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Economic analysis and research between national income and income distribution: United States, United Kingdom, Germany, France, Italy, Canada, Norway, Sweden, Denmark, and South Korea

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Abstract Sustainable economic growth is a pressing issue for most countries. Economic growth increases a country's productivity and improves the living standards of the people, significantly contributing to the country and the people economically and socially. In general, as economic growth continues, analyzing its quantitative and qualitative aspects becomes necessary, considering also that when the quantitative growth of the economy progresses well, the importance of qualitative growth of the economy increases. Hence, this study conducted an economic analysis and research between national income and income distribution to understand the qualitative growth of the global economy. Specifically, we analyzed the United States, the United Kingdom, Germany, France, Italy, Canada, Norway, Sweden, Denmark, and South Korea.

Keywords: economic analysis and research, per capita national income, income distribution

1. Introduction

Wealth inequality has risen throughout the OECD since the 1970s (Lierse, 2022). The elimination of poverty, as proposed by the sustainable development goal, is one of the main challenges faced by all countries (Alberti et al., 2023). Recently, in Organization for Economic Cooperation and Development (OECD) countries, the scale and income share of the middle class have decreased, and the proportion of wealth and income share of the upper class have increased. In many countries, income inequality intensifies with inflation, and it significantly impacts consumption expenditure, education, jobs, wealth, health and life expectancy, and quality of life. There seems to be a consensus that higher inflation, at least above some threshold, increases inequality (Colciago et al., 2019). While the extant literature shows that various indices of economic freedom display a positive relationship with the level of income inequality, it is unclear who the winners and, in particular, the losers are (Mighelia & Saccone, 2023). The inflation-first policy has important consequences for income distribution, and several post-Keynesians have been at the forefront of this discussion (Kappes et al., 2024). Furthermore, it can cause economic and social instability, hinder sustainable growth, and act as a major factor in reducing investment. The expansion of income inequality can increase consumption among the upper class, but it can significantly reduce the purchasing power of the middle class, slowing the national economy. This inequality may lead to overborrowing and excessive consumption, which is ultimately detrimental to its sustainability (Lissowska, 2015). Most mainstream work focuses on *personal* income distribution, pointing out that the distributional effects of monetary policy are not structural but rather temporary (Kappes, 2023). Restrictive monetary policy can not only fail to achieve the conventional macroeconomic goal of controlling inflation but also be seen as responsible for the increasing income inequality that has occurred in recent decades (Vianna, 2024). Indeed, income inequality can lead to the middle class and upper class having different preferences for policies. This can cause conflicts between classes. For instance, if the upper class influences policy-making, it can act as a political constraint and affect macroeconomic growth. The ideal society is a society with economic, social, and environmental sustainability and harmony based on sustainable economic growth. It has been proven that quantitative growth in the economy improves quality of life and makes people happy. Generally, the quantitative growth of the economy can be reflected in the national income, price, international balance, unemployment rate, exchange rate, monetary growth rate, and interest rate. As the quantitative growth of the economy progresses, income inequality often does not improve and worsens at a certain point. Therefore, the importance of economic qualitative growth becomes prominent. Economic growth is essential, but the issue of distribution to improve economic inequality and polarization is equally important. Hence, in this study, we perform economic analysis and research on the relationship between national income and income distribution to understand the qualitative growth of the global economy.

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We conducted a partial correlation analysis for the United States, the United Kingdom, Germany, France, Italy, Canada, Norway, Sweden, Denmark, and South Korea (Figure 1).

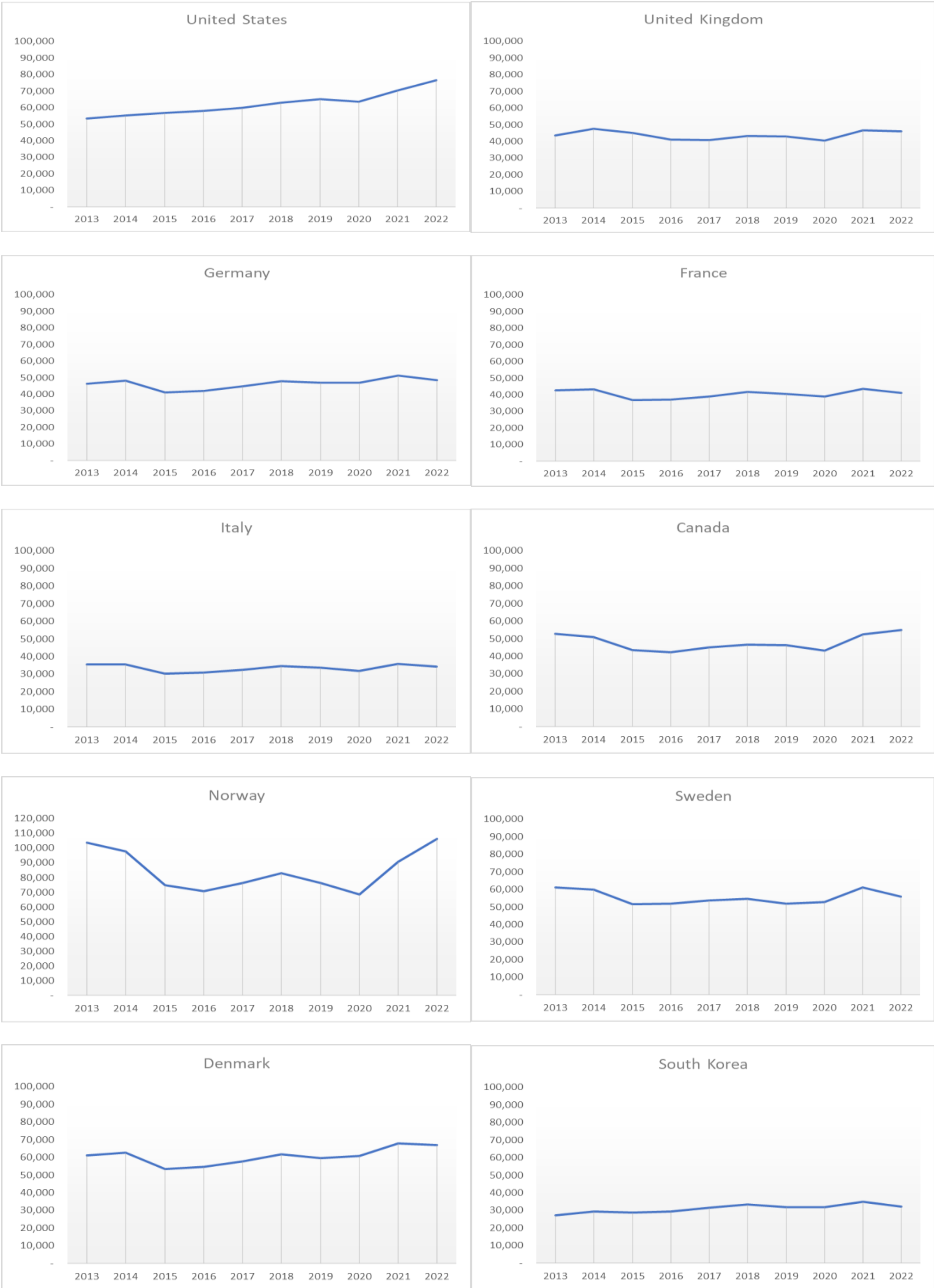

Figure 1 GDP per capita for 10 countries.
Source: GDP per capita (2022), World Bank and OECD.

2. Research methodology and analytical modeling

We utilized OECD income inequality data (2013–2019) and World Bank and OECD GDP per capita data (2013–2019) for the economic analysis. The Gini coefficient and P90/P10 were also used in the economic analysis. We targeted the United

States, the United Kingdom, Germany, France, Italy, Canada, Norway, Sweden, Denmark, and South Korea (Figure 2 and 3). Partial correction analysis was used for economic analysis. In particular, the correlation between income quality and GDP per capita is studied through correlation analysis of variables. In the partial correlation analysis, the third variable is controlled to identify the pure correlation of the variables. In this case, the third variable that affects the relationship between the two variables is set as the control variable. The equation for the population parameter (ρ) and sample statistic (r) of the correction coefficient analysis is as follows:

$$corr\ (X.Y) = \rho = \frac{cov\ (X.Y)}{\sqrt{var\ (X)}\sqrt{var\ (Y)}} = \frac{\sigma_{xy}}{\sqrt{\sigma_{xx}}\sqrt{\sigma_{yy}}} = \frac{\sigma_{xy}}{\sqrt{\sigma_{xx}}\sqrt{\sigma_{yy}}} \quad (1)$$

$$corr\ (X.Y) = r = \frac{cov\ (X.Y)}{\sqrt{var\ (X)}\sqrt{var\ (Y)}} = \frac{S_{xy}}{\sqrt{S_{xx}}\sqrt{S_{yy}}} = \frac{S_{xy}}{\sqrt{S_{xx}}\sqrt{S_{yy}}} \quad (2)$$

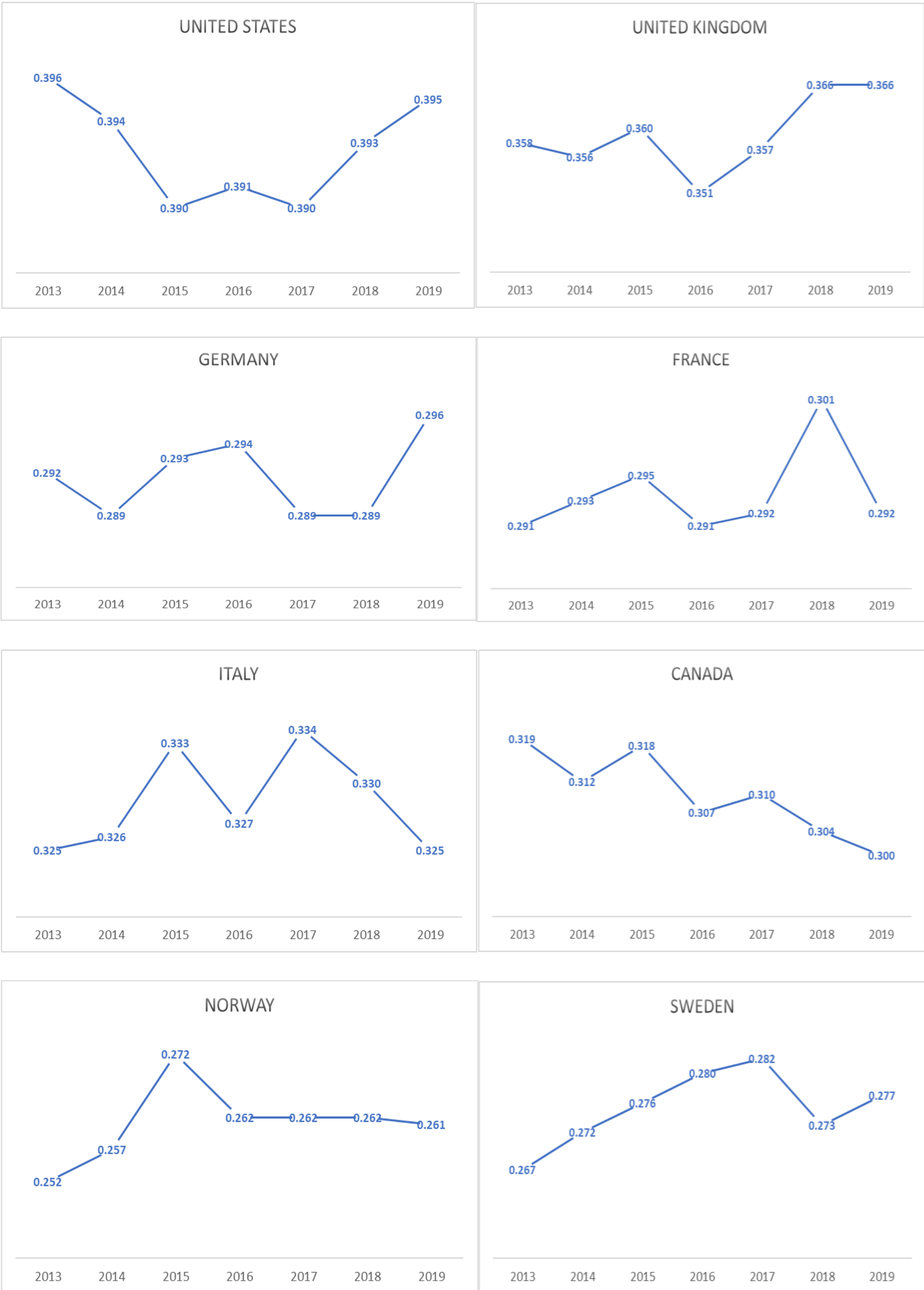

Figure 2 Gini coefficient for 10 countries.
Source: Gini coefficient, income inequality (2022), OECD.

Figure 3 P90/P10 for 10 countries.
Source: P90/P10, income inequality (2022), OECD.

The equation for the partial correction analysis is as follows.

$$r_{xy} = \frac{r_{xy} - (r_{xz})(r_{yz})}{\sqrt{1 - r_{xz}^2}\sqrt{1 - r_{yz}^2}} \qquad (3)$$

The partial correlation analysis examines the degree of pure correlation between X and Y in the correlation analysis between X and Y, excluding the effect of Z on the correlation between X and Y if both X and Y are highly correlated with Z. The correlation coefficient obtained through this partial correlation analysis is called the partial correlation coefficient. The Z that affects both X and Y simultaneously is called the control variable. This coefficient removes the influence of the third variable on the two variables and represents a pure correlation between the two variables. When the third control variable is Z, the partial coefficient between the two variables X and Y represents the correlation coefficient between the residuals remaining when the linear effect of Z on X and Y is removed. Depending on the characteristic of the effect of the variable Z, the partiality coefficient may be smaller or larger than the general correlation (Figures 4, 5, and 6).

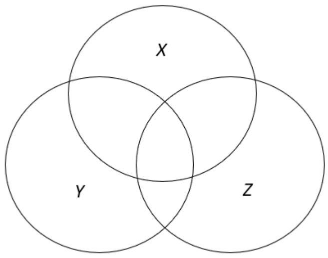

Figure 4 Linear relationships among the three variables.

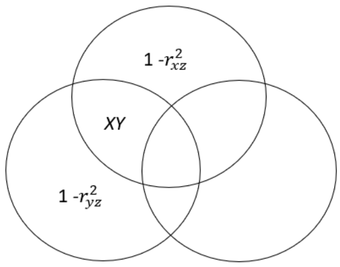

Figure 5 Excluding the influence of one variable.

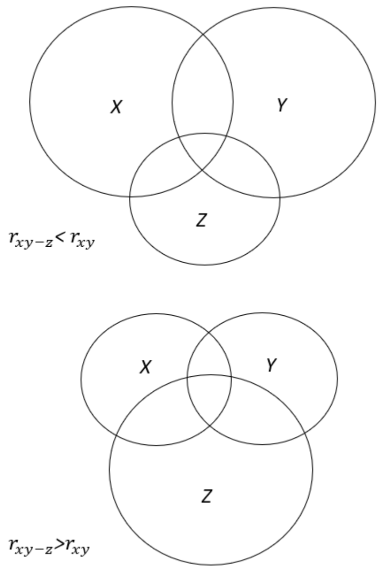

Figure 6 Pure linear relationship between two variables.

In this study, for economic analysis, P90/P10 was set as a control variable, with a focus on the correlation between GDP per capita and the Gini coefficient. The control variable affects the dependent variables. P90/P10 is used as a major indicator of national income inequality. In this study, we judged that P90/P10 could affect the dependent variables and set P90/P10 as a control variable. There is a limit to analyzing using only an indicator that is relevant to a control variable, so it is necessary to analyze using other indicators.

The hypotheses of this study are as follows:

- Research hypothesis (H_1): GDP per capita and the Gini coefficient have a linear relationship.

- The correlation coefficient between GDP per capita and the Gini coefficient is not zero (ρ ≠0).
- Null hypothesis (H_0): GDP per capita and the Gini coefficient have no linear relationship.
- The correlation coefficient between GDP per capita and the Gini coefficient is zero (ρ=0).

3. Research results and findings

The results of the correction analysis for the United States, the United Kingdom, Germany, France, Italy, Canada, Norway, Sweden, Denmark, and South Korea can be found in Figure 7.

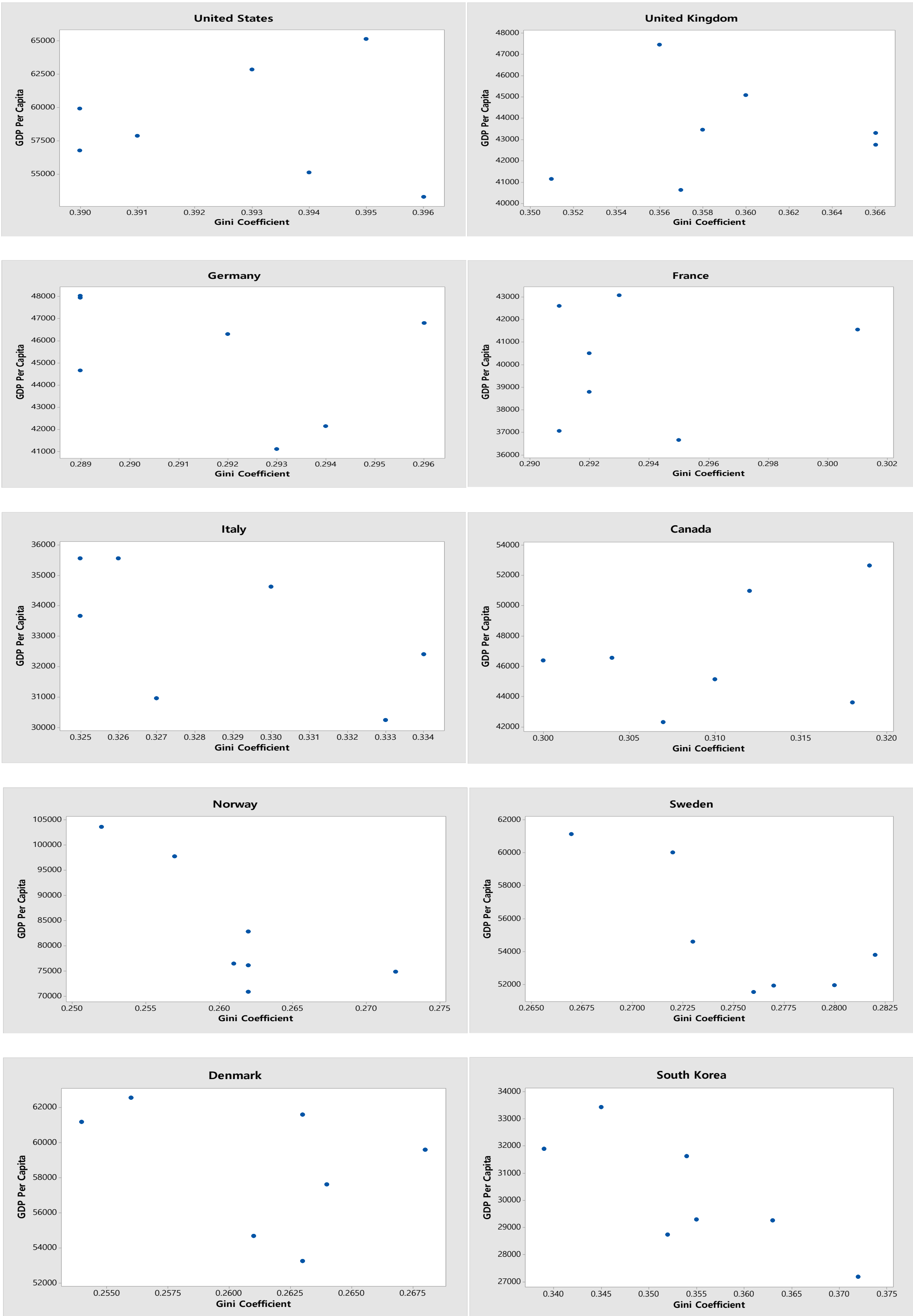

Figure 7 Scatterplot for 10 countries.

P90/P10 is not set as a control variable. The GDP per capita and the Gini coefficient in the United States, the United Kingdom, Germany, France, Italy, Norway, Sweden, and Denmark do not correlate with P90/P10 ($p > 0.1$). Moreover, the findings demonstrate that the GDP per capita of Canada and South Korea does not correlate with P90/P10 ($p > 0.1$). However, the Gini coefficient in Canada and South Korea has a very significant correlation with P90/P10 ($p < 0.1$). There is one control variable in the analysis called the first-order partial correction. In this study, P90/P10 was set as the control variable. In the United States, the United Kingdom, and France, there is a positive correlation between the analysis results of GDP per capita and the Gini coefficient. In the United Kingdom, there was a relatively high positive correlation. The Gini coefficient is approximately high in years when the GDP per capita is high. Negative correlations were found in the analysis results for Germany, Italy, Canada, Norway, Sweden, Denmark, and South Korea's GDP per capita and Gini coefficient. In Norway, Sweden, Denmark, and South Korea, there was a relatively high negative correlation, which is low in the Gini coefficient in years when GDP per capita was high. The detailed results of the correlation analysis are as follows (Table 1 and 2):

United States: GDP per capita and the Gini coefficient are positively correlated at 0.250 ($p = 0.633$). It is estimated that the Gini coefficient is also high in years when the GDP per capita is high.

United Kingdom: The correlation coefficient between GDP per capita and the Gini coefficient is 0.619 ($p = 0.190$), which is a relatively high positive correlation. The Gini coefficient is estimated to be high in years when the GDP per capita is high.

Germany: The correlation coefficient between GDP per capita and the Gini coefficient is -0.219 ($p = 0.676$), a negative correlation, which appears low in the Gini coefficient in years when GDP per capita is high.

France: The correlation coefficient between GDP per capita and the Gini coefficient is positive at 0.076 ($p = 0.886$), which is high in the Gini coefficient in years when GDP per capita is high.

Italy: The correlation coefficient between GDP per capita and the Gini coefficient is -0.260 ($p = 0.619$), a negative correlation, which is estimated to be low in the Gini coefficient in years when GDP per capita is high.

Canada: The correlation coefficient between GDP per capita and the Gini coefficient is -0.427 ($p = 0.398$), a negative correlation, which is estimated to be low in the Gini coefficient in years when GDP per capita is high.

Norway: The correlation coefficient between GDP per capita and the Gini coefficient is -0.572 ($p = 0.236$), a relatively high negative correlation that is low in the Gini coefficient in years when GDP per capita is high.

Sweden: The correlation coefficient between GDP per capita and the Gini coefficient is -0.600 ($p = 0.208$), a relatively high negative correlation, which appears low in the Gini coefficient in years when GDP per capita is high.

Denmark: The correlation coefficient between GDP per capita and the Gini coefficient is -0.825 ($p = 0.043$), a relatively high negative correlation, which is estimated to be low in the Gini coefficient in years when GDP per capita is high.

South Korea: The correlation coefficient between GDP per capita and the Gini coefficient is -0.642 ($p = 0.169$), a relatively high negative correlation, which is estimated to be low in the Gini coefficient in years when GDP per capita is high.

Table 1 Descriptive statistics for 10 countries.

Descriptive statistics for the United States		
	Mean	Std. Deviation
GDP Per Capita	58699.4286	4206.45745
Gini coefficient	.3927	.00243
P90/P10	6.2857	.10690
	Descriptive statistics for the United Kingdom	
	Mean	Std. Deviation
GDP Per Capita	43398.5714	2324.09200
Gini coefficient	.3591	.00543
P90/P10	4.3000	.14142
	Descriptive statistics for Germany	
	Mean	Std. Deviation
GDP Per Capita	45278.2857	2758.48834
Gini coefficient	.2917	.00281
P90/P10	3.6857	.06901
	Descriptive statistics for France	
	Mean	Std. Deviation
GDP Per Capita	40031.7143	2587.60048
Gini coefficient	.2936	.00355
P90/P10	3.4571	.05345
	Descriptive statistics for Italy	
	Mean	Std. Deviation
GDP Per Capita	33290.2857	2150.54216
Gini coefficient	.3286	.00378
P90/P10	4.6143	.14639
	Descriptive statistics for Canada	
	Mean	Std. Deviation

GDP Per Capita	46793.4286	3757.84406
Gini coefficient	.3100	.00700
P90/P10	4.1571	.15119
Descriptive statistics for Norway		
	Mean	Std. Deviation
GDP Per Capita	83179.1429	12530.05043
Gini coefficient	.2611	.00607
P90/P10	3.0857	.03780
Descriptive statistics for Sweden		
	Mean	Std. Deviation
GDP Per Capita	54996.7143	3976.73672
Gini coefficient	.2753	.00509
P90/P10	3.2857	.03780
Descriptive statistics for Denmark		
	Mean	Std. Deviation
GDP Per Capita	58636.2857	3588.82524
Gini coefficient	.2613	.00482
P90/P10	2.9429	.05345
Descriptive statistics for South Korea		
	Mean	Std. Deviation
GDP Per Capita	30201.4286	2174.57205
Gini coefficient	.3543	.01092
P90/P10	5.7143	.30237

Table 2 Correlation analysis for 10 countries.

Correlation analysis for United States

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	-.051	-.234
		Significance (2-tailed)	.	.914	.613
		df	0	5	5
	Gini Coefficient	Correlation	-.051	1.000	.816
		Significance (2-tailed)	.914	.	.025
		df	5	0	5
	P90/P10	Correlation	-.234	.816	1.000
		Significance (2-tailed)	.613	.025	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	.250	
		Significance (2-tailed)	.	.633	
		df	0	4	
	Gini Coefficient	Correlation	.250	1.000	
		Significance (2-tailed)	.633	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for United Kingdom

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	.104	-.254
		Significance (2-tailed)	.	.825	.583
		df	0	5	5
	Gini Coefficient	Correlation	.104	1.000	.847
		Significance (2-tailed)	.825	.	.016
		df	5	0	5
	P90/P10	Correlation	-.254	.847	1.000
		Significance (2-tailed)	.583	.016	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	.619	
		Significance (2-tailed)	.	.190	
		df	0	4	
	Gini Coefficient	Correlation	.619	1.000	
		Significance (2-tailed)	.190	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for Germany

Control Variables	GDP Per capita	Gini Coefficient	P90/P10

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	-.403	-.597
		Significance (2-tailed)	.	.370	.157
		df	0	5	5
	Gini Coefficient	Correlation	-.403	1.000	.405
		Significance (2-tailed)	.370	.	.367
		df	5	0	5
	P90/P10	Correlation	-.597	.405	1.000
		Significance (2-tailed)	.157	.367	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	-.219	
		Significance (2-tailed)	.	.676	
		df	0	4	
	Gini Coefficient	Correlation	-.219	1.000	
		Significance (2-tailed)	.676	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for France

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	.128	.142
		Significance (2-tailed)	.	.785	.761
		df	0	5	5
	Gini Coefficient	Correlation	.128	1.000	.414
		Significance (2-tailed)	.785	.	.356
		df	5	0	5
	P90/P10	Correlation	.142	.414	1.000
		Significance (2-tailed)	.761	.356	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	.076	
		Significance (2-tailed)	.	.886	
		df	0	4	
	Gini Coefficient	Correlation	.076	1.000	
		Significance (2-tailed)	.886	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for Italy

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	-.575	-.548
		Significance (2-tailed)	.	.177	.203
		df	0	5	5
	Gini Coefficient	Correlation	-.575	1.000	.826
		Significance (2-tailed)	.177	.	.022
		df	5	0	5
	P90/P10	Correlation	-.548	.826	1.000
		Significance (2-tailed)	.203	.022	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	-.260	
		Significance (2-tailed)	.	.619	
		df	0	4	
	Gini Coefficient	Correlation	-.260	1.000	
		Significance (2-tailed)	.619	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for Canada

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	.345	.468
		Significance (2-tailed)	.	.449	.289
		df	0	5	5
	Gini Coefficient	Correlation	.345	1.000	.961
		Significance (2-tailed)	.449	.	.001
		df	5	0	5
	P90/P10	Correlation	.468	.961	1.000
		Significance (2-tailed)	.289	.001	.
		df	5	5	0

P90/P10	GDP per Capita	Correlation	1.000	-.427	
		Significance (2-tailed)	.	.398	
		df	0	4	
	Gini Coefficient	Correlation	-.427	1.000	
		Significance (2-tailed)	.398	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for Norway

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	-.774	-.717
		Significance (2-tailed)	.	.041	.070
		df	0	5	5
	Gini Coefficient	Correlation	-.774	1.000	.665
		Significance (2-tailed)	.041	.	.103
		df	5	0	5
	P90/P10	Correlation	-.717	.665	1.000
		Significance (2-tailed)	.070	.103	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	-.572	
		Significance (2-tailed)	.	.236	
		df	0	4	
	Gini Coefficient	Correlation	-.572	1.000	
		Significance (2-tailed)	.236	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for Sweden

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	-.794	-.680
		Significance (2-tailed)	.	.033	.093
		df	0	5	5
	Gini Coefficient	Correlation	-.794	1.000	.718
		Significance (2-tailed)	.033	.	.069
		df	5	0	5
	P90/P10	Correlation	-.680	.718	1.000
		Significance (2-tailed)	.093	.069	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	-.600	
		Significance (2-tailed)	.	.208	
		df	0	4	
	Gini Coefficient	Correlation	-.600	1.000	
		Significance (2-tailed)	.208	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for Denmark

Control Variables			GDP Per capita	Gini Coefficient	P90/P10
-none-[a]	GDP Per Capita	Correlation	1.000	-.373	.251
		Significance (2-tailed)	.	.410	.588
		df	0	5	5
	Gini Coefficient	Correlation	-.373	1.000	.721
		Significance (2-tailed)	.410	.	.068
		df	5	0	5
	P90/P10	Correlation	.251	.721	1.000
		Significance (2-tailed)	.588	.068	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	-.825	
		Significance (2-tailed)	.	.043	
		df	0	4	
	Gini Coefficient	Correlation	-.825	1.000	
		Significance (2-tailed)	.043	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

Correlation analysis for South Korea

Control Variables			GDP Per capita	Gini Coefficient	P90/P10

-none-[a]	GDP Per Capita	Correlation	1.000	-.811	-.722
		Significance (2-tailed)	.	.027	.067
		df	0	5	5
	Gini Coefficient	Correlation	-.811	1.000	.968
		Significance (2-tailed)	.027	.	.000
		df	5	0	5
	P90/P10	Correlation	-.722	.968	1.000
		Significance (2-tailed)	.067	.000	.
		df	5	5	0
P90/P10	GDP per Capita	Correlation	1.000	-.642	
		Significance (2-tailed)	.	.169	
		df	0	4	
	Gini Coefficient	Correlation	-.642	1.000	
		Significance (2-tailed)	.169	.	
		df	4	0	

a. Cells contain zero-order (Pearson) correlations.

4. Conclusions and recommendations

Most countries have developed an interest in and expectations for economic growth. Understanding the quantitative growth of the economy, which can be seen directly from macroeconomic indicators and the qualitative growth of the economy, is crucial to sustainable economic growth. This study conducted economic analysis and research on the relationship between national income and income distribution to understand the qualitative growth of the global economy. Specifically, this study conducted a partial correction analysis of the United States, the United Kingdom, Germany, France, Italy, Canada, Norway, Sweden, Denmark, and South Korea. A positive correlation was found between GDP per capita and the Gini coefficient in the United States, the United Kingdom, and France, whereas a negative correlation was found between Germany, Italy, Canada, Norway, Sweden, Denmark, and South Korea's GDP per capita and the Gini coefficient. In this study, the control variable was set to P90/P10, and some countries do not have significant analysis results; hence, further research on economic growth and income inequality is recommended. The results of the correlation analysis show that in the United States, the United Kingdom, and France, there is a trend toward a higher Gini coefficient as GDP per capita increases through economic growth, which means that economic inequality intensifies. The United Kingdom has a relatively high positive correlation. In Germany, Italy, Canada, Norway, Sweden, Denmark, and South Korea, the higher the GDP per capita is, the lower the Gini coefficient, implying that economic inequality is mitigated. In particular, Norway, Sweden, and Denmark are representative countries with well-run social systems and welfare and have relatively high negative correlations. South Korea also has a relatively high negative correlation. The current research suggests that studies on improvement measures and policies for global economic growth and income inequality are urgently needed, and we expect this study to present the right direction for grasping the qualitative growth of the global economy.

Ethical considerations

Not applicable

Conflict of Interest

The author declares no conflicts of interest.

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