Quantitative analysis of technological investment and industrial structure upgrading on Guangzhou's technological innovation——Based on the perspective of data mining and intelligent computing

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Abstract. With the help of intelligent thinking programs, intelligent computing can help deal with various complex social problems and use data to study the essence of economic phenomena. Using the related theories and procedures of data mining and functional calculation, quantitative research is conducted on the impact of technological investment and industrial structure upgrading in Guangzhou on technological innovation. Quantitative research results show that there is a high degree of positive correlation between technology investment, industrial structure upgrading and technological innovation capabilities, among which technology investment has a more significant impact. Based on the results of intelligent computing, it is proposed that Guangzhou should attach importance to basic research, strengthen support for cutting-edge technologies such as big data and cloud computing, continuously optimize the environment for urban innovation and development, and actively cultivate new drivers of economic development.

1. Introduction
For China's economy to achieve high-quality development, the key is to transform the momentum of economic development and use technology as the core competitiveness of products. As a business center and logistics center in South China, Guangzhou has a solid economic foundation, a high degree of internationalization, and an active atmosphere for innovation. It needs to lead the way in the process of innovation and development. At present, the high-end manufacturing industry in Guangzhou is developing rapidly, the proportion of the service industry is constantly increasing, and the industrial structure is continuously optimized. Guangzhou should use the Guangdong-Hong Kong-Macao Greater Bay Area as an opportunity to build an international technological innovation center with global influence, continuously optimize the market environment, increase technological investment, and accelerate the development of emerging industries such as biomedicine, new energy, artificial intelligence, and the Internet of Things. Strengthen key technology research and give full play to Guangzhou's supporting and leading role in the national innovation and development process.

This article selects the statistical data of Guangzhou from 2010 to 2019, and uses relevant theories and methods of mathematical statistics and econometrics to empirically study the relationship between technology investment, industrial structure upgrading and innovation capability improvement in Guangzhou, provide certain theoretical support for Guangzhou to formulate relevant policies and cultivate new momentum for economic development.
2. Research Status
Scholars at home and abroad have done a lot of research on the factors affecting the improvement of technological innovation capabilities. Geppert et al. (2008) conducted a research on Germany and found that there is a positive relationship between industrial agglomeration and economic growth [1]. Ercole et al. (2017) measured the level of industrial agglomeration and came to the conclusion that specialized agglomeration has no obvious effect on economic growth [2]. Yan Chengliang et al. (2010) found that technological innovation is mainly through the further accumulation of knowledge, which is then transformed into technology and applied to real life, thereby improving the level of technological innovation [3]. Hong Yinxing (2011) believes that my country's heavy investment in technological innovation has strengthened the transformation of technological innovation from enterprises to various stages including production, education and research, and promoted the multi-faceted development of technological innovation in my country [4]. Pang Ruizhi et al. (2014) found that the level of scientific and technological innovation in various provinces in my country is insufficient, resulting in the insignificant role of scientific and technological innovation in stimulating economic growth [5]. Zhang Ke (2019) found that there is a mutual promotion mechanism between industrial agglomeration and technological innovation, and industrial agglomeration can promote technological innovation through technology spillovers and economies of scale [6]. Chen Changshi et al. (2019) found that industrial agglomeration mainly promotes the scale of innovation through spillover effects, but has a small impact on innovation efficiency [7]. Hu Bin et al. (2017) found that due to the convenience provided by the government, industrial agglomeration has reduced the efficiency of high-end innovation [8].

Domestic and foreign scholars have found a significant correlation between technology investment, industrial structure and technological innovation development from different perspectives, which has important theoretical reference value for this article.

3. Empirical analysis
3.1 Variable selection
The level of scientific and technological innovation in Guangzhou is represented by the number of patent applications (ZLSQ), R&D expenditure (YJJF) is used as the representative variable of technology investment, and the ratio of output value of the tertiary industry to the output value of the secondary industry (CYJG) is used as the representative variable of industrial structure upgrading. In order to eliminate the influence of dimension to a certain extent, this paper takes the logarithm of the explanatory variable and the explained variable, which are recorded as LOG (ZLSQ), LOG (YJJF), LOG (CYJG). It is assumed that the level of scientific and technological innovation in Guangzhou City meets linear constraints with technological investment and industrial structure upgrading. The data of each variable comes from the Guangzhou Statistical Yearbook over the years.

3.2 Descriptive statistics of each variable
From 2010 to 2019, Guangzhou's innovation and development momentum is good, the number of patent applications has increased from 20,803 to 177,223, an increase of 750% in 10 years; R&D funding has increased from 19.243 billion yuan to 67.774 billion yuan, with an average annual growth rate of approximately 13. %; the industrial structure coefficient has increased from 158.36% to 262.21%. In 10 years, Guangzhou has gradually moved from an industrial economy to a service economy. After years of development, the contribution of Guangzhou's technological innovation to the economy has increased significantly. The descriptive statistics of each variable, the trend chart is shown in Table 1, Figure 1.
Table 1  Descriptive statistics of each variable

| Variable | Mean   | Median  | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Probability |
|----------|--------|---------|---------|---------|-----------|----------|-----------|-------------|-------------|
| LOG(ZLSQ)| 4.7913 | 4.7338  | 5.2485  | 4.3181  | 0.3326    | 0.1316   | 1.6371    | 0.8029      | 0.6694      |
| LOG(YJJF)| 2.5646 | 2.5518  | 2.8311  | 2.2843  | 0.1821    | 0.0204   | 1.7786    | 0.6222      | 0.7326      |
| LOG(CYJG)| 2.2947 | 2.2771  | 2.4187  | 2.1996  | 0.0769    | 0.2665   | 1.7275    | 0.7931      | 0.6726      |

Fig.1 Trends in technology investment, industrial structure, and patent applications

3.3 ADF test
In this paper, the extended DF test, namely ADF test, is used to test the stationarity of the time series. The test results are shown in Table 2.

Table 2  ADF test result table

| Variable  | Test critical values(10% level) | T-Statistic | Conclusion |
|-----------|---------------------------------|-------------|------------|
| LOG(ZLSQ)| -2.771129                      | -0.404554   | Unstable   |
| LOG(YJJF)| -2.771129                      | -0.664921   | Unstable   |
| LOG(CYJG)| -2.771129                      | 0.979424    | Unstable   |
| D(LOG(ZLSQ)) | -2.901384                      | -2.932632   | Stable     |
| D(LOG(YJJF)) | -2.901384                      | -3.856318   | Stable     |
| D(LOG(CYJG)) | -2.901384                      | -3.308524   | Stable     |

At the 10% significance level, the first difference of each variable is a stationary time series, and there is no unit root. That is, LOG(ZLSQ)-I(1), LOG(YJJF)-I(1), LOG(CYJG)-I(1).

3.4 Heteroscedasticity test
This paper uses the ARCH method to test for heteroscedasticity, and the test results are shown in Table 3.

Table 3  ARCH test result table

| Heteroskedasticity Test:ARCH | F-statistic | Prob.F(1,7) | 0.7972 |
|------------------------------|-------------|-------------|--------|
| Obs*R-squared                | 0.090727    | Prob.Chi-square(1) | 0.7633 |
P value = 0.7633, which is far greater than the significance level of 0.05, so the null hypothesis should not be rejected, and the model does not have heteroscedasticity.

3.5 Build regression equation
According to the relevant principles and methods of intelligent data analysis, a linear regression equation between the three variables of LOG (ZLSQ), LOG (YJJF) and LOG (CYJG) can be established, as shown in formula (1), the relevant statistics of the fitting equation The results are shown in Table 4.

\[
\text{LOG(ZLSQ)} = 1.4284\text{LOG(YJJF)} + 0.9327\text{LOG(CYJG)}
\]  \hspace{1cm} (1)

| Variable | Coefficient | Std.Error | t-Statistic | Prob. |
|----------|-------------|-----------|-------------|-------|
| LOG(YJJF) | 1.428357    | 0.421681  | 3.387290    | 0.0116|
| LOG(CYJG) | 0.932716    | 0.999054  | 3.433599    | 0.0109|
| C         | -1.012086   | 1.234694  | -0.819706   | 0.4394|
| R-squared | 0.991372    | Mean dependent var | 4.791335 |
| Adjusted R-squared | 0.988907    | S.D. dependent var | 3.32643 |
| S.E. of regression | 0.035035    | Akaike info criterion | -3.621627 |
| Sum squared resid | 0.008592    | Schwarz criterion | -3.530851 |
| Log likelihood | 21.10814    | Hannan-Quinn criter. | -3.721208 |
| F-statistic | 402.1690    | Durbin-Watson stat | 2.576243 |
| Prob(F-statistic) | 0.000000    |                     |          |

From the fitting results in Table 4, the coefficient of the constant term is not significant, so it is discarded. The F statistic is 402.16, which means that the overall fitting effect of the equation is good. The correlation coefficient reached 0.99, which means that Guangzhou's technological innovation capability is highly positively correlated with technological investment and industrial structure. R&D funding and industrial structure transformation and upgrading are the main factors affecting the improvement of technological innovation capability. From the regression equation, for every 1% increase in technology investment, the level of technological innovation in Guangzhou will increase by 1.43%; every increase in the ratio of the tertiary industry to the second industry by 1%, the level of technological innovation in Guangzhou will increase by 0.93%.

4. Policy Suggestion
From the results of the empirical analysis, it can be seen that technology investment and industrial structure transformation and upgrading represented by R&D funds have a significant role in promoting scientific and technological progress in Guangzhou. Guangzhou uses industrial practices to promote scientific and technological innovation and continuously gather new momentum for economic development. In order to accelerate the development of scientific and technological innovation in Guangzhou and strengthen the leading position of science and technology in economic development, this article proposes the following policy recommendations:

4.1 Increase investment in basic research
The city of Guangzhou should give full play to the advantages of intensive universities and scientific research institutions, strengthen basic research related to strategic emerging industries, strengthen core technology research, and promote scientific and technological innovation. Guangzhou should focus on basic disciplines and cutting-edge exploration, increase investment in supporting talent and team building, promote the sharing of basic research results, and give full play to the role of basic research as the source of technological innovation. At the same time, through tax reduction and exemption, enterprises are guided to increase investment in research and development, promote in-depth
cooperation between industry, university and research, and enhance their independent innovation capabilities.

4.2 Accelerate the development of high-end manufacturing and producer services
Guangzhou should speed up the development of high-end manufacturing represented by new energy vehicles and biomedicine, and strive to move to the top of the global value chain. While expanding and strengthening advantageous industries, Guangzhou should also pay attention to promoting the development of producer services. The first is to fully tap the cultural resources of Canton and develop cultural tourism and research tourism. The second is to give full play to the advantages of freight logistics, promote the development of the airport industry, accelerate the development of port economy and warehousing services, and build Guangzhou into a global transportation hub.

4.3 Optimize the environment for innovation and development
Guangzhou should build an economic and trade rule system that is in line with high international standards, deepen the innovation of the investment management system that matches the high-level opening up, and form new advantages in an open economy. Guangzhou must also build an efficient, competitive, and standardized market order, reduce market operating costs, form a good innovation environment, and actively seize the commanding heights of the new round of technological changes.

5. Conclusion
To sum up, only by clarifying the relevant influencing factors of technological innovation and understanding the quantitative relationship between the factors, can Guangzhou be able to formulate targeted technological innovation policies and use technological innovation as a new driving force for economic development.

References
[1] GEPPERT K,GORNIG M,WERWATZ A.Economic growth of agglomerations and geographic concentration of industries:evidence for west germany[J].Regional Studies,2008,42(3):413-421.
[2] ERCOLE R,ONEILL R.The influence of agglomeration externalities on manufacturing growth within indonesian locations[J].Growth&Change,2017,48 (1):91-126.
[3] Yan Chengliang,Zhou Mingshan,Gong Liutang.Knowledge production, innovation and R&D investment return[J].Economics (Quarterly),2010(3):1051-1070.
[4] Hong Yinxing.Technological Innovation and Innovative Economy[J].Management world,2011(7):1-8.
[5] Pang Ruizhi,Fan Yu,Li Yang.Does China's technological innovation support economic development?[J].Quantitative Economic Technology Research,2014(10):37-52.
[6] Zhang Ke.The two-way influence mechanism and test of industrial agglomeration and regional innovation---an investigation based on the perspective of industrial heterogeneity[J].Auditing and Economic Research,2019(4):94-105.
[7] Chen Changshi,Jiang Tingting,Liu Chenhui.An Empirical Study on the Influence of the Direction of Industrial Agglomeration on Urban Technological Innovation[J].Science Research,2019(1):77-85.
[8] Hu Bing,Wan Daoxia.How Industrial Agglomeration Affects the Technological Innovation Mode of Manufacturing Enterprises---Concurrently Discussing the Causes of "Innovation Inertia" of Enterprises[J].Financial Research,2017(11):30-43.