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Are Chinese regions becoming more polycentric, and why?
Examining the spatial-temporal evolution of regional urban
structure in China

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Introduction

- China has experienced rapid changes in urban spatial structure in the past two decades
 - sky-rocketing urbanization since the neoliberalism reform in the 1980s
 - decentralized trends due to agglomeration diseconomies, particularly in megaregions and cities (Hu et al., 2018, 2020)
 - Generalized dispersion (Li et al., 2020; Lee, 2007; Gordon and Richardson, 1997)
 - Polycentricity (Ewing, 1997; Anas et al., 1998)
- Polycentric development or polycentrism is promising
 - European spatial policies – achieve more efficient, balanced, and sustainable territorial development (Davoudi, 2003)
 - Examples abound: Shanghai, Tianjin, Beijing, Hangzhou, Guangzhou, and Chongqing (Zhang et al., 2019; Wang et al., 2020; Qin and Han, 2013; Wen and Tao, 2015; Cheng and Shaw, 2021; Liu et al., 2019).
 - Political forces and market forces (Liu and Wang, 2016; Wang et al., 2020; Cheng and Shaw, 2018)

Contributions

Spatial-temporal trends toward polycentricity in China, and why?

• Most studies considered a cross-sectional dimension



- Spatial-temporal evolution toward polycentricity (2002-2017)
- Both cross-sectional and panel models

• Different regional delineations -> different results (Thomas et al., 2021)



- Delineating regions (prefectural regions; urban core regions (市辖区); Functional urban area)

Regional delineation and Data

Conventional urbanized area:

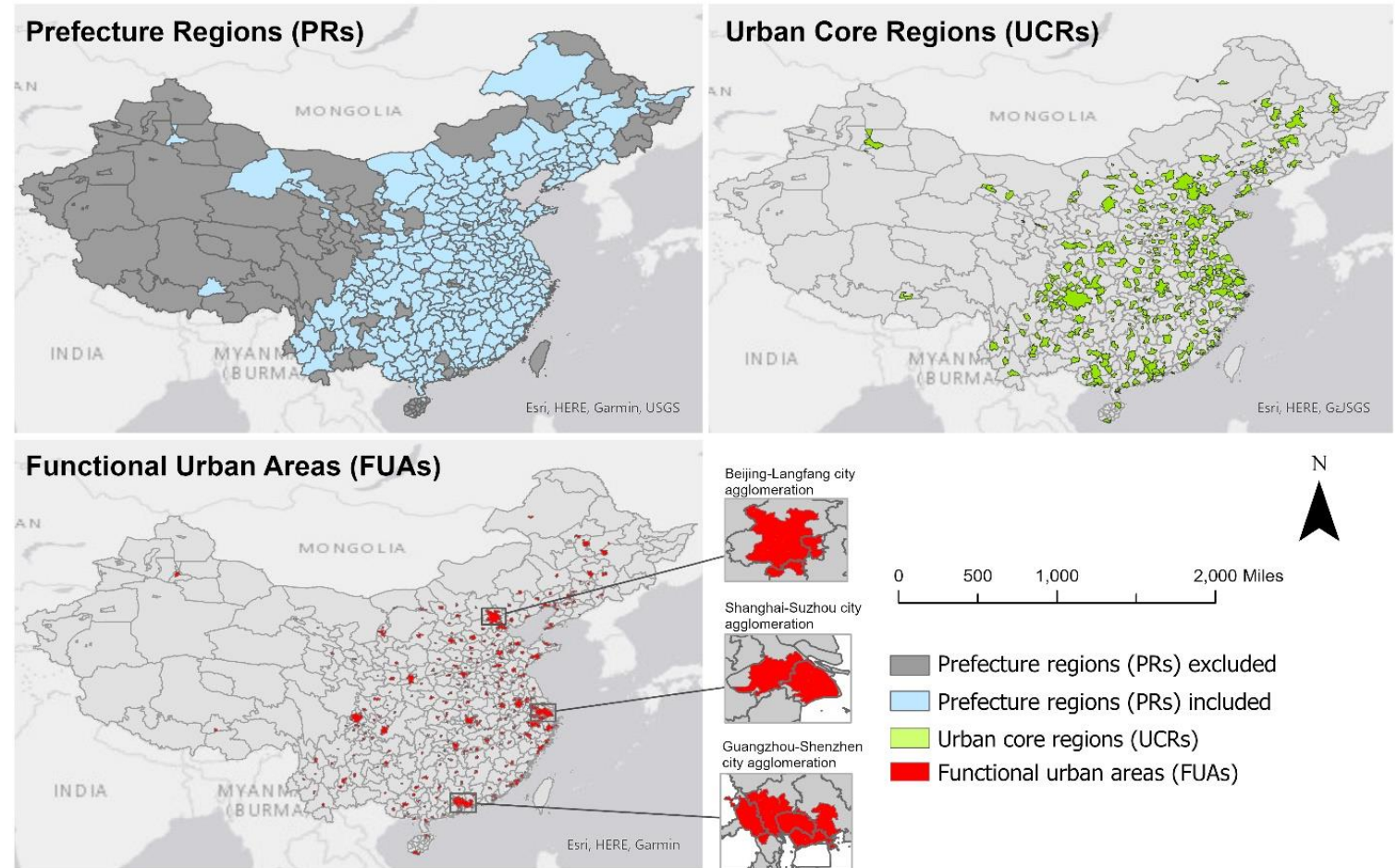
- 269 prefecture cities

What we contribute:

- 269 Urban core regions (UCRs)
- 259 Functional Urban Areas (FUAs):

LandScan datasets

- 2002, 2007, 2012, and 2017
- the 1km-by-1km population cell

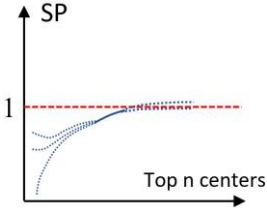
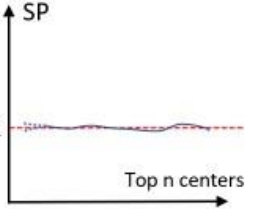
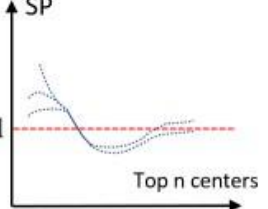



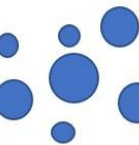


Measuring Polycentricity

Three measures:

- The number of (sub)centers (Arribas-Bel and Sanz-Gracia, 2014; Giuliano and Small, 1991)
- Morphological polycentricity index (Green, 2007)
- The stepwise polycentricity (SP) (Zhang and Derudder, 2019) (see table 1)

Table 1: The typology of Chinese regions in terms of the trajectory of stepwise polycentricity indices

	Group 1	Group 2	Group 3	Group 4	Group 5
	Region without significant centers	Single-centered region—only one main center identified	Monocentric region—a main center with many small subcenters	Region follows Zipf's Law	Polycentric region—multiple centers with equal size and many small subcenters
	No significant Center	Single-centered region			
					

Notes: (1) Group 1 and Group 2 do not contain a plot because no or too few centers are identified.

(2) $SP = 1$ implies the rank size of the actual region following Zipf's Law; $SP < 1$ implies centers are less evenly distributed than the hypothetical region following Zipf's Law; $SP > 1$ implies centers are more evenly distributed than the hypothetical region following Zipf's Law.

Spatial-temporal trends — A case study

Shanghai:

- Master Plan (2017-2035) five new districts: Jiading, Songjiang, Qingpu, Fengxia, Nanhui

Shenzhen:

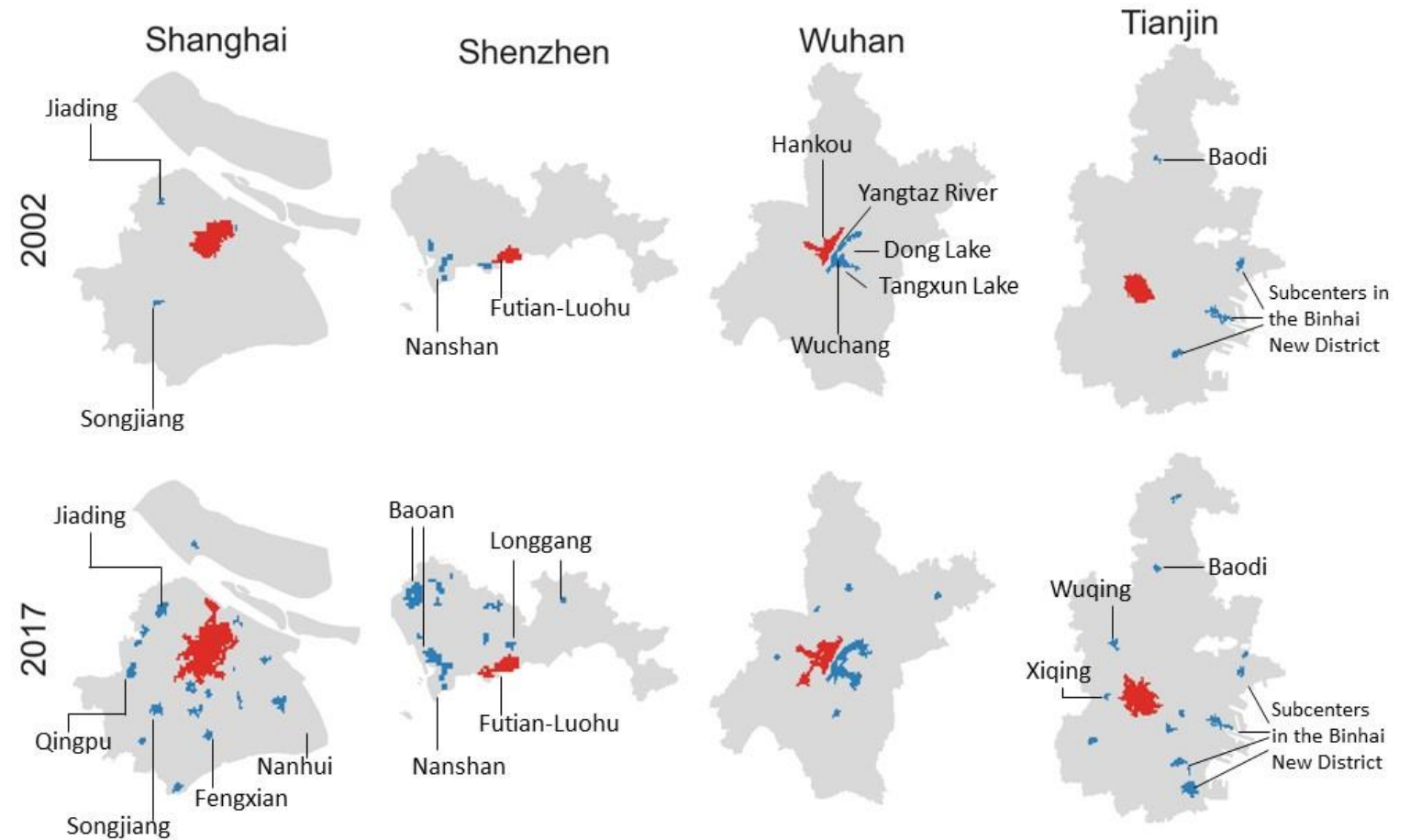
- Economic zone: Futian and Nanshan
- New subcenters: Baoan and Longgang

Wuhan:

- Physical factors: lakes and rivers

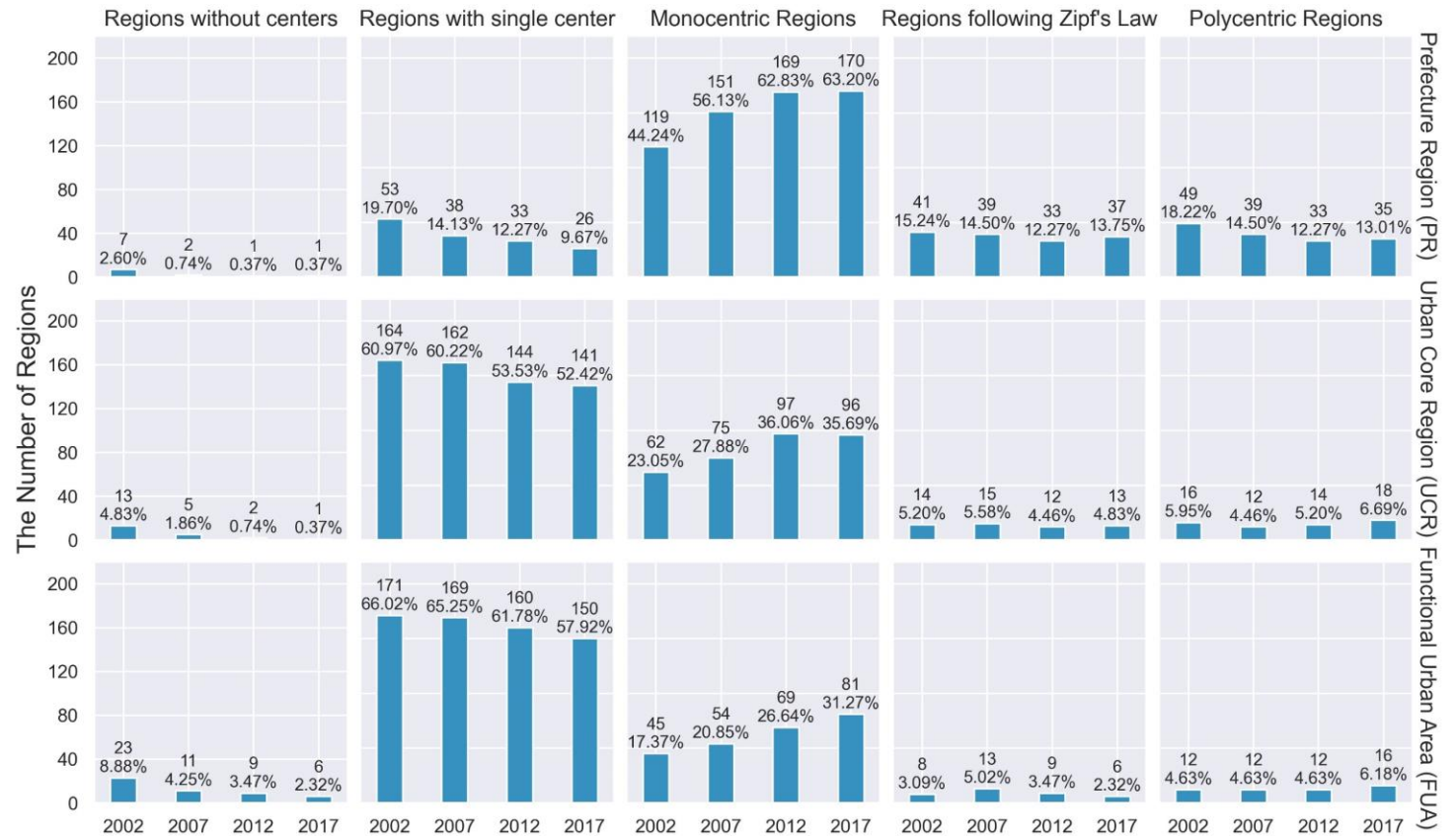
Tianjin:

- Binhai economic zone
- Regional integration policy of Beijing-Tianjin-Hebei



Spatial-temporal trends — SP typologies and 269 Chinese regions

- Cross-sectional dimension: different regional delineations, different results
- There is an unambiguous trend toward polycentricity, regardless of delineation.
- The trend is not caused by the increasing number of polycentric regions nor the regions following Zipf's Law (col 4,5), but through a continuous transition from single-centered regions (col 2) to monocentric regions (col 3).



Cross-sectional regressions

- Different measures and regional delineations, different results.
- ↑ Population, ↑ polycentricity
- ↓ Population density, ↑ polycentricity
- ↑ GDP per capita, mixed results
 - Regional delineation
 - Development stage

Variables	Prefectural regions (PRs)			Urban core regions (UCRs)		
	(1) ln(N)	(2) ln(MP)	(3) Typology	(4) ln(N)	(5) ln(MP)	(6) Typology
Total population(ln)	.5976** (.0306)	.1698** (.0342)	.0456 (.0548)	.509** (.0248)	.2782** (.0354)	.3217** (.045)
Total Popdensity(ln)	-.1035** (.0343)	-.039* (.0184)	.1208 (.0616)	-.2303** (.0401)	-.1454* (.0575)	-.1589* (.073)
GDP per capita(ln)	.1003** (.0454)	-.0197 (.0507)	-.054 (.0814)	.154** (.0335)	.1433** (.048)	.1224* (.0609)
Curvature	5.972** (.6234)	3.5771** (.6971)	6.4623** (1.1181)	4.0924** (.5353)	3.1529** (.7662)	3.7973** (.9731)
Total area(ln)	.0519 (.0266)	.0686* (.0298)	.0327 (.0477)	.0148 (.0189)	.043 (.027)	.0129 (.0343)
East zone(base)						
Northeast zone	.1168 (.0651)	-.1507* (.0728)	-.2511* (.1168)	-.1013* (.0507)	-.1258 (.0726)	-.1902* (.0922)
West zone	-.483** (.0519)	-.4194** (.058)	-.4532** (.093)	-.289** (.0419)	-.3562** (.06)	-.3432** (.0763)
Central zone	-.3436** (.0434)	-.258** (.0486)	-.2371** (.0779)	-.3313** (.0367)	-.4319** (.0526)	-.3812** (.0668)
Constant	-2.3477** (.1984)	-2.1708** (.2218)	1.6597** (.3558)	-1.8937** (.12)	-3.1835** (.1718)	.1073 (.2182)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	992	992	992	992	992	992
Adjusted R-squared	.49	.1512	.0747	.5506	.2560	.1693

(1) * $p < .05$, ** $p < .01$, Robust standard errors are in parentheses.

(2) The regressions of FUAs are absent in the table due to the lack of socio-economic datasets aggregated to the corresponding spatial scale.

(3) Data source: Chinese City Statistical Yearbook. All variables are aggregated to the corresponding spatial scales.

Panel regressions

Table 3: Panel regressions of polycentricity (year = 2002, 2017)

Variables	Prefectural regions (PRs)			Urban core regions (UCRs)		
	(1) ln(N)	(2) ln(MP)	(3) Typology	(4) ln(N)	(5) ln(MP)	(6) Typology
Total population(ln)	.5448** (.192)	.6039* (.2756)	.2538 (.4619)	.368** (.0779)	.2441* (.0952)	.5741** (.143)
Total Popdensity(ln)	-.2874** (.0809)	-.2483** (.0956)	-.2159 (.1602)	-.2829** (.0781)	-.0424 (.0384)	-.1466 (.1435)
GDP per capita(ln)	.0753* (.0381)	-.0406 (.0449)	-.0816 (.0752)	.1198* (.0693)	.0334** (.0122)	.255* (.1273)
constant	-1.6152 (1.1431)	-4.1846* (1.6456)	1.1848 (2.7574)	-1.0348* (.379)	-2.9544** (.4248)	-1.319 (.6959)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations ²	460	460	460	460	460	460
Adjusted R-squared	.7407	.5328	.4529	.7793	.7076	.8156

(1) * p<.05, ** p<.01, Robust standard errors are in parentheses.

(2) Regressions only include the observations in 2002 and 2017 to maximize the variations of dependent variables.

(3) Data source: Chinese City Statistical Yearbook. All variables are aggregated to the corresponding spatial scales.

Conclusion

- Different regional delineations lead to different spatial-temporal patterns toward polycentricity, even at the same spatial scale. Future studies should put regional delineations as important consideration.
 - Prefectural regions – political issues and spatial planning
 - Functional urban areas – regional labor markets and functional linkages, economic performances of polycentricity
- Although Chinese regions are generally monocentric, they have increasingly become more polycentric over time, which is reflected through the emergence of subcenters in previously monocentric and non-centered regions
- Population growth, political power (e.g., the establishment of economic zone), and spatial planning policies play essential roles in shaping polycentric pattern. However, GDP per capita received mixed results.
- ↓ Population density, ↑ polycentricity: compact urban form should give priority in subcenter design and policy interventions for polycentrism should work closely with policies in urban containment and growth management.

Suggestions and Comments

Thank you!

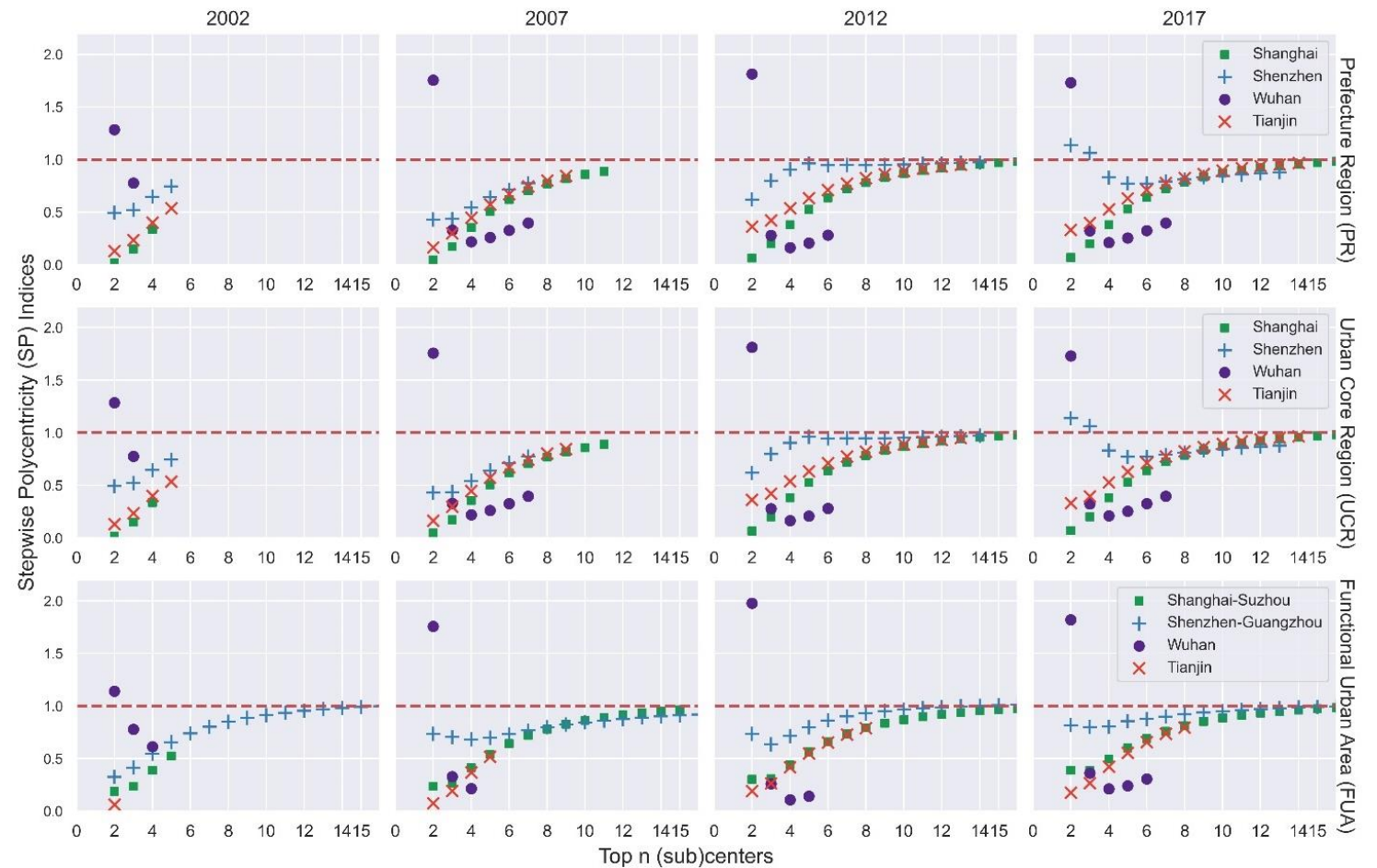
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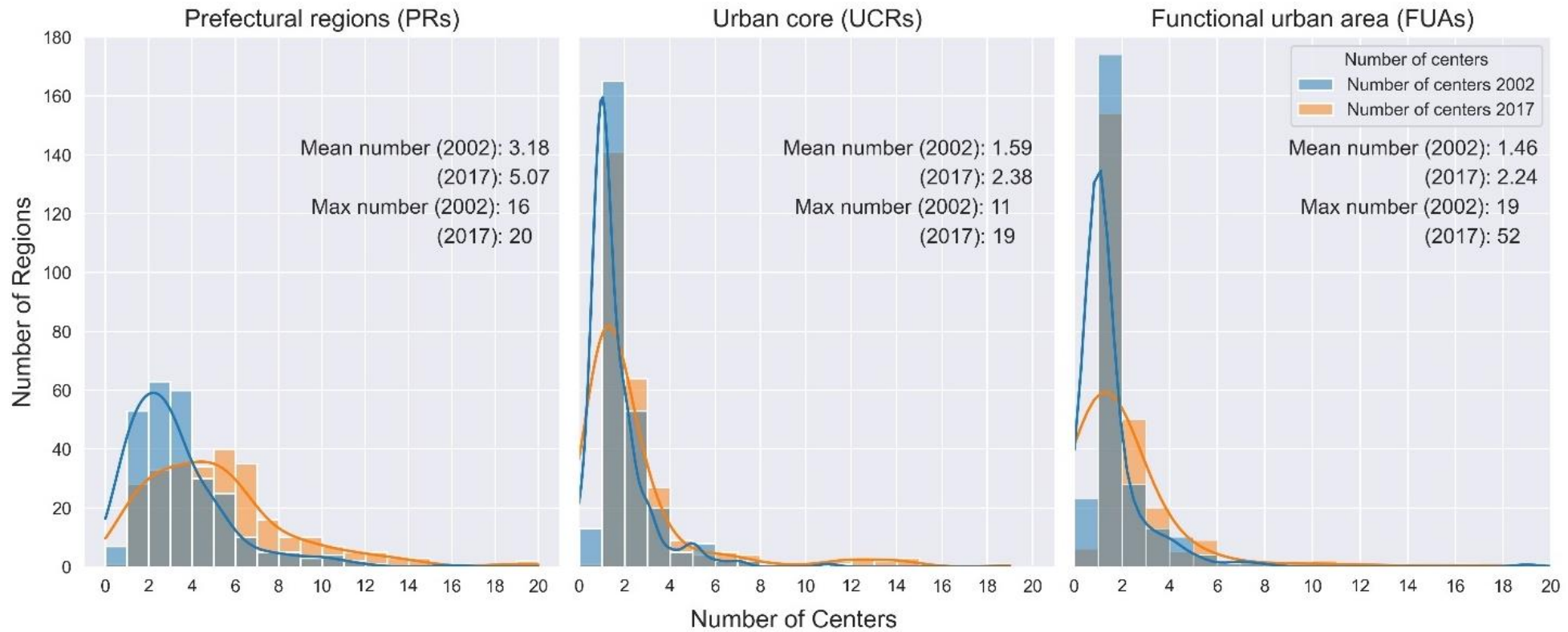
Spatial-temporal trends — SP typologies and 4 case regions

Different regional delineations (via y-axis):

- micro-level variations: (sub)centers
- fundamental changes:
 - Shenzhen as monocentric region identified by PR and UCR; as polycentric identified by FUA



Spatial-temporal trends — the number of (sub)centers



Identifying (Sub)centers -- A Combined Approach

Shanghai (prefecture city)
as an example:

Step 1: LISA – selecting significant
HH and HL cells

Step 2: GWR regression –selecting
significant residuals

Step 3: Combining the selected cell
in LISA and GWR

Step 4: Selecting (sub)centers that
have at least two continuous cells
and total population at least 50,000

