Environmental shocks and higher education

How did an earthquake and air pollution influence college access and graduate mobility?

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Motivation: Sustainable development of higher education

Talent competition and preferential policies

- The quest for the innovation-driven growth has motivated nation states, regions, and cities competing for higher education graduates with favorable admission and graduate employment policies

Another driver for brain drain and brain gain?

Environmental and health shocks as negative impacts (COVID-19, earthquake, flood)

- Environmental shocks push college applicants and graduates away from particular localities, cities, regions, or even countries

→ Do environmental shocks threaten sustainable development of higher education?

Motivation: Lack of research on large-scale environmental shocks

Impact of environmental shocks

- Quantify impact of natural shocks on individual and societal well-being
  - Earthquakes (Blumenstock et al., 2016; Filipski et al., 2019; Gignoux & Menéndez, 2016; Hombrados, 2020; Sinding Bentzen, 2019)
  - Tsunamis (e.g. Cas et al., 2014; Heger & Neumayer, 2019; Lynham et al., 2017)
  - Hurricanes (Belasen & Polachek, 2008; de Oliveira et al., 2021; Özek, 2021; Strobl, 2012)

Environment shocks, mostly natural disasters

→ Causal effect of a large natural disaster on students' educational achievement, and the associated implications for a major global economy (U.S.A); lack of research on other countries

Motivation: Lack of research on how shocks affect higher education

Impact of environmental shocks on education

- Education related research
  - Natural disasters and education attainment (Caruso and Miller, 2015; Wang et al., 2017)
  - Impact of natural disasters on intergenerational education transfer (Almond, 2006; Andrabi et al., 2021; Caruso, 2017)
  - Growth of human capital (Almond, 2006; Caruso & Miller, 2015; Lin & Liu, 2014)

Early childhood to teenagers, not on college students

→ Lack of research on college access, process, completion, and employment outcomes

Natural disasters and high-stakes exam performance: Evidence from the 2008 Wenchuan earthquake

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Motivation

- Large-scale and unpredictable natural disasters on both individual and societal well-being;
- Economic and education research on disasters and their consequences is still limited;
- We explore a more recent seismic (Wenchuan Earthquake in 2008) using the national college entrance examination database

Wenchuan Earthquake

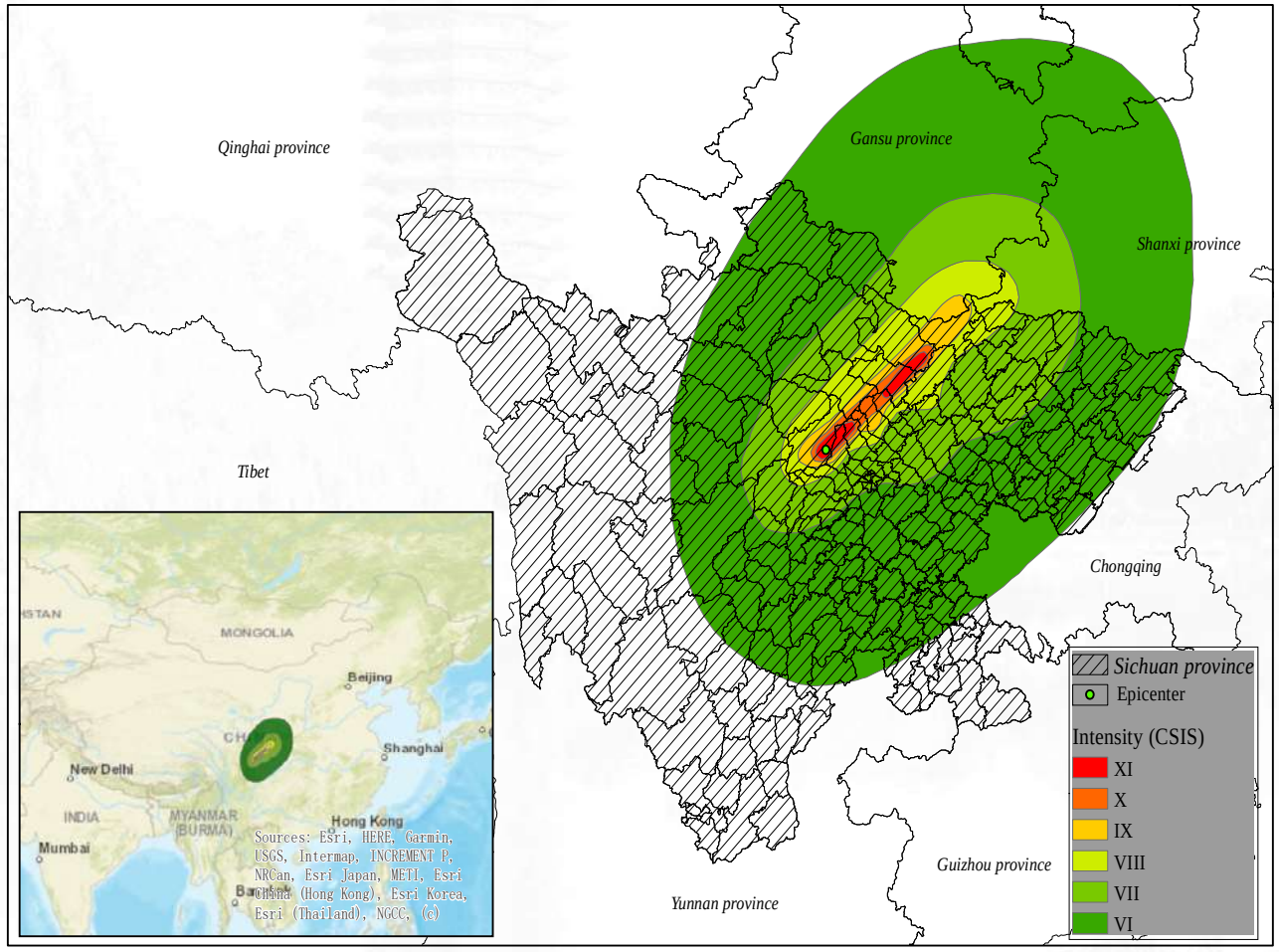


Fig1 : 2008 Wenchuan Earthquake Intensity

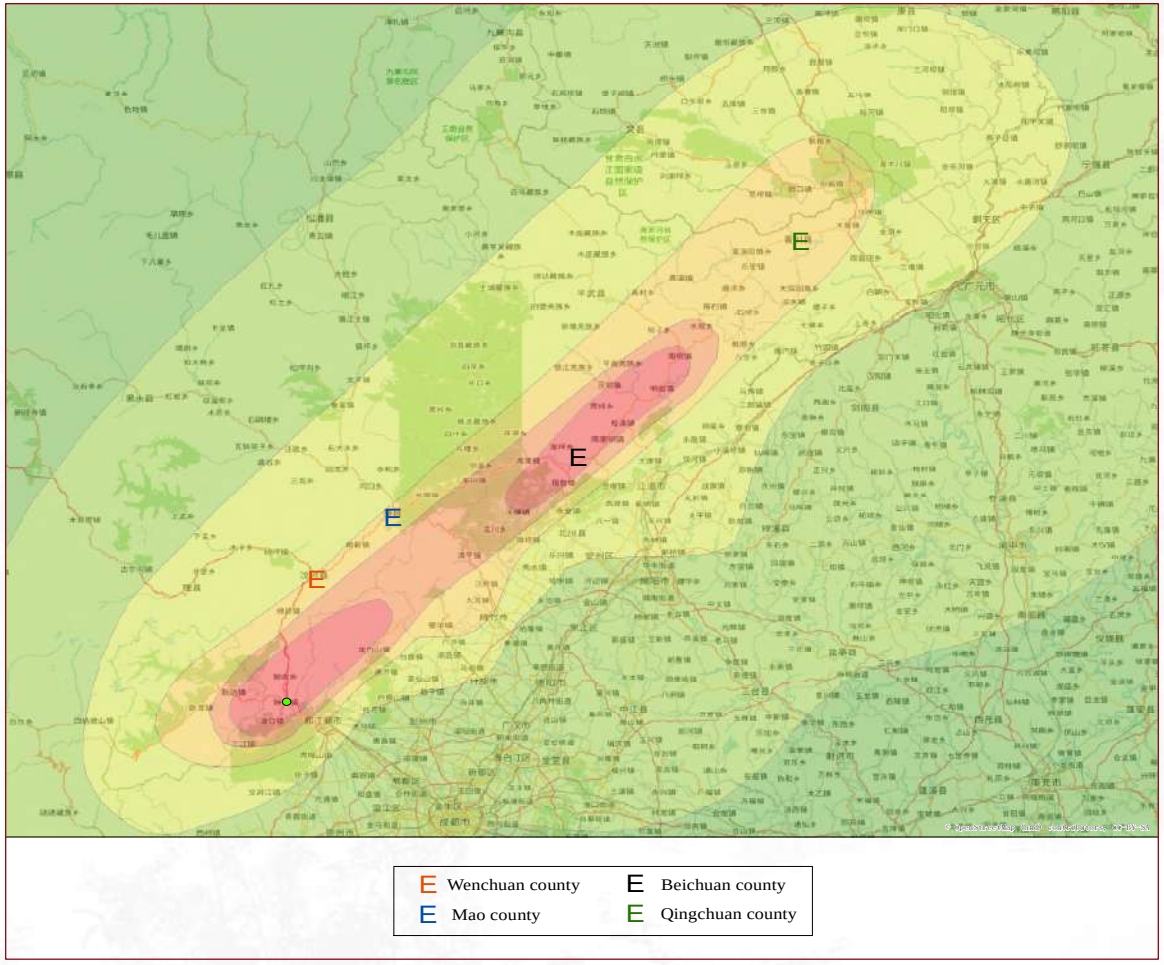


Fig2 : Locations of Treated Counties

Data and identification strategy

- Data
  - Intensity data from the International Knowledge Centre for Engineering Sciences and Technology (IKCEST)
  - Unique individual-level administrative dataset on college admissions in China , includes every student who took the NCEE and was admitted to a four-year college between 2005 and 2011
  - Several county-level variables were collected from various channels, including official websites, web services, and statistical yearbooks and annul reports

- Method: generalized difference-in-differences approach

$$(1) \qquad y_{ijt} = \beta Earthquake_j \times Post_t + \theta X_j \times Post_t + \lambda_j + \delta_{track} \times \gamma_t + \varepsilon_{ijt}$$

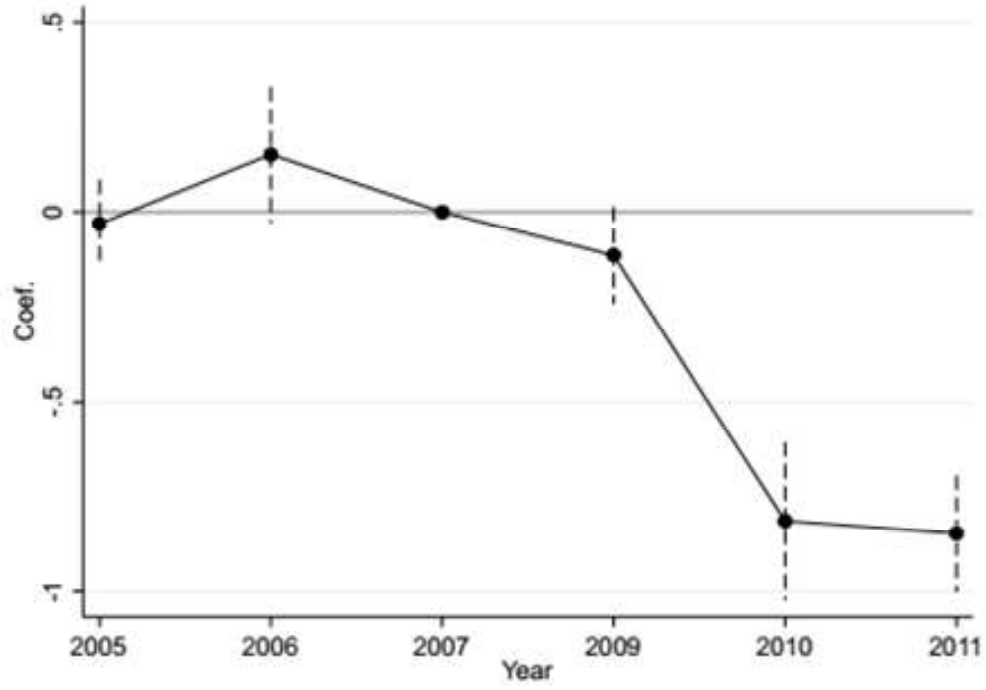
where y_{ijt} is the NCEE standard score of student i in county j in year t; the dummy variable $Post_t$ is 0 for the years before 2008 and 1 for 2009 to 2011 with samples in 2008 omitted; $Earthquake_j$ is 1 for cohorts in treated counties and 0 otherwise; and λ_j indicates county fixed effects to control for all time-invariant differences between counties. Since the design of the NCEE and exam difficulty varies by year and by track,

Results

- On average, the earthquake reduced a student's National College Entrance Examination (NCEE) standard score by **62%** of a standard deviation.

Figure 3

Dynamic Effects of Earthquake Damage on High-Stakes Exam Performance



Notes: This graph visualizes the dynamic effects of earthquake damage on students' academic performance using the year 2007 as the reference, where the solid lines connect the estimates and

Results

- Exam takers exposed to earthquake damage **for a longer time** experienced stronger negative impacts.
- The effect was slightly **greater for students who majored in the liberal arts track** and for students with low performance rankings.
- Earthquake exposure further lowers a student's probability of **being accepted to an elite college**, pursuing a **major in a high-salary field**, and moving to a **highly developed urban area** for education or employment.

Did Earthquake Reduce the Attractiveness of Cities?

The Impact of Wenchuan Earthquake on College Graduates' Job Location Choice

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Motivation

◆ **Many governments have introduced policies to attract highly skilled workers**

- Human capital is an important force of urban economic development
- College graduates in China have been migrating to the southeast coastal areas for a long time

◆ **Natural disasters occur frequently in China, showing a relatively obvious geographical law (Li, 2018)**

- Droughts occur frequently in the north
- Floods occur frequently in the south
- Typhoons occur frequently in the southeast coastal areas
- Earthquakes occur frequently in the southwest and northwest
- Earthquakes are difficult to predict and do great harm

➡ **Is natural disaster a factor of the skill spatial sorting in China?**

Literature

◆ Factors affecting labor mobility

- Economic factors: wage, Taxes, housing price (Kleven et al., 2013; Wang et al., 2012; Zhang, 2017)
- No-Economic factors: air pollution, extreme weather, education, health care, dialects (Liu et al., 2015; Xia & Lu, 2015; Zhang et al., 2019)

◆ The impact of natural disasters on labor markets and labor mobility

- Labor market: labor demand and supply, matching efficiency, wage (Belasen & Polachek, 2008; Higashi,2018; Higashi, 2020)
- Labor mobility:

  ① Disaster types: hurricanes, droughts, typhoons and floods (Gray & Mueller, 2012; Groger & Zylberberg, 2016; Mahajan & Yang, 2020)

  ② The findings are inconsistent, with some finding having no effect and some finding have negative effect

  ③ Population heterogeneity (Spitzer, 2020)

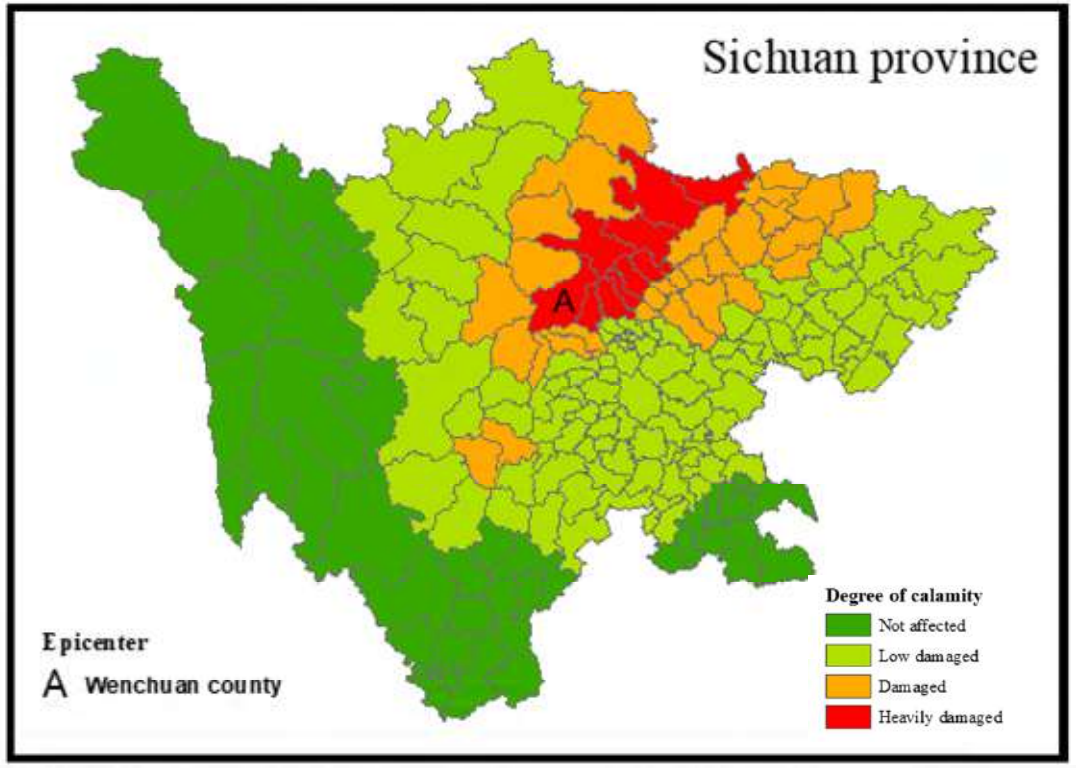
◆ The impact of the earthquake on people's economic behavior：

- House purchase, savings, leisure behavior, residents' demand, consumption concept and behavior, investor psychology, risk preference, human capital accumulation (Fan et al., 2008; Chen et al.,2010; Shan, 2011; Deng et al., 2015; Filipski et al., 2019; Wang et al, 2017)
- The impact of the earthquake on international and internal migration (Spitzer, 2020)

Research Design

◆ Wenchuan earthquake (8.0 magnitude)

- The most destructive earthquake in China since 1949
- The earthquake took place on May 12, 2008 in Sichuan province
- The damage of the earthquake spread through the entire region and even affected Gansu, the province to the north.



◆ Data

- National College Graduates Employment Sampling Survey
- From 2003 to 2019 (once every two years)

◆ Empirical design:

$$Stayschprov = \beta_0 + \beta_1 EQ_t + \beta_2 SchSC_i + \beta_3 EQ_t \times SchSC_i + \beta_4 HomeSchsame + \gamma Ind_i + \delta Fam_i + \theta Sch + \pi LocalEco + \rho \sum Schprov + \tau \sum Homeprov + \varepsilon_{it}$$

Results

	(1)	(2)	(3)	(4)
Dependent variable: **Work in the province where the college is located**				
Group	**Full sample**	**No-local Students**	**Local Students**	**Full sample**
EQ	0.0414	0.0275	0.0594	0.0277
	(0.0490)	(0.0818)	(0.0543)	(0.0490)
EQ×schSC	-0.1782***	-0.4055**	-0.1715***	-0.3429***
	(0.0479)	(0.1575)	(0.0544)	(0.0636)
schSC	0.2297***	0.5459***	0.0665	0.2986***
	(0.0599)	(0.1595)	(0.0692)	(0.0626)
Homesch	0.4378***			0.4215***
	(0.0125)			(0.0134)
EQ×schSC×Homesch				0.1902***
				(0.0465)
Individual	Yes	Yes	Yes	Yes
Family	Yes	Yes	Yes	Yes
Local Economic	Yes	Yes	Yes	Yes
School	Yes	Yes	Yes	Yes
SchprovFE	Yes	Yes	Yes	Yes
HomeprovFE	Yes	Yes	Yes	Yes
YearFE	Yes	Yes	Yes	Yes
N	12667	4409	8258	12667
R^2	0.4115	0.2004	0.2305	0.4125

Results

- After the Wenchuan earthquake, the probability of college graduates in Sichuan choosing to work in Sichuan decreased significantly
- The students from other provinces decreased more than the students from Sichuan
- This negative effect will not exist for a long time

- The higher academic achievement, the higher the probability of fleeing from Sichuan.
- Students majoring in humanities and social science or economics and management got away from Sichuan, while students majoring in science and engineering didn't.

- The main reason for fleeing from Sichuan is the fear of earthquake, rather than the labor market changing

Students from other provinces

Students from college's provinces

Does Air Pollution Affect College Graduates' Job Location Choice：Evidence from China

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Motivation

- Personal Experience: A Cantonese prefers to go back to work in Guangdong after graduation because of the serious air pollution in Beijing…
- More and more labor force understands the health risks of air pollution and adopt avoidance behaviors, especially the outflow(Zheng et al., 2014; Sun et al., 2017; Sun et al., 2019) .
- Cities in China compete for higher education graduates with favorable employment policies.
- In addition to economic factors, environmental quality has become a city's main feature to attract and retain human capital.
- The problem of "Northeastization" and the widening of the gap between the North and the South are serious.

Does Air Pollution Affect College Graduates' Job Location Choice?

Literature Review

- **Literatures on the factors affecting college graduates' job location choice**
  - ✓ Bagne（1969）: Labor mobility depends on **push** of the emigration and **pull** of the immigration.
  - ✓ Lewis（1954）;Fair（1972）; Pissarides & McMaster（1990）; Dohmen（2005）: **Economic factors** are the most important pull to attract labor force.
  - ✓ Rosen-Roback: Labor mobility also depends on **urban livability**.
  - ✓ Qin et al. (2011); Ao et al. (2015); Han et al. (2007); Grogger &Hanson(2015); Yue & Qiu(2019): The factors affecting the mobility of college graduates include **Individual, family, school, and regional factors**.
- **Literatures on the "migration" effect of air pollution**
  - ➢ **Research on the immigration:**
    - ✓ Kahn（2000）: High air quality has a significant positive effect on the number of regional immigrants.
    - ✓ Banzhaf & Walsh（2008）: Reducing pollutant emissions leads to a 5%-7% increase in the community population.
    - ✓ Sun et al.（2019）: An increase of 1μg/m3 in the annual average PM2.5 will lead to a 0.39% decrease in the probability of migrants moving to the city.
  - ➢ **Research on the emigration:**
    - ✓ Banzhaf & Walsh（2008）:Increasing pollutant emissions leads to a 5%-9% reduction in the community population.
    - ✓ Chen et al.（2017）:Air pollution that occurred in China are capable of reducing population through net outmigration by 5 percent in a given county.
    - ✓ Qin & Zhu（2017）:The higher the AQI today, the higher the search frequency of "Immigration" in Baidu the next day.
- **The most relevant literatures:**
  - ✓ Li & Zhang（2019）: A 1% increase in the city's annual AQI leads to a 3.85% decrease in the average number of foreign students coming to China.
  - ✓ Zheng et al.（2019）: Air pollution significantly reduces the probability of elite graduates accepting job offers in a polluted city.

Data and Methodology

- Data Sources：
  - ✓ College graduates' job location choice: The National Survey Data on College Graduates from Peking University in 2015, 2017 and 2019
  - ✓ Air Pollution: Ministry of Ecological Environment
  - ✓ City Characteristics : China City Statistical Yearbook
- Analysis Sample: 14,592 observations from 52 universities in 30 cities in 22 provinces

LPM Model：

$$choice_{ijkt} = \alpha + \beta pm_{i,t-1} + \theta X_{ijk} + F_i + F_t + \epsilon_{ijkt}$$

- ✓ $choice_{ijkt}$ equals 1 if student *k* chooses to stay in city *i* of the graduated school *j* after graduation in year *t*; 0 otherwise
- ✓ $pm_{i,t-1}$ includes absolute value of PM2.5 concentration and relative value of PM2.5 concentration of the graduated school
- ✓ Relative value of PM2.5 concentration measures the ratio of the graduated school 's average PM2.5 concentration in year t − 1 to the employment city's
- ✓ X_{ijk} controls for the characteristics of student, school and city

Result

Table 1 Basic Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: choice					
absolute_pm2.5	-0.0004**	0.0024***	-0.0001			
	(0.0002)	(0.0002)	(0.0005)			
Relative_pm2.5				-0.3159***	-0.2987***	-0.3561***
				(0.0094)	(0.0092)	(0.0270)
major		-0.0069	0.0134**		-0.0132*	0.0150***
		(0.0082)	(0.0056)		(0.0080)	(0.0055)
gender		0.0131	0.0107**		0.0060	0.0096*
		(0.0082)	(0.0054)		(0.0080)	(0.0053)
ethnicity		0.0065	0.0098		0.0061	0.0084
		(0.0156)	(0.0113)		(0.0149)	(0.0111)
degree		-0.0704***	-0.0107**		-0.0479***	-0.0099*
		(0.0054)	(0.0053)		(0.0052)	(0.0053)
score		-0.0128***	0.0026		-0.0060	0.0020
		(0.0049)	(0.0033)		(0.0048)	(0.0033)
urban		0.0056	0.0036		0.0042	0.0029
		(0.0102)	(0.0065)		(0.0099)	(0.0065)
single_child		0.0077	0.0004		0.0176**	0.0018
		(0.0089)	(0.0062)		(0.0087)	(0.0061)
city_rank		-0.0162***	0.0028		-0.0146***	0.0024
		(0.0034)	(0.0023)		(0.0033)	(0.0022)
family_income		-0.0137***	-0.0045***		-0.0148***	-0.0043***
		(0.0024)	(0.0016)		(0.0023)	(0.0016)
city_wage		0.5329***	0.2670***		0.4319***	0.3064***
		(0.0154)	(0.0895)		(0.0134)	(0.0878)
constant	0.4155***	-5.5012***	-2.9505***	0.7435***	-3.9460***	-3.3213***
	(0.0114)	(0.1769)	(0.9796)	(0.0124)	(0.1504)	(0.9615)
school city fixed effects	N	N	Y	N	N	Y
employment city fixed effects	N	N	Y	N	N	Y
hometown fixed effects	N	N	Y	N	N	Y
year fixed effects	N	N	Y	N	N	Y
N	14,592	14,592	14,555	14,592	14,592	14,555
R^2	0.0003	0.0753	0.6633	0.0579	0.1172	0.6701

Table 2 Robustness Tests

	(1) logit	(2) probit	(3) AQI	(4) PM10	(5) SO2	(6) Lower_pm	(7) higher_pm	(8) Farther_city	(9) further_study	(10) IV
relative_pm2.5	-21.391***	-9.555***				0.363***	-0.006	5.094***	-0.559*	-0.857**
	(1.609)	(0.585)				(0.038)	(0.029)	(0.425)	(0.289)	(0.388)
relative_aqi			-0.591***							
			(0.047)							
relative_pm10				-0.405***						
				(0.033)						
relative_SO_2					-0.172***					
					(0.015)					
constant	-57.860***	-32.126***	-4.563***	-5.094***	-3.913***	-1.653*	6.068***	74.410***	-7.835	-3.875***
	(10.537)	(6.002)	(0.994)	(0.996)	(1.055)	(0.917)	(0.892)	(15.288)	(8.071)	(1.015)
control variables	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
school city fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
employment city fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
hometown fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	8,785	8,785	13,584	13,584	13,584	14,555	14,555	14,273	727	14,555
R^2	0.581	0.556	0.666	0.667	0.672	0.694	0.611	0.677	0.895	0.657

Mechanism

Mechanism

Table 3 Health Awareness

Dependent Variable: choice	(1) hometown_high	(2) hometown_low	(3) sport	(4) non-sport	(5) outdoor	(6) indoor
relative_pm2.5	-0.489***	-0.304***	-0.515***	-0.310***	-0.393***	-0.307***
	(0.054)	(0.038)	(0.046)	(0.045)	(0.039)	(0.040)
N	7,395	7,160	6,362	7,401	7,690	6,073
R^2	0.701	0.681	0.647	0.755	0.686	0.695

Table 4 Opportunity Effect

Dependent Variable: choice	(1) high_degree	(2) low_degree	(3) 985/211	(4) others	(5) more_offer	(6) less_offer	(7) high_income	(8) low_income
relative_pm2.5	-0.337***	-0.279***	-0.314***	-0.312***	-0.386***	-0.347***	-0.420***	-0.340***
	(0.086)	(0.029)	(0.056)	(0.032)	(0.034)	(0.051)	(0.052)	(0.036)
N	2,104	11,659	3,364	10,399	10,055	3,708	4,258	9,505
R^2	0.722	0.722	0.707	0.785	0.666	0.733	0.669	0.694

Further Study

Table 5 Welfare Loss

Dependent Variable	(1) lower_wage	(2) mis_degree	(3) mis_major	(4) job_satisfaction
relative_pm2.5	0.248***	0.059*	0.129*	-0.098*
	(0.029)	(0.035)	(0.073)	(0.053)
N	14,555	8,847	8,641	8,636
R^2	0.685	0.104	0.174	0.140

Table 6 Air Pollution and North-South Migration

Dependent Variable: North-South Migration	(1) all	(2) High human capital	(3) low human capital
relative_pm2.5	0.199***	0.273***	0.188***
	(0.027)	(0.054)	(0.032)
N	14,555	4,704	9,851
R^2	0.738	0.756	0.752

Contribution

- **Systematic evaluation on impact of environmental shocks on college access and graduates mobility;**
- **Estimation of causal impact of environmental shocks on higher education;**
- **Understanding how COVID-19 might influence higher education in short- and mid-term (loss in college access and mobility of high-skill labor)**

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Thank you!

谢谢大家！