**Chinese cities and specific regimes of adaptability**

Juste Raimbault

Denise Pumain

Emeritus Professor, université Paris 1 Panthéon Sorbonne, 191 rue Saint-Jacques 75005 PARIS France

[pumain@parisgeo.cnrs.fr](mailto:pumain@parisgeo.cnrs.fr)

ORCID number: 0000-0002-0730-4563

**Abstract**

Are the dynamics of Chinese cities, since decades governed by centralized planning, different from those of other systems of cities around the world? This article investigates the particularities of the Chinese system of cities from a broad conception of complexity that includes relevant geographical and historical contexts as well as formal properties of complex systems to conduct international comparisons. The first part of the paper shows how important the definition and delimitation of cities is, as is the consideration of the long term, in order to produce a rational comparison between the Chinese system of cities and those observed in other parts of the world. This rigorous assemblage makes it possible to deconstruct some of the specificities that are sometimes claimed about the number and size of Chinese cities, even with simple statistical models. More sophisticated models are required to explore the dynamics of urban coevolution in these complex systems, which include path dependence effects that are very important for their sustainability: a second part recalls the assumptions of the evolutionary theory of cities enabling to reconstruct city growth trajectories and presents a series of integrated models to explore their diversity in international comparisons. The third part uses sophisticated methods provided on a modelling platform for analyzing and validating simulation models of the dynamics of systems of cities. The identified specific regimes of adaptability for Chinese cities authorize concluding on a limited variety of accessible urban futures.

**Keywords: China ; system of cities ; urban growth ; coevolution; urban models ; Pareto front**

**Introduction**

The development of Chinese cities raises a number of questions, some of which are common to other systems of cities around the world, and some of which are specific. Cities are complex adaptive systems. Complexity can be defined not only on the basis of formal processes, described with mathematical or computing tools (Batty 2013 and 2024; Chen et al 2017; Reggiani et al 2021) but also by the diversity of concepts and theories from different disciplines that need to be combined to acquire sufficient knowledge of a given system (Pumain 1998; Portugali 1999; Pumain 2020). The complexity of the dynamics of systems of cities is reflected, on a global scale, in significant variations of the morphology of these systems, which can only be understood by having identified the geographical and historical context of the urbanization process (Rozenblat et al 2018). Thus, specific forms have been attributed to more or less ancient territorial organizations at world scale, differentiating Old and New World systems by the density and spacing of cities, or exemplifying the duality of urban systems in countries that have undergone colonization (Bretagnolle et al 2009).

Those who are interested in international comparisons and question the specific nature of Chinese urbanization point to the very rapid pace of urban development since the end of the 1970s: "China is probably one of the fastest urbanizing countries in the world" (Chan & Hu 2003, p. 50), which has seen the urbanization rate of the population rise from some 20% in 1980 to around 65% in 2020, in parallel with economic development. China maintained during the second half of 20th century an average growth rate of urban population much larger than in any other large region of the world, exceeding 5% per year between 1964 and 2000, whereas it was only 2% per year in India (Pumain et al. 2015). Urban scientists also very often cite the planned and centralized nature of urban development since the 1949 revolution and the 1978 economic development policy as a very specific feature. A more nuanced perspective is brought by Fulong Wu (2020) who acknowledges that “China is quite specific, as elsewhere, in terms of institutional arrangements related to urbanization and political economic changes” but demonstrates on many examples that “emerging cities involve both complex market operations and governance ” (p. 181).

The Chinese urban research is characterized by a remarkable openness to the full range of urban questions in international literature (Chen, Ye et al 2019). However, more than in other countries, there is a strong interest in governance issues, which are dealt with more explicitly than in many works from other regions of the world. The specific nature of the questions raised in the literature on Chinese cities is attributable to the planned nature of recent urbanization (Wu et al 2006). The themes are often addressed from the perspective of usefulness for planning as can be observed on a variety of topics in recent papers: special economic zones (Xie et al 2018), urban competitiveness (Jiang & Shen 2010;Tionjing et al 2023), foreign investment (Li et al 2023), property market and the financing of urban extensions (Swerts 2019; Aveline-Dubach 2020; Theurillat 2022), intercity relationships (Tionjing et al 2024), inter-urban patents diffusion (Kang et al 2024), digital governance (Hsu et al 2024), carbon emission (Zhang et al 2023), the comparative efficiency of mono- and polycentric urban structures (Pan et al 2024), and even a recent growing interest in cities that are losing population, no doubt linked to the slowdown in population growth in China (Li and Mykhnenko 2018; Liu & Liu 2022).

The short duration of the data analyzed (generally 2000-2010 or 2020, a very small number goes back to 1964) in current publications may reflect this need for information aiming at immediate action, but it may also reveal a certain lack of interest in heritage issues or a mistrust of the lessons that could be learned from long history. This is paradoxical because the availability of detailed territorial information is one of the great original features for research on Chinese cities. For example, China is the only country in the world to publish precise original information on production and taxation values at fine spatial granularity for local urban entities.

We show in a first section how the sources used to define and delineate cities play an important role in enabling to provide scientific answers to questions about the number, size and growth of cities. A second section describes the theoretical principles used for developing computing models that represent the interactive development, i.e. the coevolution of cities within a system of cities. By experimenting with a simulation model on global databases with harmonized definitions, we can identify specific adaptability regimes for Chinese cities.

**1 The Chinese system of cities in the global urban evolution**

At a time when the digital and the virtual are massively interfering in cognitive representations and urban projects (Batty 2024), it is important to remember that the most apparent specificities of Chinese cities are still to be found in the materiality of its urban landscapes and the geographical pattern of its urban network. At the meso-scale of individual cities, Chinese urbanism, because of its late development and the use of recent construction techniques, would seem to be characterized in many city landscapes by the verticality of its morphology. Urban planning based on entire neighborhoods of tall residential buildings reinforces the very high densities often observed in Asia (around 40,000 inhabitants/km2 in millionaire cities, compared with 20,000 in Europe and 2,000 in North America according to Bertaud 2004). The paradoxes of a form of urban planning that provides infrastructure and green spaces before building, but tolerates very high levels of pollution from motor vehicles (while at the same time promoting the mandatory use of electric propulsion for two-wheelers in some major cities before any other country), are often cited, as are the contradictions and risks of time-limited land ownership for a population whose savings invested in this way may be threatened by an overproduction of housing (Aveline-Dubach 2020, Theurillat et al 2022).

When going from city level to the scale of system of cities, even if their size can be considered as adapted to the demographic weight of the country, China may appear as having developed huge agglomerations as shown by a simple comparison with the other most populated country of the world: 5 Chinese cities belong to the top 15 of largest urban agglomerations (2 Indian cities only), 17 cities can be considered as megacities because their population exceeds 10 million inhabitants (in India 6 only). Moreover, China is the unique country in the world that concentrate at least 3 megacities of closely interconnected large urban centers named “city regions” or megalopolises: the urban concentration of the Pearl river delta (including Guanzhou, Shenzhen, Honk-Kong and Zhuhai) arrives at first position in the world with more than 62 million inhabitants according to Population data.net, the Beijing-Tianjin-Hebei region (Jin-Jin-Ji or Bohai Rim) and the Yangtze River Delta around Shanghai, Nanjing and part of Zhejiang province, and two others are developing in the Chengdu-Chongqing Economic Circle and in the vicinity of Wuhan (Middle Reaches of the Yangtze river), corresponding to a process of “upscaling governance from individual cities to city-regions” (Wu 2020). However, among BRICS countries, China is not characterized by the macrocephaly of the system of cities.

On a map, the spatial distribution exhibit since long a visible asymmetry, according to a centre-periphery gradient oriented from the eastern coastal regions to the western continental borders. This property is shared with countries having developed their system of cities from colonial processes (as USA or Brazil). In China it results from a long history of aggregative self-centered development that has been strengthened during last decades under the pressure of maritime trade ensuring industrial development and connection with other urban systems at global scale. However, the evolution of that system is very difficult to describe because of the complexity of statistical sources and uncertainties about urban definitions.

**1.1 Definition and delineation of cities for international comparisons**

Our knowledge of Chinese cities is considerably skewed by prior issues of definition and measurement, which must be overcome if international comparisons are to be made. The urban status of populations operated an urban-rural socio-economic divide that is stronger and maintained for longer than elsewhere, via the Hukou system (Gipouloux 2015). Going beyond official statistics allows us to think comparatively about city systems in other major countries, between continents, between the Old and New Worlds, or between the global North and South.

We shall not describe here the official urban statistics of China that is very complex because cities are identified at different levels of the administrative divisions of the country. Chan & Hu (2003 p. 53) provides a table illustrating this multilevel definition of cities across administrative subdivisions. We consider the Chinacities data base (Swerts 2017) which was built over three years of intense work by an individual scholar. This open database manages to build standardized delineation of cities for China starting from built-up areas retrieved on satellite images and coupled in a GIS with data on administrative limits and population from statistical yearbooks. Thus urban agglomerations are defined as aggregations of local units with a diversity of administrativedefinitions (xian, qu, xianjishi (district level) and zhen, xiang (subdistrict level)) combined with morphological and functional features of the settlements. A total of 9294 cities are designed for 2000, the evolution of the population from census data is included from 1964 to 2000 for those larger than 100 000 inhabitants as well as employment according to activity sector in 1990 and 2000.

There is an allometric relationship that remains rather constant with an exponent of 0.8 between the urbanized surface or urban areas and their population (Swerts & Pumain 2010). Another available data base where Chinese cities are defined according to standardized international definition is provided by GHSL (Global Human Settlement Layer dataset produced by the European Commission in link with the GEO Human Planet Initiative). The data delineate comparable morphological urban agglomerations by detecting built up area from satellite images at 40 m resolution, and combining it with a population layer generated at 250 m resolution using local data at municipal and district levels provided by censuses on a regular 1 km2 grid and include diverse attributes observed between 1975 and 2015 (Raimbault et al 2020).

Occasionally remote-sensing nighttime light (NTL) data were retrieved for samples of Chinese cities (Cheng et al 2016). A more comprehensive data set named PANDA is used by Li et al (2024) for documenting urban expansion from 1984 to 2020. They conclude that NTL data are significantly correlated with various city scale assessment indexes (that quantify aspects such as the city boundary, population, and economy) but do not provide population figures nor number of cities. Cang et al (2024) bring a number of cities that is closer to international definition, with “a final result that clearly shows the presence of 4905 authentic natural cities in China in 2016”. They applied a different method based on clustering algorithms of built-up areas on satellite images around each national road intersection, combined among other with multisource big data locating elementary services (points of interest POI) to define “the true boundaries of Chinese cities. From their calculations, the average road node density of all natural cities is 64/km2, and the average POI density of all natural cities is 491/km2.

**1.2 Number, size and growth of cities from official or standardized data sets**

Although China exhibits a regular urban hierarchy whose city sizes are adapted to the demographic size of the country, there are very few studies that consider the system of cities as a whole, including small and medium-sized towns. Most of the articles that were cited here relate exclusively to officially declared prefecture level cities, i.e. less than 300 urban areas up to 657. This number is much too small, if we consider that China belongs to the type of world regions having ancient urbanization, meaning a large density of urban centers that makes Eurasia distinct from continents of the New World. In consideration of its urban population when compared with India or Europe, China should have at least more than 5000 cities. The total number is above 9000 in the Chinacities data base (Swerts 2017), among which many small and medium size towns.

The choice of data bases with different definition and delineation of cities explains the multiple contradictions that can be observed in the results of statistical investigations about rank-size rule or Gibrat’s model in China. For instance, Xu (2004) or Song & Zhang (2002), Gan, Li & Song (2006), Anderson & GE (2005), Chen & Hu (2010) analyze 657 cities only, concluding that rank-size rule does not hold for Chinese cities. Anderson & Ge (2015), who choose an exceptionally long period for observing urban growth, from 1949 to 1999, and whose sample includes from 77 to 658 cities, identify “substantial differences” in the size distribution of cities, that would be of Pareto type for USA and lognormal for China. They find a decreasing slope for Zipf’s rule in China, arriving at a very low value of 0.54 in 1999, whereas the same method applied to US result with 1.39 in 2000. On a sample of 268 cities (prefecture level, among which about 152 are larger than 1 million inhabitants) Wan et al. (2020) find an evolution of the Pareto exponents between 1990 and 2017 that denote a metropolisation trend that brings the size distribution closer to Zipf’s law which they consider as a norm to reach. However, using a panel data from UN for urban agglomerations over 300 000 inhabitants, Sun et al (2021) estimate a Pareto slope from 1.25 in 1950 to 1.21 in 2018 for China (with comparable type of data they get 1.03 to 1.08 for US and 1.04 to 1.13 for France).

Regarding urban growth and the evolution of urban hierarchy, there is a general agreement on the existence of a temporal rupture after 1978. For example, Zhou et al. (2013) conclude: “Since 1949, the size distribution of cities in China has been changing. This change process can be divided into two stages. The cut-off point of the two stages is 1978, the year China’s reform and opening-up policy started. In both stages, the central government has played a significant role. The main interventions of the central government are not Keynesian approaches but political. First, it enhanced economic vitality by implementing a new regional development strategy. Second, it promoted the development of backward or declining cities by transfer payments. Consequently, metropolises and large cities have not grown abnormally large in the globalization process of China’s urbanization.” When using the Chinacities data base, Swerts & Liao (2018) share a similar conclusion: “The evolution of the hierarchization degree of the Chinese cities, which remains low till 2000 and increases between 2000 and 2010 could be explained both by the strong growth impulse given to a few small towns from 1982 to 2000, many of them maintaining their relative size while almost half of the million plus cities were increasing theirs”. Using NTL data Li et al (2024) mention that « over the 37-year period, China’s urbanization has increased rapidly, with outward expansion, and the gap in urban scale has decreased. There was more growth in the east and less growth in the west, and growth was faster in large cities and slower in small cities (Li et al 2024, p.26). They conclude: “In China, the q-value declined continuously (at – 0.02/a) from 1984 onward, transitioning from greater than 1 to less than 1 in 2001 and reaching 0.7898 in 2020. This indicates that the urbanization gap in China gradually decreased”.

Nuances are recently brought about the hierarchical administrative organization of the Chinese system of cities, when handling careful analysis of interactions between urban stakeholders in “variegated modes of zoning and *trans*-jurisdictional projects”: “The interplay of local, regional and national actors with different motivations gives rise to a new inter-scalar and inter-jurisdictional regulatory regime for regional industrial integration with relative coherence. This emergent governance regime is sustained and embedded in both topological and territorial political relations” (Wang et al 2024). Analyzing the evolution of a set of urban attributes for 275 prefectural-level and above cities in China over last two decades, Lei et al (2024) conclude that “the dynamic fluctuations within individual cities and the macro-stability of the evolution of urban systems over the past two decades are systematically demonstrated” and “urban built-up area is more affected by scaling effects whereas social productions is driven more by global external effects”. However, Kang et al (2024) confirm a growing inequality along the urban hierarchy despite the increasing presence of global investments and firms in 230 prefecture level cities from 1999 to 2013:“While it is true that the number of cities licensing patents to import technology from overseas has been increasing, it is being outmatched by the domestic patent licensing from the top-tier cities within China”. Other papers indirectly measuring relationships between Chinese cities from toponymal co-occurrences in text corpora, such as (Tongjing et al. 2023) and (Tongjing et al. 2024) find a high correlation between the intensity of interurban relationships and urban performances. This may suggest that metropolization trends could further develop within the Chinese systems of cities, as “city network externalities turn out to be more important in explaining urban performance than agglomeration externalities”. This interpretation is shared by Zünd & Bettencourt (2019) from an exploration of scaling exponents for urban economic attributes in prefecture level cities.

All in all, the conclusion of these initial investigations is that the spatial configuration of the Chinese system of cities resembles that of other systems in the world. When this system is observed with definitions and delimitations standardized with those globally observable, it resembles the systems of cities of the Old World in its hierarchical organization and the spacing of its cities, and the systems of the New World in the asymmetry of its locations relative to the maritime façades. From a classical data analysis on standardized urban data sets of large regions of the world observed over half a century, Pumain et al (2015) could conclude “There is nothing resembling a specific urban dynamic in BRICS whether we consider the shape of urban hierarchies, city size distribution, or distribution of urban growth among individual cities.” Therefore, the dynamics of Chinese cities can be explored and compared with models that were designed for any system of cities using principles from the evolutionary theory of urban systems.

**2 A unified theory for investigating the dynamics of urban systems**

The evolution of cities over time is the result of both their own history and the interactions they develop with other cities, within multiple networks and at different scales. Systems of cities emerge from the many tangible and intangible relationships and spatial and social interactions that give rise to interdependencies between cities. This is the driving force behind their co-evolution on a macro-geographical level.

**3 A dynamic according to evolutionary theory, with regimes of adaptability**

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