Research Article

Supporting Paths for the Development of New Urbanization in Shaanxi Province Based on Fast Fourier Transform

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Since the advent of modern society, urbanization has developed significantly all over the world, especially in developing countries with large scale and good economy. However, urbanization research is often not well executed due to problems such as unpredictable and difficult to capture due to the huge amount of data. In order to be able to adapt measures to local conditions and provide classified guidance when implementing the urbanization strategy, this study takes China’s Shaanxi Province as an example to deeply explore the new problems and countermeasures faced by urbanization in the context of entering an urban society. It adopts the method of fast Fourier transform and analyzes the urbanization of Shaanxi Province. It also conducts experimental research on the industrial factors that promote its urbanization, and the results show that when the proportion of nonagricultural industry added value increases by 1 percentage point, the urbanization level of Shaanxi will increase by about 0.24 percentage points. When other factors remain unchanged, when the per capita income gap between urban and rural residents increases by 100 yuan, the urbanization level of Shaanxi will increase by 0.152 percentage points. Therefore, in order to promote the development of new urbanization in Shaanxi, Shaanxi should focus on the development of nonagricultural industries, especially the tertiary industry.

1. Introduction

Urbanization is the result and embodiment of regional economic and social development, and it is also an important part of the optimization of economic and social structure. At present, China has made a lot of achievements in the research on urbanization-related issues. However, the research on the development of urbanization in the context of urban society is in its infancy. It is accompanied by sustained and rapid economic growth and changes in industrial structure. China has a vast territory and obvious regional differences. The urbanization stages of various provinces and regions, the basic conditions, and the influencing factors of urbanization are diverse; especially after China’s reform and opening up, the level of China’s urbanization has increased rapidly. Shaanxi Province is located in the northwest inland of China, and its urbanization is affected by the foundation of urban development, relatively convenient transportation conditions, and traditional industries. The influencing factors of its urbanization are in various forms and have characteristics different from those of the eastern provinces.

The overall situation and regional characteristics of the economic development level are the basic conditions for the urbanization of Shaanxi Province. After years of development, the urban development of Shaanxi Province has formed a good foundation. The development of urbanization in Shaanxi Province has obvious characteristics in stages. Since the reform and opening up, the urbanization process of Shaanxi Province has maintained a relatively fast speed, and the urbanization level has been significantly improved. On the whole, the urbanization level of Shaanxi Province in the past 30 years shows the overall characteristics of the continuous and steady progress of the urbanization process.
in Shaanxi. However, the level of urbanization in each period has been lower than the national average. Compared with the change trajectory of the national urbanization level, the urbanization process of Shaanxi Province has obvious stage characteristics. The innovation of this study is to use a novel method, fast Fourier transform, to study the new urbanization in Shaanxi. In the process of its research, a large amount of urbanization data in Shaanxi in the past years was used and analyzed in a convenient way to provide support for the future urbanization path.

2. Related Work

Since entering the modern society, many scholars at home and abroad have carried out research on urbanization. Aghasalim learned about promoting urbanization. He proposed a differentiated approach to sustainable habitat planning. Freeman proposed that urbanization leads to significant land use changes and infrastructure development but does not damage the natural environment. His research results provided fresh ideas for the research on the development of residential and industrial areas. However, his research does not point out the general idea of future urbanization planning, which is not conducive to further study. Freeman proposed that urbanization leads to significant land use changes and infrastructure development but does not damage the natural environment [2]. His research results provided a reference method for the environmental protection of urbanization, but it focuses too much on environmental protection and ignores economic development. Liang used the panel data cointegration test method to explore the causal relationship between China’s urbanization and economic development [3]. His research can help scholars provide materials for urbanization research in Chinese provinces, but the content related to the economic level is too complicated, which is not conducive to the conclusion and promotion. Guo analyzed the relationship between urbanization and service industry in Shaanxi Province. He achieved the coordinated development of the two fields and put forward corresponding policy recommendations [4]. But his research’s recommendations for the development of urbanization are too simplistic. Most of them only involve the development of the service industry and cannot comprehensively study the urbanization of Shaanxi. Wang conducted research on the possible urbanization of Shaanxi Province as a tourist city. He proposed that the level of tourism urbanization in Shaanxi Province can maintain a leading level in the next ten years [5]. His study also has the characteristics of too one-sided research.

Lucas and Rogers proposed the mean value of the Fourier transform of the fractal measurement and improved the upper and lower bounds of the decay rate. For the Schrödinger formula and the wave formula, he derived maximum estimates for fractal measurements [6]. His method greatly improves the accuracy of the calculation, but the speed of the calculation still needs to be improved. Satpathi et al. presented a quantitative study of high-frequency components using short-time Fourier transform [7]. His research angle is relatively new, but the calculation process is too complicated to be used as a long-term tool. Moya-Cessa et al. derived the discrete fractional Fourier transform from the discrete Fourier transform [8]. His method is very efficient and concise, but the experimental arguments are too small and less convincing. Based on the fractional Fourier transform, Li proposed a quantitative statistics and detection method for mapping information to desired targets in computer systems [9]. The validity of his research can be demonstrated by applying it to different synthetic scenarios. However, most of his research is of principle content, and it lacks a certain degree of practicality when it is specifically used in the research of social science content such as urbanization.

3. New Urbanization Research Method Based on Fast Fourier Transform

This section mainly introduces the principle and process of new urbanization and also introduces the use of fast Fourier transform algorithm to discuss and identify the current characteristics and impacts of urbanization in Shaanxi Province. The functional positioning of each block in Shaanxi Province is clear, and the division of functions is clear. The northern area of the provincial capital city takes the economic and technological development zones as the main carrier. It mainly undertakes modern industrial production functions such as advanced equipment manufacturing and is a characteristic label of Shaanxi’s industrial development. The southern new technology industry development zone has a solid foundation for the development of emerging industries, high-tech industries, information industries, and creative industries, which reflects the scientific and technological talents, innovation advantages, and modern urban style [10]. These are all good factors contributing to the new urbanization of Shaanxi. Before drawing conclusions, it is necessary to conduct methodological research on the new urbanization path.

3.1. The Structure and Principle of New Urbanization. Urbanization is the process of population concentration in cities and towns for their own development and promotion of urban development. The transition from a rural society to an urban society means new urbanization, agricultural modernization, industrialization, and informatization. The continuous advancement of “four modernizations” reflects the accelerated pace of social progress, economic development, and modernization. Urbanization means that the proportion of the urban population in an urban society exceeds 50%, and the population gathers in high density in cities and towns; an urban spatial pattern with the characteristics of efficient land use, balanced allocation of urban resources, and fairness and justice in social space, urban residents have a high degree of citizenization, and urban lifestyles are popularized; distinctive regional characteristics of the city; harmonious coexistence of urban and rural areas [11]. It realizes the transformation from “population urbanization” to “human urbanization” under the transition from structuralism to humanism. The specific structure of new urbanization is shown in Figure 1.
As can be seen from Figure 1, to change the quality of urbanization development and transformation, an advanced urban society is essential. The urbanization development of regional growth poles should focus on improving the urban development environment, guiding population and industrial agglomeration, enhancing the driving force of radiation, and gradually transforming into a primary urban society [12]. The urbanization development focuses on the implementation of a stronghold space development strategy. On the premise of ecological protection, the agglomeration and radiation effects of central cities should be enhanced, and the urbanization process should be accelerated. Figure 2 shows the path of high-quality development of new urbanization.

According to Figure 2, urban spatial development strategies should promote “smart growth.” First of all, in response to the phenomenon of excessive urbanization of land, combined with ecological protection, the surrounding agricultural land should be actively protected in the transition area, and the disorderly expansion in construction land should be restrained. Instead of blindly pursuing the infinite expansion of urban space, we should vigorously develop the underground space in combination with rail transit and actively expand the urban three-dimensional space. Especially in the high-density development areas such as the central business district of the city, the height of the building should be increased and the floor area ratio of the building should be increased. It is essential to change the spatial expansion direction of the city from the “bread pie”-style plane expansion to the upward and downward depth expansion [13]. At the same time, low-density and low-volume ratio projects such as villas should be strictly approved for the construction of facilities under the support of the concept of intensive land use, so as to provide residents with good living security and job opportunities. The spatial distribution shows that the density of public housing can basically correspond to the population size. The living space advocates the mode of mixed living between the rich and the poor to ensure the healthy development of the living space [14]. The values and behaviors of an urban society should focus on quality, low carbon, green, and rest. Second, it is necessary to innovate travel modes, set up urban slow-moving systems, build multi-scale urban green belts, and create small-scale community green spaces closely related to residents’ lives. It extends from the greening on the ground plane to the three-dimensional greening on the roof and wall. Finally, it is necessary to develop public leisure space that meets different income classes, provide more leisure resources for foreigners as much as possible, and improve the quality of their living environment. Figure 3 shows how new urbanization develops in harmony with modern industries.

As is shown in Figure 3, adjusting the urban industrial structure, vigorously developing nonagricultural industries, and creating more employment opportunities can increase the economic income of urban residents and stimulate the improvement of their demand levels [15]. Specifically, similar experiences need to be drawn. It is relatively arranged in a balanced manner in urban areas or other areas with convenient commuting and complete facilities, or it is planned to be interspersed with commercial buildings. In the future, the construction of affordable housing in Shaanxi can be based on the spatial distribution characteristics of urban low-income people, make full use of existing service facilities, and build a complete set of comprehensive commercial, social services, entertainment, and leisure facilities. These measures can vigorously promote the development of the tertiary industry, attract foreign people, and accelerate the development of urbanization [16].

3.2. Fast Fourier Transform (FFT) Algorithm. The discrete Fourier transform (DFT) is an important tool in the fields of science and statistics. Given a queue \( x(n) \) of length \( N \), its DFT is also a queue \( X(k) \) of length \( N \):

\[
X(k) = \sum_{n=0}^{N-1} x(n)W_N^n, \quad k = 0, 1, \ldots, N - 1.
\]

In different research fields, the Fourier transform has many different description forms. FFT expresses a function satisfying certain conditions as a linear combination of integral or sine functions [17]. Although Fourier analysis was originally used in the field of mathematics as an analytical tool for thermal desorption processes, its method of thinking has the characteristic reductionism typical of
classical physics. From this point of view, FFT is a special form of integral.

The fast Fourier transform (FFT) algorithm published in the 1960s greatly reduced the complexity of the computationally difficult task of Fourier transform. It has created a new milestone [18]. Its basic idea is to use periodicity and symmetry to decompose the DFT of a long sequence into a DFT of smaller points, thus greatly reducing the workload.

After understanding these basics, the next step is to use the Dagum Gini coefficient and its decomposition by subgroups. It measures the relative regional differences in the development level of new-type urbanization between provinces in Shaanxi and then decomposes them. In the experimental part, it reveals the composition and source of the relative differences in the development degree of new urbanization between provinces:

\[ G = \sum_{j=1}^{k} \frac{|y_{ji} - y_{hr}|}{2c^2} \]  

According to the Gini coefficient decomposition strategy, it decomposes the Gini coefficient into three parts:
intra-regional difference contribution $G_w$, inter-regional difference contribution $G_{ik}$, and hypervariable density contribution $G_t$:  

$$G_w = \frac{1}{2Y} \sum_{i=1}^{c_i} |y_{ji} - y_{jr}|,$$  

(3)  

$$G_{ik} = \sum_{j=1}^{k} G_{jj} P_{ij},$$  

(4)  

$$G_t = \sum_{j=1}^{c_i} |\nabla$$.  

(5)  

Formulas (3) and (4) represent the intra-regional Gini coefficient and intra-regional difference contribution rate, respectively. Formula (5) represents the hypervariable density contribution rate. The Gini coefficient describes the size and source of the relative differences in the development level of new-type urbanization between provinces. It also includes the relative impact of the development level of new-type urbanization between regions and provinces.

Next, the linear weighted sum method is used to construct a model of urbanization quality under the new urbanization, namely,  

$$F_i = \sum_{i=1}^{5} X_{ij} I_j (i = 1, 2, . . . . . . , 5; j = 1, 2, 3, . . . . . , 43).$$  

(6)  

According to the principle of principal component analysis of the urban-rural integration evaluation method, it assumes that $X = (X_1, . . . . . . , X_p)$ is a P-dimensional random vector, and there is a second-order matrix, denoted as $\mu = \epsilon(x)$. It considers a linear change under constraints as follows:  

$$Y_p = I^T p = 1pX1 + . . . . . + X_{pp}X_p.$$  

(7)  

This gives  

$$\text{van}(Y_i) = I_j \sum I_j.$$  

(8)  

It classifies closely related or similar samples into one class, starts from the new class, and analyzes and studies the common characteristics of the samples in the new class. It performs cluster analysis on the filtered principal components [19]. After normalizing the original data, it gets n samples: each sample in $X_1, . . . . . . , X_n$ has m sample indicators: $y_1, . . . . . . , y_m$. $x_{ij}$ represents the jth eigenvalue of the sample:  

$$R = (X_{11} \cdots X_{1m}),$$  

$$X_{ij} = \frac{x_{ij} - X_j}{\sqrt{\text{van}(x_j)}}.$$  

(9)  

Among them, $i$ represents any one of the 11 cities and $j$ represents any one of the 15 indicators selected in the evaluation system. After normalizing the original data, if it has negative numbers and values with decimal points, then they need to be further linearly transformed and converted to positive numbers. The process is as follows:  

$$y_{ij} = a_n + \frac{x_{ij}}{\sqrt{j-1}},$$  

(10)  

$$x_{ij} = 10 \cdot x_{ij} + 50, i = (1, 2, \ldots , n); j = (1, 2, \ldots , p).$$  

The next step is to use the kernel density for estimation. The kernel density estimation essentially reflects the regional absolute differences in the development degree of new urbanization across provinces. The evolution diagram of the dynamic distribution of kernel density is shown in Figure 4. The calculation method is shown in the following formulas:  

$$f(x) = \frac{1}{Nh} \sum_{i=1}^{N} K \left( \frac{X_i - X}{h} \right).$$  

(11)  

$$K(x) = \frac{1}{(2\sqrt{2\pi})} \exp \left( -\frac{x^2}{2} \right).$$  

(12)  

It can construct an interprovincial new-type urbanization development level state transition probability through the Markov chain. If the interprovincial new urbanization development level is divided into D types, the internal dynamic evolution characteristics of the interprovincial new urbanization development level can be judged:  

$$U = (u_{ij}) D * D, (U_{ij} \geq 0, i, j \in D).$$  

(13)  

4. Experimental Results and Analysis

This section will study the development of new urbanization in Shaanxi, including analyzing the existing data, exploring the factors hindering the development of urbanization in Shaanxi, and identifying the biggest factors supporting the development of urbanization in Shaanxi. On the whole, the level of urbanization in Shaanxi Province is uneven. The urbanization level in most areas is relatively low, which results in the urbanization level of the entire Shaanxi Province being lower than that of the whole country. The data analysis used in this section comes from the statistical yearbook of Shaanxi and prefecture-level cities and urban construction statistics [20].

4.1. New Urbanization Problems in Shaanxi Province. The phenomenon of semiurbanization is remarkable. For Shaanxi, a pioneering area in the west is about to enter an urban society, and the rapid growth of its urban population is accompanied by a special phenomenon of population semiurbanization. The so-called semiurbanization refers to the fact that migrants such as farmers enter the city to work, but they cannot truly integrate into the urbanized life. They do not have social security, housing, stable living security, etc., which contradicts the connotation of the new urbanization society. The level of periurbanization can be reflected by the difference between the urbanization rate calculated by the urban population and the urbanization rate calculated by
the nonagricultural population. Figure 5 shows the comparison of urbanization rate and the difference in semi-urbanization level in Shaanxi Province calculated by the urban population and nonagricultural population.

As can be seen from Figure 5, as a typical representative of the western region, the periurbanization problem in Shaanxi is quite obvious. Since 2010, the urbanization rate calculated by the urban population in Shaanxi Province has been higher than the urbanization rate calculated by the nonagricultural population. The difference between the two has remained above 10% for many years, of which it reached the largest value in 2018 at 14.09% (Figure 5(a)). That is to say, according to the total population in 2018, there are more than 5 million semiurbanized people who are separated all the year round. From the perspective of the province, except for Baoji, Weinan, Shangluo, and Yangling demonstration areas, other cities have different degrees of semi-urbanization. Among them, Xi’an is the most prominent, with the semiurbanization level reaching 23.04% in 2020, followed by Yulin City, which is 16.29% (Figure 5(b)). In terms of the spatial distribution of periurbanization, the phenomenon of periurbanization in northern Shaanxi is more obvious, all above 12%. The phenomenon of semi-urbanization in southern Shaanxi is mainly concentrated in Ankang and Hanzhong.

The external manifestation of the periurbanization problem is the nonequal sharing of facilities by the foreign population and the unfair participation in the urban security system. The unsound system is the root cause of the phenomenon of periurbanization. The requirements for the indemnificatory housing in Shaanxi Province for migrants are that they should meet the relevant requirements in terms of household registration, labor relations, and various social insurances. In terms of education for children of migrants, although relevant policies have been issued to ensure that children of migrants who have moved with them enjoy the same compulsory education as urban residents, in the actual implementation, there have been many obstacles such as “enrollment quota is full” and “providing identity, temporary residence, tax payment certificate.” In terms of medical care and endowment insurance, new citizens also have problems such as the inability of medical insurance to effectively connect with the location of their household registration, and the lack of implementation of endowment insurance. Since they cannot enjoy equal treatment with citizens, this part of the population travels between towns and villages in the way of migratory birds during busy and slack farming periods, that is, “amphibious population.” They live in cities all the year round, but they cannot enjoy equal treatment in cities, and they occupy rural land resources at the same time. This is neither conducive to the harmonious development of cities nor the intensive integration of rural construction land. It can be seen that the fundamental way to solve the problem of semiurbanization lies in institutional reform.

**Lack of Rationality in the Spatial Layout.** Currently, the spatial layout is uneven and the urban system needs to be improved. First, the spatial pattern of cities and towns in Shaanxi Province varies greatly. The structure and spatial development of different towns are unreasonable, and the phenomenon of spatial polarization is obvious, as shown in Figure 6.

As shown in Figure 6, in the past 10 years, Shaanxi’s urbanization development space has become increasingly different. In addition, the phenomenon of urbanization regress has occurred in some areas, and the population flow is too concentrated, which has become unfavorable for economic and industrial development. Although there are a large number of small cities (towns) in Shaanxi, they lack the necessary industrial support as a whole and lack the ability to gather. Second, the spatial scale of the urban system is unreasonable, and the phenomenon of lack of hierarchy is more serious. Only 32 of the 83 counties in the middle level of the urban hierarchy have a population of more than 100,000. It can be seen that it is very essential to speed up the growth of small towns to relieve the population of large and medium cities.

Second, the urbanization of land in Shaanxi is faster than the population rate. Extensive utilization of urban land will cause more prominent contradictions between man and land. The phenomenon of “urbanization” of land such as the blind expansion of urban land and the disorderly expansion of built-up areas is not uncommon in Shaanxi. Figure 7 shows the growth of built-up area and urban rate in Shaanxi’s prefecture-level cities since 2020.
As is shown in Figure 7, since 2020, the average annual growth rate of urbanization rate in Shaanxi Province is 3.54%, and the growth rate of built-up areas (municipal districts) is even more significant. Tongchuan, Baoji, Xianyang, Xi’an, Yulin, and Yan’an’s built-up area (municipal area) growth rates have exceeded the urbanization rate growth rate. Among them, the growth rate of the built-up area (municipal districts) of Xi’an, Tongchuan, Baoji, and Xianyang has reached more than twice the growth rate of the urbanization rate. In the long run, such development will intensify contradictions.

Plus, the gap between urban and rural people in Shaanxi Province has not accelerated the development of urbanization. The urban and rural social living spaces are clearly differentiated. The market economy has given birth to the changes in the urban social structure and produced different groups that pursue the goal of multiple interests. It is manifested that homogeneous groups live in a specific urban area, heterogeneous groups are separated from each other, and the phenomenon of social living space differentiation gradually appears. Table 1 lists the difference between urban and rural residents in Shaanxi Province.
It can be seen from Table 1 that the gap is particularly evident in their residence. The effect and quality of residence can reflect the social living standard and economic development levels of a region. Affordable housing is an important part of urban resources. It not only provides material living places for urban low-income groups and new citizens, but more importantly, provides them with convenient living conditions under the premise of reducing living costs, so that they can obtain more resources and opportunities. This meets the needs of residents of specific classes for living space, so as to achieve the purpose of reducing social risks and alleviating social contradictions. At present, most of the affordable housing in Shaanxi is located in remote locations or areas with imperfect facilities.

Taking Xi’an as an example, most of the affordable housing is located in the location. The urban-rural junctions are with poor conditions, inconvenient transportation, imperfect facilities and low land prices, and even the outer suburbs. This not only increases the living cost of low-income groups but also gradually breaks the traditional living pattern based on the workplace. It has increasingly formed a differentiated form of urban living space based on income, occupation, and other characteristics. In addition, most affordable housing surrounds the main urban area or surrounding suburban counties and is spatially isolated from commercial housing. This can easily lead to social differentiation between the low-income class and the middle- and high-income class residents, both in terms of distance and social psychology, and it is easy to form a “shadow zone” surrounding the main urban area. It has become a crime-prone area and a gray area of urban management, and there are huge social hidden dangers.

From the perspective of the transformation of employment types, urban society puts forward higher requirements for the city’s employment capacity. Not only the scale of the industry should be large, but also the types of industries should be rich and reasonable. Among them, the service industry, as the largest carrier to absorb employment, should show a relatively high development stage, and the traditional service industry and the emerging service industry should develop side by side, which means the secondary industry dominated by industry and construction is still the main engine of Shaanxi’s economic growth. The proportion of employees in the industry shows an overall upward trend, which also shows from the other side that those engaged in the tertiary industry are mainly laborers who do not have higher specialized skills. Although the nonagricultural transformation of employment type has been realized, the transformation efficiency is low.

From the perspective of individual lifestyles of residents, whether it is the on-site urbanization of the villagers whose land is expropriated or the off-site urbanization of the rural population who migrated to the city, the transition from a
rural-style lifestyle to an urban-style lifestyle has not been completely realized in terms of lifestyle. Taking Xi’an as an example, the development and construction of the new urban area have requisitioned a large amount of land from farmers in the suburbs, and the farmers are “caught up” to live in buildings. They were changed from “agricultural household registration” to “urban household registration”, but their location, neighborhood, culture, and other environments have not undergone essential changes, and they still maintain the original way of life. Although in the city, it is difficult to accept and unwilling to integrate into the surrounding urban environment and culture. Faced with huge urban-rural cultural differences and temporal and spatial isolation, the migrants who moved into cities from different places choose to gather with their fellow villagers and then return to the initial small-scale rural network environment.

4.2. Empirical Analysis of Factors Influencing the Development of Urbanization in Shaanxi. This section will conduct experiments to study the best factors that can promote the new-type urbanization in Shaanxi. The analysis of the influencing factors of variables can generally use the method of econometrics to establish a model, and the most used method is the multiple regression method. This study adopts the single indicator method, namely, the population proportion method, to quantitatively examine the relationship between each influencing factor of urbanization and the level of urbanization and then select the measurement model of urbanization:

\[ Y = a_0 + a_1X_1 + a_2X_2 + \ldots + a_nX_n. \]  

The advantage of this functional form is that it can express the relationship between the explanatory variable and the target variable simply and intuitively, and this functional form is easy to operate and requires little computation [21].

It uses the urbanization rate influencing factors given in this study for data processing. This study quantitatively analyzes the relationship between Shaanxi’s urbanization rate and various influencing factors. This study uses SPSS to conduct a Pearson’s correlation analysis on each factor and the urbanization rate, and the analysis results are listed in Table 2.

According to the characteristics of urbanization in Shaanxi, the model is set as follows:

\[ Y = C + a_1X_1 + a_2X_2 + a_3X + a_4X_4. \]  

Regression analysis was performed by Eviews 6.0 software, and the calculation results are listed in Table 3.

From Table 3, we can obtain the multiple regression model 1 of the influencing factors of Shaanxi’s urbanization level:

\[ Y = -0.0175 + 0.346X_2 + 1.36 \times 10^{-2}X_4. \]  

\[ R^2 = 0.9844, \quad \text{correlation coefficient} \]  

From Table 3, we can obtain the multiple regression model 1 of the influencing factors of Shaanxi’s urbanization level:

\[ Y = -0.0668 + 9.98 \times 10^{-5}X_2. \]  

The results that \( R^2 = 0.985 \) means the coefficient of determination is high, and the F test value is 393.34. This shows that the overall regression results are significant, but except for \( X_2 \), the other constants and the coefficients of each variable are not significant. In addition, it can be seen from the table that the correlation coefficients between the respective variables are relatively high, indicating that the independent variables in model 1 have multicollinearity. Next, it uses the stepwise regression method to correct the first model, and after the correction, the second model is obtained:

\[ Y = -0.0175 + 0.346X_2 + 1.36 \times 10^{-2}X_4. \]  

\[ R^2 = F + DW[R \times 0.983]. \]  

It plots a scatterplot and residuals plot of residuals versus the dependent variable Y (Figure 8). The distribution of the absolute value of the residual is relatively random, and the residual has no obvious regularity, so it can be determined that there is no heteroscedasticity. The coefficient of determination of the regression equation is high, and the regression coefficients are all significant. It looks up the DW statistics table to know \( d_{\text{L}} \) = 1.24 and \( d_{\text{U}} \) = 1.54. In model 0 ≤ DW ≤ \( d_{\text{L}} \), it is obvious that the residual terms in the model have positive autocorrelation, which can be seen from the residual plot.

It can also be seen from Figure 8 that there will be certain statistical errors in the autocorrelation results, and remedial measures should be taken. The variation of residuals has a systematic pattern, which is continuous positive and continuous negative, indicating that the residuals have autocorrelation, and the conclusions of t statistic and F statistic in the model are not credible. It uses the Cochrane–Orcutt iterative method to analyze the residual sequence, and the result output is listed in Table 4.

As listed in Table 4, the DW value is 1.9119 at this time, which falls into the nonautocorrelation region under the 5% confidence level. Autocorrelation is eliminated from the model, and the parameter estimates of the equations are statistically reliable. From this, the influencing factors of Shaanxi’s urbanization are finally obtained. From the regression model revised in this study, we can see that non-agricultural industries, especially the tertiary industry, have a driving role in promoting and improving the level of urbanization. The development of nonagricultural industries is the main growth factor of farmers’ income in Shaanxi, and it is also an important force to change the difference between Shaanxi’s urbanization and developed areas. The development of nonagricultural industries is an inevitable requirement for expanding the county economy. The tertiary industry is the latecomer force to promote the urbanization process. Figure 9 shows the relationship and future trend of nonagricultural industries and urbanization levels in Shaanxi Province after calculation.

According to Figure 9, the analysis and calculation results show that when the adjusted R2 of the revised regression model is 0.9844, the correlation coefficient between the urbanization level of Shaanxi and the proportion of nonagricultural industry output value is 0.955. When other factors remain unchanged, nonagricultural industries increase by 1 percentage point, the urbanization level of Shaanxi will increase by about 0.24 percentage points. When
other factors remain unchanged, the urbanization level of Shaanxi will increase by 0.152 percentage points. Due to the difference in geographical location and resource endowment and the limitation of variable selection, Shaanxi Province should promote industrialization and accelerate the development of the tertiary industry. In order to narrow the per capita income gap between urban and rural residents in Shaanxi, it is necessary to further improve the relevant taxation system in Shaanxi and eliminate the barriers of the household registration system. It is necessary to strengthen the punishment of corruption and create a standardized and orderly competitive environment. It can also promote urbanization by increasing investment in industry and services.

Table 2: Correlation coefficient table of urbanization variables.

| Variable                          | Coefficient | Std. error | t statistic | Prob.  |
|-----------------------------------|-------------|------------|-------------|--------|
| Urbanization rate (%)             | 0.939       | 0.057820   | -1.156158   | 0.260  |
| GDP per capita                    | 1           |            |             |        |
| Proportion of nonagricultural output value (%) | 0.955 | 0.821 | 1 |             |
| Fixed asset investment per capita | 0.870 | 0.983 | 0.717 | 1 |             |
| The income gap between urban and rural residents | 0.973 | 0.988 | 0.890 | 0.946 | 1 |

Table 3: Regression analysis results of influencing factors of the urbanization rate in Shaanxi.

| Variable             | Coefficient | Std. error | t statistic | Prob.  |
|----------------------|-------------|------------|-------------|--------|
| C                    | -0.066849   | 0.057820   | -1.156158   | 0.260  |
| X_1                  | 9.98E-06    | 8.47E-06   | 1.178833    | 0.251  |
| X_2                  | 0.416938    | 0.083402   | 4.999125    | 0.001  |
| X_3                  | -4.11E-06   | 6.49E-06   | -0.633456   | 0.533  |
| X_4                  | -1.02E-06   | 9.61E-06   | -0.105783   | 0.916  |

Figure 8: Scatter plot of residuals and dependent variable Y.

Table 4: Calculation result table of Cochrane-Orcutt iteration method.

| Variable | Coefficient | Std. error | t statistic | Prob.  |
|----------|-------------|------------|-------------|--------|
| C        | 0.039877    | 0.017990   | 2.216647    | 0.0368 |
| X_4      | 1.52E-05    | 1.02E-06   | 14.98478    | 0.000  |
| X_5      | 0.238E-05   | 0.040069   | 5.952421    | 0.000  |
5. Conclusions

This study discusses and analyzes the trend of new urbanization in Shaanxi Province through the fast Fourier algorithm and concludes that the development of nonagricultural industries is of great help to promote the development of new urbanization in Shaanxi. The author states the concept of new urbanization from different perspectives, points out that the core of new urbanization lies in humanity, and applies it to the future development of Shaanxi province. On top of that, the author analyzed the factors that hinder the development of new urbanization in Shaanxi before giving the conclusion. In general, Shaanxi Province should increase investment in the tertiary industry, as the tertiary industry focuses on serving people and hence brings a new population and vitality to the city. In the long run, the boom of tertiary industry can bring Shaanxi province to a higher level of new urbanization. Due to the limited length of the article, it cannot cover all aspects. At the same time, there are not many examples used in the study, which is also the limitation of this study. In the future, the author looks forward to conducting more in-depth research with more real data, so as to explore more factors that promote urbanization.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Figure 9: The relationship and trend of changes in nonagricultural industries and urbanization levels in Shaanxi. (a) Relationship. (b) Tendency.
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