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The dynamic relationship between environmental pollution, economic development and public health: Evidence from China

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ABSTRACT

During the last two decades of rapid economic growth, China's environmental pollution has become increasingly serious, and the corresponding health damage has become a significant problem that has attracted domestic and foreign attention. As China pursues sustainable economic growth, the issues of environmental degradation and public health should be well addressed. Using sulfur dioxide emissions, wastewater emissions, and soot and dust emissions as indicators of environmental quality, this study investigates the comprehensive dynamic relationship between environmental quality, economic development and public health in China for the first time. To control for potential endogeneity, this paper utilizes a carefully designed simultaneous equation model (SEM) that is composed of three equations that describe the relationships among economic development, environmental quality and public health. Using panel data from 30 Chinese provinces for the period from y2002 to y2014, the model verified the negative effect of environmental pollution on public health. Moreover, economic and social factors may also affect public health. For instance, real GDP per capita has a significant negative impact on perinatal mortality rates, and education and medical conditions also contribute significantly to promoting economic growth and improving the level of public health.

1. Introduction

Since the beginning of the economic reform and opening-up in the late 1970s, China's economy has grown at a remarkable speed. However, in the meantime, environmental pollution has grown significantly and attracted increasing domestic and foreign attention (e.g., Liu et al., 2017; Zhang et al., 2017). The problems caused by environmental pollution, such as the degradation of environmental quality, the destruction of the ecological balance and the damage to public health, have gradually become key factors that constrain sustainable economic growth and social development (Guo et al., 2017; Li and Wu, 2017). According to a World Bank report, *The cost of air pollution: Strengthening the economic case for action*, the latest estimations indicate that in 2013, 5.5 M deaths in the world, accounting for 1/10 of the total number of deaths that year, could be attributed to air pollution (World Bank, 2016). In the same year, the exposure to air pollution indoors and outdoors caused approximately $5 trillion and $110 thousand million worth,

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respectively, of welfare loss globally. For instance, according to the estimation of Voorhees et al. (2014), if the air quality in Shanghai reached the national secondary standard, the monetary value of averted deaths could be as much as 1.7 to 12 thousand million RMB.

According to Liu (2013), during the last three decades, as China's economy has expanded rapidly, while the ecological environment has also deteriorated at an unprecedented rate. In particular, the great detrimental effects of environmental pollution on public health have become apparent in recent years. The World Health Organization (WHO) conducted a primary estimation and found that 21% of the disease burden of Chinese residents could be attributed to environmental pollution (WHO, 2012). This number was 8% higher than that for the U.S. In a recent study, Rohde and Muller (2015) estimated that approximately 1.6 M people died in China annually due to $PM_{2.5}$ pollution. Facing critical environmental conditions and health issues, China's government has already formulated and carried out a series of policies and regulations. For instance, the pioneer government plan, Action Plan on Environment and Health (2007–2015), proposed six action strategies and three security policies (Ministry of Environmental Protection of the People's Republic of China, 2007).

Partly because of the recent emergence of the current environmental issues, the extant studies on the relationship between environment and health are mainly in the fields of environmental epidemiology and environmental toxicology (O'neill et al., 2007). However, these studies usually have not taken into account the social and economic factors involved in environmental health issues and may therefore lack pertinence and effectiveness for the corresponding environmental and health policies.

In addition, so far a large body of literature has investigated the relationship between environment and economic development. As for China, many recent studies have verified that there is an inverted-U relationship between environmental quality and GDP per capita (e.g., Hao and Liu, 2016; Kang et al., 2016). As a result, there might probably be dynamic relationship between environmental quality, economic development and public health, which deserves careful investigation and has important policy implications.

Therefore, the main contribution of this paper is threefold. First of all, this study investigates the dynamic relationship between environmental pollution, economic development and public health. Previous studies usually focused on the relationship between the environment and economic growth or the health impacts of environmental pollution, but the comprehensive studies on the relationship between the three factors are still scarce. Correspondingly, a simultaneous equation model (SEM) is utilized to deal with the potential endogeneity that may be caused by the bilateral causal relationship between these factors (Wooldridge, 2016). Second, as Arceo et al. (2016) stressed, previous studies on the health consequences of environmental quality, especially the relationship between pollution and infant mortality, are for developed countries. The researches on the impacts of environmental pollution on public health in developing countries are still scarce. This study focuses on China, the biggest developing country with a population more than 1.3 thousand million, and carefully investigates the relationship between the environment, economic development and public health, which contributes to the literature and help policy makers better understand the impacts of environmental pollution on public health in developing world. Third, to fully evaluate the environmental quality, two types of the data for environmental pollution – air pollution and industrial wastewater – are utilized in the empirical study. It is noteworthy that different kinds of industrial sewages have their own standard treating processes and emission standards in China. Considering the air pollution and water pollution are the most acute environmental problem in China, three representative pollutants – SO_2, soot and waste water – are chosen as the main environmental indicators. By choosing these three strictly monitored pollutants that severely affect public health, the estimation results are more reasonable and reliable, and the results for three indicators could be served as robustness check for each other. Moreover, as smog and haze pollution has become increasingly serious in recent years, the health impacts of $PM_{2.5}$, the main content of smog and haze pollution, have received more and more attentions home and abroad. However, because the official data for $PM_{2.5}$ concentrations were available only since late 2012, it is impossible to incorporate $PM_{2.5}$ as a pollutant in this study. Because SO_2 and soot (dust) are two important components of $PM_{2.5}$ dust (Yao et al., 2016), the studies on these air two pollutants to some extent reflect the health impacts and economic consequences of $PM_{2.5}$ pollution during the sample period.

The remainder of this study is organized as follows: The second section briefly reviews the relevant literature and summarizes the relationship between the economy, the environment and health. The third section describes the data sources and methods of empirical analysis. In addition, the fourth section presents the empirical estimation results and the corresponding analysis of the effects of environmental pollution on public health. The final section concludes the research and proposes related policy implications.

2. Literature review

Although there has been a growing body of literature on economic development, environmental quality and public health, most of these studies have examined the relationship between two of the variables, while systematic analyses of all three of these variables are still scarce. Thus far, the relevant studies could be broadly classified into three categories.

2.1. Economic development and environmental quality

Studies on the relationship between economic development and environmental quality are based mainly on the empirical framework of the Environmental Kuznets Curve (EKC). The EKC is an empirical hypothesis describing an inverted U-shaped relationship between economic growth and environmental degradation: at the early stages of economic development, as per capita income increases, environmental quality declines continuously, whereas once income reaches an inflection point, the increase in income contributes to the improvement of environmental quality (Grossman and Krueger, 1991, 1995). It is noteworthy that the EKC is merely a hypothesis based on empirical observations, and it cannot explain why economic growth has such a dynamic impact on environmental quality. To address this problem, a growing number of studies have come up with various theoretical explanations of the EKC (e.g., Kijima et al., 2011; Smulders et al., 2011). In the more recent studies, Omri et al. (2015) claimed that there is evidence of bidirectional causality between CO_2 emissions and economic growth and there exist the EKC for CO_2 emissions. Koirala and Mysami (2015) investigated and verified the existence of an inverted-U shaped EKC for the emissions of CO_2 per capita in the US. Stern (2017) made a comprehensive and insightful review of studies on EKC so far.

Moreover, on the other hand, not only does economic development affect environmental quality but environmental quality also has an influence on economic development. For instance, López (1994) took exhaustible resources and environmental quality as the traditional material capital and labor into the production function through constructing an endogenous economic growth