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The Influence of Capital Deepening on Regional Economic Development Gap: The Intermediary Effect of the Labor Income Share

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Abstract: At the same time as economic development, the imbalance problem in regional economic development is prominent, which hinders sustainable economic development, especially in China. Explaining the causes of unbalanced regional economic development is an important scientific problem in current economic research. Here, this study takes China as the empirical research area and uses China's inter-provincial panel data to deeply analyze the impact of capital deepening on the regional economic development gap. As indicated by this study, after a series of potential factors (e.g., industrial proportion, foreign direct investment, and per capita GDP) of the regional development gap are controlled, the capital deepening measured using perpetual inventory can have a strong explanatory power for the regional development gap, i.e., the greater the value of capital deepening, the more significant the regional development gap will be. According to the above conclusion, the effect arising from capital deepening on the regional development gap is still significant, even after the Soviet Aid Project is employed as the current instrumental variable of capital deepening, as well as after the data from the world sample are estimated The study further finds that capital deepening does not directly affect the regional development gap but indirectly affects the regional development gap by affecting the labor income share. Therefore, a higher labor share can narrow the regional development gap.

Keywords: economic development; regional gap; capital deepening; labor income share

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1. Introduction

Since the introduction of the reform and opening-up, China's economy has been leaping forward. Between 2002 and 2017, China's GDP grew at an average annual rate of 9.41% (100 in 2001), and the per capita gross national income (GNI) was up-regulated to the middle-income level. On that basis, China has advanced to the world's second-largest economy. However, despite the above remarkable achievements, China's economic growth rate is declining on a year-to-year basis, and the problem of unbalanced development in China's regions has become increasingly prominent, which has progressively become a major constraint on China's sustainable economic development, social stability, and achievement of common prosperity [1–3]. For instance, in 2017, the average gap between the five provinces with the maximum regional development gap and the five provinces with the minimum regional development gap was 1.886 times, thereby indicating that unbalanced regional development remains a serious problem. Accordingly, Chinese economists and policy-makers should primarily explain the cause of unbalanced regional economic development.

Since the Second World War, mankind has been constantly suffering from global population expansion, energy crisis, excessive resource consumption, serious environmental pollution, climate change, desertification, biodiversity reduction, unemployment, poverty, disease, North–South divide, global security, etc., which have aroused great concern among

many scientists, politicians, and social figures [4,5]. In this context, the theories and actions of sustainable development emerged at a historic moment and became familiar and detailed in the world. The United Nations has also held many meetings to discuss sustainable development. In the last 30 years, through continuous exploration and practice, sustainable development theory has concluded the following three consensuses: (1) the need to adhere to scientific and technological innovation to overcome growth stagnation (provide growth impetus); (2) wealth must not be increased at the expense of the ecological environment (maintaining the quality of development); (3) joint construction and sharing must be realized to promote social harmony and overcome social unrest and disorder (seeking fairness in development) [6]. Sustainability involves economic, political, cultural, social, and other aspects. We also know that the economic foundation determines the political, cultural, and other superstructures, which should be the most fundamental. The regional imbalance of economic development, which in turn leads to the unfairness of development, is one of the important contents of sustainable development Therefore, it is of great significance to study the regional economic development gap and its influencing factors for enriching the sustainable theory and realizing sustainable development.

China has been recognized as the biggest developing country in the world, ranking in the list of high-income nations, and after the reform and opening-up, the development strategy is used for rapid development, whereas the inequalities are also growing [7]. However, few studies have discussed the development gap between provinces from the perspective of prefecture-level cities. To make up for the lack of current research, this paper takes China as the empirical research area and uses relevant data to deeply analyze the correlation between capital deepening and the regional development gap to provide scientific reference for the development of the world economy. The main contribution of this study is to reveal the correlation between capital deepening and the regional development gap as an attempt to provide a novel perspective on the development gap between provinces in China and provide an important reference for the attribution of the development gap between countries in the world and within countries, as well as for taking effective countermeasures. At the same time, this study more effectively solves the endogeneity problem in the existing empirical literature and will construct the instrumental variable of capital deepening using the interaction between the number of Soviet construction projects and the time from the present, the study results should more accurately identify the impact of capital deepening on the regional development gap.

The main arrangement of this study is as follows. Part 2 is primarily intended as a literature review. Part 3 presents the main data sources, basic models, and empirical strategies. Part 4 mainly provides the preliminary regression results and robustness test. Part 5 analyzes the labor income share as the mechanism for deepening the regional development gap. Part 6 draws the conclusions and suggestions of this study.

2. Literature Review

The world economy underwent a brief recovery after the outbreak of the financial crisis. Subsequently, with the slowdown of the economic growth in other nations; China's economy has entered a "new normal" (Figure 1). According to the report of the 19th CPC National Congress, socialism with Chinese characteristics has entered a new era, and the principal contradiction facing Chinese society has evolved into the contradiction between unbalanced and inadequate development and the people's ever-growing needs for better lives (Xi Jinping, 《Decisive Victory in Building a Well-off Society in All Aspects and Striving for the Great Victory of Socialism with Chinese Characteristics in the New Era—Report at the 19th National Congress of the CPC》, People's Publishing House, 2017). Notably, narrowing the unbalanced regional economic development acts as an integral component. The inequality of economic development is of critical significance to economic development and is a concern for scholars worldwide. Since the 1980s, the foreign-related scholars' research literature on economic inequality has mushroomed [8–13], and then relevant domestic studies began to emerge rapidly. As indicated by the existing research results,

numerous factors cause China's regional development gap to widen constantly, and they can roughly fall into two types. One is endogenous factors (e.g., capital and labor force), while the other refers to exogenous factors (e.g., policy and geographical factors).

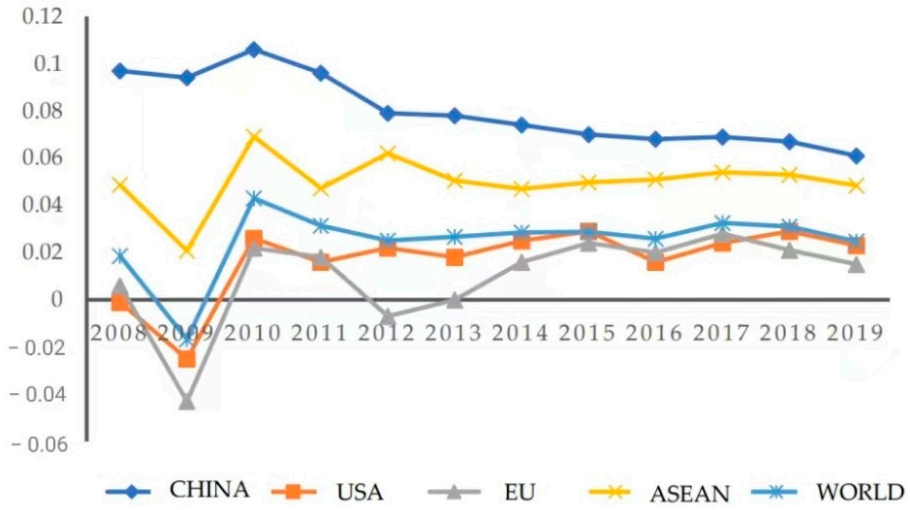

Figure 1. Changes in economic growth rate from 2008 to 2019. Explanation: 1. Data source: wind database; 2. The economic growth rate is measured using the GDP growth rate at a constant price; 3. The EU represents 27 EU members, and ASEAN represents 5 ASEAN members.

For endogenous factors, high-speed capital accumulation was always considered the most significant contributor to China's economic growth [14]. Capital deepening is a necessary stage for industrialization, and it is capable of boosting industrial structure upgrading, improving labor productivity, and achieving rapid economic growth [15]. Undoubtedly, the "Matthew Effect" may be formed, and the regional development gap will be progressively widened with the rapid economic growth. Moreover, the reasons for the regional income gap in China are explained as the labor capital gap, economic scale gap, as well as the total factor productivity, After studying the regional economic gap with the Solow residual value method and variance decomposition, it is found that capital accumulation contributes 60–75% to the regional gap [16,17].

For exogenous factors, the regional gap in domestic investment, especially the significant difference in investment efficiency, primarily accounts for the long-term existence of the regional economic gap. The differences in infrastructure investment, foreign investment, location, industrialization, urbanization, and others have further enlarged the regional development imbalance in China [18]. For example, the development strategy of the central and western regions is closer to the strategy that violates the comparative advantage than that of the eastern regions [19,20].

By the law of diminishing marginal return to capital, the marginal return to the capital of economically undeveloped regions is higher than that of economically developed regions, their economic growth rate is relatively fast, and their income level will progressively approach that of developed regions [21]. However, this is not the case, capital cannot flow spontaneously from developed regions to economically underdeveloped regions. Arising from the depletion of the "demographic dividend" and the squeezing of labor price distortion space by factor market reform, the decline of capital return in less developed regions has not changed the flow of capital, forming the "Lucas paradox", which has led to more capital factors as the main source of economic growth flowing to the developed regions, which, undoubtedly, further increases the imbalance of development between regions. Since the introduction of the reform and opening-up, China has implemented the strategy of regional economic development, thus, directly widening the regional development gap. With the widening of the regional development gap, the prosperity and development of China's economy were enhanced in the short term, whereas in the long term, it

will hinder China's rapid economic growth and its building of a moderately prosperous society in all respects.

To summarize, the regional development gap has a crucial impact on economic growth in the eastern, central, and western regions in China (Figure 2); In the face of the objective fact that global economic growth is slowing down, it is particularly important to explore the factors that affect the regional development gap. However, although economists and scholars have demonstrated economic growth and the imbalance of regional economic development from different perspectives, few scholars have comprehensively interpreted the causes of regional economic disparities. According to Figure 3, the capital deepening and regional development gap represented by China's average fluctuate in a range of directions. Most scholars have studied from the perspective of factors of economic growth, whereas rare scholars discussed the factors affecting the regional development gap and, thus, causing the slowdown of economic growth. Thus, this study will focus on the effect of capital deepening on the regional development gap, investigate the mechanism behind the correlation between the two, i.e., the intermediary effect of the labor income share, and then, discuss the reasons for the effect of capital deepening on the regional development gap.

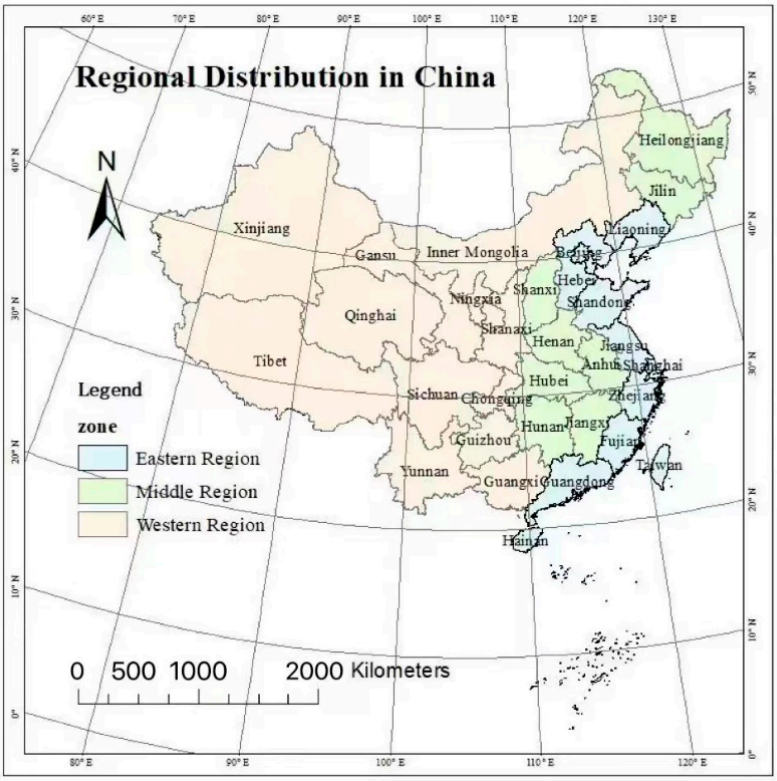

Figure 2. Eastern, central, and western regions in China.

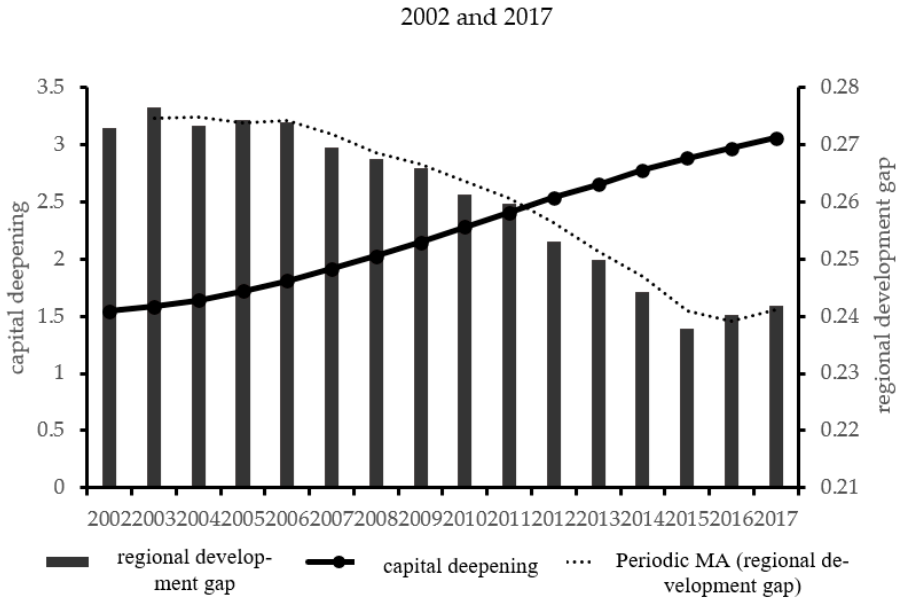

Figure 3. Changes in capital deepening and regional development gap between. Explanation: 1. The regional development gap index refers to the Gini coefficient calculated using the per capita GDP of the respective province and prefecture; 2. The capital deepening index is determined by obtaining the capital stock per capita of the respective province by the perpetual inventory method and then dividing it by the national capital stock per capita; 3. Data: Statistical Yearbook of Chinese Provinces 2002–2017, Official website of the National Bureau of Statistics of China (http://www.stats.gov.cn (accessed on 1 January 2022).

3. Empirical Model, Variable Selection, and Data Sources

3.1. Model Setting

It is assumed that there are only two economies Y_1 and Y_2 in the market, both of which meet the Cobb–Douglas production function with a constant return to scale. The capital shares of economies Y_2 are α_1 and α_2, which are expressed as Equations (1) and (2), respectively.

$$Y_1 = A_1 {K_1}^{\alpha_1} {L_1}^{1-\alpha_1} \quad (1)$$

$$Y_2 = A_2 {K_2}^{\alpha_2} {L_2}^{1-\alpha_2} \quad (2)$$

The output per capita is expressed as y_1 and y_2, which are calculated by:

$$y_1 = A_1 {k_1}^{\alpha_1} \quad (3)$$

$$y_2 = A_2 {k_2}^{\alpha_2} \quad (4)$$

Assuming that the ratio of capital factors in the two economies is the same, i.e., $\alpha_1 = \alpha_2 = \alpha$, it yields:

$$\frac{y_1}{y_2} = \frac{A_1 {k_1}^{\alpha_1}}{A_2 {k_2}^{\alpha_2}} = \left(\frac{k_1}{k_2}\right)^{\alpha} \quad (5)$$

The logarithms of both sides of Equation (5) can be written as:

$$\ln \frac{y_1}{y_2} = \alpha \ln\left(\frac{k_1}{k_2}\right) \quad (6)$$

As revealed by the above deduction, the higher the capital stock relative to the other economy, the more significant the development gap between the two regions will be. However, the mentioned deduction follows strict assumptions. To make the results more con-

vincing and better study the correlation between capital deepening and the regional development gap, the following model was constructed for testing, which is set as follows:

$$Gini_{it} = \alpha_1 + \beta_1 Capital_{it} + \gamma_1 X_{it} + \varepsilon_{it} \quad (7)$$

In baseline model (7), the explained variable $Gini_{it}$ is the regional development gap in the t year of the ith province; The core explanatory variable $Capital_{it}$ refers to the capital deepening in the tth year of the ith province; X_{it} are some other control variables that may cause the development gap in a certain region, and $Gini_{it-1}$ is the regional development gap in the lag period (used in the dynamic panel model). α_1 denotes the constant term, and β_1 and γ_1 represent the estimated coefficients of explanatory variables, respectively. When β_1 is higher than zero, the increase in capital deepening will lead to the expanded regional development gap. Model (8) applies to the regression of the dynamic panel, which is different from Model 7 in that the lag terms of explained variables are added into the model as explanatory variables.

$$Gini_{it} = \alpha_2 + \lambda_2 Gini_{it-1} + \beta_2 Capital_{it} + \gamma_2 X_{it} + \varepsilon_{it} \quad (8)$$

3.2. Variable Selection and Data Sources

3.2.1. Explained Variables

In this study, the Gini coefficient (Gini coefficient: it is a commonly used indicator to measure the income gap of residents in a country or region. It accounts for the gap between high and low incomes, while the Gini coefficient of GDP per capita in this study represents the development gap between regions) of per capita GDP of the prefecture-level cities is used as an index to measure the regional development gap. Considering the availability of data, in this study, a total of 26 provincial administrative regions between 2002 and 2017 were used as the research sample, except Beijing, Shanghai, Chongqing, Tianjin, Tibet, Hong Kong, Macao, and Taiwan (As Beijing, Shanghai, Chongqing, and Tianjin are municipalities directly under the Central Government, the relevant data from their regions are missing, so they are excluded from the study sample. Tibet's geographical environment is extremely special, so they are excluded from the sample; Hong Kong, Macao, and Taiwan are excluded from the sample due to their political and economic particularities; In addition, the prefecture-level cities in Hainan Province were not considered, namely, Sansha City and Danzhou City, since they were established as prefecture-level cities in 2012 and 2015, respectively). The per capita GDP of each prefecture-level city originates from the Statistical Yearbook of Chinese Provinces 2002–2017, involving data from 316 prefecture-level cities in 26 provinces.

3.2.2. Core Explanatory Variables

Capital is the most active factor of production, and capital deepening refers to the process in which the per capita capital ownership increases with time in the process of economic growth. In Solow's model, capital deepening corresponds to capital broadening, which means that the increase in capital accumulation equals the increase in labor input, and the amount of capital per capita remains unchanged. When the net investment per capita after deducting depreciation exceeds the capital broadening, the per capita capital increases, which is capital deepening; On the contrary, it is capitalization. Therefore, the capital deepening index measured using capital stock per capita of the respective province is the core explanatory variable to explain the regional development gap in this study. The capital deepening index refers to the calculation of physical capital stock by Liu et al. [22], Zheng; Zhang [23], and Zhang et al. [24], which is determined using the perpetual inventory method (Physical capital stock in the current period = in the previous period $\times$ (1 $-$ 9.6%) + total fixed asset formation in the current period).

3.2.3. Control Variables

Since the model aims to provide quantitative research on the effect of capital deepening on the regional development gap, other factors of the regional development gap should be controlled. For example, the difference in innovation degree and the level of opening up among regions may have an impact on the development of regions. Thus, in this study, we refer to the practices of Lu et al. [25], Zhang; Qi [26], Xu et al. [27], Liu et al. [28], Liu et al. [29], Fan et al. [30], and Liu et al. [31], Fan [32]. The square term of per capita GDP is introduced into the model as a control variable. The data of all control variables originate from China Statistical Yearbook. The statistical descriptions and data sources of the major variables and groups (grouping by economic development levels and based on eastern, western, and regional groups) are listed in Table 1.

Table 1. The statistical description of major variables.

Variable Name	Full Sample	High-Income Group	Medium Income Group	Low-Income Group	Eastern Region	Middle Region	Western Region
Regional development gap	0.260	0.263	0.251	0.265	0.246	0.239	0.288
	(0.084)	(0.077)	(0.097)	(0.079)	(0.086)	(0.055)	(0.094)
Capital deepening	11.491	14.827	12.213	7.512	13.418	9.772	11.324
	(7.356)	(8.048)	(7.135)	(4.407)	(6.184)	(6.414)	(8.510)
Labor income share	0.385	0.322	0.405	0.429	0.320	0.379	0.441
	(0.143)	(0.105)	(0.147)	(0.151)	(0.099)	(0.116)	(0.167)
The proportion of secondary industry	0.466	0.491	0.447	0.458	0.472	0.477	0.453
	(0.070)	(0.044)	(0.090)	(0.062)	(0.088)	(0.062)	(0.055)
The proportion of tertiary industry	0.404	0.413	0.405	0.395	0.419	0.060	0.404
	(0.050)	(0.047)	(0.051)	(0.052)	(0.055)	(0.052)	(0.041)
The proportion of foreign direct investment (FDI)	0.060	0.060	0.060	0.060	0.059	0.306	0.060
	(0.036)	(0.028)	(0.044)	(0.037)	(0.031)	(0.034)	(0.042)
Consumer price index	125.426	122.856	125.433	126.211	122.242	125.042	128.279
	(17.563)	(15.495)	(19.645)	(17.361)	(15.382)	(16.676)	(19.429)
Material capital investment rate	0.657	0.568	0.704	0.704	0.552	0.653	0.744
	(0.241)	(0.184)	(0.258)	(0.251)	(0.191)	(0.235)	(0.247)
GDP per capita (ten thousand yuan)	2.936	4.137	2.593	2.039	4.016	2.545	2.384
	(1.921)	(0.645)	(0.623)	(0.676)	0.624	(0.640)	(0.732)
Sample size	416	144	128	144	128	128	160

Explanation: 1. (1) Proportion of secondary industry: added value of secondary industry/GDP ×100%; (2) Proportion of tertiary industry: ratio of tertiary industry/GDP ×100%; (3) Proportion of foreign direct investment: Foreign direct investment/Total foreign investment ×100%; (4) Total investment in fixed assets/GDP ×100% (5) Per capita GDP: Local GDP/total local population ×100%; 2. Mean value before parentheses, the standard deviation in parentheses; 3. The economic development level falls into three quintile groups according to the per capita GDP between 2002 and 2017. The low-income group refers to regions with a per capita GDP of less than 24,234 yuan, which include Henan, Shanxi, Sichuan, Jiangxi, Anhui, Guangxi, Yunnan, Gansu, and Guizhou. The middle-income group refers to regions with per capita GDP of 24,234–24,305 yuan, which include Shaanxi, Hebei, Ningxia, Heilongjiang, Xinjiang, Hunan, Hainan, and Qinghai; The high-income group refers to regions with a per capita GDP of 29,148 yuan or higher (e.g., Jiangsu, Zhejiang, Guangdong, Inner Mongolia, Fujian, Shandong, Liaoning, Jilin, and Hubei). Beijing, Tianjin, Shanghai, Chongqing, and Xizang are not included in the sample for missing data from some regions. 4. Data source: China Statistical Yearbook and Provincial Statistical Yearbook. Impacted by some missing data, municipalities directly under the Central Government, Tibet Autonomous Region, Hong Kong, Macao, and Taiwan are not included.

4. An Empirical Analysis of the Influence of Capital Deepening on Regional Development Gap

4.1. Preliminary Regression Results

First, bilateral fixed effects (full sample and grouped sample following income levels) and dynamic panel are applied for estimation, and preliminary regression results are listed in Table 2. The capital stock per capita in the respective region is adopted as a measure of capital deepening, and its effect on the regional development gap is examined. The first and second columns show the correlation between capital deepening and the regional

development gaps without adding any control variables and introducing any control variables. As revealed by the results, when the bilateral fixed-effect method is applied, capital deepening exerts a significant positive effect on the regional development gap (0.058). The third, fourth, and fifth columns are bilateral fixed effect regressions based on grouped samples of income levels. According to the results, the effect of capital deepening on the regional development gap is more significant in the central and western regions, while its effect on the eastern regions is insignificant, thus, confirming that capital inflow into more developed regions will drive local economic growth to a certain extent, and capital will not flow from more developed regions to less developed regions. However, unbalanced capital inflow in wide regions will cause the widening of the regional development gap. The sixth column presents the regression results based on the differential GMM dynamic panel model (Table 2). Regardless of the regression method applied, capital deepening exerts a significant positive effect on the regional development gap, which reveals that the results are still robust. When capital deepening (logarithm) rises from the minimum value of 2.330 (Guizhou) to the maximum of 3.706 (Inner Mongolia), the development gap between the two regions increases by 1.131 times. Thus, it can be seen that capital deepening can have a significant explanatory power to explain the regional development gap in China, and it is a vital factor in the regional development gap.

Table 2. Effect of capital deepening on the regional development gap.

Explained Variables:	**Regional Development Gap**					
	(1) Full Sample	**(2) Full Sample**	**(3) Low-Income Group**	**(4) Medium Income Group**	**(5) High-Income Group**	**(6) Dynamic Panel**
Core explanatory variables:						
Regional development gap L1						0.759 ***
						(0.042)
Capital deepening	0.058 ***	0.063 ***	0.103 ***	0.156 ***	0.040 *	0.024 *
	(0.015)	(0.018)	(0.038)	(0.037)	(0.025)	(0.014)
Control variables:						
The proportion of secondary industry		0.696 ***	0.018	1.097 ***	0.667 *	0.353 ***
		(0.131)	(0.293)	(0.171)	(0.381)	(0.125)
The proportion of tertiary industry		0.516 ***	0.080	1.286 ***	0.375	0.381 ***
		(0.155)	(0.316)	(0.215)	(0.387)	(0.120)
The proportion of foreign direct investment (FDI)		−0.133	−0.385	−0.114	0.668 ***	0.010
		(0.090)	(0.250)	(0.105)	(0.213)	(0.040)
Consumer price index		0.002 ***	−0.009 ***	−0.001	0.001	−0.001 *
		(0.001)	(0.002)	(0.001)	(0.003)	(0.0004)
Material capital investment rate		−0.043 **	−0.036	0.036	−0.090 ***	−0.045 ***
		(0.019)	(0.038)	(0.047)	(0.026)	(0.011)
GDP per capita		−0.052	−0.858 ***	1.819 ***	0.606 **	−0.018
		(0.091)	(0.301)	(0.583)	(0.255)	(0.069)
Per capita GDP square		−0.002	0.004 **	−0.101 ***	−0.033 ***	0.001
		(0.004)	(0.018)	(0.030)	(0.011)	(0.004)
Time fixed effect	Yes	Yes	Yes	Yes	Yes	No
Regional fixed effect	Yes	Yes	Yes	Yes	Yes	No
Constant term	0.183 ***	0.097	5.105 ***	−9.196 ***	−3.161 ***	−0.067
	(0.024)	(0.443)	(1.341)	(2.772)	(1.197)	(0.323)
Observed value	416	416	144	128	144	364
R-squared	0.167	0.260	0.419	0.484	(0.630)	

Explanation: 1. In Table 2, bilateral fixed effect regression of panel data is selected as the estimation method of models (1)–(5); dynamic panel regression is used as the estimation method of the model (6). 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; 3. The economic development level falls into three quintile groups by the per capita GDP between 2002 and 2017. The low-income group consists of the regions achieving a per capita GDP of lower than 24,234 yuan, which include Henan, Shanxi, Sichuan, Jiangxi, Anhui, Guangxi, Yunnan, Gansu, as well as Guizhou. The middle-income group consists of regions achieving a per capita GDP between 24,234 and 24,305 yuan, which involve Shaanxi, Hebei, Ningxia, Heilongjiang, Xinjiang, Hunan, Hainan, as well as Qinghai. The high-income group covers the regions with a per capita GDP of 29,148 yuan or higher, which include Jiangsu, Zhejiang, Guangdong, Inner Mongolia, Fujian, Shandong, Liaoning, and Jilin, as well as Hubei. Beijing, Tianjin, Shanghai, Chongqing, and Xizang are not included in the sample because of missing data from some regions.

4.2. Robustness Test

4.2.1. Endogenous Test

Although several control variables probably affecting the regional development gap are introduced to the model to maximally reduce the measurement error caused by missing variables, the endogenous capital deepening problems remain and cannot be excluded. For instance, the regions with a small regional development gap will boost the development of the region and attract more capital investment, which arises from the certain relatively balanced development. In the above case, the regional development gap, serving as an explained variable, can exert a reverse effect on capital deepening as an explanatory variable. Thus, simple linear regression results cannot indicate the causal effect of capital deepening on the regional development gap. Accordingly, in this study, the method of instrumental variables is selected to eliminate the effect of endogenous problems and make the results more robust. The instrumental variable selected in this study is the interaction between the Soviet Aid Project in 1954 and the time from now. The reason for this choice is that the impact of Soviet aid projects on economic development is long-term [18,33]. The Soviet Aid Project tended to promote regional capital inflows, whereas it was not directly related to the regional development gap. Furthermore, 156 Soviet Aid projects involved national defense, mining, and other industrial regions, and China received nearly 7% of the capital project aid in the total output value of the Soviets, thus rapidly boosting the accumulation of capital in China and the rapid advance of industrial economy in the first five-year period. Thus, the interaction between the Soviet Aid Projects and the time from the present can serve as instrumental variables of capital deepening to estimate the causal effect arising from capital deepening on the regional development gap.

Accordingly, the following two-stage regression model is built to research the causal effect of capital deepening on the regional development gap with the interaction between the Soviet Aid projects and the time from the present as the instrumental variable.

$$\text{Stage 2: } Gini_{it} = \alpha_1 + \beta_1 Capital_{it} + \gamma_1 X_{it} + \varepsilon_{it} \quad (9)$$

$$\text{Stage 1: } Capital_{it} = \alpha_2 + \beta_2 Soviet\_aid_{it} + \gamma_2 X_{it} + \varepsilon_{it} \quad (10)$$

where Model (9) denotes the regression of the first stage, and its explained variable is capital deepening. $Soviet\_aid_{it}$ represents the Soviet Union aid project. If the Soviet Union aid project leads to a considerable amount of regional capital inflow, β_2 is significantly higher than zero. Model (10) represents the regression result of the second stage, and its setting is the same as that of Model (7), except that the core explanatory variable capital deepening refers to the estimated value of the regression of the first stage.

The regression results of the two stages are listed in Table 3. As indicated by the regression results of the first stage, the Soviet Union construction aid exerts a significant positive impact on capital deepening. The greater the gap between the Soviet Union's construction aid and capital deepening in the two regions, the greater the gap between the two regions will be. According to the regression results of the second stage, the coefficient of capital deepening was significantly positive after the regression of the two stages with the Soviet Union construction aid as the instrumental variable of capital deepening, thus, confirming that capital deepening after eliminating endogenous problems will significantly widen the regional development gap. Accordingly, through instrumental variable regression, the endogenous problems of capital deepening caused by the Soviet Union construction aid from 1954 to the present are excluded, and it is reported that capital deepening has a strong explanatory power for the regional development gap.

Table 3. Regression results of instrumental variables of capital deepening and the regional development gap.

Explained Variables	Stage 1	Stage 2
	(Capital Deepening)	(Regional Development Gap)
The Soviet Aid Project	0.0018 ***	
	(0.0001)	
R-squared	0.963	
F test	46.85	
Core explanatory variables		
Capital deepening		0.068 **
		(0.035)
Control variables		
The proportion of secondary industry	1.988 ***	0.698 ***
	(0.556)	(0.148)
The proportion of tertiary industry	2.443 ***	0.478 ***
	(0.636)	(0.174)
The proportion of foreign direct investment (FDI)	1.038 ***	−0.115
	(0.210)	(0.082)
Consumer price index	0.008 ***	0.001 *
	(0.002)	(0.0006)
Material capital investment rate	0338 ***	−0.050 **
	(0.059)	(0.024)
GDP per capita	−1.131 ***	0.056
	(0.247)	(0.090)
Per capita GDP square	0.075	−0.008
	(0.013)	(0.005)
Time fixed effect	Yes	Yes
Observed value	416	416

Explanation: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2.2. Robustness Test of Different Samples

In addition, to test the robustness of the results in depth, the samples were selected from the World Bank (http://www.worldbank.org (accessed on 1 January 2022) database, and the Gini coefficient was used to measure the degree of development inequality among various nations. Given the availability of the data, the sample data of 30 nations from 2005 to 2018, including high-income nations and middle and high-income nations, were selected for testing. Table 4 lists the results of the mixture regression. It is indicated that based on the full-sample regression results, a 1% increase in capital deepening leads to a significant 0.9% decline in income inequality. In the grouping regression, the correlation between capital deepening and income inequality in high-income nations shows a consistent tendency with the full sample data, with significant results. However, in medium- and high-income nations, a 1% increase in capital deepening will increase income inequality significantly by 16%. As revealed by the regression results, In China, a medium- and high-income developing nation, the correlation between capital deepening and income inequality is significantly positive and robust.

Table 4. Correlation between capital deepening and income inequality (World sample).

Explained Variables:	**Income Inequality**					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Full Sample	**Full Sample**	**High Income**	**High Income**	**Medium and High Income**	**Medium and High Income**
Core explanatory variables:						
Capital deepening	−0.009 ***	−0.002 **	−0.006 ***	−0.003 ***	0.100 **	0.160 *
	(0.001)	(0.001)	(0.001)	(0.001)	(0.046)	(0.094)
Control variables:						
The proportion of the agricultural-added value		1.486 ***		0.538 **		−2.744 *
		(0.252)		(0.223)		(1.334)
The proportion of the industrial-added value		−0.213 ***		−0.262 ***		0.854
		(0.038)		(0.038)		(0.548)
Material capital investment rate		0.166 ***		0.009		−0.770
		(0.062)		(0.060)		(0.575)
The growth rate of consumption		0.116 *		0.127 *		0.022
		(0.070)		(0.076)		(0.211)
Urbanization level		−0.008		−0.043 **		−0.870
		(0.020)		(0.020)		(0.528)
Constant term	0.340 ***	0.299 ***	0.325 ***	0.390 ***	0.331 ***	0.968 *
	(0.004)	(0.020)	(0.003)	(0.021)	(0.044)	(0.510)
Observed value	420	420	392	392	28	28
R-squared	0.128	0.296	0.083	0.144	0.103	0.915

Explanation: 1. The estimation methods of models (1), (2), (3), (4), (5), and (6) are mixed regression models, in which (1), (3), and (5) lead to the regression results without control variables, and (2), (4), and (6) represent the regression results with control variables. 2. The contents in the brackets are robust standard errors; 3. Data source: World Bank (http://www.worldbank.org (accessed on 1 January 2022); 4. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Mechanism Testing

Given the empirical research mentioned above, this study indicates that capital deepening is indeed a vital factor in the regional development gap. Thus, a question is raised whether there is any measure to reduce capital deepening to boost balanced regional development in the present society. Since the reform and opening-up, the rapid accumulation of capital in China has propelled economic development, which can give rise to an increasingly serious problem of regional development imbalance. Over the past few years, China's labor income share has been declining from 0.661 in 2002 to 0.291 in 2017, marking a decrease of 55.98%. According to Figure 4, the labor income share in China has been decreasing on a year-to-year basis (The labor income share is calculated using the production function with constant returns to scale to determine the capital share, and then it is calculated according to the labor income share = $\beta\left(\frac{K}{AL}\right)^{\alpha} \times L \div Y$), which tends to be consistent with capital deepening. Thus, this study attempts to interpret the effect of capital deepening on the labor income share in the regional development gap to offer useful enlightenment to China's current economic policy.

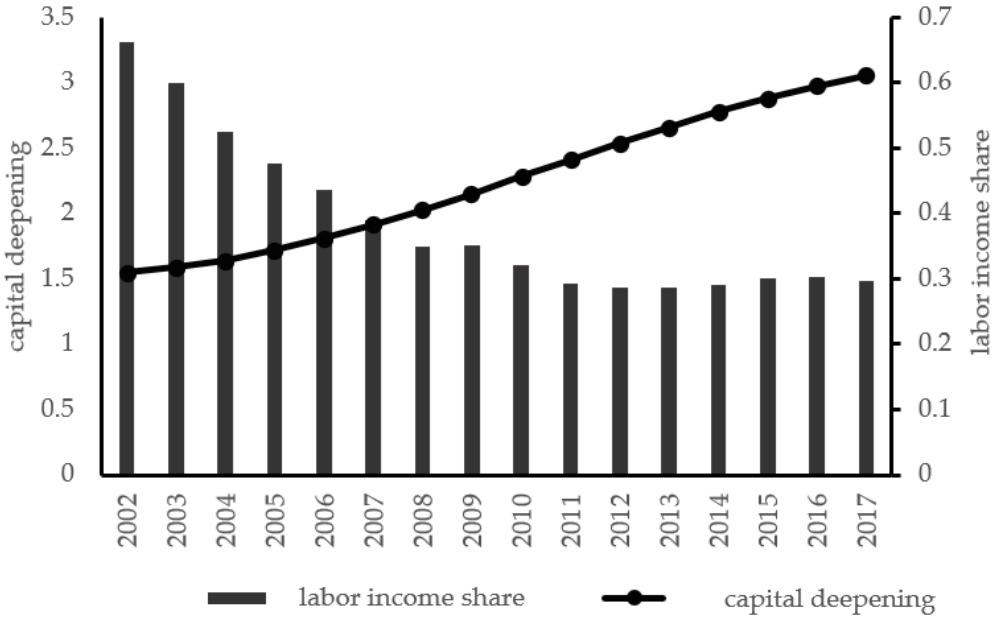

Figure 4. Changes in capital deepening and labor income share. Explanation: 1. Labor income share is calculated by using the production function with constant returns to scale; 2. Capital deepening is determined by obtaining the capital stock per capita of the respective province by the perpetual inventory method and then dividing it by the national capital stock per capita; 3. Data: Statistical Yearbook of Chinese Provinces 2002–2017, Official website of the National Bureau of Statistics of China (http://www.stats.gov.cn (accessed on 1 January 2022)).

5.1. Theoretical Analysis and Mechanism Test Model Setting

It was generally considered by early scholars that the labor income share was fixed, i.e., the "typical fact" considered by Kaldor [34]. However, with the deepening of research, most scholars have supported that the labor income share is changing. On that basis, scholars worldwide have conducted numerous studies on the factors of the labor income share, and the results show that the labor income share will be dependent on technological progress, industrial structure adjustment, capital deepening, foreign trade, foreign direct investment, the effect of the labor market, the capital-output ratio, human capital accumulation, the provinces economic development level, economic structure, and the state-owned economy proportion, fiscal expenditure, and government policy, labor supply and demand, the enterprise tax burden level, the residents' consumption proportion, as well as investment rate [35–37]. Moreover, some studies reported that the enhancement of the product market monopoly will cause the labor share to decrease [38]; however, for factor market distortion, the existing research primarily discussed the effect arising from the labor market control and negotiation ability, capital market regulation, and the reform of state-owned enterprises on the labor share [39,40]. There have been significant but small differences between the capital return and the economic growth rate, thus having powerful and destabilizing effects on the structure and evolution of social inequality in the long run [41].

Over the past few years, China's capital has rapidly accumulated, and the effect arising from capital deepening and technological progress bias on the labor share has aroused the wide attention of scholars. Based on the perfect competition hypothesis, labor share is determined using the capital–labor ratio, factor-enhanced technological progress, as well as factor substitution elasticity [42]. Additionally, the effect of capital deepening on labor share is correlated with factor substitution elasticity. It is assumed that the capital–labor ratio remains unchanged, if the elasticity of substitution is higher than (less than)1, the labor-enhanced technological progress is biased towards the labor (capital), thus, helping increase the labor (capital) share.

Capital in the 21st Century mentioned that "The main mechanism of convergence, whether at the global level or the national level, is the diffusion and communication of knowledge." In other words, underdeveloped nations catch up with developed nations by improving their science and technology, expertise and skills, and education, rather than becoming assets of rich nations. The Wealth of Nations pointed out that the increase in labor productivity caused by the division of labor and the increase in the number of workers caused by capital accumulation are the way to increase the real wealth and income of a country. Since the reform and opening-up, China's capital has rapidly accumulated, and in this process, the increase in local labor income is expanded, while the increase in labor income promotes the development of the local economy; thus, it can narrow the gap in regional economic development. To verify that capital deepening influences the regional development gap by influencing the labor income share, this study constructed the following model to discuss the labor income share effect of capital deepening on the regional development gap.

$$Labor_{it} = \alpha_2 + \beta_2 Capital_{it} + \gamma_2 X_{it} + \varepsilon_{it} \quad (11)$$

$$Gini_{it} = \alpha_1 + \beta_1 Capital_{it} + \chi_1 Labor_{it} + \phi_1 Capital_{it} \times Labor_{it} + \gamma_1 X_{it} + \varepsilon_{it} \quad (12)$$

In Model (11), the explained variable labor income share ($Labor_{it}$) is the labor income share of the tth year in the ith province; The core explanatory variable $Capital_{it}$ refers to the capital deepening index in the tth year of the ith province; The explained variables in Model (12) are set the same as those in Model (7), and the core explanatory variables are added labor income share ($Labor_{it}$)and the interaction between capital deepening and labor income share ($Capital_{it} \times Labor_{it}$) based on Model (7).

5.2. Empirical Results of Mechanism Test

The correlation between capital deepening and the labor income share is regressed using the bilateral fixed effect model, and then, bilateral fixed effect regression is performed by introducing the labor income share and the interaction terms between capital deepening and labor income share. The results are shown in Table 5. Columns 1 and 2 illustrate the effect of capital deepening on the labor income share. As indicated by the results, the greater the value of the capital deepening index in a certain region, the more significantly it will promote the local labor income share, which confirms that the increase in regional capital will promote workers' income to a certain extent. The third and fourth columns indicate the effects arising from the capital deepening on the labor income share of the regional development gap, and the results reveal that the increase in capital deepening will facilitate the expansion of the regional development gap, which will be inhibited by the labor income share. Moreover, the inhibition results have strong robustness without control variables and with control variables. Accordingly, capital deepening has an indirect effect on the regional development gap by impacting the labor income share. The improvement of the labor income share will inhibit the formation of the regional development gap and ultimately alleviate the problem of regional development unbalance.

Table 5. Analysis of the labor income share effect of capital deepening on the regional development gap.

Explained Variables:	**Labor Income Share**		**Regional Development Gap**	
	(1)	**(2)**	**(3)**	**(4)**
Core explanatory variables:				
Capital deepening	0.083 ***	0.192 ***	0.065 ***	0.145 ***
	(0.029)	(0.013)	(0.021)	(0.036)
Labor income share			0.023	0.280 **
			(0.049)	(0.109)
Capital deepening × Labor income share			−0.013	−0.169 ***
			(0.030)	(0.055)

Table 5. *Cont.*

Explained Variables:	Labor Income Share		Regional Development Gap	
	(1)	(2)	(3)	(4)
Control variables:				
The proportion of secondary industry		0.283 ***		0.761 ***
		(0.093)		(0.134)
The proportion of tertiary industry		0.193 *		0.627 ***
		(0.110)		(0.159)
Proportion of FDI		−0.048		−0.142
		(0.064)		(0.090)
Consumer price index		−0.004 ***		0.002 **
		(0.001)		(0.001)
Material capital investment rate		0.114 ***		−0.042 **
		(0.014)		(0.021)
GDP per capita		−1.466 ***		0.391 ***
		(0.064)		(0.191)
Per capita GDP squared		0.052 ***		−0.025 ***
		(0.003)		(0.009)
Time fixed effect	Yes	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes	Yes
Constant term	63.366 ***	−9.487 ***	0.170 ***	−2.165 **
	(6.444)	(0.313)	(0.039)	(1.041)
Observed value	416	416	416	416
R-squared	0.684	0.969	0.168	0.278

Explanation: 1. The estimation method of models (1), (2), (3), and (4) is the panel data fixed effect model; 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6. Conclusions and Suggestions

Since the introduction of the reform and opening-up, China's economy has leapt forward by exploiting considerable capital accumulation, whereas the problem of unbalanced regional development has been the concern of numerous scholars and progressively become a vital constraint on China's sustainable economic development and social stability. Therefore, it is widely of concern for scholars. At present, different development regions attract different capital inflows, which further deepens the imbalance of development among different regions and hinders fairness in economic development. Sustainable development must reduce the negative impact of imbalance on economic growth within a controllable scope. This paper uses measurement methods to study the correlation between capital deepening, the labor income share, and regional development gap, and draws the following conclusions:

(1) Capital deepening has a significant positive impact on the regional development gap and the results are stable. This shows that capital deepening has significant explanatory power for explaining the regional development gap in China and is an important factor affecting the regional development gap.
(2) Capital deepening does not directly affect the regional development gap but indirectly affects the regional development gap by affecting the labor income share. Therefore, increasing the labor income share is an effective way to narrow the formation of the regional development gap and alleviate the problem of unbalanced regional development.

This study provides a new perspective on China's current regional economic development imbalance while effectively inspiring the current formulation of the regional balanced development policy. Based on the research results of this study, the following suggestions are proposed from the perspective of the causes of capital deepening:

(1) for the occlusive geographical environment in underdeveloped regions, it is required to significantly strengthen the infrastructures (e.g., traffic and communication), encourage appropriate capital inflows, positively cultivate the competitive innovation

environment and business environment, and enhance the domestic and foreign high-quality innovation elements and the attraction of the innovative subject. On that basis, the industry–university–research connection among universities, scientific research institutions, and enterprises can be deepened, the technology trading market and the intellectual property trading platform can be optimized, efficient technology transfer channels can be set, economic development can be boosted, and the gap can be narrowed.

(2) In addition to improving the infrastructure in underdeveloped regions, it is necessary to up-regulate the income of workers, increase the investment in basic education in underdeveloped regions, improve the quality of education and teaching, and encourage the introduction of talents and innovation as an attempt to boost economic development, narrow the development gap, and achieve sustained, healthy, and high-quality development of the Chinese economy.

This study has some shortcomings. Due to a lack of data, Beijing, Shanghai, Chongqing, Tianjin, Xizang, and other Chinese regions such as Hong Kong, Macao, and Taiwan were not included in the study. However, this does not affect our results and conclusions. Meanwhile, our research mainly uses statistical methods, which have advantages in quantification but are not enough to describe the influencing process and the internal mechanism. In future studies, it is necessary to further describe the process and internal mechanism of capital deepening's influence on the regional economic development gap.

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