Social and Economic Impacts of Air Pollution: The Case of Ulaanbaatar, Mongolia

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Introduction

Air pollution and its impact on society, human health, and the economy has become a serious problem, particularly for developing countries. Over the last two decades, the level of air pollution has increased drastically in Ulaanbaatar, Mongolia, along with the growing number of the Ger district residents, and has become an actual threat to health and well-being of the citizens. The health effects of air pollution are well examined, but the social and economic costs seem to be overlooked. This dissertation examines how air pollution affects society and the economy in Ulaanbaatar, Mongolia by exploiting labor supply data and school attendance data.

Labor supply, one of the essential economic indicators, is likely to be affected by the high level of air pollution in Ulaanbaatar. Individuals experiencing acute air pollution have severe health problems, which may cause early retirement from work and even premature death in the mid and long-term. In the short-term, air pollution reduces labor productivity and labor supply (Fu, Viard, & Zhang, 2021; Hanna & Oliva, 2015) and may result a non-negligible economic loss. However, the effect of air pollution on labor supply is not adequately analyzed in Mongolia.

Due to the developing lung function, children are more susceptible to air pollution and incur more significant health damage. Health damage is one of the factors that affect children's human capital attainment. Several studies have provided evidence that health problems attributable to the high level of air pollution cause absenteeism from school (Currie, et al., 2009), and in turn, lower educational performance (Ebenstein, Lavy, & Roth, 2016; Mohai, Kweon, Lee, & Ard, 2011), eventually increasing the likelihood of dropping out of school (Bener, 2011). Therefore, a detailed understanding of the effect of air pollution on society, especially on educational attainment and school attendance, is essential for ensuring a country’s future prosperity.

Mongolia is a unique case study given the source of air pollution and high correlation between air pollution and the season. Air pollution in Mongolia is generated indoors. Therefore, presumably, the Ger districts’ individuals constantly experience a high level of air pollution in the cold season, hence under a high risk of decreasing their quality of life and well-being.

The main contributions of this dissertation are as follows. First, it contributes to the knowledge of air pollution impacts and their cost in a developing country context. Developing countries are struggling to deal with air pollution, so the need of research in this area is considerable. Second, due to the origin of air pollution, the research in this dissertation can be generalized to developing countries with similar extreme weather conditions, such as Kazakhstan and Kyrgyzstan. Finally, the studies in this dissertation will be an essential source to estimate the effects of air pollution and its costs and may lead to more comprehensive future research in the Mongolian context for other researchers, given the fact that air pollution is not going to decline significantly anytime soon in Ulaanbaatar because of lack of targeted policies and poor local economic situation, among others.

Methodology

This study utilizes the Labor Force Survey (LFS) data, which covers the years between 2014–2018. The survey is conducted quarterly, and sample selection is at the household level, including all members aged 15 and above in selected households. The pooled cross-sectional data includes a rich set of individual, household, and employment characteristics.

The number of hours worked in the week prior to the interview data is served as a proxy variable for labor supply. Since hours worked cannot take a negative value, the dependent variable is limited. Moreover, a non-negligible share in the dataset is recorded as zero, so the data is left censored, thus, limited dependent variable models are employed in the analyses.

Air pollution in Ulaanbaatar is endogenous. We employed wind speed as an instrumental variable for air pollution. Wind occurs naturally; it is not caused by air pollution or other human activities. Mongolia does not have days off from work or school in response to extreme weather conditions such as strong wind, rain, or snow, so wind speed is exogenous. Strong wind blows local pollution elsewhere (UNDP, 2019), and we assume that wind speed has no direct relationship with labor supply or any other variables which affect labor supply.

To explore the effect of air pollution on social costs, we examined student attendance data from a public secondary school in Ulaanbaatar. The school is located in one of the most populated areas of the city, and one with the highest level of air pollution, which makes it suitable for this study.

The data covers two academic years of 825 students, 355 students in first and second grade: 171 girls, 184 boys; 270 students in fourth and fifth grade: 136 girls, 134 boys; 200 students in eighth and ninth grade: 81 girls,119 boys. These students are about 27 percent of the school's students. Apart from the total of 825 students' data, first and second-grade students' data is estimated separately.

We considered total absent days and illness-related absent days as the main dependent variables. To examine this causal relationship, first, we employ a Linear Probability Model and a fixed effect probit model.

Up to seven days lag in air pollution variables and weather variables are employed. We are able to eliminate the other unobservable variables, such as teacher performance, differences within groups, and peer effects, by means of panel settings.

Results

Air pollutants, namely, SO_2, NO_2, PM_{10}, and $PM_{2.5}$ are served as explanatory variables. Addressing the endogeneity of air pollution, the results suggest that a 1 $\mu g/m^3$ increase in SO_2 causes 0.5 hours (or 30.1 minutes) decrease in labor supply at a 5 percent confidence level. The results are consistent with the findings of other studies (Fan & Grainger, 2019; Hanna & Oliva, 2015). We do not find any significant results for PM_{10}, $PM_{2.5}$, and NO_2 at this level. This suggests that our result is sensitive to pollutants. The result also suggests that younger individuals' work hour is affected by air pollution. This contrasting result may be because of the difference between the job type of the younger and older generations. More detailed investigation result suggests that younger people who work outside are likely to reduce their working hours due to high level of air pollution.

Lost work hours due to the high level of air pollution has a substantial impact on an individual's economic situation, in matters such as lost salary attributable to lost work hours and increased health expenditure on medical treatment.

Several robustness checks are performed to ensure the validity of the results. First, data for January is dropped (the month with the highest pollution) from the dataset, second, outliers of the explanatory variables are dropped, finally, a placebo test on the instrumental variable is performed.

Based on that result we estimate the economic cost of lost work hours, using the GDP per working population as an indicator of productivity. We find that total lost working hours carried a cost of approximately MNT81,242.7 million (USD36.1 million), about 0.5 percent of the average total GDP of Mongolia.

Air pollution has a significant effect on school attendance. Results are significant up to four– lagged days. Employing air pollutants, SO_2, PM_{10}, and $PM_{2.5}$, fixed effect probit model results suggest that a 10 $\mu g/m^3$ increase in PM_{10} causes an increase in the probability of absence by 0.002 to 0.004 for first and second-grade students. Park et al., (2002) found similar results, although of higher magnitudes, for PM_{10} in South Korea. The effect is less significant for all students. The results for $PM_{2.5}$ present the same pattern as PM_{10} results. A 10 $\mu g/m^3$ increase of $PM_{2.5}$ causes an increase in the probability of being absent by 0.003 to 0.005 for first and second graders.

We get similar results of slightly larger in magnitude for sick leave days. The results are significant for both first and second-grade and all students. A 10 $\mu g/m^3$ increase in PM_{10} causes an increase in the probability of sick leave by 0.002 to 0.006. A 10 $\mu g/m^3$ increase in $PM_{2.5}$ leads to an increase in the probability of sick leave days by 0.004 to 0.008. This result is consistent with those of previous studies (Chen, Guo, & Huang, 2018). The coefficients of SO2 are mostly negative.

We also provide evidence about academic performance and school attendance. Previous studies have shown a decline in academic performance caused by absence among students. Using micro level data, we find a strong relationship between academic performance and school attendance.

Conclusion

Understanding the effect of air pollution is essential to formulate effective policies. This study is the first study of the impact of air quality on labor supply and school attendance in Mongolia and one of the first to examine the impact of air quality in a developing country context. This is important because citizens of developing countries experience the most severe air quality; hence the effect of air pollution is more significant. Therefore, the effect of air pollution and its cost in developing countries is an important area to investigate.

The findings of this study have important implications to address the cost of poor air quality and its consequences. The findings of this study will be a source of highly useful data for the framing of policy on the topic and could provide a baseline for future studies in this topic area in developing countries in general.

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