Regional Economic Growth and Technological Innovation in the Belt and Road Based on Big Data Analysis - An Example from Shaanxi Province

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Abstract: In recent years, the global economy has been weak, and scientific and technological innovation (SATI) has become a new driving force for economic development (ED), while the construction of SATI requires a large amount of capital investment as a guarantee. As the core of modern economy, economic growth (EG) can rely on its own advantages to gather social idle funds to invest in ED, so it has a very good role in supporting and promoting the promotion of SATI. This paper takes Shaanxi Province as the main research object, and based on big data analysis (BDA), studies and analyzes the EG and technological innovation (TI) of the belt and road (BAR) region of Shaanxi Province. This paper plans to select the spatial econometric model of computer technology to estimate the financial support for SATI in the five northwestern provinces. By drawing on the good experience of EG and TI at home and abroad, and combining with the specific empirical and theoretical analysis results of the five northwest provinces, this paper analyzes the EG and TI of Shaanxi Province; The results show that Shaanxi Province needs to continue to strengthen the support of EG for SATI; We should also strengthen regional cooperation to form a good spatial spillover effect of EG and SATI; More importantly, we should seize the opportunity of the construction and development of the the BAR, give full play to regional advantages, and extensively absorb domestic and foreign EG funds to promote regional SATI.

Keywords: Big Data Analysis, Belt and Road, Regional Economic Growth, Technological Innovation

1 Introduction

As the initiator of the BAR Initiative, China has been committed to strengthening the economic and trade cooperation of countries along the route and playing an important leading role in the ED of the regions along the route. It can be said that the construction of the BAR provides opportunities for the development of the northwest region; and the development of the economy of the northwest region will also inject momentum into the construction of the BAR. Therefore, against the background that the country vigorously advocates entrepreneurship and innovation and strives to improve the capacity of SATI, it is important to study how the northwest region can take advantage of the opportunity of the BAR construction to improve the capacity of SATI and thus create momentum for ED; how to explore the potential of EG and SATI and support SATI, which is important for accelerating the ED of the northwest region, promoting the BAR construction, achieving regional EG and thus narrowing the It has important theoretical and practical significance to accelerate the ED

MSIEID 2022, December 09-11, Chongqing, People's Republic of China

DOI 10.4108/eai.9-12-2022.2327586

of the northwest region, promote the construction of the BAR, achieve regional EG and thus reduce the differences between the east and west regions of China. Based on BDA, this paper takes Shaanxi Province as the research object and conducts a research analysis on regional EG and TI in the BAR.

Since EG has a catalytic effect on the development of the real economy, SATI is an inexhaustible driving force for ED [1]. Therefore, studies on EG and SATI have been receiving attention from scholars at home and abroad. These researches mainly focus on three points: studying the horizontal capacity, efficiency, and economic effects of SATI or EG development alone; combining EG and SATI for research, analyzing the relationship between the two, the impact of EG development on SATI, and the specific effects of EG and SATI, supporting the impact situation, etc.; exploring the methods of using EG resources to promote SATI, and Put forward appropriate models, paths, countermeasure suggestions, etc. In addition, this paper intends to carry out a study on EG and SATI in Shaanxi Province, Northwest China, in the context of "One Belt and One Road" [2].

This paper analyzes the current situation of EG and SATI in Shaanxi Province of Northwest China by sorting out the theory of EG and SATI, and empirically analyzes the effect of EG and SATI and the spatial effect of Shaanxi Province by using the method of BDA on the basis of comprehensive measurement of SATI and the development level of EG and SATI in five provinces of Northwest China. The empirical results show that: there are regional differences in the construction of EG and SATI in the northwest region, and Shaanxi Province is far ahead of other provinces in both the development of SATI and the level of EG and SATI; there is a spatial effect of EG and SATI development in the northwest region, and between the absolute advantage of Shaanxi Province, a siphon effect is formed, resulting in a kind of spatial discrete state; with the passage of time, the effect of EG in Shaanxi Province on the support role of SATI has increased [3-4].

2 Analysis of EG and TI in Shaanxi Province along the BAR

2.1 EG and SATI in the BAR Region

The core area of the economic belt, with the construction of "One Belt, One Road", the strategic position of the northwest region will certainly be enhanced, the study of EG and scientific and TI in this region, can provide theoretical reference for the development of areas along the "One Belt, One Road", for the study of EG and SATI in this region can provide theoretical reference for the development of the regions along the BAR, and inject momentum into the ED of the Northwest region, thus promoting the better development of the BAR[5].

EG can provide strong support for ED in the process of development, which also applies to the development of SATI work. EG institutions support the construction of SATI by providing funds for scientific research and development, enterprise TI and other scientific and TI work, consulting services to relevant enterprises in the business of EG, and insurance for scientific and TI subjects. The most important of these supports for science, technology and innovation is the provision of financial support [6-7].

2.2 Measurement of EG and STI Development Level in Shaanxi Province, Northwest China

This paper uses BDA to measure the level of EG and SATI in Northwest China to reflect more objectively the situation of SATI and the development of EG and SATI in Northwest China.

2.2.1 Construction of the index system of EG and the level of development of SATI

The purpose of this paper for measuring the level of EG and SATI in Northwest China is to reflect more objectively and comprehensively the progress of Northwest China in promoting the construction of SATI and the use of EG resources and SATI activities, and to further illustrate the capacity and level of EG and SATI in the five Northwest provinces from an empirical perspective [8].

The construction of SATI in a region is mainly reflected in its investment in SATI activities, the output of SATI and the support of some infrastructure facilities. Thus, the examination of the level of STI in this paper focuses on these three aspects.

The first is the input of SATI, the input of SATI factors is the source and driving force of its development, mainly including the input of human resources and the input of financial resources. The article selects the number of research and development institutions and the number of employees in research and development institutions; the second is the output of SATI, including the direct output of science and technology results and the transformation of science and technology results in two aspects, respectively, the number of published science and technology papers, the number of patent applications, effective invention patents, and technology market turnover are selected to reflect, the first two represent the direct output of science and technology results, and the latter two represent the transformation and marketization of science and technology results. The third aspect is the basic support of SATI, these are the prerequisites for the development of SATI, and the article selects four indicators most related to scientific research and development to reflect them, which are the number of higher education schools, the number of public libraries, the number of Internet access and the new fixed assets of urban scientific research and technology service industry [9-10]. The details of the indicator system are shown in Table 1.

Table 1. Comprehensive evaluation index system of scientific and TI

Level I indicators	Secondary indicators
Scientific and TI investment	Number of research and development institutions
	Number of employees in research and development institutions (person)
	Full time equivalent of R&D personnel (person year)
	Internal expenditure of RAD funds (10000 yuan)
Scientific and TI output	Published scientific papers
	Number of patent applications
	Valid invention patents (piece)

	Technical market turnover (10000 yuan)
Basic support for scientific and TI	Number of colleges and universities
	Number of public libraries
	Number of Internet users (10000)
	New fixed assets of urban scientific research and technology service industry (100 million yuan)

2.2.2 Level of development of SATI in Shaanxi Province

In this paper, the weights of each indicator are determined by the entropy value method, and finally the comprehensive evaluation value of SATI and EG and SATI development level in five northwestern provinces during 2007-2016 is used to reflect the level of SATI and EG and SATI in each province during this period of time, and the specific results are shown in Figure 1.

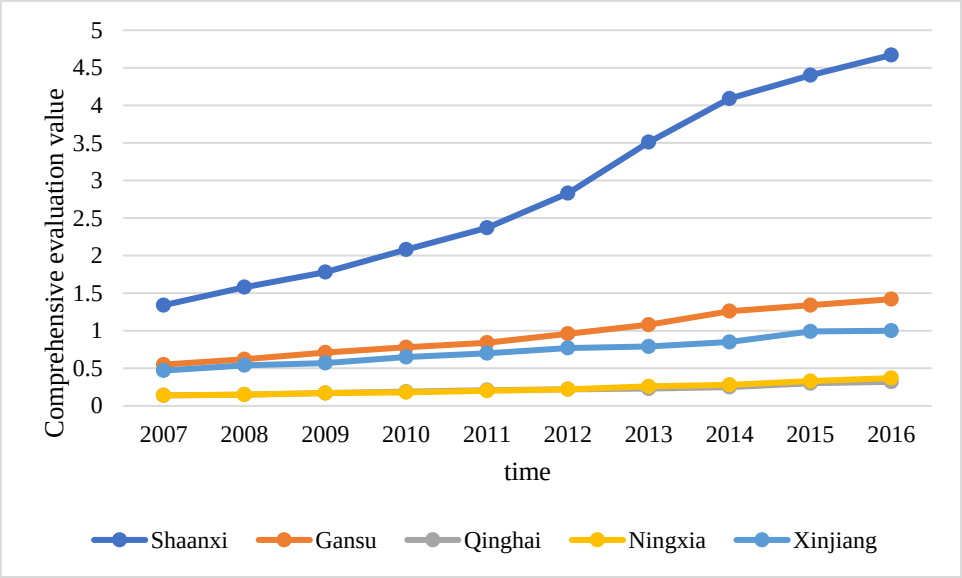

Figure 1. The line chart of the change of TI development level in the five provinces of northwest China

As can be seen from the above figure, temporally, the level of SATI development in the five northwestern provinces has shown an upward trend on the whole during 2007-2016, especially the obvious growth trend in Shaanxi; compared with Shaanxi, the level of SATI in Gansu, Xinjiang, Qinghai and Ningxia has grown more slowly. This overall rising trend of SATI level reflects to a large extent that the five northwestern provinces have been guided by national policies, the awareness of SATI has been enhanced, the construction of SATI has been increased, and the ability of SATI input and output have been improved accordingly. In addition, it can also be seen from the chart that this rising trend has become more obvious after 2011, which is related to the opportunities brought to the northwest region by the country's vigorous promotion of entrepreneurship and innovation in recent years and the "One Belt, One

Road" initiative [11].

Spatially, Shaanxi Province has always been at the top of the line graph, especially since 2011, its level of SATI has increased significantly, and is far ahead of the five provinces in Northwest China.

Shaanxi, with its long history, has always been in the forefront of ED in the five northwestern provinces, and its rich educational resources and superior geographical location compared to the other four provinces in the northwest have better conditions for the development of SATI. The reason for the low level of SATI in the five northwestern provinces is the remote geographical location and the closed transportation, which makes its ED late and backward. It will also provide a good opportunity for the development of science and technology [12].

2.3 Level of EG and SATI in Shaanxi Province

Figure 2 shows the data of the integrated evaluation value of EG y and the level of SATI in Shaanxi Province

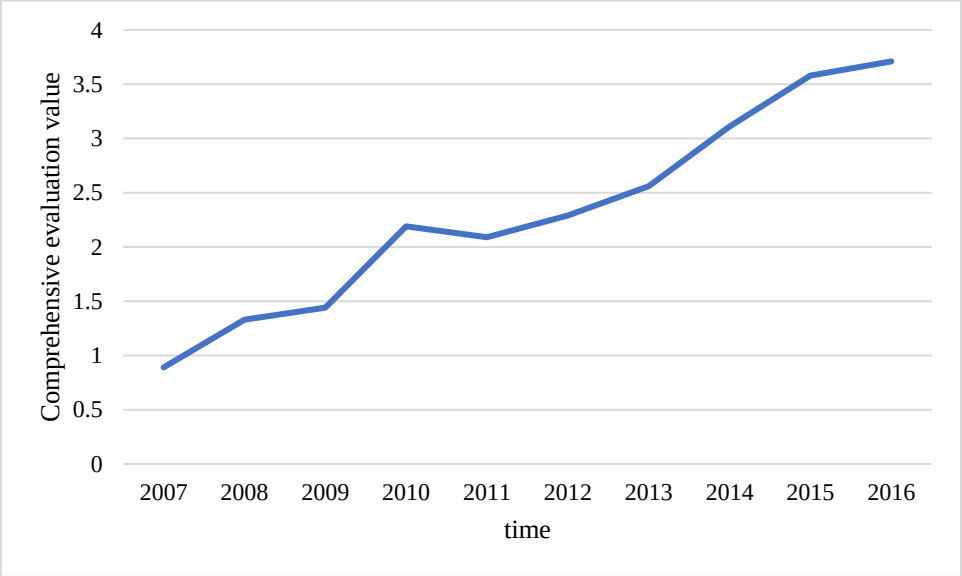

Figure 2. comprehensive evaluation value of EG and scientific and TI level in Shaanxi Province

According to Figure 2, it can be seen that like the development level of SATI, temporally, the comprehensive evaluation value of EG and SATI in the five northwestern provinces during the period of 2007-2016 is increasing, and the corresponding line graph shows an overall upward trend. Specifically observing some nodes in the line graph, Shaanxi experienced a period of rapid increase in the level of EG and SATI in 2009-2010, and the growth rate of Shaanxi region is obvious, which to a large extent can indicate that Shaanxi province can realize the important role of EG in supporting SATI work in the process of strengthening the construction of SATI, and strengthen the use of resources for EG; in turn, it may also be precisely because the EG The increase in resource investment has promoted the development of SATI work in the northwest.

Spatially, and similar to the change in the level of SATI, Shaanxi Province also has the most resources invested in EG in SATI, and is at the bottom of the line graph, which to some extent indicates that it lacks resources invested in EG in SATI, and needs to strengthen EG to hold SATI. Analyzing the reasons for this significant spatial variability in the level of EG and holding of SATI in the five northwestern provinces, more still lies in the weakness of the overall economic strength of other regions in the northwest except Shaanxi, causing them to have fewer resources for EG themselves, and the capital market and venture capital market are chaotic or even vacant, while Shaanxi, relatively speaking, has a certain strength in ED, science and education are also more developed, and the EG market can be developed earlier and can better serve the regional SATI.

2.4 Application of Big Data Technology in Agricultural Economic Growth and Technological Innovation

The main purpose of applying it to agricultural monitoring is to better realize the transformation from "looking at the sky and doing things" to "knowing the sky and doing things" according to the monitoring of changes in cultivated land, crop yields, and the probability of natural disasters. On the basis of big data and according to the analysis and processing of the data processing platform, the agricultural monitoring system will be more perfect and bring new opportunities to the agricultural monitoring work. The second is crop yield estimation and growth dynamic monitoring. The method of combining remote sensing technology and crop simulation technology is generally used for crop growth monitoring: remote sensing satellite monitoring feeds back crop growth data from a macro perspective, and crop growth model simulates the growth process through crop growth environment from a mechanism, which together can provide a systematic and comprehensive prediction of agricultural production. Macro data provided by remote sensing satellite monitoring can be comprehensively analyzed using big data processing platform to provide important information for crop yield estimation and growth dynamic monitoring.

2.4.1 Applied to agricultural product monitoring and early warning

Monitoring and early warning of agricultural products refers to the prediction of preventing agricultural products through monitoring the quality and market of agricultural products, so as to make modern agriculture develop steadily. The advent of the big data era provides massive data support for agricultural product market monitoring and early warning work, so it will promote agricultural product monitoring and early warning work to be more standardized and accurate. In terms of monitoring and early warning of agricultural product quality, big data technology provides a technical basis for the comprehensive collection of agricultural product information, enabling all-round comparison of agricultural product quality and increasing the accuracy of agricultural product quality monitoring.

2.4.2 Application to precision agriculture decision-making

Precision agriculture decision-making refers to formulating a set of feasible precision management measures based on agricultural information in all aspects. Before the emergence of big data processing and analysis technology, expert system, crop simulation model and crop production decision support system were the main production decision technologies. Big data processing and analysis technology can integrate the growth and development status of crops

themselves and the climate, soil, biological and other data in the crop growth environment, and comprehensively consider the indicators of economy, environment and sustainable development, so as to provide agricultural production decision-makers with more accurate, real-time and efficient agricultural decisions.

2.4.3 Construction of rural comprehensive information service system

The establishment of the national rural comprehensive information service system is conducive to the dissemination of agricultural information. The rural comprehensive information service refers to integrating and integrating various decentralized information resources and systems according to the idea of "moving up the platform and extending down the service", so as to realize the sharing of information resources nationwide. In the process of building the information service platform, the volume of data resources is large, the data processing process is complex, and the information service mode is diverse. It is necessary to achieve the integration of massive agricultural information data acquisition, transmission, processing, and service. Therefore, big data processing and analysis technology must be used in the research of complex and diverse user requirements, the realization of on-demand allocation of information services and the processing of large-scale resource data. The application research of agricultural big data provides necessary technical support for the construction of rural comprehensive information service system.

3 Research on EG and TI in Shaanxi Province based on BDA of the BAR

3.1 Research Methodology

How specifically the investment of resources for EG affects the development of STI and what is the effect of the role of EG and STI needs to be further explored. Based on this, this paper intends to choose a spatial econometric model to estimate and study the financial support for SATI in five northwestern provinces. And the use of the spatial econometric model is based on the assumption that it has spatial autocorrelation. Therefore, the spatial correlation of the level of STI development needs to be tested first.

Referring to the general research experience, the article uses the Moran'sI index method to test whether there is spatial correlation in the development of SATI in the five northwestern provinces, and the formula of Moran'sI index is as in equation (1).

$$I = \frac{n\sum_i\sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{(\sum_i\sum_j w_{ij})\sum_i (x_i - \bar{x})^2} \quad (1)$$

where n denotes the number of study regions, w_{ij} is the spatial weight (0-1 spatial weight is used in this paper), and x_i and x_j denote the STI levels of provinces i and j, respectively.$\bar{x}$ is the average of all the STI capabilities in the five northwestern provinces.

Currently, there are three main types of spatial panel econometric models: first, the spatial lagged model (SLM), which includes the spatial lagged term of the explanatory variable in the

model and considers its effect on the model, which is also known as the spatial autoregressive model (SAR); second, the spatial error model (SEM), which considers the effect of residuals in the model setting; and third, the spatial Durbin model (SDM), which model is a SLM model augmented by the inclusion of spatial lag variables, and can be considered as a model that encapsulates both SLM and SEM. The specific forms of the three models are as follows.

$$SLM: Y = \rho WY + X\beta + \varepsilon, \varepsilon \sim [0, \sigma^2 I] \quad (2)$$

$$SEM: Y = X\beta + \varepsilon, \varepsilon = \lambda W\varepsilon + u, u \sim [0, \sigma^2 I] \quad (3)$$

$$SDM: Y = \rho WY + X\beta + W\overline{X}\gamma + \varepsilon, \varepsilon \sim [0, \sigma^2 I] \quad (4)$$

The specific form of the model was determined by LM test, Wald test, and Hausman test.

3.2 Selection and Description of Indicators

The comprehensive evaluation value of SATI determined by the entropy method, "the level of development of SATI", is used as the dependent variable (kjcx) in this part of the model. The independent variables are bank loans for science and technology (yh), total market value of listed companies in science and technology (zq), total capital of venture capital (fx), government investment in science and technology (cz) and R&D investment in enterprises' own funds (qy), which represent the support of banks, securities, venture capital, government and enterprises for SATI, and reflect the influence of each subsystem of EG on SATI. In addition, considering that the level of ED of a region also has a relatively large impact on its regional SATI capacity, the representative indicator of regional ED level (GDP) is introduced here as a control variable.

4 Empirical results and analysis

4.1 Test for Spatial Autocorrelation of STI Development Levels

Using GeoDa software to estimate the Moran'sI index of SATI level in five northwestern provinces from 2007-2016, the specific values are shown in Table 2, all of which passed the significance test at 10% level (P0.1). During 2007-2016, the Moran'sI values of SATI in five northwestern provinces are are smaller than 0. According to the correlation theory, it can be concluded that there is a negative spatial correlation in the development of SATI in the five northwestern provinces, and the development of SATI in their regions is characterized by discrete distribution, i.e. regions with high development levels are connected to regions with low development levels and do not form a good agglomeration effect. This is basically consistent with the results of the previous analysis on the level of SATI development in the five northwestern provinces, that is, the level of SATI in Shaanxi is far in the forefront, followed by Gansu and Xinjiang, and the level of SATI in Qinghai and Ningxia is low, which, when combined with the map, is a characteristic of being in a discrete distribution of high and low values.

Table 2. Moran's I value of SATI development level in northwest five provinces from 2007 to 2016

particular year	2007	2008	2009	2010	2011
Moran's I	-0.304**	-0.301*	-0.290*	-0.292*	-0.283*
particular year	2012	2013	2014	2015	2016
Moran's I	-0.268*	-0.242**	-0.236**	-0.242**	-0.233**

In conclusion, up to now, the development of SATI in the five northwestern provinces still shows negative correlation, except for Shaanxi, which has a high level of SATI development, the rest of the provinces have a relatively low level of development, and have not yet been able to form a good clustering and spillover effect; however, there is a trend towards positive correlation and clustering in the future.

4.2 Overall Regression Results for EG and STI in the Northwest

According to the previous test on the spatial autocorrelation of STI development level, it can be found that there is spatial correlation in the construction of EG and STI in the five northwestern provinces, and it is more rigorous and accurate to estimate the data with a spatial econometric model, but in order to better compare the differences between the models that consider spatial effects and those that do not, a general panel regression of the data is conducted first, and the estimation results are shown in Figure 3.

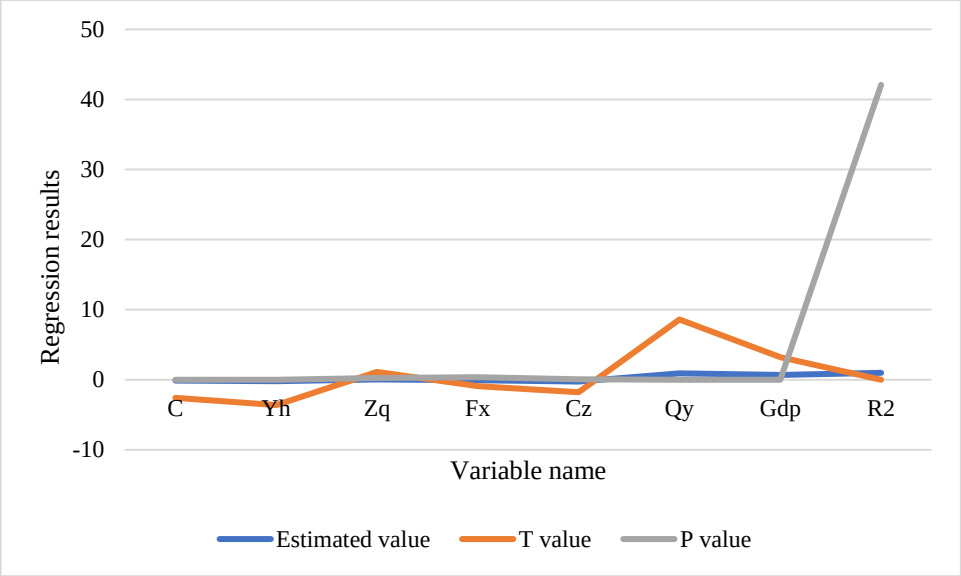

Figure 3. The common panel regression results of financial support technology innovation from 2007 to 2016

According to Figure 3, it can be seen that firstly the model has a goodness of fit of 0.99, indicating that the ordinary panel model is also appropriate for estimating EG and STI in the Northwest region. Specifically, the coefficient of the impact of bank loans on STI in the Northwest region for the period 2007-2016 is -0.2103, which passes the 1% significance level

test. It shows that bank loans did not play a good role in supporting the process of strengthening EG and SATI in the five northwestern provinces during this period, but had a negative impact on SATI.

4.3 Conclusion Analysis and Response

The spatial correlation test and the regression of the construction of the spatial econometric model on the EG and SATI in the five northwestern provinces led to the following conclusions.

The development of SATI in the five northwestern provinces has a negative spatial correlation, with the better-developed regions being connected to the less-developed ones and being scattered. This indicates that the five northwestern provinces have not formed a good clustering and spillover effect in SATI, but there may be a "siphoning" effect. For example, Shaanxi, with its leading ED strength, attracts the inflow of innovation resources from the neighboring regions, which weakens the development of SATI in the neighboring regions and causes negative externalities.

4.3.1 Seizing geographical advantages to enhance regional competitiveness in SATI

First, in terms of geographical location, the five northwestern provinces are in the far northwest of China, connected to Central Asia, and are the hub of China's inland development to Central Asia and Eastern Europe on the BAR. This special geographical location allows the five northwestern provinces to absorb good resources and ED experience from the mainland, but also to introduce good enterprises from Central Asia and Western Europe to develop together. And the promotion of the BAR construction will certainly promote the exchange and cooperation of the regions along the route, the northwest region will be able to rely on this geographical advantage to obtain funds and resources for development. Then, how to seize this geographical advantage, the most important thing that the northwest region needs to do is to enhance regional influence and improve the competitiveness of regional SATI. First of all, the five northwestern provinces should do a good job of regional ED, increase the construction of SATI, and encourage EG and scientific and TI. Secondly, the five northwestern provinces can get the recognition of the governments and enterprises along the route by doing a good job of service for the regions along the route. Finally, the five northwestern provinces should give play to regional characteristics and create regional exclusive business cards, so as to improve regional influence and thus better attract funds and develop SATI.

4.3.2 Take advantage of policies to increase support for EG in support of science, technology and innovation

Up to now, the State Administration of Taxation has issued ten measures for the development strategy of "One Belt, One Road", proposing tax concessions and tax relief for related enterprises; the State also strongly supports the construction of the Xinjiang Horgos National ED Zone, offering tax concessions and strategic support to the enterprises located there. The implementation of all these policies has positively contributed to the ED and technological progress in the northwest, providing opportunities for the five northwestern provinces to strengthen their EG and TI efforts. Therefore, the five northwestern provinces need to give full play to this policy advantage and increase the support for EG to support SATI. First, the policy should encourage EG institutions to strengthen their investment in science and innovation;

then, the relevant subsidies and preferential policies should be implemented to subsidize EG institutions that actively support regional SATI; finally, the management of policy implementation should be strengthened to ensure that each fund is put into practice.

4.3.3 Leveraging resource (financial) advantages to enrich the means of supporting EG

With the special geographical advantages since the construction of the BAR, as well as the policy bias, will bring more funds and resources to the EG and SATI work in the northwest. How to make good use of these resources to promote EG and SATI, on the one hand, the five northwestern provinces can absorb the introduction of investment funds and EG resources from countries and regions along the route to invest in the process of science and technology construction, enriching the region's EG resources and alleviating the difficulties of financing the development of science and technology-based enterprises. On the other hand, the five northwestern provinces can also learn from the excellent means and experience of EG and scientific and TI in the process of cooperation with the countries and regions along the route, apply them to the development of scientific and TI in the region, and constantly improve and perfect the shortcomings of the region in carrying out EG and scientific and TI. In conclusion, the five provinces in Northwest China must seize the opportunity of the BAR construction, strengthen the support of EG to SATI, improve the regional SATI capacity, and help economic transformation.

5 Conclusions

"The One Belt, One Road follows the approach of "moving from point to point, from line to line, promoting regional cooperation", a step-by-step approach that demonstrates our policy arrangements in different spatial dimensions and different time dimensions. The "community" theory proposed by the "BAR" strategy has innovated the theory of globalization. This paper takes Shaanxi province as the research object, based on the BDA of EG and TI in the BAR region, but there are also shortcomings in the paper: in view of the slight difficulty in obtaining micro data on EG and TI, there are certain limitations in the selection of indicators of EG and TI; the article still needs to be strengthened in the depth of the research, and the specific reasons for the different subsystems of EG in the northwest region. The article still needs to be strengthened in terms of research depth, and the specific reasons for the different situations of supporting SATI in each subsystem of EG in Northwest China need to be further explored. Along with the promotion of the BAR construction and the improvement of the strategic position of the northwest region, the research on the ED of the northwest region will definitely increase, and the research on the northwest EG supporting SATI will also be further improved to point out the direction for the ED of Shaanxi Province.

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