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# GINI's Odyssey in Greece: Econometric Analysis of Income Inequality, GDP, and Unemployment Through Economic Phases (Pre-Crisis, Crisis, Memoranda, and Post-Memoranda)

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**Abstract:** This study explores the relationship between income inequality, economic growth, and unemployment in Greece from 2003 to 2020, encompassing key economic phases: pre-crisis, crisis, memoranda, and post-memoranda. The aim is to analyze how economic growth (logarithm of GDP-LOGGDP) and unemployment influenced income inequality (GINI coefficient) during periods of economic turmoil and recovery. Using linear regression analysis on 18 years of annual data, this study identifies significant relationships between the variables, with diagnostic tests confirming model robustness. The findings reveal a strong positive and statistically significant relationship between LOGGDP and income inequality, indicating that economic growth, without effective redistributive mechanisms, exacerbated disparities. Unemployment had an even stronger positive effect on inequality, highlighting its role in deepening income disparities, particularly during the crisis years marked by economic contraction and austerity measures. These results underline the critical need for balanced economic policies that promote inclusive growth while addressing structural inequalities and labor market vulnerabilities. This study also employs advanced econometric methods, including Vector Autoregression (VAR), Vector Error Correction Model (VECM), and Granger Causality Test, to analyze the dynamics between GDP (LOGGDP), income inequality (GINI), and unemployment. The Granger Test reveals that unemployment Granger-causes GDP with a two-period lag, highlighting the importance of labor market conditions for economic growth, while no direct causal relationship is found between GDP and inequality. These methods provide deeper insights into the short- and long-term interactions, offering valuable guidance for balanced economic policymaking.

**Keywords:** economic growth; GDP; income inequality; GINI coefficient; unemployment; Greece; memorandum; financial crisis; econometric analysis

**JEL Classification:** E0; E6; O0; O4

## 1. Introduction

Income inequality is not just a statistic—it tells the story of how societies distribute opportunity, wealth, and security. In Greece, a country that has weathered dramatic economic turbulence, the interplay of GDP growth, unemployment, and inequality forms a compelling narrative. From the rapid expansion of the pre-crisis era to the austerity-driven contraction of the memoranda years and the uneven recovery that followed, each phase

shaped the country's socio–economic fabric in unique ways. Much like the trials and tribulations of Odysseus on his epic journey, Greece's economy has navigated turbulent waters, battling the sirens of debt, the Cyclopes of austerity, and the Scylla and Charybdis of financial crises. Income inequality, captured by the GINI index, reflects the scars and triumphs of this odyssey. From the booming optimism of the pre-crisis period to the stormy seas of the memoranda years and the tentative shores of post-crisis recovery, this study explores how GDP and unemployment shaped the socio–economic landscape of Greece.

Economic inequality has been a subject of extensive study in recent decades, particularly in the wake of the 2008 global financial crisis. The effects of economic inequality on growth and social cohesion have garnered significant interest from economists and policymakers (Balakrishnan et al. 2013). Studies have shown that inequality can lead to slower economic growth while also creating conditions conducive to political and social instability (Dabla-Norris et al. 2015; Keeley and Ikeda 2017). Specifically, income inequality, combined with austerity policies implemented in many countries, including Greece, has deepened the economic crisis and increased poverty. Greece's experience during the crisis and the memorandum periods serves as a case study for understanding how inequality impacts economic growth (Ostry et al. 2014).

The study of income inequalities in Greece is of paramount importance, particularly when analyzed over distinct economic periods. The term "inequality" itself, derived from the Greek word "ανισότητα" (anisotita), underscores the imbalance and disparity in the distribution of wealth and resources within a society. Income inequality, as captured by the GINI coefficient, reflects the concentration of income across various segments of the population. The study of Fasianos and Tsoukalis (2023) reveals significant wealth asymmetries in Greece, with the richest 1% holding as much wealth as the poorest 50%, and wealth inequality worsening between 2009 and 2017.

This research seeks to investigate the evolution of income inequality in Greece during three critical periods: 2003–2008, the pre-crisis era; 2009–2014, the period dominated by economic memoranda; and 2015–2020, the post-memoranda phase. The primary purpose of this study is to explore the correlation between the GINI coefficient, the Gross Domestic Product (GDP), and unemployment over these periods. By employing linear regression analysis, this research aims to uncover the extent to which economic growth or contraction impacts income distribution. This investigation is significant, as it provides insights into how macroeconomic policies and external shocks, such as financial crises and austerity measures, have influenced economic disparity in Greece. Understanding these dynamics is crucial not only for economists but also for policymakers who seek to design interventions that mitigate inequality.

This study contributes to the existing literature by offering a comprehensive analysis of income inequality trends in Greece over nearly two decades. While previous studies have focused on specific periods or factors influencing inequality (Christopoulou and Monastiriotis 2016), this research provides a longitudinal perspective, bridging the gap between pre-crisis, crisis, and post-crisis Greece. Moreover, by focusing on the Greek economy—a case study that epitomizes the challenges of economic adjustment under external constraints—this research contributes to broader discussions on inequality in economies facing similar structural challenges.

By examining the relationship between the GINI coefficient of GDP and the unemployment rate, this study also addresses the ongoing debate regarding the efficacy of economic growth as a mechanism for reducing inequality. While some scholars argue that growth inherently leads to more equitable income distribution, others contend that without targeted policies, growth may exacerbate disparities. This research will shed light on these divergent hypotheses within the context of the Greek economy. Furthermore, the findings of this study are expected to provide valuable insights into the factors driving income inequality in Greece, thereby informing future policy decisions aimed at fostering both economic growth and social equity.

Income inequality is a multifaceted phenomenon that has gained significant attention in both academic and policy circles over the past few decades. Stiglitz (2012) argues that income inequality is not merely a symptom of economic disparity but a driver of economic instability itself. Research has shown that high levels of inequality can impede growth, weaken social cohesion, and lead to political unrest (Piketty 2014; Atkinson 2015). The work of Kuznets (1955) laid the foundation for understanding the relationship between economic development and income distribution, famously hypothesizing the "Kuznets Curve", where inequality initially increases during economic development but decreases after a certain level of income is reached. However, a recent panel data analysis of OECD countries from 1990 to 2019 challenges this hypothesis, revealing a U-shaped relationship between economic growth and income inequality. The study of Alves et al. (2022) suggests that countries prioritizing GDP growth over GNI (Gross National Income) have contributed more to rising inequality, and promoting GNI growth policies could help achieve economic growth while reducing disparities.

The global financial crisis of 2008 exacerbated income disparities worldwide, as noted by Milanovic (2016), who emphasizes that globalization and technological changes have led to an increased concentration of wealth. Inequality has become a global concern, with scholars like Bourguignon (2015) and Coffey et al. (2020) highlighting the growing divide between the rich and the poor. However, the effects of inequality are not uniformly distributed across countries, as factors such as policy responses, social safety nets, and labor market structures play critical roles (OECD 2011).

Within the European context, studies have shown that the economic crisis and subsequent austerity measures had profound impacts on income distribution. Darvas and Wolff (2016) found that Southern European countries, particularly Greece, Spain, and Portugal, experienced sharp increases in income inequality during the crisis. Meanwhile, Collignon (2012) argues that the Eurozone's institutional design exacerbated the crisis, leading to uneven recovery and heightened disparities. Income inequality in Europe presents a complex landscape influenced by various factors, including regional disparities, perceptions, and historical contexts. Research indicates that actual income inequality, measured by indices such as the GINI coefficient, shows a relatively even distribution across most EU countries, with Bulgaria as a notable exception, exhibiting higher inequality levels (Kolluru and Semenenko 2021).

However, perceptions of inequality often diverge from reality; individuals in regions with low actual inequality may overestimate inequality, while those in high-inequality areas may underestimate it (Faggian et al. 2023). Furthermore, the concept of income fairness reveals a consensus on perceived inequities, particularly between top and bottom income earners, which intensifies in countries with greater income disparities (Kalleitner and Bohmann 2023). Historical analyses of Eastern Europe highlight how institutional and political factors have shaped income inequality over time, with significant shifts occurring post-1945 (Nikolić et al. 2024). Overall, these findings underscore the necessity of integrating both objective and subjective measures to fully understand income inequality in Europe.

Greece's economic trajectory during the pre-crisis period was characterized by rapid growth, largely fueled by public spending and external borrowing (Featherstone 2008). However, as noted by Koutsoukis and Roukanas (2014), this growth was not accompanied by significant improvements in income distribution. On the contrary, the GINI coefficient remained relatively high, reflecting persistent inequality despite the economic boom.

During the pre-crisis period in Greece (2003–2008), income inequality exhibited notable characteristics influenced by various socio–economic factors. Research indicates that while the overall income distribution was relatively stable, underlying disparities were present, particularly across different socio–economic groups. The geographical analysis revealed that income inequality varied significantly by municipality, suggesting that urban areas experienced different economic dynamics compared to rural regions (Psycharis et al. 2023a). Moreover, the relationship between economic growth and income distribution

was complex; growth often exacerbated inequality, with benefits not equitably shared among the population (Petrakos et al. 2023). The pre-crisis period also saw a decline in the relative position of the unemployed, while pensioners maintained a more favorable status, indicating a shift in income dynamics that would later be exacerbated by the economic crisis (Andriopoulou et al. 2018). Overall, the pre-crisis landscape set the stage for the significant increases in inequality and poverty that followed the onset of the crisis in 2009 (Giannitsis and Zografakis 2018).

The Greek debt crisis, triggered by excessive borrowing and structural weaknesses, led to severe austerity measures imposed by the International Monetary Fund (IMF), European Central Bank (ECB), and European Commission—collectively known as the "Troika" (Arghyrou and Tsoukalas 2011). These measures, as pointed out by Matsaganis and Leventi (2014), had a devastating impact on income distribution, with the GINI coefficient increasing sharply. Social safety nets were eroded, unemployment skyrocketed, and poverty levels reached unprecedented heights. According to Mitrakos (2014), income inequality and relative poverty have risen modestly during the crisis, but the composition of the poor has shifted significantly. The sharp drop in disposable income and the surge in unemployment, however, have led to a substantial decline in economic well-being and a marked increase in absolute poverty, with the poverty line held constant in real terms from the pre-crisis period.

Research by Christopoulou and Monastiriotis (2019) underscores that the austerity measures disproportionately affected low-income households, exacerbating existing inequalities. The period was marked by a deep recession, with GDP contracting by nearly 25%. In this context, studies by Papanastasiou and Papatheodorou (2018) suggest that the Greek crisis was not just a fiscal crisis but also a social crisis, with long-lasting effects on income inequality.

Following the third economic adjustment program, Greece officially exited the bailout programs in 2018. However, as Kaplanoglou (2022) argues, the recovery has been slow and uneven. The GINI coefficient, while showing signs of improvement, remains elevated compared to pre-crisis levels. Inequality during this period has been shaped by several factors, including labor market reforms, tax policies, and changes in social welfare provisions (Matsaganis 2020). The post-memoranda period led to the implementation of various austerity measures in Greece. These measures aimed to stabilize the economy and reduce the country's debt burden but also had implications for income inequalities. Research has shown that austerity policies can have adverse effects on income distribution, with the burden often falling disproportionately on the lower-income groups (Mavromaras et al. 2017; Matsaganis 2019).

Income inequalities in Greece during the post-memoranda period (2015–2020) have been characterized by significant disparities exacerbated by economic policies and social conditions. Research indicates that income inequality, as measured by the GINI coefficient, has reached unprecedented levels, surpassing previous assessments by international organizations (Kotsios 2022). The economic crisis and austerity measures have led to a marked increase in health-related quality of life (HRQoL) inequalities, particularly affecting lower-income groups, with the Theil index showing a 222.3% increase in income-related HRQoL disparities (Yfantopoulos et al. 2023). Furthermore, the geographical analysis reveals that income inequalities are more pronounced in urban areas like Attica compared to rural regions, highlighting a growing socio–economic divide (Psycharis et al. 2023a). The impact of inflation and austerity measures has further intensified these inequalities, with the poorest segments of the population experiencing severe hardships (Missos et al. 2024).

Despite the extensive literature on income inequality in Greece, there is a noticeable gap in longitudinal analyses that compare the evolution of inequality across different economic periods. Most studies focus on specific time frames, such as the crisis years or the post-crisis recovery, but few provide a comprehensive comparison that spans pre-crisis, crisis, and post-crisis periods. This research aims to fill this gap by examining the

relationship between the GINI coefficient, GDP, and unemployment across three periods: 2003–2008 (pre-crisis), 2009–2014 (memoranda), and 2015–2020 (post-memoranda).

The research question guiding this study is:

"How has income inequality, as measured by the GINI coefficient, evolved in Greece during the pre-crisis, crisis, and post-crisis periods, and what role has GDP and unemployment played in this evolution?"

Economic inequality and its causes have been extensively researched globally, as it is intricately linked to development, unemployment, and social cohesion. General studies, such as those by Brueckner and Lederman (2018), highlight how income inequality can impact economic growth, depending on a country's income level. Cysne (2009) offers a theoretical framework to explain the positive correlation between unemployment and inequality, asserting that labor market uncertainty exacerbates income disparities. Similarly, Sheng's (2011) study on the US identifies persistent relationships between unemployment and inequality, noting that high unemployment sustains elevated inequality levels. Additionally, research by Topuz (2022) examines the transmission channels through which inequality affects growth, while Ochi et al. (2024) explore the interplay between inequality, poverty, and institutional quality globally.

Karountzos et al. (2024) add to this growing body of research by conducting a comparative analysis of the United States and the United Kingdom, focusing on the relationship between economic growth (GDP) and income inequality (measured by the GINI index). Their findings reveal a significant positive correlation between GDP and inequality in the United States, suggesting that economic growth disproportionately benefits higher-income groups. In contrast, the United Kingdom shows a weaker correlation, highlighting the mitigating role of redistributive policies and social welfare programs. This study underscores the critical importance of national policy frameworks in shaping the interplay between growth and inequality and offers empirical insights for tailoring policy interventions to address disparities in advanced economies.

In the Greek context, specific studies provide crucial insights into the relationship between GDP, unemployment, and inequality across different periods. Mitrakos (2021) focuses on the social and political consequences of inequality, emphasizing the need for redistributive policies. His analysis reveals that Greece entered the crisis with high levels of inequality and poverty compared to other EU countries, which further worsened during the early years of the crisis and have shown little improvement since, disproportionately affecting unemployed individuals and younger families with children.

The correlation between GDP, unemployment, and inequality in Greece is driven by complex mechanisms that intertwine economic growth, labor market dynamics, and structural factors. The interplay of these elements reveals how economic policies and external shocks can exacerbate inequalities, particularly during crises. During the recent crises, unemployment surged, leading to a vicious cycle where increasing unemployment rates further deteriorated economic confidence and competitiveness (Juselius and Dimelis 2019). While these mechanisms illustrate the challenges Greece faces, it is also important to consider that some policies, particularly during election cycles, have temporarily reduced inequality, suggesting that political factors can influence economic outcomes (Petrakos et al. 2023).

These studies collectively establish the strong linkage between inequality, economic contraction, and unemployment, forming a critical foundation for the formulation of hypotheses. Based on this evidence, the research hypothesizes that:

**H1:** *There is a positive relationship between GDP (measured as the logarithm of GDP–LOGGDP) and income inequality, suggesting that economic growth without equitable distribution mechanisms exacerbates disparities.*

**H2:** *There is a positive relationship between unemployment and income inequality, reflecting how labor market disruptions disproportionately affect lower-income groups.*

This dual focus on GDP and unemployment aims to capture the dynamics of inequality within Greece's socio–economic trajectory, providing a robust framework for further investigation.

The findings of this study confirm both research hypotheses. A statistically significant positive relationship was identified between GDP (measured as LOGGDP) and income inequality, suggesting that economic growth without equitable redistribution mechanisms exacerbates disparities. Similarly, a positive and statistically significant correlation was observed between the unemployment rate and income inequality, highlighting that higher unemployment levels disproportionately impact lower-income groups, intensifying economic disparities.

This article is structured into five main sections, as follows. Section 1: Introduction outlines the issue of income inequality in Greece covering the pre-crisis, crisis, and post-crisis periods. Section 2: Results presents findings supported by statistical analysis. Section 3: Discussion interprets these results in the context of the existing literature. Section 4: Materials and Methods explains the econometric models, data sources, and variables used in the analysis. Finally, Section 5: Conclusion summarizes the key insights and suggests policy recommendations to address income inequality in Greece.

## 2. Results

In this section, we will present the findings from the analysis of the relationship between income inequality, as measured by the GINI coefficient, LOGGDP, and unemployment rate. Initially, we present four graphs that mirror the evolution of the GINI coefficient (Figure 1a), GDP (Figure 1b), LOGGDP (Figure 1c), and unemployment rate (Figure 1d). The following graphs provide a preliminary overview of the trajectory of the Greek economy from 2003 to 2020, highlighting the evolution of income inequality as measured by the GINI coefficient of GDP and unemployment rate.

The GINI coefficient (Figure 1a) shows a noticeable fluctuation over the analyzed period (2003–2020). There is a steady increase during the early years of the crisis (2008–2014), peaking in the middle of the austerity period. Afterward, a slight decline is evident, stabilizing in the post-memoranda period, though not returning to pre-crisis levels. This trend reflects increased income inequality during the economic downturn, exacerbated by unemployment and austerity measures, with partial recovery afterward.

The absolute (Figure 1b) and logarithmic (Figure 1c) GDP values present similar trends. A significant decline is evident after 2008, coinciding with the onset of the Greek debt crisis, and stabilization occurs in the latter years (2014–2020). A slight dip appears again in the last years of the timeline. The decline underscores the contraction of the Greek economy during the crisis and austerity period. The limited recovery reflects structural weaknesses and ongoing challenges.

The unemployment rate (Figure 1d) demonstrates a sharp and sustained increase from 2009, peaking around 2013, followed by a gradual decline toward 2020. The unemployment rate aligns closely with the timeline of the economic crisis, peaking during the height of austerity and stabilizing during the recovery period. This sharp increase highlights the immediate impact of economic contraction on labor markets. The gradual decrease reflects reforms and external financial assistance but suggests lingering structural challenges.

The following statistical tables present the results of the analysis: Descriptive Statistics summarizing key metrics such as mean, standard deviation, and range for the GINI coefficient, LOGGDP, and unemployment; Model Summary showcasing R-squared, Adjusted R-squared, and the standard error of the estimate; ANOVA Table confirming the statistical significance of the regression model; Coefficients Table detailing the unstandardized and standardized coefficients (Beta), t-statistics, and *p*-values for each variable; Durbin–Watson statistic evaluating the presence of autocorrelation; Collinearity Statistics assessing tolerance and VIF to ensure no multicollinearity; and Residual Statistics, including the range and standardized distribution of residuals. These tables will be interpreted in the following

section to evaluate the relationships between the variables and validate the robustness of the regression model.
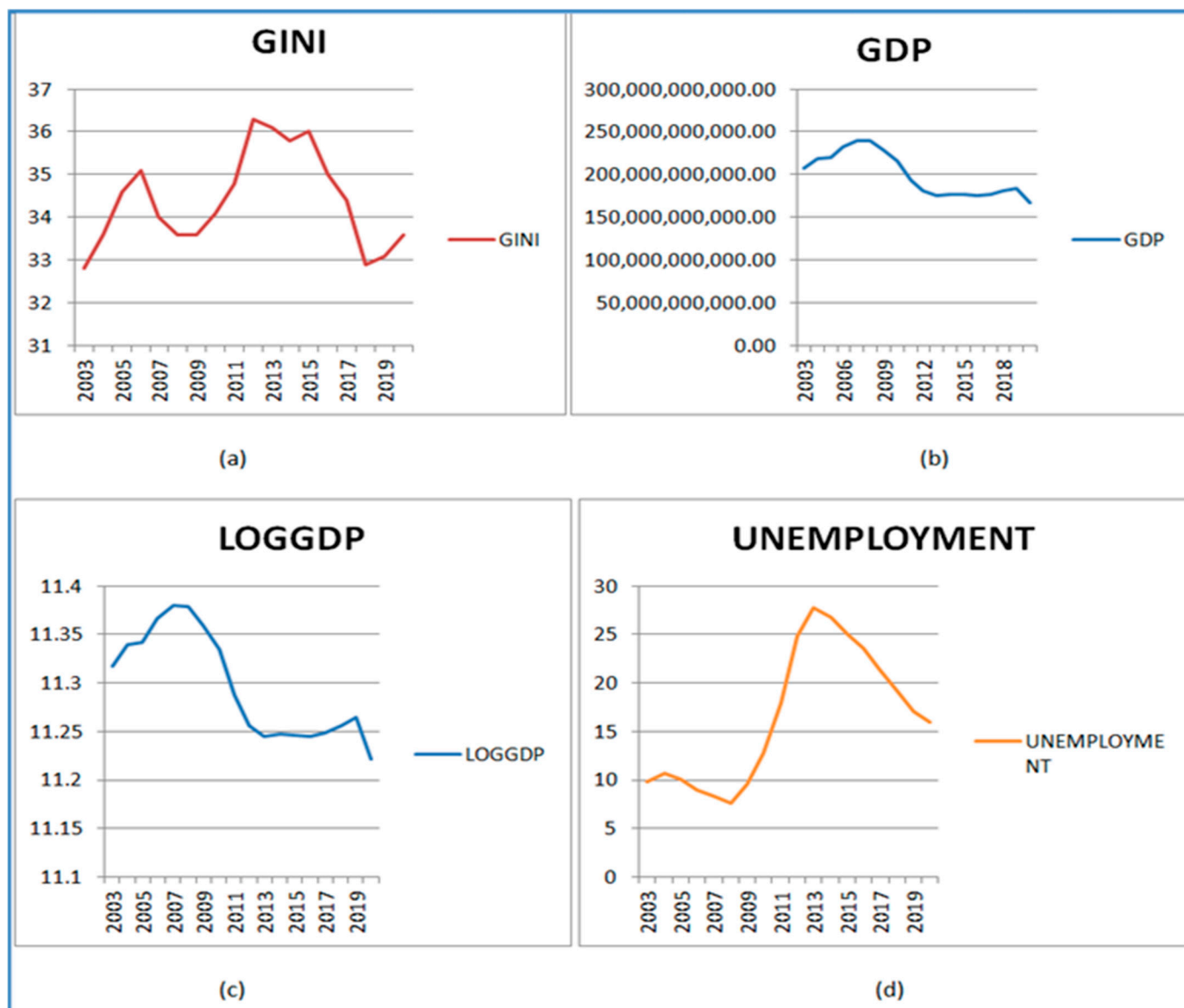


**Figure 1.** (**a**) GINI index, (**b**) GDP, (**c**) LOGGDP, and (**d**) unemployment in Greece through the years 2003–2020.

The Descriptive Statistics (Table 1) reveal important characteristics of the analyzed variables over the 2003–2020 period. The GINI coefficient, with a mean of 34.411 and a standard deviation of 1.121, indicates moderate and relatively stable income inequality, despite economic fluctuations during the crisis and recovery periods. The mean LOGGDP of 11.296 and its low standard deviation (0.054) suggest minimal variability in economic output in logarithmic terms, reflecting consistent changes even during the economic downturn. Conversely, unemployment demonstrates significant variability, with a mean of 16.492% and a standard deviation of 7.018, highlighting the profound impact of the crisis on Greece's labor market. The sample size of 18 for all variables ensures consistency across the analysis.

**Table 1.** Descriptive Statistics.

|  | Mean | Std. Deviation | N |
|---|---|---|---|
| GINI | 34.411 | 1.121 | 18 |
| LOGGDP | 11.296 | 0.054 | 18 |
| Unemployment | 16.492 | 7.018 | 18 |

The Model Summary (Table 2) provides key insights into the performance and validity of the regression model. The R value (0.833) indicates a strong positive correlation between the independent variables (LOGGDP and unemployment) and the dependent variable (GINI coefficient). The R-squared (0.694) shows that 69.4% of the variance in income inequality is explained by the model, suggesting a high explanatory power. The Adjusted R-Square (0.653) accounts for the number of predictors, confirming that the model remains robust after adjustments. The standard error of the estimate (0.660) indicates the average distance of the observed values from the regression line, which is relatively small, signifying a good fit. Lastly, the Durbin–Watson statistic (1.384) is slightly below the acceptable range (1.5–2.5).

**Table 2.** Model Summary.

| R | R-Squared | Adjusted R-Squared | Std. Error | Durbin–Watson |
|---|---|---|---|---|
| 0.833 | 0.694 | 0.653 | 0.660 | 1.384 |

ANOVA Table 3 evaluates the overall significance of the regression model. The Regression Sum of Squares (14.832), compared to the Residual Sum of Squares (6.546), indicates that a substantial portion of the variance in the GINI coefficient is explained by the independent variables (LOGGDP and unemployment). The Mean Square for Regression (7.416) is significantly larger than the Mean Square for Residuals (0.436), demonstrating the model's effectiveness. The F-statistic (16.995), which tests the null hypothesis that the regression coefficients are equal to zero, is highly significant with a *p*-value of 0.000 (Sig.), confirming that the model is statistically significant and the predictors collectively have a strong influence on the GINI coefficient. These results support the robustness of the model in explaining variations in income inequality.

**Table 3.** ANOVA.

|  | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 14.832 | 2 | 7.416 |  |  |
| Residual | 6.546 | 15 | 0.436 | 16.995 | 0.000 |
| Total | 21.378 | 17 | - |  |  |

The coefficients and Collinearity Statistics (Table 4) confirm the significance of both predictors in explaining income inequality. The unstandardized coefficients indicate that for every unit increase in LOGGDP, the GINI coefficient rises by 21.603 units, while each 1% increase in unemployment results in a 0.254-unit increase in GINI, holding other factors constant. The standardized coefficients show that unemployment (Beta = 1.587) has a slightly stronger relative impact on inequality than LOGGDP (Beta = 1.051). Both predictors are statistically significant, with *p*-values of 0.003 for LOGGDP and 0.000 for unemployment, validating their inclusion in the model. The Collinearity Statistics, with a tolerance of 0.229 and a VIF of 4.368, suggest moderate collinearity between the predictors but remain within acceptable limits. These results confirm that both economic growth (LOGGDP) and labor market conditions (unemployment) are critical determinants of income inequality, with unemployment exhibiting a stronger effect in this model.

**Table 4.** Coefficients and Collinearity Statistics.

| | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Tolerance | VIF |
| (Constant) | −213.811 | 70.040 | - | −3.053 | 0.008 | - | - |
| LOGGDP | 21.603 | 6.139 | 1.051 | 3.519 | 0.003 | 0.229 | 4.368 |
| Unemployment | 0.254 | 0.048 | 1.587 | 5.314 | 0.000 | 0.229 | 4.368 |

The Residual Statistics (Table 5) demonstrate that the regression model fits the data well, with predicted GINI values ranging from 32.649 to 36.143, closely matching the observed mean of 34.411. The residuals, which measure the differences between observed and predicted GINI values, have a mean of 0 and a standard deviation of 0.620, indicating minimal prediction error. The standardized predicted values, ranging from −1.886 to 1.854, and standardized residuals, ranging from −2.004 to 1.688, fall within acceptable bounds, suggesting no significant outliers or deviations from normality. These results confirm the model's reliability and its robustness in explaining the variation in the GINI coefficient.

**Table 5.** Residual Statistics.

| | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| Predicted Value | 32.649 | 36.143 | 34.411 | 0.934 |
| Residual | −1.323 | 1.115 | 0 | 0.620 |
| Std. Predicted Value | −1.886 | 1.854 | 0 | 1.000 |
| Std. Residual | −2.004 | 1.688 | 0 | 0.939 |

The statistical analysis confirms both research hypotheses. For H1, the positive and statistically significant standardized coefficient for LOGGDP ($\beta$ = 1.051, *p* = 0.003) indicates that economic growth, measured logarithmically, exacerbates income inequality, supporting the hypothesis of a positive relationship. Similarly, for H2, the unemployment standardized coefficient ($\beta$ = 1.587, *p* = 0.000) demonstrates a significant positive effect on the GINI coefficient, confirming that higher unemployment intensifies income disparities. The model explains a substantial portion of the variance in income inequality (R-squared = 0.694), with overall significance validated by an F-statistic of 16.995 (*p* = 0.000). Diagnostic tests reveal no major violations of assumptions, and while moderate multicollinearity exists, it remains within acceptable limits. These results collectively validate the research hypotheses, highlighting the critical roles of economic growth and unemployment in shaping inequality in Greece.

Afterwards, we conducted an advanced econometric analysis called Vector Autoregression (VAR) and Vector Error Correction Model (VECM). The Vector Autoregression (VAR) and Vector Error Correction Model (VECM) are advanced econometric techniques designed to analyze the dynamic relationships among multiple time series variables. In this analysis, VECM was applied as the time series variables—LOGGDP (logarithmic GDP), GINI (income inequality index), and unemployment—were found to be non-stationary but cointegrated, meaning they share a long-term equilibrium relationship. The Johansen Cointegration Test indicated one cointegration rank (rank = 1), allowing us to implement the VECM framework. This method decomposes relationships into two components: the long-term equilibrium dynamics (captured by cointegration coefficients) and the short-term adjustments to deviations from equilibrium (represented by adjustment coefficients). The VECM also incorporates lagged values of all variables to model their interdependencies dynamically. Table 6 shows the results of the two analyses.

**Table 6.** VAR and VECM analysis results.

| Variable | Cointegration Coefficients (Beta) | *p*-Values (Beta) | Adjustment Coefficients (Alpha) | *p*-Values (Alpha) |
|---|---|---|---|---|
| LOGGDP | 1 | - | −0.1134 | 0.111 |
| GINI | −0.0259 | 0.018 | 6.1553 | 0.022 |
| Unemployment | 0.0016 | 0.308 | 22.6511 | 0 |

The cointegration coefficients (Beta) indicate the long-term relationships between the variables:

- LOGGDP has a coefficient of 1.000 as the reference variable.
- GINI shows a significant negative coefficient (−0.0259; $p = 0.018$, $p = 0.018$, $p = 0.018$), indicating that economic growth (LOGGDP) reduces income inequality (GINI) in the long run. For every unit increase in LOGGDP, the GINI index decreases by 0.0259 units.
- Unemployment has a small and statistically insignificant coefficient (b = 0.0016; $p = 0.308$), suggesting that unemployment does not exhibit a meaningful long-term relationship with LOGGDP and GINI.

The adjustment coefficients (Alpha) reveal how quickly each variable adjusts to restore equilibrium after deviations:

- GINI and unemployment exhibit statistically significant and positive adjustment coefficients (6.1553 and 22.6511, respectively, with $p = 0.022$, $p = 0.022$, $p = 0.022$; $p = 0.000$, $p = 0.000$, $p = 0.000$), indicating rapid and significant responses to equilibrium deviations.
- LOGGDP, on the other hand, has an insignificant adjustment coefficient (b = −0.1134; $p = 0.111$), suggesting that it does not actively restore equilibrium in response to long-term shocks.

The findings underscore the critical role of economic growth in reducing income inequality over the long term, as evidenced by the significant and negative relationship between LOGGDP and GINI. However, unemployment does not appear to have a substantial direct impact on these long-term dynamics. The adjustment dynamics highlight that income inequality (GINI) and unemployment (unemployment) are highly responsive to deviations from equilibrium, suggesting that both are strongly influenced by short-term economic fluctuations. In contrast, GDP exhibits weaker short-term adjustments, potentially reflecting its more stable and persistent nature. These results emphasize the importance of policies that promote inclusive economic growth and address structural inequalities to achieve sustainable and equitable development. Finally, a Granger Causality analysis is performed. Table 7 shows the results of the Granger Causality analysis.

**Table 7.** Results of Granger Causality analysis.

| | Lag 1 *p*-Value | Lag 2 *p*-Value |
|---|---|---|
| LOGGDP causes GINI | 0.686 | 0.144 |
| GINI causes LOGGDP | 0.831 | 0.151 |
| LOGGDP causes unemployment | 0.782 | 0.488 |
| Unemployment causes LOGGDP | 0.370 | 0.002 |

The results indicate no significant Granger-causal relationship between LOGGDP (logarithmic GDP) and GINI (income inequality index) in either direction, as all *p*-values are greater than the 0.05 significance level. This suggests that past values of GDP do not predict income inequality, and vice versa, in the examined lags. Similarly, LOGGDP does not Granger-cause unemployment, as the *p*-values for both lagged relationships are insignificant. However, unemployment Granger-causes LOGGDP at a lag of two periods ($p = 0.002$), indicating that changes in unemployment have a delayed, statistically significant predictive effect on GDP. This directional relationship highlights how labor market fluctuations can influence economic growth in the medium term.

The Granger Causality analysis reveals that the dynamic interplay between GDP, income inequality, and unemployment is limited. There is no evidence of direct predictive relationships between GDP and income inequality in either direction. However, unemployment significantly influences GDP with a two-period lag, suggesting that labor market conditions can impact economic growth over time. These findings underscore the importance of addressing unemployment to foster economic stability and growth, while the lack of causality between GDP and inequality suggests that structural factors may play a greater role in shaping income distribution.

The contribution of the Granger Causality Test to our research is particularly significant, as it reveals the dynamic causal relationships between LOGGDP, GINI, and unemployment. Specifically, the test demonstrated that unemployment Granger-causes economic growth (LOGGDP) with a two-period lag, indicating that changes in unemployment have a delayed but substantial impact on economic growth. This underscores the importance of reducing unemployment not only for social cohesion but also for fostering economic activity. On the other hand, no Granger-causal relationship was observed between LOGGDP and inequality (GINI), or vice versa, suggesting that short-term changes in growth do not directly affect inequality and that other factors, such as institutional reforms, are likely more decisive. This insight enriches our understanding of the relationships between these variables, adding a dynamic perspective to the analysis that cannot be captured solely through static regression or VECM. The findings from the Granger Test enhance the scientific foundation of our research and provide practical insights, emphasizing the need for targeted policies that promote job creation as a means of boosting economic growth and maintaining social balance.

The findings from the three analyses—regression, VAR–VECM, and Granger Causality—offer a comprehensive understanding of the relationships between economic growth, unemployment, and income inequality. Regression analysis reveals a positive and significant relationship between LOGGDP (economic growth) and GINI (income inequality), indicating that economic growth exacerbates inequality in the short term, likely due to the lack of redistributive mechanisms. Unemployment also shows a significant positive association with GINI, underscoring its strong role in deepening inequality during periods of economic contraction.

The VECM analysis provides a contrasting perspective by highlighting a long-term negative relationship between LOGGDP and GINI. This suggests that sustained economic growth, over time, reduces inequality, likely due to structural adjustments and stabilization effects. In contrast to the regression findings, unemployment shows no significant long-term relationship with inequality, though it demonstrates rapid adjustment dynamics, indicating its influence in restoring equilibrium in the short term.

The Granger Causality analysis complements these findings by exploring predictive dynamics. It finds no significant causality between LOGGDP and GINI, implying that past values of economic growth do not predict income inequality, nor do past values of inequality predict growth. However, the analysis identifies a significant causal relationship between unemployment and LOGGDP with a lag of two periods, suggesting that changes in unemployment influence GDP in the medium term. This finding highlights the critical role of labor market dynamics in shaping economic trajectories, although it does not directly link unemployment to income inequality.

Taken together, these results provide a nuanced understanding of the interplay between growth, unemployment, and inequality. In the short term, as shown by regression analysis, economic growth can exacerbate inequality without targeted redistributive measures, and rising unemployment significantly worsens income disparities. In the long term, as revealed by the VECM, economic growth can act as a force for reducing inequality if accompanied by structural reforms and sustained stability. The absence of direct causality between GDP and GINI, as shown by Granger Causality, indicates that external factors such as policy interventions and market structures play a significant role in shaping these relationships. The predictive causality from unemployment to GDP underscores

the importance of addressing labor market inefficiencies to ensure economic growth and social equity.

## 3. Materials and Methods

### 3.1. Data Collection and Sources

- Data Sources: The primary data used in this study were obtained from the World Bank Open Data database (World Bank 2024; Karountzos 2024). The data include annual figures for GDP (in constant US dollars), unemployment rate (%), and the GINI coefficient for Greece. The data were processed with the IBM SPSS STATISTICS 23 statistical program.
- Dependent Variable: Income inequality, measured by the GINI coefficient, which represents the distribution of income across the population. A higher GINI coefficient indicates greater income inequality.
- Independent Variable: GDP, measured in constant US dollars, which represents the overall economic output of Greece.
- Unemployment rate (%): Unemployment, total (% of total labor force). Unemployment refers to the share of the labor force that is without work but available for and seeking employment.
- Time Period (2003–2020): The study spans three distinct periods:
  - (i)    2003–2008: Pre-crisis period characterized by economic growth.
  - (ii)   2009–2014: Crisis and memoranda period marked by economic contraction and austerity measures.
  - (iii)  2015–2020: Post-crisis period involving economic recovery and structural reforms.

### 3.2. Data Analysis and Model Specification

- Correlation Analysis: To explore the relationship between the GINI coefficient GDP and the unemployment rate, Pearson correlation coefficients were calculated. This step provided insight into the direction and strength of the relationship between economic growth and income inequality.
- Linear Regression Analysis: A linear regression model was used to quantify the relationship between the GINI coefficient (dependent variable) logarithm of the GDP and unemployment rate (independent variables). The model was specified as follows.
- $GINI_t = \alpha + \beta LOGGDP_t + \gamma UNEMPLOYMENT_t + \varepsilon_t$, where $GINI_t$ is the GINI coefficient at time t, $\alpha$ (Alpha) is the intercept, $LOGGDP_t$ is the logarithm of GDP at time t, $\beta$ (Beta) is the coefficient representing the impact of LOGGDP on the GINI coefficient, $UNEMPLOYMENT_t$ is the rate of unemployment at time t, $\gamma$ (Gamma) is the coefficient representing the impact of unemployment rate on the GINI coefficient, and $\varepsilon_t$ (epsilon) is the error term.
- Hypothesis Testing: The regression analysis was used to test the study's hypotheses by examining the statistical significance of the $\beta$ (Beta) and $\gamma$ (Gamma) coefficients. The significance of the relationship was determined using *p*-values, with a threshold of $p < 0.05$ indicating statistical significance.
- Vector Autoregression (VAR) and Vector Error Correction Model (VECM):
  - (a)    VAR and VECM are used to analyze the dynamic relationships between multiple time series.
  - (b)    VECM was applied as the time series LOGGDP (logarithmic GDP), and GINI (income inequality index) and unemployment were found to be non-stationary but cointegrated, indicating a long-term equilibrium relationship.
  - (c)    The Johansen Cointegration Test identified one cointegration rank (rank = 1), allowing VECM to decompose relationships into long-term dynamics (captured by beta coefficients) and short-term adjustments (captured by Alpha coefficients) while incorporating lags to model interactions.
- Granger Causality Test:

    (a)    This method examines whether the past values of one time series (X) can predict another (Y).

    (b)    It tests whether adding lagged values of X significantly improves the prediction of Y, beyond what Y's own lagged values can explain.

    (c)    The Granger Causality Test is a statistical method used to determine whether one time series can predict another. It does so by testing whether the past values of one variable (X) provide statistically significant information about the future values of another variable (Y) beyond what the past values of Y alone can explain. While it does not establish strict causality, it identifies directional predictive relationships between variables. The method involves estimating two models: one with only the lagged values of Y and another including the lagged values of both X and Y. If adding X's lags significantly improves the model's explanatory power (determined by *p*-values), then X is said to "Granger-cause" Y.

    (d)    In this study, the Granger Causality Test was used to explore predictive relationships among LOGGDP, GINI, and unemployment, identifying potential causal links at different lag levels.

### 3.3. Evaluation of Results

- Model Fit: The model fit was evaluated using R-squared and Adjusted R-squared values, along with the F-statistic from the ANOVA Table. These metrics provided insights into how well the model explained the variation in income inequality for each period.

- Residual statistics, Collinearity Statistics, and the Durbin–Watson statistic were used to check for autocorrelation and heteroscedasticity and validate the assumptions of the regression model.

### 3.4. Limitations

- Data Limitations: The analysis is limited by the availability of data for certain years and periods. Additionally, while GDP is a key indicator of economic activity, it may not capture all the factors affecting income inequality, such as tax policies, labor market conditions, and social safety nets.

- Model Assumptions: The linear regression model assumes a linear relationship between GDP, unemployment rate, and the GINI coefficient, which may not fully capture the complexity of the relationship in different economic contexts.

### 3.5. Methodological Rationale and Variable Justification

The selection of variables, the regression analysis method, and the time period were carefully chosen to provide a comprehensive understanding of income inequality in Greece. The GINI coefficient was selected as the dependent variable due to its established role as a robust measure of income inequality, capturing changes in income distribution over time. LOGGDP, the logarithm of GDP, was chosen as an independent variable to reflect economic output while accounting for non-linear growth effects, as economic growth does not always lead to equitable outcomes. Unemployment was also included as an independent variable, representing labor market conditions and its direct impact on income disparities, particularly during periods of economic downturn.

Linear regression analysis was employed to quantify the relationships between GINI, LOGGDP, and unemployment. This method enables the estimation of the magnitude and direction of each variable's impact while providing statistical validation through metrics such as *p*-values, R-squared, and diagnostic assessments. The model evaluates how much variance in income inequality is explained by the predictors and ensures robustness by addressing potential issues like multicollinearity and residual autocorrelation.

The time period 2003–2020 was selected to encompass key phases of Greece's economic trajectory: the pre-crisis growth period (2003–2008), the economic crisis and austerity

phase (2009–2014), and the post-crisis recovery period (2015–2020). This comprehensive timeframe captures the evolution of inequality under varying economic conditions, including structural reforms, external shocks, and policy interventions, providing a diachronic perspective essential for understanding the dynamics of income inequality in Greece. This approach ensures that the analysis reflects both the immediate and long-term impacts of economic changes on inequality.

## 4. Discussion

The statistical analysis revealed significant findings regarding the factors influencing income inequality in Greece. The results demonstrated that both economic growth (LOGGDP) and unemployment have a statistically significant positive impact on income inequality, as measured by the GINI coefficient. Specifically, economic growth during the analyzed period, particularly without redistributive mechanisms, exacerbated income disparities, aligning with the previous literature that economic expansion alone cannot address inequality. Similarly, unemployment had an even stronger effect, disproportionately affecting low-income groups and intensifying economic disparities, especially during the crisis and austerity years. These findings resonate with theories that structural weaknesses and labor market disruptions amplify inequality, underscoring the need for targeted policies that balance growth with equity, improve labor market resilience, and strengthen social safety nets to mitigate the adverse effects on vulnerable populations.

The results of our study resonate with Piketty's (2014) argument that capital accumulation tends to increase inequality unless countered by progressive taxation. Similarly, Stiglitz (2012) emphasizes that economic growth often fails to benefit the lower-income segments of society without appropriate policies in place. Milanovic (2016) also supports this view, highlighting that globalization and technological changes during growth periods can exacerbate income disparities. Featherstone (2008) further corroborates this, noting that Greece's growth during this period was unsustainable and unevenly distributed, setting the stage for the subsequent crisis.

Moreover, our results are consistent with research by Matsaganis and Leventi (2014), who found that poverty and inequality in Greece increased significantly during the recession, primarily due to the erosion of social safety nets. The findings also resonate with Stiglitz's (2012) argument that austerity measures, rather than stabilizing economies, often deepen economic downturns and exacerbate inequality. Our finding, that GINI is positively correlated with GDP (H1), aligns with Atkinson's (2015) argument that economic recovery alone is insufficient to reduce inequality without targeted policies that address structural issues. Milanovic (2016) also points out that inequality tends to persist even during periods of economic recovery unless deliberate efforts are made to redistribute income more equitably.

Our study, focusing on the periods before, during, and after the crisis, aligns with the findings of Andriopoulou et al. (2018), which examine the impact of the crisis on inequality and poverty in Greece from 2007 to 2014. Both studies observed a significant increase in inequality, particularly driven by rising unemployment. However, while our research highlights the correlation between GDP, unemployment, and inequality, Andriopoulou et al. (2018) provide a deeper analysis of the differential impact on various socio–economic groups, noting that pensioners improved their relative position, whereas households headed by unemployed individuals faced severe deterioration, contributing markedly to the rise in poverty. This comparison underscores the complex and varied effects of the crisis across different population segments.

In our study, we identify a significant increase in income inequality in Greece during the economic crisis, driven by economic contraction and austerity measures at the national level. This finding aligns with the results of Psycharis et al. (2023a), who also observed a rise in inequality in the period from 2002 to 2014, but focused on the geographical variation across different regions. While we emphasize the uniform national trends in inequality, Psycharis et al. (2023b) highlighted that metropolitan areas experienced a sharp increase

in inequality, whereas non-metropolitan regions saw a decrease, primarily due to tax policies and the broader distribution of lower incomes. This distinction underscores that the impact of the crisis on inequality was not homogeneous across all regions. Nonetheless, both studies concur on the overall detrimental effect of the crisis on income distribution, particularly in urban areas.

The findings of our study align with those of Petrakos et al. (2023), which demonstrate that the economic crises of the 2010s significantly exacerbated income inequality and poverty in Greece. Both studies confirm that income inequality worsened during the crisis period, with the economically disadvantaged being disproportionately affected. While our analysis emphasizes the correlation between GDP and inequality across different periods, highlighting that economic growth alone did not suffice to reduce inequality, Petrakos et al. extend this by incorporating additional measures such as the quintile share ratio (S80/S20) and the at-risk-of-poverty rate, further illustrating the broader negative social impacts of the crises. Both studies call for more effective policy interventions, particularly in the areas of labor market reforms and social protection, to mitigate the persistent inequalities that have emerged. This convergence in findings underscores the need for targeted and sustained policy efforts to address the structural challenges in the Greek economy.

In reflecting on the findings, Greece's economic journey underscores how the dynamics of growth and unemployment have directly influenced income inequality, validating the study's research hypotheses. The strong positive correlation between economic growth (LOGGDP) and inequality confirms that growth without redistributive mechanisms exacerbates disparities, particularly during periods of expansion. Similarly, the significant impact of unemployment highlights its role in disproportionately affecting lower-income groups, intensifying inequality during times of economic contraction. Like Odysseus navigating through the trials of Scylla and Charybdis, Greece must balance economic policies to address these dual challenges.

The combined findings from the regression analysis, VECM, and Granger Causality provide a multifaceted view of the dynamics between economic growth, unemployment, and income inequality, shedding light on both short-term and long-term mechanisms. The regression analysis highlights that economic growth exacerbates income inequality in the short term, likely due to the uneven distribution of growth benefits during expansion phases, while unemployment emerges as a critical driver of inequality. The VECM, however, underscores a different narrative, showing that in the long run, sustained economic growth can reduce inequality, suggesting that structural adjustments and economic stabilization play a vital role over time. Granger Causality adds depth to these insights by demonstrating a significant causal relationship from unemployment to economic growth with a lag of two periods, emphasizing the importance of labor market conditions in shaping economic performance and indirectly influencing inequality. The lack of direct causality between growth and inequality indicates the influence of external factors such as policy interventions and institutional frameworks. These findings collectively stress the need for comprehensive policy approaches that address unemployment, promote inclusive growth, and ensure equitable distribution, while recognizing that the pathways through which growth and inequality interact are dynamic and context-dependent.

This analysis embarked on a tempestuous odyssey through the seas of data, where each method—regression, VECM, and Granger Causality—acted as a different compass, pointing to unique horizons. While Linear Regression revealed the turbulent waves of short-term inequality, VECM charted a steadier long-term course of equilibrium, and Granger Causality highlighted the hidden undercurrents of unemployment shaping economic growth. Together, they paint a picture of a journey marked by shifting tides, where the interplay of growth, unemployment, and inequality is anything but linear, requiring a skilled navigator to reconcile their diverging paths.

## 5. Conclusions

This study aimed to examine the relationships between income inequality, as measured by the GINI coefficient, economic growth (LOGGDP), and unemployment in Greece over the period 2003–2020, covering distinct economic phases: pre-crisis, crisis, memoranda, and post-memoranda. The findings reveal a strong and statistically significant positive relationship between LOGGDP and the GINI coefficient, indicating that economic growth, particularly during periods without effective redistributive policies, exacerbated income inequality. Unemployment showed an even stronger positive and statistically significant effect on the GINI coefficient, confirming that rising unemployment disproportionately impacted lower-income households, intensifying inequality, especially during the economic crisis and austerity period.

Based on these findings, it is imperative to design and implement balanced economic policies that address both economic growth and income redistribution. Specifically, targeted interventions are needed to mitigate the exacerbation of inequality during economic expansions, such as progressive taxation and robust social safety nets, to ensure that the benefits of growth are more equitably distributed. Additionally, comprehensive labor market reforms aimed at reducing unemployment, particularly among vulnerable groups such as young families and the long-term unemployed, are critical for tackling the structural drivers of inequality. Policymakers should also prioritize investments in education and training to enhance workforce adaptability and reduce disparities. Monitoring and evaluating the impact of fiscal and social policies on inequality will be essential for fostering sustainable and inclusive economic development.

Tsitouras and Papapanagos's (2022) study concludes that economic freedom should be viewed as a significant long-term goal for policymakers aiming to reduce income inequality. However, in the short term, economic growth is found to be more effective in promoting income equality. This distinction is crucial for developing targeted economic policies that address both immediate and long-term challenges. According to Mitrakos (2004), addressing educational inequalities is crucial for mitigating economic disparities in Greece and other EU-15 countries. By implementing targeted educational policies, it may be possible to foster a more equitable economic landscape.

To effectively address income inequality in Greece, policymakers should adopt a dual strategy that focuses on both short-term and long-term goals (Migkos et al. 2022). In the short term, promoting economic growth is crucial for immediate reductions in income disparities. However, for sustained improvements, increasing economic freedom should be a significant long-term objective. Additionally, addressing educational inequalities through targeted policies is essential for fostering a more equitable economic landscape. By improving access to quality education and enhancing economic freedom, Greece can create the conditions necessary for reducing income inequality both now and in the future.

The significance of this study lies in its comprehensive analysis of the complex relationship between economic performance, unemployment, and income inequality in Greece across different economic phases. By providing a diachronic examination of this relationship, this study contributes to a deeper understanding of how economic policies and external shocks impact income distribution. This research also highlights the need for targeted policy interventions to address inequality, particularly during periods of economic crisis and recovery. The findings of this study have broader implications for other countries facing similar economic challenges, as they underscore the importance of balancing economic growth with social equity.

Looking ahead, future research should focus on exploring the impact of specific policy measures on income inequality in Greece. For instance, examining the effects of labor market reforms, tax policies, and social welfare programs on income distribution could provide valuable insights for policymakers. Additionally, more granular analyses that consider regional disparities and the experiences of different demographic groups would offer a more nuanced understanding of inequality in Greece. Longitudinal studies that

track the impact of economic policies over time would also be beneficial in assessing the effectiveness of various interventions.

Despite the contributions of this study, certain limitations must be acknowledged. The analysis primarily relied on GDP and the GINI coefficient as the key indicators of economic performance and inequality. While these measures provide valuable insights, they may not capture all aspects of inequality, such as wealth distribution or access to essential services. Furthermore, this study's focus on Greece may limit the generalizability of the findings to other contexts. However, the choice to focus on Greece is justified given the country's unique economic trajectory during the past two decades, making it a particularly valuable case study for examining the effects of economic crises and austerity measures on inequality. Additionally, the statistical methods employed, such as linear regression, assume a linear relationship between GDP, unemployment rate, and the GINI coefficient, which may not fully capture the complexity of the relationship. Despite these limitations, this study offers a robust analysis that contributes to the ongoing discourse on economic inequality and provides actionable insights for policymakers.

In conclusion, much like Odysseus' epic journey through the turbulent seas of mythos, Greece's economic odyssey underscores the imperative for policies that address the endemic issue of income inequality, particularly during periods of crisis and catharsis. The interplay of GDP growth, unemployment, and disparity has the sculpted the socio–economic ethos of the nation, revealing the necessity of harmonizing economic dynamism with social equilibrium. As in Odysseus' navigation past the sirens and Scylla, Greece must employ phronesis and sophrosyne to ensure that the benefits of economic progress are equitably distributed across its polis. Future research must continue to explore the nexus of economic performance and inequality, elucidating policies that embody arete and promote both sustainable growth and equitable wealth distribution, forging a path toward greater social cohesion and stability.

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