Post-industrial Economic Restructuring and Wage Inequality in Urban China, 2003−2015: A Sectoral Perspective

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Abstract: Income inequality in urban China has attracted growing attention from China's urban researchers and policy makers. Whereas many studies have interrogated the pattern and process of the income gap in Chinese cities undergoing the institutional transformation from plan to market, relatively little is known about how such unequal distribution of income is related to China's ongoing structural transformation toward a post-industrial economy. Drawing on a decomposition methodology based on the Theil index, this study aimed to address this lacuna through an empirical investigation of China's urban wage inequality from a sectoral perspective. Our empirical study identified the low-wage manufacturing sector and the high-wage producer services sector as the two biggest contributors to urban wage inequality in China. Urban wage inequality within the producer services was found to be caused by the spatial concentration of a disproportionate number of high-paying jobs in a few developed, high-tier city-regions on the eastern coast. Our empirical findings have important implications for the formulation of policies to address the income inequality that plagues China's continuing urbanization.

Keywords: wage inequality; post-industrial economy; economic restructuring; producer service; urban China

1 Introduction

Concerns over inequality have recently surged to the fore of public policy and popular debate, partly because of the observed long-term trend of growing income disparities in the vast majority of Organisation for Economic Co-operation and Development (OECD) countries and partly because that growing inequality has been argued to be one cause of the recent populist surges and seismic political changes in the developed world (OECD, 2008; Piketty, 2014; Gordon, 2018; Rodríguez-Pose, 2018). Some high-profile academic studies have documented the fact that inequality can have negative social consequences in terms of increased crime, deteriorating health outcomes, and reduced life satisfaction for society as a whole (Frank, 2007; Wilkinson and Piketty, 2009; Dorling, 2010). Although some degree of inequality may not be a problem insofar as it provides incentives for human capital accumulation, upward social mobility, innovation, and entrepreneurship, high and sustained levels of inequality can significantly undermine individuals' educational and occupational choices and can create perverse incentives for resource misallocation and investment-reducing political and economic

instability (Dabla-Norris et al., 2015). Entrenched and rising inequality requires serious policy attention from decision-makers and logical explanation from researchers.

The unprecedented scale and pace of China's urban and economic transformation experienced during the past four decades has been accompanied by two concurrent processes of structural and social changes. On one hand, along with China's phenomenal economic growth, there has simultaneously been a structural change in the urban economy, with the growth and expansion of services gradually replacing the manufacturing sector as a key force shaping the growth and transformation of Chinese cities (Lin, 2004). Especially since the early years of the 21st century, China's urban development has been said to have entered its fourth wave, characterized by the rapid growth of producer services (Yeh et al., 2015). On the other hand, China's fast economic growth has also featured a high level of income inequality, with the national Gini coefficient estimated to have increased from approximately 0.300 in the early 1980s to 0.462 in 2015 (National Bureau of Statistics of China, NBSC, 2016a). Specifically, income inequality in urban China has continued to rise from a Gini coefficient of 0.230 in the late 1980s to 0.280 in the mid-1990s and to approximately 0.340 in 2009 (Meng et al., 2013; Li and Sicular, 2014). Concerned by rising inequality and its potential threat to China's regime legitimacy, Chinese leadership has emphasized equitable growth and has implemented a range of policy measures since the early 2000s to reduce income disparities and protect the economically vulnerable (Li and Sicular, 2014). The two processes of structural transformation and social inequalities have been well documented in the existing literature, but with a few exceptions (e.g., Zhang and Wan, 2017), relatively little has been done to investigate their interrelationship. As a result, it remains unclear how service-oriented economic restructuring has affected changes in income inequality in urban China.

The dominant explanations of rising inequality in social science can be generally classified into three types focusing on demand-side, supply-side and institutional factors respectively (Donegan and Lowe, 2008; Breau and Essletzbichler, 2013; Dabla-Norris et al., 2015). The demand-side explanation links inequality to the structure of the labor market and employment opportunities in terms of globalization, skill-based technological change, and the resultant demand for more-educated workers, to the detriment of less-skilled workers. The supply-side explanation associates increased inequality with changes in the demographic composition of the labor force, in terms of its educational profile, age structure, female participation, and share of immigrants. In contrast, the institutional account attributes high levels of inequality to labor market institutions, and especially to the decline in unionized labor and the fall in the real minimum wage. Most relevant to the discussion in this paper are the demand-side explanatory factors that emphasize the level of economic development, globalization, and structural change.

Early theorization of the association between economic structural change and income inequality was often stimulated by the seminal work on the Kuznets curve. According to Kuznets (Kuznets, 1955; Yin et al., 2006), as a country develops and modernizes, the dominant sector of the economy shifts from a low-productive agricultural sector to high-productive manufacturing and service sectors, and income inequality will keep rising until it reaches a threshold, after which it starts to decline, ultimately displaying an inverted U shape. Although the Kuznets curve has stimulated a long-term debate and more recently a powerful critique by Piketty (2014), it mainly focuses on the broad processes of modernization, industrialization, and urbanization, without shedding much light on the nuanced effects of heterogeneous nonagricultural sectors in the post-industrial era.

The hypothesized relationship between service-oriented economic restructuring and income inequality has long been a hotly debated topic in the well-established literature on global cities and city-regions. Scholars argue that structural changes in global city development, as represented by the processes of deindustrialization and the ascendancy of financial and producer services, have led to the disappearance of good-paying manufacturing jobs, an expansion of a high-income stratum of transnational capitalist class, and the growth of a low-wage service underclass, and the subsequent enlargement of wage inequalities (Friedmann, 1995; Sassen, 2001; Burgers and Musterd, 2002; Hoyler and Harrison, 2017). This hypothesized impact of the post-industrial economic transformation of global cities on income and social polarization is based on two assumptions. One holds that the manufacturing sector is the main provider

of stable, semi-skilled and middle-income jobs and that the service sector is more polarized in occupational and income distribution than the manufacturing sector is. The other assumption is that the pattern of inequality within each individual economic sector remains unchanged during the process of service-oriented economic restructuring.

These two assumptions, developed predominantly on the basis of case studies of a select number of paradigmatic cities at the top of global urban hierarchy in the global north, however, may not hold for many ordinary cities 'off the global city map' in the global south (Robinson, 2002). They are found to be especially problematic in the Chinese context. First, the assumption that the widening income gap in global cities was brought about by the retrenchment of the manufacturing sector and the associated erosion of middle-class jobs is at odds with the pattern of 'simultaneous industrialization and tertiarization' observed in Chinese cities (Lin, 2004). The fact that the manufacturing sector still constitutes a significant portion of China's urban and regional economies therefore points to the necessity to investigate in details the relationship between deindustrialization and urban inequality in the Chinese context.

Second, China is a huge country with great regional disparities. The combination of resource endowments, locational advantages, agglomeration economies, development history, and other factors has led to significant spatial differences in labor productivity, even when controlling for the same sector. It is quite plausible that the wage income of the employed workforce within the same economic sector varies considerably across regions and over time. A recent estimation of wages in different Chinese regions, when controlling for educational levels, revealed that the returns on education vary significantly across regions (Li et al., 2016). As Crankshaw and Borel-Saladin (2014) rightly pointed out, in order to understand the impact of sectoral changes on the overall income structure, 'We need to measure the extent to which changes in the overall occupational (*and income*) distribution of employment can be attributed to changes in the relative sizes of economic sectors or to changes in the occupational (*and income*) distribution within each economic sector' (Crankshaw and Borel- Saladin, 2014, italics added).

The interrogation of these two assumptions in the Chinese context has important policy implications. In the existing literature on income inequality in Western advanced economies, the decline and hollowing out of middle-income manufacturing jobs is often blamed for the rise in urban inequality. Following that logic, it is consequently suggested that bringing manufacturing back or instituting programs designed to promote job growth in manufacturing industries could help to curb the rise of inequality in post-industrial society. This policy suggestion, however, may be off target if deindustrialization is not the main cause of the changing income structure. In addition, reducing income inequality requires the redistribution of income from the high-income group to the low-income group. From a sectoral perspective, this redistribution entails the amelioration of income disparity at both inter-sector and intra-sector levels. Controlling the income gap between the high-income sector (e.g., the financial sector) and the low-income sector (e.g., the consumer services sector) through public policy intervention will be quite challenging, however. Inter-sector income differences tend to reflect the impact of dominant market forces in terms of the wage premium for skills and education, and the improvement of workers' skills through training support is a long-term investment that may not pay off in the short run. What is more feasible and relevant for inequality-reducing efforts in the context of China would be to enact central or local policy assistance that focuses on reducing the inter-regional income gap within the same economic sectors. To do that will require a nuanced analysis to measure the relative sizes of intra-sector inequality across different sectors.

The rise of wage inequality in urban China has also been analyzed in several empirical studies from different perspectives (Knight and Song, 2003; Appleton et al., 2014). Much of the existing literature on China's wage inequality focuses on the segmentation of social groups in the urban labor market and on their earnings differences along such dimensions as education, skill competence, household registration status, location, employer ownership types, and so on (Zhang et al., 2005; Demurger et al., 2012; Cheng et al., 2013; Meng et al., 2013; Zhou, 2014; Li et al., 2016; Whalley and Xing, 2016). Most analysts have identified education, the skill premium, household registration (*hukou*) status, ownership transformation, and widening regional disparities as the major contributors to overall wage inequality in China's urban economy undergoing profound market transition.

However, relatively little has been said about how the unequal distribution of urban income is related to China's ongoing structural transformation toward a post-industrial economy. A notable exception was Zhang and Wan's (2017) recent analysis, which revealed that the wage inequality of urban households in China from 2003 to 2012 was dominated by an inequality component within the service industry. However, their analysis did not go further to quantify the relative contributions of the different service sectors to China's changing income inequality.

Against the above academic backdrop, this study followed the methodology of Zhang and Bao (2015) to examine the association between the ongoing economic restructuring and the evolution of China's urban wage inequality, from a sectoral perspective, using the between-groups and within-groups components of the Theil index, across regions and sectors. In particular, we attempted to address the following research questions. How has wage inequality in urban China changed amid its post-industrial transformation? Which sectors are the main contributors to the evolution of China's urban wage inequality? Has deindustrialization been the main cause of rising urban inequality in China, as was observed in Western advanced economies? How has a service-oriented economic transformation affected the rise and fall of income inequality in China's city-regions?

In attempting to answer these questions, this research has the potential to make the following contributions. First, it goes beyond the general focus on the macro forces of globalization, economic development, and industrialization in the existing literature on China's income inequality, to provide a nuanced view of the uneven contributions of disaggregated economic sectors at both national and provincial levels. Second, it challenges the perceived association between unequal urban income distribution and deindustrialization, highlighting the necessity for a contextualized account of the variegated trajectories of China's post-industrial transformation and its distributional consequences in different world regions. Third, it complements the large body of literature on urban and regional inequality in China by revealing an intriguing mosaic of spatial inequality that is characterized by a spatial convergence of average wages in the manufacturing sector and a spatial divergence of average wages in some representative producer service sectors.

2 Urban Economic Restructuring in Post-reform China

It has been well documented that the growth of the Chinese urban economy before economic reforms was characterized by a peculiar pattern of extensive industrialization with the containment of urban services, driven by the socialist development strategy of transforming Chinese cities from the center of consumption into the center of production (Lin, 2004). Such a growth strategy has led to a pattern of urban employment structure dominated by the secondary industry in 1978, when workers in the secondary industry accounted for over 45% of the urban labor force. After decades of socialist suppression, the intrusion of market forces and globalization following the 1978 economic reforms has allowed tertiary activities to flourish in urban China (Lin, 2004). Since then, the process of urban economic change in the post-reform period has evolved in three stages (Lin and Zhu, 2001; Yeh et al., 2015).

(1) 1978 to the mid-1990s. In post-reform China, urban economic growth from the late 1970s to the mid-1990s was a market liberalization process of 'reform without losers' (Lau et al., 2000), which featured the considerable expansion of urban employment in nonpublic secondary and tertiary sectors. In this stage, the employment share of the secondary industry experienced a slight decrease, while that of the tertiary industry increased considerably, by approximately 7.8 percentage points (NBSC, 2016b). As was the case with the results from some case studies (Zhang and Wan, 2017), the growth of services in urban China during this stage was dominated by the low-end/ low-value-added and public service sectors. Specifically, the consumer service sector of wholesaling, retailing, and catering, the public services sector of government agencies and social organizations, and the education, culture, and entertainment sector, constitute the three major service sectors in employment absorption.

(2) 1995 to 2002. Starting from late 1990s, the Chinese government began to implement ownership restructuring of state-owned enterprises under the reform strategy known as 'holding on to large enterprises and letting go small ones' (*zhuada fangxiao*) (Lin and Zhu,

2001; Lin and Hu, 2011). Amid such reform process, many surplus workers were laid off from loss-making state-owned manufacturing firms, leading to the decrease of share that the manufacturing industry held in total urban employment by more than 7% between 1997 and 2002 (NBSC, 2016b). Meanwhile, the share that the educational and cultural sector held in total urban employment increased significantly, from 9.57% in 1997 to 14.36% in 2002 (NBSC, 2016b), mainly as a result of China's massification of higher education that began in the late 1990s.

(3) 2003 to the present. The employment share of the manufacturing sector in urban China stabilized at approximately 27% to 28% since 2003, whereas housing-related construction and the real estate sector, and some high-end service sectors, such as information transmission, computer services and software, leasing and business services, finance and real estate, scientific research and technical services, and the like, all witnessed a considerate increase in their shares of total urban employment (Table 1). At the same time, wholesalers and retailers, and educational and government agencies, which were the main providers of urban employ-

ment in the previous stages, have seen their shares declining in the past decade. How such uneven changes in the sectoral employment share might influence urban income inequality will be estimated through the following methodology.

3   Data and Methodology

The central question for this study's theoretical and empirical inquiry concerns the extent to which overall wage inequality in urban China is brought about by changes in the relative sizes of the economic sectors versus changes in the wage distribution within each economic sector. This research effort has brought up several research parameters that require clarification. We have used the terms post-industrial era, post-industrial transformation, and post-industrial society to denote the hypothetical staged process of a sectoral transition in which the emphasis of the economy shifted step by step from the primary sector to the secondary sector and then to the tertiary sector, and the society evolved from a pre-industrial stage to an industrial stage and then to a post-industrial stage.

Table 1   Percentage share of China's total urban employment by sector, 2003−2015 (%)

Sector	2003	2009	2015	2003−2015
Secondary industry	37.79	39.98	45.81	8.03
Manufacturing industry	27.63	28.59	29.33	1.70
Utilities	2.79	2.51	2.25	−0.53
Construction	7.37	8.88	14.23	6.86
Tertiary Industry	53.25	52.69	49.63	−3.62
Transportation, storage, and postal services	5.81	4.98	4.85	−0.96
Information transfer, computer services, and software	0.99	1.34	2.00	1.01
Wholesaling and retailing	5.64	4.17	4.96	−0.68
Accommodations and catering	1.52	1.57	1.51	−0.01
Finance	2.73	2.94	2.82	0.09
Real estate	1.03	1.48	2.32	1.29
Leasing and commercial services	1.60	2.22	2.65	1.05
Scientific research, polytechnic services, and geologic prospecting	1.97	2.16	2.29	0.32
Administration of water, environmental, and public facilities	1.56	1.56	1.37	−0.19
Residential and other services	0.45	0.47	0.41	−0.04
Education	13.36	12.70	9.81	−3.55
Health care, social insurance/welfare	4.50	4.77	4.68	0.18
Culture, sports, and entertainment	1.16	1.03	0.83	−0.34
Public administration and social organizations	10.93	11.31	9.13	−1.79

Notes: Data come from Chinese Statistical Yearbook and do not include information for Hong Kong, Macao and Taiwan of China

3.1 Sectoral classification

China's sectoral classification system does not completely match the international standard industrial classification of all economic activities (ISIC). The correspondence between the Chinese standard and the ISIC is provided in the publication of National Bureau of Statistics (Ji, 2011). According to China's 2011 standard, the Chinese economy has a total of 20 one-digit sectors, 96 two-digit sectors, 432 three-digit sectors, and 1094 four-digit sectors. The definition of sectors in the Chinese statistical standard is based on the principal activity of legal unit or industrial establishment unit, which constitutes the micro unit in China's national income and product accounts. When a legal or industrial establishment unit undertakes economic activities in two or more fields, the field with the largest share of that unit's value added will be identified as the sector to which it belongs. For reasons of data availability and comparability, this study focused on the analysis of 20 one-digit sectors. Because this study examined only the income inequality in urban areas, we excluded two one-digit sectors, the agricultural sector and the mining and quarrying sector, which were not closely related to urban economies. Another one-digit sector, international organizations, was excluded because of the lack of detailed data on employment and income across regions for that sector. There were 17 one-digit sectors left: 1) manufacturing; 2) utilities; 3) construction; 4) wholesaling and retailing; 5) transportation, storage, and postal services; 6) accommodations and catering; 7) information transfer, computer services, and software; 8) finance; 9) real estate; 10) leasing and commercial services; 11) scientific research, polytechnic services, and geologic prospecting; 12) administration of water, environmental, and public facilities; 13) residential and other services; 14) education; 15) health care, and social insurance/welfare; 16) culture, sports, and entertainment; and 17) public administration and social organizations.

3.2 Research method

Previous studies on wage inequality in urban China were primarily based on survey data collected in a limited number of sampled cities or on cross-sectional census data from a single year, which may not provide a broad picture of the level of wage inequality and its changes over time and across regions. To overcome that deficiency, Zhang and Bao (2015) provided an original estimate of wage inequality in urban China based on the Theil index (T). The Theil index has two notable advantages over other inequality measurements: it allows the use of group data, which are more easily accessible than individual data, and it is decomposable, which allows the inequality index to be decomposed into a between-group element and a within-group element. The Theil index value is 0 if the income distribution is extremely equal, with every individual having the same income. Its value is calculated as the logarithm of the number of observations if the income distribution is extremely unequal, with one individual taking all the income. Whereas Zhang and Bao (2015) used the method primarily to examine the trends of between-province and within-province wage inequalities, the same method can also be employed to measure the between-sector and within-sector dimensions of urban wage inequality. Specifically, China's urban wage inequality, T, can be decomposed into a between-sector component T^{B}, and a within-sector component T^{W}.

$$T = T^{\mathrm{B}} + T^{\mathrm{W}} \tag{1}$$

The between-sector T^{B} component can be expressed as

$$T^{\mathrm{B}} = \sum_{i=1}^{n} S^i LN\left(\frac{W_i}{W}\right) \tag{2}$$

where S^i is the wage weight for the ith sector. It is calculated as the share of the total wage of the ith sector (T^i) in the total wage of all sectors (T). Thus, $S^i = T^i/T$. The use of the total wage as the weight follows the previous practices of Zhang and Bao (2015) and Liu and Xie (2013). Furthermore, W_i is the average wage of the ith sector and W is the average wage of all sectors.

The within-sector T^{W} component can be expressed as

$$T^{\mathrm{W}} = \sum_{i=1}^{n} S^i \overline{T}^i \tag{3}$$

where $\overline{T}^i$ represents the between-regions inequality for each sector i. Because of data availability, the term region in this study refers to the urban areas in 30 provincial-level units; $S^i \overline{T}^i$ is termed the within-sector Theil element of the ith sector; and $\overline{T}^i$ can be further expressed as

$$\overline{T}^i = \sum_{r=1}^{m} S^{ir} LN\left(\frac{W_{ir}}{W_i}\right) \tag{4}$$

where m is the number of regions used for the calculation of inter-regional variation in the average wage of the ith sector. It is set as 30 in this study. S^{ir} is the wage weight for the ith sector in the rth region. It is calculated as the share of total wage of the ith sector in the rth region (T^{ir}) in the total wage of the ith sector (T^i). $S^{ir} = T^{ir}/T^i$. W_{ir}/W_i is the ratio of the average wage of the ith sector in the rth region to the average wage of the ith sector in the whole country. By decomposing China's urban wage inequality into the between-sector Theil element, the within-sector Theil element, and the sector-region Theil element, we can calculate the relative contribution of each sector to either between-sector inequality or within-sector inequality as well as the relative contribution of each region to the within-sector inequality of a particular sector.

3.3 Data source

The primary data of urban employment and wages that we used for calculating the Theil index came from China's statistical yearbooks. It does not include Hong Kong, Macao and Taiwan owing to data limitation. Tibet is excluded from the following decomposition analysis because of the lack of data breakdown by sector in some years. Urban employment refers to the employment of on-post staff and workers in urban units, which covers most types of ownership and excludes urban private enterprises and individual businesses. The calculation of income inequality involves the measurement of individual income. According to the Chinese statistical definition, urban individual income refers to disposal income, including income from employment, self-employment, assets, and net transfers from public and private sources, minus taxes and fees (Li and Sicular, 2014). It is a broader measurement than urban wages, which refer to wages, salaries, and other payments by employers to their staff and workers. Owing to data limitation, this study used wage inequality as a narrow measurement of income inequality. We recognize that income from private assets and wealth has become an increasingly important contributor to income inequality, but that income is beyond the scope of this article because of the lack of systematic data on it in China. Data on employment and wages were consistently reported in the section on 'Employment and wages' in the Chinese statistical yearbook for each year. They were collected annually by the National Bureau of Statistics, together with the Ministry of Human Resources and Social Security of China. Data from China's statisti-

cal yearbooks were cross-checked with similar data reported in other sources, such as China city statistical yearbook and Chinese statistical yearbook for regional economy. This study focused on the period 2003−2015. We chose 2003 as the starting year because China's statistical authority changed the industry classification standard in 2003, so restricting the study period to years after 2003 ensured data consistency and comparability.

4   Understanding China's Changing Wage Inequality, 2003−2015

How has wage inequality in urban China changed amid its post-industrial transformation? What is the relative importance of the between-sector component versus the within-sector component in driving the changes in urban inequality in China? Based on the Theil's index (T) values explained in the above section, Fig. 1 shows the changes in China's urban wage inequality during the period 2003−2015. The top line refers to the overall Theil's T value. As is explained above, the between-sectors Theil component is the sum of the ratio of each sector's average wage to the average wage of all sectors weighted by the sector's share of the national wage. The within-sector Theil component refers to the sum of each sector's between-regions inequality weighted by the sector's share of the national wage. It is observable that the overall wage inequality reached its peak in 2008 and then began to decrease thereafter, reflecting the negative effect of the global financial crisis in 2008–2009. The decomposition of overall wage inequality reveals that within-sector inequality was the main source of urban wage inequality, although the gap between within-sector inequality and between-sectors inequality began to narrow in recent years. This result suggests that reducing the urban wage inequality in China requires not just
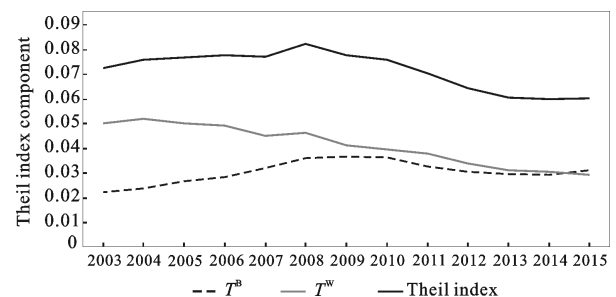

Fig. 1 China's Theil index of urban wage inequality and its between-sector (T^B) and within-sector (T^W) components, 2003−2015

narrowing the gap between the high-wage sector and the low-wage sector, but also reducing the spatial differentiation of workers' wages within the same economic sectors.

4.1   Between-sector inequality

Which sectors are the main contributors to the between-sector component of China's urban wage inequality? Fig. 2 shows the between-sector dimensions (T^B) of China's urban wage inequality in 2003, 2009, and 2015. Data for each sector represent the value of the between-sector Theil element of the sector (T^B) in that year. It took into account both the wage weight of the sector and the ratio of the average sector wage to the national average wage. Data above zero denotes sector with an average wage above the national average level, and vice versa. As is shown in Fig. 2, among all economic sectors, the high-wage financial sector and the low-wage manufacturing sector were the two biggest contributors to between-sector wage inequality in urban China during the examined time period. The large positive contribution by the financial sector is not surprising as it has been well documented that the financial sector is populated by a disproportionately high share of educated professionals who possess a high level of analytical and cognitive skills and are more likely to receive high monetary returns in an urban labor market (Poon et
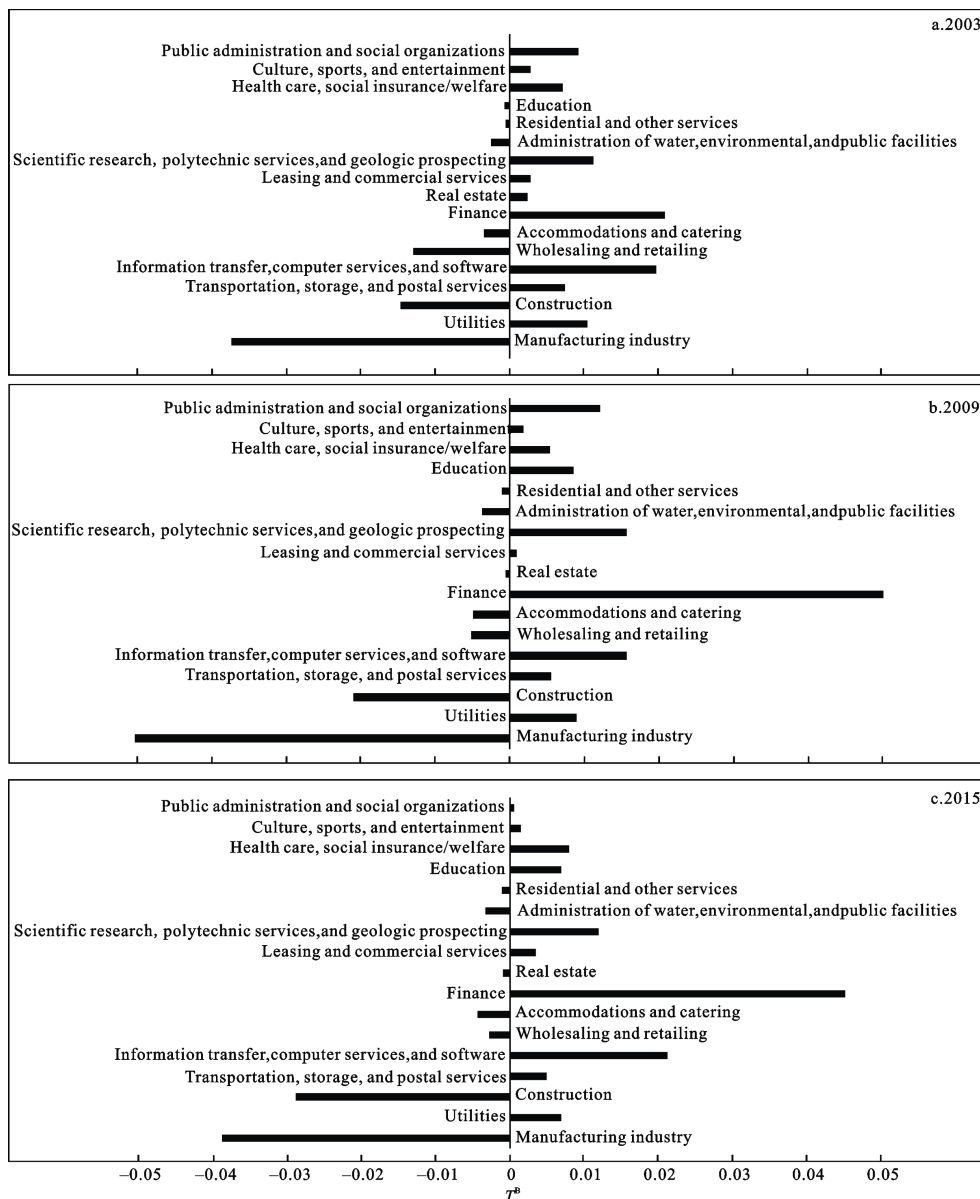

Fig. 2   Between-sector Theil elements (T^B) of China's urban wage inequality by sector, 2003−2015

al., 2015). The consistently large and negative contribution of the manufacturing sector to between-sector inequality, however, was unexpected and noteworthy. This result was quite contrary to the prediction from the deindustrialization hypothesis, which ascribes the rise of income inequality in industrialized countries to the loss of middle-income jobs in the manufacturing sector, brought about by the availability of low-cost production spaces elsewhere in the new international division of labor. In fact, a simple calculation of the ratio of the average wage of the manufacturing sector to that of all economic sectors in whole China generated a figure ranging from 0.8 to 0.9 during 2003−2015. The low wages earned by China's manufacturing workers indicate that they are not a group of middle class whose presence can ameliorate income inequality, as has been described in the West, but instead a major source of low-wage jobs whose growth and expansion may contribute to the enlargement of wage inequality. This finding is consistent with the modeling results in Liu and Xie (2013), which identify a positive and significant impact of manufacturing employment on inequality.

Fig. 2 also shows that in addition to the financial sector, two knowledge-intensive service sectors, the information services sector and the scientific research sector, also made a consistently positive contribution to the between-sector inequality from 2003 to 2015. This suggests that the development of a knowledge-based economy in urban China may lead to a growing urban inequality (Liu et al., 2019). Moreover, the negative contribution of the urban construction sector to the between-sector inequality confirms our impression of that sector as an employer of low-paid workers, mostly rural migrants in Chinese cities.

Fig. 3 displays the percentage contribution to the between-sector Theil component (T^B) by each sector whose average wage was higher than the national average level. It is apparent that the contribution of the financial sector increased gradually beginning in 2003, peaked in 2012, and declined thereafter. In addition, the two sectors of information services and scientific research services exhibited a relatively stable contribution to the between-sector wage inequality. In contrast, the sectors of utilities, public administration and social organization, transportation, storage and postal services, and culture, sports, and entertainment witnessed a generally declining trend in terms of their contributions during 2003–2015. These sectors are either public sectors or sectors with a heavy presence of public ownership. Their declining contributions reflect the ongoing process of marketization, which undermined the monopolistic profits/advantages enjoyed by publicly owned units in these sectors and weakened the wage premium of public employees.
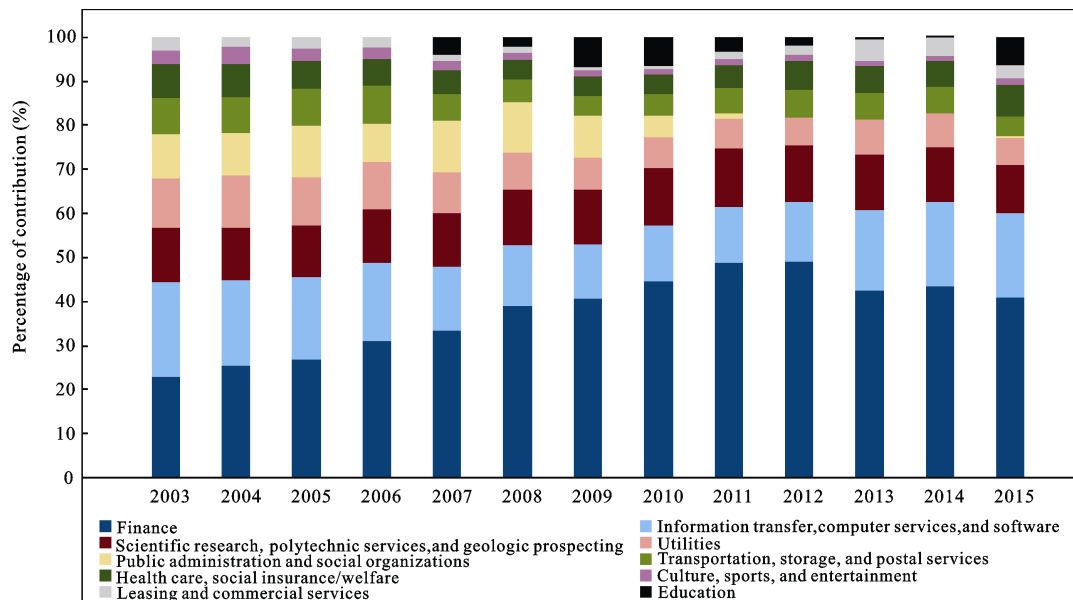

Fig. 3   Sectoral contributions to the between-sector Theil elements of China's urban wage inequality, 2003−2015

4.2 Within-sector inequality

Which sectors were the main contributors to the within-sector component of China's urban wage inequality? As Fig. 1 shows, within-sector inequality was the primary contributor of overall wage inequality in urban China and exhibited a consistent pattern of decline from 2003 to 2015. Fig. 4 further shows the percentage contribution of each sector to the within-sector Theil component (T^W). As is illustrated in the section of data and methodology, within-sector inequality was measured as the sum of each sector's between-region inequality weighted by that sector's share of the national total wage. Fig. 4 shows clearly the significant decline in the manufacturing sector's contribution to within-sector inequality. This pattern indicates the trend of many labor-intensive manufacturing firms relocating from the coastal region to less-developed inland cities in central and western China, which led to a spatial dispersion of workers' wages in the manufacturing sector (Zheng et al., 2014).

As was the case with the manufacturing sector, three service sectors—the public administration, education, and transportation sectors—also experienced considerable declines in their contributions to the within-sector Theil component (T^W), by 5.1, 3.9 and 3.2 percent points, respectively (Fig. 5). In other words, there was a trend toward equalization of the average wage for employees in those three sectors across different regions

during 2003−2015. This pattern of spatial convergence of the average wage may have resulted from the efforts made by the Chinese central government in recent decades to increase investments in transportation infrastructure and public services through fiscal transfers and other spatial redistribution policies (Li and Sicular, 2014). In view of the significant gaps in the levels of economic development and personal income between coastal and inland areas, China's central government has since the late 1990s launched the 'Go West' (China's Western Development Program) development strategy, which included massive central subsidies to develop infrastructure, promote education, and retain talent in the impoverished western regions, in an effort to narrow their gaps with the affluent east coast. In addition, since 2003, the central government has advocated increasing subsidies for the central and western regions that are facing economic difficulties, in an effort to equalize the basic public services—a balance that is considered necessary for building a harmonious society. Such central policy assistance may help to reduce the inter-regional disparities in the transportation and public service sectors.

By contrast, four service sectors—the finance, business service, information service, and scientific research and technical service sectors—all dramatically raised their contributions to within-sector inequality during the examined time period, by 9.0, 6.5, 3.0, and 1.5 percent points, respectively (Fig. 5). These four sectors are all
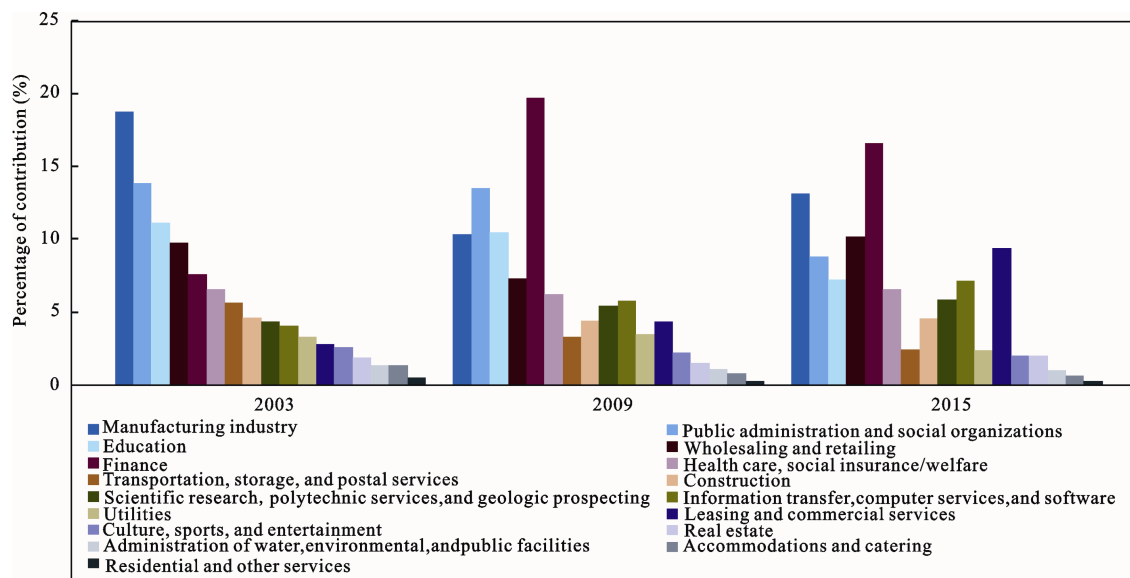

Fig. 4 Sectoral contributions to the within-sector Theil elements of China's urban wage inequality in 2003, 2009 and 2015
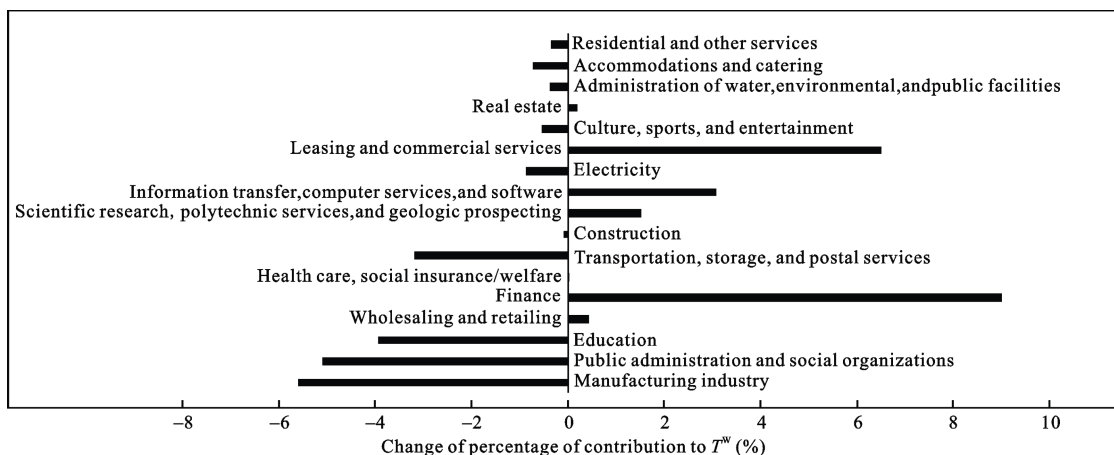
Fig. 5   Changes in the percentages that each sector contributed to the within-sector Theil elements of China's urban wage inequality, 2003−2015

producer services that are commonly understood to be the essential sector responsible for economic and urban development in a post-industrial society (Yang and Yeh, 2013). When the patterns in Fig. 2 and Fig. 5 are combined, we see the key role of the knowledge-intensive producer services sectors in shaping China's urban wage inequality through enlarging both the inter-sector and intra-sector, inter-regional gaps in the average wage.

In order to better explore the impact of producer services on urban inequality, this study followed the methodology of Liu and Xie (2013) to further classify all Chinese economic sectors into four broad groups: the working sector, the producer services sector, the public services sector, and the other services sector. Producer services are those services based on knowledge-intensive activities that provide intermediate inputs to the producers of goods or other services. They are identified to be the most important service categories because they constitute an important segment of the regional economic base in advanced economies (Yang and Yeh, 2013). Working sectors are those activities involved in the transformation of raw materials into products or goods, while public services sectors include the education, health care, and other social services provided by the government to people living within its jurisdiction. These sectors have different requirements for labor skills and may thus exert differing impacts on income inequality. Details of the sector composition for each group are listed in Table 2. Based on that group classification, we conducted a similar analysis using the between-group and within-group components of Theil's

index. As is seen in Fig. 6, during the time period examined, the producer services were the biggest contributor to between-sector wage inequality, with the average wage in the knowledge-intensive sectors being consistently higher than the national average wage. For within-sector inequality, the contributions of the working sectors and the public service sectors were both larger than that of the producer services sector in 2003. But they were surpassed by the latter in 2007 and in 2013 respectively. In 2015, the producer services sector had become the dominant source of within-sector inequality among all four groups.

Which region was the main contributor to within-sector inequality in producer services? The burgeoning literature on urban and regional inequality in China has thoroughly documented that spatial inequality is sensitive to geographic scale and is influenced by the multiple mechanisms of globalization, marketization, and decentralization that characterize China's transitional economy (Wei, 1999; Fan and Sun, 2008; Li and Wei, 2010; He et al., 2017). However, little has been done to interrogate the sectoral dimension of China's urban and regional inequality. As a matter of fact, significant variations exist in the spatial pattern of the average wage across different sectors. For spatial analysis, Fig. 7 displays four producer services sectors: the financial sector, the leasing and business services sector, the information transmission, computer services, and software sector, and the scientific research and technical services sector. It show the geographic distribution of the sector-regional Theil elements. According to Yang and Yeh

Table 2 Classification of economic sectors in China

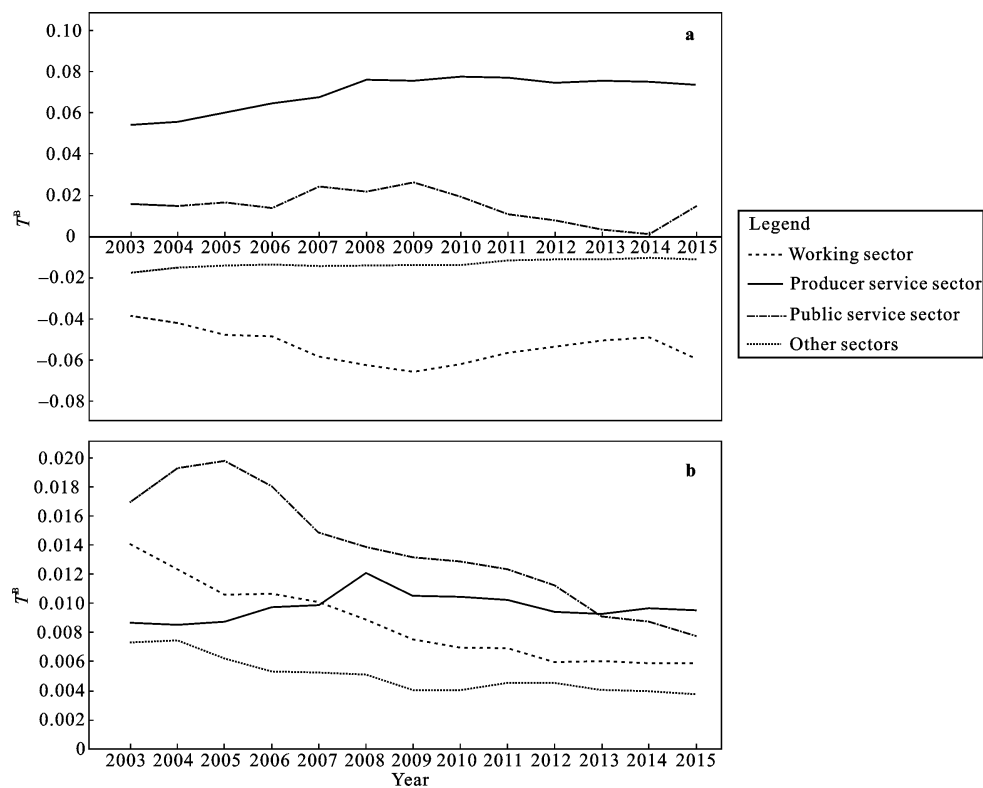| Group	Sector
Working sector	Manufacturing
	Utilities
	Construction
	Transportation, storage, and postal services
Producer services sector	Finance
	Real estate
	Leasing and commercial services
	Scientific research, polytechnic services, and geologic prospecting
	Information transfer, computer services, and software
Public services sector	Education
	Health care, and social insurance/welfare
	Public administration and social organizations
Other services sector	Culture, sports, and entertainment
	Administration of water, environmental, and public facilities
	Wholesaling and retailing
	Accommodations and catering service
	Residential and other services

Fig. 6 Contributions by four groups of sectors to between-sector inequality (a) and within-sector inequality (b) in urban China, 2003−2015

(2013), the Chinese definition of producer services includes high-order categories such as finance, insurance, and real estate, 'information transmission, computer services and software', 'leasing and business service', 'scientific research and technical service', and low-order categories such as 'transportation, storage and postal service'. The spatial distribution of wage income in these four sectors can thus represent the general situation of spatial wage inequality in the producer services fairly closely. A sector-regional Theil element represents the contribution that a particular sector within a particular region makes to the within-sector inequality. Fig. 7
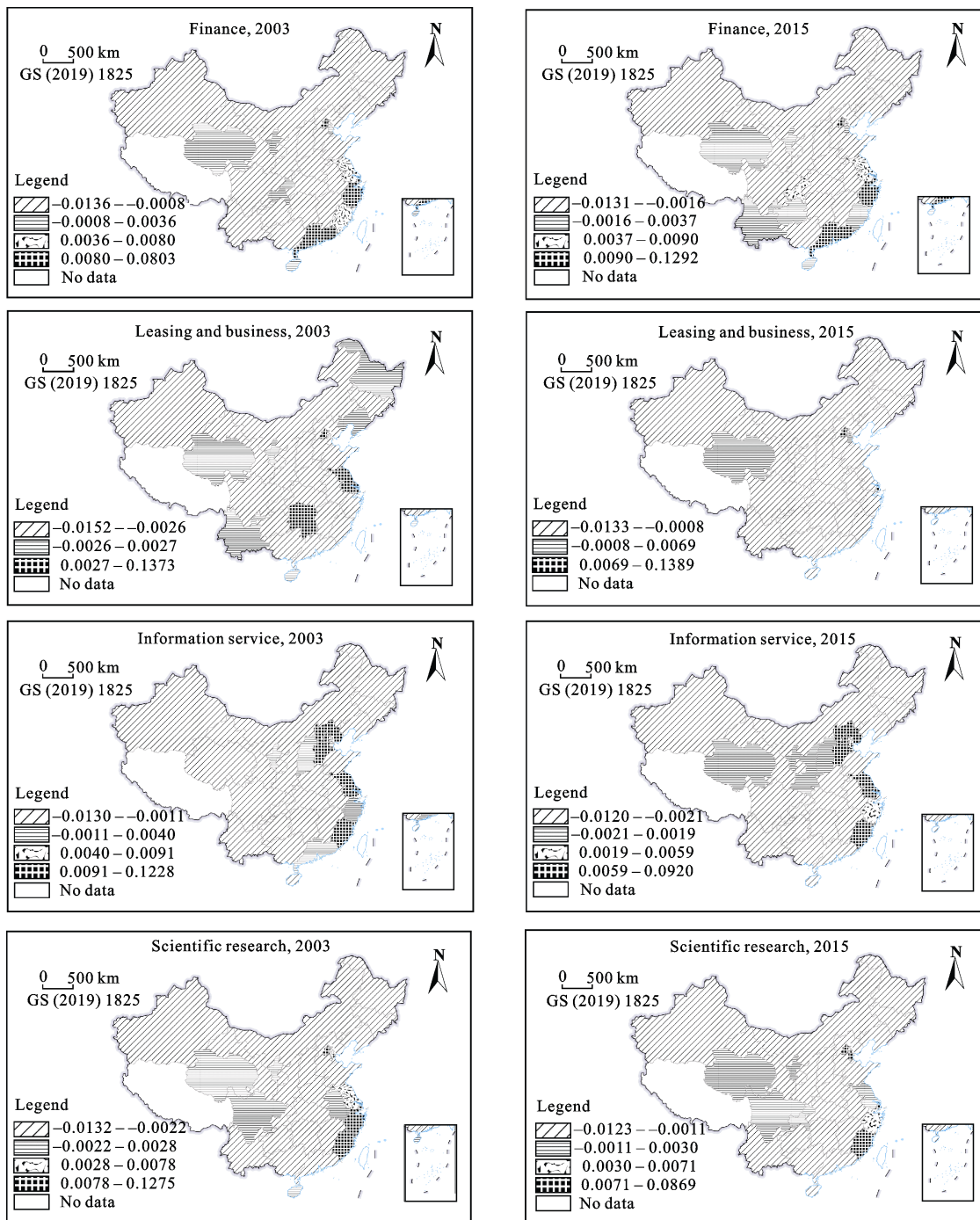
Fig. 7 Spatial distribution of sector-regional Theil elements of China's urban wage inequality in 2003 and 2015. Data of Hong Kong, Macau, Taiwan and Tibet are excluded

reveals that only a small number of city-regions displayed a positive value of sector-regional Theil elements in the producer services sectors. The providers of high-paying jobs in the producer services sectors were often found in selected high-ranking city-regions along the eastern coast, such as Beijing, Tianjin, Shanghai,

Jiangsu, Zhejiang, and Guangdong. This result is quite consistent with previous studies, which suggested that China's knowledge-intensive economic activities were more likely to be located in highly dense and agglomerated metropolises in eastern China (Yang and Yeh, 2013; Rodríguez-Pose and Wilkie, 2016). Among all regions,

Beijing and Shanghai stood out as the two biggest contributors to inter-regional differentiations of the average wage in the four producer services sectors. In particular, Beijing, as China's capital city and the host of a disproportionate number of top political organizations, national regulatory agencies, and prestigious universities and research institutes, exhibited an unparalleled advantage in the development of the knowledge and information intensive sectors such as finance, information services, and technical services. The availability of more high-paying positions in the producer services in Beijing points to the possible presence in that city of a wage premium whose nature and determinants might deserve to be investigated in future analysis.

5 Conclusions and Policy Implications

This study investigates the impact of China's ongoing structural transformation toward a post-industrial economic transformation on wage inequality in urban China. Drawing upon a decomposition methodology based on the Theil index, we calculated the between-sector and within-sector components of Theil index to examine the pattern and process of China's urban wage inequality from a sectoral perspective. Our empirical analysis led to the following major findings. 1) Within-sector inequality was more important than between-sectors inequality in shaping the evolution of China's urban wage inequality during 2003−2015, which suggests that the linkage between sector and inequality in China goes beyond the relative sizes of different economic sectors in the urban economy and involves more complexly the spatial heterogeneity internal to each sector. 2) The growth and expansion of the manufacturing sector, which is characterized by the dominance of low-wage jobs, contributed to the enlargement of between-sector and overall urban wage inequality in China. This finding stands in sharp contrast to the perceived positive association between deindustrialization and social/income polarization in global city regions. 3) Since 2003, the producer services sectors, including the finance, business services, information services, and scientific research and technical services, have gradually stepped up their impact on both the within-sector and the between-sector wage inequality, thereby confirming the hypothesized impact that the rise in the knowledge-based economy would have on in-

creasing income inequality in urban China; 4) Urban wage inequality within the producer services was brought about by the spatial concentration of a disproportionate number of high-paying jobs in a few developed, high-tier city-regions on the east coast, thus pointing to the presence of significant urban wage premiums for better educated and skilled workers in the Chinese context.

The research findings of this study have important implications for policy making to reduce inequality in Chinese cities. First, unlike the situation in the Western advanced countries, where manufacturing employment has served as the stabilizer of urban income distribution, China's manufacturing sector is often populated by low-paying jobs whose growth and expansion tend to enlarge the urban income disparity. Addressing urban wage inequality in China therefore entails the improvement of the average wage for manufacturing workers. Policy initiatives, such as minimum wage legislation, labor union formation, *hukou* reform, and others that can enhance the bargaining power of industrial workers, especially those migrants with rural, non-local *hukou*, and can facilitate their social mobility, are expected to ameliorate rising urban inequality. Second, in a manner similar to observations for the West, a knowledge-based economy in general and producer-services sectors in particular were found to enlarge urban wage inequality through their impacts on both the between-sector and the within-sector inequality. The rise of between-sector wage inequality brought about by producer services sectors could be ameliorated by policy initiatives designed to enhance the earnings capacity and advancement opportunities of low-wage employees in other sectors, as is mentioned above. What this study has revealed is that an inter-regional gap in the average wage of producer services employees also constitutes an important source of China's overall urban wage inequality. This gap is mainly reflected in the underdevelopment of China's producer services sectors in central and western regions vis-à-vis coastal regions. In order to reduce urban inequality, policy efforts could be made to promote agglomeration and productivity improvements of producer services firms in China's underdeveloped inland areas. Given that knowledge-based producer services firms have a strong proclivity to locate in dense and large metropolises, policy preferences could be granted to selected inland megacities with well-established in-

frastructures and advantageous industrial clusters, in an effort to improve the wage income of producer services employees therein and counteract the spatial imbalance in wage premiums for the skilled labor workforce. This suggestion echoes the recent acknowledgement that there is no one-size-fits-all approach to tackling inequality and the nature of appropriate inequality-reducing policies depends on the underlying drivers and country-specific policy and institutional settings.

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