Impacts of air pollution on investors' moods[*]

Replicating 'Ambient particulate air pollution and daily stock market returns and volatility in 47 cities worldwide'

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Abstract

The silent killer, air pollution, can cause not only health issues but psychological and economic effects. This paper replicates the 2021 article 'Ambient particulate air pollution and daily stock market returns and volatility in 47 cities worldwide,' and uses the results as evidence to examine the non-health effects of air pollution. Models in the article have shown that the daily stock returns decrease by 1.2% on average globally as PM2.5 concentration increases by 10 microgram per cubic metre. This analysis provides substantial evidence that air pollution might affect human behavior.

Keywords: Environmental Economics, Ambient Particular Air Pollution, Stock Price, PM2.5

1 Introduction

In recent years, extreme pollution events bring people's attention to studying the impacts due to air pollution. Exposure to pollutants such as nitrogen oxides (NOX) or sulfur oxides (SOX) can cause serious health issues including damaging lung function(Government of Canada, 2021). As the main component of smog, fine particulate matter and ground-level ozone (O3) can cause dysfunction of the eye, nose, throat, or lung(Government of Canada, 2021). Fine particulate matter has been identified as one of the risk factors for cardiovascular disease and premature death(Government of Canada, 2021). Other pollutants such as Carbon monoxide (CO) and Ammonia (NH3) are also harmful to human health(Government of Canada, 2021). Most of them are colorless gas to be not noticed. The vulnerable group, children and the elderly, can be harmed more easily at greater risk(Government of Canada, 2021). In addition, indirect evidence was found to explain how air pollution influences mood and human cognitive functions.

The article 'Ambient particulate air pollution and daily stock market returns and volatility in 47 cities worldwide' by Simo Kiihamäki, Marko Korhonen, and Jouni Jaakkola investigates how daily concentrations of fine particulate matter influence daily stock market returns and volatility. They aim to test two hypotheses. The first is that the increases in the daily PM2.5 concentrations decrease daily stock returns. The second is that the increases in daily PM2.5 concentrations increase daily stock volatility. Linear models and meta-regression analysis are performed to generate results at the global level. Evidence from regression models for each city supports that short-term exposure to PM2.5 could lead to a decrease in stock returns.

This paper replicates the original analysis in the article by using the dataset provided by the authors. Data related to air pollution data, stock index, and meteorology are provided in the dataset. The dataset will be introduced and explained in more detail first in the Data section. Their methods will be explored in the Results section. Regression models created in the original analysis will be replicated while additional models are produced and explored. Results and discussion will be presented in the end.

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[*]Code and data are available at: https://github.com/zhongyuhuang/Impacts-of-air-pollution-on-investors-moods.git

2 Data

2.1 Data source and collection

This paper uses the datasets conducted by Kiihamäki etc. The datasets are available as CSV files from https://data.mendeley.com/datasets/z8t3s8btxv/1. They store air pollution data, stock index data, and meteorological data for 47759 observations from 47 cities worldwide. Daily returns of stocks are collected from investing.com. This website is a financial markets platform offering access to real-time data and free financial tools across 250 exchanges around the world. However, it is worthy to notice that this platform claims that data provided by them is not necessarily by any market or exchange, hence not necessarily real-time nor accurate. Data related to air pollution are collected from various sources including the European Environment Agency, the U.S. Department of State, and so on. Only 47 out of 88 countries have sufficient PM2.5 concentration to be involved in the original analysis. Meteorological data for these countries are obtained from the Global Surface Summary of the Day. It is a product of the National Oceanic and Atmosphere Administration and it possesses averages of daily weather elements computed from global hourly station data.

2.2 Missing Values

The authors used two technics to deal with missing values in datasets. As for the missing values that exist in either stock data or air pollution data, the authors choose to omit observations from all day if any of the stock returns or PM2.5 concentration is missing. This decision is made based on that it is impractical to find relations in the absence of these data. As for meteorological variables, there exist a large amount of randomly missing data. These variables are served as confounding factors that affect the research question in the original paper. The authors decide to impute these missing values to perform adjustments due to confounders by using classification and regression training.

2.3 Visualization of variables

Most of the observations are from London, Toronto, New York City, Copenhagen, and Helsinki.(Figure 1). They are almost equally distributed each day of the week. The dependent variables here are logarithmic daily returns, 1-day lagged returns, and 2-day lagged returns. The daily return of stock indicates the dollar change in a stock's price as a percentage of the previous day's closing price. We use the logarithmic daily returns of stock instead the daily return to ensure the normality of the dependent variable. From the plots of explanatory variables, a significant amount of outliers are presented(Figure 2). It is possible to have problematic observations in the dataset which could affect the further models. Categorical Variables would be transformed to factors in further analysis.

3 Model

4 Results

5 Discussion

5.1 Cleaner air indicates higher stock returns?

It might be possible for stock returns to be higher when there is no pollution. However, we cannot make such a statement without further investigation. The results shown in the analysis are not necessarily saying
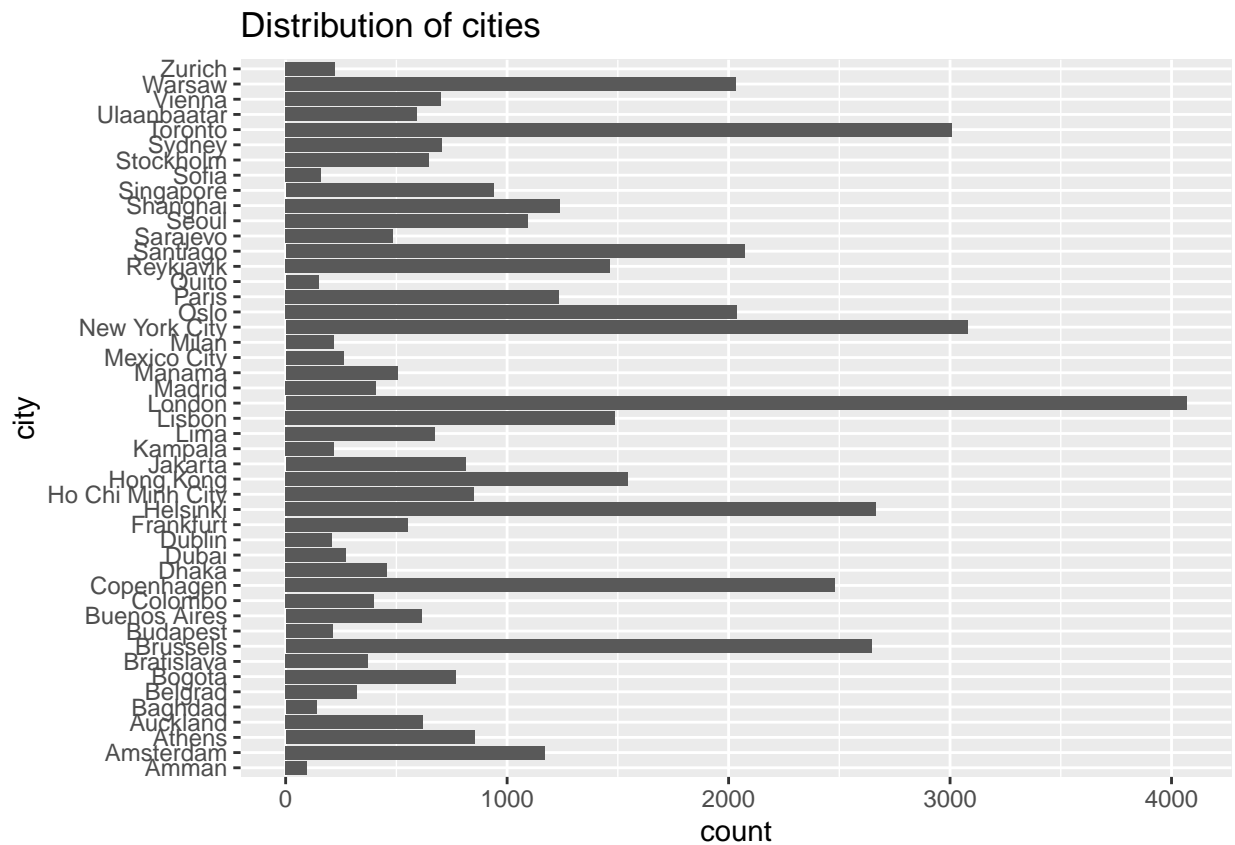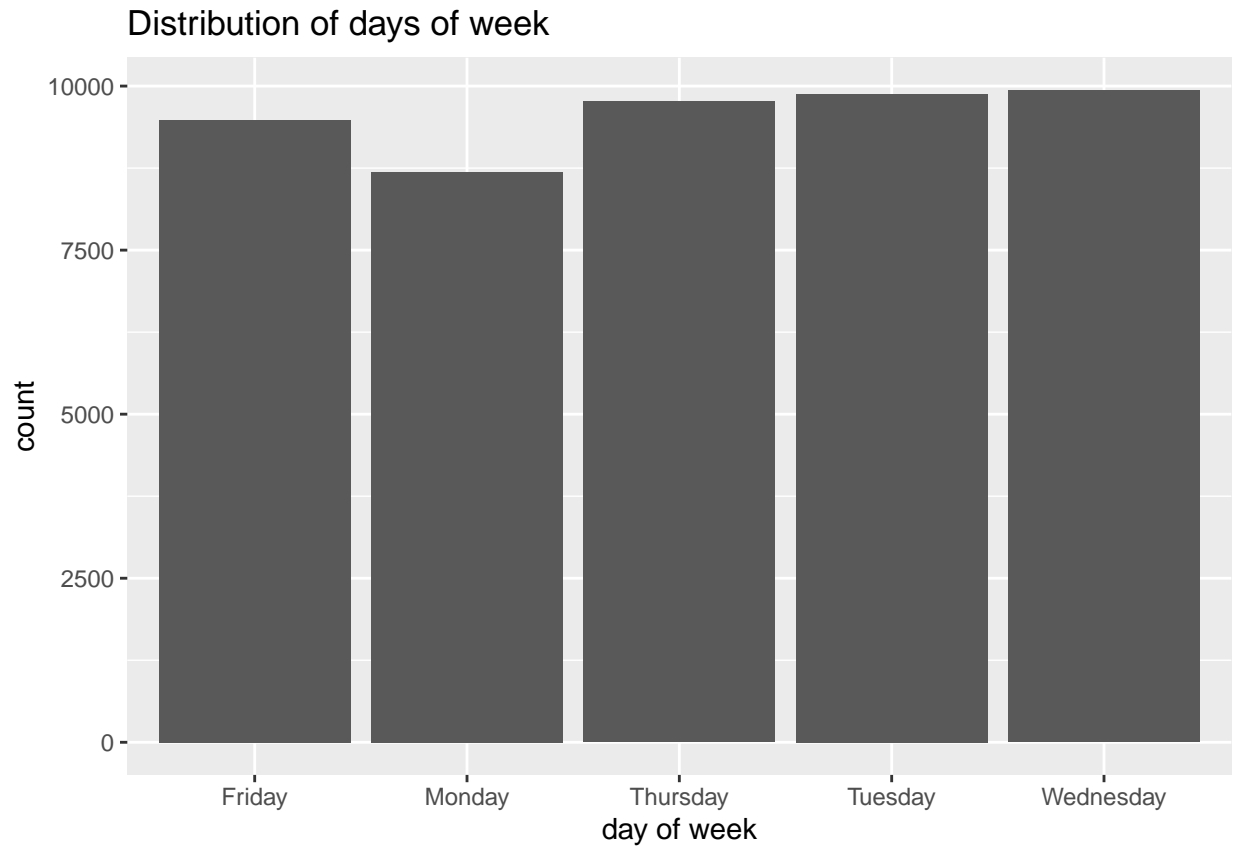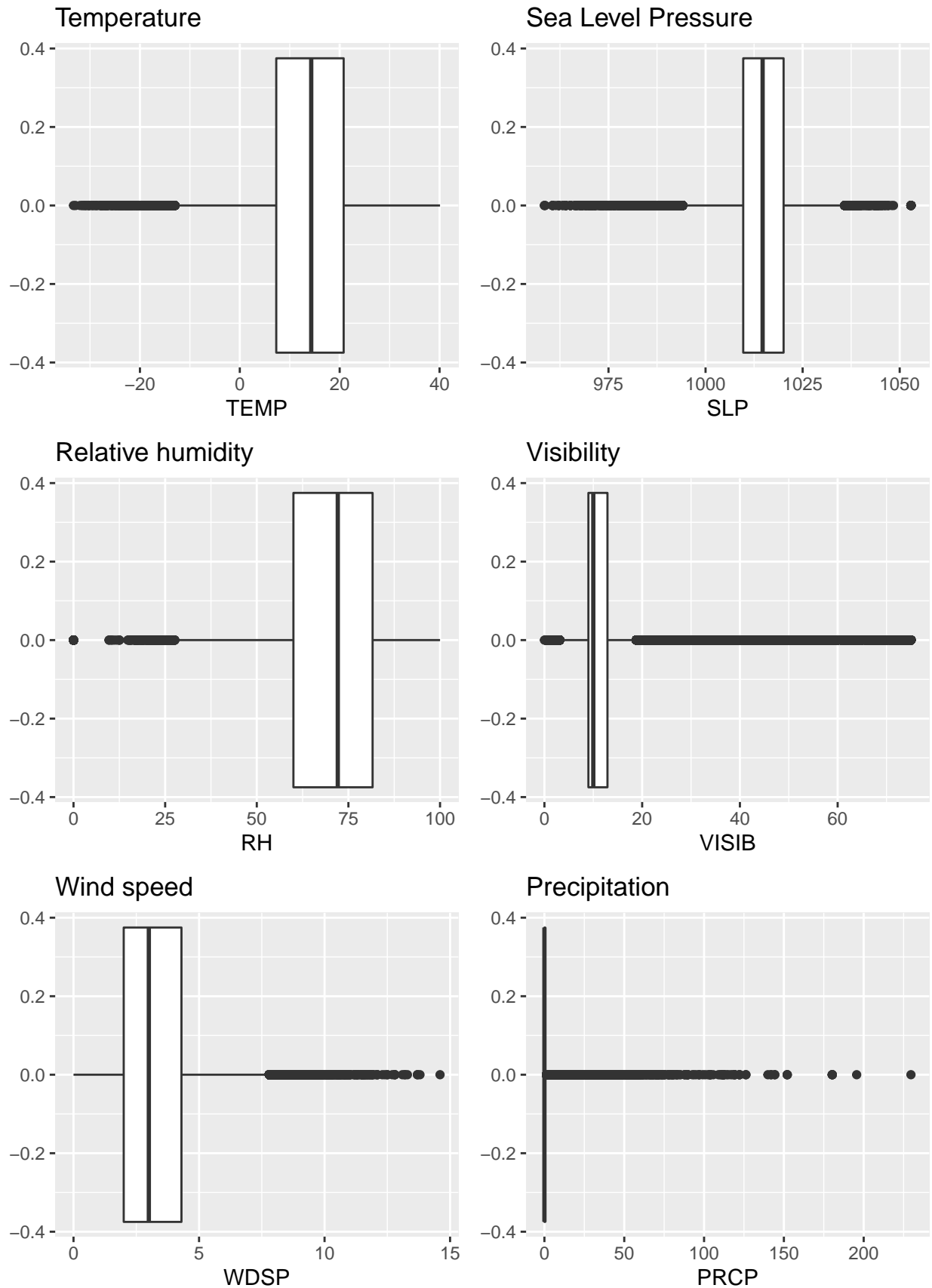
Figure 1: Cities and days of week of observations

Figure 2: Visualization of explanatory variables

"Let's rise the stock return by cleaning the air." Indeed, they indicate that we will see more accurate stock returns and volatility with cleaner air. In this case, the volatility will follow the market fundamentals. A strong relation between air pollution and stock volatility actually indicates the inefficiency of the market.

5.2   Other non-health outcomes

Often we could hear discussions on how human behaviors produce or reduce air pollution. It is rare to talk about this topic in the opposite perspective, especially on psychiatric aspect. Only a few researches had examined these effects linked to air pollution. However, evidence had been found to suggest that air pollutants interfere with functioning of the nervous system. Other than that, although the ability to withstand anxiety depends on individual, medical effects of air pollution can indirectly affect psychological health. Research from 2017 had found the relationship between ambient air pollution and increased aggressive behavior in teenagers.

5.3   Weaknesses and next steps

Although we found a link between the daily concentration of PM2.5 and the daily stock return, we did not prove the causality between them. Other than that, there exists confounding factors such as other pollutants can effect the models and results established in the analysis. Whether the effect of PM2.5 on stock volatility is temporary or permanent is not examined. As described in the previous section, a significant amount of metro data are estimated. All of the results are made under bias including data error.

Appendix

A   Additional details

References

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