

# Technology Choice, Government Subsidies, and Industrial Structure Upgrading

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## Abstract

Through the development of a theoretical model encompassing industrial structure, technology selection, and governmental subsidies, and the utilization of panel data from 31 Chinese provinces as a sample, this paper investigates the regional implications of technology choice and governmental subsidies on the upgrading of industrial structure. The results demonstrate that technology selection, coupled with prudent capital investment, can expedite the process of upgrading industrial structure across various regions. Moreover, it is observed that the impact of technology choice on promoting the transition to the service industry is significantly more profound in the central and eastern regions as compared to the western region. It is further noted that governmental subsidies can facilitate the shift to the service industry in the central and eastern regions; However, their impact on upgrading the industrial structure in the western region is not significant.

## Keywords

Industrial Structure; Technology Selection; Governmental Subsidies.

## 1. Introduction

Over the past forty years of reform and opening up, China's economy has undergone rapid development. Nevertheless, this high-input, high-consumption, and high-pollution growth model has exerted significant pressure on both resources and the environment. As such, transforming the economic growth model represents the sole viable approach to achieving sustainable economic development in China [1]. Since China's proposal of supply-side structural reform in 2015, the rate of economic growth has gradually decelerated, and the current phase of the Chinese economy mired in a difficult period of industrial structural adjustment. Technology selection constitutes a decisive factor that determines the development strategy of urban economies, while government subsidies, as a critical fiscal policy tool, can effectively augment the level of local industrial development. Therefore, identifying the interrelationship between technology selection, government subsidies, and industrial structure in each region is of paramount importance for cities seeking to optimize and upgrade their industrial structure.

The "technology selection hypothesis" proposed by Lin [2] was regarded as the most representative research on technology selection and industrial structure, which posited that the optimal industrial structure of an economy was determined endogenously by the structure of its factor endowments. Deviating from the optimal technology selection could lead to a negative impact on a country's economic growth rate. Huang [3] conducted panel analysis using inter-provincial data in China and found that industrial structure upgrading, labor productivity improvement, and rapid economic growth could be achieved through technology selection and

reasonable capital deepening. Similarly, Xue [4] concluded that China's overall industrial development continued to advance technologically, resulting in capital deepening and increased output, leading to the continuous transformation and upgrading of industries. However, some scholars held a different view. Chen [5] discovered, based on a semi-parametric spatial panel vector autoregression model, that while technology selection hindered short-term economic growth, it promoted overall regional economic growth in the long term.

Government subsidies are a crucial element in the process of industrial structure adjustment. The policy strategy of "technological innovation and government support" was explicitly put forward during the Fourth Plenary Session of the 18th CPC Central Committee, which highlighted the importance of industrial policies in promoting the rationalization and high-level development of regional industrial structures [6]. Tang [7] contended that government subsidies could facilitate the rational allocation of production factors, break through the many restrictions that industry adjustment would face in natural monopoly industries, and accelerate the process of industrial structure adjustment. Liu [8] believed that tax and subsidy measures could indirectly guide enterprises to invest in R&D activities at the optimal social level, making the industrial structure adjustment more timely and targeted.

However, some scholars argued that decision-making errors in industrial structure adjustment in some departments, as well as the temporal nature and non-uniformity of multi-target subsidies, slowed down the industrial structure adjustment process in some regions, and even created new structural imbalances [9]. Wang [10] posited that after government subsidies were invested in enterprises, they might not have effectively stimulated technological innovation, and the unclear concept of government subsidies on enterprise specialization had reduced their guiding role. Zhang [11] used a VAR model to analyze the dynamic impact of government subsidies on emerging, traditional, and backward industries and found that government subsidies only had a significant impact on emerging industries, while fiscal revenue policies had a weaker impact on traditional and backward industries.

In summary, although many scholars have discussed the impact of technology selection or government subsidies on industrial structure upgrading, there is still considerable controversy over the research conclusions, and only a few studies have provided theoretical explanations for industrial structure upgrading. This article intends to combine existing research to theoretically explain the relationship between technology selection and government subsidies and industrial structure, and use panel data from 31 provinces and cities in China for empirical testing, providing more reliable research conclusions.

## 2. Theoretical Model Analysis

This article aims to investigate the impact of technology selection and government subsidies on industrial structure by employing the Cobb-Douglas production function. Specifically, this article assumes that urban output can be described by the following functional form:

$$Y = AK^\alpha L^\beta G^\gamma \quad (1)$$

Where  $Y$ ,  $A$ ,  $K$ ,  $L$ , and  $G$  respectively represent urban output, level of technological progress, capital input, labor input, and government subsidies.  $\alpha$ ,  $\beta$ , and  $\gamma$  represent the output elasticity of capital, labor, and government subsidies, respectively, and  $\alpha + \beta + \gamma = 1$ .

Similarly, we construct the production function of each industry in the city:

$$Y_i = A_i K_i^{\alpha_i} L_i^{\beta_i} G_i^{\gamma_i} \quad (2)$$

The symbols in the above formula have the same meaning as equation (1), and  $\alpha_i + \beta_i + \gamma_i = 1$  needs to be satisfied. The subscript  $i=1, 2, 3$  represents the primary industry, secondary industry, and tertiary industry, respectively.

The variables are expressed in per capita form, and the variables are defined as:

$$\bar{Y} = \frac{Y}{L}, \bar{K} = \frac{K}{L}, \bar{G} = \frac{G}{L} \tag{3}$$

$$\bar{Y}_i = \frac{Y_i}{L_i}, \bar{K}_i = \frac{K_i}{L_i}, \bar{G}_i = \frac{G_i}{L_i} \tag{4}$$

Dividing both sides of equations (1) and (2) by  $L$  and  $L_i$ , respectively, we obtain the following per capita production functions:

$$\bar{Y} = A\bar{K}^\alpha\bar{G}^\gamma \tag{5}$$

$$\bar{Y}_i = A_i\bar{K}_i^{\alpha_i}\bar{G}_i^{\gamma_i} \tag{6}$$

Referring to the method of Lin [2] and Huang [3], the technology selection index is defined as the ratio of the capital-labor ratio of an industry to that of the entire region. This index reflects the degree to which the economic development strategy of an industry deviates from the comparative advantage of the region. The formula is:

$$TCI_i = \frac{K_i/L_i}{K/L} = \frac{\bar{K}_i}{\bar{K}} \tag{7}$$

By combining equations (5), (6), and (7), we can deduce that:

$$\bar{Y}_i = \frac{A_i}{A^\alpha} (TCI_i)^{\alpha_i} (\bar{Y})^{\frac{\alpha_i}{\alpha}} (\bar{G})^{(\gamma_i - \frac{\alpha_i}{\alpha}\gamma)} \tag{8}$$

From the above equation, it can be seen that per capita output of the industry is closely related to the per capita output level of the region, industrial technology selection, and government subsidies. In the case where the output elasticity of capital is positive ( $\alpha_i > 0$ ), the per capita output level of the industry is positively correlated with the industry's technology selection. This shows that changing the resource endowment structure, promoting the deepening of industry capital, and improving the ratio of industry capital to labor can effectively increase industrial productivity.

The effect of government subsidies on per capita output of the industry depends on the size of the output elasticity of capital and the output elasticity of government subsidies, defined as:

$$\eta = \frac{\gamma}{\alpha} = \frac{dY/Y}{dG/G} \div \frac{dY/Y}{dK/K} = \frac{dK/K}{dG/G} \tag{9}$$

$\eta$  can be explained as the elasticity of capital government subsidies, which measures the change in capital investment with an increase of one unit of government subsidies. When  $\eta_i > \eta$ , it indicates that the increase of government subsidies in the city will lead to a greater increase in capital investment in industry  $i$  than the average level of the entire region. At this time,

government subsidies have a positive effect on per capita output of the industry. Conversely, when  $\eta_i < \eta$ , it indicates that the increase of government subsidies in the city will lead to a smaller increase in capital investment in industry  $i$  than the average level of the entire region. At this time, government subsidies will have a negative impact on per capita output of the industry. This means that for industries with a high elasticity of capital government subsidies, their productivity is greatly affected by policies, and local governments should increase their support for such industries to improve output levels.

In theory, industrial structure upgrading refers to the process or trend of the transformation of industrial structure from a lower form to a higher form. In empirical studies, indicators that measure industrial structure mainly include the proportion of the tertiary industry in GDP, the output value ratio of each industry, and the proportion of intermediate services paid in the production cost of manufacturing [12-14]. It can be seen that the current discussion among scholars on industrial structure mainly focuses on the evolution process from industry to the service sector, but neglects the evolution process from agriculture to industry. Currently, in many provinces of China, the proportion of agricultural output value to GDP is still large, such as Guangxi, Guizhou, Heilongjiang and other provinces. Therefore, this study considers both the industrial structure upgrade from agriculture to industry and from industry to service industry, and measures the industrial structure by per capita output of the industry.

Based on equation (8), the per capita output ratio of the secondary industry and the primary industry can be derived as:

$$IS_{21} = \frac{\bar{Y}_2}{\bar{Y}_1} = \frac{TCI_2^{\alpha_2} A_2}{TCI_1^{\alpha_1} A_1} A^{\frac{\alpha_1 - \alpha_2}{\alpha}} \bar{Y}^{\frac{\alpha_2 - \alpha_1}{\alpha}} \bar{G}^{(\gamma_2 - \gamma_1 + \frac{\alpha_1 - \alpha_2}{\alpha} \gamma)} \quad (10)$$

The per capita output ratio of the tertiary industry and the secondary industry is:

$$IS_{32} = \frac{\bar{Y}_3}{\bar{Y}_2} = \frac{TCI_3^{\alpha_3} A_3}{TCI_2^{\alpha_2} A_2} A^{\frac{\alpha_2 - \alpha_3}{\alpha}} \bar{Y}^{\frac{\alpha_3 - \alpha_2}{\alpha}} \bar{G}^{(\gamma_3 - \gamma_2 + \frac{\alpha_2 - \alpha_3}{\alpha} \gamma)} \quad (11)$$

The variables  $IS_{21}$  and  $IS_{32}$  measure the industrial structure upgrade. Taking equation (10) as an example to analyze the factors affecting the industrial structure upgrade from agriculture to industry, the analysis of equation (11) is similar to that of equation (10), which will not be repeated in this paper.

Firstly, the technological selection level of each industry. Technological selection that favors the secondary industry is conducive to the upgrading of the industrial structure from agriculture to industry, while the technological selection of the primary industry will hinder the process of optimizing the industrial structure.

Secondly, the technological progress of each industry and urban technological progress. The technological progress of the secondary industry is conducive to the optimization of urban industrial structure, while the technological progress of the primary industry will hinder the process of optimizing the industrial structure. The impact of urban technological progress on industrial structure depends on the capital output elasticity of each industry. If  $\alpha_1 - \alpha_2$  is positive and the larger the value, the larger impact of urban technological progress on the upgrading of the industrial structure.

Thirdly, the per capita output level of the city. The impact of the per capita output level of the city on the industrial structure depends on the capital output elasticity of each industry. If  $\alpha_2 - \alpha_1$  is positive and the larger the value, the more favorable the per capita output of the city is to the optimization and upgrading of the industrial structure.

Fourthly, the per capita government subsidy of the city. The impact of the per capita government subsidy of the city on the industrial structure depends on the size of the government subsidy output elasticity and the capital output elasticity. Only when  $\gamma_2 - \gamma_1 + \frac{\alpha_1 - \alpha_2}{\alpha} \gamma > 0$ , increasing government subsidies is conducive to accelerating the optimization process of the urban industrial structure. However, when  $\gamma_2 - \gamma_1 + \frac{\alpha_1 - \alpha_2}{\alpha} \gamma < 0$ , increasing government subsidies will hinder the optimization process of the industrial structure. This also explains why many scholars have found that government subsidies cannot accelerate the process of industrial structure optimization, and even hinder the upgrading of the industrial structure.

### 3. Empirical Analysis

#### 3.1. Model Specification

Based on the theoretical analysis in the previous section, the influence of technology selection and government subsidies on industrial structure is greatly affected by the specific characteristics of the industry and regional development, which have strong industry-specific and regional-specific characteristics. In this paper, we establish a provincial panel data model to test the impact of urban technology selection and government investment in science and education on industrial structure.

First, we define the relative technology selection indicators  $RTCI^{21}$  and  $RTCI^{32}$  as follows:

$$RTCI^{21} = \frac{TCI_2}{TCI_1}, RTCI^{32} = \frac{TCI_3}{TCI_2} \quad (12)$$

Where the  $RTCI^{21}$  index reflects the proportion of technology selection bias towards the second industry over the first industry. The larger the  $RTCI^{21}$  index, the greater the bias towards industrial development in agriculture and industry, which measures the degree of emphasis on industry in regional development strategies. The  $RTCI^{32}$  index reflects the proportion of technology selection bias towards the third industry over the second industry. The larger the  $RTCI^{32}$  index, the greater the bias towards the development of the service industry in industry and service sectors, which measures the degree of emphasis on the service industry in regional development strategies.

Based on the above setting, take the logarithm of Equation (10) and Equation (11) respectively to obtain the following linear regression equation:

Equation 1: First Industry-Second Industry:

$$\ln(IS_{i,t}^{21}) = \alpha_i + \beta_1 \ln(RTCI_{i,t}^{21}) + \beta_2 \ln(\bar{Y}_{i,t}) + \beta_3 \ln(\bar{G}_{i,t}) + \varepsilon_{i,t} \quad (13)$$

Equation 2: Second Industry-Third Industry:

$$\ln(IS_{i,t}^{32}) = a_i + b_1 \ln(RTCI_{i,t}^{32}) + b_2 \ln(\bar{Y}_{i,t}) + b_3 \ln(\bar{G}_{i,t}) + \mu_{i,t} \quad (14)$$

Where the explained variable  $IS_{i,t}$  represents industrial structure, the explanatory variables  $RTCI_{i,t}$ ,  $\bar{Y}_{i,t}$ ,  $\bar{G}_{i,t}$  respectively represent the relative technology selection between industries, per capita output, and per capita government subsidies.  $\varepsilon_{i,t}$  and  $\mu_{i,t}$  are random disturbance terms. Subscripts  $i$  and  $t$  represent cities and time, respectively.

### 3.2. Data Sources and Descriptions

This article selects the provincial macroeconomic data of 31 provinces and cities in China from 2014 to 2022, except for Hong Kong, Macau, and Taiwan, as the research object, with a total of 279 research samples. The data sources are the China statistical yearbook and the statistical yearbooks of various provinces.

The industrial structure indicators ( $IS^{21}$  and  $IS^{32}$ ) are expressed by the per capita output ratio of the second industry to the first industry and the per capita output ratio of the third industry to the second industry, respectively, obtained by the output and employment of each industry in the region, measured by the added value of each industry in the city and the number of employed people in each industry.

The per capita output ( $\bar{Y}$ ) of the city is measured by the ratio of regional GDP to the total employed population.

The per capita government subsidy in urban areas ( $\bar{G}$ ) is represented by the ratio of regional government subsidies to the total employed population. The general budget expenditure of local finance can mainly be divided into economic construction expenditure, administrative management expenditure, social security expenditure, education expenditure, scientific and technological expenditure, and other financial expenditure. Considering that only education expenditure and scientific and technological expenditure (referred to as sci-tech expenditure) have a significant impact on industrial structure upgrading, this paper measures government subsidies based on regional sci-tech expenditure.

The determination of the relative technical selection index ( $RTCI^{21}$  and  $RTCI^{32}$ ) requires the use of per capita capital of various industries in the region. Currently, there is no publicly available statistical data on the per capita capital stock of various provinces in China. This paper estimates based on existing literature. The measurement method of capital stock  $K_t$ , which is widely used at present, is the perpetual inventory method pioneered by Goldsmith [15], which can be expressed as follows:  $K_t = K_{t-1}(1 - \delta) + I_t$  is the actual investment, which is measured by the fixed asset investment of various industries in the region.  $\delta$  is the depreciation rate of capital, set at 9.6% according to the estimation results of Zhang [16]. Xu [17] estimated the capital stock of the three industries in each province from 1979 to 2002. Based on the research conclusions of Xu, this paper sets 2002 as the base year, estimates the capital stock of various industries in each province from 2003 to 2022, and calculates the technical selection level of various industries in the region.

### 3.3. Estimation of the Full Sample Industry Structure Model

This article uses the inter-provincial panel data mentioned above to estimate equation (13) and equation (14). First, it is necessary to test the form of parameter estimation and determine whether to use a mixed data model or a varying intercept model. The test results indicate the existence of individual effects, and a mixed regression model should not be used. Then, it is necessary to test whether to use a fixed effect model or a random effect model and conduct the Hausman test on the sample data. The results show that the assumption of a fixed effect model is met. Before conducting the regression analysis, a suitable econometric model must also be selected. Table 1 shows the estimation results of the fixed effect model (FE) and the feasible generalized least squares (FGLS) regression.

Regression results show that the results estimated by FGLS are significantly better than those estimated by the fixed effects model, from both the perspective of fitting goodness and variable significance, indicating the possible presence of autocorrelation or heteroscedasticity in the sample data. Therefore, this paper conducts regression analysis based on the estimation results of FGLS.

**Table 1.** Overall Sample Estimation Results

Explanatory variable	Regression equation 1, dependent variable $IS^{21}$		Explanatory variable	Regression equation 2, dependent variable $IS^{32}$	
	FE	FGLS		FE	FGLS
Intercept	-1.6326***	-2.0538***	Intercept	1.3286***	1.0384***
$\bar{Y}$	0.1621	0.2897***	$\bar{Y}$	-0.5418***	-0.4516***
$RTCI^{21}$	0.7533***	0.7923***	$RTCI^{32}$	0.6289***	0.6973***
$\bar{G}$	-0.1700	-0.1480*	$\bar{G}$	0.5662***	0.4670***
$Adj\_R^2$	0.9807	0.9933	$Adj\_R^2$	0.8988	0.9659
Sample size	279	279	Sample size	279	279

Note. \*, \*\*, \*\*\* respectively represent the significance levels of 10%, 5%, and 1%, and the standard error is in parentheses.

From Table 1, the P values of the relative technical selection coefficients all pass the significance level test of 1%, and their coefficient values are significantly greater than 0, indicating a significant positive impact of relative technical selection on the upgrading of industrial structure, which is consistent with the results of theoretical analysis. For every 1% increase in the ratio of per capita capital between the second and first industries, the per capita output ratio will increase by 0.7923%; for every 1% increase in the ratio of per capita capital between the third and second industries, the per capita output ratio will increase by 0.6973%. Based on this, it can be inferred that each province should choose a development strategy based on its actual factor endowment. During the transition from agriculture to industry, the technology selection should lean towards industry, while during the transition from industry to service, the technology selection should lean towards the service industry. A reasonable technology selection process can help promote the deepening of regional industrial capital and accelerate the optimization process of urban industrial structure.

Government subsidies have an impact on the industrial structure and the upgrading process of the regional industrial structure. In the process of the first industry evolving into the second industry, government investment in science and education has a negative impact on the industrial structure, and for every 1% increase in per capita government investment in science and education, the per capita output ratio between the second and first industries will decrease by 0.148%. This may be due to the fact that in areas where agriculture is the main industry, a large proportion of local science and education investment is used to improve agricultural production technology, and the proportion used for industry and service is relatively small, thereby hindering the optimization process of the industrial structure. In the process of the third industry evolving into the second industry, government investment in science and education has a significant positive impact on the industrial structure, and for every 1% increase in per capita government investment in science and education, the per capita output ratio between the third and second industries will increase by 0.467%. This indicates that for relatively developed cities, local governments pay more attention to the transfer of the industrial structure from industry to service, and the proportion of government science and education investment in the third industry is much higher than that in the second industry. This also shows that from the perspective of industrial structure upgrading, local government subsidies are not necessarily effective, and targeted and rational choices should be made based on the characteristics of the local industry.

The per capita output of cities also has a certain impact on the industrial structure, which helps to accelerate the process of the first industry upgrading to the second industry, while hindering the process of the second industry upgrading to the third industry. This indicates that an increase in per capita output in cities is more conducive to the development of regional industry.

### 3.4. Regional Effects Analysis of Industrial Structure Model

Given the significant differences in industrial structure among the eastern, central and western regions of China, this paper divides the sample provinces into three regions for study: the east, central, and west. The regional division criteria refer to the standards provided by the National Bureau of Statistics, and the specific division is shown in Table 2.

**Table 2.** Provincial Regional Division Standards

Region	Cities
Eastern Region	Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan
Central Region	Shanxi, Jilin, Hunan, Heilongjiang, Anhui, Jiangxi, Henan, Hubei,
Western Region	Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang

Before conducting panel regression analysis by region, it is still necessary to test the fixed effects and random effects of the model. The Hausman test results show that, except for the random effects exhibited in the eastern region of regression equation 1, all other models show compliance with the hypothesis of fixed effects models. Due to the existence of autocorrelation or heteroscedasticity among the sample data, the estimation results of FGLS are more significant. Therefore, the regional panel regression model only provides the estimation results of FGLS. The specific results are shown in Table 3.

**Table 3.** Regional Estimation Results

Explanatory variable	Regression equation 1, dependent variable $IS^{21}$			Explanatory variable	Regression equation 2, dependent variable $IS^{32}$		
	East	Central	West		East	Central	West
Intercept	-2.1386	-4.0658***	0.1305	Intercept	1.6400***	0.8910	-0.0964
$\bar{Y}$	0.2877	0.8492***	-0.3541**	$\bar{Y}$	-0.5761***	-0.3738	-0.1848
$RTCI^{21}$	0.7908***	0.8473***	0.7283***	$RTCI^{32}$	0.7851***	0.8828***	0.3735***
$\bar{G}$	0.0101	-0.3859***	0.1062	$\bar{G}$	0.4328***	0.5631***	0.2975
$Adj\_R^2$	0.7969	0.9918	0.9923	$Adj\_R^2$	0.9612	0.7427	0.8410
Sample size	99	72	108	Sample size	99	72	108
Hausman test (p-value)	0.2205	0.0079	0.0054	Hausman test (p-value)	0.0000	0.0022	0.0068
Model form	Random	Fixed	Fixed	Model form	Fixed	Fixed	Fixed

Note. \*, \*\*, \*\*\* respectively represent the significance levels of 10%, 5%, and 1%, and the standard error is in parentheses.

From the perspective of technical selection parameters, among the six sample groups, relative technical selection has a significant positive impact on industrial structure upgrading. However, in regression equation 1, the coefficient gap is not large, and there is no obvious regional effect. This indicates that for all provinces, increasing the proportion of per capita capital in the secondary industry during the process of the primary industry's evolution to the secondary industry can effectively accelerate the transformation of the industrial structure from agriculture to industry. The estimation results of regression equation 2 show a significant regional effect. The impact of relative technical selection on industrial structure upgrading is more than twice as high in the eastern and central regions as in the western region. This may

be because some areas in the west are still in the stage of agricultural to industrial development, and the relative imperfection of the service industry makes the effect of increasing the per capita capital proportion of the service industry on the improvement of industrial productivity less effective than in the central and eastern provinces with higher industrial structures.

From the perspective of government subsidy parameters, the estimated results in the western region are not significant, which may be due to the relatively scarce resources and backward development of the western region, and the relatively smaller scale of local government's investment in science and education, which cannot significantly promote the development of regional industries. For the central region, government subsidies have a significant impact on industrial structure. Increasing government investment in science and education will increase the per capita output ratio of the tertiary industry to the secondary industry, but will reduce the per capita output ratio of the secondary industry to the primary industry. This is because many provinces in the central region are at a critical period of transition from industrial dominance to service dominance, and the region will sacrifice some industrial development in accelerating the development of the service industry, thereby increasing the per capita output of the tertiary industry and inhibiting the development of the secondary industry. For the eastern region, government investment in science and education can significantly promote the upgrading of the secondary industry to the tertiary industry. This is because the proportion of the service industry in the eastern region is significantly larger than that in the central and western regions, and government investment in science and education is mainly used for the service industry, further improving the productivity of the service industry. However, the industrial structure of the eastern region is more advanced, and the government investment in science and education does not have a significant impact on the per capita output ratio of the secondary and primary industries.

#### 4. Conclusion and Policy Recommendations

This article constructs a model reflecting the relationship between technical selection, government subsidy, and industrial structure upgrading and theoretically explains the impact of technical selection and government subsidy on industrial structure upgrading. At the same time, panel data from 31 provinces and cities in China from 2014 to 2022 were used to further verify the relationship between the three. From the perspective of technical selection, national data estimates show that relative technical selection has a significant promoting effect on industrial structure upgrading, but this promoting effect is still very different among different regions, with the central and eastern regions being significantly larger than the western region. From the perspective of government subsidy, increasing local government investment in science and education has no significant impact on the industrial structure upgrading in the western region, and will significantly accelerate the upgrading of industrial structure from the secondary industry to the tertiary industry in the eastern and central regions, but will to a certain extent reduce the per capita output ratio of the secondary and primary industries in the central region. This conclusion also explains the phenomenon that the western development strategy did not achieve the desired results, although the government had overall planning and increased investment in the region, the effect was average, and the development of the region was relatively slow.

Based on the empirical research conclusions mentioned above, this paper puts forward the following suggestions for upgrading the industrial structure of cities in China: firstly, in the current stage of economic development in various provinces of China, local resource endowments should be relied on to formulate reasonable economic development strategies, promote industrial structure upgrading, enhance labor productivity, and achieve rapid economic growth through technological selection and reasonable capital deepening. Secondly,

when the economic scale of the region develops to a certain stage and the proportion of the secondary industry is shifted to the tertiary industry, the government should expand subsidies and accelerate the process of upgrading the industrial structure. At present, many cities in the central and eastern regions of China are in this stage, but the speed of transformation still needs to be strengthened, so the increase of government subsidies is also in a critical period. Thirdly, in terms of upgrading the industrial structure in western regions, the government should not increase science and education investment excessively or blindly learn high-tech and develop emerging industries. It should be based on the factor endowment structure of the province, develop industries with comparative advantages, and promote enterprises to introduce advanced technology from developed areas at low cost, and upgrade the factor endowment structure to drive the industrial structure to upgrade more quickly.

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