How do the economic activities influence the air quality in China?

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Overview

Introduction

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- China is one of the largest developing countries and experiencing severe air pollution.
- How to measure the impact of economic activities on air pollution in China?

Introduction

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- Few studies focus on investigating small-scale administrative regions, such as community-level regions.
- In this study, we investigate the impact of activities based on monthly night lights on air pollution at the community-level administrative regions in China.

Overview

Model

- Our study uses nighttime light as the proxy of nighttime economic activity.
- While many industrial plants do not emit light at night, nighttime economic activities in service sectors are normally observable and hence can be captured by their light emission.
- Our study assume that all the nighttime economic activities can be captured by nighttime lights.

Model

- Our baseline model to estimate the effect of nighttime light ($NL_{i,t}$) on nighttime AQI ($AQI_{N,i,t}$) at community i in city k in month t is specified as:

$$AQI_{N,i,k,t} = \alpha_i + \beta NL_{i,k,t} + \boldsymbol{\delta} \mathrm{X}_{i,k,t} + f_{i,k,t} + \varepsilon_{N,i,k,t} \tag{1}$$

  - $\mathrm{X}_{i,k,t}$: meteorological covariates such as air temperature and precipitation
  - $f_{i,t}$: the full set of location dummies interacted with time dummies
  - α_i: the fixed effect of community i in city k in month t

Model

- Equation (1) can bring in a potential **endogenous** problem if people stay indoors caused by heavy air pollution outsides.
- Salvo (2020): A local pollution was a determinant of electricity demand under poor air quality; naked eye can detect differences in PM2.5 concentrations below 10 $\mu g/m^3$ versus above 50 or 100 $\mu g/m^3$.
  - Inference: If the air quality gets worse, i.e., AQI $\in [100, +\infty)$ & PM 2.5 $\in [75, +\infty]$, people can detect the bad air qualify and is likely to stay at home.
- Under a certain level, pollution will not affect the indoor activities and further not affect nighttime light.

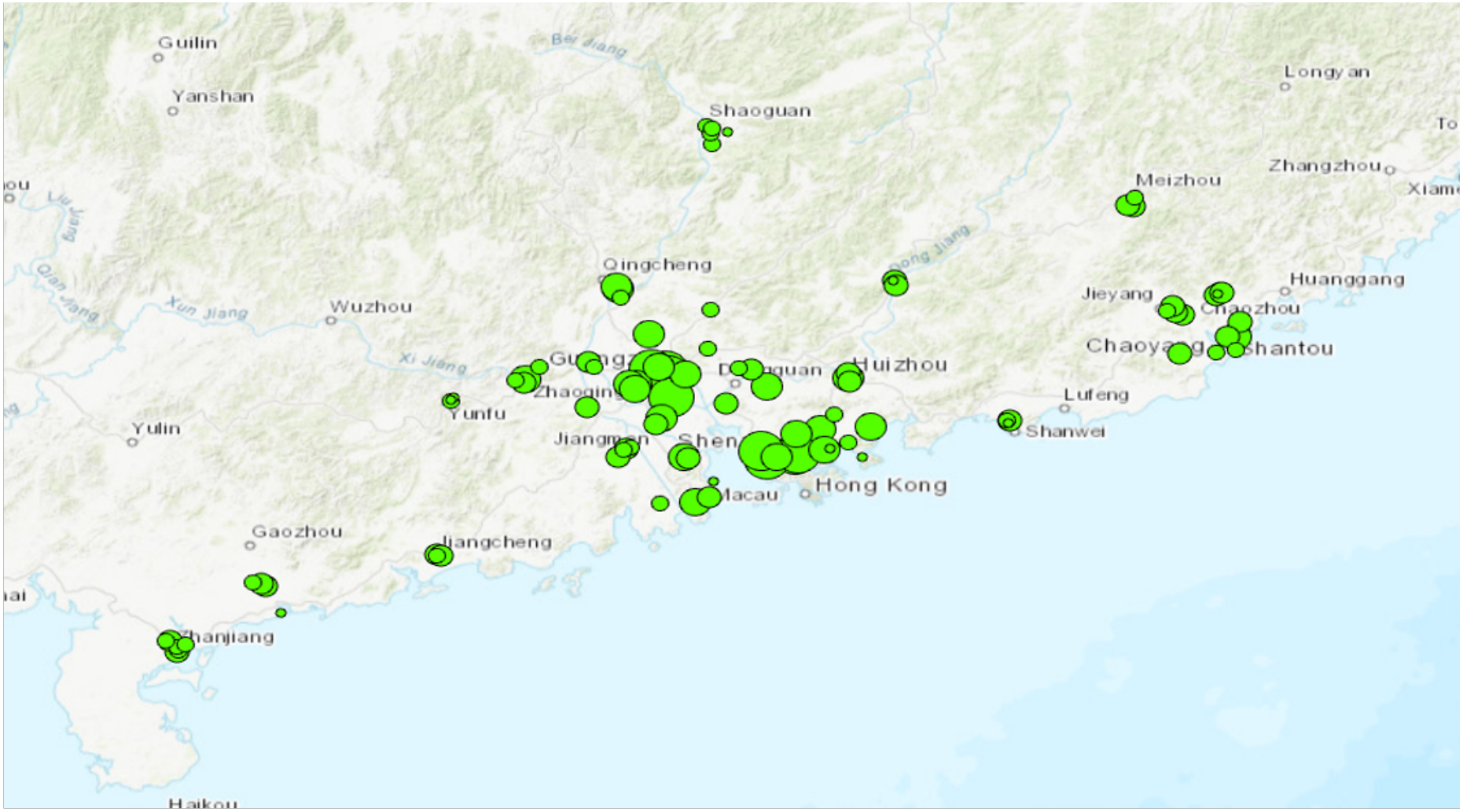
Model

Nighttime differenced air quality indicators ($AQI_{F,i,k,t}$), derived by $AQI_{F,i,k,t} = AQI_{N,i,k,t} - AQI_{D,i,t}$, where $AQI_{N,i,k,t}$ is the nighttime AQI and $AQI_{D,i,k,t}$ is the daytime AQI at community t in month t.

$$AQI_{F,i,k,t} = \alpha_i + \phi NL_{i,k,t} + \boldsymbol{\delta} \mathbf{X}_{i,k,t} + f_{i,k,t} + \varepsilon_{F,i,k,t} \tag{2}$$

Overview

Figure 1: Average Nighttime Light in the Communities of Guangdong Province

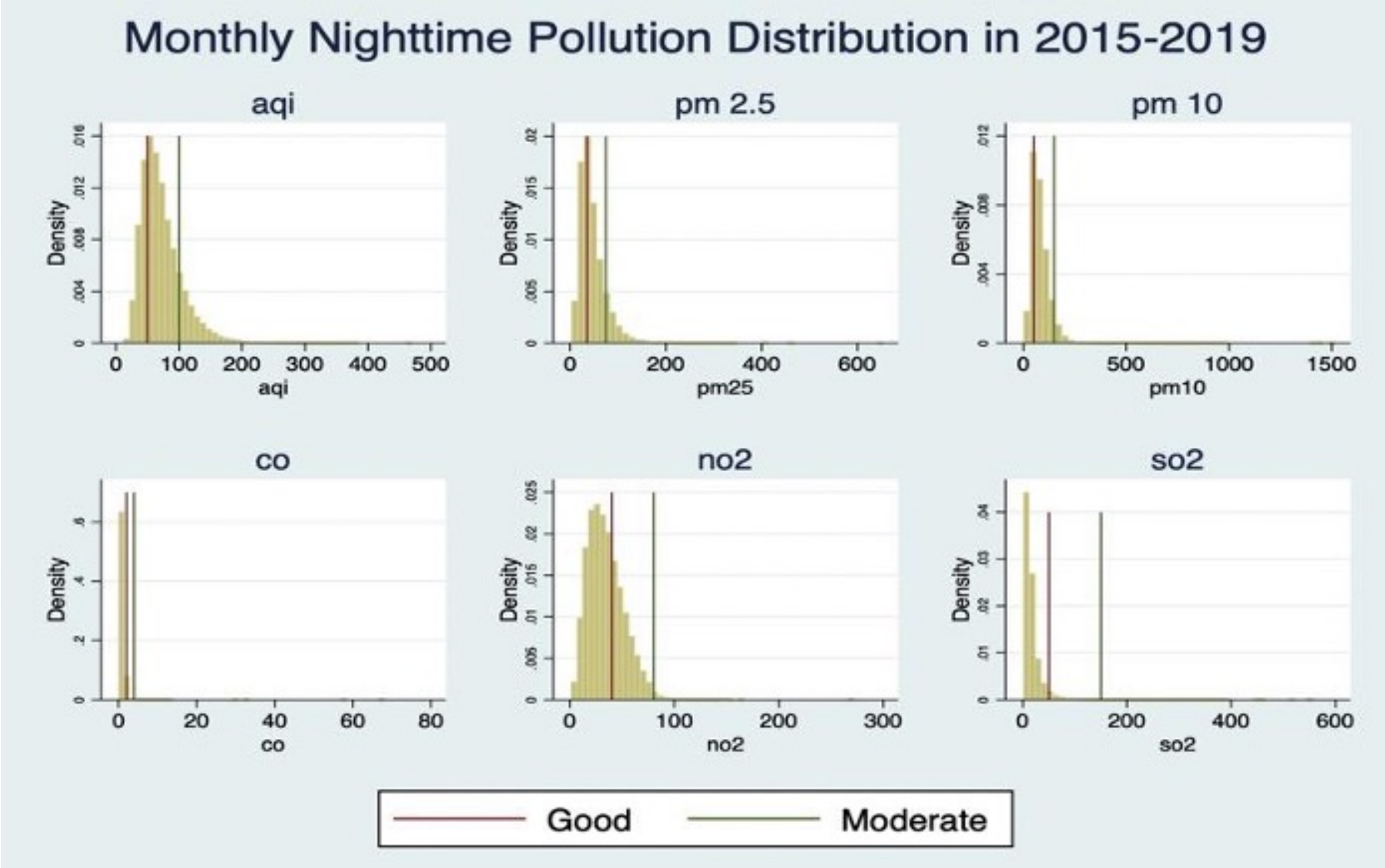


Data

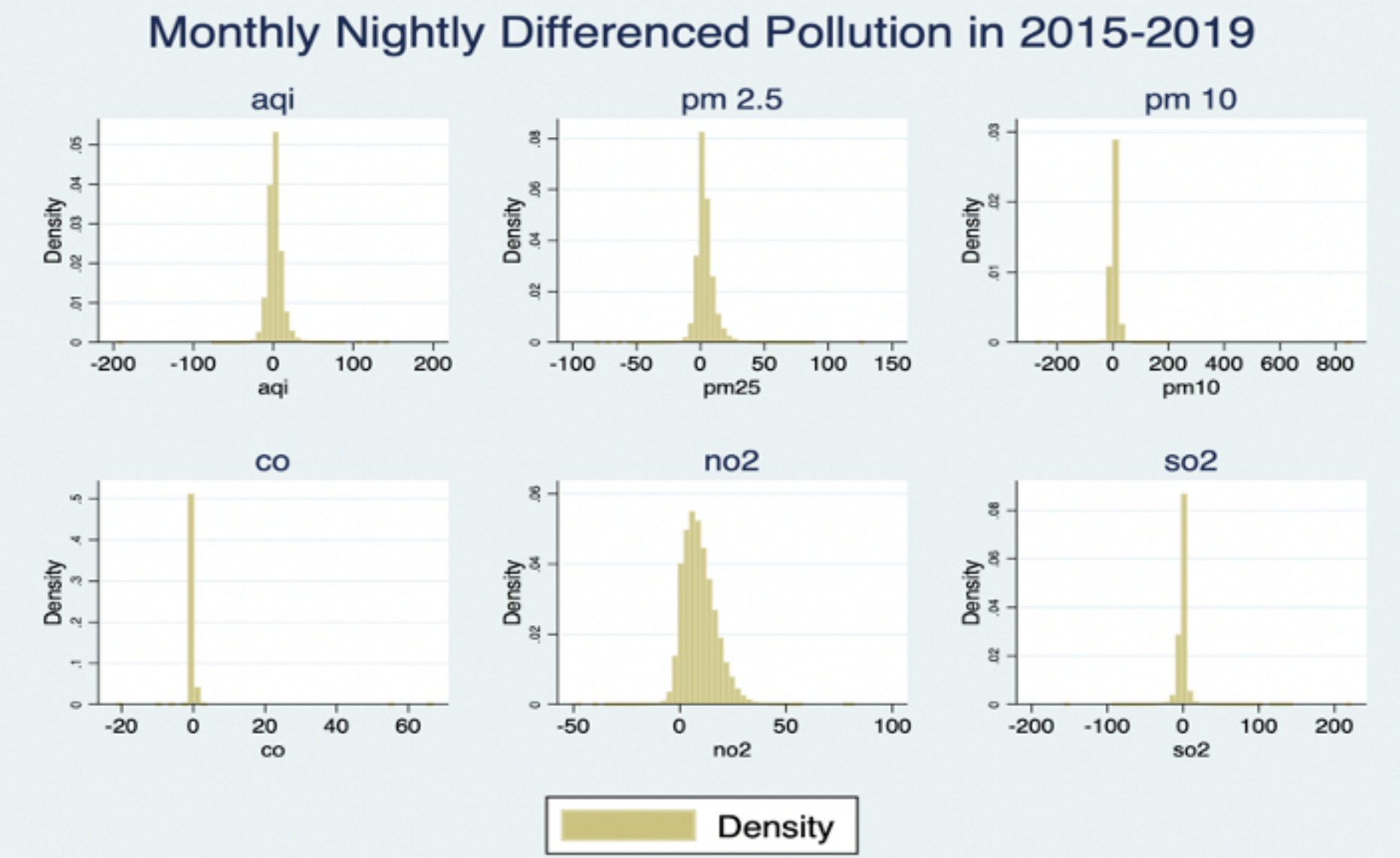
Table 1: Descriptive Statistics for nighttime pollution, meteorological variables and light

Variables	Observations	Unit	Mean	Median	S.D.	Maximum	Minimum
AQI	83917	index	72.36	65.16	33.57	469.60	12.00
pm 2.5	83872	ug/m3	46.10	39.57	27.75	653.62	2.67
pm 10	83847	ug/m3	81.15	71.53	45.36	1517.38	0.80
co	83898	ug/m3	0.97	0.86	0.59	68.00	0.04
no2	83845	ug/m3	34.31	31.95	17.16	271.75	1.00
so2	83857	ug/m3	17.63	12.42	18.41	556.28	1.12
Air Temperature	89855	celsius degree	13.52	15.13	10.37	36.87	-30.39
Precipitation	79694	millimeters (mm)	33.87	25.33	31.87	372.00	0.00
Nighttime Light	89871	nW/cm2/sr	11.57	8.39	11.14	126.36	0.00

$AQI_{N,i,k,t}$


Monthly Nighttime Pollution Distribution in 2015-2019
aqi
pm 2.5
pm 10
co
no2
so2
Density
aqi
pm25
pm10
co
no2
so2
Good
Moderate

$AQI_{F,i,k,t}$


Monthly Nightly Differenced Pollution in 2015-2019
aqi
pm 2.5
pm 10
co
no2
so2
Density
aqi
pm25
pm10
co
no2
so2
Density

Overview

Results

Table 2: Main nighttime air quality indicators and nighttime light estimations for the full sample

Dependent Variable:	AQI		PM 2.5		PM 10	
	(1)	(2)	(3)	(4)	(5)	(6)
Nighttime Light	0.0573***	0.0545	0.0242	0.0680**	0.0672***	0.0367
	(0.0077)	(0.1058)	(0.2169)	(0.0249)	(0.0095)	(0.4049)
Air Temperature	Yes	Yes	Yes	Yes	Yes	Yes
Precipitation	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE		Yes		Yes		Yes
Month × city FE	Yes		Yes		Yes	
Province × year FE	Yes		Yes		Yes	
Month × year FE	Yes		Yes		Yes	
Month × year × province FE		Yes		Yes		Yes
Observations	74519	74504	74475	74460	74456	74439
R-squared	0.839	0.841	0.821	0.817	0.827	0.817

Notes: P-value in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Results

Table 3: Main nighttime air quality indicators and nighttime light estimations when **air quality is at good or moderate level**

Dependent Variable:	AQI		PM 2.5		PM 10	
	(1)	(2)	(3)	(4)	(5)	(6)
Nighttime Light	0.0441***	0.0100	0.0169**	0.0229**	0.0817***	-0.0128
	(0.0000)	(0.4368)	(0.0468)	(0.0477)	(0.0000)	(0.4972)
Air Temperature	Yes	Yes	Yes	Yes	Yes	Yes
Precipitation	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE		Yes		Yes		Yes
Month × city FE	Yes		Yes		Yes	
Province × year FE	Yes		Yes		Yes	
Month × year FE	Yes		Yes		Yes	
Month × year × province FE		Yes		Yes		Yes
Observations	62037	62044	64767	64771	68815	68815
R-squared	0.819	0.833	0.806	0.816	0.832	0.847

Notes: P-value in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Results

Table 4: **Nightly differenced** air quality indicators and nighttime light estimations when **air quality is at good or moderate level**

Dependent Variable:	AQI		PM 2.5		PM 10	
	(1)	(2)	(3)	(4)	(5)	(6)
Nighttime Light	0.0064	0.0148*	0.0087	0.0124**	0.0134	-0.0028
	(0.4897)	(0.0980)	(0.1306)	(0.0434)	(0.2133)	(0.8048)
Air Temperature	Yes	Yes	Yes	Yes	Yes	Yes
Precipitation	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE		Yes		Yes		Yes
Month × city FE	Yes		Yes		Yes	
Province × year FE	Yes		Yes		Yes	
Month × year FE	Yes		Yes		Yes	
Month × year × province FE		Yes		Yes		Yes
Observations	60494	60489	62996	62995	67175	67152
R-squared	0.603	0.569	0.661	0.570	0.553	0.522

Notes: P-value in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Results

- Heterogeneous Effects
  - *Other Pollutants*
  - *Seasonal Variations*
  - *Spatial Effects* (in progress)
- Heavy Pollution (in progress)

Results

Table 5: Nightly differenced co, no2, so2 and nighttime light estimations when **air quality is at good or moderate level**

Dependent Variable:	CO		NO2		SO2	
	(1)	(2)	(3)	(4)	(5)	(6)
Nighttime Light	0.0001	-0.0001	-0.0018	0.0129*	0.0431***	0.0105
	(0.3972)	(0.5283)	(0.8073)	(0.0792)	(0.0000)	(0.2260)
Air Temperature	Yes	Yes	Yes	Yes	Yes	Yes
Precipitation	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE		Yes		Yes		Yes
Month × city FE	Yes		Yes		Yes	
Province × year FE	Yes		Yes		Yes	
Month × year FE	Yes		Yes		Yes	
Month × year × province FE		Yes		Yes		Yes
Observations	71410	71384	71371	70891	70920	71343
R-squared	0.589	0.529	0.528	0.741	0.756	0.469
R-squared	0.589	0.529	0.528	0.741	0.756	0.469

Notes: P-value in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Results

Table 6: Nightly differenced air quality indicators and nighttime light estimations for four seasons when **air quality is at good or moderate level**

	April - June		July - September		October - December		January - March	
Dependent Variable:	AQI		AQI		AQI		AQI	
Mean of Nightly Diff AQI	-0.84		-1.09		5.00		4.90	
Nighttime Light	-0.0059	0.0012	0.0237*	0.0041	-0.0118	0.0110	0.0308**	0.0342*
	(0.5960)	(0.9136)	(0.0852)	(0.7343)	(0.3987)	(0.5404)	(0.0464)	(0.0561)
Air Temperature	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Precipitation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City FE		Yes		Yes		Yes		Yes
Month × city FE	Yes		Yes		Yes		Yes	
Province × year FE	Yes		Yes		Yes		Yes	
Month × year FE	Yes		Yes		Yes		Yes	
Month × year × province FE		Yes		Yes		Yes		Yes
Observations	17504	17496	18760	18756	13735	13199	10914	10920
R-squared	0.570	0.580	0.609	0.608	0.653	0.622	0.716	0.687

Notes: P-value in parentheses. * p<0.10, ** p<0.05, *** p<0.01

Overview

Conclusion

- We firstly apply the night lights as a measurement of economic activities and investigate the effect of night lights on air pollution in developing country context.
  - Under the good air quality, the effect is significantly positive.
- This study also contributes to the literature on empirically estimating the satellite imagery night lights on air pollution with a wide range of spatial and temporal variation.

Thank you very much!