The Environmental Pollution Effects of Industrial Agglomeration
A Spatial Econometric Analysis Based on Chinese City Data

Suxia Liu, Nanjing University of Science and Technology, Nanjing, China & Zhengzhou University, Zhengzhou, China
Yingming Zhu, Nanjing University of Science and Technology, Nanjing, China
Weiqiang Wang, Zhengzhou University, Zhengzhou, China
Yu Pei, Nanjing University of Science and Technology, Nanjing, China
Kuanqi Du, Nanjing University of Science and Technology, Nanjing, China

ABSTRACT
To analyze the environmental pollution effects elicited by industrial agglomeration, a spatial econometric model is constructed based on the Green Solow model. Using data derived from 285 Chinese cities between 2003 and 2014, the global Moran’I and local bivariate LISA agglomeration map demonstrates that there is significant correlation between industrial agglomeration and industrial pollution discharge. Then, the spatial Durbin model (SDM) is built and the empirical results are as follows. First, inter-city industrial pollution discharge has a demonstration effect. Cites in the same region should take measures to cooperate to lower industrial pollution discharge. Second, the relationship between the local cities’ industrial agglomeration and the local cities’ industrial pollution discharge fits the inverted “U” curve. While the neighboring cities’ industrial agglomeration will decrease the local cities’ industrial pollution discharge. So, measures should be taken to increase the industrial agglomeration degree in the long run.

KEYWORDS
China, Demonstration Effect, Industrial Pollution, LISA, Moran’s I, Spatial Correlation, Spatial Durbin Model, Spatial Spillover

INTRODUCTION
Industrial agglomeration contributes a lot to spur economic growth of China mainly through Marshall-Arrow-Romer (MAR) externalities or Jacobs externalities. While with the enhancing of industrial agglomeration and rapid economic growth, China now has been noted for not only its high economic growth but also its severe environmental degradation (Sun & Yuan, 2015). According to the “Towards the environmentally sustainable future: national environmental analysis of the People’s Republic of China” issued by Asian development bank 2013, only less than 1% of the 500 large cities in China are up to the world health organization (WHO) air quality standards. In 2012, 33 out of 113 key environmental protection cities achieved the National Air Standard II level (Ministry of Environmental Protection, 2012).

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The industrial pollution also leads to China’s agricultural losses by reducing yields and reducing areas suitable for crops. The concentrations of SO$_2$ and fluoride typical for some Chinese cities and industrial areas in the 1980s can reduce the growth and yield of local crops and vegetables by 5-25% (Cao, 1989). Wei et al. (2014) noted that an agricultural loss of $1.43$ billion was caused by industrial SO$_2$ pollution in China, which accounted for approximately 0.66% of the total agricultural added value of 899 countries. Monterroso-Rivas et al. (2018) estimates the double impact of climate change and soil loss over crops and gets the result that with climate change caused by environmental pollution, potential crop yields suffer a generalized decrease.

As the environmental pollution appeared with the industrial agglomeration, the relationship between industrial agglomeration and industrial pollution discharge has received high attention within the field of environmental economics. Most of the literature use Chinese provincial panel data to do empirical research and contradictory findings have been reported. The industrial agglomeration may aggravate industrial pollution discharge due to the industrial production expansion (Fagbohunka, 2012; Sun & Yuan, 2015) and the “pollution haven” effects (Zeng & Zhao, 2009; Wagner & Timmins, 2009). By contrast, research also provides evidence that industrial agglomeration is conducive to abate industrial pollution discharge because of the scale effect in pollutant treatment (Copeland & Taylor, 2004), more stringent environmental regulations in the industrial agglomeration (Lu & Feng, 2014; Milani, 2017), the knowledge and technology spillover effect (Porter, & Van, 1995; Popp, Newell, & Jaffe, 2010) and the industrial symbiosis effects in the industrial agglomeration (Cheng, 2016). There are also research gets the conclusion that the relationship between industrial agglomeration and environmental pollution is nonlinear because of the effect of the intermediate variables such as city size, marketization level, industrial agglomeration degree, industrial structure and technological innovation (Zhang & Dou, 2015; He, Huang, & Ye, 2014).

Although previous studies make this topic clearer, there are still deficiencies. One is that the existing literatures based on China used the provincial data. As a large country, the industrial agglomeration level is quite different in different region of a province, so the research using provincial data cannot reflect the real relation between industrial agglomeration and environmental pollution. In addition, most of the existing research ignored the spatial correlation and spillover effects of industrial agglomeration and industrial pollution. In reality, the flow of contaminated water, the diffusion of air pollution, and the spread of dust all lead to spatial correlation and spatial dependence of regional environmental pollution levels (Wang, Kang, Wu, & Xiao, 2013; Li, 2014). Furthermore, spatial correlation could also result from endogenous interactions in plant behavior in the industrial cluster, which could generate both the “selection effect” and “demonstration effect” (Gray & Shadbegian, 2007). So the research results without considering the spatial correlation may be biased.

Compared with previous researches, the contributions of this study are mainly embodied in the following two aspects. First, the study uses panel data of 285 prefecture level cities’ annual data from 2003-2014 to investigate the relationship of industrial agglomeration and industrial pollution discharge in China. Second, The Moran's I and bivariate LISA is used to estimate the spatial autocorrelation of industrial agglomeration and industrial pollution discharge in China. Furthermore, spatial Durbin model (SDM) is applied to estimate the effect of industrial agglomeration on industrial pollution discharge to ensure that the spatial autocorrelation effect and spatial spillover effect be taken into consideration.

The rest of this paper is organized as follows. Section 2 describes the variables, methodology and builds the spatial econometric model. Section 3 does empirical estimation using the panel data of 285 prefecture level cities of China from 2003-2014. Section 4 concludes the paper with a brief summary of findings and discussion of policy implications.
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