PM2.5, Investor Sentiment, and Stock Returns

Xiaobei Huang

ABSTRACT

This paper investigates how PM2.5 affects the stock price of firms from heavy polluting industries and environment-friendly industries in China, applying the emotion cognition theory into the investor sentiment theory framework. We argue that PM2.5 will affect people’s emotion, which in turn, affect their investing decision. Meanwhile, people will attribute the release of PM2.5 to heavy polluting firms, when have better predictions for environment-friendly firms. The empirical results are consistent with the argument: PM2.5 has negative impact on stock price of heavy polluted firms, and has positive impact on environment-friendly industries firms. The results of this paper imply that capital market can play as an “invisible hand” to improve air quality of China.¹

INTRODUCTION

Since 2011, more and more continuous fog and haze weather makes "PM2.5", a strange terminology, become a hot word among Chinese people in recent years. Starting from "investor sentiment" in behavioral finance, combined with the theory of emotional cognition, this paper selected the PM2.5 value in China from November 1, 2013 to September 30, 2016 to make a comparison with the stock returns of energy conservation and environmental protection shares and heavy polluting enterprises in Shanghai and Shenzhen Stock Exchanges. The results showed that in China's stock market, PM2.5 have effect on the stock returns, which revealed the dominant role of the "invisible hand", capital market, in capital flow, resource allocation and industrial structure adjustment, thereby responding to the "heavy blow" of China's haze governance from the supply side, promoting the

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change from passive "political blue sky" to initiative "economic blue sky" and achieving sustainable economic and ecological development.

LITERATURE REVIEW AND HYPOTHESES

Studies on investor sentiment in the field of behavioral finance have shown that negative sentiment from air pollution can lead to investors' pessimistic expectations about the future stock returns. Levy and Yagil (2011) found that market participants in the exchange were influenced by the local air, thereby promoting changes in stock prices, indicating that the worse the air quality of New York was, the lower the stock returns of the New York Stock Exchange would be. Hu et al. (2010) found that the local air quality of the exchange would not affect the stock returns, but the relative values of the air quality index (AQI) of Shanghai and Beijing were significantly negatively correlated with stock returns, indicating that Chinese investors would compare the local air quality with Beijing's air quality, and Beijing's air quality had become an important "benchmark" affecting investor sentiment in China. Guo and Zhang (2016) found that PM2.5 in Shanghai also have a negative impact on stock returns on Shenzhen and Shanghai Stock Exchanges, which provided evidence for the negative spillover effect of PM2.5 on China’s capital markets.

Even though PM2.5 repeatedly exceeded the upper limit of the current standard, environmental protection stocks have begun the red jump in the K-line diagram. Air pollution can not only bring negative emotions such as anxiety and perception of the causes and consequences of air pollution among the public, but also exacerbate the impact of such negative emotions on decision making (Zeidner and Shechter, 1988). Therefore, the investors will be pessimistic about the future development of heavy polluting enterprises that release PM2.5, but will be optimistic about the development prospect of energy-saving and environment-friendly industries which can reduce PM2.5 emissions. Thus the following assumptions are put forward:

**Hypothesis 1**: PM2.5 is negatively related to stock price of heavy polluting firms.

**Hypothesis 2**: PM2.5 is positively related to stock price of environment-friendly firms.

SAMPLE AND RESEARCH DESIGN

Sample Selection

This paper collect PM2.5 values of Beijing, Shanghai and Shenzhen from November 1, 2013 to September 30, 2016 (China established the first PM2.5 monitoring station on November 1, 2013) and the stock returns of heavy pollution as well as environment-friendly industries from Shanghai and Shenzhen Stock Exchanges as the sample. After excluding the samples with data missing, we have 170,162 observations of heavy polluting firms and 12,137 observations of
environment-friendly firms in Shanghai Stock Exchange. 236,686 observation of heavy polluting firms and 3,882 observed values of environmental protection firms in Shenzhen Stock Exchange were included. PM2.5 data used in this paper is from the average daily PM2.5 announced by the Ministry of Environmental Protection, and the stock return data is from the CSMAR database.

**Variables and Regression Model**

We define the daily stock return of each firm in our sample as our dependent variable $D_{retwd}$. We obtain this variable from CSMAR database. We use the mean value of daily PM2.5 value of Beijing, Shanghai, and Shenzhen released by Ministry of Environmental Protection as our independent variable. Following the extant literature, we also include the dummy variables for Week Effects and Month Effects as our control variables. We define Model (1) to test our research hypothesis. In this model, PM2.5 represents the daily average PM2.5 value from Beijing, Shanghai, and Shenzhen, respectively. All the continuous variables are winsorized at 1% and 99% in the regression.

$$D_{retwd} = \alpha + \beta_1 \times PM2.5 + \beta_2 \times MONTH\_DUMMY + \beta_3 \times WEEK\_DUMMY + \epsilon$$  \hspace{1cm} (1)

**EMPIRICAL RESULTS**

In the regression tests, we exam the PM2.5 effect on stock price of firms listed in Shenzhen Stock Exchange and Shanghai Stock Exchange separately. Table 1 and Table 2 demonstrate the result respectively. We can see from the two tables that, both local PM2.5 and PM2.5 in Beijing have significantly negative impact on stock returns of heavy polluting firms, they also have positive impact on stock returns of environmental-friendly firms in Shanghai Stock Exchange. The positive impact is not significant for firms listed in Shenzhen Stock Exchange may because that the air quality at Shenzhen is relatively better than Beijing and Shanghai, therefore the investor sentiment is week. The results above are all consistent with hypothesis 1 and hypothesis 2, which imply that the PM2.5 have different impacts on different industries that stimulated by investors emotion cognition.
TABLE 1. REGRESSION RESULTS FOR SHANGHAI STOCK EXCHANGE.

<table>
<thead>
<tr>
<th>DRETWD</th>
<th>Heavy polluting Firms</th>
<th>Environmental Friendly Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHPM2.5</td>
<td>-0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td>BJPM2.5</td>
<td>-0.001***</td>
<td>0.001***</td>
</tr>
<tr>
<td></td>
<td>(-4.50)</td>
<td>(2.83)</td>
</tr>
<tr>
<td></td>
<td>(-5.42)</td>
<td>(2.54)</td>
</tr>
<tr>
<td>MONTH/WEEK EFFECTS</td>
<td>Control</td>
<td>Control</td>
</tr>
<tr>
<td>Constant</td>
<td>0.001*</td>
<td>-0.006***</td>
</tr>
<tr>
<td></td>
<td>(1.96)</td>
<td>(-3.02)</td>
</tr>
<tr>
<td>Observations</td>
<td>170162</td>
<td>12137</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.004</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Note: BJPM2.5, SHPM2.5 represents the daily average PM2.5 value from Beijing and Shanghai, respectively. We estimate the linear regression using the robust-regression estimation method with standard errors robust to heteroskedasticity. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 2. REGRESSION RESULTS FOR SHENZHENI STOCK EXCHANGE.

<table>
<thead>
<tr>
<th>DRETWD</th>
<th>Heavy polluting Firms</th>
<th>Environmental Friendly Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>SZPM2.5</td>
<td>-0.002***</td>
<td>0.000*</td>
</tr>
<tr>
<td>BJPM2.5</td>
<td>-0.001***</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(-10.75)</td>
<td>(0.32)</td>
</tr>
<tr>
<td></td>
<td>(1.91)</td>
<td>(0.86)</td>
</tr>
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<td>MONTH/WEEK EFFECTS</td>
<td>Control</td>
<td>Control</td>
</tr>
<tr>
<td>Constant</td>
<td>0.009***</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(11.72)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>Observations</td>
<td>236686</td>
<td>3882</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.009</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Note: BJPM2.5, SZPM2.5 represents the daily average PM2.5 value from Beijing and Shenzhen, respectively.

CONCLUSIONS

This paper investigates the relationship between PM2.5 and stock returns of different industries in China. Starting from "investor sentiment" in behavioral finance, combined with the theory of emotional cognition, this paper selected the PM2.5 value in China from November 1, 2013 to September 30, 2016 to make a comparison with the stock returns of environmental-friendly and heavy polluting...
firms in Shanghai and Shenzhen Stock Exchanges. The results showed that in China's stock market, since investors will attribute the air pollution to industrial released by heavy polluting firms, PM2.5 have negative effects on stock price on heavy polluting firms while have positive effects on environmental-friendly firms. The conclusion of this paper reveal the dominant role of the "invisible hand", capital market, in capital flow, resource allocation and industrial structure adjustment, thereby responding to the "heavy blow" of China's haze governance from the supply side, promoting the change from passive "political blue sky" to initiative "economic blue sky" and achieving sustainable economic and ecological development.

ACKNOWLEDGEMENTS

Xiaobei Huang thanks for the support by the National Natural Science Foundation of China (Grant No. 71602004).

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