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Does foreign direct investment affect environmental pollution in China's cities? A spatial econometric perspective

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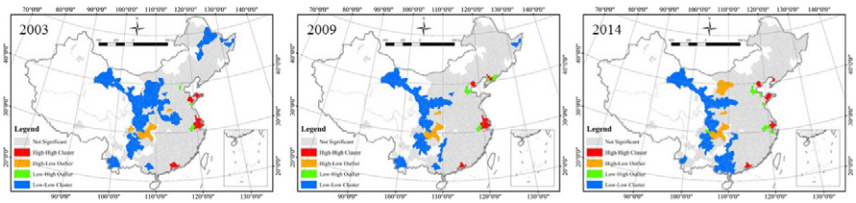
HIGHLIGHTS

- The spatial agglomeration effects of FDI and environmental pollutants are estimated.
- Global and local spatial autocorrelation and spatial panel data models are adopted.
- FDI and environmental pollution had obvious path dependence characteristics.
- FDI had distinct effects on different environmental pollutants.
- FDI reduced waste soot and dust, and increased wastewater and sulfur dioxide.

GRAPHICAL ABSTRACT



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ABSTRACT

Environmental pollution has aroused extensive concern worldwide. Existing literature on the relationship between foreign direct investment (FDI) and environmental pollution has, however, seldom taken into account spatial effects. Addressing this gap, this paper investigated the spatial agglomeration effects and dynamics at work in FDI and environmental pollution (namely, in waste soot and dust, sulfur dioxide, and wastewater) in 285 Chinese cities during the period 2003–2014, using global and local measures of spatial autocorrelation. Our results showed significant spatial autocorrelation in FDI and environmental pollution levels, both of which demonstrated obvious path dependence characteristics in their geographical distribution. A range of agglomeration regions were observed. The high-value and low-value agglomeration areas of FDI were not fully consistent with those of environmental pollution. This result indicates that higher inflows of FDI did not necessarily lead to greater environmental pollution from a geographic perspective, and vice versa. Spatial panel data models were further adopted to explore the impact of FDI on environmental pollution. The results of a spatial lag model (SLM) and a spatial error model (SEM) revealed that the inflow of FDI had distinct effects on different environmental pollutants, thereby confirming the Pollution Heaven Hypothesis and Pollution Halo Hypothesis. The inflow of FDI was found to have reduced waste soot and dust pollution to a certain extent, while it increased the degree of wastewater and sulfur dioxide pollution. The findings set out in this paper hold significant implications for Chinese environmental pollution protection.

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1. Introduction

Recent decades have witnessed an economic renaissance in China (Liu and Wang, 2017; Liu et al., 2017). With economic globalization, the foreign direct investment (FDI) of China reached 126.3 billion dollars in 2015, ranking the first amongst developing countries in terms of FDI for the last 24 years.[1] Indeed, FDI has gradually become one of the most important driving forces for economic development (Wang and Chen, 2014). Despite these successes, it is also important to note that a large proportion of FDI has gone into pollution-intensive industries, and thus brought about severe environmental pollution (Li and Zhang, 2014; Liu and Wang, 2017). To address these issues, the Chinese government has officially implemented the Environmental Protection Law in 2015, indicating China is entering a new phase in environmental conservation. There is, however, a great deal of work to be done. The World Environmental Performance Index (EPI), for instance, ranked China 118 of 178 countries and regions in 2014,[2] and the Asian Development Bank and Tsinghua University has found that less than 1% of the 500 large cities in China complied with World Health Organization (WHO) air quality standards in 2013 (Zhang et al., 2016). Achieving compliance with international environmental protection standards, and finding ways to coordinate FDI and concurrently address regional environmental problems, now constitute serious tasks for local governments across the country.

The relationship between FDI and environmental pollution has aroused extensive interest in the world's research community. At the same time, research into this relation has been plagued by contradictory and ambiguous empirical results. Existing literature has tended to concentrate on three quite separate understandings of this relationship. The first—and the prevailing—view is that the impact of FDI on environmental pollution follows the Pollution Haven Hypothesis (PHH), which holds that inward FDI worsens environmental conditions (Hoffmann et al., 2005; Wang et al., 2017b). Walter and Ugelow (1979) were the first to propose that the environment should be treated as factor of production, arguing that differences in environmental regulation are an important stimulant of capital flows. Since then, larger number of scholars, such as Cole (2004), Levinson and Taylor (2008), and Lan et al. (2012) have conducted empirical analysis in line with the PHH and concluded that FDI indeed aggravates environmental pollution. In recent years, though, a number of studies have estimated the effect of FDI on environmental degradation by considering other control variables, including: economic growth, trade openness, R&D levels, energy consumption, urbanization, etc. (Yin et al., 2008; Cole et al., 2011; Mutafoglu, 2012; Wang et al., 2017a). For example, Omri et al. (2014) estimated the relationship between FDI, economic growth, and CO_2 emissions, finding a bidirectional causality to exist between FDI and environmental pollution, and FDI inflows aggravated environmental pollution. Kivyiro and Arminen (2014) tested the relationship between FDI, energy consumption and economic growth in a study of data from sub-Saharan Africa. The findings of their study demonstrated the existence of causal links between FDI and CO_2, indicating that FDI resulted in higher CO_2 emissions. Wang et al. (2014) investigated the relationship between FDI and environmental pollution, noting that FDI accelerated domestic production and production efficiency, but also increased environmental pollution. Shahbaz et al. (2015) investigated the nonlinear correlation between FDI and environmental degradation for high-, middle-, and low-income countries. Their estimated results indicated that FDI enhanced environmental degradation. Finally, Khan et al. (2014) investigated the linkages between energy consumption, economic growth, FDI, relative price, and financial development in countries with different income levels in both the OECD outside it, concluding that FDI enhanced energy demand in both middle- and high income, non-OECD and OECD countries.

The second area of scholarship follows the Pollution Halo Hypothesis, which holds that while the introduction of FDI results in deteriorating environmental quality in the host country, it is also conducive to improving regional environmental conditions (He, 2006; Liang, 2008). Generally, previous studies with this focus have shown that the progress in green technologies that accompanies FDI inflows can lead to rapid improvements in energy efficiency and thus result in reductions in CO_2 emissions (Dincer and Rosen, 2011; Lee, 2009). Such studies tend to firstly characterize the production and pollution control behaviors of FDI in terms of increasing returns to scale (Zarsky, 1999). FDI is thus shown to be able to boost income levels and, accordingly, to improve environmental quality (Mani and Wheeler, 1998). Secondly, this group of studies have shown that compared with local enterprises, foreign-funded enterprises generally implement unified and strict environmental standards, and that as a result, overseas investment lessens local pollution emission levels (Chudnovsky et al., 2005). In addition, research has noted that the international environmental standards implemented by foreign-funded enterprises can facilitate the development of environmental technology in host countries, further validating the existence of Pollution Halo Hypothesis (Eskeland and Harrison, 2003). Finally, the new technology provided by FDI has been shown to be conducive to promoting environmental quality (Frankel, 2003).

Following the decomposition of environmental effects put forward by Grossman and Krueger (1994), He (2006) and Lee (2009) argued that complex transmission mechanisms for environmental pollution exist in relation to FDI; as such, they broke their analysis of FDI down into scale, technique, and composite effects. At present, the majority of existing studies suggest that scale effects exert a negative impact on environmental quality. There is, however, less consensus in relation to technique and composite effects—this may be due to the range of different research objects and methods seen in this work (Bao et al., 2008; Wang et al., 2016). For example, a study by Pao and Tsai (2011) addressed the effect of economic growth and FDI on environmental degradation in BRIC countries (Brazil, Russia, India, and China), by applying a panel cointegration technique. These scholars found that a bidirectional causality exists between pollution emissions and FDI, supporting the Pollution Haven and Pollution Halo Hypotheses and demonstrating scale effects. Lan et al. (2012) estimated the impact of FDI and human capital on environmental pollution in China. Their results show that the impact of FDI on pollution emission is heavily dependent on the level of human capital stock—in provinces with low human capital, FDI was found to maintain a negative relation to polluting emissions, and conversely FDI was found to be positively associated with pollution emission levels. Al-mulali and Tang (2013) estimated the Pollution Haven Hypothesis using panel cointegration and causality methods in member countries of the Gulf Cooperation Council (GCC). Their analysis showed that while FDI reduced pollutant emissions, energy consumption and economic growth aggregated pollution levels. Their causality results imply a neutral influence between FDI and environmental pollution. Similar studies have also been undertaken in developed and developing countries (Kim and Baek, 2011), in Europe (Leiter et al., 2011), and in relation to 112 cities in China (Cole et al., 2011).

Generally, due to differences in research objects, ideas, and methods, research on the impact of FDI on the environment has not arrived at a unanimous conclusion. The existing literature has mainly addressed sulfur dioxide, carbon dioxide, and other pollution emission, and ignored wastewater, and waste dust and soot. The effect of FDI on a range of different pollutants thus remains to be investigated and discussed. It is also worth noting that environmental pollution has a strong spatial linkage, and as such a high degree of concentration of FDI will further strengthen the spatial correlation of environmental pollution (Poon et al., 2006). Traditional panel data analysis has overlooked the impact of spatial

[1] Data are derived from the 2016 China Foreign Investment Report issued by the Ministry of Commerce's Foreign Investment Management.

[2] The Environmental Performance Index (EPI) is a quantitative measure of environmental performance, used in a range of national policies. This index replaces the previous Environmental Sustainability Index (ESI), which was published between 1999 and 2005. The two indices are developed by Yale University and Columbia University.