

Income Inequality — Analysis Based on Dynamic Economic Growth Model

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Abstract

In the continuous forward development of the world economy, the issue of wealth disparity has become increasingly prominent, gradually becoming a focal point in the socio-economic development of countries. It is worth thinking about the future trend of income inequality. In previous studies, it was generally believed that under current conditions, the wealth gap would continue to widen rather than narrow. This paper takes a conservative stance on this widely held view. I believe that during economic development, the autonomous creation and learning of technology will gradually reduce this gap, even if relevant studies suggest that technical barriers may hinder technological learning.

However, previous studies on income inequality have predominantly focused on static analyses. Building upon the traditional Cobb-Douglas (C-D) function, this study introduces the concept of growth residual per capita income for dynamic analysis. The model reveals that when capital growth rate equals labor growth rate and the latter remains positive, the growth residual per capita income exhibits a monotonically decreasing trend, with its maximum value occurring at the technological progress growth rate.

Keywords: wealth gap, technological progress, population growth, development, two departments

JEL: A10, A14

1. Introduction

In the course of economic development, income inequality has increasingly become a focal point of growth, posing significant challenges to social stability. Since the Industrial Revolution, rapid technological advancements and capital accumulation have led to a continuous decline in global absolute poverty. However, substantial disparities in Gini coefficients across regions persist, with considerable income gaps remaining between areas. Different countries have implemented varying approaches to address widening income inequality. Consequently, predicting future trends in income inequality remains challenging—a critical issue that warrants our careful consideration.

2. Literature Review

The academic community has conducted extensive research on the phenomenon of wealth inequality. From the perspective of the regions where the wealth gap is developing, the wealth gap in some major cities in Europe is constantly increasing. (Mustard et al., 2017), and there is a phenomenon in developed economies where the higher the degree of economic openness, the more unequal income distribution. (Özdemir, 2020). In the study of individual subjects with wealth inequality, it was revealed that there is a significant difference in individual wealth levels between men and women, which is more conducive to male wealth inequality (Pugliese et al., 2023).

The wealth gap is influenced by many factors. In terms of technology, technological progress can accelerate breakthroughs in innovation, accelerate industrial transformation and upgrading (Niggli et al., 2023). Regional technological progress can not only increase employment opportunities in underdeveloped areas through knowledge spillovers, but also enhance the competitive advantage of local enterprises compared to those in underdeveloped areas, increasing talent loss in these areas. (Hean., 2022). In terms of population, studies have shown that changes in population growth have a significant impact on the share of enterprise population and labor income (Hopenhayn et al., 2022). In addition to technology and population, there are also some other influencing factors mentioned above. For

example, per capita GDP has an impact on income inequality (Han et al., 2023); The income gap between industries and education premiums have an impact on income inequality (Zhuang, J et al., 2023); The differences in education, industry, and return rates between urban and rural households have an impact on the urban-rural income gap (Wang, 2023).

The research on how to solve the problem of wealth gap is also very extensive. In terms of taxation, especially in most developing countries, research has shown that the increase in direct taxes relative to indirect taxes has a significant positive impact on income inequality, due to the progressive nature of direct taxes relative to indirect taxes (Brown et al., 2023). In terms of enterprises, they should enhance their vitality and innovation, absorb more market labor, and thereby reduce the poverty gap (Padhi, 2020). In addition, relevant studies have also shown that pension wealth can further narrow the gender wealth gap (Cordova et al., 2023), and the substitutability between labor income and pension is gradually increasing when addressing the wealth gap (Zhang et al., 2023).

In previous literature studies, the gap between the rich and the poor has been studied in a relatively comprehensive and profound manner. However, these studies often focus on potential influencing factors, causes, and solutions to the wealth gap. To a large extent, these studies have shown that in the short term, the wealth gap may widen, without considering the long-term perspective.

3. The State of Global Income Inequality

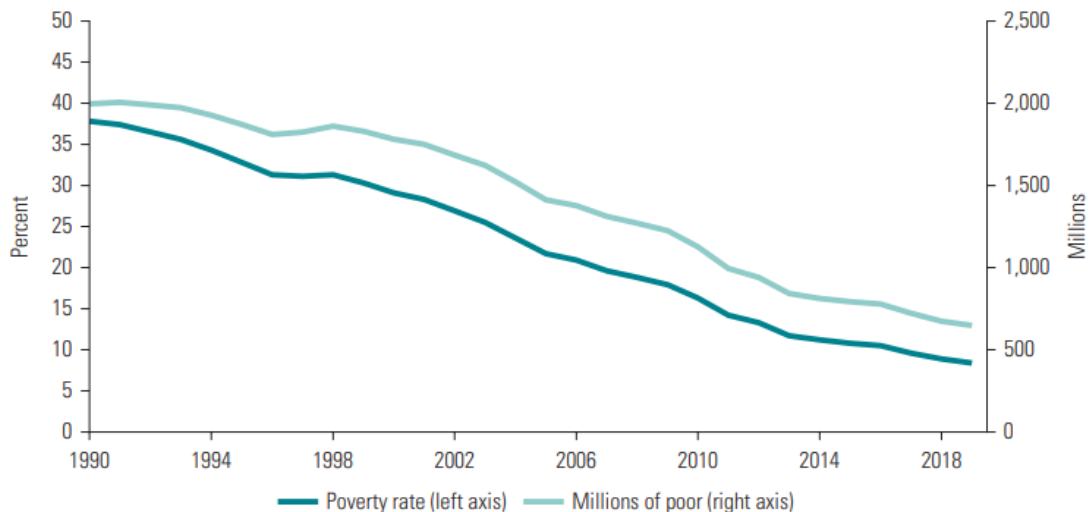


Figure 1. Global poverty rate and number of people in poverty since 1990 (Note 1)

Source: World Bank, Poverty and Inequality Platform, <https://pip.worldbank.org>.

Note: The figure shows the poverty rate and number of poor at the international poverty line of US\$2.15 (2017 PPP) per person, per day.

According to data from the World Bank, since 1990, the world's poverty rate has dropped from over 35% to below 10%, indicating an overall improvement and gradual stabilization in global poverty. The number of people living in poverty is also declining and stabilizing. This suggests that the world's impoverished population is gradually improving, and the wealth gap is narrowing.

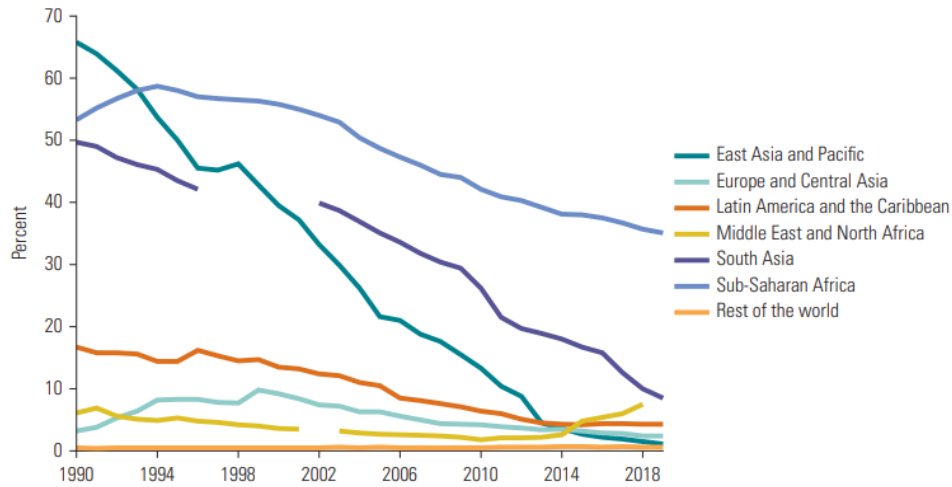


Figure 2. Poverty change trend in different regions from 1990 to 2019 (Note 2)

Source: World Bank, Poverty and Inequality Platform, <https://pip.worldbank.org>.

Note: The figure shows poverty trends at the US\$2.15-a-day poverty line, by region, 1990–2019.

From the perspective of poverty change trends in various regions of the world, the poverty situation in all regions of the world is improving, with East Asia and the Pacific showing the most significant improvement and the fastest pace, while the poverty situation in sub-Saharan Africa is changing more slowly compared to other regions, but it is also declining overall. However, it is not difficult to find that the global regional income inequality gap is still very obvious.

4. Dynamic Model Establishment and Analysis

The following production function is given:

$$Y = e^{\lambda t} K^\beta L^{1-\beta} \tag{1}$$

Further, we give the growth residual per capita income γ

$$\frac{Y_t - Y_0}{L_t} = \gamma(t) \tag{2}$$

The population growth function:

$$L_t = L_0 e^{\theta t} \tag{3}$$

θ is Population growth rate.

Assume that the capital production elasticity coefficient and labor elasticity coefficient change with technological progress, and the scale return is constant. The technology growth rate is an exogenous constant and greater than 0.

Substitute functions (1) and (3) into function (2):

$$\frac{e^{\lambda t} K^{\beta t} L^{1-\beta t} - e^{\lambda t} K^\beta L^{1-\beta}}{L} \tag{4}$$

So:

$$\frac{e^{\lambda t} K^\beta L^{1-\beta} \left(\frac{e^{\lambda t} K^{\beta t} L^{1-\beta t}}{e^{\lambda t} K^\beta L^{1-\beta}} - 1 \right)}{L} \tag{5}$$

Since capital and labor are functions of time t and are linear functions, the logarithm of formula (5) is taken and the derivative is calculated for unit time t respectively to obtain the growth rate of per capita income surplus. The specific derivation is as follows:

$$\ln \gamma(t) = \ln (e^{\lambda t} K^\beta L^{1-\beta} (\frac{e^{\lambda t} K^{\beta t} L^{1-\beta t}}{e^{\lambda t} K^\beta L^{1-\beta}} - 1)) - \ln L \tag{6}$$

$$\ln \gamma(t) = \lambda t + \beta \ln K + (1-\beta) \ln L + \ln (\frac{e^{\lambda t} K^{\beta t} L^{1-\beta t}}{e^{\lambda t} K^\beta L^{1-\beta}} - 1) - \ln L \tag{7}$$

$$\frac{d \ln \gamma(t)}{dt} = \lambda + \beta (\frac{\dot{K}}{K} - \frac{\dot{L}}{L}) + \frac{d(\ln (\frac{e^{\lambda t} K^{\beta t} L^{1-\beta t}}{e^{\lambda t} K^\beta L^{1-\beta}} - 1))}{dt} \tag{8}$$

Also because:

$$\frac{d(\ln (\frac{e^{\lambda t} K^{\beta t} L^{1-\beta t}}{e^{\lambda t} K^\beta L^{1-\beta}} - 1))}{dt} = \frac{d(\ln (\frac{Y_t - Y_0}{Y_0}))}{dt} = \frac{d(\ln \frac{\dot{Y}}{Y})}{dt} = \frac{d(\ln (\frac{d(\ln Y)}{dt}))}{dt}$$

$$\frac{d(\ln \frac{d(\ln Y)}{dt})}{dt} = \frac{\frac{\dot{L}^2}{L} - \frac{\dot{K}^2}{K}}{\lambda + \beta (\frac{\dot{K}}{K} - \frac{\dot{L}}{L}) + \frac{\dot{L}}{L}}$$

It boils down to this:

$$\frac{d \ln \gamma(t)}{dt} = \lambda + \beta (\frac{\dot{K}}{K} - \frac{\dot{L}}{L}) + \frac{\beta (\frac{\dot{L}^2}{L} - \frac{\dot{K}^2}{K}) - \frac{\dot{L}^2}{L}}{\lambda + \beta (\frac{\dot{K}}{K} - \frac{\dot{L}}{L}) + \frac{\dot{L}}{L}} \tag{9}$$

So $\frac{\dot{L}}{L} = h$, $\frac{\dot{K}}{K} = g$.

Formula (9) is finally changed to:

$$\frac{d \ln \gamma(t)}{dt} = \lambda + \beta (g-h) + \frac{\beta (h^2 - g^2) - h^2}{\lambda + \beta (g-h) + h} \tag{10}$$

Theorem 1: When the growth rate of capital is equal to the growth rate of labor, and the growth rate of labor is greater than 0, the growth rate of surplus per capita income increases monotonically.

Prof: When the growth rate of capital is equal to the growth rate of labor, $\frac{d \ln \gamma(t)}{dx} = \lambda - \frac{h^2}{\lambda+h} = f(h)$. Differentiate h further,

$\frac{df}{dh} = -\frac{h^2 + 2h\lambda}{(\lambda+h)^2}$ When h is greater than 0, $\frac{df}{dh} < 0$, Then the function $f(h)$ is a monotonic decreasing function.

Theorem 2: When the growth rate of capital is equal to the growth rate of labor, the maximum growth rate of per capita production surplus is λ .

Prof: By Theorem 1, $\frac{df}{dh} = -\frac{h^2 + 2h\lambda}{(\lambda+h)^2}$. When $-2\lambda < h < 0$. The function $f(h)$ is monotonically increasing. The remaining intervals are monotonically decreasing ($\lambda \neq h$). Of course, this constraint doesn't affect our search for extreme points. So, $f(0)$ and $f(-2\lambda)$ is the two extreme values of the function $f(h)$. Further, when $f(h) > 0$, The range of the solution is $\frac{(1-\sqrt{5})\lambda}{2} < h < \frac{(1+\sqrt{5})\lambda}{2}$, So, $f(0)$ is the maximum value λ .

4. Conclusion

Through modeling analysis, it is found that in production functions, when the growth rate of income capital equals the growth rate of labor, the growth rate of surplus per capita income will continuously decline. This conclusion may

sound surprising at first glance. It inevitably raises the question: Could a country's balanced growth strategy exacerbate income inequality? Since this study does not delve deeply into this aspect, my preliminary explanation for this phenomenon is that different countries possess varying endowments of capital and labor resources. Consequently, the efficiency and output of their production sectors differ. If development follows a balanced growth model, it may fail to achieve socially optimal output, leading to a downward trend in surplus per capita income. In such cases, adopting production based on comparative advantages might prove more advantageous.

The following factors merit further consideration: (1) The government should implement active industrial policies and strengthen the protection of backward industries. (2) The government should promote balanced development of economic regions and assist underdeveloped areas. (3) Encourage enterprises to engage in technological innovation and accelerate the progress of productivity. (4) We should attach importance to the important role of human capital in economic development. (5) We need to improve the market economy system, enable the free flow of production factors, and stimulate the vitality of social innovation. (6) The government should strengthen the protection of the impoverished population in society, and enterprises should provide better employee benefits for their employees.

Finally, if countries around the world open their hearts and minds to greater economic exchange, it will be even more beneficial to the continued improvement of existing income inequality.

However, there are some limitations in the research process of this paper. Although we have answered the trend of income inequality changes under the condition of economic growth to some extent, we have not answered this question from the micro level, which is expected to be further discussed in the following research.

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Competing interests

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Informed consent

Obtained.

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Data sharing statement

No additional data are available.

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Notes

Note 1. World Bank. Poverty and Shared Prosperity 2022: Correcting Course. Washington, DC: World Bank. doi:10.1596/978-1-4648-1893-6. License: Creative Commons Attribution CC BY 3.0 IGO.

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