

# A New Explanation for Changes in China's Labor Income Share: Capital Heterogeneity

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**Abstract:** In this paper, a two-sector general equilibrium model with Putty-Clay technology is constructed, and the characteristics of capital heterogeneity are depicted in the model in the form of capital goods productivity variance. Through the capital selection mechanism, the impact of capital heterogeneity on labor income share is explored. It is found that the inverted U-trend of relative capital heterogeneity in capital-intensive industries is the cause. Second, the mechanism of capital heterogeneity affecting labor income share lies in the capital goods selection mechanism. With the increase of capital heterogeneity, the investment uncertainty faced by enterprises is strengthened. When choosing capital goods, enterprises will diversify investment and reduce capital intensity. After capital goods are put into production, firms will use high-productivity capital goods and shut down low-productivity capital goods, leading to a decline in capital utilization, the increase in total factor productivity, and the increase in output. Third, in the capital-intensive sector, the increase of capital heterogeneity will reduce, while in the labor-intensive sector, the opposite effect is presented. The new characteristics of Chinese capital and the change of labor income share, and has important policy reference significance for promoting.

**Keywords:** Labor Income Share; Capital Choice; Capital Heterogeneity

## 1. Introduction

Undoubtedly, labor and capital are the two most important elements in the initial distribution, so it is inevitable to study the share of capital income when discussing the share of labor income. The deepening of

capital will enable the economy to achieve unbalanced growth, and capital will achieve unequal distribution in the two sectors and affect the share of labor in total income (Acemoglu and Guerrieri, 2008)[1]. Some scholars believe that China's biased technological progress is conducive to increasing the marginal output of capital but will deteriorate the distribution status of labor income (Wang Linhui et al., 2018)[2]. As information technology continuously progresses, the important role of capital in income distribution is reflected in both the total level and the continuously increasing heterogeneity of capital at the structural level. Generally speaking, capital heterogeneity is reflected in two aspects: firstly, new capital goods are often more productive than old ones; secondly, there are obvious differences in the productivity of capital goods during the same period. It is precisely because of the increased capital heterogeneity and the broadened scope of capital goods selection of enterprises that enterprises tend to use capital goods with higher productivity to replace those with lower productivity, thus promoting their technological level and output level. Therefore, in the two sectors with different factor intensities, if the capital heterogeneity of the capital-intensive sector increases, then the overall share of labor income will decrease, and vice versa. Based on this, the starting point of this paper is focusing on the fact that capital heterogeneity may play an important role in affecting labor income share. By constructing a macro general equilibrium model, capital heterogeneity is included in the analysis framework, and the impact of this theoretical mechanism on China's labor income share is measured quantitatively using macroeconomic data.

## 2. Typical Facts

### 2.1 From a Macro Perspective, Capital Formation Rate Show a Reverse Changing Tendency.

capital investment has continued to grow, which significantly promoted the transformation of traditional industries, the renewal of old equipment, as well as the upgrading of production technology. In 2022, China's total social fixed asset investment reached 57.21 trillion yuan, with an increase of 53.94 trillion yuan from 2000. This pattern of paying more attention to assets and less attention to labor leads to relatively low labor returns and labor income share (Chen Binkai and Lin Yifu, 2012)[3], and the resulting technological progress is generally capital-biased (Zhang Shangfeng and Lu Xueqin, 2016)[4]. Therefore, investment has become an important entry point to understanding China's economic growth.

Fig. 1 shows capital formation rate since 2000. Among them, the macro labor income share is calculated by the income approach based on the GDP calculation results, and the sharp in 2004 and the sharp rise in labor income share in 2008 are partly caused by the adjustment of statistical caliber. If the impact of statistical caliber adjustment is not considered, the macro labor income share is generally U-shaped, of which before 2010 is a decline period and after 2010 is a slow rise period. Besides, before around 2009, decreased while the capital formation rate continued to rise, and the capital formation rate gradually decreased. It should be noted that the statistical caliber was adjusted in 2004 and 2008. Therefore, from 2004 to 2008, the positive correlation between capital formation rate and labor income share needs to be treated cautiously. So it can be seen that there is a significant negative correlation between capital formation rate and labor income share.

### 2.2 From The Micro Perspective, the Overall Capital Heterogeneity of Enterprises has Increased, and the Relative Capital Heterogeneity Has Shown an Inverted U-Shaped Tendency.

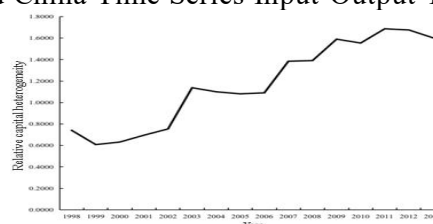
This paper focuses more on the horizontal difference of capital goods, that is, the

variance of the productivity of capital goods in the same age. As the variance of capital goods productivity is closely related to the realization of investment return on capital goods, and higher capital heterogeneity leads to an increase in average productivity (Ishise, 2016)[5], capital heterogeneity can be embodied by the productivity variance of capital goods. From the the micro-enterprise level, the return on capital is grouped by year to calculate the annual capital heterogeneity, and it can be seen that the capital heterogeneity of listed companies shows an upward tendency during the sample period (as shown in Fig.2). Due to a clear listing threshold for listed companies, the variance of their scale is generally smaller than that of all industrial enterprises, and the variance of their return on capital is also smaller, so the capital heterogeneity of listed companies is significantly smaller than that of industrial enterprises, which verifies the explanation of the scale differentiation of labor income share (Lu Xueqin and Tian Lei, 2020; Autoret al., 2020), that is, enterprises As shown in Fig.3, the relative factor-intensive enterprises are distinguished according, and then the relative capital heterogeneity index is calculated, respectively. The results show that the relative capital heterogeneity continued to rise before 2005, and then gradually declined, showing an inverted U-shaped distribution as a whole.

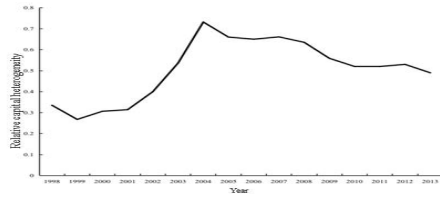


**Figure 1. Labor Income Share and Capital Formation Rate**

Data source: CEINET Statistical Database and China Time Series Input-Output Table



**Figure 2. Annual Capital Heterogeneity of Listed Companies**



**Figure 3. Relative Capital Heterogeneity of Listed Companies**

Data source: CSMAR  
Data source: CSMAR

### 3. Model Construction

Based on the studies carried out by Gilchrist and Williams (2000, 2005) and Ishise (2016), a two-sector general equilibrium model including Putty-Clay technology was constructed. A group of literature related to the theoretical model of this paper includes the studies conducted by Gilchrist and Williams (2000, 2005). Gilchrist and Williams (2000) explored the impact of average productivity of Vintage Capital on capacity utilization, working hours and economic output by constructing a standard real business cycle (RBC) model including Putty-Clay technology. Based on this, Gilchrist and Williams (2005) further studied the horizontal capital heterogeneity, that is, the impact of the variance of capital productivity on economic output and working hours, and believed that the increased capital heterogeneity led to the expanded choice range of capital goods. The contribution made by Gilchrist and Williams (2000, 2005) is that they applied the Putty-Clay technology to the RBC model, thus providing a general framework for the modeling of the Putty-Clay technology. The model essentially traces the technology shock to the selection mechanism of different capital goods, which explains the source of exogenous technology shock and supplements the RBC model. However, this literature are based on the single-sector Cobb-Douglas production function, so they are only suitable for analyzing the total quantity problem, but difficult to analyze. The literature that is most relevant to the proposed theoretical model is the literature of Ishise (2016)[6]. Ishise (2016) further expanded the model of Gilchrist and Williams (2005) to a two-country two-sector model, proving that capital heterogeneity, namely the variance of capital productivity,

is an important source of comparative competitive advantage in international trade. Meanwhile, they also explained that the selection mechanism caused by capital heterogeneity would lead to a market pattern in which firms with high-productivity capital goods would serve more foreign markets, and those with low-productivity capital goods would serve more domestic markets. The model developed by Ishise (2016) further enriched the application scope of the Putty-Clay technology modeling, so that it can be used to analyze international trade issues[7-8].

The theoretical core of this paper lies in the capital selection mechanism, that is, due to the increased capital heterogeneity, the scope of capital goods selection of enterprises will expand, and enterprises will use capital goods with higher productivity to replace those with lower productivity, thus promoting their technical level and output level. Therefore, in the two sectors with different factor intensities, if the capital heterogeneity of the capital-intensive sector increases, the overall share of labor income will decrease, and vice versa. To this end, in this paper, a two-sector general equilibrium model was constructed to demonstrate in detail. The model is characterized by the choice of endogenous capital density and capacity utilization rate based on the Putty-Clay technology. The specific performance is that, one is the risk dispersion in advance, which means that enterprises will “put eggs into more baskets” in the face of increased investment uncertainties, thereby increasing investment and reducing capital density per unit machine; The other is the selection mechanism of capital goods, which means that after determining the machine productivity, enterprises will use machines with higher productivity to replace those with lower productivity and increase productivity and output through the reallocation of labor. Based on this selection mechanism, the enhancement of capital heterogeneity increases in the proportion of corporate output. Therefore, if the capital heterogeneity of capital-intensive enterprises increases more significantly, the overall labor income share will decrease; on the contrary, if the capital heterogeneity of labor-intensive enterprises increases more

significantly, the overall labor income share will increase[9-10].

The construction process of the theoretical model is as follows: first of all, describe the setting of the model; secondly, based on the economic environment of zero growth, the general proposition that capital heterogeneity affects labor income share under steady state is obtained; Thirdly, the economic environment of balanced growth is introduced to obtain the corresponding steady-state value; Finally, the parameter calibration and numerical simulation are carried out.

#### 4. Parameter Calibration and Numerical Simulation

##### 4.1 Parameter Calibration

For the above model under balanced growth, its exogenous parameters were calibrated and the impact of capital heterogeneity shocks on the steady state was simulated. Generally speaking, there are two main methods for the assignment of structural parameters in the model: one is calibration, and the other is estimation. The calibration method is mainly used in this study, mainly referring to the existing literature and related data to confirm the specific parameters. This method has obvious advantages and is simple and convenient, but it is often criticized for its insufficient reality fitting. Considering that the purpose of this part is mainly to analyze the impact of capital heterogeneity shock on labor income share rather than to accurately simulate the real economy, it is believed that the calibration method is also desirable. To carry out the correlation operation, the initial values of some variables are also needed. The specific calibration is as follows:

In this paper, China's input-output time series table is used to calculate the labor income share as the estimated value  $\alpha$  of the labor share. Specifically, labor-intensive industries and capital-intensive industries are distinguished in this paper. The former mainly includes the light industry and service industry, while the latter mainly includes the heavy industry. The mixed income of China's agricultural sector is all classified as labor compensation, but the production of the agricultural sector, especially the smallholder production

process, uses a lot of agricultural capital goods, so the labor income share of the sector will be overestimated. Further, the average labor income share of labor-intensive and capital-intensive industries is obtained as the estimated value of labor income share in this paper. Therefore, the average labor income share in labor-intensive and capital-intensive industries is 0.40 and 0.47, respectively.

Referring to Zhuang Ziguan et al. (2012) and Chen Yanbin et al. (2019), the time discount factor  $\beta$  is set to 0.099, and by referring to Ye Mingqing and Fang Ying (2012) and Wang Haibing (2017), the depreciation rate is set to 0.096. In addition, according to Ishise (2016), the proportion  $\psi$  of leisure in utility is set to 0.25. The growth rate  $g$  is set to 0.09 based on the average growth rate of China's economy during the sample period. According to the proportion of light industry and heavy industry consumption in the input-output table,  $\epsilon$  is set to 0.20. The average productivity of capital  $\tilde{\theta}$  is set according to Ishise (2016), and it is set to 1 in both sectors. As for the setting of capital heterogeneity, Gilchrist and Williams (2005) set it to 0.2 to match the average capacity utilization rate of the United States. Therefore, the setting of capital heterogeneity in this paper refers to the measurement of China's capacity utilization rate by Yu et al. (2018). To match the average capacity utilization rate of 74 % and 65 %, the variance representing capital heterogeneity is set to 0.26 and 0.31, respectively.

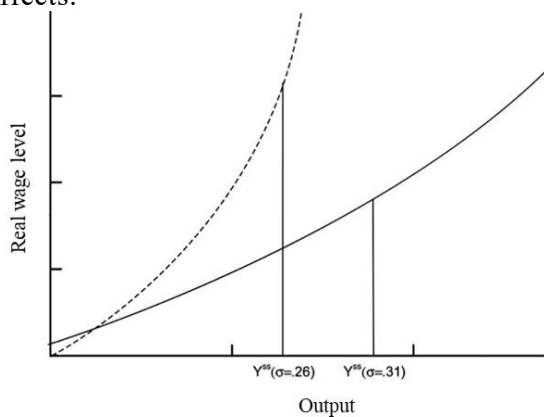
$\beta$	$\psi$	$\tilde{\theta}$	$\alpha_A$	$\alpha_B$	$\sigma^A$	$\sigma^B$	$\epsilon$
0.99	0.25	1	0.53	0.6	0.26	0.31	0.2

##### 4.2 Numerical Simulation

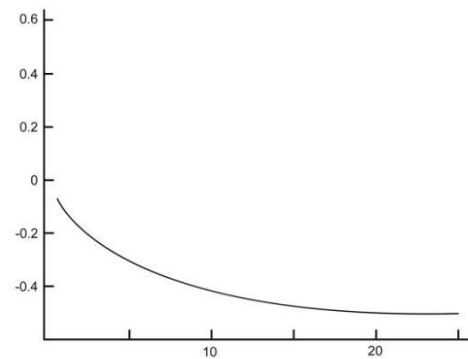
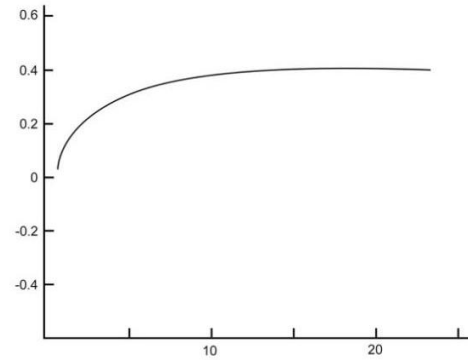
In this paper, the impact of capital heterogeneity on the economy is discussed from the perspective. In the short term, the capital density is set to a fixed value to study the impact of capital heterogeneity shocks on the premise of a lack of capital selection mechanism. The short-term exploration paves the way for understanding the mechanism of the model and the understanding of long-term changes below. Specifically, as shown in Fig.4, lower capital heterogeneity will lead to a steeper

short-term supply curve. In other words, when capital heterogeneity is lower, the short-term supply curve is less elastic. As the output increases, the marginal cost or wage rate rises faster. The logic behind it is that in the short term, capital, that is, “machine”, is fixed, and there is no entry or exit of capital goods. Labor chases among the limited capital goods, but the labor contained in a single capital goods is limited, so there will be a phenomenon that “labor competes for capital”, leading to the rise of the wage rate. In the case of less capital heterogeneity, the productivity of capital goods is more homogeneous, the wage rate rises faster, and the elasticity is smaller. In other words, labor can chase more productive machines when heterogeneity is greater.

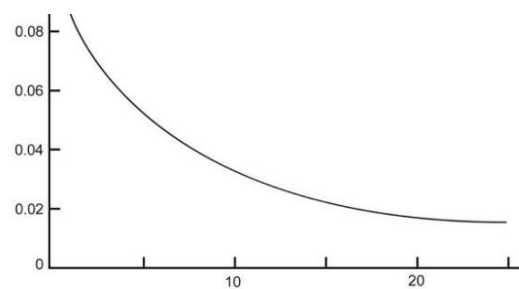
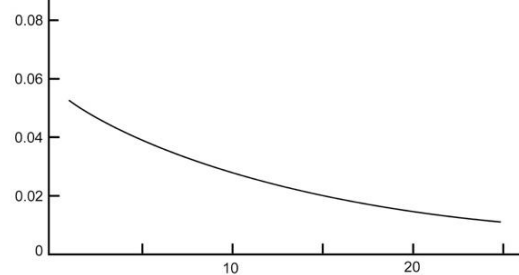
Figs. 5 and 6 show the influence of a positive impact of one percentage point of capital heterogeneity on the output share and total factor productivity of the two sectors. Among them, the left side of Fig.5 but began to rise very slowly and remained stable within 45 years. The right figure shows the impact of one percentage point of capital-intensive capital heterogeneity on the share of total labor income, and it can be found that the response of the share of total labor income decreased rapidly at first, but began to decline very slowly and remained stable within 4 or 5 years. According to these two figures, it can be found that the capital heterogeneity impact of the capital-intensive sector negatively affects the labor income share, while the capital heterogeneity impact of the labor-intensive sector positively affects.



**Figure 4. Short-Term Impact of Capital Heterogeneity**



**Figure 5. Impact of Capital Heterogeneity Impact on Labor Income Share**



**Figure 6. Impulse Response Diagram of Capital Heterogeneity Impact on Total Factor Productivity**

The two figures in Fig. 6 show the influence of capital heterogeneity impact on the growth rate of total factor productivity in one percent of labor-intensive sectors and capital-intensive sectors. It can be found that its growth rate shows an upward tendency, and the capital heterogeneity of capital-intensive sectors has a higher impact on its

total factor productivity. However, the growth of total factor productivity is gradually declining.

### 5. Conclusion

the Putty-Clay technology was constructed, the characteristics of capital heterogeneity were characterized in the model in the form of capital goods productivity variance. It was found that, first of all, the inverted U trend of relative capital heterogeneity is the cause of the U trend of China's labor income share; Secondly, the mechanism of capital heterogeneity affecting labor income share lies in the selection mechanism of capital goods. After the capital heterogeneity increases, the investment uncertainty faced by enterprises will strengthen. Enterprises often diversify their investment and reduce capital intensity when choosing capital goods; after the machine is put into operation, enterprises will use more capital goods with higher productivity to replace those with lower productivity through the selection mechanism of capital goods, resulting in a declined capital utilization and increased total factor productivity and output;

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