Multi-perspective Study on the Impact of Population Agglomeration on Haze Pollution in China

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Contents

Introduction

Haze pollution in China is a serious problem and an inevitable threat to public health. In the new century, haze pollution has shown new spatial characteristics and development trends. Especially, the high frequency, extensiveness and severity of haze pollution in densely populated areas and economically developed areas has aroused public concern.

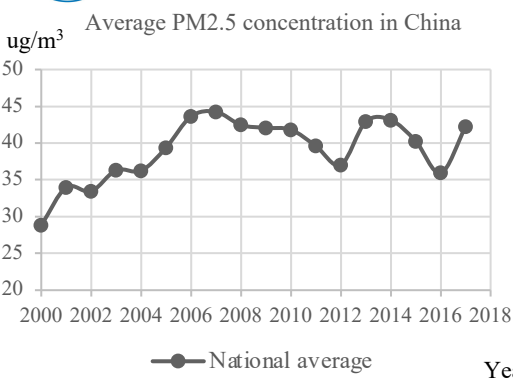


Figure 1: Time trend of annual average PM2.5 intensity in China

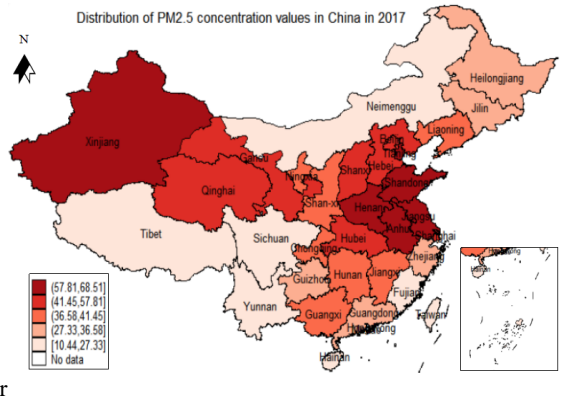


Figure 2: Spatial distribution of annual average PM2.5 intensity in China

- Actually,the trend of population agglomeration is becoming more and more obvious in China,which is formed a spatial distribution characteristic of dense in the eastern provinces and sparse in western region.
- The frequency and severity of haze pollution in population agglomeration areas make us realize that the link between population factors and haze pollution.

- In theory, the impact of population agglomeration on the haze pollution is not a single but multi-dimensional relationship. Changes in population scale, structure, and space caused by population agglomeration have different effects on haze pollution.
- How does the scale, structure, and spatial dimensions of population agglomeration affect haze pollution?

Hypothesis

- Hypothesis 1: The growth of population scale has exacerbated haze pollution. However, due to the population scale effect, population growth has a threshold effect on haze pollution.
- Hypothesis 2: Human capital inflows caused by population agglomeration are conducive to reducing haze pollution.
- Hypothesis 3: Population agglomeration has a spatial spillover effect on haze pollution.

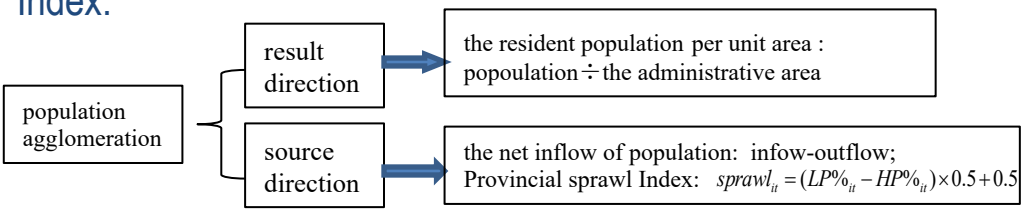
Method

- Based on the STIRPAT model and introducing the square and interaction terms of population variables ,we analyze the scale effect, structural effect and spatial effect of population agglomeration on haze pollution by using the Feasibility Generalized Least Squares(FGLS) and Spatial Durbin Model (SDM) .

Variables and data

- **Variables：**

- The explained variable :haze pollution is represented by PM2.5.
- The main explanatory variable:The population agglomeration indicators come from the two directions of result and source to improve the measurement dimension. 1. the resident population per unit area; 2. the net inflow of population; 3. Provincial sprawl Index.



- **Data：**

- The PM2.5 data comes from Atmospheric Composition Analysis Group (van Donkelaar et al. 2019).
- Relevant demographic data comes from the National Bureau of Statistics in China from 2000 to 2016.

Variable description

Variable	Variable abbreviation	Variable interpretation
Explained variable	lnpm	Logarithm of PM2.5
Main explanatory variables	lnpdensity	Logarithm of resident population per unit area(province)
	bfp	Standardized value of net population inflows
	sprawl	Provincial sprawl Index
Other variables	$lnpdensity^2$	Square of resident population per unit area(province)
	bfp^2	Square of the net population inflow
	$sprawl^2$	Square of provincial sprawl index
	fz	Average household size
	dividend	Proportion of labor force(15-64 year old) in total population
Control variables	lnagdp	Logarithm of per capital GDP
	lnretail	Logarithm of the total retail sales of consumer goods
	rd-gdp	R&D as a percentage of GDP
	pindustry	Industrial output as a percentage of total output

Results

Direct impact of population agglomeration on haze pollution

(lnpm)	(1) Result variable	(2) Source variable	(3) Result variable	(4) Source variable
lnpdensity	**0.082***(0.077)**		0.503*(0.257)	
bfp		**0.226***(0.035)**		0.467***(0.123)
sprawl		**-0.440***(0.058)**		-1.139***(0.270)
lnpdensity2			**-0.050*(0.029)**	
bfp2				**-0.379*(0.210)**
sprawl2				**0.909***(0.320)**
lnagdp	0.046(0.053)	0.056**(0.027)	0.053(0.050)	-0.004(0.036)
lnretail	-0.339***(0.057)	-0.376***(0.02844)	-0.326***(0.077)	-0.391***(0.036)
rd-gdp	5.482***(2.104)	-3.962**(1.746)	3.618(2.806)	4.308(2.205)
pindustry	0.794***(0.094)	0.888***(0.057)	0.522***(0.115)	0.961***(0.065)
Time/Province	YES	YES	YES	YES

Structural effects of population agglomeration on haze pollution

lnpm	(1)	(2)
lnpdensity		-0.111(0.263)
fz	-0.242***(0.020)	0.060(0.190)
dividend	-0.748***(0.180)	-3.660**(1.631)
lnpdensity*fz		-0.056*(0.032)
lnpdensity*dividend		0.543**(0.262)
Constant	-149.575***	-112.042 ***
Control variables	YES	YES
Time/Province	YES	YES

Spatial impact analysis（SDM)

lnpm	(1)	(2)	(3)	(4)
lnpdensity	**0.069***(0.020)**			-0.672*(0.378)
bfp		0.033(0.073)		
sprawl		**-0.268*(0.154)**		
fz			-0.03179(0.041)	0.043(0.220)
dividend			-0.541*(0.294)	-7.186***(2.251)
lnpdensity*fz				-0.020(0.038)
lnpdensity*dividend				**1.098***(0.378)**
W lnpdensity	**-0.177***(0.045)**			-0.334***(0.090)
W bfp		0.177(0.129)		
Wsprawl		**-0.692**(0.324)**		
W fz			**-0.167***(0.047)**	-0.420**(0.177)
Wdividend			**-1.093***(0.341)**	-0.408(0.820)
W lnpdensity*fz				**0.072**(0.033)**
W lnpdensity*dividend				0.060(0.158)
Control variables	YES	YES	YES	YES

Regional heterogeneity

lnpm	Population scale			EKC curve		
	East	Central	West	East	Central	West
lnpdensity	**0.088*** **	-0.673	0.004	-0.085	9.548**	0.162
bfp	**0.338*** **	-0.029	0.057	3.397***	0.214	0.581
sprawl	**-0.758*** **	0.106	-0.087	-2.708***	-1.79	-0.072
$lnpdensity^2$				0.020	-0.929**	-0.879
bfp^2				**-2.085*** **	-1.857**	-0.879
$sprawl^2$				**3.328*** **	2.194	-0.017
lnpm	**Population structure**			**Interaction effect**		
	East	**Central**	**West**	**East**	**Central**	**West**
lnpdensity				1.130***	-0.844	0.569
fz	-0.205***	-0.257***	-0.134***	0.648*	-1.445**	0.101
dividend	-0.395	0.094	-1.585***	4.363*	-3.947	1.488
lnpdensity*fz				**-0.135** **	0.209*	-0.043
lnpdensity*dividend				**-0.737***	0.679	-0.545
Control variables	YES	YES	YES	YES	YES	YES
Time/Province	YES	YES	YES	YES	YES	YES
n	187	136	187	187	136	187

conclusion

- First， the impact of population agglomeration on haze pollution has a significant scale effect.There is a significant U-shaped structural relationship between the population agglomeration and PM2.5. (Hypothesis 1)
- Second, structural effect studies show that the increase of household size and labor force caused by population agglomeration is conducive to the reduction of haze pollution. (Hypothesis 2)
- Third, The scale and structure adjustments caused by population agglomeration have significant spatial spillover effects and regional heterogeneity on the impact of haze pollution. (Hypothesis 3)

- In summary, the intensification of haze pollution is not an inevitable result of population agglomeration, but its periodic performance. Promoting the process of urbanization, developing population agglomeration in city belt, and rational population distribution can effectively reduce haze pollution to a certain extent.

Limitations

- As with all research, the present study has its limitation. This article examines inter-provincial panel data, but haze pollution in China are often closely related to the development of urban agglomerations. However, since the time span of haze and population agglomeration data in most cities is not sufficient and access to them is limited, this article only analyzes inter-provincial panel data, but fails to conduct research at the city level ,which is what we need to further deepen.


Thanks