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INCOME INEQUALITIES IN EU COUNTRIES: GINI INDICATOR ANALYSIS

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ABSTRACT

Franklin Delano Roosevelt said that "the test of our progress is not whether we add more to the abundance of those who have much; it is whether we provide enough for those who have too little." According to the World Economic Forum (2021), income disparity is at the top of global risks in the coming years. The development of income inequality is a growing concern worldwide, particularly since the Great Recession. This study is based on available data on the Gini coefficient of equivalized disposable income from 2005 to 2019 for the 27 European Union countries. We found that the indicator's value demonstrates a reasonably even distribution of income (not exceeding 40%) in all European Union countries, except Bulgaria. We used the FORECAST ETS function (Excel for Microsoft 365) that is based on the AAA version of the Exponential Smoothing (ETS) algorithm to conduct our analysis. We grouped the EU 27 countries to investigate income equality behavior. According to the interval's median of the sample's standard deviation, we selected Italy, Spain, Germany, Slovakia, Hungary, Bulgaria for further investigation. We conclude the absence of general trends in the inequality of income distribution in society due to the financial crisis factors. The research presents exploratory insights into income inequality in the European Union.

Keywords:
EU; Income inequality; Gini; Sturges formula; quintile; forecast; Exponential Smoothing; Global financial crisis; Standard deviation

JEL Classification: D33, E17, E21, E25, E24, Y1, Y10

INTRODUCTION

The European Union (EU) is a novel economic and political union among 27 countries. It is a voluntary arrangement in which control rests with the separate member States who can, if they wish so, decide to leave the Union as the UK did on 31st January 2020. More than 340 million EU citizens in 19 countries now use it as their currency and enjoy its benefits. Checchi et al. (2015) states that the EU is the largest economy globally, with a GDP per head of €25,000 for its 500 million consumers. With time European Union has acquired many attributes of a state, and, in economic terms, it can be considered a single market. Nonetheless, the differences between member states are enormous. Income inequality is a natural result of the individual and economic performance of individuals. Individual heterogeneity in talent and effort will result in different income results and consequently in a certain level of overall inequality. Income inequality is a factor that influences economic growth and development. It may result in higher taxes, political conflict, lower capital accumulation. Both scholars and government administrators are concerned about the evolution and negative impact of inequality on growth and development. Inequality has never been easy to measure. There are many problems when measuring and comparing income levels. There are aspects like income and expenditure, income before and after redistribution, the effect of owner occupancy and household production, and other various elements. Further, the different aspects that need to be considered are exchange rates and purchasing power, inflation rates, and considerable differences in national statistics. According to OECD (2021), the Gini coefficient is regularly used as a measure of inequality of income, consumption, or wealth. The Gini coefficient is based on comparing cumulative proportions of the population against cumulative proportions of income they receive. It ranges between 0 and 1, in the case of perfect equality value is 0 and in the case of perfect inequality, value equals 1.

The development of income inequality in the EU member states is a growing concern for the European region. There seems to be a general trend of widening the income gap starting in the 1980s CSRI (2017). There is a significant increase in income inequality of former 'equal societies', such as the Nordic countries and Germany. In general, there seems to be a convergence trend towards a generally higher level of income inequality. The 2007-2009 Great Recession more frequently known as the Global Financial Crisis had a significant negative impact on economic and household income growth in the EU. Still, the effect was more marked in some countries like the Baltic, and Southern European regions, leading to more significant divergence across and within countries. Growth resumed in all EU countries by 2014, some of the crisis-induced variations between countries have been reverted, and convergence remains hampered. As a result, EU-wide inequality increased in the aftermath of the crisis. Reducing inequality is an official aim of the European Union. It is a primary goal of their strategic plan. Ferrer (2005) describes that income equality is also worth achieving because greater equality is likely to increase the overall welfare of society. Understanding and measuring income inequality is significant. Frey and Stutzer (2002) portrays a picture of the income inequality in any region empowers the authorities to make better-informed decisions. EU has witnessed many dynamic changes on the political and economic front and yet they are the most competitive regions of the world. Checchi et.al, (2010) states that Over the past decade, economic unification has slowed down, giving birth to concerns over income inequality and social separation. Growth in household incomes and conjunction across countries until 2008 has been followed by years of crisis and stagnation, leading to attention over continued growth and integrity in the EU. The recession has impacted communities, but the impact has touched lives equally. Recent literature by Piketty (2013) has stimulated a fierce debate on inequality among academics and policymakers. Our research analyzing the Gini coefficient of equivalised disposable income from 2005 to 2019 for the EU 27 countries. We explored the Gini behavior during the Global Financial Crisis period to find out if there are general trends in the equality of income distribution associated with the

crisis. Based on the sample standard deviation, we grouped the EU 27 countries by homogeneity to further explore income equality behavior. According to the criterion of the median, standard deviation of the sample, we selected one country in each group. As a result, we got a shortlist of countries for further research (Italy, Spain, Germany, Slovakia, Hungary, Bulgaria). We conclude the absence of general trends in changes in the inequality of income distribution in society as a reaction to the factors of the financial crisis. We limited the calculation of forecast values to three periods, including 2020.

1. LITERATURE REVIEW

The economic integration and unification of countries of the European Union have concerns over income inequality for the past decades. When you look at the EU as a single country, the income inequalities have declined over the years, but the income disparity between the rich and emerging countries is still vast. The present literature review is conducted to gauge the various studies on income inequalities across the European region.

Alfani (2019) the findings of this article show that inequality has been growing over the centuries. The authors describe how inequality is perceived in the modern world. Some causal factors are like demographic, social-economic, and institutional are explored to shed more light on the cause of inequality. Heiko (2017) discusses the hot topic of income inequality. In many countries where economic growth is sluggish, and unemployment is high, income inequality is debated in political circles. The article discusses the drivers of income inequality as globalization, technological change, and migration. Over the years, various scholars have studied the relationships between income inequality and important social outcome variables. Giorgi (1990) states that the Gini is a well-studied index with a long history and is associated with the area between equality and the Lorenz curve. The Italian statistician Corrado Gini devised this statistical tool in the year 1912. It is a popular measure of socioeconomic inequality, especially in income and wealth distribution. Gini (2005) states that the Gini index can be calculated as the area between the perfect equality line and the Lorenz curve divided by the total area under the ideal equality line. The Gini index takes values in the unit interval. The closer the index is to zero, the equal income distribution. The closer the index is to one (where the area A is large), the more unequal the income distribution. Gastwirth (1972) provides a graphical summary of the distribution, which economists and policymakers use. The studies of Wilkinson and Pickett (2009), Atkinson (2013), and Piketty (2020) show that higher inequality leads to adverse socio-economic outcomes in advanced economies. According to Eliazar (2012), the Gini index application has crossed socioeconomic scope and entered various science disciplines. Another study by Elizar (2018) states that the Gini index applies to any size distributions in the context of available data sets with non-negative quantities such as count, length, area, volume, mass, energy, and duration. The panel data analysis of the Gini coefficient by Fajnzylber et al. (2002a) shows that inequality increases homicide and robbery rates. In another study, Fajnzylber et al. (2002b) also conclude that crime rates and inequality are positively correlated. Alesina and La Ferrara's (2002) investigations on the Gini for a metropolitan region show that respondents living in more fragmented, and income unequal communities report lower trust levels. Another interesting study is done by Knack and Keefer (1997). Their work demonstrates that trust and civic norms are more robust in nations with higher and more equal incomes. The result of Perotti (1993) links society to education. He states that an equal society has higher rates of investment in education. Checchi (2003) studies the relationship between the Gini and school enrollment rates. He looks at 108 countries to confirm the negative correlation between income inequality and secondary enrollment; he further claims that income inequality has a more substantial effect on women's primary and tertiary education enrollment. Solt (2008) brings out the relationship between income inequality and citizens' political involvement. His study on 23 advanced countries from 1984 to 2000 reveals that the country's income inequality reduces individual political engagement. The effect increases with relative declining income. Schwarze & Harpfer (2007) studied the negative effect of income inequality on life satisfaction in Germany. They found that it did had an impact on

life satisfaction but influenced the relative income position of people. They used the Gini coefficient for their study. Senik (2004) used the Gini with Ordered probit on a study of Russian individuals and concluded that inequality indices do not affect individual satisfaction. The reviews of Sanfey and Teksoz (2005) show that inequality harms life satisfaction across multiple transition countries. Several studies have analyzed the relationship between income inequality and life satisfaction in various transition countries.

The global concern for income inequality has increased further since the start of the Global Recession. The studies of Krugman (2008) have shown the role of inequality in the growth process and stated that the evolution of inequality is the leading cause and natural consequence of the Great Recession. The studies of Stiglitz (2009) and Rajan's (2010) findings are in line with Krugman's results. Patridge (2005) for the USA, Rodríguez, and Tselios (2008) for Europe, and Castells and Royuela et al. (2014b) for the OECD have studied the relationship between Gini Index and GDP per capita over several years. Their findings demonstrate that, on average, more developed countries have lower inequality levels. It is fair to think that Europe is already a developed region in the world. But other scholars demonstrate the negative association of the Gini Index and economic development. Some models of 1996 and 2000 have proved that higher inequality in more developed regions can be linked to the idea of evolution through innovations associated with increasing inequalities. Therefore, it shows that the sectoral composition of the economy matters. The work of Castells and Royuela (2014a) states that inequality can be associated with agglomeration economies and the spatial concentration of resources, which circumstances can be a positive factor for economic development. Blanchet et al. (2019) bought together all existing sources on income inequality in Europe since 1980 to *produce national distributional accounts. He further comments on inequality since the 1980s, and notes that there has been an increase in income disparities. The researchers Dorwick and Akmal (2005), Milanovic (2002) and Sala-i-Martín (2006), Brandolini (2007), Barro (2020), Dauderstädt (2008), and Franzini (2009) have explicitly covered European income inequality. However, according to Anand and Segal (2008), these approaches have many limitations. They are also subject to academic criticism. Inequality is difficult to measure, but measuring transnational inequality is especially difficult. Constructing a measure of international income inequality is no simple mathematical operation. The Gini and the Theil T-index and income brackets, such as deciles or quintiles, are common measures of inequality. In economic terms, European Union is considered as a single market and has over the years developed the attributes of a single state. Nonetheless, the differences between member states are enormous. Small, rich countries, such as Luxembourg, contrast sharply with big, poor ones, such as Romania.*

The literature review substantially demonstrates that the Gini coefficient is a widely used and accepted measure for income inequality. There are many scholarly contributions to the Gini coefficient and European studies. There is a scope for adding to the available body of knowledge, especially since the world is facing declined economic growth with the pandemic's advent. Our research attempts to add an iota of knowledge to understanding the income inequality in EU-27. Our research work has four aims: First, to analyze the Gini coefficient for EU countries from 2005-2019, to highlight the trends in income distribution inequality during the Global Financial crisis of 2008-2009. Second, examine if the extremes (minimum and maximum values) are consistent with the corresponding response of the S80/S20 disposable income quintile share ratio. Third, to give a forecast estimate of the Gini coefficient for future periods.

2. METHODOLOGY

The presented study is based on available data on the Gini coefficient of equivalized disposable income for the period from 2005 to 2019 for the 27 countries that make up the European Union at the time of the study. The data source was mainly open data from the official Eurostat website-Eurostat database (2021). Missing data for specific periods for some countries have been supplemented with relevant data from other sources – the World Data Atlas (2021). Note an important point: data

from other sources were considered only when there was a coincidence of other relevant (in the series) already available data from Eurostat. Thus, we draw your attention to the fact that the data in various sources may not coincide due to their possible unreliability of the use of different methods for calculating the Gini coefficient itself.

To achieve the goal of the study, we took six countries as a sample. For the classification of countries, grouping data was used - the division of the considered set of data into homogeneous ones according to the studied characteristics. The sample was created based on the values of the standard deviation of the sample. To do this, we have determined a variation interval series with equal intervals according to the following algorithm, based on the Sturges formula (Feshchur, 2003):

1. Determination of the number of intervals by the formula:

$$m = 1 + 3{,}332 \lg n, \quad (1)$$

where n is the number of elements in the population.

2. Determination of the width (step) of the interval by the formula:

$$h = \frac{x_{max} - x_{min}}{m}, \quad (2)$$

where x_{max}, x_{min}- respectively, the largest and the smallest value of the feature.

3. Plotting intervals for forming groups:

Step	Factor attribute x_i
1.	$[x_{min}; x_{min} + h)$
2.	$[x_{min} + h; x_{min} + 2h)$
3.	$[x_{min} + 2h; x_{min} + 3h)$
…	…
N	$[x_{max} - h; x_{max}]$

One country was selected based on the median's criterion and the sample's standard deviation in each group. When the group contained an even number of countries, the country was established, which corresponded to the sample's standard deviation preceding the median. Thus, we formed a list of countries for further research. Since we took the time series of unstable values in the study field, the FORECAST ETS function (Excel for Microsoft 365) was used to determine the trend and calculate the Gini coefficient's predicted values. Calculates or predicts a future value based on existing (historical) values using the AAA version of the Exponential Smoothing (ETS) algorithm. The predicted value is a continuation of the historical values in the specified target date, which should be a continuation of the timeline.

3. RESULTS

In our analysis of the Gini coefficient from 2005 to 2019 (Table 1), we found indicator's value demonstrates an even distribution of income (not exceeding 40%) in all countries of the European Union, except Bulgaria. Where the value of the coefficient exceeded the threshold value in 2019 (40.8%), and this is the maximum value among all available for analysis. Following the method

described above, we took the number of elements in the population n = 27. According to formula (1), we obtained a value for the number of intervals m = 5.769. That is, the list of 27 countries was divided into six groups.

Following formula (2), the step width of the interval was h = 0.410. Next, we formed intervals to highlight groups of countries (table 2). According to the sample's median standard deviation criterion, one country was selected in each group. When the group contained an even number of countries, the country was selected, which corresponded to the standard deviation of the sample preceding the median. Thus, a list of countries for further research was formed: Italy, Spain, Germany, Slovakia, Hungary, Bulgaria.

We consider it necessary to supplement the analysis of the Gini coefficient dynamics with an emphasis on its maximum and minimum values during the study period relative to the values of 2008 and 2009 - the period of the financial crisis. Interestingly, the Gini coefficient values give the different amplitude of fluctuations (Table 3) - for Italy and Spain, the increase in the coefficient value is within 9%, and for Bulgaria - more than 30%. Simultaneously, in Slovakia and Hungary, there is a decrease in amplitude during 2005-2019 by more than 34 and 38%, respectively. The analysis of the Gini coefficient values' reaction to the factors of the financial crisis of 2008-2009, complementing the study of the ratio S80/S20 disposable income quintile share reveal a decrease in Italy's studied indicator to 31.2% in the 2008 crisis year compared to the value before the crisis (32%) with an increased S80/S20 ratio from 5.2 to 5.3 (table 4). In Spain, on the contrary, the indicator reaches its minimum value precisely in the pre-crisis year (with S80/S20 = 5.4). During the crisis, the value of the coefficient increases by 1 pp, and this trend continues until 2014, when the maximum is reached (34.7% at S80/S20 = 6.6). For Germany, the maximum and minimum values were recorded practically at the extreme points of our time series - in 2005 (31.1%) and in 2018 (26.1%), respectively (information on S80/S20 specifically for these periods in the considered database, was absent). A similar situation in the dynamics of the Gini coefficient is observed for Bulgaria. For Slovakia, the case is the opposite: the maximum (28.1%) was recorded in 2006, and in the first year of the crisis, the value of the coefficient increased by 4.4 pp, the minimum was reached in 2018, and the difference in values is 9.2 pp with a slight difference S80/S20 - 3.6 in 2006 and 3.5 in 2018 with a maximum of 4.0 in the crisis of 2009. Finally, the Gini coefficient's most considerable fluctuation is observed in Hungary's indicators for - a decrease of 9.2 pp, which is -38.17%.

Table 1. Gini coefficient and sample standard deviation values for 27 European Union countries for 2005-2019 (scale from 0 to 100)

COUNTRY	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Std. dev.
FIN	26	25,9	26,2	26,3	25,9	25,4	25,8	25,9	25,4	25,6	25,2	25,4	25,3	25,9	26,2	0,354
CZE	26	25,3	25,3	24,7	25,1	24,9	25,2	24,9	24,6	25,1	25	25,1	24,5	24	24	0,511
ITA	32,7	32,1	32	31,2	31,8	31,7	32,5	32,4	32,8	32,4	32,4	33,1	32,7	33,4	32,8	0,569
SVN	23,8	23,7	23,2	23,4	22,7	23,8	23,8	23,7	24,4	25	24,5	24,4	23,7	23,4	23,9	0,571
MLT	27	27,1	26,3	28,1	27,4	28,6	27,2	27,1	27,9	27,7	28,1	28,6	28,2	28,7	28	0,698
AUT	26,3	25,3	26,2	27,7	27,5	28,3	27,4	27,6	27	27,6	27,2	27,2	27,9	26,8	27,5	0,760
BEL	28	27,8	26,3	27,5	26,4	26,6	26,3	26,5	25,9	25,9	26,2	26,3	26,1	25,7	25,1	0,784
NLD	26,9	26,4	27,6	27,6	27,2	25,5	25,8	25,4	25,1	26,2	26,7	26,9	27,1	27,4	26,8	0,811
ESP	32,2	31,9	31,9	32,4	32,9	33,5	34	34,2	33,7	34,7	34,6	34,5	34,1	33,2	33	0,975
HRV	31,1	..	..	29	32,6	31,6	31,2	30,9	30,9	30,2	30,4	29,8	29,9	29,7	29,2	1,013
GRC	34,6	35,1	34	33,6	33,6	32,9	33,5	34,3	34,4	34,5	34,2	34,3	33,4	32,3	31	1,035
IRL	31,9	31,9	31,3	29,9	28,8	30,7	29,8	30,4	30,7	31,1	29,7	29,6	30,6	28,9	28,3	1,089
FRA	27,7	27,3	26,6	29,8	29,9	29,8	30,8	30,5	30,1	29,2	29,2	29,3	28,8	28,5	29,2	1,178
LVA	36,2	38,9	35,4	37,5	37,5	35,9	35,1	35,7	35,2	35,5	35,4	34,5	34,5	35,6	35,2	1,211
DEU	26,1	26,8	30,4	30,2	29,1	29,3	29	28,3	29,7	30,7	30,1	29,5	29,1	31,1	29,7	1,359
DNK	23,9	23,7	25,2	25,1	26,9	26,9	26,6	26,5	26,8	27,7	27,4	27,7	27,6	27,8	27,5	1,369
SWE	23,4	24	23,4	25,1	26,3	25,5	26	26	26	26,9	26,7	27,6	28	27	27,6	1,466
EST	34,1	33,1	33,4	30,9	31,4	31,3	31,9	32,5	32,9	35,6	34,8	32,7	31,6	30,6	30,5	1,531
LUX	26,5	27,8	27,4	27,7	29,2	27,9	27,2	28	30,4	28,7	28,5	29,6	29,2	31,3	32,3	1,594
LTU	36,3	35	33,8	34,5	35,9	37	33	32	34,6	35	37,9	37	37,6	36,9	35,4	1,714
SVK	26,2	28,1	24,5	23,7	24,8	25,9	25,7	25,3	24,2	26,1	23,7	24,3	23,2	20,9	22,8	1,717
PRT	38,1	37,7	36,8	35,8	35,4	33,7	34,2	34,5	34,2	34,5	34	33,9	33,5	32,1	31,9	1,801
ROU	35,9	39,6	38,3	35,9	34,5	33,5	33,5	34	34,6	35	37,4	34,7	33,1	35,1	34,8	1,842
CYP	28,7	28,8	29,8	29	29,5	30,1	29,2	31	32,4	34,8	33,6	32,1	30,8	29,1	31,1	1,856
POL	35,6	33,3	32,2	32	31,4	31,1	31,1	30,9	30,7	30,8	30,6	29,8	29,2	27,8	28,5	1,900
HUN	27,6	33,3	25,6	25,2	24,7	24,1	26,9	27,2	28,3	28,6	28,2	28,2	28,1	28,7	28	2,192
BGR	..	31,2	35,3	35,9	33,4	33,2	35	33,6	35,4	35,4	37	37,7	40,2	39,6	40,8	2,817

Source: Author's calculation

Table 2. Formation of the shortlist countries

Interval	Interval start	End of interval	Median	Country
1	0,354	0,765	0,570	ITA
2	0,765	1,175	0,994	ESP
3	1,175	1,585	1,364	DEU
4	1,585	1,996	1,759	SVK
5	1,996	2,406	..	HUN
6	2,406	2,817	..	BGR

Source: Author's calculation

Table 3. Extremes of the Gini coefficient values in the shortlist countries

Country	Maximum, %	Minimum, %	Rate of increase, %
ITA	33,4	31,2	+7,05
ESP	34,7	31,9	+8,78
DEU	31,1	26,1	+19,16
SVK	28,1	20,9	-34,45
HUN	33,3	24,1	-38,17
BGR	40,8	31,2	+30,77

Source: Author's calculation

Table 4. S80/S20 disposable income quintile share for the shortlist countries

Countries	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ITA	5,5	5,5	5,2	5,3	5,3	5,8	5,7	5,9	5,8	5,9	6,3	5,9	6,1	..	..
ESP	..	..	5,4	5,7	6	6,1	6,3	6,1	6,6	6,6	6,5	6,5	6	5,9	..
DEU	..	..	..	4,3	4,3	4,3	4,4	4,3	4,4	4,4	4,5	4,6	4,5	..	..
SVK	4,2	3,6	3,6	3,7	4	3,9	3,9	3,7	4,1	3,7	3,7	3,7	3,2	3,5	..
HUN	..	3,8	3,7	3,5	3,4	3,9	3,9	4,2	4,3	4,3	4,3	4,3	4,4	..	..
BGR	..	7,1	6,9	5,8	5,9	5,8	6,3	6,6	6,7	7,1	7,7	8,3	7,7	8,1	..

Source: OECD Statistical Database (2021)

These tables show different ranges of fluctuations in the S80/S20 ratio for the countries under consideration in the period from 2005 to 2018:

- for Italy 5.2≤ S80 / S20 ≤ 6.3.
- for Spain 5.4 ≤ S80 / S20 ≤6.6.
- for Germany 4.3≤ S80/S20 ≤4.6.
- for Slovakia 3.2≤ S80/S20 ≤4.2.
- for Hungary 3.4≤ S80/S20 ≤4.4.
- for Bulgaria 5.9 ≤ S80/S20 ≤ 8.3.

As we can see, the maximum amplitude of the disposable income quintile share fluctuations is typical for Bulgaria, and the minimum for Germany. We consider it necessary to further pay attention to the study of these countries in distributing society's income. The calculation of the correlation coefficient for the Gini coefficient and the S80/S20 ratio gave the following results: its value for five countries is in the range from 0.20 to 0.66, and for Spain - 0.86 (please, see table 5).

Table 5. Correlation coefficients for the Gini coefficients and the S80/S20 ratios for the shortlist countries

Countries	ITA	ESP	DEU	SVK	HUN	BGR
Correlation coefficients	0,564532	0,865265	0,196429	0,382344	0,410166	0,658433

Source: Author's calculation

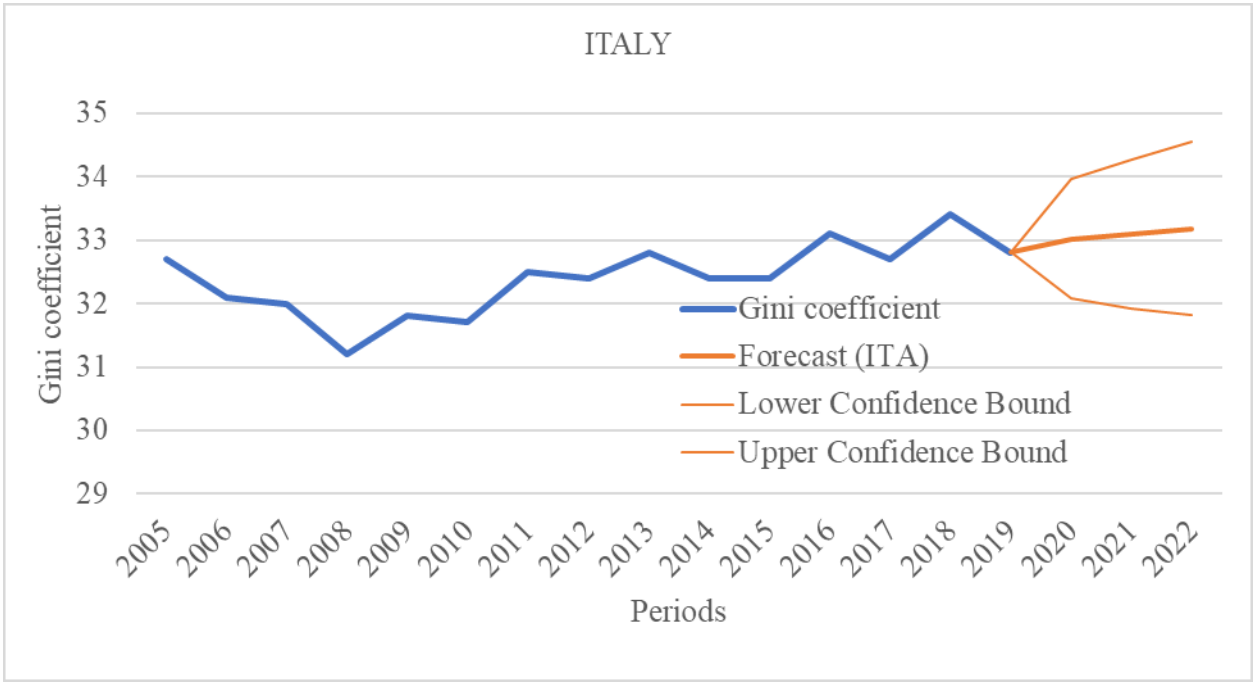
We are using Excel FORECAST.ETS function to define the predicted Gini coefficient values and trendline for the three periods. Note that for 2020 the situation has already developed. We are only waiting for the Gini coefficient results for the last year to appear in the available databases to compare with our forecast. The forecast starts in 2019 since this period's values finish our data taken for research (Table 1). The results of calculating the predicted values and their graphical interpretation are presented below. We took a 95% confidence interval for trend plotting. (Tables 6-11 and Figures 1-6).

Table 6. Predicted values of the Gini coefficient for Italy

Periods	Gini coefficient	Forecast (ITA)	Lower Confidence Bound	Upper Confidence Bound
2019	32,8	32,8	32,80	32,80
2020		33,01837622	32,08	33,95
2021		33,09967338	31,93	34,27
2022		33,18097054	31,81	34,55

Source: Author's calculation

Figure 1. The graphical interpretation of forecast the Gini coefficient for Italy



Source: Author's calculation

Table 7. Predicted values of the Gini coefficient for Spain

Periods	Gini coefficient	Forecast	Lower Confidence Bound	Upper Confidence Bound
2019	33	33	33,00	33,00
2020		33,14285714	32,08	34,21
2021		33,28571429	32,10	34,47
2022		33,42857143	32,13	34,73

Source: Author's calculation

Figure 2. The graphical interpretation of forecast the Gini coefficient for Spain

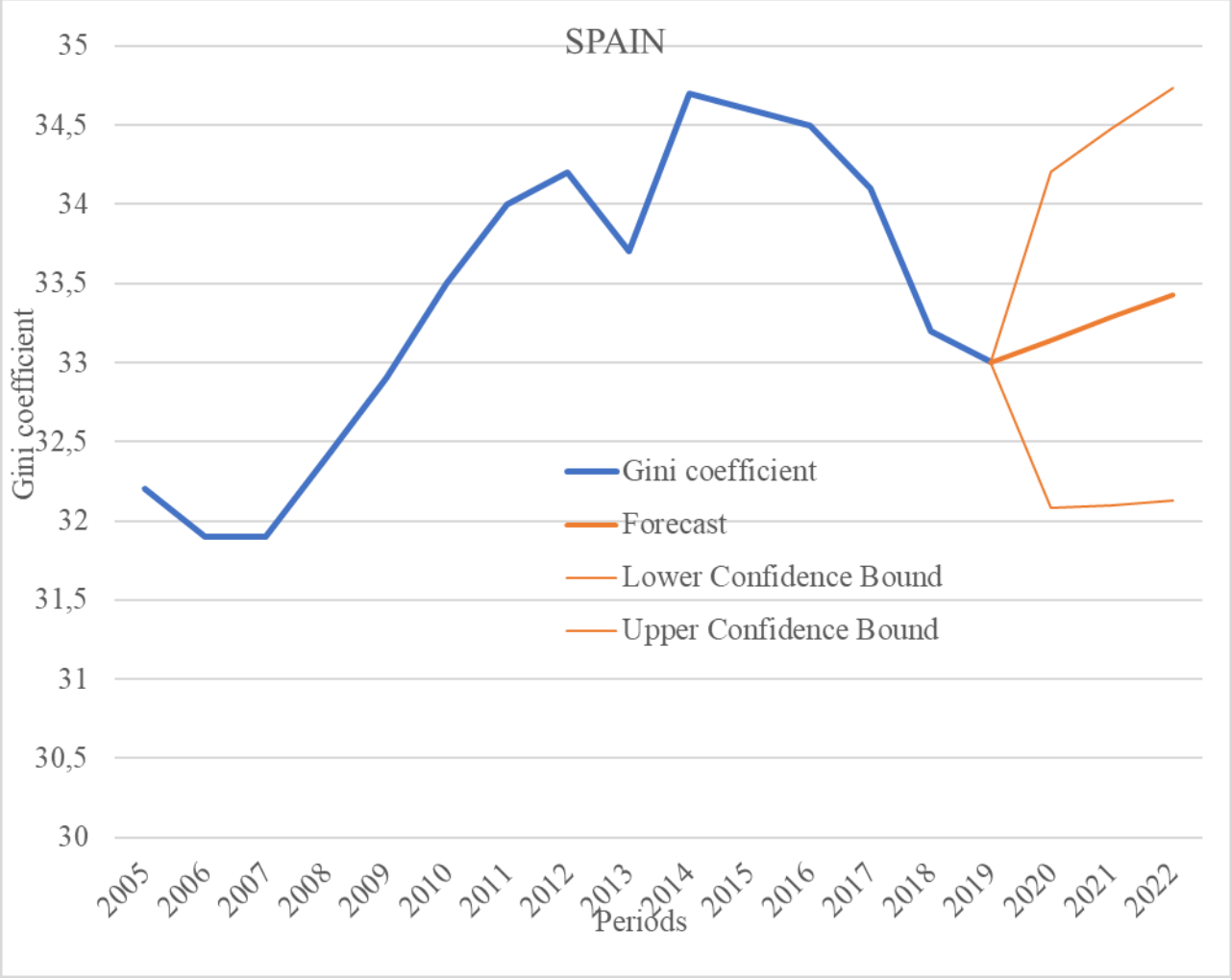
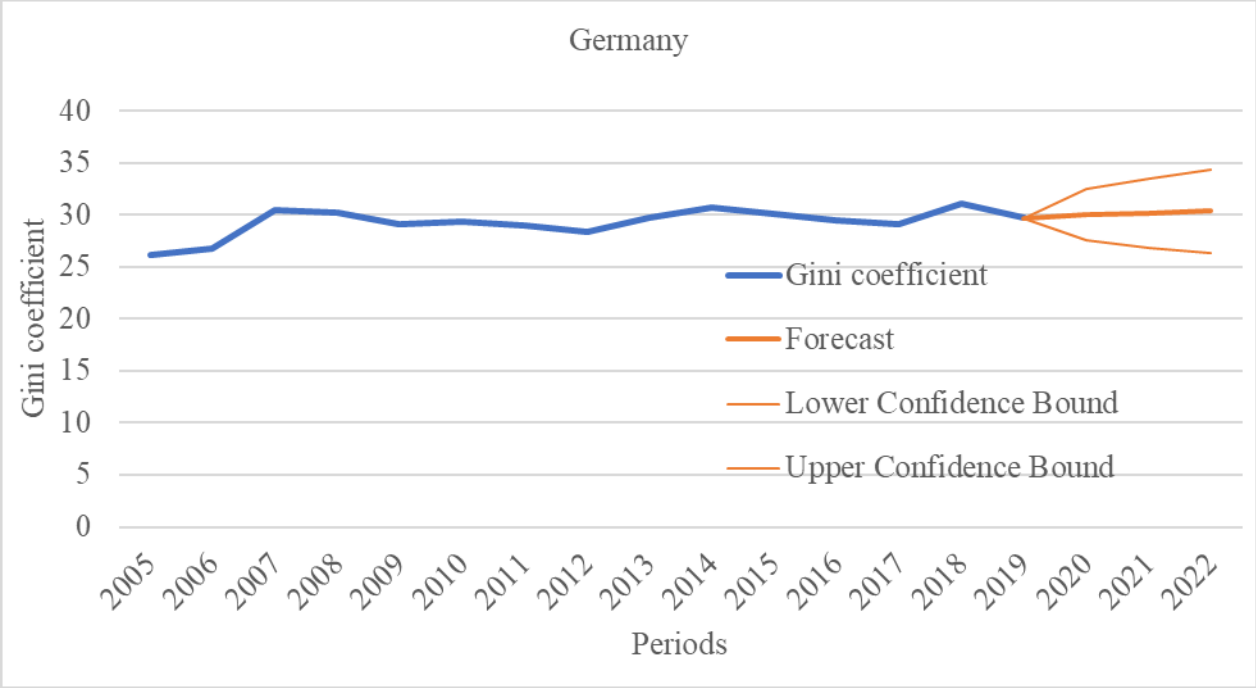


Table 8. Predicted values of the Gini coefficient for Germany

Periods	Gini coefficient	Forecast	Lower Confidence Bound	Upper Confidence Bound
2019	29,7	29,7	29,70	29,70
2020		30,01347503	27,54	32,49
2021		30,18706115	26,85	33,52
2022		30,36064727	26,35	34,37

Source: Author's calculation

Figure 3. The graphical interpretation of forecast the Gini coefficient for Germany



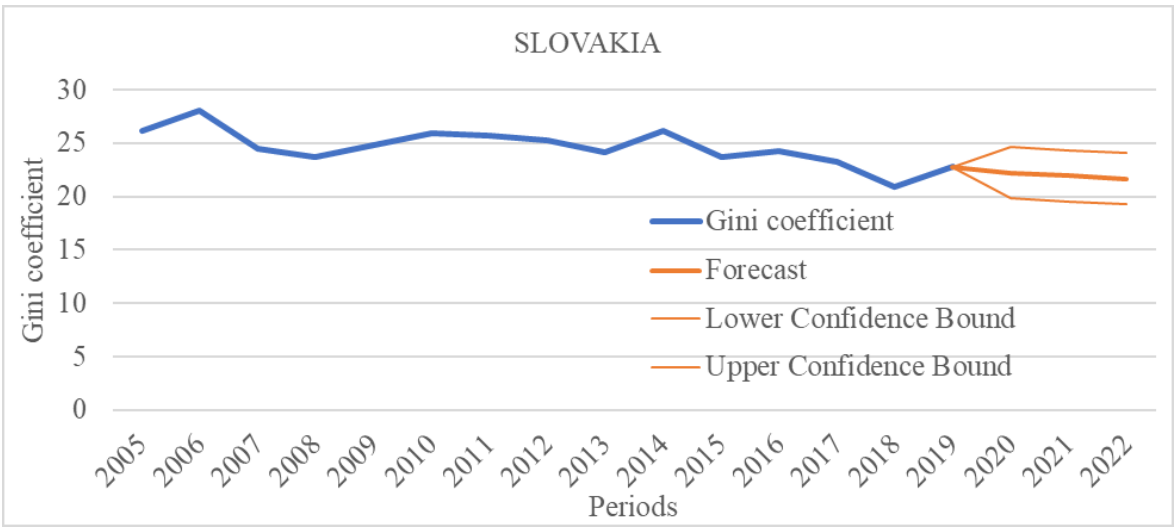
Source: Author's calculation

Table 9. Predicted values of the Gini coefficient for Slovakia

Periods	Gini coefficient	Forecast	Lower Confidence Bound	Upper Confidence Bound
2019	22,8	22,8	22,80	22,80
2020		22,20130967	19,81	24,60
2021		21,93617828	19,54	24,33
2022		21,67104688	19,28	24,06

Source: Author's calculation

Figure 4. The graphical interpretation of forecast the Gini coefficient for Slovakia



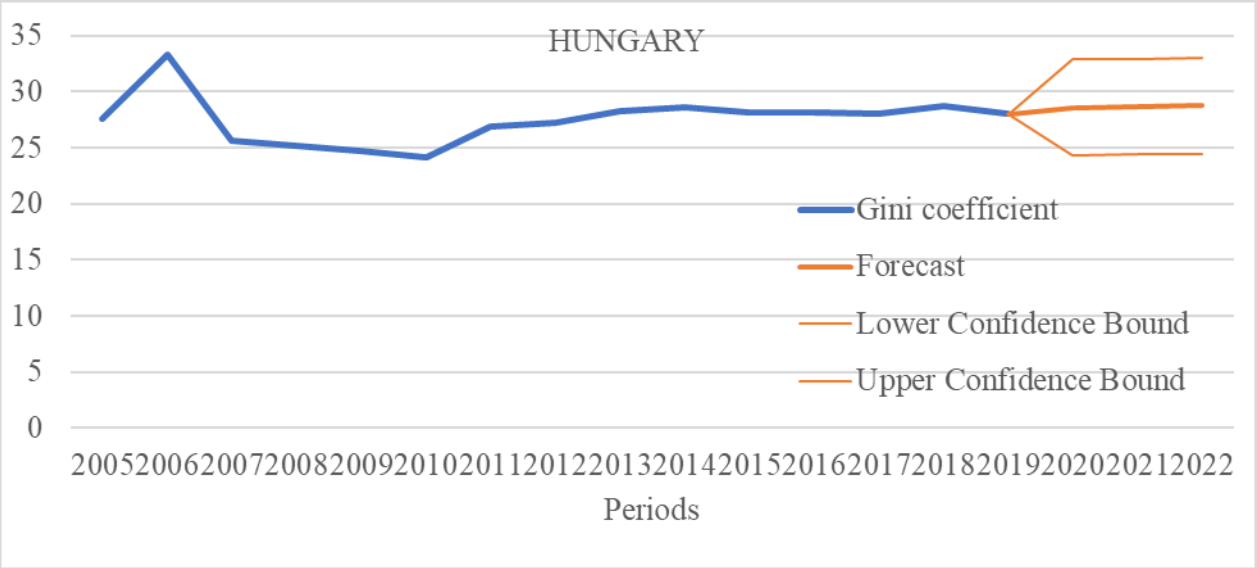
Source: Author's calculation

Table 10. Predicted values of the Gini coefficient for Hungary

Periods	Gini coefficient	Forecast	Lower Confidence Bound	Upper Confidence Bound
2019	28	28	28,00	28,00
2020		28,61505522	24,34	32,89
2021		28,67996771	24,41	32,95
2022		28,74488019	24,47	33,02

Source: Author's calculation

Figure 5. The graphical interpretation of forecast the Gini coefficient for Hungary



Source: Author's calculation

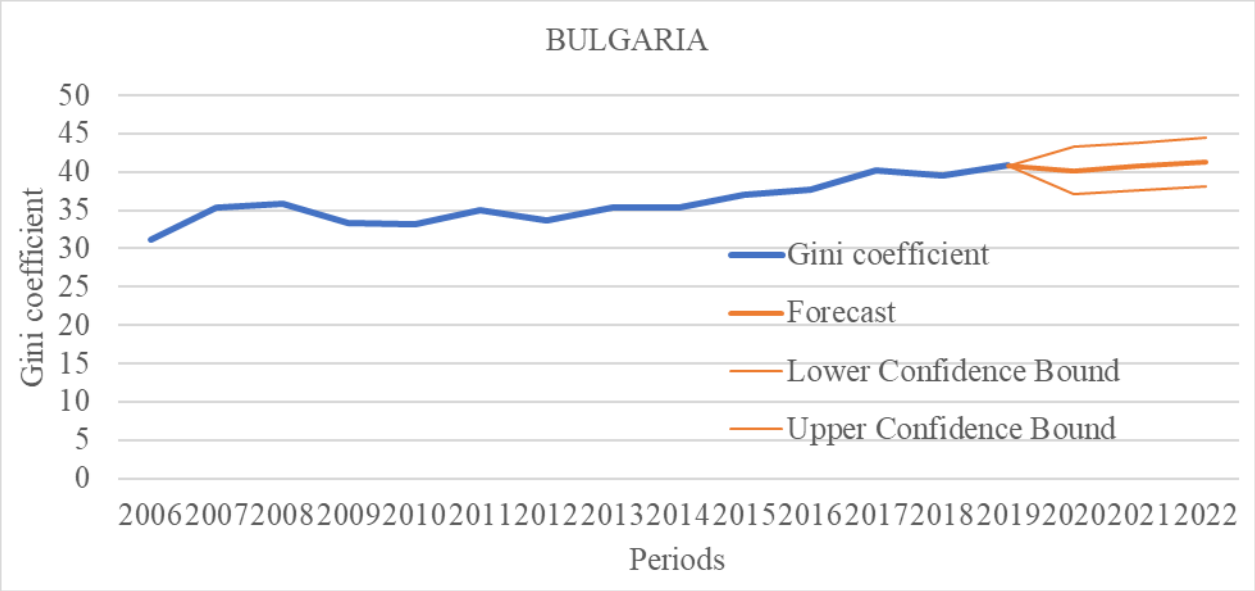
Table 11. Predicted values of the Gini coefficient for Bulgaria

Periods	Gini coefficient	Forecast	Lower Confidence Bound	Upper Confidence Bound
2019	40,8	40,8	40,80	40,80
2020		40,16218628	37,06	43,26
2021		40,74805038	37,63	43,86
2022		41,33391449	38,20	44,47

Source: Author's calculation

From the "Forecast" columns in tables 6-11 and the corresponding middle lines in Figures 1-6, we can see a steady decline in income equity for four of the six countries. Only for Bulgaria, we can expect insignificant fluctuations, but with an increased value of the Gini coefficient in 2023 (41.3) compared to 2019 (40.8). For Slovakia, on the contrary, after fluctuations during the forecast period, we can expect a decrease in the coefficient Gini in 2023 (21.67) compared to 2019 (22.8).

Figure 6. The graphical interpretation of forecast the Gini coefficient for Bulgaria



Source: Author's calculation

4. DISCUSSION

This study aims to study the Gini coefficient's behavior from 2005 to 2019 and predict its values for three subsequent periods. This time interval includes the financial crisis of 2008-2009. This made it possible to analyze whether there is a commonality for all countries' specific reactions to the recession factors. Our analysis was complicated because the Eurostat statistical database for the Gini coefficient contained incomplete information since the list of 27 European Union countries relevant at the time of the study was not formed at one time. It is known that this process was extended over time. Some countries during this period became members of the EU. Others, on the contrary, left it. We had to turn to other scattered sources, which also introduced problems informing the database for research. After all, it is known that there are various algorithms for calculating the Gini coefficient, allowing the use of different levels of income (before or after taxation, with or without transfers, and other nuances). We decided to consider the indicator's values from other sources only if Eurostat's existing values for different periods coincided. As a result, several cells in Table 1 related to Croatia (2006, 2007) and Bulgaria (2005) were left blank. We also assume that we came across inaccurate information in the event of a contradiction with the available Eurostat data. Since the Eurostat database uses a scale from 0 to 100, that is, the Gini coefficient is estimated as a percentage, our entire study is based on the use of this measurement scale too.

To concentrate on-point the analysis of the Gini coefficient values (extremes are the minimum and maximum values during the entire study period) and the reaction of these values to the crisis period, we decided to form a shortlist of countries represent our general list. As a criterion for classification, we took the standard deviation of the sample. In table 1, the list of countries is presented in a sorted form for this very indicator. Choosing a grouping method was also not easy. Depending on the data analyzed, statistical theory offers many different options for grouping. This procedure's simplicity and clarity were essential for us, so we stopped at the division of the considered set of data into homogeneous ones according to the studied characteristics, based on the Sturges formula. In our case, we used the sample standard deviation as such a feature, as noted above. As a result, a shortlist of countries for in-depth analysis was determined - Italy, Spain, Germany, Slovakia, Hungary, and Bulgaria.

In Table 1, we highlighted the values of the highs and lows for all 27 countries, but for all countries, we did this only to demonstrate that the spread of these values is not related to the crisis period (two columns are highlighted in grey). There is no synchronicity in the Gini coefficient reaching extremes. We have provided more detailed comments on the extremes for the short-listed countries. We supplemented the analysis of extreme values with an estimate of the rate of growth of the indicator (Table 3), which made it possible to feel the scope and direction of change in the indicator for each of the six countries separately and compare countries with each other. A point to be noted is that the "-" sign indicates that the sequence of minimum and maximum values along the period under study also does not have a general rule and is not associated with the crisis period. We concluded the absence of general trends in changes in the inequality of income distribution in society as a reaction to the factors of the financial crisis. We were interested in introducing the study field S80/S20 disposable income quintile share for shortlisted countries. It shows the ratio of the 20% of people with the highest household income in total household income to 20% of persons with the lowest household income in total household income. Analysis of the S80/S20 ratio made it possible to single out Germany and Bulgaria as the countries with the smallest and largest ratios, respectively. We have already planned to delve deeper into studying the policies and instruments used by government regulation to reduce inequality in these two countries for comparative analysis. Calculation of the correlation coefficient for the Gini coefficient values and the S80/S20 ratio showed a weak strength of the statistical relationship. Only for Spain, the value reaches 0.86, which is not enough for generalization.

Concerning forecasting the values of the Gini coefficient for future periods, we limited the calculation to three periods, including 2020. We will soon be able to check the accuracy of our forecast by comparing our values with the actual ones in the available sources soon. Realizing that the world economy, including the economies of the EU countries, is still under the influence of the Covid-19 pandemic and having information about the third wave of the virus, we decided not to extend the forecast period. As we demonstrated in Tables 6-11 and Figures 1-6, the shortlisted countries show predominantly increases in inequality in income distribution, as evidenced by an increase in the Gini coefficient for five countries out of six. And only for Slovenia, the statistical forecast gave a decrease in the values of the coefficient, that is, the dynamics towards greater equality in the distribution of income. The extension of the general forecasting period is inappropriate due to the impact of the crisis provoked by the Covid-19 pandemic. The impact of the pandemic causes large errors in longer projections.

CONCLUSION

We studied the Gini coefficient's behavior over a reasonably long time - from 2005 to 2019 and predicted its values for three subsequent periods. This time interval was interesting for the authors because it included the period of the financial crisis of 2008-2009. Our first objective, in which we highlight the trends in income distribution inequality during the Global Financial crisis of 2008-2009, showed the absence of general trends in income distribution inequality in society due to the financial crisis. The second objective was an analysis of the S80/S20 ratio, calculation of the correlation coefficient for the Gini coefficient values, and the S80/S20 rate showed a weak strength of the statistical relationship. Only for Spain, the value reaches 0.86, which, of course, is not enough for generalization. In the third objective, we attempt to predict the Gini coefficient's future value for three future periods. The results of the shortlisted countries show predominant increases in income distribution inequality, as evidenced by the Gini coefficient's rise for five countries out of six. And only for Slovenia, the statistical forecast gave a decrease in the coefficient values, that is, towards greater equality in the distribution of income. However, the study has some limitations. We have considered only the Gini coefficient; researchers can include other measures of income inequalities.

We do not have a multivariate model, so for future studies, other measures of income inequality can be included. There is also scope for an in-depth analysis of the future of three countries - Germany, Bulgaria, Slovakia. Additional research could establish links between these countries' monetary policies and the values of the Gini coefficient. Scholars can also extend the study to compare the EU countries' income inequality with other trade blocs like BRICS and G-20 and other European countries.

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