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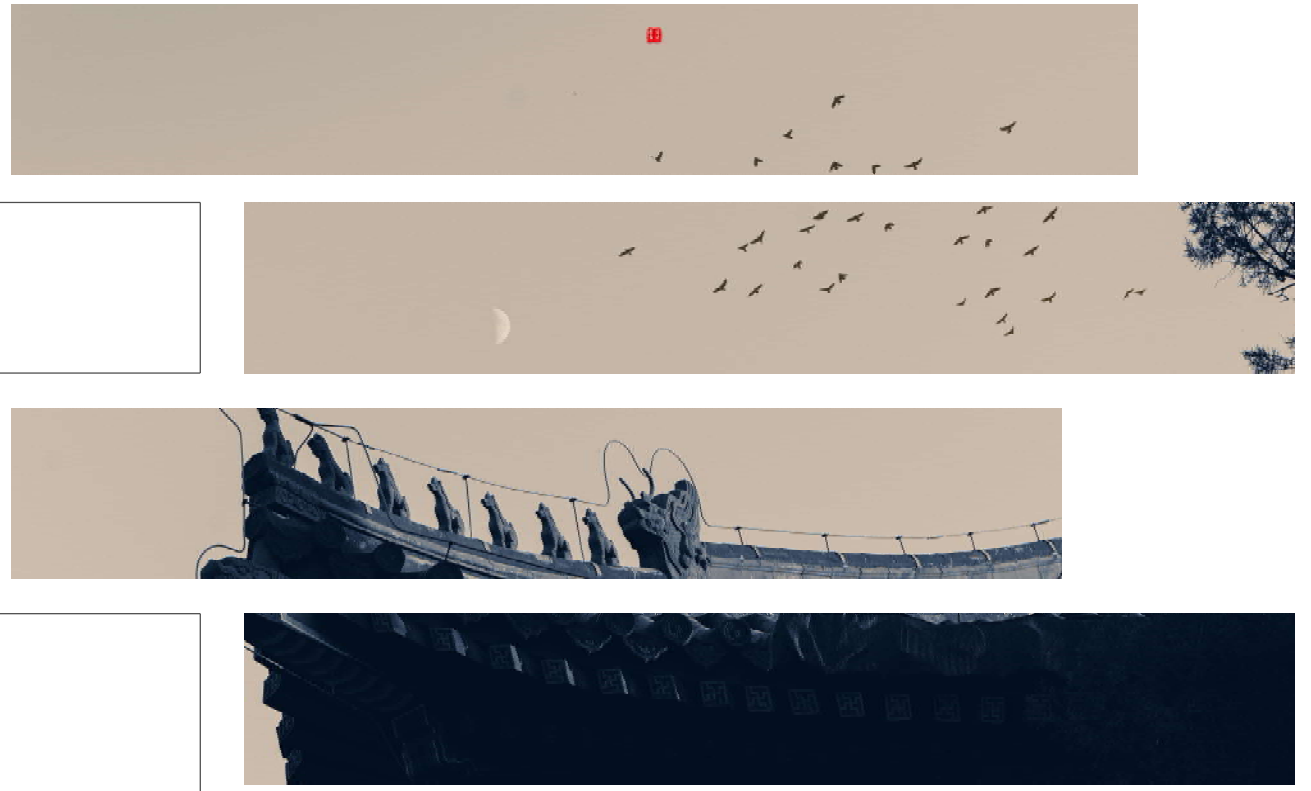
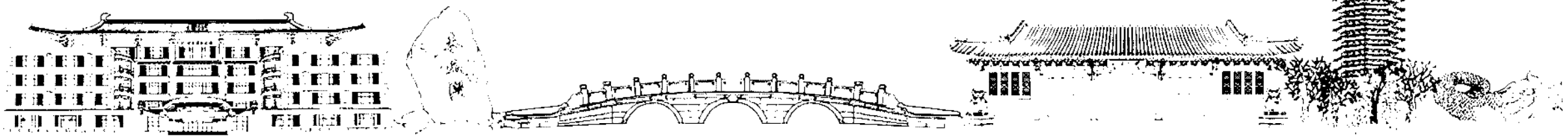
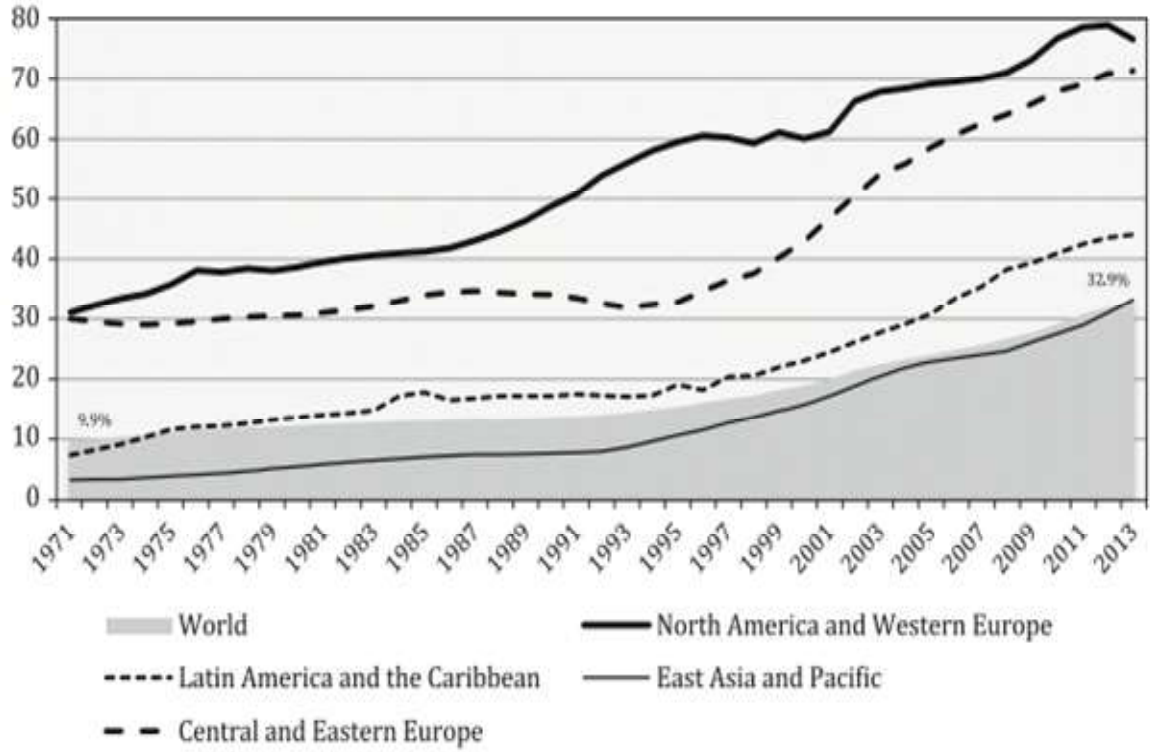
The Influence of High Skill Agglomeration on Skill Sorting: Evidence from China Tertiary Education Expansion

CGHE Panel Liu Yangxi & Po Yang





Higher education expansion at global scale (Marginson, 2016)



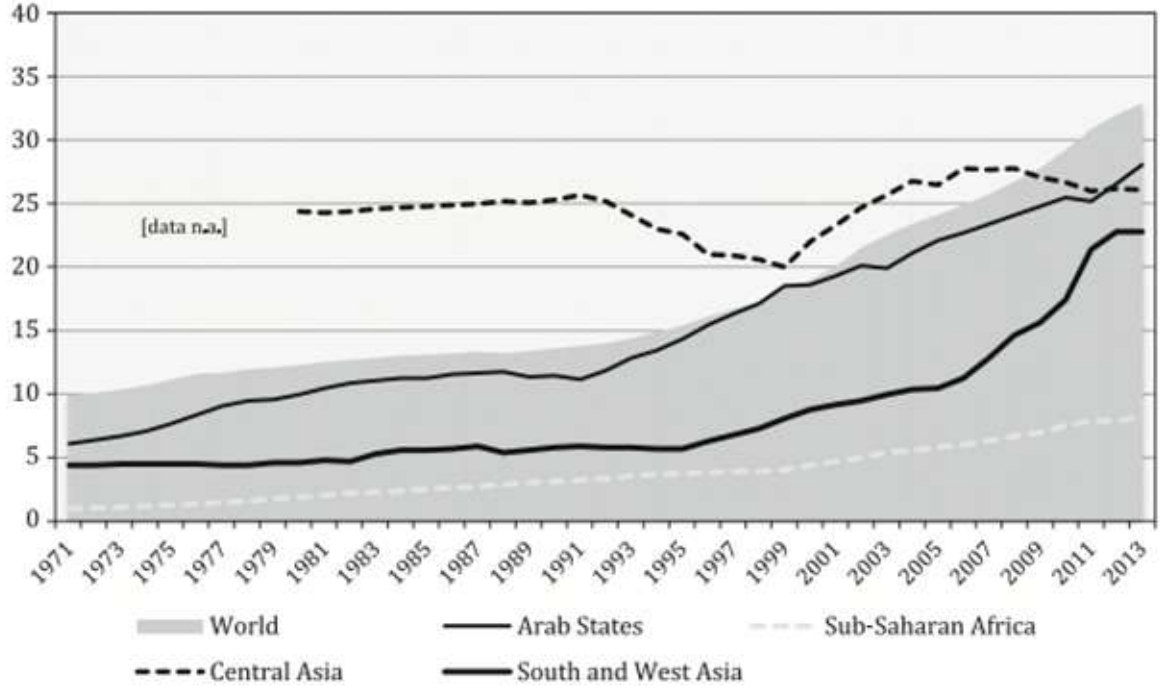


Fig. 1 Gross Tertiary Enrolment Ratio (%), world and world regions: 1971–2013. [data n.a.] = regional data for Central Asia not available for 1971–1979. *Source*: Chart prepared by the author using data from UNESCO (2015)

Intended consequence of higher education expansion

01 **Human capital accumulation; better employment quality; college wage premium** (UK-Walker& Zhu, 2008; Blundell, Green, & Jin, 2022; US-Fortin, 2006; Lindley, & Machin, 2016)

02 **Economic growth** (Hanushek, E. A., & Woessmann, L. 2015; Lindahl, 2015); **research and innovation** (Brunello, Garibaldi, & Wasmer, 2007; Marginson, 2021a, 2021b: Marginson, S. (2021). 'All things are in flux': China in global science. Higher Education, 1-30)

03 **Positive externalities** (migration, crime, health and nutrition, credit, income level, home ownership, marriage and family formation)

Unintended consequence of higher education expansion

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01 **Graduate unemployment/underemployment/over education** (Bai, 2006; Green & Henseke, 2016; Li, Whalley, & Xing, 2014; Núñez & Livanos, 2010)

02 **Increasing price of housing , crowded medical service and schooling in urban areas** (Moretti 2004a, 2004b; Shapiro 2006)

03 **The Great Divergence: Changes in migration patterns and skill sorting** (Diamond, 2006); **income inequality** (Moretti, 2013)

How does higher education expansion affect cities?

01 **How local wages, rents, and employment respond to local labor demand shocks** (Topel, 1986; Bartik, 1991; Blanchard and Katz, 1992; Saks, 2008)

02 **How amenities change in response to the composition of an area's local residents** (Becker and Murphy, 20000; Card, Mas and Rothstein, 2008; Handbury, 2013)

03 **Diverging local choices of high and low skill workers and impacts of local labor supply on local wages in cities** (Moretti, 2013; Card, 2009)

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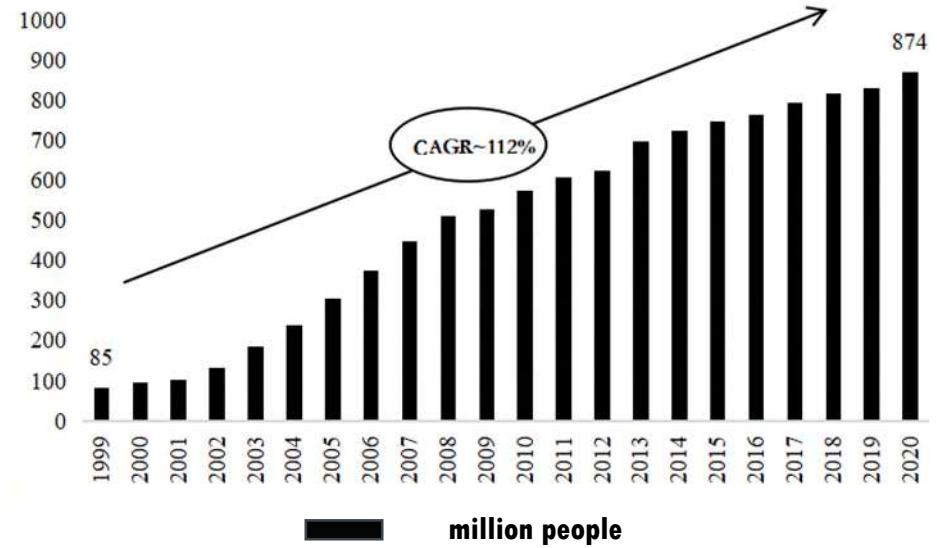
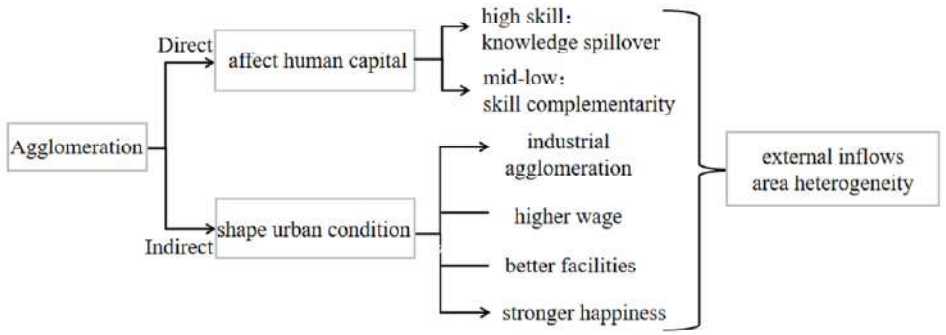
Introduction

Tertiary Education Reform & Human Capital Agglomeration

- ✓ In China, the latest tertiary expansion since 1999 has raised the educational level of a large number of individuals
- ✓ College-concentrated cities attracted more population to settle since the tertiary expansion (Winters, 2011)
- ✓ Tertiary expansion not only improves the overall level of China's high-skilled human capital, but also intensifies the regional heterogeneity of agglomeration

Number of college graduates in China



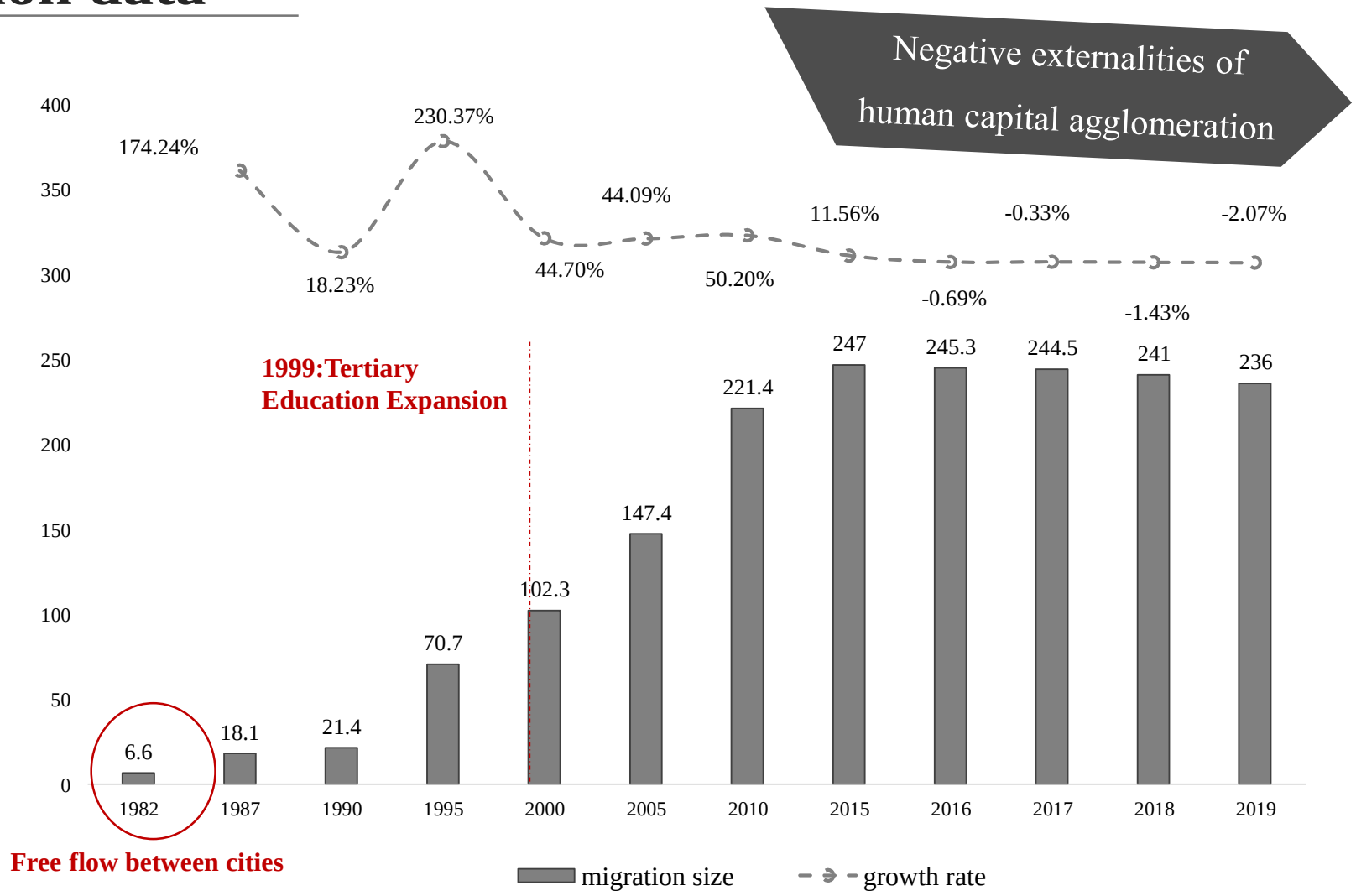


Human Capital Externality

Human Capital Externality

- ✓ Human capital agglomeration can attract the inflow of external labor through knowledge spillover and skill complementarity, thereby continuously attracting further inflows(Diamond, 2013; Eeckhout et al., 2014; Liang & Lu, 2017; Glaeser & Lu, 2018)
- ✓ Also change the livability of city, increasing the degree of urban industrial agglomeration and wage return, improving public resources, and enhancing the happiness of personal life, thereby attracting the inflow of external population (Berry & Glaeser, 2005; Moretti, 2010; Florida et al., 2013; Glaeser et al., 2016; Liu & Yang, 2020; Guo & Qian, 2021)

China's migration population data



Research Question

01 **Does the agglomeration of high-skilled human capital caused by the Tertiary Education Reform limit further urban population inflow?**

02 **What kind of heterogeneity exists between different regions and groups in the restriction of population mobility due to the Tertiary Education Reform?**

03 **What are the mechanisms forTertiary Education Reform restricting population mobility?**

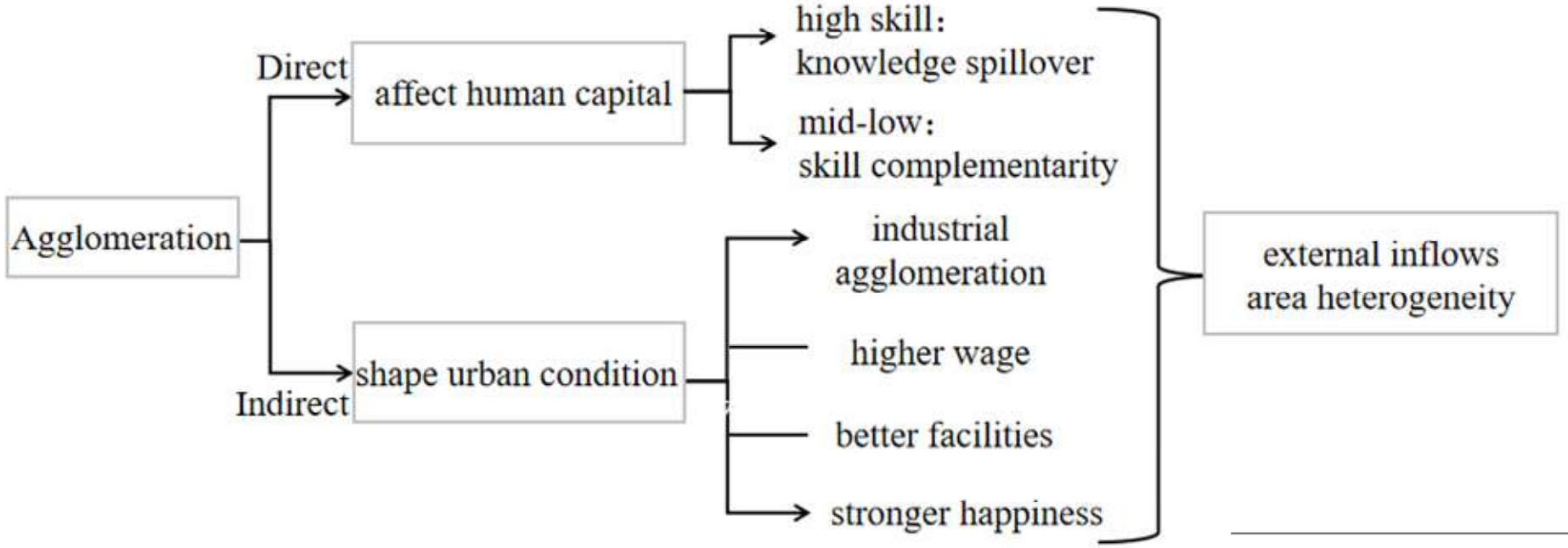
Literature review

Migration Theory

- Micro: push-pull model; benefit-cost theory
- Macro: Two-Sector Model; Todaro Model
- Human Capital Externalities: Lucas (1988)

Empirical literature

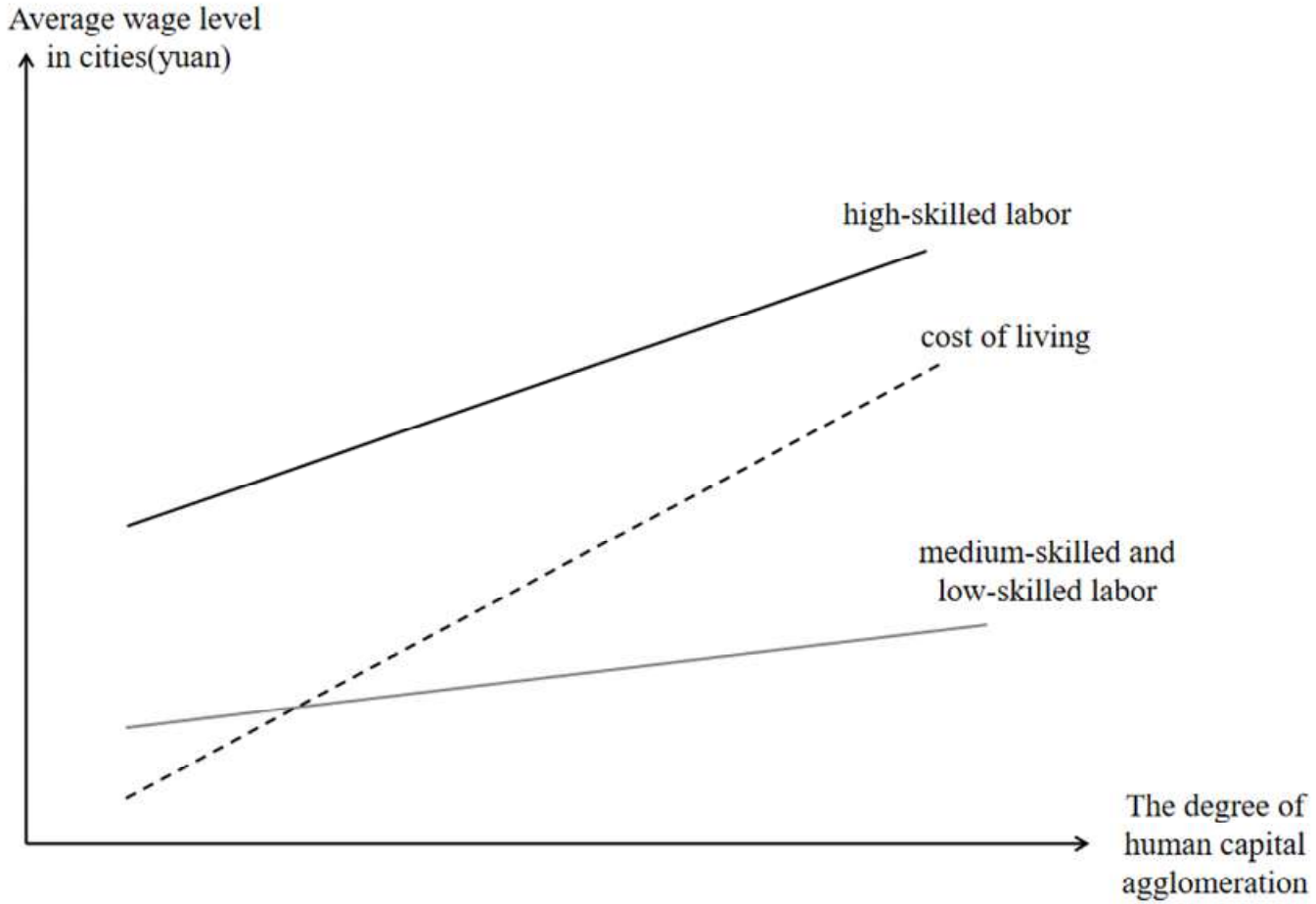
- Population mobility due to rising education levels
- The mechanism by which human capital externalities affect population mobility
- College Enrollment Expansion: Reducing Higher Income Premiums, Increasing Intergenerational Mobility and Income Gap



Negative externalities of human capital agglomeration

Rapid growth of living cost

- ✓ Giannetti (2003) first theoretically proposed a transfer equilibrium model with asymmetric skill distribution to explain that human capital agglomeration may limit the further agglomeration of external low- and medium-skilled labor.
- ✓ Income and cost increase unevenly on human capital with different skills
- ✓ Spatial diversion of human capital with different skills



Migration equilibrium model with asymmetric skill distribution

Negative externalities of human capital agglomeration

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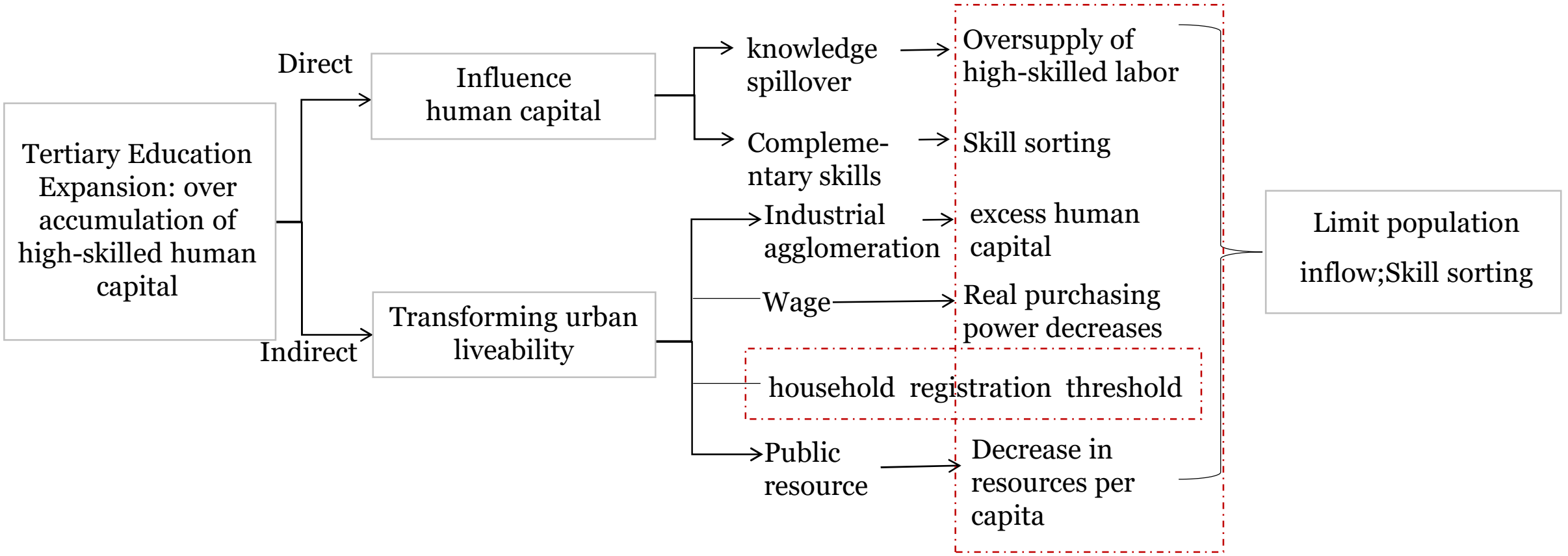
Decrease in public resources per capita

- ✓ Public Service good in big cities, population grow faster, lower access to public resources

Rising Household registration threshold

Inbalanced Labor market supply and demand

Research Framework



Data Source ►►►

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- **Dependent variable:**1% population sample survey data in 2015
- **Independent variable:** sixth national census in 2010
- **Control variables:**"China Urban Statistical Yearbook", "China Regional Economic Statistical Yearbook"(Left)
- Report on the employment quality of college graduates by provincial education departments(right)

district	collshare_ci	expansic	cityco	2015wage	2015medic	regi_120	regi_all	wage1	unempl	structure	PPE/GD	portdistanc	2013housepric	medical
东莞市	7.25%	0.0104	4419	53221	3.903061	1.0553	1.0553	47600	0.38%	109.75%	24.27%	89.43	11511.46	4.423522
吴忠市	5.35%	0.0674	6403	54334	3.174941	0	0.5107	51666	3.57%	50.67%	157.02%	963.85	11407.04	1.350413
深圳市	17.64%	1.6586	4403	81034	2.681684	1.8626	1.8626	73492	0.85%	134.81%	16.98%	27.75	11629.96	3.370033
鄂州市	7.39%	16.3827	4207	37215	2.284057	0.4062	0.4062	34042	1.25%	48.70%	100.06%	635.05	10960.45	1.015629
克拉玛依市	21.93%	0.2197	6502	84559	2.282689	0	0.5299	86358	0.62%	31.67%	39.49%	2731.81	10667.84	-0.122106
太原市	23.53%	22.4891	1401	60516	2.219497	0.5163	0.5163	57771	4.46%	146.18%	68.99%	426.74	11371.34	2.387501
北京市	31.50%	27.5933	1100	113073	2.203758	2.496	2.4960	103400	0.98%	365.79%	35.21%	113.84	14501.40	2.469873
酒泉市	8.85%	0.0784	6209	54778	2.118782	0	0.2451	49757	3.67%	84.64%	164.39%	1605.77	10761.67	0.2124953
乌鲁木齐市	24.70%	27.5979	6501	67617	2.048181	0.5299	0.5299	61617	4.98%	168.65%	62.01%	2506.71	11483.61	2.507946
海口市	16.96%	8.3962	4601	57455	1.952459	0.4646	0.4646	50653	2.75%	375.75%	75.25%	482.38	10719.79	1.38196
忻州市	6.57%	0.0280	1409	44880	1.925187	0	0.4534	40399	2.87%	90.26%	141.90%	394.41	11858.97	1.24827
大庆市	11.96%	2.9574	2306	66839	1.837765	0	0.4922	67671	7.51%	26.16%	22.55%	1052.83	12138.03	2.008362
昆明市	15.25%	21.3675	5301	62033	1.773067	0.5106	0.5106	58153	3.64%	129.51%	84.52%	1189.13	12004.45	1.737181
广州市	19.62%	18.2594	4401	81171	1.622096	1.5534	1.5534	74246	7.46%	194.89%	29.27%	129.52	13353.83	1.859108
成都市	16.67%	13.4528	5101	69123	1.540669	1.1379	1.1379	63201	5.62%	115.15%	65.83%	1360.51	12371.57	1.642057
鄂尔多斯市	11.66%	0.0443	1506	73377	1.517623	0	0.5728	62651	6.19%	67.88%	84.39%	640.51	12732.84	1.521465
杭州市	18.88%	16.7843	3301	77816	1.512267	0.514	0.5140	70823	1.37%	132.27%	53.80%	162.97	12033.76	1.450658
双鸭山市	7.09%	0.0587	2305	42176	1.487745	0	0.4922	39116	5.31%	137.12%	34.67%	1411.61	12716.05	-0.0543225
攀枝花市	9.36%	7.0751	5104	61915	1.476775	0	0.7836	57635	5.31%	32.07%	66.92%	1345.54	11912.28	1.420837
西宁市	12.96%	19.4458	6301	58099	1.476524	0.599	0.5990	54914	6.02%	93.79%	108.10%	1379.81	10788.59	1.379163
济南市	19.91%	22.6916	3701	68997	1.391418	1.175	1.1750	62323	2.32%	142.33%	53.09%	270.80	11897.53	1.243217
拉萨市	12.32%	0.1536	5401	114582	1.36109	0	0.5299	72468	4.40%	161.84%	131.07%	2433.56	11882.35	0.6710381
武汉市	25.19%	29.8465	4201	65720	1.359792	0.676	0.6760	60624	5.02%	103.09%	69.14%	687.42	12174.15	1.224688
长沙市	19.14%	24.4001	4301	67266	1.313295	0.8018	0.8018	61847	4.48%	77.14%	69.47%	669.17	12259.90	1.482879

太原市	Taiyuan		102.94	97.53	6229561	6005569	60516	61577

Empirical model ►►►

$$Migrant_{i,2015} = \beta_0 + \beta_1 Collegeshare_{i,2010} + \beta_2 X_{i,2014} + c_i + \varepsilon_{i,2015} \quad (3\text{-}4)$$

2SLS Model

$$Collegeshare_{i,2010} = \chi_0 + \chi_1 \frac{NCollege_{i,1998} \times Enrollincre_{1998\sim2010}}{Population_{i,2010}} + \chi_2 X_{i,2014} + c_i + \upsilon_{i,2010} \quad (3\text{-}5)$$

Dependent variable: $Migrant_{i,2015}$

- The inflow of human capital from 2010~2015
- Referring to Wang Chunchao and Yin Jinghua (2022), the newly-immigrated population is defined as the population who have left the registered districts and counties to live, live and work in other districts and counties for more than six months and less than five years

Independent variable: $Collegeshare_{i,2010}$

$$Collegeshare_{i,2010} = \frac{highskilledlabor_{i,2010}}{citypopulation_{i,2010}}$$

$Collegeshare_{i,2010}$	the proportion of the population with a college degree or above in city i in 2010
$highskilledlabor_{i,2010}$	the population of city i with a college degree or above in 2010
$citypopulation_{i,2010}$	the total population of city i in 2010

Instrumental variable

$$\frac{NCollege_{i,1998} \times Enrollincre_{1998\sim2010}}{Population_{i,2010}}$$

$NCollege_{i,1998}$

The number of colleges and universities in city *i* in 1998. For cities without colleges and universities in 1998, set its output to 0.10 to calculate the intensity of tertiary expansion in the city

$Enrollincre_{1998\sim2010}$

The increase of the national enrollment scale in 2010 relative to 1998

$Population_{i,2010}$

The total population of city *i* in 2010. The data comes from the China Statistical Yearbook of the corresponding year

Data source: comes from the sixth national census and the 2015 1% population sample survey data provided by NBS-PKU Research Data Center.

Control variable ►►►

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- Calculation
- Definition

Table 1. Definition and measurement of control variables (2014)

Variable Name	Variable Measurement	Unit
Average wage	The average wage of workers in the city	yuan
Unemployed	$\frac{\text{registered unemployed}}{\text{registered unemployed} + \text{employed employees}}$	%
Industrial structure	$\frac{\text{ratio of tertiary industry to GDP}}{\text{ratio of secondary industry to GDP}}$	%
Fixed asset investment	$\frac{\text{fixed asset investment}}{\text{GDP}}$	%
House price	$\frac{\text{city's commercial housing sales in 2013}}{\text{sales area}}$	yuan/㎡
Public Service	Eduservice = first principal component value taken fromPCA result based on the number of primary schools, ordinary middle schools, and ordinary institutions of higher learning per capita, the variance contribution rate is 70.14%	-
	Medservice = first and second principal component value taken fromPCA result based on the number of health institutions per capita, the number of doctors, and the number of hospital beds, the variance contribution rate is 91.93%	-
Port distance	The geographic distance from the latitude and longitude of the city center to the three major ports (Tianjin, Shanghai, Hong Kong)	km

Data sources: 2013-2014 China Urban Statistical Yearbook

Heterogeneity and Mechanisms

- Heterogeneity city groups (by high & low):
  - cost of living
  - household registration threshold
  - graduate retention rate
- Mechanism(mediation effect), agglomeration affects:
  - living costs
  - medical services per capita
  - graduate retention

Empirical Result ►►►

- **Stage 1:**Validity of Instrumental Variables;the tertiary expansion caused accumulation of high-skilled human capital
- **Stage 2：** Agglomeration restricts population inflow, mainly mid-low skilled labor

Table 3. The impact of high-skilled human capital agglomeration on population inflow

Model	2010-2015 Population inflow (10,000 people)			
	（1）	（2）	（3）	（4）
	Total population	High-skilled labor	Med-skilled labor	Low-skilled labor
Stage 1				
Expansion intensity (e-03)		1.831***		
Other variables		YES		
F Test		42.19***		
Stage 2				
College share	-743.915***	-80.925	-2029.428***	-4384.320***
	(274.459)	(539.502)	(684.333)	(1317.201)
Average wage	0.326	0.204	-0.675	0.961
Unemployed	102.002	188.011	362.756	387.662
Industrial structure	7.955	28.092**	1.531	21.040
	(7.215)	(11.074)	(21.374)	(39.349)

Table 5. Heterogeneity analysis results of agglomeration on human capital inflow

Model	2010-2015 Population inflow from 2010 to 2015 (10,000 people)							
	(1) Wage≤47000 yuan	(2) Wage≥47000 yuan	(3) House price≤4500 yuan	(4) House price≥4500 yuan	(5) Household registation≤0.5866	(6) Household registation≥0.5866	(7) Retention rate≤72.96 %	(8) Retention rate≥72.96 %
Stage 1								
Expansion intensity (e-03)	1.435***	1.944***	1.468***	2.054***	1.866***	1.670***	1.848***	1.537***
	(0.419)	(0.397)	(0.389)	(0.419)	(0.488)	(0.393)	(0.444)	(0.420)
F Test	13.05***	19.47***	15.25***	24.74***	18.95***	16.66***	19.50***	16.08***
Stage 2								
Object	Total population							
College share	53.682	-872.902**	17.910	-686.891**	19.470	-880.224**	87.400	-1845.081***
	(48.126)	(576.659)	(0.650)	(338.601)	(56.088)	(413.559)	(103.858)	(937.327)
Object	High-skilled labor							
College share	843.490**	-333.342	303.178**	-183.760	337.331	-504.571	1087.598*	-1578.423*
	(356.793	(805.758)	(583.920)	(532.827)	(267.001)	(687.585)	(583.920)	(952.125)
Object	Medium-skilled labor							
College share	-150.537	-2484.830**	-48.843	-1844.268*	-86.232	-2407.246**	12.725	-5214.486***
	(100.724)	(891.834)	(51.086)	(992.361)	(91.268)	(1215.610)	(153.000)	(1590.328)
Object	Low-skilled labor							
College share	-155.747	-4933.122**	-367.578**	-4101.725**	4.141	-5182.367**	-179.194	-10200.0***
	(215.732)	* (1671.386)	(179.482)	(1726.808)	(282.549)	(2117.094)	(328.269)	(2885.950)
Other variables	YES	YES	YES	YES	YES	YES	YES	YES
Observation	147	139	126	160	159	127	160	126
Adj R^2	0.96	0.97	0.98	0.96	0.97	0.97	0.97	0.97

Note: ***, **, * represent significance at the 1%, 5%, and 10% levels, respectively; the coefficient of average salary is corrected by scientific notation.

Heterogeneity

- city groups (by high & low):
  - cost of living
  - household registration threshold
  - graduate retention rate

Table 6. The impact of agglomeration on the cost of living, retention rate and public services

Model	Population inflow from 2010 to 2015 (10,000 people)						
	(1) 2015 Nominal wage (logarithm)	(2) 2015 Real wage (logarithm)	(3) 2013 House price (logarithm)	(4) Graduate retention rate	(5) Public Services - all sample	(6) Public service - wage ≤ 47000 yuan	(7) Public service - wage ≥ 47000 yuan
Stage 1							
Expansion intensity (e-03)	2.396*** (0.362)	2.396*** (0.362)	1.797*** (0.296)	2.396*** (0.362)	1.957*** (0.276)	1.789*** (0.404)	2.002*** (0.394)
F Test	43.96***	43.96***	36.96***	43.96***	50.39***	21.86***	26.10***
Stage 2							
College share	10.633** (4.537)	2.088 (1.598)	3.683* (1.951)	0.530** (0.260)	5.516 (3.909)	21.256** (8.775)	-0.169 (5.214)
Other variables	YES	YES	YES	YES	YES	YES	YES
Observation	286	286	286	286	286	147	139
Adj R^2	0.96	0.96	0.97	0.96	0.97	0.96	0.97

Note: ***, **, * represent significance at the 1%, 5%, and 10% levels, respectively; the coefficient of average salary is corrected by scientific notation.

Mechanism

- Agglomeration limit population infows by affects:
  - living costs
  - medical services per capita
  - graduate retention

Implication

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Reduce migration costs

Improve production factors

Configure public resources

Limitations

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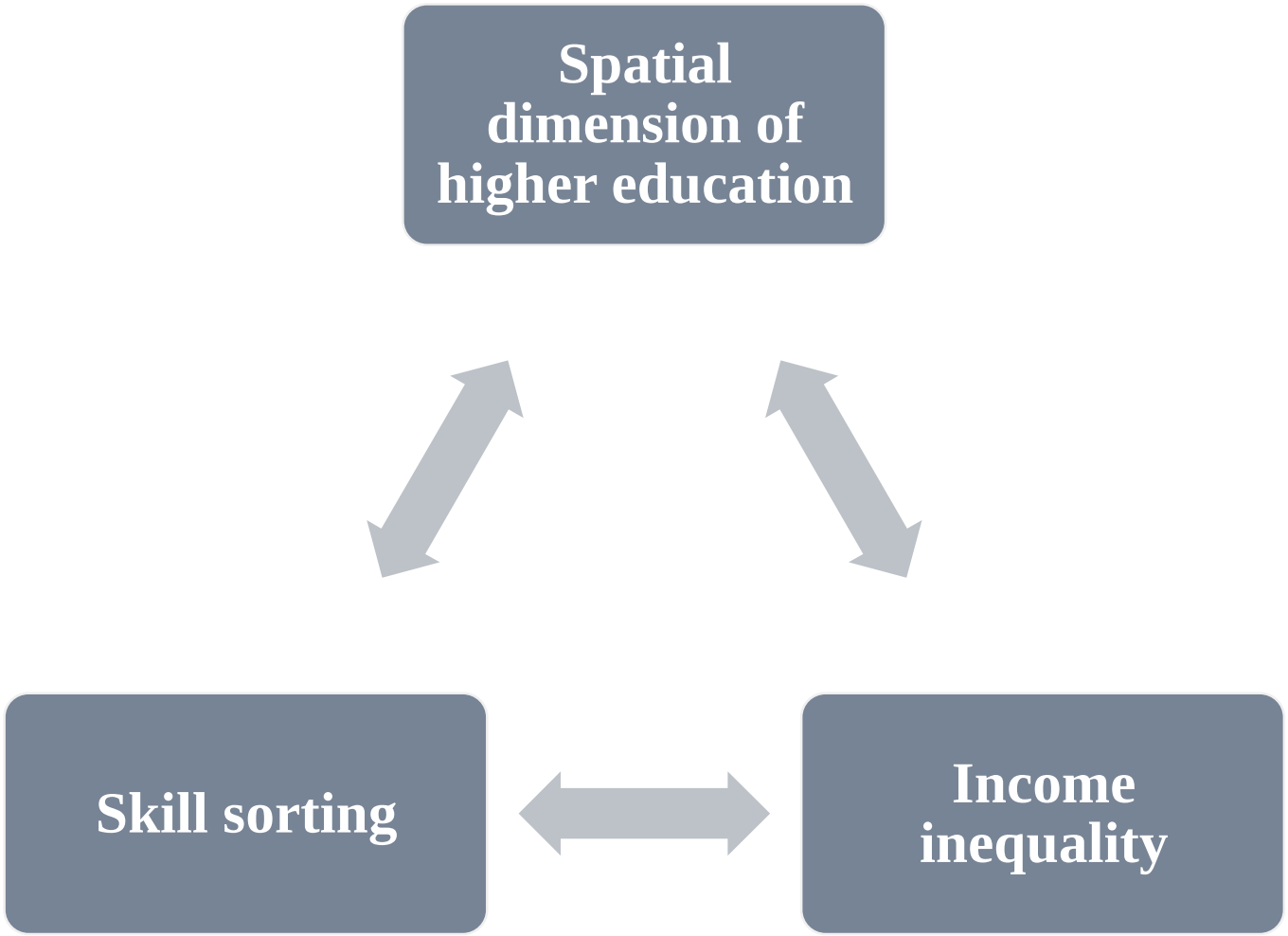
Research objects: add micro-levels

Add Model with 2020 Seventh Census Data

Research Methods:

- Effectiveness of Instrumental Variables;
- Calculation of Household Registration Threshold;
- Cost of Living Proxy Variables

The Great Divergence and future of higher education




Thank You
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