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Essay on the Spatial Correlation Between Foreign Direct Investment and Environmental Regulation: The China Case Study

M2 ESDP – *Spatial Econometrics*

Introduction

Since the beginning of the XXI[st] century the People's Republic of China (here after China), has increasingly opened up to global trade which has exceptionally encouraged foreign direct investment (here after FDI) and has sharply busted its economic growth. Nevertheless, the Chinese success has its downturns: income gains and investment attractiveness are followed by a rise on air emissions (greenhouse gases and air pollutants), and therefore hindering the local environmental quality.

According to the "*Pollution Haven"* hypothesis[1], FDI are more attracted to regions with more relaxed environmental regulations (here after EGs). This phenomenon occurs since multinational companies (MNCs) aim to maximize profits by diminishing their production costs, which can be otherwise increased by abatement efforts imposed by environmental regulations. Thus, in order to attract more FDI and be more economic competitive, local governments will tend to have laxer environmental regulations or inhibit the implementation of central governmental policies.

In their paper Cheng, Li & Liu (2018) (here after the authors), discuss how in the competition for economic prowess exceled thanks to FDI, the reduction of environmental standards may spread to neighbour regions, leading to the imitation of regional environmental regulation strategies. They aim to resolve the following questions: Do local governments attract FDI by reducing their environmental standards? Considering environmental regulations, do regions imitate each other in order to remain competitive? And finally is the "*pollution haven"* hypothesis firmly established in China? Answering these questions will be key for the proper implementation of the 14[th] Five-Year Plan [2] developed recently by the central Chines government, as well as the improvement and adaptation of current FDI and environmental policies for the future sustainable development of China's urban economy.

Literature Review

In the past, many scholars analysed the effect of environmental regulations (EGs) on FDI, obtaining three different conclusions: EGs as not conductive to the inflow of FDI, EGs conductive to FDI's inflows and evidence of little or null effect on FDI [3]. Other scholars, studied the inverse causality between FDI and EGs and concluded there was no simple and direct effect of FDI on EGs although there can be an effect that is closely related to both degrees of corruption of local governments and market size[4].

Since those studies seemed to ignore the endogenous simultaneous relationship between EGs and FDI, the authors aimed with this paper to represent the two-way mechanism between them.

[1] "The "Pollution Haven "Hypothesis argues that firms will seek to avoid the cost of stringent environmental regulations (and high energy price) by locating production in countries (or places) where environmental norms are laxer" – OECD, 2017.

[2] More information in: https://www.hkstrategies.com/en/chinas-14th-five-year-plan-2021-2025-report/

[3] Some authors on the matter: Tang (2015), Chung (2014), Millimet and Roy (2009), Elliot and Zhou (2013), Ferrara et al. (2015), Marconi (2012), Poelhekke and Van der Ploeg (2015).

[4] Some authors on the matter: Erdogan (2014), Cole and Fredriksson (2009) and Dong et al. (2012).

On the one hand, EGs can affect the location choice of FDI through cost effects, innovation compensation and competition effects (D'Agostino, 2016). On the other hand, FDI can affect the formulation and implementation of EGs through market effects, corruption and welfare effects (Erdogan, 2014). At the same time, the authors add to the analysis the potential spatial spillover effects of both FDI and EGs on surrounding regions and cities in aims to have models more in line with reality.

Considering the particular case of China, under the decentralized governance structure and performance appraisal mechanism, local governments tend to reduce EGs' standards or distort the implementation of central government environmental policies in order to attract more FDI and promote their economic growth (Lan et al, 2012). Thus, surrounding regions might fear a loss on their competitive advantage to attract FDI. Moreover, if local governments follow a collective behaviour (rational or irrational), a "race to the bottom" phenomenon can have place with regards EGs by making them laxer. This is because, when considering environmental concerns, the optimal strategy for local governments can be to reduce EGs and share the responsibility for the losses caused by environmental pollution between neighbour regions or cities (Heyvaert,2013). Many studies such as those made by Levinson in 2003 aimed to determine whether competitive behaviour in EGs actually existed by looking into spatial lags. However, there is little research that has focused on the spatial interaction between FDI and EGs, and thus, the authors incorporate this with a particular eye on city-level data. Using this scale of analysis allows them to control for the within variations in Chinese provinces and better capture the spatial spillover effects.

Empirical Strategy

Data

In order to capture the spatial spillover effects, Cheng et al. (2018) use statistical municipal data from 285 cities around China and cover the period from 2003 to 2014. All data came from the China City Statistical Yearbook (2004-2015), the China Statistical Yearbook (2004-2015) and the China Audit Yearbook (2004-2015). Due to availability, validity and consistency of data, they decided to exclude Lhasa, Chaohu, Bijie, Tongren, Sansha and Haidong cities.

Endogenous Variables

Tab1. Endogenous Variables Description

Variable	***Methodology***	***Unit of Analysis***
Environmental Regulation Intensity	Weighted linear sum for the index construction. Weight estimated as the ratio of pollutant j for city i to pollutant j for all the sample to the ratio of GDP for city I to GDP for all sample cities.	Industrial sulphur dioxide removal rate and the industrial (powder) dust removal rate
Foreign Direct Investment		% GDP

Control Variables

Tab 2. Control Variables Description of FDI Equation

Variable	***Methodology***	***Unit of Analysis***
Urban Market Potential	Harris Method (1954)[5]	Urban GDP (currency not specified), Euclidean distance between cities, Two-thirds of the urban radius for the internal distance
Factor Endowment	Ratio of capital to labour (capital intensity)	
Labour Cost	Average wage of urban workers	Currency not specified
Infrastructure Level		Per capita urban roads
Degree of opening to the world	Dummy variable where 1 denotes that the city belongs to either a special economic zone or is a coastal open city	

Tab.3 Control Variables Description of EG Equation

Variable	***Methodology***	***Unit of Analysis***
Economic Development Level	Urban per capita GDP and incorporation of the quadratic term to verify the nonlinear effect given the Environmental Kuznets Theory	Currency not specified
Industrial Structure		% of the added value of secondary industry to GDP
Degree of Corruption	Violations listed by urban audit bureaus	% of total amount of violations to GDP
Degree of Government Intervention	Ratio of fiscal revenue to GDP	% GDP

Econometric Model

To answer their three main questions (see introduction), the authors decided to use spatial simultaneous equation models to analyse the two-way mechanism between EGs and FDI. They compare estimations from traditional spatial econometric models such as the SEM, SSE and SAR models. Using the Lagrange Multiplier test and Robust LM test they concluded that the SAR was a better fit. They proceeded to estimate the SE models using three stage least squares (3SLS) method and the SSE models using the Generalized Spatial Three Stage Least Squares (G3SLS). After confirming there wasn't multicollinearity issues between the independent variables and running the different models, they concluded that the G3SLS gave more accurate and reliable results. This is mainly because it considers the two-way mechanism between EGs and FDI as well as the spatial spillovers of both them, plus it solves the endogenous problems between variables and spatial correlation issues.

[5] HARRIS, C. (1954). The Market as a factor in the localization and geographic concentration. *Annals of the Association of American Geographers*, 64, 315–348.

Robustness testing and Sensitivity Analysis

In order to assess the efforts made to control the degree of urban environmental pollution, the authors calculated the Relative Nationwide Urban Pollution Emission Intensity given the Location Entropy Method used by Levinson (2003), Kukenova & Monteiro (2008) and Zhu et al. (2011). Here, the larger the index the laxer the urban environmental pollution control is and the lower the standards of the urban EGs. In this scenario, they considered three pollutants: industrial waste water, industrial sulphur dioxide and industrial dust**.** When using this variable, coefficients of EGs, FDI and the spatial spillover effects, as well as their significance levels, were consistent with their previous conclusions.

Since the spatial spillover effect is related at some extent to geographical distance, the authors set the spatial weight matrices of different distance thresholds for sensitivity analysis. They started first with a 50 km threshold, followed by a 150 km, 200km and 350 km. They concluded that both FDI equation and EG equation presented an inverted U-shaped curve. With increases in geographical distance over 200km, the FDI spatial spillover effect decreases because of stronger information asymmetries and the increases in matching and migration costs. For the EG equation, the local competitive effect of environmental regulations peaks at 350 km and has then a continuous downward trend due to increases in costs of regulation and migration.

Results

After the different regressions made, the results show that there is a **significant two-way mechanism between environmental regulations (EGs) and FDI in China.**

On the one hand, FDI tends to shift to a city with relatively relaxed environmental regulations. This indicates that EGs are one of the many factors that have a significant impact on the location of multinational companies (MNCs). Due to the competition between local governments to attract FDI, if a city strengthens its EGs by imposing new constraints on production performance, it will increase the cost burden on MNCs. Therefore, in order to maintain their international competitiveness, they might be forced to transfer to neighbour regions with less strict EGs and thus increase these regions' FDI inflow. The spatial lag coefficient of FDI being significantly positive indicates that FDI has a significant spatial spillover effect; that is, stronger FDI inflows in surrounding cities can significantly increase FDI inflow in the studied city via spatial spillovers. This can be explained by increases in demand and consumption leading to higher economic exchanges and technological transfers between neighbour cities. In their results, market potential, factor endowment (low capital intensity) and infrastructure level are important factors affecting the location choice of FDI as well. However, the effect of labour cost on FDI is not significant because the effects are mixed.

On the other hand, the **inflow of FDI increases local and neighbour cities environmental regulations in both severity and application**. This happens firstly because MNCs are expected to choose higher technological standards for production and operation with regard to environmental issues due to their corporate culture, social responsibility and overseas competition strategy, and therefore serve to significantly improve EGs' standards. Secondly, because MNCs have normally less contact with local environmental regulators they tend to have lesser rent-seeking behaviours that reduce the strict application of EGs. Thirdly, FDI can have inter-industrial and intra-industrial spillover effects,

promoting then the improvement of environmental innovation and technologies in the host country and thus strengthen EGs. At the same time, the spatial lag estimation coefficient of EGs being significantly positive indicates that surrounding cities will vary the standards of their EGs correspondingly to the variation of their neighbours' standards. The regression also showed that there is a U relationship between economic development level and environmental regulations. Moreover, an increase in the proportion of secondary industry is not conductive to an improvement in urban EGs (significant negative coefficient). Since this sector is dominated by manufacturing and resource extensive industries, local governments may lower their EGs' standards in order to achieve economic growth. Lastly, an increase in the degree of corruption reduces local EGs intensity as expected and the estimation coefficient of government intervention is not significant because of mixed effects on EGs.

For the authors, given the different results and a local competitive effect of environmental regulations to attract FDI, there will be a "race to the bottom" (reduction on EGs intensity) phenomenon in North China especially in Shandong, Hebei, Henan and Shanxi province. Meanwhile there are signs of a "race to the top" phenomenon (increase on EGs intensity) in Guangdong, Fujian, Zhejiang and other southern provinces. This confirms that **in China the "pollution haven" hypothesis does not completely hold**. **Here, FDI and environmental regulations will have then significant spatial spillover effects:** changes in FDI inflows and environmental standards in neighbour cities have important impacts on those of a particular city.

Conclusion

To conclude, the authors achieved to verified that for the Chines case there are spatial spillovers of both FDI and Environmental Regulations, and spatial interactions between them. An increase in FDI in a particular city can raise to some extent the FDI inflows of neighbour cities as well as to encourage the reinforcement of local and national environmental regulations and policies. At the same time, cities mimic the variation of environmental regulations' standards of their neighbours in aims to remain competitive and avoid losing FDI inflows. However, the mimicry seems to depend on the region: north regions being more encourage to have laxer EGs that the southern regions.

The methodologies developed by this paper to study the spatial relationship between FDI and Environmental Regulations can be mobilized to the case study of other countries where there exists a certain degree of institutional autonomy between sates, cantons or departments such as the USA or Switzerland. However, in further studies there should be a distinction between the effect of entry modes and sector composition of the considered FDI. This is because greenfield investments directly add to production capacity and contribute to capital formation and employment in the host country; while Mergers & Acquisitions (M&A) represent only a change in ownership that does not necessarily involve any immediate addition to investment, multifactor productivity or employment in the country (UNCTAD, 2006) that will enhance stern EGs. On parallel, if FDI is mainly directed to the extractive industries and the exploitation of natural resources, it can lead to rent-seeking practices and a higher pressure on local governments to establish laxer environmental regulations. Thus, when accounting for the contribution of FDI on the GDP and its interactions with the environmental regulations and policies stringency, those distinctions will enhance a more thorough representation. Finally, the authors' approach can be enlarged by including other air emissions (e.g. CO_2, CH_4), as well as by mobilizing the Environmental Policy Stringency Index made by the OECD.

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