Technological innovation, industrial upgrading and regional economic development: evidence from China's Yangtze River Economic Belt

Min Wu¹ᵃ, Mengyun Jin¹ᵇ and Yihao Tian¹ᶜ*

¹ School of Public Administration, Sichuan University, Chengdu, Sichuan, China
ᵃ email: wuminhelen@163.com, ᵇ e-mail: jinmengyun@stu.scu.edu.cn
ᶜ Corresponding author:  e-mail: yihao.tian@scu.edu.cn

Abstract. The development strategy of the Yangtze River Economic Belt is an important strategy for China to cope with the new normal of economic development. This paper uses provincial panel data from the Information Network of the National Bureau of Statistics of China and the Development Research Centre of the State Council and conduct a panel data fixed effect regression model to empirically study the impact of technological innovation and industrial upgrading on economic development of 11 provinces in the Yangtze River economic belt. The results of full sample estimation show that technological innovation and industrial upgrading can promote economic growth at a significant level of 1%, but the impact of industrial upgrading is not obvious when they are considered separately. According to the results of sub-regional estimation, there is regional heterogeneity in the degree of effect of technological innovation and industrial upgrading on economy. Therefore, the Yangtze River Economic Belt should increase investment in science and technology, adjust industries according to the development orientation of provinces, pay more attention to the rationalization of industrial structure, rationally allocate resources among industries, and pay attention to the complementary development among regions.

1. Introduction
The development strategy of the Yangtze River Economic Belt is one of the major strategies for China's regional coordinated development. The Yangtze River Economic Belt not only has problems such as unbalanced economic development, insufficient innovation drive and lagging industrial development, but also has the advantages of complementary provinces, accumulation of scientific and technological resources (Wu and Deng, 2019). Under this background, what we want to know is: what is the impact of technological innovation and the upgrading of industrial structure on the development of the Yangtze River economic belt? Which factor has a greater impact? What are the regional differences in these impacts? The answers are helpful to better understand the relationship between technological innovation, industrial structure and economic development in the Yangtze River economic belt, and to provide decision-making reference.

A kind of research closely related to this paper focuses on the impact of technological innovation on economic development, and empirically analyses the impact and mechanism of technological innovation on economic growth and high-quality development, most of which belong to applied research (Li and Fan, 2019). In the analysis of the relationship between technological innovation and economic development, most studies have confirmed the positive impact of technological innovation on regional economic development (Wang et al., 2018; Yin and Jia, 2019). In addition, many scholars have also
paid attention to the differences in the role of technological innovation in economic development among different regions in China (Yi et al., 2017).

Another kind of research related to this paper focuses on the impact of industrial structure upgrading on economic development. Some scholars focus on the important role of a certain industry, especially the tertiary industry, in economic growth, and point out that the production efficiency of the service industry is higher than that of industry on average (Pang and Deng, 2014). It is believed that producer services can become a new driving force for China's high-quality economic growth under the new normal (Li, 2017). However, more and more studies pay more attention to the joint role of industrial structure upgrading, finance, technological innovation and other elements. These studies suggest that the driving force of urban economic growth in China has been transformed into the improvement of total factor productivity (Yu, 2015). Therefore, the balanced development trend of industry and service industry (Qu and Lu, 2016) should be maintained, and China's industrial policy at this stage should focus more on the rationalization of industrial structure (Che et al., 2019).

Compared with the existing literature, this paper focuses on the joint effect of technological innovation and industrial upgrading on the economy. Furthermore, the research on the interaction between technological innovation, industrial structure upgrading and economic development in the Yangtze River economic belt has not yet entered a mature period, our study is a complement of this.

2. Materials and Methods

2.1. Model

Based on the literature review and the analysis of the impact mechanism of technological innovation and industrial upgrading on economic development, the following fixed effect regression model is constructed:

\[ \text{PGDP}_{it} = \alpha_0 + \alpha_1 \text{INNO}_{it} + \alpha_2 \text{GJH}_{it} + \alpha_3 X_{it} + \epsilon_{it} \]  

In the above model, \( i \) and \( t \) represent 11 provinces in the Yangtze River Economic Belt and 10 years from 2008 to 2017 respectively, \( \epsilon \) is the random error. PGDP is dependent variable, which represents the level of economic development of the provinces in the Yangtze River economic belt. INNO and GJH are independent variables, INNO represents the level of technological innovation, and GJH represents the level of industrial upgrading. X represents the vector composed of control variables that affect economic development.

2.2. Variables and data

(1) Dependent variable. The dependent variable of this study is the economic development level, measured by the per capita regional gross domestic product (GDP), recorded as PGDP.

(2) Independent variables. The core independent variables of this paper are the level of technological innovation and industrial upgrading. The level of innovation was usually measured by innovation input or innovation output (Zhang et al., 2016, Wang and Zheng, 2014). This paper mainly selects the index of domestic patent application authorization, recorded as INNO. Then, we learn from the existing research (Li, 2018; Che, 2019), choose the ratio of the added value of the tertiary industry to the added value of the secondary industry to measure the level of industrial upgrading, recorded as GJH.

(3) Control variables. We learn from the existing research (Chao et al., 2014; Li et al., 2017), select the following control variables: MARK is the level of marketization, measured by the proportion of non-state investment in the total social investment. OPEN is the level of opening up, measured by the ratio of total imports and exports of provinces and cities to regional gross domestic product. HR is the level of human capital, measured by the average number of students per 100,000 population in colleges and universities. GOV is the degree of government regulation and control, measured by the ratio of total local fiscal expenditure to regional gross domestic product. URB represents the level of urbanization. FIN is the level of financial development in the region, measured by the ratio of the added value of the financial industry to the gross domestic product of the region. The summary statistics are shown in Table
1. All of data come from the Information Network of the National Bureau of Statistics of China and the Development Research Centre of the State Council.

Table 1. Summary statistics.

| Variable | Obs. | Mean | Std. Dev | Min  | Max  |
|----------|------|------|----------|------|------|
| Ln PGDP  | 110  | 10.520 | 0.585 | 9.090 | 11.750 |
| Ln INNO  | 110  | 10.161 | 1.260 | 7.450 | 12.510 |
| GJH      | 110  | 0.984 | 0.322 | 0.600 | 2.340 |
| MARK     | 110  | 0.717 | 0.092 | 0.500 | 0.870 |
| OPEN     | 110  | 0.342 | 0.396 | 0.030 | 1.620 |
| Ln HR    | 110  | 7.740 | 0.290 | 6.880 | 8.390 |
| GOV      | 110  | 0.225 | 0.140 | 0.100 | 0.520 |
| URB      | 110  | 0.534 | 0.140 | 0.310 | 0.900 |
| FIN      | 110  | 0.063 | 0.032 | 0.010 | 0.170 |

3. Results and Discussion

3.1. Full sample estimation

As shown in Table 2, model 1 shows that both the level of technological innovation and the upgrading of industry have a positive impact on economic development. For each unit of technological innovation, it can bring 0.312 units of economic growth, and it is significant at the level of 1%. For each unit of industrial upgrading, the level of economic development is increased by 0.27, and at the level of 5%. Among the control variables, the marketization level has a positive effect on economic development at a significant level of 5%; the level of human capital has a positive impact on economic development at a significant level of 1%; and the degree of government regulation and control plays a reverse role in economic development, indicating that excessive government regulation and control may be detrimental to economic development. For each unit of urbanization, the economic volume can be increased by 1.244 at a significant level of 5%. It can be seen that the higher the level of urbanization, the more it able to promote economic growth. Due to the influence of unstable factors such as the international financial crisis, the level of opening up has a negative impact on economic development. It can be seen that taking the road of endogenous development will be a better choice for provinces in the Yangtze River economic belt.

Table 2. The impact of technological innovation and industrial upgrading on economic development.

| Independent variable | Dependent Variable: Ln PGDP |
|----------------------|-----------------------------|
|                      | Model 1         | Model 2         | Model 3         |
| Ln INNO              | 0.312***         | 0.302***         |                |
|                      | (8.464)         | (7.986)         |                |
| GJH                  | 0.270**         |                  | 0.179          |
|                      | (2.614)         |                  | (1.306)        |
| MARK                 | 0.521**         | 0.579**         | 0.380          |
|                      | (2.081)         | (2.251)         | (1.144)        |
| OPEN                 | -0.123          | -0.274**        | -0.206         |
|                      | (-0.895)        | (-2.134)        | (-1.135)       |
| Ln HR                | 0.601***        | 0.521***        | 1.026***       |
|                      | (4.835)         | (4.193)         | (6.794)        |
| GOV                  | -1.060**        | -1.292***       | -0.240         |
|                      | (-2.537)        | (-3.068)        | (-0.444)       |
| URB                  | 1.244**         | 1.599***        | 3.902***       |
|                      | (2.501)         | (3.242)         | (7.609)        |
General speaking, from the estimated results, technological innovation and industrial structure upgrading can jointly promote economic growth. After controlling other factors, the regression coefficient of technological innovation to economic development is still significantly positive, while the role of industrial upgrading in promoting economic development is not significant, indicating that technological innovation plays a direct role in promoting economic development. However, blindly pursuing the upgrading of industrial structure does not necessarily bring benefits, therefore, industrial upgrading and technological innovation need work together.

3.2. Estimation in different regions
The Yangtze River economic belt straddles the east and west of China, so this paper carries on the panel fixed benefit regression analysis to Shanghai, Jiangsu and Zhejiang in the east, Hubei, Hunan, Anhui and Jiangxi in the middle, Chongqing, Sichuan, Yunnan and Guizhou in the west.

Table 3. Estimation in different regions.

| Independent variable | Eastern provinces | Central provinces | Western provinces |
|----------------------|-------------------|------------------|------------------|
| Ln INNO              | 0.125             | 0.268***         | 0.354***         |
|                      | (1.551)           | (3.621)          | (3.644)          |
| GJH                  | 1.238***          | 0.074            | 0.0757           |
|                      | (4.535)           | (0.418)          | (0.408)          |
| MARK                 | -1.904***         | 2.970***         | 0.071            |
|                      | (-2.408)          | (5.735)          | (0.201)          |
| OPEN                 | -0.027            | 0.824            | 0.214            |
|                      | (-0.097)          | (1.025)          | (0.830)          |
| Ln HR                | 0.277             | -0.531           | -0.107           |
|                      | (0.630)           | (-1.247)         | (-0.289)         |
| GOV                  | -4.994**          | 0.004            | -0.856           |
|                      | (-2.218)          | (0.002)          | (-1.389)         |
| URB                  | 2.735***          | 0.990*           | 4.562**          |
|                      | (3.631)           | (1.705)          | (2.235)          |
| FIN                  | -2.780            | 3.811            | -2.251           |
|                      | (-1.521)          | (1.502)          | (-0.783)         |
| Constant             | 6.648             | 8.785***         | 5.845***         |
|                      | (1.613)           | (3.036)          | (2.822)          |
| Obs.                 | 30                | 40               | 40               |
| R-squared            | 0.960             | 0.974            | 0.964            |

Note: The values in brackets are standard errors. *, **, and *** refer to significance at the 10%, 5%, and 1% levels, respectively.
The estimated results are reported in Table 3. For the three eastern provinces, both the level of industrial upgrading and the level of urbanization have a positive effect in promoting economic development, and have passed the significance test of 1%. For the four central provinces, the level of technological innovation and the level of marketization have a positive impact on the economy at a significant level of 1%. For the four western provinces, the impact of technological innovation and urbanization on the economy is more significant. It can be seen that for different provinces of the Yangtze River economic belt, technological innovation and industrial upgrading have different effects on the economy. Because the industrial development is more mature and the urbanization level is higher in the eastern region, the contribution rate of industrial structure upgrading to economic growth is higher, and the industrial structure in the central and western regions is not mature enough, but the rising level of technological innovation has gradually become the intrinsic driving force of economic growth.

4. Conclusions
The conclusions are as follows: First of all, the technological innovation and industrial upgrading play a role in promoting economic development in the Yangtze River economic belt. When the effects are considered respectively, it is found that technological innovation has always had a positive impact on economic development, while the role of industrial upgrading is not significant. Secondly, when the sub-regional analysis is carried out, it is found that for the eastern provinces, the constantly optimized industrial structure has a significant impact in promoting economic development, for the central and western provinces, technological innovation is constantly becoming the driving force of economic growth. For the central provinces, raising the level of marketization is conducive to economic growth, for the western region, the improvement of urbanization rate will bring more room for economic growth. This study mainly has the following policy implications: Firstly, China should make good use of the government and the market to promote innovation output, improve the level of industrial development, and give full play to the joint role of technological innovation and industrial upgrading on the economy. Secondly, from the perspective of regional comparison, the impact of technological innovation and industrial upgrading on the economy is heterogeneous among different provinces, so each province should further clarify its own orientation. Some provinces should not excessively pursue industrial upgrading, but should pay more attention to the rationalization of industrial structure, optimize the allocation of resources, at the same time, they should clarify the interaction of regional development to realize the complementary development of different provinces.

References
[1] Wu, C.Q., Deng, M.L. (2019) Technological innovation, opening up and high quality development of Yangtze River economic belt. Science & Technology Progress and Policy, 36(3): 33-41.
[2] Li, G.L., Fan X.X. (2019) Fiscal expenditure, technological innovation and economic high quality development-based on the empirical test of 108 cities in the Yangtze River economic belt. Shanghai Journal of Economics, 10: 46-60.
[3] Wang, X., Chen, R., Li, M.B. (2018) The influence of science and technology innovation on regional economy—an empirical analysis based on provincial panel data. Journal of Industrial Technological Economics, 37(09): 39-44.
[4] Yin, L.S., Jia, J.Q. (2019) The spatial spill-over effect of technological innovation on economic growth in the Yangtze River economic belt. Statistics & Decision, 35(16):138-142.
[5] Pang, R.Z., Deng, Z.Q (2014) Is productivity of science sector really low. Economic Research Journal, 49(12):86-99.
[6] Li, P., Fu, Y.F., Zhang, Y.F. (2017) Can the productive service industry become new momentum for China’s economic growth. China Industrial Economics, 12:5-21.
[7] Yu, B.B. (2015) Economic growth effects of industrial restructuring and productivity improvement—analysis of dynamic spatial panel model with Chinese data. China Industrial Economics, 10: 46-60.
[8] Qu, S.N., Lv, T. (2016) Does updating industrial structure represent the more important role of service industry? — on the effect of interaction between manufacturing and services on China’s economic growth. Finance & Trade Economics, 3: 138-147.

[9] Che, M.H., Deng, X.L., Chen, B.D. (2019) Rationalization and improvements of industrial structure and economic growth: from the perspective of threshold effect. Journal of Management, 32(04): 12-20.

[10] Zhang, L. (2016) Financial development, technological Innovation and real economic growth — an empirical study based on spatial econometrics. Financial Economics Research, 31(01): 14-25.

[11] Wang, G.D., Zheng, Z.M. (2014) Technological innovation, industrial upgrading and employment. Journal of Industrial Technological Economics, 33(03): 19-24.

[12] Li, Z., Yang, S.Y. (2017) Science and technology innovation, industrial upgrading and economic growth: interactive mechanism and empirical test. Jilin University Journal Social Sciences Edition, 57(03): 41-52+204-205.

[13] Chao, X.J., Shen, K.R. (2014) Urban- rural income disparity, labour quality and economic growth in China. Economic Research Journal, 49(06): 30-43.

[14] Li, X., Deng, F. (2018) Research on the economic growth effect of technological Innovation and Industrial structure optimization: an empirical analysis based on dynamic spatial panel model. Inquiry into Economic Issues, 6: 144-154.