

Research Article Changing Regional Inequality Patterns in Western China: A Case Study of Xinjiang

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Regional inequality in western China has been rarely examined and has risen as an important issue in the Chinese academic circle. This study, taking Xinjiang as a case, investigated regional inequality in Xinjiang since the 1990s. The results show that the interregional inequality became more prominent, while the overall regional disparities among counties and cities have experienced an inverted U-shape path and have been mainly caused by the inequality of the intra-north part of the province. Counties with high economic development levels were mainly located in northern Xinjiang and had a high probability of further moving economic levels. We further found that the regional development pattern in Xinjiang was significantly associated with spatial accessibility, followed by population density and urbanization factors. This paper deepens our understanding of the complex pattern and mechanism of regional inequality in western China, and local specific policies, therefore, are needed to solve the problem.

1. Introduction

Along with rapid economic growth in China, there has been a sharp rise in regional inequality in recent decades [1]. The primary regional gap manifests itself in the eastern coastal provinces in China that have experienced rapid growth for a long time, while the western regions have lagged [2, 3]. Since the new millennium, the central government has initiated several national policies to promote balanced economic development. It started several preferential policies to stimulate economic growth in the western regions, such as the Western Development Strategy. However, these policies only favored a few central cities, and most small towns and rural areas are still impoverished [4, 5]. Previous studies have reported that western provinces always suffered from imbalanced growth, which has led to the widening regional gap and intensified social injustice within and among western provinces, especially for the poor ethnic areas [6-9]. More importantly, this blame for regional inequality has increasingly coincided with the concerns over national stability and unity [10].

Regional inequality has been a long concern in academic circles. Due to the rapid economic growth of different cities and provinces in China, scholars are very interested in studying regional inequality on multiple scales [4, 11–14]. However, for a long time, research on regional inequality in China mainly focused on two spatial scales: (1) interprovincial and group-province inequality [15, 16]; (2) intraprovincial inequality, especially in the developed coastal provinces, such as Zhejiang [17, 18], Guangdong [19, 20], and Jiangsu [21, 22]. However, regional inequality in the western provinces, such an essential scale of regional inequality, has been seriously underinvestigated.

In this research, we use Xinjiang Uygur autonomous province as a case study to examine the spatial-temporal evolution of regional inequality from the perspective of multiscale and the relevant impact factors. The research findings will deepen our understanding of regional inequality in different development contexts and inform placespecific policies in impoverished regions.

2. Literature Review

Regional inequality has drawn tremendous attention from geographers since it is one of the important dimensions of global sustainable development goals (i.e., SDGs 10). Scholars have done a lot of studies on regional disparities in developed eastern China. The results indicated that regional inequality had changed dramatically since the reform and opening-up policy in the late 1970s [22]. It is significantly related to the country's context of economic transition, especially the factors of FDI, education, urbanization, economic structure, fiscal expenditure, population migration, and labor market reform [23–26]. However, the existing findings cannot fully explain the regional inequality in the less-developed regions as they are less influenced by globalization.

As the Western Development Strategy became an important national policy in the 2000s, regional disparities in the west of provinces have become a new hotspot, and a few scholars have examined regional inequality of the mountainous regions in southwest China, such as Guizhou province and Guangxi Zhuang autonomous province [27, 28]. However, much more remote, poorer, and more complex provinces have not been thoroughly investigated. Therefore, it is necessary to research regional inequality in western China and explore the underlying driving forces.

It is no doubt that the determinants of regional development patterns in western China are different from those of eastern China. First, the natural environment in these regions is inferior, with mountainous terrain, lousy climate, and lack of resources such as water, sunshine, and fertile soil [29–33]. Second, ethnic difference is a significant social feature in western China, where poverty coincides with high ethnic diversity [34, 35]. Third, accessibility in western China is relatively poor, and many peripheral areas have difficulties in contacting the outside world, which has seriously restricted the local economic development [36].

In this context, this paper aims to examine the regional inequality in Xinjiang with an emphasis on its dynamic mechanism. We address two issues: (1) the intraprovincial economic inequality and the mechanisms underlying poor regions in China; (2) driving forces underlying regional inequality and relevant policy implications.

3. Research Methods and Data Sources

3.1. Study Area. Xinjiang, located in the northwest of China, borders Kazakhstan to the west and Russia to the north (Figure 1). The total land area of Xinjiang is 1,664,600 km², accounting for 17.3% of China. In 2018, the total population was 22.8 million, accounting for 1.6% of the country; GDP is 1219.9 billion yuan, accounting for 1.3% of the national average; and per capita GDP is 49475 yuan/person, about

76.7% of the national average (Table 1). Xinjiang is a desert area with a low population density, only 13.7 people/km², about 9.6% of the national average. Xinjiang is a Uygur autonomous province with many ethnic minorities, including Uygur, Hui, Mongolian, and Kazakh, accounting for 65.6% of the population. Based on various indicators at the national average, Xinjiang is regarded as a typical poor ethnic province in China.

There are fourteen prefectures in Xinjiang, with Urumchi as the provincial capital. Geographically, Xinjiang can be divided into the southern and northern parts: the north is the core area with a higher population density and economic development levels, covering Urumchi, Karamay, Changji, Hami, Tulufan, Yili, Bortala, Tacheng, and Aletai; the south is a peripheral area with a broader land and more ethnic minorities, covering Aksu, Bayinguole, Hetian, Kashi, and Kezilesu. Unlike the inland region, there are special prefecture-level administrative units in Xinjiang, such as Shihezi, Wujiaqu, Alaer, and Tumushuke, administrated by Xinjiang Production and Construction Corps (XPCC). In order to maintain consistency for spatiotemporal analysis, the county-level administration boundary in 2000 was used, and there were 84 county-level units.

3.2. Methods. In this research, we used multiple indices to examine regional differences, analyzed spatial clustering trends by spatial autocorrelation analysis, explored place mobility of regional development status by rank correlation analysis, and investigated the determinants of changes in regional development pattern by the panel regression model.

3.2.1. Regional Difference Indices. The research methods of regional inequality and polarization include the coefficient of variation (CV), Gini coefficient (G) [37], Theil index [38], ER index [39], Wolf index [40], Kanbur–Zhang index [41], and Tsui–Wang index [42]. There is no doubt that these methods are similar, and each index has its advantages. The Theil index was initially proposed by the Dutch economist Theil to calculate income inequality between regions. The Theil index can not only measure the disparity between regions, but also measure the inequality within regions [18, 43].

Theil =
$$\sum_{j=1}^{n} \frac{Y_j}{Y} \log\left(\frac{Y_j/Y}{P_j/P}\right),$$
(1)

where Theil is the index, *Y* is the GDP of the whole area, Y_j is the GDP of unit *j*, P is the population of the entire area, and P_j is the population of unit *j*. If the whole study area is divided into *i* groups, the Theil index can be further decomposed as follows:

$$\text{Theil}_{\text{total}} = \text{Theil}_{\text{wr}} + \text{Theil}_{\text{br}} = \sum_{i=1}^{n} \frac{Y_i}{Y} \sum_{j=1}^{m} \frac{Y_{ij}}{Y_i} \log\left(\frac{Y_{ij}/Y_i}{P_{ij}/P_i}\right) + \sum_{i=1}^{n} \frac{Y_i}{Y} \log\left(\frac{Y_i/Y}{P_i/P}\right), \tag{2}$$



FIGURE 1: Location of Xinjiang in China.

TABLE 1: Major development indicators of Xinjiang, 2018.

Indicator	Xinjiang	0/ of China	% of Xinjiang	
Indicator		% Of Clillia	Northern	Southern
Residential population (million)	22.8	1.6	47.7	52.3
Land area (km ²)	1,664,600	17.3	36.1	63.9
GDP (billion yuan)	1219.9	1.3	72.8	27.2
Per capita GDP (yuan)	49475	76.7	165.2	56.2
Population density (persons/km ²)	13.7	9.6	132.0	81.9
Proportion of ethnic minorities (%)	65.6	768.1	32.0	68.0

Data source: Xinjiang Statistical Yearbook in 2019.

where Theil_{total} is the overall inequality, Theil_{wr} is the inequality within regions, Theil_{br} is the inequality between regions, Y is the GDP of the whole area, Y_i is the GDP of region *i*, Y_{ij} is the GDP of unit *j* in the region *i*, *P* is the population of the whole area, P_i is the population of region *i*, and P_{ij} is the population of unit *j* in the region *i*.

3.2.2. Spatial Autocorrelation Analysis. Spatial autocorrelation is an excellent method to analyze the spatial clustering pattern of the study area [44]. Specifically, it can also be used to evaluate regional inequality levels between neighbors. Different from the regional difference indices, spatial autocorrelation can consider spatial effects. In this study, we employed the Global Moran's *I* to explore spatial inequality on regional development, and the equation is as follows:

$$I = \frac{N}{S_o} \times \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} W_{ij} (x_i - \overline{x}) (x_j - \overline{x})}{\sum_{i=1}^{N} (x_i - \overline{x})^2},$$
(3)

where *N* is the number of samples; X_i and X_j are variable values of sample *i* and sample *j*; \overline{x} is the average of all samples; $S_o = \sum_{i=1}^N \sum_{i=1}^N W_{ij}$; and W_{ij} is the spatial weight matrix of sample *i* and sample *j*, and if they are adjacent to each other, it is defined as 1. Otherwise, it is 0. Moran's *I* is [-1, 1]; when I > 0, the whole area is spatially positively correlated; when I = 0, the samples are irregular; and when I < 0, the whole area has a spatially negative correlation.

3.2.3. The Spatial Autoregressive Model. To understand the uneven geography of economic development identified by the above methods, we examined the determinants of regional disparity in Xinjiang. The spatial autoregressive model is widely used in previous studies to detect the significance and contributions of different factors to regional inequality [26, 28]. It is worth mentioning that previous studies also employed more complex models such as learning models or complex network-based models to explore the pattern [45, 46].

The model is used to explore whether there were spatial effects of independent and dependent variables. The spatial autocorrelation analysis suggests that there is significant spatial autocorrelation between those variables, which indicates the effect of using the spatial autoregressive model on conducting the investigation.

$$Y_t = \rho W_{ij} Y_t + X_t \beta + \mu + \varepsilon_t, \tag{4}$$

where *Y* is N * 1 vector of factor variables for each administrative unit *i* (*i* = 1, 2, . . . , N = 84) in the panel section; *t* is time dimensions during the study period; *X* is the matrix of factor variables; and *Wij* is a vector of spatial weights measuring the spatial relation of one unit to the others. For the spatial panel regression analysis, it is generally assumed that $u \sim N(0, \sigma_{\mu}^2)$ with a random distribution, and μ is to be estimated for the fixed effects.

3.3. Data Sources. This study adopts the most used variable, per capita GDP (GDPPC), as the indicator of regional development status. The study period is from 1990 to 2018, focusing on 1990, 2000, 2010, and 2018. We acquired 14 prefecture-level units, including 84 county-level units with geographic, environmental, population, ethnic, and socioeconomic indicators and policy documents. The statistical tables, including GDP, per capita GDP, population density, ethnic and socioeconomic data, are from Xinjiang Statistical Yearbook. Due to technical limitations in statistical surveys, the GDP before 1994 was national income, and GDP per capita was national income per capita. The GIS maps (shapefiles), including geographic, environmental, and spatial data, were downloaded from the China Data Center and transformed into the county scale.

4. Inequality of Regional Development Pattern in Xinjiang

4.1. Overall Process of Regional Economic Development. Since the reform and opening-up, China's economy has been multiplying, as has Xinjiang's economy. As shown in Figure 2, Xinjiang's overall economic development process since 1990 can be divided into three stages: before 2002, its economic growth was relatively stable; then, it entered a period of rapid growth; after 2014, it entered a period of fluctuated growth, and the economic growth rate slowed slightly. From 1990 to 2018, Xinjiang's per capita GDP increased from 1,776 yuan/person to 40,475 yuan/person, about 27.5-fold increase in 28 years (in current price). It should be noted that Xinjiang's economic growth rate is a little lower than the national average, which makes its per capita GDP in 2018 only equal to 76.5% of the national average.

The spatial structure of regional development is usually analyzed by "geography of social divisions" [47]. In the research, we categorized the GDPPC data into four groups in relation to the national average, that is, P (poor: <50% of average), L (less developed: 50%–100% of average), D (developed: 100%–150% of average), R (rich: >150% of average). The periods of 1990, 2000, 2010, and 2018 are highlighted in



FIGURE 2: The growth of per capita GDP and ratio to the national average in Xinjiang, 1990–2018.

Figure 3. Globally, there has been an obvious and stable spatial pattern of the north-south divide in Xinjiang over the three decades. The economic development level of most counties in northern Xinjiang has always been higher than that in southern Xinjiang. In 1990, there were only two rich units, both located in north Xinjiang, the capital Urumchi and the second large city (Karamay), and nine developed counties, four in northern Xinjiang and five in southern Xinjiang. Most of the counties in the north were higher than the less-developed level, while most counties in the north were poor. In 2000, the developed counties started to cluster in the northern part, and the region between Urumchi and Karamay became an economic zone, while most counties in the south remained the poorest. In 2010, as more northern counties upgraded their economic status, counties with above-average economies began to become the majority in northern Xinjiang. The gap between the north and the south was getting wider and wider. In 2018, the number of counties with the poorest economy in southern Xinjiang began to decrease.

4.2. Multiscale Patterns of Regional Inequality. We examine three scales of regional inequality in Xinjiang, including counties, prefectures, and regions in Figure 4. The interregional Theil index has been increasing since 1990, indicating that the difference between the north and the south of Xinjiang is getting larger and larger. The intercounty Theil and the intercity Theil indices show similar trends, an inverted U shape, which can be divided into three subperiods: From 1990 to 2000, the two Theil indices at county and prefecture scales increased significantly, which indicates that regional inequality became more intensified. It was closely related to reform progress, and opening-up in northern Xinjiang is earlier than that in southern Xinjiang. The two indices fluctuated, peaking in 2006, but regional inequality between the northern and southern areas was still high. After 2010, the two indices were rapidly decreasing, indicating that a balanced development trend appeared.

To investigate the relationship between regional inequalities of different scales, we decomposed the overall regional inequality into inequalities between two regions (northern and southern region) by Theil index and within



FIGURE 3: Spatial patterns of per capita GDP in Xinjiang, 1990–2018: (a) 1990; (b) 2000; (c) 2010; (d) 2018. P: poor, L: less developed, D: developed, R: rich.



FIGURE 4: Multiscale regional inequality in Xinjiang, 1990-2018.

them. Figure 5 shows that the inter-north Theil and the intra-north Theil indices show a similar trend while the inter-north inequality is much higher than the intra-north inequality. Thus, we can infer that regional disparities in northern Xinjiang are higher than those in southern Xinjiang, and the overall regional inequality is highly influenced by the intra-north inequality.

4.3. Spatial Clustering and LISA Map of Regional Development Pattern. Overall regional inequality tends to mask spatial clustering patterns. Therefore, we used a spatial autocorrelation analysis to examine the spatial characteristics. As shown in Figure 6, the global spatial autocorrelation index (Moran's I) increased after 1994, and the spatial clustering level became higher and higher. It is known that Urumqi and Karamay firstly carried out economic reform and openingup policy, which made northern Xinjiang develop faster than southern Xinjiang and become a clustered area with higher economic levels. However, the global spatial autocorrelation index (Moran's I) decreased after 2012, mainly because the government began to pay attention to the economic development of the border counties and cities, which improved the economic development of counties in the west part, causing south and east to rise rapidly. The economic distribution of the whole province became more balanced.

Global Moran's I only provides insights into the global pattern but cannot detect any local clusters or outliers. We further employed the Local Moran's I and the LISA map of county-level GDPPC in Xinjiang. As shown in Figure 7, in the past three decades, more and more high-level economic counties are clustered in northern Xinjiang, while more and more low-level economic counties are clustered in southern Xinjiang. In 1990, there was one High-High cluster in northern Xinxiang, but no Low-Low spatial cluster. The reason is that the northern part has historically been a high-level economic area, with Urumqi being the provincial capital and Karamay being the second-largest city. In 2000, a Low-Low cluster began to appear in southern Xinjiang. It is known that many ethnic minorities inhabited the southern part for a long time, and many poor counties were located in this place. In 2010, the Low-Low southern Xinjiang cluster became more apparent; most of the counties in Kashgar region and Hotan region were included. Mainly because the economic gap between north and south widened continuously, more counties in southern Xinjiang became relatively poor. In 2018, there was another High-High cluster located in the Tuluva region in Northeast Xinjiang. It can be found that over the 28 years, the core-periphery structure became more and more evident, with the north being the core area and the south being the peripheral area.

4.4. Place Upgrading of Regional Development Status. We examined spatial-temporal changes of regional development. As shown in Table 2 and Figure 8, the probability of moving upward is greater than that of moving downward in the whole study period. Still, there are different spatiotemporal characteristics at different subperiods. In the



FIGURE 5: Theil decomposition of overall intercounty inequality, 1990–2018.



FIGURE 6: Global Moran's *I* of county-level GDPPC in Xinjiang, 1990–2018.

first period (1990-2000), counties across the province had a similar probability of moving upward and downward. The upward counties were mainly located in Urumqi metropolitan area, Tulufan, and Kuerle, while the downward counties were found in the Yili River Valley. From 2000 to 2010, the probability of moving up became much more remarkable than moving down. The upward counties expanded to prefecture-level units of Tacheng, Aletai, and Bayinguole. From 2010 to 2018, the probability of moving upward decreased. The counties that moved upward scattered to Yili and the southwestern border. For example, Wuqia County in Kizilsu moved up two classes. In conclusion, most of the counties in northern Xinjiang have moved upward, while most of the counties in southern Xinjiang were stable during the study period.

We further conduct rank correlation analysis to detect the probability of place upgrading in the whole period and three subperiods. As shown in Table 3, Spearman's ρ and Kendall's τ rank correlation coefficient indicated similar trends of the relationship between county-level units' previous rank and their subsequent rank. The positive correlation between them has increased over the years. The ranking of a county-level unit at the end of a subperiod became more correlated to that at the beginning of this subperiod, indicating that the upgrading of county-level units decreased. Most of them stayed in the same category during the entire subperiod.

Complexity



FIGURE 7: LISA map of spatial clustering for county-level GDPPC in Xinjiang, 1990–2018. HH: High-High cluster, LL: Low-Low cluster, HL: High-Low outlier, and LH: Low-High cluster outlier.

Region	Period	Downward two classes	Downward one class	No change	Upward one class	Upward two classes
The whole province	1990-2000	0.012	0.167	0.690	0.119	0.012
	2000-2010	0.000	0.048	0.702	0.214	0.036
	2010-2018	0.000	0.060	0.762	0.155	0.024
	1990-2018	0.012	0.083	0.524	0.321	0.060
Northern Xinjiang	1990-2000	0.000	0.163	0.674	0.140	0.023
	2000-2010	0.000	0.047	0.558	0.349	0.047
	2010-2018	0.000	0.093	0.698	0.186	0.023
	1990-2018	0.000	0.047	0.442	0.419	0.093
Southern Xinjiang	1990-2000	0.024	0.171	0.707	0.098	0.000
	2000-2010	0.000	0.024	0.829	0.122	0.024
	2010-2018	0.000	0.049	0.854	0.073	0.024
	1990-2018	0.024	0.122	0.610	0.220	0.024

TABLE 2: Change trend for county-level GDPPC in different regions, 1990-2018.

5. Impact Factors of Regional Inequality Pattern in Xinjiang

Based on the review of the existing literature on regional development and work on western China, as well as on the multimechanism framework that conceptualizes Xinjiang's regional inequality as the determinant of environmental, population, spatial, and special policy, we have identified several exploratory variables (Figure 9). The vegetation index (VI) is employed to investigate the impact of natural environment characteristics on regional development. There are two deserts in Xinjiang, with a total area of about 1.02 million square kilometers, accounting for 61.4% of the total land area of Xinjiang [48, 49]. We use the vegetation index



FIGURE 8: Place mobility map of per capita GDP in Xinjiang, 1990-2018.

TABLE 3: Rank correlation analysis in different periods, 1990-2018.

Coefficient	1990-2000	2000-2010	2010-2018	1990-2008
Spearman's ρ Kendall's τ	0.847** 0.668**	0.897** 0.747**	0.941** 0.810**	0.724** 0.539**

**A significant correlation.

(differences between vegetation reflectance in visible and near-infrared bands and soil background) to investigate whether regional development is restricted by natural environmental factors. The lower the VI, the higher the water scarcity in local development. Population density (PD) and urbanization rate (UR) are commonly used variables to reflect regional population distribution. The population density in Xinjiang is extremely low, and most of the area is rural; the urbanization rate is also extremely low, which has a significant impact on regional economic development. As one of China's five autonomous provinces, Xinjiang has many long-dwelling ethnic groups, with ethnic minorities accounting for more than 60%. These ethnic minorities are located in different areas with different performances, and ethnic differences are relatively various. We use the proportion of ethnic minorities in the total population (PEM) to measure the ethnic composition of each region.

Location is one of the critical factors that determine regional economic development. Accessibility in most parts of Xinjiang is relatively poor, which has brought a lot of barriers to regional economic development in the past. It is widely accepted that the closer the city is to the provincial capital, the more advantageous it will be in terms of economic opportunities. Therefore, we use the time distance to the provincial capital (TD) to measure the accessibility of a city. Special policy factor is selected because Xinjiang is located in the western frontier region of China, and the security situation in history is relatively poor. In Xinjiang, an important group in its total population is XPCC, which is administrated by central government. These XPCC farmers live on state-owned farms and enterprises to develop local economy. Therefore, we use the proportion of XPCC farmers in the total population (PMF) to measure the government support.

We examined the correlation coefficients between the per capita GDP and the six determinants and the variance inflation factors (VIFs). We found that VIFs are all below 4, suggesting the suitability of conducting regression analysis for all selected factors. Per capita GDP is closely correlated to the accessibility, urbanization rate, and proportion of ethnic minorities. Their correlation coefficients are, respectively,



FIGURE 9: The distribution of impact factors of regional economic development in Xinjiang, 2018.

0.452, 0.434, and -0.523 at 1% significant level (Table 4). Based on the correlation analysis result, we employed the panel regression model to examine the driving forces behind uneven regional development to further understand the

interaction of different factors between time distance, urbanization level, ethnic minority, and XPCC farmer population. The Chi² tests suggest that each listed model is solid at 1% significant level and accounts for about a quarter of

arson	GDPPC	VI	TD	PD	UR	PEM	PMF
OPPC	1						
	-0.068	1					
)	0.452**	0.294**	1				
)	-0.037	0.145	-0.051	1			
ξ	0.434**	0.253*	0.561**	0.191	1		
М	-0.523**	-0.323**	-0.714	0.022	-0.622**	1	
1F	0.269*	0.164	0.415**	-0.111	0.305**	-0.574^{**}	1
)) { M 1F	-0.068 0.452^{**} -0.037 0.434^{**} -0.523^{**} 0.269^{*}	$1 \\ 0.294^{**} \\ 0.145 \\ 0.253^{*} \\ -0.323^{**} \\ 0.164$	$1 \\ -0.051 \\ 0.561^{**} \\ -0.714 \\ 0.415^{**}$	1 0.191 0.022 -0.111	1 -0.622** 0.305**	1 -0.574**	1

TABLE 4: The correlation coefficient between regional development factors in Xinjiang.

**Significant at 0.01 level; *significant at 0.05 level.

TABLE 5: Panel regression results of GDP per capita (in log) in Xinjiang, 1990–2018.

	(1)	(2)	(3)	(4)
TD	-0.205**	-0.132**	-0.134**	-0.075^{**}
UR		0.307**	0.211**	0.192**
PMD			-0.277	-0.342
PMF				0.076**
R2	0.220	0.248	0.318	0.356
Ν	336	336	336	336

**Significant at 0.01 level; *significant at 0.05 level.

variations (Table 5). The regression analysis shows that the spatial accessibility, urbanization rate, and ratio of the XPCC farmers significantly contributed to regional economic development after a stepwise regression treatment. It also shows that the contribution of spatial accessibility was the most significant predictor and its contribution decreased, followed by adding more variables. It suggests that the regional inequality resulted from a combination of multiple factors rather than some particular factors. The relatively low population density and scarcity of labor forces were other important factors in the backward economy in the region. These probably resulted from the place-specific preconditions of Xinjiang—a region with vast mountainous land, low population density, and insufficient transportation infrastructure—compared with the rest of the country.

6. Discussion and Conclusion

This study examined the regional difference and spatial clustering patterns of economic growth in Xinjiang over the past three decades. It also examined the place upgrading of the economic status of different counties by ranking analysis and investigated the impact factors of regional development pattern by the panel regression model. This paper further deepens our understanding of the complex mechanism of regional inequality in the western China, which is different from that in the eastern China. It is suggested that more place-specific policies are needed to solve regional inequality in China's impoverished regions.

Over the past thirty years, regional inequality between the north and south in Xinjiang was significant and has experienced an inverted U-shaped process. In the early stage, the state implemented a polarization strategy supported by the national western development policies and the reform of Xinjiang Production and Construction Corps in economic

development. Most investments were dominated by the northern region, where they are superior in spatial accessibility, dense population, and urbanization level. The economic development in northern Xinjiang was relatively fast, which resulted in more and more developed counties clustered in the north. It also enlarged regional inequality and increased northern-southern divide. After that, the Chinese government began to pay attention to regional equality and initiated a balanced development strategy in Xinjiang. It supported the development of ethnic minority areas in terms of poverty reduction and tourism development, which accelerated the economic development in southern Xinjiang and reduced the regional inequality between the north and the south. It suggested that not only natural factors and location factors determine the regional disparities in Xinjiang, but also the place-specific policies have played a significant role. This echoes previous studies reporting that the lagging behind regions need the support of national regulations and preferential policies to promote local economic development and reduce regional inequality.

In the context of the rapid expansion of transport infrastructures in China, the contribution of spatial accessibility to regional economic development is diminished [11, 15]. However, spatial accessibility is still a prominent factor in economic development in Xinjiang. It probably resulted from the place-specific preconditions of Xinjiang—a region with vast mountainous land, low population density, and insufficient transportation infrastructure. Besides, the development of transport infrastructures in China was highly unbalanced, as most investments were dominated by eastern and central regions. Therefore, for less-developed regions like Xinjiang, regional transportation infrastructure development supported by the national government would be an essential mediator for future unbalanced economic development.

This paper has also identified several limitations and pointers for future research on policy implications: (1) Examining the place-specific upgrading mechanisms of different cities and countries in Xinjiang: case studies of cities and countries would have illustrated how central and local governments have played a role in the process. (2) Studying the impact of different factors on changing the relationships between different cities in the urban system in Xinjiang: as we know, the primary city (Urumchi) dominates the urban system in the region. It is worth understanding how the development factors have changed the form of connections between the primary city and the rest of cities and countries over the past decades. (3) Exploring the contribution of interregional transportation infrastructures to regional development and inequality in Xinjiang. Following the economic globalization and regionalization in China, economic activities in Xinjiang have been increasingly connecting it with the developed regions in the country. It is important to understand what the short-comings are and how different interregional transportation networks facilitate regional development and inequality in Xinjiang.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

X. Q. and H. Z. are responsible for conceptualization, methodology, data curation, formal analysis, and funding acquisition. L. W. reviewed and edited the manuscript. All the authors have read and approved the final manuscript.

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