company's investment situation. First, the decline in sustainability and ESG indicators not only directly increases a company's sustainable investments but also reduces investment efficiency, thereby indirectly increasing investment volume. For example, Nishihara[21] found that higher ESG risks caused by low ESG indicators primarily increase sustainable investments through their impact on net present value and timing option value. Al-Hiyari et al[22] empirically demonstrated that companies with poorer ESG performance have lower investment efficiency, and for companies in environments with excessive investment tendencies, board cultural diversity negatively moderates the impact of ESG performance on investment efficiency. Second, increased uncertainty leads to higher corporate investment levels. For example, Kong et al.[23] used a mechanism test to show that macroeconomic policy uncertainty promotes corporate R&D investment, while local economic policy uncertainty promotes green investment. Ilyas et al.[24] argue that firms increase corporate social responsibility investment in response to rising economic policy uncertainty, and this effect is more pronounced in larger firms, with consistent results across all three dimensions of ESG. He et al.[25] demonstrate that firms' perceptions of EPU are positively correlated with their overseas investment. When firms perceive an increase in EPU, they are more likely to engage in overseas investment, and their overseas investment becomes more diversified. This positive correlation is stronger in firms operating in highly competitive industries. Finally, there is a significant negative correlation between firm investment and expected stock returns[19][26].

Combining the above with the literature in Section 2.3, it can be inferred that when the ESGUI beta increases, corporate uncertainty rises, ESG indicators decline, leading to increased corporate investment, and ultimately resulting in a decrease in future stock returns. Additionally, the correlation coefficient between the ESGUI beta and the investment factor (Investment) is significantly positive at the 1% level (not reported), further confirming this point.

5.3. Investor Beliefs

We believe that investors' growing concern about sustainability uncertainty risk will lead them to prefer stocks with low sustainability uncertainty exposure. Due to this preference, the prices of stocks with low sustainability uncertainty exposure are pushed up, resulting in significant excess returns.

To test this hypothesis, we use the monthly Baidu Search Volume Index (SVI) for the “Sustainable Development ” theme to measure investor concern over sustainability uncertainty risks. Before our study, numerous studies have used online search volumes to study investor attention. Due to data availability, the sample period for the SVI spans January 2011 to December 2024. To capture changes in investor attention, we calculate the logarithmic changes in the Baidu Search Volume Index (DSVI). To ensure data smoothness and avoid spurious regression, we calculate the logarithmic change in the ESG uncertainty index (DESGUI). We then test the relationship between sustainability uncertainty and investor attention to sustainability uncertainty risk through the following regression:

$$DSVI_t = \alpha + \beta DESGUI_t + \varepsilon_t \tag{5}$$

where $DSVI_t$ represents the SVI for month t, $DESGUI_t$ represents the DESGUI for month t, and β is the regression slope of interest.

The regression results indicate that the β estimated value is 0.26 and significantly positive (t-statistic = 4.19), suggesting that when faced with high sustainability uncertainty, individuals tend to pay more attention to sustainability uncertainty risk. In summary, we confirm that during periods of high sustainability uncertainty, investors pay more attention to sustainability uncertainty risks.

Changes in investors' beliefs about sustainability uncertainty risks update their valuations of companies, providing an explanation for the low ESGUI beta premium.

5.4. Sustainability Uncertainty Risk Attention and ESGUI Beta Premium

It has been verified in the previous part that investor attention will change correspondingly with the changes in ESGUI. Moreover, this phenomenon will be used to study the relation between investor attention and ESGUI beta premium, so as to account for this premium.

To gauge sustainability uncertainty risk attention, the SVI is utilized, and the square root of the original SVI (SSVI) is taken. The reason is that a single search related to sustainability uncertainty risk might boost attention, yet 10 searches are unlikely to enhance attention tenfold. In light of this, the method of Ardia et al. (2023) is followed, and a square root function is applied to the initial SVI data for further data issue resolution. The AR(1)'s forecast error is adopted for gauging the shock of sustainability uncertainty risk attention. For a specific month, the study estimates the AR(1) model with SSVI data from the 36 months prior and defines the prediction error as the SSVI value in that month minus the predicted value of the AR(1) model. Figure 2 presents the relation between the long-short portfolio's LCRs depending on ESGUI beta and the cumulative shock of sustainability uncertainty risk attention. Evidently, the pattern of the LCRs of the long-short portfolio according to ESGUI beta closely resembles the cumulative impact of the concern. Based on the prior findings, it can be affirmed that when investors' worry regarding sustainability uncertainty risk rises, they will favor stocks with a low ESGUI beta. As a result, their prices are pushed up, and a low ESGUI beta premium is created.

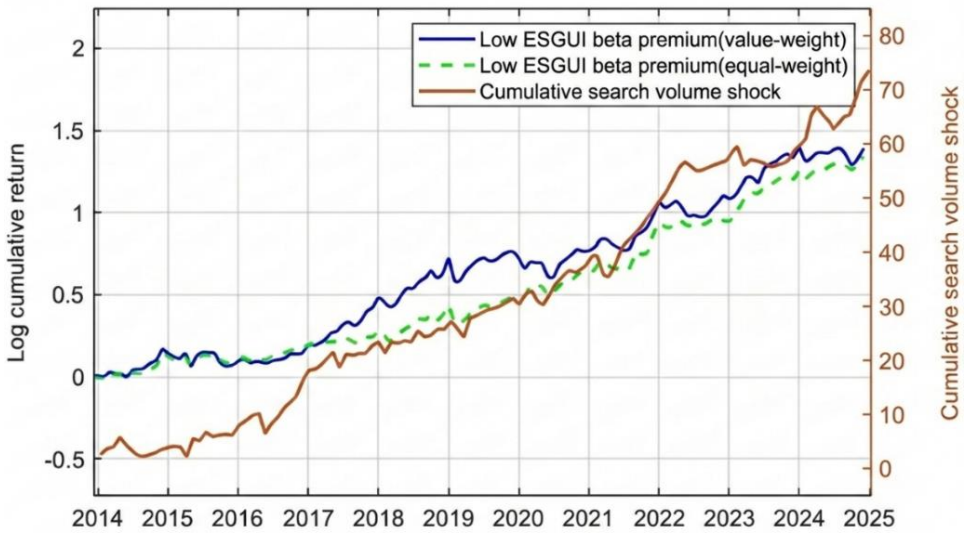

Fig. 2 Sustainability Uncertainty Risk attention and ESGUI beta premium

Note: The figure plots the logarithmic cumulative return of the ESGUI spread portfolio and the cumulative search volume shock to sustainability uncertainty risk.The sample period is from January 2014 through December 2024.

6. Conclusion

Based on the ESGUI indicator proposed by Ongan et al.[1], this paper explores the relationship between sustainability uncertainty risk exposure and cross-sectional returns in the Chinese stock market. Empirical results show that long-short portfolios constructed based on ESGUI beta generated monthly excess returns of 0.94% and 0.91%. Correspondingly, companies with lower ESGUI betas exhibit higher future stock returns. Results from a dual-sorting portfolio controlling for firm size and market factors indicate that the low ESGUI beta premium is unaffected by firm size and market factors. Additionally, Fama-MacBeth regression results suggest that existing predictive factors cannot explain the negative predictive power of ESGUI beta. We then conducted several alternative settings

to demonstrate the robustness of the low ESGUI beta premium. Finally, through literature review and empirical analysis, we attempted to explain the mechanism behind the low ESGUI beta premium. We found that company profitability, investment status, investor beliefs, and sustainability uncertainty risk concerns can effectively explain this phenomenon. In summary, this paper confirms the importance of sustainability uncertainty risk in individual stock cross-sectional pricing in the Chinese stock market, providing investors with a new dimension for asset allocation.

However, due to space constraints and limitations in the authors' capabilities, we also leave some open questions for future research. First, given the impact of sustainability uncertainty on stock returns, more diverse methods could be employed to construct sustainability uncertainty indicators, thereby further reinforcing the importance of sustainability uncertainty. Second, it is also necessary to study the impact of sustainability uncertainty on other types of markets. Third, given that sustainability and uncertainty affect different industries to varying degrees, analyzing the impact of sustainability uncertainty on stock returns across different industries (i.e., heterogeneity analysis) is of significant importance.

Acknowledgements

We thank seminar participants at Nanjing University of Science and Technology for helpful comments and suggestions. This work is supported by the National Undergraduate Training Program for Innovation and Entrepreneurship (202510288092).

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