

Comprehensive urbanization level and its dynamic factors for five Central Asian countries

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Abstract: In the context of accelerated development of the Silk Road Economic Belt, it is necessary to conduct in-depth research on urbanization of Central Asian countries. This paper analyzes the spatial and temporal patterns and evolution dynamics of urbanization during the period 1991–2017 from the perspective of internal–external forces. The results are as follows. (1) The urbanization process of the five Central Asian countries studied is significantly influenced by their political and economic situations and displays periodic characteristics. All five countries experienced a stagnation development stage at the beginning of independence, and then a rapid growth stage since the year 2000. The average annual growth rates of the two stages were 0.19% and 1.45%, respectively. (2) Differences in the urbanization of the studied countries are obvious, and the evolutionary characteristics of each subsystem of urbanization are different. It is therefore necessary to distinguish and clearly understand the urbanization process of each country. (3) Internal and external factors play a role in the urbanization processes of Central Asian countries. External railway transportation facilities are particularly important for the development of urbanization in these countries. The regression coefficients of railway construction length, total merchandise trade and actually utilized foreign capital are 0.5665, 0.0937 and 0.0806, respectively. (4) Countries with smaller populations and economic scales need to engage in international cooperation to promote healthy development of urbanization. The results of the study indicate that internal and external factors work together in the urbanization process of Central Asian countries, and external forces are particularly important for the development of such urbanization.

Keywords: Central Asia; national scale; comprehensive urbanization; dynamic factors; external dynamics; Silk Road Economic Belt

1 Introduction

Central Asia is the main thoroughfare of the ancient Silk Road and the core hub of the Silk Road Economic Belt. It is also an important link for communication of Asian, European and

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Middle Eastern cultures, as well as opening of the Chinese economy to the West (Mao *et al.*, 2013; Liu *et al.*, 2018). After the five Central Asian countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) became independent, they were politically separated from the Soviet Union. The economies and societies of the five countries faced prominent inconsistencies, and the process of urbanization was affected to varying degrees. After entering the 21st century, the politics of the five Central Asian countries became more stable, the economy and society developed steadily, and urbanization entered a stage of rapid development. With the construction and development of the Silk Road Economic Belt, cooperation between Central Asia and China in trade, transportation and communications has been strengthened. The development of Central Asian countries has brought new impetus and new opportunities (Liu and Dunford, 2016; Ma and Sun, 2018). To ensure more in-depth cooperation between Central Asia and China, it is necessary to carry out further research on Central Asian countries, especially for the urbanization process.

Urbanization is a complex migration process involving many factors of society, economy and space. It is also the inevitable trend of economic and social development and the only way to modernization (Chen *et al.*, 2019). The healthy urbanization process of Central Asian countries will have a great impetus for regional social and economic progress (Yeerken *et al.*, 2014; Yang *et al.*, 2018). However, research on Central Asia has concentrated on energy resources and environmental health (Zhao and Fang, 2014; Abdullaev and Rakhmatullaev, 2015; Fang *et al.*, 2018). There are few studies on urbanization, and most of them are focused on a single country (Yeerken *et al.*, 2014; Ma and Zhang, 2013) or from a single indicator on urbanization of the five countries (Alimujiang *et al.*, 2013). There are few comparative studies on the urbanization level of Central Asian countries and analysis of the driving factors. This is not conducive to comprehensively recognizing the urbanization process of these countries. It will also affect in-depth cooperation between Central Asia and the international community in the field of urbanization during construction of the Silk Road Economic Belt.

Therefore, based on previous urbanization research, this paper starts from a generalized connotation of urbanization, builds a comprehensive urbanization evaluation index system of the five Central Asian countries, analyzes the evolution process and spatial pattern of urbanization since the independence of the countries, and explores the influencing factors and forces of the comprehensive urbanization level of the countries. Such research may provide a reference for comprehensive cognition and healthy development of Central Asian urbanization in the context of the Silk Road Economic Belt.

2 Research background

Urbanization is an important indicator for measuring the level of economic and social development of a country or a region, and an important factor in promoting global economic progress and sustainable development (Shan and Huang, 2013; Chen *et al.*, 2014; Sun and Ma, 2018). The concept of urbanization can be divided into a narrow sense and a generalized sense. Narrow urbanization refers to the transfer process of the rural population to urban areas; generalized urbanization includes the urbanization process of the population, economy, society and space (Xue and Yang, 1997; Liu and Yang, 2012; Fang *et al.*, 2017; Liu *et al.*,

2018; Li *et al.*, 2019), which is called comprehensive urbanization.

The measurement methods of urbanization level are not uniform. Current measurement methods include two types: the single index method and the composite index method. The single index method mainly uses the proportion of urban population to the total population to measure the urbanization rate (Sanjib *et al.*, 2010; Alimujiang *et al.*, 2013; Liu *et al.*, 2018). It is effective and easy to compare horizontally, but it may ignore a series of changes in economy, industry, land and lifestyle during the urbanization process, and cannot fully reflect the level of urbanization (Lu *et al.*, 2007; Lei *et al.*, 2018). The composite index method starts from the connotation of generalized urbanization and constructs an index system that includes population, society, economy, space and other aspects to measure the level of comprehensive urbanization. It can fully reflect the level of regional urbanization, and thus it has been widely accepted by academic and political circles (Zhang, 2008; Wang *et al.*, 2019; Yang *et al.*, 2019).

However, the indicators in the composite index method involve multiple aspects, and different researchers may have different settings for the index system. For example, Chen *et al.* (2009) divided urbanization into four subsystems of population, economy, land and society, and measured the level of comprehensive urbanization and the level of urbanization of subsystems in China from 1981 to 2006. Yeerken *et al.* (2014) also studied the urbanization process from these four aspects in Kazakhstan from 1992 to 2011, but the specific indicators were different. Chu *et al.* (2018) measured the level of urbanization in Russia, Siberia and the Far East in terms of population, economy and society. Ma and Zhang (2013) evaluated the level of urbanization in Tajikistan in terms of population, economy and life quality. This paper refers to related research and selects the recognized demographic, economic, social and spatial urbanization indicators to build an index system that fully reflects the urbanization level of the five Central Asian countries.

The dynamic mechanism of urbanization is the core proposition of urbanization research, and there have been many discussions on this. As early as the beginning of the 20th century, the famous German economist Weber (1909) proposed that the division of labor caused by industrialization was the driving force for urbanization. Later, some scholars added elements such as economic growth and industrial structure transformation to the driving factors of urbanization. They believed that the growth of urban economy and the upgrading of industrial structure promoted urbanization (Friedman, 1973; Northam, 1975; Moomaw and Shatter, 1996). Early studies of urbanization dynamics mainly focused on economic factors. Later studies began to incorporate factors outside the economy into analysis of urbanization dynamics, with obvious diversity characteristics. For example, some scholars have proposed “urban pull” and “rural thrust” from the perspective of “urban-rural dual structure” to explain China’s urbanization dynamics (Cui and Ma, 1999). From the perspective of “the main body of urbanization”, government power, market power and civil power were proposed to help understand the dynamic process of urbanization (Wei *et al.*, 2013). There were also views that took resources and technology into account, and it was believed that market economies, political decentralization, demographic changes, resource development and technological changes were the main reasons for the rapid development of urbanization (Heikkila, 2007).

However, these studies were based on national or regional internal factors. It is believed that the urbanization process is constantly evolving due to the interaction and common influence of various internal factors. In the context of increasing regional economic integration and economic globalization, urbanization in any place is inseparable from capital, material, knowledge, technology and talent outside the locality. Therefore, it is not enough to focus on the urbanization dynamics within a locality to understand the urbanization process and its dynamics in the context of globalization. Some scholars have already noticed this problem. They incorporated external forces into the framework of urbanization dynamic analysis, and analyzed the dynamic factors of urbanization with administrative, market and internal forces (Ou *et al.*, 2008; Chen *et al.*, 2009). Other scholars analyzed the process of urbanization dynamics in some regions of developing countries from the perspective of foreign capital and globalization (Xue and Yang, 1997; Wu, 2003). However, on the one hand, these studies explained only the external force as the actual use of foreign capital and lacked consideration of foreign trade and connectivity facilities. On the other hand, the research objects of these studies were only for part of a country or a whole country. They lacked comparative analysis of multiple countries, especially specific attention on external force research of developing “small countries” (countries with a small-scale population and economy). Although such small countries are politically independent, the capital, material and labor required for the urbanization process cannot be separated from external resources. Therefore, external forces are more important for urbanization of small countries. Based on the above considerations, this paper divides the urbanization dynamics of the five Central Asian countries into two types – inward forces and outward forces, and analyzes the dynamic factors according to the targeted index.

3 Materials and methods

3.1 Study area

The subjects of this research are the five countries in Central Asia, namely, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (Figure 1). The countries are located in the hinterland of the Eurasian continent. They are the backbone of road transport between Asia and Europe, the Pacific Ocean and the Atlantic Ocean, and are also the hub of the Silk Road Economic Belt. The five countries declared independence after the collapse of the Soviet Union in 1991. They have the characteristics of a small population, a low population density and a small economic volume. The total land area of the five Central Asian countries is about 4 million km². In 2018, the total population was 72.50 million, of which the urban population was 34.51 million, the population urbanization rate was 48.16%, the population density was 18.47 persons/km², the gross domestic product (GDP) was 277.42 billion US dollars (USD) and the GDP per capita was 3826.45 USD/person (Table 1). Kazakhstan is the largest of the five countries, accounting for 68.09% of Central Asia, and Uzbekistan is the most populous country, accounting for 45.46% of Central Asia. Kazakhstan is the country with the highest per capita income, and its per capita GDP was 11.29 times that of Tajikistan.



Figure 1 Locations of the five Central Asian countries

Table 1 Main economic and social indicators of the five Central Asian countries in 2018

	Independence time	Country area ($\times 10^4$ km ²)	Total population ($\times 10^4$ persons)	Urbanization rate (%)	Population density (persons/km ²)	GDP ($\times 10^8$ USD)	Per capita GDP (USD/person)
Kazakhstan	1991–12	272.49	1827.65	57.43	6.77	1705.39	9331.05
Uzbekistan	1991–08	44.74	3295.54	50.48	77.47	505.00	1532.37
Turkmenistan	1992–01	48.81	585.09	51.59	12.45	407.61	6966.64
Tajikistan	1991–09	14.14	910.08	25.23	65.57	75.23	826.62
Kyrgyzstan	1991–08	20.00	631.58	39.10	32.93	80.93	1281.36
Central Asia	–	400.17	7249.94	48.16	18.47	2774.16	3826.45

3.2 Comprehensive urbanization assessment

3.2.1 Index system

Based on a review of urbanization research and considering the availability of data, this paper constructs a comprehensive urbanization level evaluation index system of the five Central Asian countries from four subsystems – demographic, economic, social and spatial urbanization – and includes 12 specific indicators (Table 2). Demographic urbanization mainly reflects the process of population concentration in urban areas, among which the urban population proportion index (i.e., the commonly used urbanization rate) reflects the degree of concentration of the national population to urban areas and the urban population growth rate indicator reflects the growth of the urban population. The proportion of non-agricultural employment personnel reflects the degree of non-agriculturalization of the employment pattern of the population. Economic urbanization mainly reflects the level of urban economic development. The per capita GDP index reflects the overall level of national economic development, the per capita industrial output value reflects the degree of industrialization of the country and the non-agricultural output ratio indicator reflects the degree of non-agriculturalization of the national production mode. Social urbanization mainly reflects the level of resident access to urban public services. The per capita medical expenditure, the per capita public education spending and the internet coverage rate reflect the national

medical and educational levels and the coverage of internet facilities, respectively. Spatial urbanization mainly reflects the non-agricultural transformation of land use and landscape, reflecting the three indicators of land urbanization rate (urban land area ratio), urban built-up area and urban road network density. Through this indicator system, the present study seeks to objectively and comprehensively reflect the level of urbanization in the five Central Asian countries.

Table 2 Comprehensive urbanization evaluation index system of the five Central Asian countries

Target layer	Subsystem	Weight	Evaluation indicators	Unit	Weight
Comprehensive urbanization level	Demographic urbanization	0.278	Urban population proportion	%	0.091
			Urban population growth rate	%	0.070
			Non-agricultural employment proportion	%	0.117
	Economic urbanization	0.284	Per capita GDP	USD/person	0.095
			Per capita industrial output value	USD/person	0.089
			Non-agricultural output ratio	%	0.100
	Social urbanization	0.216	Per capita medical expenditure	USD/person	0.090
			Per capita public education spending	USD/person	0.061
			Internet coverage rate	%	0.065
	Spatial urbanization	0.222	Land urbanization rate	%	0.085
			Urban built-up area	km ²	0.051
			Urban road network density	km/km ²	0.086

3.2.2 Assessment methods

The weights of the indices are determined using a combination of the entropy method and the Delphi method. The entropy method calculates the weight of the index according to the degree of variation of each index. In this study, the index weights are obtained by calculating the entropy values of the data from the five Central Asian countries from 1991 to 2017. The Delphi method invites experts to combine the situation of Central Asian countries to score the importance of the indicators. The combination of the two methods can make the results more objective (Table 2). The entropy method is calculated as follows:

(1) Data standardization:

$$\text{Positive indicator: } S_{ij} = \frac{x_{ij} - \min\{x_{ij}\}}{\max\{x_{ij}\} - \min\{x_{ij}\}} \quad (1)$$

$$\text{Negative indicator: } S_{ij} = \frac{\max\{x_{ij}\} - x_{ij}}{\max\{x_{ij}\} - \min\{x_{ij}\}} \quad (2)$$

where x_{ij} represents the value of the j -th indicator in the i -th country, and $\max\{x_{ij}\}$ and $\min\{x_{ij}\}$ respectively represent the maximum and minimum values of the j -th index in the i -th country.

(2) Calculate the information entropy value of the j -th indicator:

$$e_j = -k \sum_{i=1}^n (Y_{ij} \times \ln Y_{ij}), Y_{ij} = \frac{S_{ij}}{\sum_{i=1}^n S_{ij}}, k = \frac{1}{\ln n} \quad (3)$$

(3) Calculate the weight of the indicator x_j :

$$w_j = \frac{g_j}{\sum_{j=1}^p g_i}, g_j = 1 - e_j \tag{4}$$

3.3 Dynamic factor analysis

3.3.1 Explanatory variable index

Based on review of the driving factors of urbanization, this study considers the particularity of urbanization at the national scale and the availability of international data in Central Asia, and establishes an explanatory variable index system for urbanization dynamics in Central Asian countries from three aspects: internal dynamic factors, external dynamic factors and bidirectional dynamic factors (Table 3). The basic assumptions are as follows. Internal dynamics: (1) the higher the per capita income of the urban area, the greater the attraction to population, capital and production factors, and the more favorable it is to the development of urbanization; (2) the lower the agricultural income, the more favorable the transfer of agricultural surplus labor to the urban area; (3) by increasing capital investment, the government can improve the level of urban industry and infrastructure, and promote urbanization; and (4) the higher the level of market economy and its activity, the more it contributes to the rational allocation of national production factors, and the more favorable it is to promote economic urbanization. External dynamics: (1) the use of foreign capital can drive changes in a country’s technology, trade, industrial structure and employment structure, which is conducive to improvement of urbanization; (2) foreign trade is a necessary way to obtain essential materials and export superior products in the process of urban development and construction in Central Asian countries, and is an indispensable driving factor for the urbanization process. Bidirectional dynamics: (1) the external transportation infrastructure is an important part of urbanization construction, and also an important support for foreign trade; and (2) logistics transportation capacity is an important manifestation of the internal and external connectivity of a country and one of the basic driving forces for urbanization.

Table 3 Explanatory variables of urbanization dynamics in the five Central Asian countries

Types	Dynamic indicator (abbreviation)	Unit	Explanation
Internal dynamics	Urban per capita income (UPI)	USD per person	Urban income pulls
	Per capita agricultural output (PAO)	USD per person	Rural income thrust
	Government final consumption (GFC)	10,000 USD	Government administrative motivation
	Total market capitalization (TMC)	10,000 USD	Market economy motivation
External dynamics	Actually utilized foreign capital (AFC)	10,000 USD	External investment motivation
	Total merchandise trade (TMT)	10,000 USD	External trade motivation
Bidirectional dynamics	Railway construction length (RCL)	km	External transportation facilities motivation
	Railway freight volume (RFV)	10,000 tonne × km	Internal and external logistics connection

3.3.2 Panel data regression model

The Pedroni and Kao methods are used to perform a cointegration test on the panel data of

the explanatory variables. The P -value of the Pedroni test statistic is less than 0.05, and the Kao test statistic corresponding to the P -value is less than 0.01 (Table 4). Therefore, the test results significantly reject the original hypothesis that there was no cointegration relationship, indicating there is a cointegration relationship between the selected eight explanatory variables and the level of comprehensive urbanization.

Table 4 Data cointegration test results

Test method	Items	T -statistic	P -value
Kao test	Modified Dickey–Fuller	-2.7650	0.0028
	Dickey–Fuller	-2.1039	0.0077
	Augmented Dickey–Fuller	-2.6177	0.0045
	Unadjusted modified Dickey–Fuller	-2.6768	0.0037
	Unadjusted Dickey–Fuller	-2.0764	0.0189
Pedroni test	Modified Phillips–Perron	1.8399	0.0329
	Phillips–Perron	-2.3175	0.0102
	Augmented Dickey–Fuller	-2.0685	0.0193

The static panel data model generally includes three types: a hybrid model, a fixed-effect model, and a random effects model. Using the F test and the Hausman test, it is found that the statistical value of the test results is large, and the P -value is much less than 0.05 (Table 5). Therefore, the fixed-effect model is used to quantitatively analyze the dynamic factors of comprehensive urbanization.

Table 5 Test results of model assumptions

Test method	Assumption	F -statistic	P -value	Test result
F test	Hybrid model	88.54	0.0000	Fixed-effect model
Hausman test	Random-effects model	230.35	0.0000	Fixed-effect model

Taking the comprehensive urbanization level as the dependent variable, the urbanization dynamic factor index inside and outside a country is taken as the explanatory variable, and the fixed-effect panel data regression model of quantitative analysis of the dynamic factors for the comprehensive urbanization level can be constructed as follows:

$$\begin{aligned} \ln IndexUR_{it} = & \\ & a_0 + a_1 \ln UPI_{it} + a_2 \ln PAO_{it} + a_3 \ln GFC_{it} + a_4 \ln TMC_{it} + \\ & a_5 \ln AFC_{it} + a_6 \ln TMT_{it} + a_7 \ln RCL_{it} + a_8 \ln RFV_{it} + u_i + v_{it} \end{aligned} \quad (5)$$

where i represents different countries, t represents the year, u_i represents the unobservable country effect, v_{it} represents the random error term, a_0 represents the intercept term of the research unit, and a_1 – a_8 are the regression coefficients of each explanatory variable in Table 3.

3.4 Data

The statistical data used in this paper are from the national statistical yearbooks of the five

countries,¹ as well as United Nations Development Programme Human Development Reports (<http://hdr.undp.org>), Food and Agriculture Organization of the United Nations country profiles (<http://www.fao.org/countryprofiles/data-source>) and World Bank Open Data (<https://data.worldbank.org.cn>). Part of the case data comes from author field visits to Tajikistan, Kazakhstan and Uzbekistan in June and August 2018 and June 2019. Considering the different currencies in the five countries, this study converts economic indicators into current US dollars to ensure the data are comparable.

4 Evolution of comprehensive urbanization

4.1 Comprehensive urbanization index

The differences in the comprehensive urbanization level in the five Central Asian countries are obvious. The comprehensive urbanization levels of Kazakhstan, Uzbekistan and Turkmenistan were relatively high, and those of Kyrgyzstan and Tajikistan were significantly lower than the average level of Central Asia. Since the independence of the five Central Asian countries in 1991, the level of comprehensive urbanization has undergone major changes. The overall performance is characterized by stagnation of the development trend, and the characteristics of the stage are obvious. With the year 2000 as the demarcation point, comprehensive urbanization can be divided into two stages of development (Figures 2 and 3).

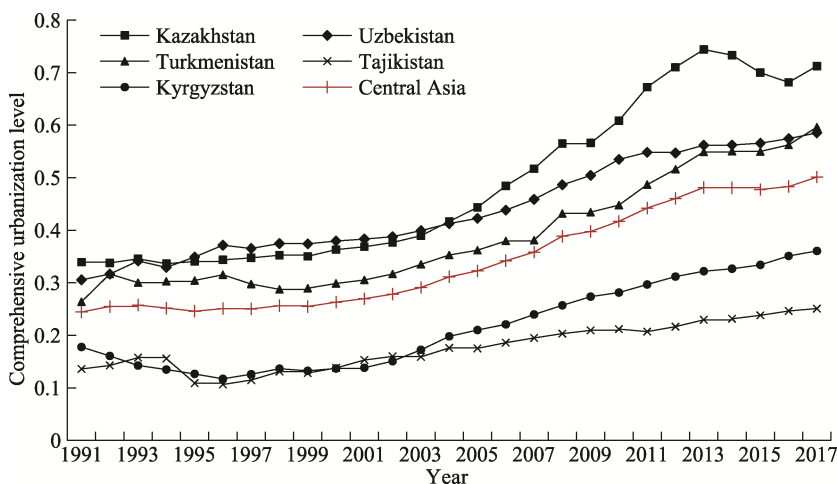


Figure 2 Evolution of the comprehensive urbanization level of the five Central Asian countries during 1991–2017

The first stage is the stagnation period of urbanization before 2000. This stage was the first decade after the independence of the five Central Asian countries which experienced reconstruction of their political powers and adjustment of their economies. The level of urbanization was generally maintained at the level of the collapse of the Soviet Union. The

¹ Agency of Statistics of the Republic of Kazakhstan, <https://www.ivisa.com/visa-blog/history-of-stat.kz>; State Committee of the Republic of Uzbekistan on Statistics, <http://www.stat.uz/STAT/index.php?lng=1>; Agency of Statistics under the President of the Republic of Turkmenistan, <https://www.adb.org/projects/documents/capacity-development-gender-statistics-agency-statistics-president-tajikistan-pilot-project-final-report>; Agency of Statistics under the President of the Republic of Tajikistan, <https://www.adb.org/mn/node/79982>; National Statistics Committee of Kyrgyzstan, <http://www.stat.kg/>.

comprehensive urbanization level of Central Asia was 24.45% in 1991 and 26.32% in 2000. The average annual growth rate was just 0.1%. Only Uzbekistan's comprehensive urbanization level has increased in the five countries (average annual increase of 0.74%), and the other four countries have basically shown a retreat or stagnation in the level. The decline in Kyrgyzstan was most obvious, from 17.78% in 1991 to 13.70% in 2000. Turkmenistan, Kazakhstan, and Tajikistan were basically stagnant, with annual growth rates of 0.35%, 0.24% and 0.02%, respectively. Therefore, it can be seen that the independence of the five Central Asian countries has had a great impact on their urbanization processes. The process of decomposition from the former Soviet Union's economic system to the establishment of independent economic systems, as well as reorganization of state power institutions, has had a tremendous impact on urbanization. It can also be seen that the smaller the national economy, the more significant the impact is, as in the case in Kyrgyzstan and Tajikistan.

The second stage is the rapid development of the urbanization level after the start of the new century. After 2000, the political systems of the five Central Asian countries stabilized, their economic development began to recover and the pace of urbanization accelerated. The results show that the level of comprehensive urbanization in Central Asia increased from 26.97% in 2001 to 50.11% in 2017, with an average annual growth rate of 1.45%. The comprehensive urbanization level of the five Central Asian countries has experienced rapid growth. Kazakhstan has had the fastest growth, with an average annual growth rate of 2.15%, and it has become the country with the highest level of comprehensive urbanization out of the five countries. Turkmenistan has grown at an average annual rate of 1.82% and surpassed Uzbekistan in 2017 to become the second-highest level of comprehensive urbanization in Central Asia. Uzbekistan's average annual growth rate was 1.26%, and the overall level of urbanization was mostly between that of Kazakhstan and Turkmenistan, but it was exceeded by Turkmenistan in 2017. Kyrgyzstan had an average annual growth rate of 1.39%, which was higher than that of Uzbekistan, but the overall level was not high, and was lower than the average of Central Asia by 14.05 percentage points. Tajikistan had an average annual growth rate of 0.61%, which was the lowest absolute growth rate of the comprehensive urbanization level out of the five countries.

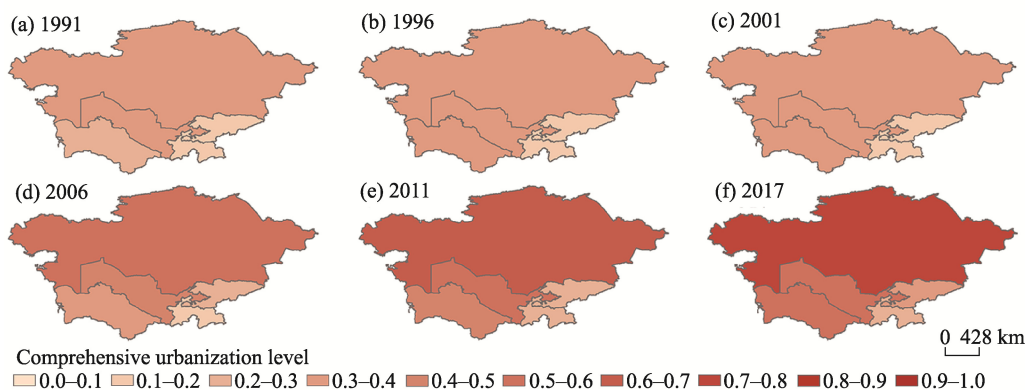


Figure 3 Spatial distribution of the comprehensive urbanization level of the five Central Asian countries

4.2 Urbanization subsystem index

Measurement of the urbanization subsystem can further demonstrate the development proc-

ess of demographic urbanization, economic urbanization, social urbanization, and spatial urbanization in the five Central Asian countries. Different urbanization subsystems have unique evolution characteristics (Figure 4).

(1) Demographic urbanization. Among the urbanization subsystems, the differences among countries in the demographic urbanization level are most obvious. The demographic urbanization levels in Kazakhstan, Turkmenistan and Uzbekistan were significantly higher than those of Kyrgyzstan and Tajikistan. The average demographic urbanization level (1991–2017) of Kazakhstan was 75.65%, while the average annual rate of Tajikistan was only 15.19% – the gap was as high as 60.46%. And this gap has been maintained since independence. From the perspective of changing trend, only Uzbekistan’s demographic urbanization level showed a relatively stable low growth trend. The other four countries showed different degrees of decline over a period after independence, and began to show growth momentum around 2000. The demographic urbanization levels in Kazakhstan, Turkmenistan, Tajikistan, and Kyrgyzstan returned to the levels of independence (1991) in 2002, 2004, 2008 and 2010, respectively. The general decline in the demographic urbanization level at the beginning of independence was because a large number of residents of Central Asian countries moved to Russia for ethnic reasons (especially Russians), and these populations were mostly urban residents. Conversely, because of the decline of industry, non-agricultural employment opportunities have been greatly reduced (this is the main reason). Uzbekistan’s demographic urbanization level did not decrease as much as those of the other four countries after independence, but the data clearly show that it was also affected. The average annual growth rate before 2000 was 0.52%, and the average annual growth rate after 2000 was 0.93%.

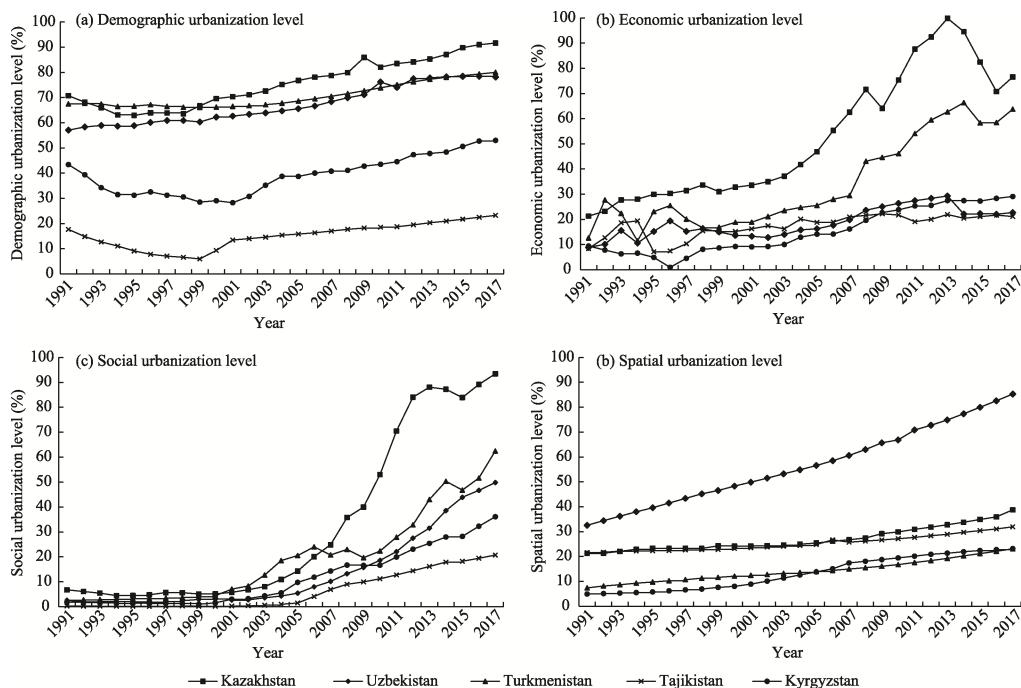


Figure 4 Evolution of four urbanization subsystems of the five Central Asian countries during 1991–2017

(2) Economic urbanization. Among the urbanization subsystems, the fluctuation of economic urbanization level is most obvious. Overall, the economic urbanization of the five Central Asian countries has gone through three stages: a period of shock adjustment during 1991–2000, a stage of rapid growth during 2001–2008, and a stage of deceleration and fluctuation during 2009–2017. At the beginning of independence, only Kazakhstan's economic urbanization level maintained relatively stable low growth, while the other four countries' economic urbanization level curves experienced large rises and falls. The average increase of these four countries was only 5.81% in 1991–2000. The period 2001–2008 was the fastest growing and most stable growth period for the five countries in Central Asia, with an average increase of 17.70%, which was the “golden period” for the development of Central Asia. Kazakhstan had the highest growth rate of 37.99%, and Turkmenistan reached 24.22%. Affected by the global financial crisis in 2008, the economic development of the five Central Asian countries declined after 2009. Also affected by the decline in international crude oil prices in 2013, the economic urbanization level of three countries (Kazakhstan, Turkmenistan and Uzbekistan) with energy resources in Central Asia dropped significantly, with Kazakhstan dropping by 29.09% between 2013 and 2016.

(3) Social urbanization. Among the urbanization subsystems, the level of social urbanization has had the best growth momentum since 2000. In the first decade after independence, Turkmenistan's social urbanization level had a stable and weak growth; the levels of the other four countries declined slightly and did not return to the 1991 levels until around 2000. After 2001, the social urbanization level showed a good momentum of development on average. Kazakhstan's level increased by 87.69% in 17 years, Turkmenistan's increased by 55.43%, Uzbekistan's increased by 47.19%, Kyrgyzstan's increased by 36.10% and Tajikistan's increased by 20.71%. Before their independence, the five countries were part of the socialist state of the Soviet Union. Service facilities such as education and medical care were allocated by the state. After independence, although a capitalist system was implemented, education and medical care were still mainly allocated by the state. Due to insufficient state funds, the level of social services stagnated or even declined. When the economy improved after 2000, the level of social urbanization in Central Asian countries increased rapidly.

(4) Spatial urbanization. Among the urbanization subsystems, the growth of spatial urbanization level has been the most stable. After independence, the development of spatial urbanization in the five countries maintained a steady growth. With less interference from the political and economic situation, urban construction and spatial expansion developed at a uniform rate; the development curve of the spatial urbanization level was almost straight, but the growth rate was different. Uzbekistan had the highest level of urbanization and the fastest growth, from 32.55% in 1991 to 85.29% in 2017, an increase of 52.73%; Kyrgyzstan's level increased by 18.25%, ranking second; Kazakhstan's level increased by 17.51%, ranking third. The level of spatial urbanization in Kazakhstan was not high, and was affected by its large land area and small population density. Tajikistan's spatial urbanization level was unexpected, at the bottom of the five countries in a comparison of demographic, economic and social urbanization levels. The reason is that after independence, urban population and urban construction land in Tajikistan significantly increased. The construction of urban settlements mostly followed that in Europe and America. Large single-family houses have increased in number around towns, which has made the area and

proportion of urban construction land in the valley basins higher.

The development characteristics of each of the four urbanization subsystems are obvious, with the largest differences being in demographic urbanization, the most obvious fluctuations being in economic urbanization, the fastest development being in social urbanization and the most stable growth being in spatial urbanization. There are also significant differences among countries. The urbanization levels of Kazakhstan are relatively high in all four aspects of urbanization levels; Uzbekistan’s spatial and demographic urbanization levels are relatively high, but the level of economic urbanization is very low; Turkmenistan’s demographic, economic and social urbanization levels are relatively high, but the level of spatial urbanization is relatively low; and Tajikistan’s and Kyrgyzstan’s four aspects are all relatively low.

5 Dynamic factors of comprehensive urbanization

Using the selected fixed-effect panel data regression model, this paper quantitatively analyzes the dynamic factors of comprehensive urbanization in five Central Asian countries. From the regression coefficients of the model, all explanatory variables pass the 5% significance test (Table 6). From the overall significance of the model, the *F*-statistic is 207.25, the corresponding *P*-value is 0.0000 (<0.05) and the overall *R*² is 0.7365 (close to 1) (Table 7), indicating that the overall model fits well. Therefore, in general, the selected explanatory variables give a strong indication of the comprehensive urbanization level of Central Asian countries. The regression coefficient results show that except for the per capita agricultural output value (PAO), which has a strong negative correlation with the comprehensive urbanization level, the other indicators are positively affected. The railway construction length (RCL) has the strongest impact on the level of comprehensive urbanization, which greatly exceeds the urban per capita income (UPI, ranked second) and the government final consumption (GFC, ranked third). The least-affected factor is the total market capitalization (TMC). In general, the internal factor indicators have a strong impact on the level of comprehensive urbanization in Central Asian countries, and external factor indicators have also played an important role.

Table 6 Coefficient estimation results of the fixed-effect model

Types	Variable	Coefficient	<i>T</i> -statistic	<i>P</i> -value
Internal dynamic	Urban per capita income (UPI)	0.2813	5.18	0.000
	Per capita agricultural output (PAO)	-0.2218	-7.43	0.000
	Government final consumption (GFC)	0.2348	4.30	0.000
	Total market capitalization (TMC)	0.0612	2.45	0.016
External dynamic	Actually utilized foreign capital (AFC)	0.0806	2.11	0.017
	Total merchandise trade (TMT)	0.0937	2.27	0.007
Bidirectional dynamic	Railway construction length (RCL)	0.5665	4.94	0.000
	Railway freight volume (RFV)	0.0887	2.88	0.005
-	Constant term	-13.64932	-15.89	0.000

Table 7 Overall estimation of the fixed-effect model

<i>F</i> -statistic	R^2 -within	R^2 -between	R^2 -overall	<i>P</i> -value (<i>F</i>)
207.25	0.9218	0.8386	0.7365	0.0000

The impact of various indicators (interpreted variables) on the comprehensive urbanization level in Central Asian countries is as follows.

(1) RCL (a bidirectional dynamic factor) has the most significant impact on the level of comprehensive urbanization in Central Asian countries. The coefficient is positive, indicating that the better the railway facilities are, the better the comprehensive urbanization level will be. The railway facilities in Central Asia have gradually developed on the basis of the former Soviet Union, and the main structure was still left in the Soviet era. The domestic railway transportation system of the former Soviet Union became an international railway system after the independence of Central Asia, and undertakes the main external freight transportation of Central Asian countries. With the planning and operation of the Silk Road Economic Belt, the construction of cross-border railways in Central Asian countries such as the China–Kazakhstan railway, the China–Kyrgyzstan–Uzbekistan railway, the Russia–Kazakhstan–Kyrgyzstan–Tajikistan railway and the Kazakhstan–Turkmenistan–Iran railway has been promoted. This will greatly enhance the ability of Central Asian countries to transport and transship to foreign railways; enhance the economic ties between Central Asian countries and China, European countries, and Southeast Asian countries; promote the development of related industries; and improve the level of comprehensive urbanization. The railway facilities in Tajikistan and Kyrgyzstan are lagging behind those of the other Central Asian countries and the external connectivity was not smooth, which have become important limiting factors for the development of urbanization.

(2) UPI (internal dynamic factor) has had a significant impact on the level of comprehensive urbanization in Central Asian countries. The coefficient is positive, indicating that the higher the UPI is, the higher the level of comprehensive urbanization. UPI is an important pull of population concentration in cities and towns. The big income gap between urban and rural areas makes cities more attractive to the rural population. The research results show that UPI is one of the most important internal driving factors in the process of urbanization in Central Asian countries. For example, the per capita income of the agricultural industry in Kazakhstan was far lower than the per capita income of the non-agricultural industry. In 2000, the per capita income of the agricultural industry was only 39.56% of the per capita income of the whole industry, which was 27.40% of the per capita income of the industry. By 2014, the two proportions had increased to 54.94% and 41.59%, but the gap between urban and rural incomes was still large. According to information released by the Chinese Embassy in Tajikistan, the income of each industrial post in Tajikistan in 2018 was 9.7 times that of agricultural workers. It can be seen that the choice of residents for urban employment is the main driving force of urbanization in Central Asian countries.

(3) PAO (internal dynamic factor) has also had a significant impact on the level of comprehensive urbanization in Central Asian countries. The coefficient is negative, indicating that the higher the PAO is, the more unfavorable the country's urbanization process. PAO directly reflects the per capita income level of agriculture. This result is consistent with the analysis of UPI indicators, further confirming that the urban–rural income gap is an important driving force for urbanization. At present, the infrastructure and agricultural technology of agricultural

development in Central Asian countries are still relatively inadequate, making PAO very low. For example, the PAO values of Kazakhstan, Uzbekistan, and Turkmenistan in 2017 were about 1000 USD per person, and in Tajikistan and Kyrgyzstan only 250 USD per person. The reason for the low PAO of Central Asian countries lies in the low level of agricultural technology and modernization, and the low efficiency and added value of agricultural production.

(4) GFC (internal dynamic factor) has a very significant impact on the level of comprehensive urbanization in Central Asian countries. The coefficient is positive, indicating that the more government investment there is, the more favorable urbanization is. After the five Central Asian countries became independent, they tried to shift from a planned economy to a market economy. However, after independence, the roles of the national governments were still strong. Government forces played a decisive role in urban construction and even in national development (Musabek *et al.*, 2005; Becker and Morrison, 1999). The GFC of the five Central Asian countries continued to increase after independence. Compared to 1991, Kazakhstan's GFC tripled by 2017, and the values of the remaining four countries have grown about twice. The increase in government investment will promote infrastructure construction and public service capacity improvement, and improve the investment environment, which is crucial to the development of urbanization. In addition, the Central Asian governments have used administrative power to build new urban areas and industrial parks, and have also vigorously promoted the urbanization process. For example, the Kazakhstan Government decided in 1997 to set Astana as the capital, so that the original small towns quickly developed into a modern city with a population of 1 million. Uzbekistan has actively developed industrial parks in recent years and strongly promoted the country's urbanization process.

(5) Total merchandise trade (TMT, external dynamic factor), actually utilized foreign capital (AFC, external dynamic factor) and railway freight volume (RFV, bidirectional dynamic factor) are positively correlated with the level of comprehensive urbanization. These three indicators are all external indicators, indicating that external factors also have a positive impact on urbanization of the Central Asian countries. The coefficients of the three indicators are close, indicating that their influence is similar. The economies of Central Asian countries are small and the industrial system is not perfect. Therefore, a large number of non-agricultural products have needed to be obtained through imports during the urbanization process, and economic development also introduced a large amount of foreign capital. In 2017, Kazakhstan's TMA and AFC values were 5.65 times and 5.81 times those of 2000, Uzbekistan's values were 4.05 times and 4.42 times, Turkmenistan's values were 2.80 times and 3.39 times, Tajikistan's values were 2.71 times and 3.38 times, and Kyrgyzstan's values were 5.87 times and 8.08 times. Under the background of economic globalization, the development of any country is inseparable from foreign economic and trade links. The development of Central Asian countries (including urbanization) requires external funds and cargo links. With the development of the Silk Road Economic Belt, the links between Central Asian countries and China's import and export of goods, and the use of foreign capital and freight transportation have greatly increased, which will help Central Asian countries to strengthen foreign economic and trade ties, and promote development of urbanization.

(6) TMC (internal dynamic factor) is positively correlated with the level of comprehensive urbanization in Central Asian countries, but the impact is the smallest among all the indicators. After the disintegration of the Soviet socialist republics, the Central Asian coun-

tries became independent, implemented capitalism, and developed a market economy, hoping to rationally allocate resources through the market economy. But since independence, the market economies of the Central Asian countries did not develop smoothly, and the results of the analysis show that the influence of market forces on the urbanization of a country has not been as strong as the government. With the gradual improvement of the market economy operation system in Central Asian countries, the role of the market economy in promoting the urbanization of a country will gradually increase.

By comprehensively comparing the estimated results of the coefficients of the explanatory variables, the urbanization process since the independence of Central Asian countries has been affected by internal and external factors, and the internal and external bidirectional force indicators have played a more important role. On the one hand, the urban–rural income gap and government market forces are important drivers of urbanization in the five countries. The urban income pull is slightly higher than the rural income thrust, and the government force is much higher than the market force. This reflects the longing of Central Asian residents for urban life and the important role of governments in the process of urbanization. On the other hand, foreign funds and foreign trade commodities have also significantly promoted the urbanization of Central Asian countries, and the role of import and export commodities is even slightly higher than the actual use of foreign capital. This shows that the urbanization process in Central Asian countries is largely inseparable from the external capital, and a city's production and living are inseparable from various import and export commodities. Judging from the comparison of internal and external forces, it seems that internal forces are stronger than external forces in the urbanization of Central Asian countries, but the stronger internal and external bidirectional forces show that urbanization of Central Asian countries is more inseparable from the external links of the countries and materials and funds outside the countries.

Reviewing the discussion on the dynamic mechanism of urbanization in relevant literature, and combining the quantitative analysis results of the dynamic factors of urbanization in Central Asia, the dynamic mechanism of urbanization in Central Asia is obtained (Figure 5). Previous research on the dynamic mechanism of urbanization can be summarized as three theories: the growth theory, the difference theory, and the subject theory. The growth theory states that industrialization, industrial structure upgrading and economic growth are the core driving forces of urbanization. The difference theory states that the larger urban–rural gap drives residents to move from rural to urban areas to seek better employment opportunities and higher income. The subject theory regards the government, market, and residents as the three major actors of urbanization, and jointly promotes the development of urbanization. These three theories do not conflict, but coexist and interact with the urbanization process of Central Asian countries. Among the three actors, residents are the key drivers of urbanization. They are affected by the urban–rural income gap and have different yearnings for urban life, which in turn affects the strength of pushing rural residents to urban areas. The two main actors of the government and the market affect national economic and social development, the core driving force of urbanization, by increasing investment or optimizing the environment.

On this basis, the process of urbanization in Central Asian countries has been driven by forces outside the countries. Regardless of whether foreign investment is actively attracted by the favorable market environment or has attracted investment from the state or local gov-

ernments, foreign funds have strengthened the national development momentum and provided more non-agricultural employment for domestic residents. Foreign trade commodities have activated local markets, provided urban and rural residents with more and better commodities and services, and pushed local products into the international market. Whether in urban or rural areas, foreign-funded foreign trade can promote rapid urban and rural development and rapid urbanization through the provision of capital, employment opportunities, advanced technology, excellent equipment and rich commodities. External channels and logistics connectivity have played a role in the internal and external power of connection, supporting, and guaranteeing the external dynamic factors of foreign capital and foreign trade to better affect the internal dynamic factors, thereby promoting the rapid development of urbanization in Central Asia.

The urbanization of Central Asian countries is constantly moving forward under such a dynamic mechanism. When the external power is insufficient or the internal and external communications are not smooth, the internal power will also be weak, and it is difficult to promote urbanization. When the external environment is good or foreign trade is active, the internal power will increase, and urbanization will accelerate development. The populations and economies of Central Asian countries are not large, and they are considered small countries in terms of global comparison. For these countries, external power plays a vital role in the urbanization process of each country. Therefore, from the national scale, more attention should be paid to the study of external forces and the cultivation of external forces in the process of urbanization.

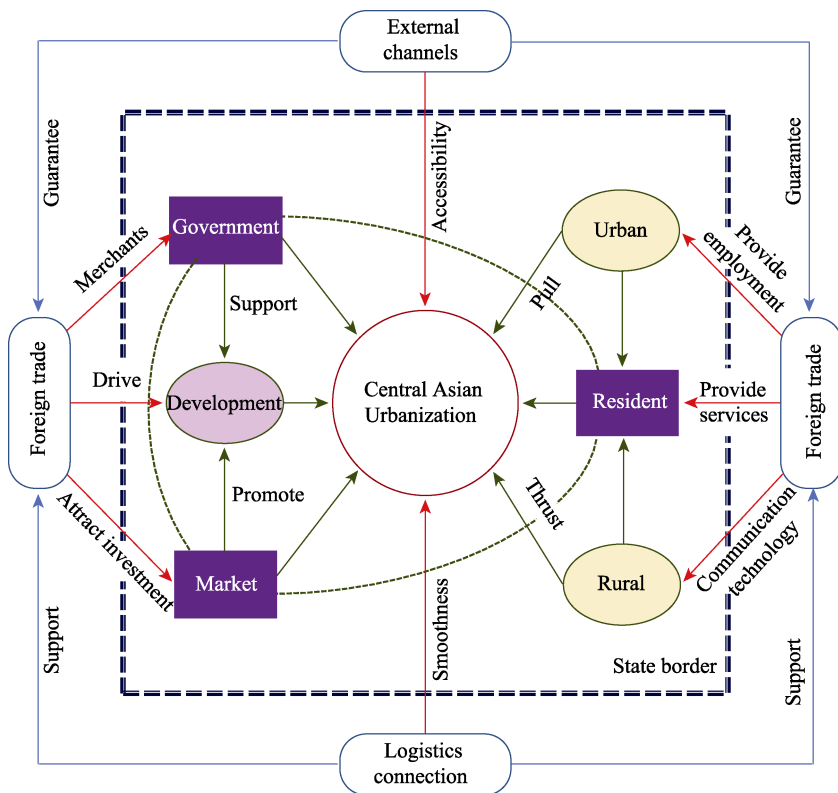


Figure 5 Urbanization dynamic mechanism of Central Asian countries based on internal and external forces

6 Conclusions

Under the context of the development of the Silk Road Economic Belt, it is necessary to carry out comprehensive comparative studies and dynamic factor analysis of urbanization in Central Asian countries. This paper has analyzed the evolution process and spatial pattern of urbanization of the five Central Asian countries by constructing a comprehensive urbanization level evaluation index system. A fixed-effect panel data regression model was used to analyze the dynamic factors of comprehensive urbanization. The conclusions are as follows.

(1) The urbanization process of the five Central Asian countries has regional commonality and national individuality. After the five Central Asian countries became independent, their urbanization process first experienced a period of shock and slow development in the early stage, with an average annual growth rate of urbanization of only 0.19%. After the turn of the new century in 2000, they then entered a stage of rapid development, and the average annual growth rate of urbanization reached 1.45%. However, the resource and environmental foundations of urbanization vary from country to country, and the socio-economic conditions are different. So, the urbanization differences among countries are obvious. The levels of comprehensive urbanization, demographic urbanization, economic urbanization, and social urbanization in Kazakhstan were much higher than those in Kyrgyzstan and Tajikistan in recent years. The level of spatial urbanization in Uzbekistan was significantly higher than that in the other Central Asian countries. The understanding of urbanization in Central Asia needs to be treated differently in terms of national characteristics.

(2) Internal and external factors work together in the urbanization process of Central Asian countries, and external forces are particularly important for development of urbanization. Although the three internal forces of government power, urban pull and rural thrust have a significant impact on the urbanization level of Central Asian countries, the external force of external transportation is the most significant factor affecting urbanization. The regression coefficient of RCL was the highest among all indicators, reaching 0.5665. Moreover, the three external forces of foreign capital (coefficient of AFC = 0.0806), trade (coefficient of TMT = 0.0937) and logistics (coefficient of RFV = 0.0887) all have a positive impact on urbanization, which demonstrates the impact of export forces on the urbanization of Central Asian countries. These countries need to establish good and all-round external contacts to achieve healthy development of urbanization. Nowadays, the Silk Road Economic Belt advocates joint construction and sharing. Therefore, the development of multi-faceted international cooperation with China will bring good opportunities for the development of urbanization in Central Asia.

(3) The urbanization process in Central Asia has a clear relationship with the national scale and system. This study has found that although the population and economic scale of Central Asian countries are relatively small, in comparison, Uzbekistan with a large-scale population, and Kazakhstan with a large economy have been relatively strong in resisting external interference after independence, and their levels of urbanization have developed faster since 2000. Kyrgyzstan and Tajikistan, which have small populations, economies and territories, have low anti-interference abilities in urbanization and comprehensive urbanization, and their various aspects of development after independence have been slow. In addition, although the five countries have adopted capitalism and market economic systems after

independence, the political traditions of the former Soviet Union are difficult to change rapidly. In the research period, the influence of market power on the urbanization of Central Asian countries has not been significant.

Although this study has conducted a comprehensive comparative analysis of the urbanization of the five Central Asian countries, and has analyzed the dynamic factors of urbanization from the new perspective of internal–external forces, there are still problems to be further studied. On the one hand, it is necessary to continuously collect and accumulate the basic data of Central Asian countries, and improve the current quantitative analysis problems caused by incomplete and inconsistent data. On the other hand, it is necessary to continue research on the dynamic mechanism of urbanization in Central Asian countries and establish links among various dynamic factors, and focus on the mechanism of external forces acting on the urbanization of Central Asian countries to better serve the construction and development of the Silk Road Economic Belt.

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