

# *The Impact of Air Quality and Investor Sentiment on Rate of Return on the Stock in China*

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**Abstract:** For a long time, the impact of environmental factors on stock returns has always been a hot topic. An unfavorable environment for investors affects investors' emotions and causes them to have negative emotions, which leads to changes in investors' purchase preferences and thus affects stock returns. This paper uses the daily stock return data of the daily return rate of all outstanding A- shares on the Shanghai Stock Exchange in China in 2014, the local daily AQI data of 363 cities in 2014, and other control variable data to explore the effect of air quality on stock return through panel regression. The reasons for the effect of air quality on stock returns will be explained in this paper from the perspective of investor emotions. The results show that the worse the air quality is, the lower the stock return will be. This result still holds when controlling for city fixed effects and month fixed effects. Moreover, the interference of other control variables such as circulation market value and market risk premium on the results is excluded, indicating that investors' sentiment does affect stock returns.

**Keywords:** Air quality, rate of return on the stock, investor's sentiment, panel regression.

## 1. Introduction

Air pollution has always been a topic of great concern. Air pollution not only affects people's health, such as increasing the risk of heart disease and respiratory diseases, but also affects people's mental health, such as making people more anxious and irritable[1]. Therefore, air pollution will also affect people's behavior in public places by affecting their emotions[2]. For example, pessimism leads investors to evaluate things more negatively, become more risk averse, and become less willing to trade, thus affecting the stock return rate of the whole financial market[3]. However, how air pollution affects stock returns and whether other factors interfere still need to be clarified through analysis.

When considering the impact of environmental factors, the reason why this paper adopts air pollution is that different investors will have different preferences for different weather, some investors like sunny days, while for others, rainy days make them feel better, so using weather as an indicator of the environment is unreliable. Therefore, due to the bias of weather indicators, this paper adopts air pollution. Because air pollution is an environmental indicator that can cause anyone to feel negative emotions. Related medical studies have found that being exposed to polluted air may increase the cortisol hormone in the human body, cause metabolic disorders, reduce people's incentive to take risks, and change people's preference of risk [4].

Air pollution contains many kinds of pollution, It includes sulfur compounds (SO<sub>2</sub>, etc.), nitrogen compounds (NO<sub>2</sub>, etc.), carbon compounds (CO, etc.) and so on. This paper uses AQI (Air Quality Index), a single conceptual index of monitored air concentration integrated based on the proportion of various components in the air. The value of AQI ranges from 0 to 500, and the greater the value, the worse the air quality. See table 1 for details. In this way, we can more intuitively analyze whether the air pollution there is severe or not.

Table 1: AQI Index

AQI	Level	Category	Impact on Health
0-50	1	Good	The air quality is satisfactory and there is basically no air pollution
51-100	2	Moderate	Air quality is acceptable, but some pollutants may have a weak effect on the health of a very small number of exceptionally sensitive people
101-150	3	Unhealthy for Sensitive Groups	There is a mild exacerbation of symptoms in susceptible people and irritating symptoms in healthy people
151-200	4	Unhealthy	Further aggravate the symptoms of susceptible people, may have an impact on the heart and respiratory system of healthy people
201-300	5	Very Unhealthy	Patients with heart and lung disease have significantly increased symptoms, reduced exercise tolerance, symptoms are occurred commonly in healthy people
>300	6	Hazardous	Healthy people have reduced exercise tolerance, obvious and intense symptoms, and some diseases appear in advance

## 2. Literature Review

At present, the research on the relationship between air quality and stock return rate has not been widely popularized, because air quality and stock return rate are indeed topics in two different fields. However, there are still many studies to explain the relationship between these two variables. Some scholars believe that the worse the air quality, the lower the stock return. Xin believes that air quality affects personal investment behavior mainly through two channels: psychological and physical health [2]. When the air quality is poor, the health of individual investors will be impaired and they will have more negative emotions, which will make individual investors' decision-making ability decline and they will be pessimistic about the future expectation of stock investment, so they are more inclined to risk aversion, which will further reduce the future excess return of individual stock portfolio. The influence pattern of investor sentiment also has two aspects: One is to reduce investors' trading willingness, and the other is to increase their pessimism. Chen et al. verified that air quality affects stock return rates by reducing the trading willingness of local investors rather than increasing their pessimism [5]. The worse the air quality is, the lower the stock liquidity is, indicating that the air quality is more likely to make investors reduce the trading willingness due to worry and anxious. The reduced willingness to trade worsens stock liquidity and causes stock prices to fall on the day. At the same time, some scholars have analyzed the impact of different indicators of investor sentiment on stock return rates. For example, Peng believes that stock returns are influenced by investor emotion in the short term and have a short-term inertia effect, while in the long term, when the price returns to value, stock returns will be affected by the reversal effect [6]. And Peng also found that attention is one of the important channels through which emotions influence stock returns. In the sector with

high attention, the influence of investor sentiment will be magnified, that is, the influence of investor emotion on stock returns of the stock market with high attention is much higher than that on ordinary stocks. In the short term, it shows that the returns caused by high investor sentiment rise rapidly, in the long term, the sentiment reversal utility is also stronger. However, for stocks with low attention, investor sentiment does not affect the level of returns in either the long or short term.

### 3. Research Methodology

#### 3.1. Sample Selection

This paper choose the daily data of AQI in 363 cities in China, and the daily stock return rate data of the daily return rate of all outstanding A shares on the Shanghai Stock Exchange in China in 2014 from CSMAR (After processing, it becomes the total representative data, Portfolio yield), to process and analyze data. The specific variable definitions can be found in Table 2.

Table 2: Definition of Variables

Variable Name	Variable Symbol	Variable Definition
Air Quality Index	AQI	A single conceptual index of monitored air concentration integrated based on the proportion of various components in the air. The value of air pollution index ranges from 0 to 500, and the greater the value, the worse the air quality
Portfolio Yield	Portfolio	The daily return rate of all stocks in each city is weighted by the circulation market value to obtain the portfolio return rate of the city
Market Risk Premium Factor	RisPre	A-share market capitalization weighted return minus risk-free interest rate, daily data
Market Value Factor	SMB	According to the high and low book-to-market ratio, the stocks in the whole market are divided into two times three groups, and calculate the weighted average return rate of each group respectively. The market value factor is obtained by the average return rate of three groups with small market value minus the average return rate of three groups with large market value, daily data
Book-to-Market Factor	HML	According to the high and low book-to-market ratio, the stocks in the whole market are divided into two times three groups, and calculate the weighted average return rate of each group respectively. The book-to-market factor is obtained by the average return rate of two groups with high book-to-market ratio minus the average return rate of two groups with low book-to-market ratio, daily data
Circulation Market Value	CMV	Natural logarithm of the circulation market value of shares outstanding, daily data

##### 3.1.1. Indicator Variable of Air Quality

The reason of choosing AQI (Air Quality Index) to represent air quality is that it is a single conceptual index of monitored air concentration integrated based on the proportion of various components in the air, which is more intuitive, comprehensive and convenient to observe the quality of air [7]. And the

reason of choosing AQI from 2014.1.1 to 2014.12.31 is that from the second half of 2013, the public has a significant interest in air quality. Before the first half of 2013, the attention is significantly low, and it is difficult to have a significant effect on emotions [5]. So that the data in 2014 are more persuasive and effective.

### 3.1.2. Selection of Control Variables

Fama-French 3-factor model can help to explain the rate of return of stock [8]. Fama-French 3-factor model includes market risk premium factor, market value factor (SMB) and book to market ratio factor (HML). It is quite possibly that investors tend to hold familiar stocks, which means that companies with high circulation market value have a more diverse pool of investors, leading to more active trading behavior, so stocks with high circulation market value should have higher returns [9]. To avoid the influence of this factor on the experimental results, ensure the accuracy and reliability of the experimental results, this paper choose circulation market value as control variable. It is quite possible that air quality is continuous over time. Therefore, one lag and two lags of AQI are added to this paper to test whether air quality has continuity and whether it will have an impact on stock returns.

## 3.2. Fixed Control Effect

### 3.2.1. Month Fixed Control Effects

Because air quality may have seasonal effects, the air quality will have obvious seasonal variation characteristics in different seasons, this study uses the month fixed control effect to eliminate the data interference caused by the seasonal effect of air quality [10].

### 3.2.2. City Fixed Control Effects

Different regions also have different air quality problems[11]. Because the northern region of China has early winter, and the night is cold, it has more temperature inversion weather and less precipitation than the southern region, pollutants stay in the atmosphere for a relatively longer time and are easier to accumulate. The southern region of China is characterized by higher temperatures, more active vertical atmospheric motion, and stronger near-surface turbulence, which is conducive to diffusion. Moreover, the industrial structure in the south of China is dominated by light industry, while most important cities in the north are dominated by heavy industry. So that it is necessary to use city fixed control effects to avoid the interference caused by different air conditions in different cities.

## 3.3. Descriptive Statistics of the Main Variables

Table 3 is the descriptive statistics of portfolio yield of stocks, AQI, risk premium factor, market value factor (SMB), book to market ratio factor (HML) and circulation market value from 2014.1.1 to 2014.12.31.

Table 3: Descriptive Statistics

VarName	Obs	Mean	SD	Min	Median	Max
portfolio	85112	0.0003	5.2763	-218.4473	0.1789	208.1189
AQI	85112	91.3424	43.1213	14.0000	82.3750	458.0000
rispre	85109	-0.7969	1.0993	-6.5187	-0.8733	3.3746
CMV	85112	21.9801	0.9142	19.6720	21.8559	26.1011
HML	85112	0.0004	0.0027	-0.0245	0.0002	0.1361
SMB	85112	0.0006	0.0024	-0.0809	0.0002	0.2413

It can be seen that AQI has the mean of 91.3424, which is moderate index of AQI, it means that the overall air quality in China is moderate, which is no too harmful for people. The standard deviation of AQI is 43.1213, which is relatively large, meaning that the fluctuation of AQI in this year is relatively large. The standard deviation of portfolio is 5.2763, indicating that there is some small fluctuations.

### 3.4. Panel Regression Results

The panel structure is used to run the regressions, including dependent variables, independent variables, control variables, obtaining the following function (1).

$$\text{Portfolio}_{i,t} = \alpha + \beta_1 \text{AQI}_{i,t} + \beta_2 \text{rispre}_{i,t} + \beta_3 \text{CMV}_{i,t} + \beta_4 \text{HML}_{i,t} + \beta_5 \text{SMB}_{i,t} + \mu_{i,t} + \eta_{i,t} \quad (1)$$

Where  $\alpha$  is the intercept term,  $\beta$  is the regression coefficient of AQI,  $\mu_{i,t}$  is the random response of the individual, and  $\eta_{i,t}$  is the residual term. Moreover, the hypothesis is set:

- $H_1$ : The rate of return of stock is negatively related to AQI. The higher the AQI, the lower the rate of return of stock.

Using STATA 18 to run out the results, the results is showed in table 4. The column (1) gives out the results, it can be seen that the coefficient of AQI is -0.0059, and it is significant at the 1% level, indicating that AQI and portfolio yield is negatively related, which means that the worse the air quality, the lower rate of return of stocks. Whenever the AQI rises by 100 points, the portfolio yield falls by 0.59%. In column (2), it is added the month fixed effect, to exclude the seasonal effect brought by different months. And the result is -0.0025, which was also significant at the 1% level. Whenever the AQI rises by 100 points, the portfolio yield falls by 0.25%. In the column (3), it was added the control variables including Fama-French 3-factors and circulation market value, the result is -0.0015, still significant at 1% level. In the column (4), the AQI lagged term and AQI lagged two term were added into regression. The results is -0.0030, significant at 1% level, and its difference from other columns is very small, meaning that the air pollution does not last very long, it usually last only a day [5], so that do not need to consider too much on the air pollution continuity. In column (5), it was added the month fixed effect, to verify whether the seasonal effect will influence the results or not. The result shows that it is still significant at 1% level, and there is not much change from the results in the previous columns, meaning that the seasonal effect does not affect too much. Considering that there are different regional conditions that lead to changes in AQI due to the environment conditions and industry, the city fixed effect was also added in column (6), with month fixed effect. The result is -0.0019, significant at 1% level, which means that difference of regions does not affect too much.

Table 4: Panel Data Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
	portfolio	portfolio	portfolio	portfolio	portfolio	portfolio
AQI	-0.0059***	-0.0025***	-0.0015***	-0.0030***	-0.0021***	-0.0019***
	(0.0004)	(0.0005)	(0.0004)	(0.0005)	(0.0006)	(0.0006)
rispre			0.7885***	0.7918***	0.8470***	0.8465***
			(0.0161)	(0.0161)	(0.0166)	(0.0166)
CMV			0.0801***	0.0782***	0.1005***	0.2479***
			(0.0191)	(0.0191)	(0.0193)	(0.0669)
HML			-402.2497***	-400.1732***	-402.0785***	-402.9953***
			(6.8164)	(6.8259)	(6.9364)	(6.9475)

Table 4: (continued).

SMB			36.7167***	34.6206***	30.0118***	30.2170***
			(7.5461)	(7.5787)	(8.4063)	(8.4204)
AQI(-1)				0.0034***	0.0037***	0.0038***
				(0.0007)	(0.0007)	(0.0007)
AQI(-2)				-0.0018***	-0.0015***	-0.0014**
				(0.0005)	(0.0006)	(0.0006)
_cons	0.5366***	-0.9376***	-0.8511**	-0.8190*	-1.3618***	-4.6507***
	(0.0423)	(0.0877)	(0.4234)	(0.4247)	(0.4343)	(1.4932)
N	85112.0000	85112.0000	85109.0000	85107.0000	85107.0000	85107.0000
r2	0.0023	0.0075	0.0719	0.0723	0.0757	0.0784
month	No	Yes	No	No	Yes	Yes
city	No	No	No	No	No	Yes

Standard errors in parentheses \* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01

From the overall results, it is obvious that the hypothesis is true, the stock rate of return is negatively related to AQI. The higher the AQI, the lower the stock rate of return.

#### 4. Conclusion

In conclusion, the rate of return of stock is negatively related to AQI. The higher the AQI, the lower the rate of return of stock. When AQI is high, meaning that air quality is unhealthy, will influence the investors emotion, making them feel pessimistic, pessimism leads investors become more risk averse, and become less willing to trade [5], thus affecting the stock return rate of the whole financial market.

This paper fully considered the seasonal effect of AQI and the impact generated by different cities to avoid the error of data caused by these effects, and by using these control variables, the overall data is made more convincing, which makes the conclusion more accurate.

However, there are also some limitations in this paper. For example, during this period, some listed companies will change their position or industry type, which may have some minor influence in the results, but because some small data changes cannot be observed, these changes can only be ignored for the time being. However, it was not taken into account because it did not have a large impact on the overall results. Therefore, in future research, more attention should be paid to the changing data and capture more tiny details, so as to make the data more accurate and convincing.

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