Research on the Evaluation of the Input and Output Efficiency of Three Industries in Qinghai Province *

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Abstract. Since the western development, the investment in science and technology in Qinghai Province, the input of scientific and technological personnel, and the expenditure on new product development of large and medium-sized enterprises have continued to increase; the amount of patent output and the turnover of technology contracts in the output of science and technology have steadily increased, and new product sales income fluctuations have risen, but there is a clear gap with Shaanxi and Gansu in the west. An analysis of the three industrial capital inputs and scientific and technological personnel inputs in Qinghai Province, and an evaluation of the efficiency of scientific and technological input and output, found that there are the following aspects of the technological input and output efficiency of various industries in Qinghai. Problems: insufficient scientific and technological input; lack of scientific and technological talents and inefficient coexistence of talent output; co-existence of growth in three industrial inputs and decline in scientific and technological output; misalignment of scientific and technological resource allocation and low level of scientific and technological management. Proposed the establishment of a stable growth mechanism for scientific and technological inputs; Strengthening the introduction of talents and improving the mechanism of selecting, educating and employing people; optimizing the combination of scientific and technological investment structure and adjusting and optimizing the industrial structure; accelerating the transformation of scientific and technological achievements to realistic productivity and other measures to promote the efficiency of scientific and technological innovation and achieve high-quality development in Qinghai Province.

1. General Situation of Science and Technology Input and Output in Qinghai Province

1.1. Status of Science and Technology Investment in Qinghai Province

1.1.1. Current status of science and technology funding. From 2003 to 2017, the internal expenditure of R&D in Qinghai Province can be divided into four stages. From 2003 to 2008, due to the poor foundation of innovation level in Qinghai, the internal expenditure of R&D expenditure in Qinghai Province was relatively low and was in a stagnant stage, changing from 106 million yuan to 72 million yuan; from 2009 to 2011, the Qinghai Provincial Government increased its investment in scientific and technological innovation, and the internal expenditure of R&D funds has increased significantly, at a rapid growth stage, from 139 million yuan to 1.258 billion yuan; 2011-2014 science and technology funding expenditure continues to rise, but the overall growth rate is relatively slow and in a slow growth stage, which increased from 1.312 billion yuan to 1.432 billion yuan. In 2015-2017, the internal expenditure of R&D funds again experienced rapid growth and was in a rapid growth stage.
Overall, from 2003 to 2017, the internal expenditure of R&D funds in Qinghai Province continued to increase, which indicates that the Qinghai provincial government has continuously increased its emphasis on science and technology, but in 2017, the internal expenditure of R&D funds in Shaanxi and Gansu was 25.73 times and 4.94 times of Qinghai Province in the same period, there is still a large gap compared with other western provinces.

1.1.2. Current status of scientific and technological personnel. From 2003 to 2017, the full-time equivalent of R&D personnel in Qinghai Province is mainly divided into four stages. From 2003 to 2008, the full-time equivalent of R&D personnel in Qinghai Province is low and in a state of slow development, increasing from 245 person-years to 413 person-years; from 2009 to 2012, the overall is in a rapid growth stage, from 511 person-years to 5181 person-years; from 2013 to 2015, there was a decline, to 4008 person-years; the full-time equivalent of R&D personnel in Qinghai Province increased again from 2015 to 2017, from 4008 person-years to 5656 person-years, which is in a period of rapid increase. From a horizontal comparison, in the northwest region, although the full-time equivalents of R&D personnel in Qinghai Province have improved significantly, they are only equivalent to 23.8% and 14.5% of Gansu Province and Shaanxi Province, respectively. Factors affect the regional innovation capacity of Qinghai Province.

1.1.3. Current Status of Expenditures for New Product Development of Large and Medium-sized Enterprises. From 2003 to 2017, Qinghai Province's large and medium-sized enterprises' new product development expenditures were divided into three stages. From 2003 to 2011, it was in a slow growth stage, from 43.7 million yuan to 347.54 million yuan; from 2011 to 2014, new product development expenditures increased at a rapid pace, in a rapid growth stage, from 34.745 million yuan to 99.76 million yuan; from 2015 to 2017, fluctuations in new product development expenditures fluctuated. It fell to 803.54 million yuan in 2017. Although the expenditure on research and development of new products in Qinghai Province continued to increase from 2003 to 2017, the Qinghai Provincial Government and large and medium-sized enterprises paid more and more attention to the research and development of new products. Compared with Shaanxi Province, the gap is large. In 2017, the R&D expenditure of new products in Gansu and Shaanxi was 3.63 and 25.42 times of that in Qinghai respectively.

1.2. Status of Science and Technology Output in Qinghai Province

1.2.1. Patent Output Status. From 2003 to 2018, the total number of patent applications granted in Qinghai Province tended to increase, and the increase was large. The number of patent grants in 2018 was 2,664, which was only 91 in 2003, a 29.27-fold increase compared to 2003. There is still a gap between Qinghai Province and Gansu Province and Shaanxi Province. In 2017, the number of patent applications authorized in Gansu Province was 2.57 times that of Qinghai Province, and the number of patent application authorizations in Shaanxi Province was 34,554, which was 21.87 times that of Qinghai Province. Compared with Shaanxi Province, the number of patent grants in the province has a large gap, and the level of regional innovation is low.

1.2.2. Status of technology contract turnover. From 2003 to 2006, Qinghai Province's technology contract turnover was low and was in a slow growth stage, maintaining between 83 and 118 million yuan; from 2007 to 2009 is in the rapid development stage, from 118 million yuan to 775 million yuan; from 2009 to 2018, the turnover of technology contracts has increased rapidly, with a large growth rate, and is in a rapid development stage, with an increase of 7.936 billion yuan from 854 million yuan. Compared with 2003, Qinghai Province's technology contract turnover in 2018 was 95.72 times the turnover in 2003. This shows that Qinghai Province has given increasing attention to scientific and technological innovation in recent years, and the innovation activities of the Qinghai Provincial Government and the whole society are increasing. Actively, the level of regional innovation continues
to increase, and the effect is significant. However, in 2018, the turnover of technical contracts between Gansu and Shaanxi was 2.41 and 13.61 times that of Qinghai. There is still a large gap with Gansu and Shaanxi Province.

1.2.3. New Product Sales Revenue. The sales revenue of new products from large and medium-sized enterprises in Qinghai Province from 2003 to 2017 can be divided into three stages. The sales revenue of new products from large and medium-sized enterprises from 2003 to 2009 has clearly increased and is in a rapid growth stage; 2010-2014 Large and medium-sized enterprises in Qinghai Province have low sales revenue for new products, which has a large gap compared with other years; from 2014 to 2017, the sales revenue of new products has greatly increased and is in a rapid growth stage. Overall, the sales revenue of new products has fluctuated. In Qinghai Province, the output of new product sales revenue is relatively low.

2. Analysis of three industrial science and technology investment in Qinghai Province

2.1. Analysis of Three Industrial Science and Technology Fund Inputs in Qinghai Province

Qinghai Province’s investment in science and technology funds in various industries can be expressed by the amount of fixed asset investment in each industry. Figure 1 directly reflects the investment in fixed assets of the three industries in Qinghai Province in 2008-2018. From a vertical perspective, 2008-2018 The overall investment in fixed assets in the primary industry is on the rise, especially in 2014, due to the increase in investment in industrial funds during the implementation of the "Twelfth Five-Year Plan"; the investment in secondary industries and tertiary fixed assets It also shows an overall upward trend, with annual average growth of 17.65% and 14.65%, respectively. From a horizontal perspective, from 2008 to 2018, the intensity of investment in the three industries was different in each year, and the investment in fixed assets in the secondary and tertiary industries was compared. Large, but less investment in the primary industry.

![Figure 1. Comparison of total investment of three industrial funds in Qinghai Province. Data source: Statistical Yearbook of Qinghai Province, 2009-2019](image)

2.2. Analysis of Investment in Scientific and Technological Personnel of Three Industries in Qinghai Province

Scientific and technological personnel are the key to improve the ability of independent innovation, which is related to the technological progress and the improvement of the level of scientific and technological development of a country or region. As can be seen from Figure2 from 2009 to 2017, the number of scientific and technological personnel in the primary industry has shown a downward trend; the number of scientific and technological personnel in the secondary industry has fluctuated and has declined in recent years. Trend; the number of scientific and technological personnel in the tertiary industry is generally increasing. This is mainly due to the mobility of scientific and
technological personnel, and it is also a reflection of the gradual marketization of talent allocation in Qinghai Province.

Figure 2. Comparison of investment in scientific and technological personnel of the three industries in Qinghai Province.
Data source: Statistical Yearbook of Qinghai Province in 2018. Due to incomplete data, only 2009-2017 data were selected.

3. Analysis of Science and Technology Output of Three Industries in Qinghai

3.1. Analysis of the total output value of the three industries
It can be seen from Figure 3 that the overall output of the three industries in Qinghai Province is on the rise. From the horizontal perspective, the output value of the secondary industry is the highest among the three industries in each year, and the output value of the primary industry is the lowest. From the perspective of the output value, it is in line with the characteristics of Qinghai's industrial structure and is generally in the industrialization stage.

Figure 3. Comparison of the total output value of the three industries in Qinghai.
Data source: Statistical Yearbook of Qinghai Province, 2007-2019

3.2. Analysis of the output of three industrial science and technology achievements in Qinghai
Table 1 reflects that the major scientific and technological achievements of various industries in Qinghai Province in 2017 and 2018. In terms of industries, in 2018, the number of scientific and technological achievements in the secondary industry was the largest, reaching 157 items; while the number of scientific and technological achievements in the primary industry was less than that in the secondary industry, which was 131. The number of major scientific and technological achievements in the tertiary industry is the least, only 103. From the perspective of the output units of scientific and technological achievements, the number of major scientific and technological achievements from enterprises is the largest, reaching 151, accounting for 29.2% of the total number of major scientific and technological achievements, followed by It is a major scientific and technological achievement
from medical institutions, the number of which is 106, accounting for 20.5% of the total. This shows that the main units responsible for major scientific and technological innovation activities in Qinghai Province are enterprises and medical institutions, reflecting that enterprises have gradually become the main body of scientific and technological innovation. It has laid an important foundation for future scientific and technological innovation and technological progress in Qinghai Province.

Table 1. Major scientific and technological achievements of various industries in Qinghai Province in 2017 and 2018

| Years | Research institutions | College | Enterprise | Medical institutions | Other | Total |
|-------|-----------------------|---------|------------|----------------------|-------|-------|
| Primary industry |
| 2017  | 70                    | 31      | 22         | /                    | 40    | 163   |
| 2018  | 41                    | 13      | 35         | 1                    | 41    | 131   |
| Secondary industry |
| 2017  | 11                    | 4       | 93         | /                    | 13    | 121   |
| 2018  | 17                    | 13      | 93         | /                    | 34    | 157   |
| Tertiary Industry |
| 2017  | 6                     | 9       | 11         | 54                   | 8     | 88    |
| 2018  | 8                     | 15      | 34         | 58                   | 16    | 103   |
| Total |
| 2017  | 87                    | 44      | 126        | 54                   | 106   | 372   |
| 2018  | 86                    | 68      | 151        | 106                  | 107   | 518   |

Data source: Statistical Yearbook of Qinghai Province in 2018 and 2019

4. Evaluation of the input and output efficiency of the three industries in Qinghai

4.1. Analysis of changes in the input and output efficiency of the three industrial funds in Qinghai

It can be seen from Figure 4 that the technology input-output efficiency value of the first industry in Qinghai Province has been slowly decreasing from 2008 to 2015, and it has rebounded slightly from 2016 to 2018. It has a volatile nature as a whole, but the fluctuation is not large. The technology input-output efficiency of the secondary industry in 2015 showed a downward trend, and it picked up in 2015-2018. The technology input-output efficiency value of the tertiary industry in 2008-2018 showed a downward trend. Overall, the input-output efficiency of the three industries in Qinghai Province is on the decline, which indicates that there are problems in the current input structure and industrial structure.

Figure 4. Comparison of changes in input-output efficiency of the three industries in Qinghai.

Data source: Qinghai Province Statistical Yearbook 2019
4.2. Comparison of Science and Technology Input-Output Efficiency in Qinghai Province and the Nation

Only through the transformation of scientific and technological achievements, can the potential economic benefits be brought into play, while driving the overall economic growth. According to Table 2, it can be seen that from 2007 to 2017, R&D expenditures and the amount in Qinghai increased year by year. However, there is a significant gap compared with the national average over the same period. In 2017, the ratio of Qinghai Province's output and transaction value to R&D expenditure was 9.8, while the national level was 13.1, a difference of 34%. It can be seen that Qinghai R&D personnel invented per 10,000 people in 2007 The number of patents was 0.0025, which increased to 0.7716 by 2017. In the same period, the number of invention patents per 10,000 people of R&D personnel nationwide was 0.082 in 2007, and increased to 2.572 by 2017. Qinghai Province is only equivalent to 30% of the national average.

Table 2. Comparison of National Science and Technology Input-Output Efficiency in Qinghai Province.

| Years | Ratio of output to transaction value and R&D expenditure | Scientific and technological personnel input-output efficiency value |
|-------|--------------------------------------------------------|---------------------------------------------------------------|
|       | Qinghai Province | Nationwide | Qinghai / National | Qinghai Province | Nationwide | Qinghai / National |
| 2007  | 5.2            | 7.5        | 0.69              | 0.0025           | 0.082      | 0.3              |
| 2008  | 5.4            | 7.6        | 0.71              | 0.0274           | 0.137      | 0.2              |
| 2009  | 6.8            | 7.8        | 0.87              | 0.0713           | 0.285      | 0.25             |
| 2010  | 6.6            | 8.3        | 0.79              | 0.1205           | 0.482      | 0.25             |
| 2011  | 8.3            | 8.5        | 0.97              | 0.1305           | 0.687      | 0.19             |
| 2012  | 8.6            | 9.7        | 0.89              | 0.2255           | 1.025      | 0.22             |
| 2013  | 9.3            | 10.5       | 0.88              | 0.4291           | 1.341      | 0.32             |
| 2014  | 9.6            | 11.4       | 0.84              | 0.5365           | 1.578      | 0.34             |
| 2015  | 9.8            | 11.6       | 0.84              | 0.5733           | 1.911      | 0.3              |
| 2016  | 10.2           | 12.8       | 0.80              | 0.6524           | 2.33       | 0.28             |
| 2017  | 9.8            | 13.1       | 0.75              | 0.7716           | 2.572      | 0.3              |

4.3. Comparison of Science and Technology Input-Output Efficiency in Qinghai Province with Shaanxi and Gansu

As the three provinces of the five northwestern provinces, Qinghai and Shaanxi and Gansu provinces are all interconnected. There is still a certain gap between Qinghai and Gansu Provinces and Shaanxi Province. Shaanxi The ratio of R&D funding is significantly higher than that of Qinghai and Gansu. Qinghai has always been below 1%, indicating that it is still driven by resources and factors; Gansu Province is in the early stage of investment drive; Shaanxi Province is basically greater than 2% It is in the late stage of investment-driven. None of the three provinces has entered the innovation-driven stage, and Qinghai Province faces the greatest challenge. The high-quality development of its economy requires the improvement of productivity and wisdom. In the patent output rate of scientific and technological funds, Shaanxi and Gansu are roughly Convergence, the output rate of Qinghai Province was significantly lower than that of Shaanxi and Gansu Province from 2007 to 2009, and the yield of Qinghai Province increased significantly in 2010, which was higher than that of Shaanxi and Gansu Province, indicating that the allocation of input-output resources has been optimized In recent years, it has been in a stable development stage.
Table 3. Comparison of Science and Technology Input and Output of Qinghai Province with Gansu Province and Shaanxi Province.

| Years | R&D funding input intensity (%) | Ratio of invention patent to input of scientific and technological personnel (pieces per 10,000 people) |
|-------|---------------------------------|--------------------------------------------------------------------------------------------------|
|       | Qinghai Province | Gansu Province | Shaanxi Province | Qinghai Province | Gansu Province | Shaanxi Province |
| 2007  | 0.49              | 0.95            | 2.23             | 0.017             | 0.025            | 0.035            |
| 2008  | 0.41              | 1.00            | 2.09             | 0.017             | 0.030            | 0.033            |
| 2009  | 0.70              | 1.10            | 2.32             | 0.021             | 0.029            | 0.031            |
| 2010  | 0.74              | 1.02            | 2.15             | 0.038             | 0.022            | 0.022            |
| 2011  | 0.75              | 0.97            | 1.99             | 0.023             | 0.020            | 0.021            |
| 2012  | 0.69              | 1.07            | 1.99             | 0.025             | 0.017            | 0.019            |
| 2013  | 0.65              | 1.06            | 2.12             | 0.027             | 0.014            | 0.016            |
| 2014  | 0.62              | 1.12            | 2.07             | 0.023             | 0.015            | 0.016            |
| 2015  | 0.48              | 1.22            | 2.18             | 0.010             | 0.012            | 0.012            |
| 2016  | 0.54              | 1.22            | 2.19             | 0.010             | 0.011            | 0.009            |
| 2017  | 0.68              | 1.15            | 2.10             | 0.011             | 0.009            | 0.013            |

5. Problems in the Efficiency of Science and Technology Input and Output in Qinghai Province

5.1. Insufficient investment in science and technology
The Outline of the National Medium- and Long-Term Scientific and Technological Plan states that the proportion of R&D expenditures in the whole society as a proportion of gdp will reach 2% in 2010 and more than 2.5% by 2020. Taking 2016 as an example, the proportion of R&D expenditures in the United States as a proportion of gdp is 2.74%, Germany is 2.93%, France is 2.25%, Canada is 1.60%, and Qinghai is only 0.54%. By comparison, we can see that Qinghai Province is far from this average target, which shows that the total investment in science and technology in Qinghai Province Insufficient amounts will affect the process of scientific research in Qinghai Province, and then affect the economy of Qinghai Province, which is not conducive to the long-term development of Qinghai's economy.

5.2. Coexistence of lack of scientific and technological talents and inefficient output of talents
On the one hand, there is currently a shortage of scientific and technological talents in Qinghai Province, and there is a shortage of high-level and high-skilled innovative talents. Compared with the national average, the gap is still large. In 2017, for example, Qinghai had only 117,000 scientific and technological personnel, and national scientific and technological activities. The number of personnel was 6.214 million, and Qinghai's scientific and technological activities accounted for only 0.19% of the country's total; while the number of R&D personnel in Qinghai was only 0.31 million years, the number of national R&D personnel was 4.034 million years, and the percentage of R&D personnel in Qinghai Province accounted for only 0.08%; the number of R&D science workers in Qinghai Province is 0.19 million years, and the number of R&D science workers in China is 1.740 million years. The proportion of R&D science workers in Qinghai Province only accounts for 0.0011. In this process, the training of human resources was ignored and its education The intensity is also far from enough, the talent training specifications are unreasonable, the human resources investment is insufficient, and there is no sound mechanism for talent flow. On the other hand, from the perspective of the patent index for the output of 10,000 scientific and technological personnel, the national average is 2.572,
and Qinghai Province is 0.3, which is far lower than the national average. The reason is that in addition to the hard environment of scientific research affecting the output results, in addition, the soft environment of scientific research has a great impact on the output efficiency of scientific and technological personnel. In 2018, Qinghai Province introduced 20 reforms (temporary) of "decentralization services" in the scientific and technological field, which greatly encouraged the enthusiasm of scientific and technological personnel and improved the efficiency of scientific research. However, it is still necessary to implement this policy well in practice.

5.3. Coexistence of the three industries' input growth and decline in science and technology output
On the one hand, the investment structure of various industries is unreasonable, and the investment in the tertiary industry is not strong enough, which is manifested in the deficiencies in capital investment and talent input, ignoring the development of the tertiary industry, and paying too much attention to the development of the secondary industry. The slow and free development of the primary industry has caused an uncoordinated development of the three major industries, which has hindered the overall economic development of Qinghai Province. On the other hand, this shows that all three industries in Qinghai need to adjust and optimize their structure, enhance their competitiveness, and equip each industry with high technology to achieve high-quality development.

5.4. Coexistence of misallocation of science and technology resources and low level of science and technology management
On the whole, Qinghai Province's science and technology investment in science and technology activities is at a relatively low level, and funding and manpower investment are still insufficient compared with the national average. At the same time, the allocation of scientific and technological resources is unreasonable. The proportion of R&D investment in important parts of science and technology investment is still low, and the overall layout of scientific and technological activities has not been adjusted, resulting in a disconnect between scientific and technological research and development and production. In the final analysis, it is due to the lack of independent innovation awareness and ignore the leading role of the market in resource allocation. Restricted the improvement of scientific and technological innovation capabilities of the province.

6. Measures to improve the input and output efficiency of the three industries in Qinghai

6.1. Actively strive for central transfer payments and establish a stable growth mechanism for science and technology investment
Through the comparison, it is found that there is a problem of insufficient investment in science and technology in Qinghai Province. Therefore, it is necessary to increase science and technology investment. In terms of scope, it is necessary to ensure its proportion in gdp in Qinghai Province. Secondly, in terms of the amount and speed of scientific and technological investment, the Qinghai provincial government should establish a guarantee mechanism for scientific and technological investment on the premise of complying with relevant national regulations on scientific and technological investment. The demand for scientific and technological development in the region ensures that the increase rate of fiscal investment in science and technology must be lower than the regular fiscal revenue; finally, it is necessary to effectively ensure the sustainable and stable growth of scientific and technological investment and strive to achieve the goals of the National Medium- and Long-Term Scientific and Technological Planning Outline. In addition, as Qinghai Province undertakes the important functions of Sanjiangyuan's ecological environmental protection, it should actively seek national financial transfer payments for tilt and support in terms of scientific and technological investment in Sanjiangyuan's ecological environmental protection related industries, strengthen the construction of a hard environment for scientific research, and continue to increase Great investment efforts to build various research laboratories, research platforms, and research and development
centers to promote industrial innovation. Capacity has been improved, and the output of scientific and technological innovation has continued to increase.

6.2. Strengthen the introduction of talents and improve the mechanism for selecting, educating, and hiring

From the analysis above, we can see that Qinghai Province lacks scientific and technological talent resources, especially high-level, high-skilled innovative talents. Therefore, Qinghai Province should strengthen the cultivation of such talents in universities in the province; in addition, it is also necessary to improve the training mechanism and strengthen the introduction of scientific and technological innovation talents. Attaching importance to foreign talents with high education backgrounds and local growth talents who have been struggling in the Qinghai-Tibet Plateau for a long time. In terms of the employment mechanism, Qinghai Province will implement 20 reforms (temporary) of "decentralization services" in the field of science and technology in 2018 to fully stimulate the enthusiasm of scientific and technological personnel Reduce burdens and incentives in parallel, improve the enthusiasm and initiative of scientific and technological personnel, be brave in innovation, and improve the efficiency of science and technology input and output in Qinghai Province.

6.3. Combination of optimizing the structure of science and technology investment and adjusting and optimizing the industrial structure

On the one hand, Qinghai Province should adjust the allocation of resources for science and technology investment to optimize the investment structure. Increase investment in the tertiary industry in terms of funds and talents to stimulate its innovation ability, we should shift investment from low value-added, high-consumption, high-pollution, and high-emission industries to high-value-added, green, low-carbon, and competitive industries, so as to improve the innovation efficiency of the secondary industry; enhance the development space of the primary industry, increase investment in science and technology for facility agriculture and other modern agriculture, and accelerate the transformation of traditional agriculture to industrialization and modernization. On the other hand, Qinghai Province should adjust and optimize the industrial structure, enhance industrial competitiveness, and arm industries with high technology. The combination of adjustment and optimization and the optimization of the structure of science and technology investment has achieved high-quality development.

6.4. Speed up the transformation of scientific and technological achievements into real productivity

First, the allocation efficiency of science and technology resources should be improved so that higher inputs can obtain higher output. Second, while increasing scientific and technological investment, we should increase the proportion of research and development investment in scientific and technological inputs, and strengthen market entities such as scientific research institutions and enterprises. The exchanges and cooperation between them have made the scientific research results of scientific research institutions more in line with the needs of the market, thereby accelerating the transformation of scientific and technological achievements into real productivity.

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