The Restraining Effect of Human Capital Mismatch and Structure Distortion on Economic Growth

-- A New Structural Economics Analysis

Chenyang Li[1]

[1] School of Economics, Nankai University, Tianjin, China

Correspondence: Chenyang Li, School of Economics, Nankai University, Tianjin, China.

Received: January 12, 2023 Accepted: February 16, 2023 Online Published: March 7, 2023

doi:10.5430/ijfr.v14n2p1 URL: https://doi.org/10.5430/ijfr.v14n2p1

Abstract

Based on the theory of new structural economics, this paper investigates the restraining effect of human capital mismatch and structural distortion on economic growth. First of all, this paper puts forward the core hypothesis through theoretical analysis, and then analyzes it by mathematical model, which shows that the human capital mismatch between monopoly departments and competitive departments will inhibit innovation efficiency, and then inhibit economic growth. The structural distortion of human capital in the two sectors will make industrial structure deviate from the comparative advantage, and then restrain economic growth. Secondly, using the provincial panel data of China from 2006 to 2019, this paper establishes the index of human capital mismatch and structural distortion to conducts empirical tests on the theoretical model. The conclusion shows that the uneven distribution of human capital among industries in China will restrain economic growth through human capital mismatch and structural distortion, while the latter has a greater impact, so structural distortion is the main reason why human capital accumulation cannot effectively promote economic growth, which is consistent with the basic theory of new structural economics.

Keywords: industrial distribution of human capital, human capital mismatch, human capital structure distortion, economic growth

1. Introduction

Since the reform and opening up, China's economy has achieved sustained and rapid growth, the average annual growth rate of China's GDP from 1979 to 2018 was 9.4%. At present, China is gradually shifting from rapid growth stage to high-quality development stage, which requires the transformation of economic development mode.

The academic research on human capital provides some references for China's economic transformation. Some scholars believe that human capital accumulation has a significantly positive impact on economic growth (Nelson&Phelps, 1966; Romer, 1990; Benhabib&Spiegel, 1994). With economic development, human capital will gradually replace physical capital as the main driving force for economic growth (Galor&Weil, 2000; Peretto, 2015; Justin Yifu Lin, 2019). In recent studies, some economists regard human capital accumulation as the determinant of differences in development degree among countries, and believe that human capital accumulation can effectively narrow the economic development gap between developing countries and developed countries (Cheshire&Margini,2000;Amitrajeet, 2013; Qadri&Waheed, 2013; Teixeira&Queiros, 2016), which provide some important references for China's sustained economic growth.

The above researches provide a theoretical framework for understanding the impact of human capital on economic growth, and provide some important references for understanding China's economic development. Under the practical demand of changing economic development mode, China has promoted the accumulation of human capital by expanding enrollment in universities, increasing education and research funds and other means on the basis of existing theories. The result is that the level of human capital has increased year by year. According to the theory of neoclassical economics, the premise for human capital accumulation to play its role in promoting economic growth is effectively allocating them to industrial sectors. However, the distribution of human capital among industries in China shows: high-skilled human capital is excessively concentrated in monopoly sectors that do not pursue

economic efficiency, while competitive sectors that aim at economic efficiency face the dilemma of insufficient human capital supply. There is a sharp difference in the average level of education year between the two sectors, which is as shown in Figure 1 and Figure 2:

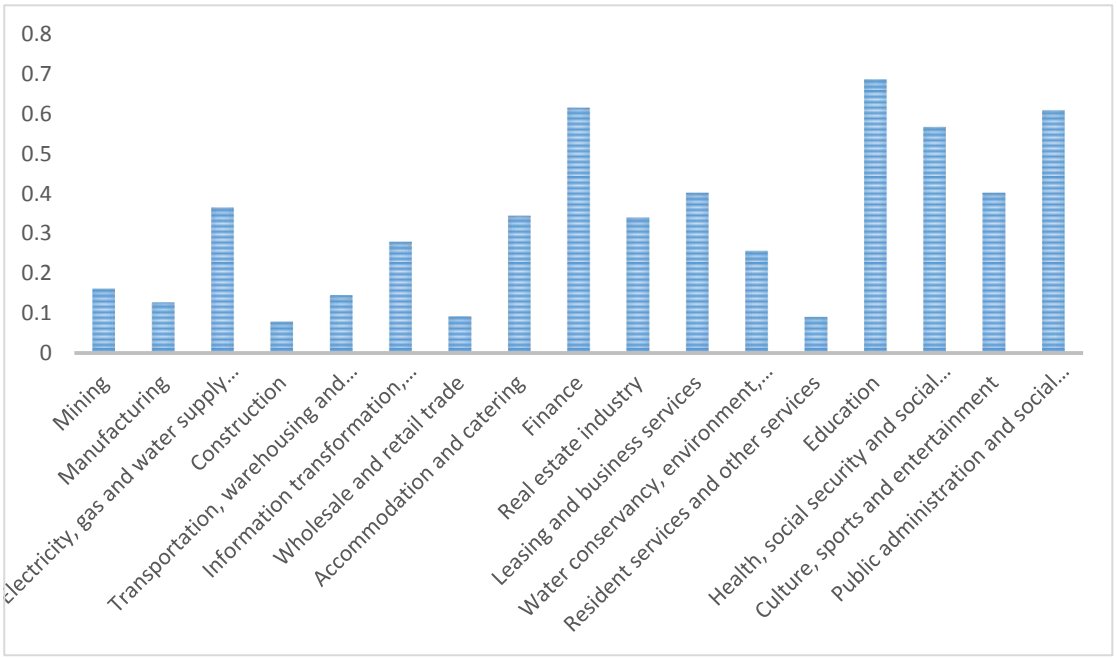

Figure 1. The average proportion of labor force with college education or above by industry from 2006 to 2019

Note: Among them, education, health, social security and social welfare, culture, sports and entertainment, public administration and social organizations are monopolistic sectors with strong government intervention, while the other 13 sectors are competitive industries. Data source: Calculated according to the data of China Labor Statistics Yearbook from 2006 to 2019.

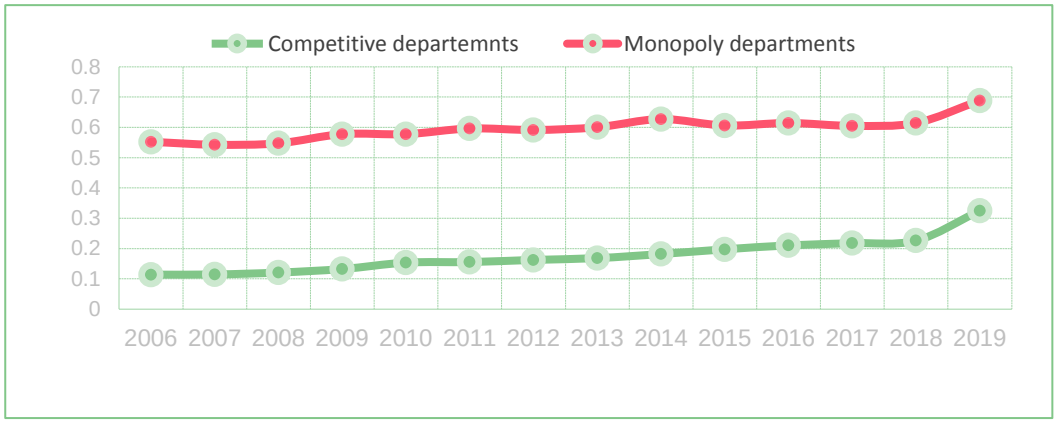

Figure 2. Proportion of labor force with college education or above in two departments from 2006 to 2019

Note: Data source: calculated according to the data of China Labor Statistics Yearbook from 2006 to 2019.

In addition, according to some researches, the promotion effect of human capital accumulation on China's economic growth is not obvious, and a large amount of education investment has not produced the expected effect, which is similar in many developing countries (Pritchett, 2001; Qadri&Waheed, 2014; Justin Yifu Lin, 2019). Why does China's human capital accumulation generates a very limited contribution to economic growth? Most of the existing

studies use the analytical framework of neoclassical economics to answer this question from the perspective of resource allocation failure. In order to answer this question, this paper uses the structural change equation of new structural economics to describe the distortion effect of human capital structure on industrial structure, thus revealing the restraining impact of human capital mismatch and structural distortion on economic growth. Different from the previous literature, this paper describes, measures and compares the impact of human capital mismatch and structural distortion at the same time, thus revealing that the factors that inhibit economic growth are mainly structural distortion rather than human capital mismatch. Therefore, the conclusions of new structural economics are more explanatory.

The rest of this paper is arranged as follows: The second part analyzes the theoretical mechanism and puts forward the core hypotheses. The third part establishes mathematical model to display the hypotheses. The fourth part introduces the empirical analysis, including data source, indicator selection and model setting. The fifth part reports the benchmark regression results, intermediary regression results and regression results with intermediary variables. Finally, the conclusion is given.

2. Theoretical Hypothesis

The relationship between human capital accumulation and economic growth is not a simple linear relationship. There is a complex transmission mechanism between them. Because of this, the uneven distribution of human capital in industries may have an important impact on China's economic growth through intermediary mechanism. This phenomenon shows two problems: first, the excessive concentration of human capital in monopoly departments, while the relative shortage of human capital in competitive departments, which means that the market allocation of human capital is ineffective, that is, the human capital mismatch between the two departments, which is emphasized by neoclassical economies. Secondly, it means the distortion of the supply and demand of human capital, which makes the arrangement of human capital structure deviate from the optimal human capital structure, that is, the structural distortion of human capital, which is emphasized by new structural economics. Therefore, the uneven distribution of human capital means the mismatch and structural distortion of human capital at the same time, both of which inhibit economic growth through different transmission paths. This paper hopes to reveal the transmission mechanism between human capital accumulation and economic growth through theoretical analysis, and on this basis, demonstrate the inhibitory effect of human capital mismatch and structural distortion on economic growth.

First, scholars have made many analyses on the transmission mechanism between human capital and economic growth. The impact of human capital on economic growth can be divided into direct and indirect impacts: 1. Human capital can improve the quality of workers, optimize the production process and improve productivity (Romer, 1990; Teixeira&Fortuna, 2010), which is the direct impact of human capital as production factor on economic growth. Secondly, the accumulation of human capital can help absorb foreign advanced technology on the one hand, and improve domestic innovation capacity on the other hand. They jointly improve innovation efficiency and indirectly drive economic growth (Strulik, 2005; Bucci, 2014), which is the indirect innovation effect of human capital. In addition to these two effects, Justin Yifu Lin (2019) believes that the accumulation of human capital endogenously determines the optimal industrial structure. The dynamic matching of human capital structure and industrial structure can give full play to the production capacity and effectively promote economic growth, which is the indirect structural effect of human capital. Therefore, when human capital is effectively accumulated, it will promote economic growth through direct effect, indirect innovation effect and indirect structure effect. The problem that the promotion effect of human capital accumulation on economic growth in China is not obvious may due to the failure of intermediary effect caused by uneven distribution of human capital.

Second, the mismatch of human capital between the two departments will inhibit indirect innovation effect, and then inhibit economic growth. The allocation of human capital in China makes a large number of high-skilled human capital redundant in monopoly and public service sectors. Most of these sectors serve the normal operation of an economy rather than pursuing economic efficiency, such as communications, railways, energy, government departments, etc. Personal wages within these departments usually do not change significantly with their contributions, so their innovation incentives are very low. Both high-skilled human capital and low-skilled human capital within these departments play a role in economic growth as production factors, and can not give full play to the innovation and intellectual advantages of high-skilled human capital. At the same time, the competitive departments cannot obtain enough high-skilled human capital. The economic goal of these departments is to pursue profits, and their economic efficiency has a great relationship with innovation, such as high-tech enterprises, Internet enterprises, knowledge intensive service industries, etc. In these departments, individual wages are closely related to their marginal contributions. The increase of individual contributions can bring about the improvement of wages to a

large extent, so their innovation incentives are very high. High-skilled human capital within these departments is engaged in innovative activities such as scientific research and innovation, product research and development, and its innovation and intellectual advantages can be brought into full play. Low-skilled human capital is used as production factor to participate in economic growth. Therefore, with the increase of human capital mismatch degree, more and more high-skilled human capital is redundant in monopoly sectors, while the high-skilled human capital required by competitive sectors is relatively lacking, which inhibits their innovation efficiency and further hinders economic growth (Baumol, 1990; Hsieh&Klenow, 2009; Sequeria, 2003; Vandenbusche, 2006; Raustiala&Sprigman, 2012; World Bank, 2014).

Therefore, this paper proposes the first hypothesis: The uneven distribution of human capital in industries is first manifested as the mismatch of human capital between the two departments, which will have a restraining effect on the overall innovation efficiency, and then inhibit economic growth.

Third, some scholars believe that the mismatch of human capital is not conducive to the upgrading of a country's industrial structure, and thus inhibits economic growth (Lucas, 1988; Young, 1993; Dash, 2006; Manca, 2009; Ciccone&Papaioannou, 2009), but they did not explain the internal relationship between human capital and industrial structure upgrading. Different from these scholars, Justin Yifu Lin (2019) explained the internal relationship between human capital and industrial structure. He believed that different industries have different demand for human capital, on this basis, the supply of human capital structure determines the optimal industrial structure endogenously, the industrial structure established conforms to its comparative advantage can operate with the maximum economic efficiency. Therefore, the accumulation of human capital indirectly promotes economic growth by promoting the upgrading of industrial structure.

In the presence of human capital structural distortion, the supply of human capital structure is higher than the demand of monopoly departments, which makes the actual level of industrial structure lower than the optimal industrial structure, thus inhibiting the indirect structural effect. The supply of human capital structure is lower than the demand of competitive sectors, making the level of industrial structure higher than the optimal industrial structure, thus inhibiting the indirect structural effect. The human capital structural distortion causes the industrial structure to deviate from their comparative advantages, thus inhibiting the play of the indirect structural effect and jointly inhibiting economic growth.

Based on the above analysis, this paper proposes the second hypothesis: The uneven distribution of human capital in industries is manifested as the structural distortion of human capital, which causes industrial structure to deviate from its comparative advantage, inhibit the play of indirect structural effect, and then inhibit economic growth.

3. Mathematical Model

3.1 The Influence Mechanism of Human Capital Accumulation on Economic Growth in Two Sectors

3.1.1 The Impact of Human Capital on Economic Growth in Monopoly Sectors

Because of the characteristics of monopoly sectors, both high-skilled human capital and low-skilled human capital are used as production factors to conduct production. Build Cobb Douglas production function of monopoly sectors (Mankiw, Romer and Weil, 1990):

$$Y_{Gt} = A_G K_G{}^{\alpha} H_{Gt}{}^{\beta_t} L_{Gt}{}^{\gamma} \tag{1}$$

G represents monopoly sectors; t represents time period; A_G And K_G respectively represent exogenous technology level and total capital stock; Y_{Gt}, H_{Gt} and L_{Gt} respectively represent the total output, total human capital and total labor force in period t. β_t represents the density characteristics of human capital in period t, $\alpha$and γ respectively represent the exogenous density characteristics of capital and labor elements. Assume $\alpha + \beta_t + \gamma = 1$, then the per capita production function is:

$$y_{Gt} = A_G k_G{}^{\alpha} h_{Gt}{}^{\beta_t} \tag{2}$$

y_{Gt} and h_{Gt} respectively represent the per capita output and per capita education years in period t. Under the condition that the characteristics of factor density remain unchanged, the per capita education years will directly affect the per capita output.

The theoretical logic of neoclassical economics is that a single department chooses the level of factor input to pursue profit maximization, that is

$$\max\{\pi(x) = py_{Gt} - rh_{Gt} - w\} \tag{3}$$

The optimization condition is:

$$r = p \cdot \frac{\partial y_{Gt}}{\partial h_{Gt}} \tag{4}$$

Where p is the price of unit output and r is the cost to be paid for per unit of education year. Under the condition that the total input for purchasing production factors is exogenous, the maximization of profit in the current period is equivalent to the maximization of per capita income in the current period, that is, the optimal per capita income:

$$\max\{py_{Gt} = \pi(x) + rh_{Gt} + w\} \tag{5}$$

Let the value creation function of labor force be:

$$v(\beta_t(h_{Gt})) = py_{Gt} - rh_{Gt} = py_{Gt} - p \cdot \frac{\partial y_{Gt}}{\partial h_{Gt}} h_{Gt} = pA_{Gt}{k_G}^{\alpha}{h_{Gt}}^{\beta_t}(1-\beta_t) \tag{6}$$

The derivative of the feature density is obtained:

$$\frac{\partial v}{\partial \beta_t} = pA_G{k_G}^{\alpha}{h_{Gt}}^{\beta_t}(\ln h_{Gt} - 1 - \beta_t \ln h_{Gt}) = 0 \tag{7}$$

The equation of industrial structure change is:

$$\beta_t = 1 - \frac{1}{\ln h_{Gt}} \tag{8}$$

$$y_{Gt} = A_G{k_G}^{\alpha}{h_{Gt}}^{\beta_t} = A_G{k_G}^{\alpha}{h_{Gt}}^{1-\frac{1}{\ln h_{Gt}}} = A_G \frac{1}{e}{k_G}^{\alpha}{h_{Gt}} \tag{9}$$

When the characteristics of factor density are variable, the economic growth brought by the change of human capital is:

$$\Delta y_G = \Delta h_G * \frac{\partial y_{Gt}}{\partial h_{Gt}} + \Delta h_G * \frac{\partial y_{Gt}}{\partial \beta_t} * \frac{\partial \beta_t}{\partial h_{Gt}} = \Delta h_G * A_G{k_G}^{\alpha}\frac{1}{e} \tag{10}$$

Among them, $\frac{\partial y_{Gt}}{\partial h_{Gt}}$ is the direct contribution of human capital as production factor, and $\frac{\partial y_{Gt}}{\partial \beta_t} * \frac{\partial \beta_t}{\partial h_{Gt}}$ is the indirect structural effect of human capital on economic growth. In monopoly sectors, the sum of the two is an exogenous given quantity, which will not change with the change of per capita education year. Therefore, the marginal contribution of human capital to economic growth is a positive constant when monopoly departments conform to comparative advantage to establish industrial structures.

3.1.2 Impact of Human Capital on Economic Growth in Competitive Sectors

Build the overall Cobb Douglas production function:

$$Y_{Mt} = A_{Mt}{K_M}^{\delta}{H_{ut}}^{\varepsilon_t}{L_{Mt}}^{\epsilon} = A_{Mt-1}(1+gH_{iMt}){K_M}^{\delta}(\theta_{Mt}H_{Mt})^{\varepsilon_t}{L_{Mt}}^{\epsilon} \tag{11}$$

$$A_{Mt} = A_{Mt-1}(1+gH_{iMt}) \tag{12}$$

M represents competition sectors; A_{Mt-1} indicates the technical level of the previous year; H_{iMt} represents the high-skilled human capital in period t; $1+gH_{iMt}$ represents the technological progress brought by high human capital in period t, which equals to g_t'; H_{uMt} refers to the low-skilled human capital in period t; H_{Mt} represents the total level of human capital in period t.

$$H_{uMt} + H_{iMt} = H_{Mt} \tag{13}$$

$$L_{Mt} = L_{imt} + L_{umt} \tag{14}$$

L_{Mt} represents the total labor force in the competitive sector, L_{imt} represents the number of labor force with high-skilled human capital, L_{umt} represents the number of labor force with low-skilled human capital.

$$\theta_{Mt} = 1 - \frac{L_{iMt}}{L_{Mt}} = \frac{L_{uMt}}{L_{Mt}} \tag{15}$$

$$L_{uMt} * h_{uMt} + L_{iMt} * h_{iMt} = h_{Mt} * L_{Mt} \tag{16}$$

$$\theta_{Mt} * h_{uMt} + (1-\theta_{Mt}) * h_{iMt} = h_{Mt} \tag{17}$$

h_{uMt} and h_{iMt} respectively represent the average education year of labor force with low-skilled human capital and

the average education year of labor force with high-skilled human capital, h_{Mt} indicates the per capita education level. Assume $\delta + \varepsilon_t + \epsilon = 1$, then the per capita production function is:

$$y_{Mt} = A_{Mt}(1 + gL_{Mt}(1 - \theta_{Mt}) * h_{Mt})k_M{}^{\delta}(\theta_{Mt}h_{mt})^{\varepsilon_t} = A_{Mt}(1 + g_t{}')k_M{}^{\delta}(\theta_{Mt}h_{mt})^{\varepsilon_t} \quad (18)$$

According to profit function, value creation function and their respective optimization conditions, we can get:

$$\max\{\pi(x) = p_M y_M - \sigma h_M - w\};\ \sigma = p_M \cdot \frac{\partial y_M}{\partial h_M} \quad (19)$$

$$v\big(\varepsilon(h_M)\big) = p_M y_M - \sigma h_M;\ \frac{\partial v}{\partial \varepsilon} = 0 \quad (20)$$

Get the feature of element density:

$$1 > \varepsilon = \frac{1}{1+gL_M(1-\theta_M)h_m} - \frac{1}{\ln\theta_M + \ln h_m} = \frac{1}{1+g_t{}'} - \frac{1}{\ln\theta_M + \ln h_m} > 0 \quad (21)$$

It can be seen that human capital in competitive sectors can affect economic growth through direct effect, indirect innovation effect and indirect structural effect:

$$\Delta y_M = \Delta h_M * \left(\frac{\partial y_{Mt}}{\partial h_{Mt}} + \frac{\partial y_{Mt}}{\partial \varepsilon_t} * \frac{\partial \varepsilon_t}{\partial h_{Mt}} + \frac{\partial y_{Mt}}{\partial g'} * \frac{\partial g'}{\partial h_{Mt}}\right) \quad (22)$$

$\Delta h_M * \frac{\partial y_{Mt}}{\partial g'} * \frac{\partial g'}{\partial h_{Mt}}$ is the indirect structural effect of human capital. $\Delta h_M * \frac{\partial y_{Mt}}{\partial g'} * \frac{\partial g'}{\partial h_{Mt}}$ is the indirect innovation effect of human capital.

$$\frac{\partial y_M}{\partial \varepsilon} * \frac{\partial \varepsilon}{\partial h_M} = A_{Mt}(1 + g')k_M{}^{\delta}(\theta_{Mt}h_{mt})^{\varepsilon_t} * (\ln\theta_M + \ln h_m) * \left\{\frac{1}{(\ln\theta_M + \ln h_M)^2 h_M} - \frac{g'}{(1+g')^2 h_m}\right\} > 0 \quad (23)$$

$$\frac{\partial y_{Mt}}{\partial g'} * \frac{\partial g'}{\partial h_{Mt}} = A_{Mt-1}k_M{}^{\delta} * g'\theta_{Mt}{}^{\varepsilon_t}h_{Mt}{}^{\varepsilon_t - 1} = A_{Mt-1}k_M{}^{\delta}gL_M(1 - \theta_M)\theta_{Mt}{}^{\varepsilon_t}h_{Mt}{}^{\varepsilon_t} > 0 \quad (24)$$

Therefore, the two indirect effects of human capital on economic growth in competitive sectors are greater than zero.

3.2 The Inhibition Effect of Human Capital Mismatch on Economic Growth

The structural effect is not considered here. From the analysis in the previous part, it can be seen that the difference between the impact of human capital on economic growth in monopoly and competitive sectors is mainly concentrated in indirect innovation effect. The human capital in competitive sectors can affect economic growth through direct effects, indirect innovation effects and indirect structural effects, while the human capital in monopoly sectors can only affect economic growth through direct effects and indirect structural effects. It can be seen from this that when human capital is excessively concentrated in monopoly departments, the exertion of innovation effect will be restrained by human capital mismatch. In addition, with the growth of per capita education year, the marginal contribution of human capital to economic growth through innovation efficiency is increasing:

$$\frac{\partial\left(\frac{\partial y_{Mt}}{\partial g'} * \frac{\partial g'}{\partial h_{Mt}}\right)}{\partial h_{Mt}} = \varepsilon_t A_{Mt-1}k_M{}^{\delta}gL_M(1 - \theta_M)\theta_{Mt}{}^{\varepsilon_t}h_{Mt}{}^{\varepsilon_t - 1} > 0 \quad (25)$$

Therefore, when the degree of human capital mismatch is growing, its inhibition effect on innovation will increase. This proves the first hypothesis proposed in this paper: The uneven distribution of human capital in industries is first manifested as the mismatch of human capital between the two departments, which will have a restraining effect on the overall innovation efficiency, and then inhibit economic growth.

3.3 The Restraining Effect of Human Capital Structural Distortion on Economic Growth

In the previous analysis, this paper assumes that the supply of human capital is matched with the demand of industrial structure for human capital. In fact, the uneven distribution of human capital in industries is not only reflected in the mismatch of human capital, but also in the structural distortion of human capital, which makes industrial structure deviate from comparative advantage, inhibits the play of indirect structural effects, and then inhibits economic growth.

3.3.1 Restraining Effect of Human Capital Structural Distortion on Economic Growth in Monopoly Sectors

A large number of high-skilled human capital is redundant in monopoly sectors, which makes the supply of human

capital is higher than the demand of industrial structure for human capital, it is reflected in the structural distortion of human capital. This makes the level of industrial structure of monopoly sectors lower than the optimal industrial structure with comparative advantages, inhibits the play of indirect structural effects, and thus inhibits the economic growth of monopoly sectors.

Assume that the factor density characteristics of monopoly sectors in the base period is $\beta_{t-1} = 1 - \frac{1}{\ln h_{Gt-1}}$. To meet the demand of industrial structure upgrading $\Delta\beta = \beta_t - \beta_{t-1}$, the required human capital upgrading is $\Delta h_G = h_{Gt} - h_{Gt-1}$. Human capital structural distortion is represented as $\Delta h_G{}' = h_{Gt}{}' - h_{Gt-1} > \Delta h_G$. The optimal industrial structure upgrading corresponding to $\Delta h_G{}'$ should be $\Delta\beta' > \Delta\beta$. At this time, the level of industrial structure is lower than the optimal industrial structure with comparative advantages: $\beta_t < \beta_t{}'$.

When there is no structural distortion, the economic growth brought by the accumulation of human capital is:

$$\Delta y_G{}' = \Delta h_G{}' * \frac{\partial y_{Gt'}}{\partial h_{Gt'}} + \Delta h_G{}' * \frac{\partial y_{Gt'}}{\partial \beta_{t'}} * \frac{\partial \beta_{t'}}{\partial h_{Gt'}} \tag{26}$$

When there is structural distortion, the economic growth brought by the accumulation of human capital is:

$$\Delta y_G = \Delta h_G{}' * \frac{\partial y_{Gt}}{\partial h_{Gt'}} + \Delta h_G{}' * \frac{\partial y_{Gt}}{\partial \beta_t} * \frac{\partial \beta_t}{\partial h_{Gt'}} \tag{27}$$

$\frac{\partial \beta_t}{\partial h_{Gt'}}$ means that human capital with a total amount of $h_{Gt}{}'$ and human capital with a total amount of h_{Gt} play an equal role in the upgrading of industrial structure, and can only upgrade the industrial structure to the level of β_t.

The restraining effect on economic growth is:

$$\Delta y_G - \Delta y_G{}' = \Delta h_G{}' * \frac{\partial y_{Gt}}{\partial h_{Gt}{}'} + \Delta h_G{}' * \frac{\partial y_{Gt}}{\partial \beta_t} * \frac{\partial \beta_t}{\partial h_{Gt}{}'} - \Delta h_G{}' * \frac{\partial y_{Gt}{}'}{\partial h_{Gt}{}'} + \Delta h_G{}' * \frac{\partial y_{Gt}{}'}{\partial \beta_t{}'} * \frac{\partial \beta_t{}'}{\partial h_{Gt}{}'}$$

$$= \Delta h_G{}' * \left(\frac{\partial y_{Gt}}{\partial \beta_t} * \frac{\partial \beta_t}{\partial h_{Gt'}} - \frac{\partial y_{Gt'}}{\partial \beta_{t'}} * \frac{\partial \beta_{t'}}{\partial h_{Gt'}}\right) \tag{28}$$

Where $\beta_t < \beta_t{}'$

$$\Delta y_G - \Delta y_G{}' = \Delta h_G{}' * \left(\frac{\partial y_{Gt}}{\partial \beta_t} * \frac{\partial \beta_t}{\partial h_{Gt'}} - \frac{\partial y_{Gt'}}{\partial \beta_{t'}} * \frac{\partial \beta_{t'}}{\partial h_{Gt'}}\right) < 0 \tag{29}$$

It can be proved that the structural distortion of human capital in monopoly departments will lead to the industrial structure level lower than the optimal industrial structure with comparative advantages, and eventually lead to the inhibition effect on economic growth.

3.3.2 Restraining Effect of Human Capital Structural Distortion on Economic Growth in Competitive Sectors

In competitive departments, the supply of human capital is lower than the demand of industrial structure for human capital, which is reflected in the structural distortion of human capital. This makes the level of industrial structure in competitive sectors is higher than the optimal industrial structure with comparative advantages, inhibits the play of indirect structural effects, and thus inhibits the economic growth of monopoly sectors.

Assume that the factor density characteristics of competitive sector in the base period is $\varepsilon_{t-1} = \frac{1}{1+g_{t-1'}} - \frac{1}{\ln\theta_{Mt-1} + \ln h_{Mt-1}}$. To meet the demand of industrial structure upgrading $\Delta\varepsilon = \varepsilon_t - \varepsilon_{t-1}$, the required human capital upgrading is $\Delta h_M = h_{Mt} - h_{Mt-1}$. Human capital structural distortion is represented as $\Delta h_M{}' = h_{Mt}{}' - h_{Mt} < \Delta h_M$. The optimal industrial structure corresponding to $h_{Mt}{}'$ should be $\varepsilon_1{}'$. At this time, the level of industrial structure is higher than the optimal industrial structure with comparative advantages: $\varepsilon_1 > \varepsilon_1{}'$.

When there is no structural distortion, the economic growth brought by the accumulation of human capital is:

$$\Delta y_M = \Delta h_M * \frac{\partial y_{Mt}}{\partial h_{Mt}} + \Delta h_M * \frac{\partial y_{Mt}}{\partial \varepsilon_t} * \frac{\partial \varepsilon_t}{\partial h_{Mt}} \tag{30}$$

When there is structural distortion, the accumulation of human capital $\Delta h_M'$ brings about a nominal upgrading of industrial structure $\Delta\varepsilon$, and in fact its economic efficiency cannot reach its optimal level when the industrial structure is ε_t, so this nominal upgrade is recorded as $\Delta\varepsilon'$, and economic growth is:

$$\Delta y_M' = \Delta h_M' * \frac{\partial y_{Mt}}{\partial h_{Mt}'} + \Delta h_M' * \frac{\partial y_{Mt}}{\partial \varepsilon_t'} * \frac{\partial \varepsilon_t'}{\partial h_M'} \tag{31}$$

The restraining effect on economic growth is:

$$\Delta y_M' - \Delta y_M = (\Delta h_M' * \frac{\partial y_{Mt}}{\partial h_{Mt}'} - \Delta h_M * \frac{\partial y_{Mt}}{\partial h_{Mt}}) + (\Delta h_M' * \frac{\partial y_{Mt}}{\partial \varepsilon_t'} * \frac{\partial \varepsilon_t'}{\partial h_M'} - \Delta h_M * \frac{\partial y_{Mt}}{\partial \varepsilon_t} * \frac{\partial \varepsilon_t}{\partial h_{Mt}}) \tag{32}$$

As human capital is positively related to per capita output, so

$$\Delta h_M' * \frac{\partial y_M}{\partial h_M'} - \Delta h_M * \frac{\partial y_M}{\partial h_M} < 0 \tag{33}$$

As human capital is positively correlated with industrial structure and industrial structure is positively correlated with per capita output, so

$$\Delta h_M' * \frac{\partial y_{Mt}}{\partial \varepsilon_t'} * \frac{\partial \varepsilon_t'}{\partial h_M'} - \Delta h_M * \frac{\partial y_{Mt}}{\partial \varepsilon_t} * \frac{\partial \varepsilon_t}{\partial h_{Mt}} < 0 \tag{34}$$

It can be seen that the uneven distribution of human capital makes the supply of human capital is lower than the demand of industry structure upgrading for human capital in competitive sectors, and industrial structure is nominally higher than its optimal industrial structure with comparative advantages. However, due to insufficient supply of human capital, this upgrading of industrial structure is inefficient and inhibits the play of indirect structural effects, which will have a restraining effect on economic growth. This proves the second hypothesis:

The uneven distribution of human capital in industries is manifested as the structural distortion of human capital, which causes industrial structure to deviate from its comparative advantage, inhibit the play of indirect structural effect, and then inhibit economic growth.

4. Variable Selection and Data Introduction

4.1 Explained Variables

The explained variable of this paper is China's economic growth. The logarithm of China's per capita GDP is selected to measure the change of per capita output (lngdp). In the robustness test, this paper takes the logarithm of China's per capita disposable income (lninc) as the replacement indicator of per capita output change.

4.2 Core Explanatory Variables

There are two core explanatory variables: the degree of human capital mismatch between the two departments and human capital structural distortion.

4.2.1 The Degree of Human Capital Mismatch Between the Two Departments (Humbs)

It is measured by the ratio of human capital concentration degree in monopoly departments to that in competitive departments. The specific steps of indicator calculation are as follows: First, obtain the employment structure data of the two sectors. Using the sum of employee number in state-owned units, urban collective units, state-owned joint ventures, collective joint ventures and wholly state-owned enterprises to represent the number of employees in monopoly sectors. Using the sum of employee number in ordinary joint ventures, joint stock limited companies, Hong Kong, Macao and Taiwan investment units, and foreign investment units to represent the number of employees in competitive sectors. Second, calculating the fitting indicator of human capital allocation. The China Labor Statistics Yearbook only provides the national data of education level by industry, we uses the weighted average education level of education sector, health and social work sector, culture sector, sports and entertainment sector, public management and social organization sector to represent the average education level of monopoly sectors. The weighted average education level of the other 13 profit oriented industries (Note 1) is used to represent the average education level of competitive sectors, and the proportion of college graduates and above in the two sectors is used as the fitting indicator of human capital allocation. Third, calculating the adjustment factor of human capital. Divide the fitting index of human capital allocation in the two sectors by their respective proportion of added value to GDP to obtain the human capital adjustment factor. Fourth, the employment structure of the two sectors is multiplied by their respective human capital adjustment factors to obtain the concentration intensity of human capital in the two

sectors. Then, the concentration intensity of human capital in monopoly sectors is divided by the concentration intensity of human capital in competitive sectors to obtain the mismatch degree of human capital in the two sectors, namely *Humbs*. The greater the absolute amount of this indicator, the greater the mismatch degree of human capital.

4.2.2 The Degree of Human Capital Structural Distortion (Hmstrbs)

It is measured by the difference between the supply of China's human capital structure and the optimal human capital in each period (Justin Yifu Lin, 2019). The specific steps of indicator calculation are as follows: First, obtain the data of per capita education year and per capita GDP of 22 developed countries from 1997 to 2019 (Note 2). Then obtain the fitting curve between per capita education year and per capita GDP (USD) through regression analysis, so as to obtain the optimal human capital in different development stages of developed countries. Second, China's per capita GDP is substituted into the fitting curve to obtain the optimal human capital level corresponding to the development level in different periods. Third, calculate the deviation from actual human capital structure to the optimal human capital structure, which shows the degree of human capital structural distortion, namely Humstrbs. The greater the absolute value of this indicator, the greater the degree of human capital structural distortion.

4.3 Intermediary Variable

4.3.1 Distortion Degree of Industrial Structure (Strubs)

In this paper, technology choice index (TCI_{it}) is used to measure the overall distortion degree of industrial structure of region i in period t. This indicator is defined as follows:

$$TCI_{it} = \frac{Indus_{it}/LI_{it}}{GDP_{it}/L_{it}} \tag{35}$$

$Indus_{it}$ represents the industrial added value of region i in period t; GDP_{it} is the gross domestic product of region i in period t; LI_{it} represents the industrial employment number of region i in period t; L_{it} represents the total number of labor force of region i in period t. The idea is that if industrial structure of an economy violates its comparative advantage, its industrial added value will be higher, and the amount of labor it absorbs will be lower. Thus, the degree of deviation from the technology choice index to its optimal state can be used to measure the distortion degree between industrial structure and endowment structure:

$$Strubs = TCI_{it} - TCI_{it}^{*} \tag{36}$$

Assuming that TCI_{it}^{*} is a positive constant number, thus TCI_{it} can be directly put into econometric model.

4.3.2 Technological Innovation Efficiency (Lninno)

Taking 2006 as the base period, the growth rate of the stock of invention patents is used to reflect the efficiency of technological innovation.

4.4 Control Variables

First, the degree of opening up (Open), which is measured by the proportion of total imports and exports of each province in GDP. Second, the degree of industrialization (Industry), which is measured by the proportion of the added value of the secondary industry in GDP. Third, the urbanization rate (Urban), which is measured by the proportion of urban population in the total population. Fourth, the proportion of state-owned enterprises (Soep), which is measured by the proportion of the number of state-owned enterprises in the total number of enterprises. Fifth, the perpetual inventory method is adopted to measure the physical capital stock in urban areas of each province. The calculation formula of the physical capital stock is:

$$K_{i2006} = \frac{I_{i2006}}{g+\delta} \tag{37}$$

K_{i2006} represents the capital stock of region i in the base year 2006, I_{i2006} represents the fixed asset investment of region i in the base year 2006, g and δ represents the investment growth rate and depreciation rate respectively. Among them, the data of I_{i2006} is taken from the China Statistical Yearbook, the value of g is calculated by the formula $g = \frac{I_{it}^{\frac{1}{n}}}{I_{io}}$, and the depreciation rate refers to the data used in the literature. Then we can calculate the capital stock of each region in 2006. Based on the data in 2006, we can calculate the capital stock of the following years:

$$K_{it} = \frac{I_{it}}{P_{it}} + (1-\delta)K_{it-1} \tag{38}$$

After calculating the physical capital stock of each province, the per capita physical capital stock k can be obtained.

The sample period of data selected in this paper is 2006-2019, including panel data from 30 provinces except Tibet, Hong Kong, Macao and Taiwan. The indicator data are mainly from China Statistical Yearbook, China Labor Statistics Yearbook, the database of the National Bureau of Statistics of China, China Economic and Social Big Data Research Platform (CNKI), the World Bank databank and CEIC databases. At the same time, interpolation and extrapolation are used to supplement some missing data. Descriptive statistics of each variable are shown in Table 1:

Table 1. Descriptive statistics of variables

Variables	Observation numbers	Mean	Standard deviation	Minimum Value	Maximum Value
Per capita national income (lngdp)	420	10.48	0.601	8.717	11.99
Per capita disposable income (lninc)	420	10.02	0.453	9.091	11.21
Human capital mismatch (Humbs)	420	96.23	213.7	6.581	2,141
Human capital structural distortion (Hmstrbs)	420	0.930	0.205	0.729	1.454
Industrial structure distortion (Strubs)	420	1.538	0.619	0.699	3.613
Technological innovation efficiency (lninno)	420	10.72	1.966	3.091	14.89
Economic openness (Open)	420	0.309	0.354	0.0128	1.708
Industrialization level (Industry)	420	0.405	0.0804	0.202	0.610
Urbanization rate (Urban)	420	0.547	0.137	0.275	0.942
Proportion of state-owned enterprises (Soep)	420	0.436	0.0963	0.214	0.665
Urban per capita capital stock (k)	420	103.3	74.83	17.38	368.6

5. Econometric Models

The regression model is set as follows:

$$lngdp_{it} = a + \alpha_1 Humbs_{it} + \sum_j \alpha_j control_{it} + \mu_i + u_t + \varepsilon_{it} \tag{39}$$

$$lngdp_{it} = a_1 + \delta_1 Humstrbs_{it} + \sum_j \delta_j control_{it} + \mu_i + u_t + \varepsilon_{it} \tag{40}$$

$$lninno_{it} = b + \beta_1 Humbs_{it} + \sum_j \beta_j control_{it} + \mu_i + u_t + \varepsilon_{it} \tag{41}$$

$$\mathrm{Strubs}_{it} = c + \gamma_1 \mathrm{Humstrbs}_{it} + \sum_j \gamma_j \mathrm{control}_{it} + \mu_i + u_t + \varepsilon_{it} \quad (42)$$

$$\mathrm{lngdp}_{it} = d + \theta_1 \mathrm{Humstrbs}_{it} + \theta_2 \mathrm{lninno}_{it} + \theta_3 \mathrm{Strubs}_{it} + \sum_j \theta_j \mathrm{control}_{it} + \mu_i + u_t + \varepsilon_{it} \quad (43)$$

Where

lngdp_{it} = Economic growth

Humbs_{it} = Human capital mismatch

$\mathrm{Humstrbs}_{it}$ = Human capital structural distortion

lninno_{it} = Technological innovation efficiency

Strubs_{it} = Industrial structure distortion

$\mathrm{control}_{it}$= control variables

μ_i, u_t and ε_{it} are region fixed effect, year fixed effect and random disturbance term respectively.

The specific estimation steps of empirical analysis are as follows: First, use formula (1) and formula (2) for regression. α_1 and δ_1 respectively reflect the overall inhibitory effect of human capital mismatch and human capital structure distortion on economic growth. Second, use equation (3) to regress and identify the inhibitory effect of human capital mismatch on innovation efficiency. Third, use equation (4) to regress and identify the restraining effect of human capital structural distortion on structural effect. Fourth, add two intermediary variables and use Formula (5) to regress, in order to identify the direct and indirect inhibitory effect of excessive concentration of human capital in monopoly sectors on economic growth.

6. Regression Results and Empirical Analysis

6.1 Benchmark Regression and Robustness Test

In the analysis of panel data, it is necessary to test the model setting to determine the empirical analysis form of the model. Therefore, mixed effect regression is made at first. Secondly, the fixed effect regression is carried out. The P value in F test is 0, indicating that fixed effect regression is better than mixed effect regression. Thirdly, the random effects model is tested. The LM test rejected the original hypothesis that there is no individual random effects, indicating that the random effect regression is better than the mixed effect regression. At last, the Hausman test indicates that fixed effect regression is better than random effect regression, and we choose fixed effect model. Based on this, this paper uses the fixed effect model to test the inhibitory effect of excessive concentration of human capital in monopoly sectors on economic growth.

In order to identify the overall inhibitory effect of human capital mismatch and human capital structural distortion on economic growth, this paper uses formula (1) and formula (2) to conduct benchmark regression and robustness test. Table 2 shows the benchmark regression results. The result in column (1) of Table 2 shows that the coefficient of Humbs is significantly negative (-0.0001) at the significance level of 1%, which represents the overall inhibitory effect of human capital mismatch on economic growth. In order to control the problem of missing variables, column (2) adds four control variables to conduct estimation. In order to control endogenous problems that may be caused by two-way causality, column (3) uses 1 period lag of the core explanatory variable as tool variable, and use GMM method to conduct estimation. It can be found from column (2) and column (3) that the absolute value of the coefficient of Humbs has declined, but it is still negative at the significance level of 5% and 10% respectively, which shows that the mismatch of human capital in the two sectors does have a restraining effect on economic growth.

Then, use human capital structure distortion (Humstrbs) to conduct regression analysis. The result of column (4) shows that the coefficient of Humstrbs is significantly negative (-2.5439) at the significance level of 1%. Three control variables are added in column (5). In column (6), the proportion of state-owned enterprises (Soep) is used as the tool variable of Humstrbs, and GMM method is used for regression. It can be seen from the regression results that although the coefficient of Humstrbs has changed, it is always negative at the significance level of 1%, which means that the structural distortion of human capital has an overall inhibitory effect on economic growth.

Table 2. Benchmark regression

	lngdp			lngdp		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Humbs	-0.0001***	-0.0000362**	-0.0000338*			
	(-4.95)	(-2.07)	(-1.70)			
L.Humbs			0.7461***			
			(4.61)			
Humstbs				-2.5439***	-2.4575***	-2.8737***
				(-41.09)	(-30.22)	(-17.42)
Soep		-0.3272**	-0.2981***			0.5534***
		(-2.87)	(-2.63)			9.15
Open		0.1844***	0.1799***		0.2287***	0.3774***
		(4.14)	(3.75)		(5.14)	(5.47)
Urban		1.4810***	1.3090***		1.4562***	0.5224
		(6.18)	(5.41)		(6.12)	(1.41)
Industry		1.2277***	1.1850***		1.3205***	1.5259***
		(5.33)	(5.31)		(6.20)	(6.87)
Cons	10.6543***	9.1175***	10.5523***	14.3357***	12.4320***	13.4995***
	(238.75)	(44.98)	(50.56)	(194.99)	(48.54)	(32.30)
Province fixed effect	control	control	control	control	control	control
Year fixed effect	control	control	control	control	control	control
Observation numbers	420	420	390	420	420	420
R^2	0.98	0.99	0.99	0.98	0.99	0.99

Note: t value are in parentheses; *, ** and *** represent the significance levels of 10%, 5% and 1%, respectively. The below is the same.

In order to ensure the robustness of estimation results, this paper replaces the change of per capita GDP (lngdp) with the change of per capita disposable income (lninc), and then repeats the regression analysis of column (1) - (6). It can be seen from column (7) - (9) that the coefficient of Humbs is always negative at the significance level of 1%. In column (10) - (12), the coefficient of Humstrbs is still negative at the significance level of 1%. These analyses can ensure the robustness of the inhibitory effect of human capital mismatch and human capital structure distortion on economic growth to some extent.

Table 3. Robust Test

	lninc			lninc		
Variables	(7)	(8)	(9)	(10)	(11)	(12)
Humbs	-0.0000353***	-0.0000331***	-0.0000397***			
	(-3.98)	(-3.34)	(-4.60)			
L.Humbs			0.7461***			
			(4.61)			
Humstbs				-2.2798***	-2.2587***	-2.3465***
				(-113.84)	(-54.83)	(-31.97)
Soep		-0.0797*	-0.1221***			0.5534***
		(-1.66)	(-2.68)			(9.15)
Open		0.0157	-0.0134		0.0306	0.0620*
		(0.54)	(-0.43)		(1.07)	(1.84)
Urban		0.0951	0.0679		0.1083	-0.0887
		(0.84)	(0.57)		(0.95)	(-0.51)
Industry		-0.0573	-0.1533*		-0.0689	0.0364
		(-0.59)	(-2.68)		(-0.07)	(0.40)
Cons	9.8762***	9.8444***	11.1701***	13.1851***	13.0339***	13.2590***
	(620.52)	(100.79)	(103.55)	(489.12)	(99.11)	(65.48)
Province fixed effect	control	control	control	control	control	control
Year fixed effect	control	control	control	control	control	control
Observation numbers	420	420	390	420	420	420
R^2	0.99	0.99	0.99	0.99	0.99	0.99

From the above analysis, it can be seen that although both human capital mismatch and structural distortion have significantly negative impact on economic growth, the coefficient of human capital structural distortion is much higher than that of human capital mismatch. After considering their different units, the former may be the most important cause for the restraining effect of uneven human capital distribution on economic growth, which means that the theory of new structural economics have stronger capacity for explaining.

6.2 Mediation Effect Analysis

In order to identify the intermediary mechanism of excessive concentration of human capital in monopoly sectors on economic growth, this paper continues to use formula (3) and formula (4) for testing. Table 4 shows the estimated results and robustness test results of formula (3) and formula (4). The coefficient of human capital mismatch (Humbs) in column (1) is significantly negative, which means that human capital mismatch has a restraining effect on innovation efficiency. In order to ensure the robustness of this result, human capital structure distortion (Humstrbs) is used to replace Humbs for regression, and its coefficient in column (2) is still significantly negative. The coefficient of Humstrbs in column (4) is significantly positive, which means that human capital structural distortion has a restraining effect on industrial structure upgrading. To ensure the robustness of this result, human capital mismatch (Humbs) is used to replace Humstrbs for regression, and its coefficient in column (3) is still significantly positive.

From the above regression results, we can find an important information: although both human capital mismatch and structural distortion have significantly negative impact on technology progress and industrial structure upgrading, the

coefficient of human capital structural distortion is much higher than that of human capital mismatch, which may means that structural distortion rather than human capital mismatch is the most important factor for mediation effect.

Table 4. Mediation regression and robust test

	lninno		Strubs	
Variables	(1)	(2)	(3)	(4)
Humbs	-0.0000694*		0.0006301***	
	(-1.70)		(10.34)	
Humstbs		-7.3164***		0.9023***
		(-34.70)		(3.30)
lnk	0.0016***	0.0017***		
	(3.86)	(4.04)		
Soep			-0.7896***	
			(-2.47)	
Open			-0.5589***	-0.5715***
			(-4.08)	(-4.23)
Urban			-1.6958**	-2.3247***
			(-2.38)	(-3.11)
Industry			1.9226***	1.3247*
			(2.70)	(1.69)
Cons	9.3409***	9.8444***	3.4869***	2.4740***
	(117.91)	(100.79)	(5.87)	(3.02)
Province fixed effect	control	control	control	control
Year fixed effect	control	control	control	control
Observation numbers	420	420	420	420
R^2	0.99	0.99	0.85	0.85

6.3 Regression Analysis With Intermediate Variables

On the basis of benchmark regression and intermediary regression, this paper adds intermediary variables and takes structural distortion of human capital (Humstrbs) as the core explanatory variable to carry out the final regression analysis. The regression results and robustness test results are shown in Table 5. The result of column (1) is the overall inhibitory effect of Humstrbs on economic growth when the control variables are added. The estimated coefficient of Humstrbs is significantly negative (-2.4575) at the significance level of 1%. On the basis of column(1), intermediary variables lninno and Strubs is added in column (2). The coefficients of the two variables are positive at the significance of 1%, which means that there exist intermediary effects. At this time, the absolute value of the coefficient of Humstrbs decreases (-1.6260) but still significant. While the human capital distribution plays a direct inhibitory effect, it will have indirect inhibitory effects on economic growth through intermediary variables.

In order to ensure the robustness of estimation results, we use lninc instead of lngdp to conduct regression. The result of column (3) is the overall inhibitory effect of Humstrbs on income growth when control variables are added. The coefficient of Humstrbs is significantly negative (- 2.2587) at the significance level of 1%. Intermediary variables are added in Column (4). The coefficient of lninno is significantly positive, while the coefficient of Strubs is significantly negative. At this time, the absolute value of the coefficient of Humstrbs decreases (- 2.0991) but still

significant, which means that intermediary effects exist. While playing a direct inhibitory effect, the core explanatory variable will have indirect inhibitory effects on economic growth through intermediary variables. Therefore hypothesis 1 and hypothesis 2 are proved by the above analysis, and their robustness is guaranteed.

It should be noted that when lngdp is taken as the explanatory variable, the coefficient of Strubs is positive, while when lninc is taken as the explanatory variable, the coefficient of Strubs is negative, which means that when a country ignores the supply of endowment structure and adopts a development strategy deviating from comparative advantages to develop economy, the economic level may be increased to a certain extent, but the disposable income of people will not increase effectively. Typical examples of this economic development mode are China's priority development strategy for heavy industry and the catching up strategy of some developing countries.

Table 5. Regression Results with Intermediate Variables and Robustness Test

	lngdp		lninc	
Variables	(1)	(2)	(3)	(4)
Humstrbs	-2.4575***	-1.6260***	-2.2587***	-2.0991***
	(-30.22)	(-10.08)	(-54.83)	(-35.73)
lninno		0.1137***		0.0170***
		(6.15)		(3.40)
Strubs		0.0537***		-0.0309***
		(3.83)		(-4.63)
Open	0.2287***	0.2427***	0.0306	0.0104
	(5.14)	(5.69)	(1.07)	(0.37)
Urban	1.4562***	1.3536***	0.1083	0.0024
	(6.12)	(5.71)	(0.95)	(0.02)
Industry	1.3205***	1.0863***	-0.0069	0.0096
	(6.20)	(5.52)	(-0.07)	(0.11)
Province fixed effect	control	control	control	control
Year fixed effect	control	control	control	control
Observation numbers	420	420	420	420
R^2	0.99	0.99	0.99	0.99

7. Conclusion

Based on the theory of new structural economics, this paper conducts mathematical and empirical analysis on the transmission path of human capital mismatch and human capital structural distortion on economic growth, thus explaining the restraining effect of uneven allocation of human capital on economic growth.

The following conclusions are drawn through theoretical analysis and mathematical models: human capital affects economic growth through direct effects and indirect structural effects in monopoly sectors, and affects economic growth through direct effects, indirect innovation effects and indirect structural effects in competitive sectors. The uneven distribution of human capital is firstly manifested as the mismatch of human capital in the two departments. Without considering the structural effect, the mismatch inhibit the innovation effect of competitive departments and further inhibits economic growth. The higher the degree of human capital mismatch, the higher the inhibition effect on innovation efficiency, and then the greater the inhibition effect on economic growth. Secondly, this phenomenon is manifested as the structural distortion of human capital. The structural distortion of human capital makes the actual industrial structure of monopoly sectors is lower than the optimal industrial structure determined by their

comparative advantages, and makes the actual industrial structure of competitive sectors is higher than the optimal industrial structure determined by their comparative advantages. The industrial structures of the two sectors are deviate from their comparative advantages and inhibit the play of indirect structural effects, and ultimately inhibit economic growth. The greater the structural distortion of human capital, the greater its restraining effect on economic growth.

Subsequently, this paper uses the provincial panel data of China from 2006 to 2019 to make benchmark regression and intermediary regression on the relationship between excessive concentration of human capital in monopoly sectors and economic growth. Benchmark regression results show that the mismatch of human capital and the structural distortion of human capital have overall inhibitory effect on economic growth respectively. The intermediary regression results show that both human capital mismatch and human capital structural distortion have restraining effect on technological innovation efficiency and positive impact on the deviation of production structure. The regression results after adding intermediary variables show that excessive redundancy of human capital have a direct inhibitory effect on economic growth, and indirect inhibitory effect on economic growth through intermediary variables.

Through the analysis of this paper, we can know that the relationship between human capital accumulation and economic growth is not a linear relationship. If the allocation efficiency of human capital is too low, the promotion of human capital to economic growth will be offset by human capital mismatch and structural distortion.

References

Amitrajeet, A. B., & Nijkamp, P. (2013). Human capital use, innovation, patent protection, and economic growth in multiple regions. *Economics of Innovation and New Technology*, *22*(2). https://doi.org/10.1080/10438599.2012.715823.

Barro, R. J. (2016). Economic growth and convergence, applied to China. *China & World Economy*, *24*(5), 5-19.

Baumol, W. J. (1990). Research on High School Economic Education: Discussion. *Journal of Economic Education*, *21*(3), 248-253.

Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development: Evidence from aggregate cross-country data. *Journal of Monetary Economics*, *34*(2), 143-173. https://doi.org/10.1016/0304-3932(94)90047-7

Bucci, A. (2014). Population, competition, innovation, and economic growth with and without human capital investment. *International Economic Review*, *61*(1), 61-84. https://doi.org/10.1007/s12232-013-0192-2

Cheshire, P., & Margini, S. (2000). Endogenous Processes in European Regional Growth: Convergence and Policy. *Growth and Change*, *31*(4), 455-479. https://doi.org/10.1111/0017-4815.00140

Ciccone, A., & Papaioannou, E. (2009). Human Capital, the Structure of Production and Growth. *Review of Economics and Statistics*, *91*(1), 66-82.

Dash, S. (2006). Human Capital as a Basis of Comparative Advantage Equations in Services Outsourcing: A Cross Country Comparative Study. *Information and Communication Technologies and Development*, 165-175.

Galor, O., & Weil, D. N. (2000). Population, technology, and growth: From Malthusian stagnation to the demographic transition and beyond. *American Economic Review*, *90*(4), 806-828.

Hsieh, C. T., & Klenow, P. J. (2009). Misallocation and Manufacturing TFP in China and India. *Quarterly Journal of Economics*, *124*(4), 1403-1448.

Justin, Lin, Y. F., & Fu, C. H. (2019). *Introduction to New Structural Economic*. Beijing: Higher Education Press.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42. https://doi.org/10.1016/0304-3932(88)90168-7

Manca, F. (2009). Human Capital Composition and Economic Growth at a Regional Level. *Regional Studies*, *46*, 1367-1388. https://doi.org/10.1080/00343404.2011.598503

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, *107*(2), 407-437.

Nelson, R. R., & Edmund, S. P. (1966). Investment in Humans, Technological Diffusion, and Economic Growth. *The American Economic Review*, *56*(3), 69-75.

Peretto, P. F., & Valente, S. (2015). Growth on a Finite Planet: Resources, Technology and Population in the Long

Run. *Journal of Economic Growth*, *20*(3), 305-317.

Pritchett, L. (2001). Where Has All the Education Gone?. *The World Bank Economic Review*, *15*(3), 367-391.

Qadri, F. S., & Waheed, A. (2014). Human capital and economic growth: A macroeconomic model for Pakistan. *Economic Modelling*, *42*(7), 66-76. https://doi.org/10.1016/j.econmod.2014.05.021

Raustiala, K., &Sprigman, C. (2012). *The Knock off Economy: How Imitation Sparks Innovation*. Oxford University Press.

Romer, P. (1990). Endogenous Technological Change. *Journal of Political Economy*, (5), 71-102.

Sequeria, T. N. (2003). High-tech Human Capital: Do the Richest Countries Invest the Most?. *B.E. Journal of Macroeconomics*, *3*(1), 1-28. https://doi.org/10.2202/1534-5998.1115

Strulik, H. (2005). The role of human capital and population growth in R&D-based models of economic growth. *Review of International Economic*s, *13*(1), 129-145. https://doi.org/10.1111/j.1467-9396.2005.00495.x

Teixeira, A. A. C., & Fortuna, N. (2010). Human capital R&D, trade, and long-run productivity: Testing the technological absorption hypothesis for the Portuguese economy, 1960-2001. *Research Policy*, *39*(2), 335-350. https://doi.org/10.1016/j.respol.2010.01.009

Teixeira, A., & Queiros, A. (2016). Economic Growth, Human Capital and Structural Change: A Dynamic Panel Data Analysis. *Research Policy*, *45*(8), 1636-1648. https://doi.org/10.1016/j.respol.2016.04.006.

Vandenbussche, J., Aghion, P., & Meghir, C. (2006). Growth, Distance to Frontier and Composition of Human Capital. *Journal of Economic Growth*, *11*, 97-127.

Young, A. (1993). Invention and Bounded Learning by Doing. *Journal of Political Economy*, *101*(3), 443-472.

Notes

Note 1. These 13 industries include: mining, manufacturing, production and supply of electricity, gas and water, construction, transportation, warehousing and postal services, information transmission, computer services and software, wholesale and retail, accommodation and catering, finance, real estate, leasing and business services, water environment and public facilities management, residential services and other services.

Note 2. The data is from Barro (2016).