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The Impact of Inflation on Income Disparities

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Mestrado em Economia Monetária e Financeira

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CIÊNCIAS SOCIAIS
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Departamento de Economia Política

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“Just keep swimming”

-Dory

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Resumo

A economia global tem recentemente experienciado uma subida da inflação, após um período prolongado de taxas de juro baixas ou até negativas, impulsionada por fatores como as disrupções nas cadeias de abastecimento, o aumento dos preços da energia e políticas fiscais expansivas implementadas durante a pandemia de COVID-19. Este surto inflacionário, particularmente acentuado nas economias desenvolvidas, tem tido um impacto significativo na distribuição de rendimentos, afetando de forma desproporcional os agregados familiares de rendimentos mais baixos. O rápido aumento dos preços ao consumidor diminuiu os salários reais e o poder de compra, especialmente entre aqueles com rendimentos fixos ou com acesso limitado a ativos que resistem à inflação.

Nesta investigação, analisamos como a inflação influencia a desigualdade de rendimentos em quatro economias avançadas — Alemanha, Portugal, Estados Unidos e Japão — entre 1980 e 2023. Especificamente, o efeito da inflação no coeficiente de GINI, nas quotas de rendimento dos 50% mais baixos e dos 10% mais altos, utilizando um modelo de Vetor Autorregressivo (VAR) e Funções de Resposta ao Impulso (IRF).

A análise indica que a inflação tende a agravar a desigualdade de rendimentos nos Estados Unidos e na Alemanha, onde o poder de compra dos agregados familiares de rendimentos mais baixos é significativamente diminuído, enquanto os indivíduos mais ricos conseguem preservar ou até aumentar a sua riqueza. Por outro lado, no Japão, a inflação parece ter um efeito mais neutro ou até igualitário, reduzindo por vezes a quota de rendimento dos 10% mais altos. Em todos os países, o PIB revela-se como um fator central na redução da desigualdade, promovendo uma distribuição mais equitativa através do crescimento económico. As taxas de juro de longo prazo (ILRV) têm um efeito mais moderado, mas ainda relevante, particularmente em mercados com sistemas financeiros mais desenvolvidos.

Ao examinar estas variáveis macroeconómicas ao longo do tempo, esta investigação oferece insights valiosos sobre as interações complexas entre inflação, desigualdade de rendimentos e crescimento económico, fornecendo recomendações para os decisores políticos sobre como enfrentar os efeitos negativos da inflação nas populações mais vulneráveis.

Palavras-chave: Inflação, Desigualdade de Rendimentos, Série temporal, Estacionaridade, Modelos VAR, Funções de Resposta ao Impulso.

Abstract

The global economy has recently experienced rising inflation following a prolonged period of low or even negative interest rates, driven by factors such as supply chain disruptions, rising energy prices, and expansive fiscal policies implemented during the COVID-19 pandemic. This inflationary surge, particularly pronounced in developed economies, has had a significant impact on income distribution, disproportionately affecting lower-income households. The rapid increase in consumer prices has diminished real wages and purchasing power, especially among those with fixed incomes or limited access to inflation-resistant assets.

In this research, we analyze how inflation influences income inequality across four advanced economies—Germany, Portugal, the United States, and Japan—from 1980 to 2023. Specifically, we investigate the effect of inflation on the GINI coefficient, the income shares of the bottom 50%, and the top 10%, using a Vector Autoregression (VAR) model and Impulse Response Functions (IRFs).

The analysis indicates that inflation tends to exacerbate income inequality in the United States and Germany, where the purchasing power of lower-income households is more significantly diminished, while wealthier individuals are able to preserve or even grow their wealth. Conversely, in Japan, inflation appears to have a more neutral or equalizing effect, at times reducing the income share of the top 10%. Across all countries, GDP is shown to play a central role in reducing inequality, promoting more equitable distribution through economic growth. Long-term interest rates (ILRV) have a more moderate but still relevant effect, particularly in markets with more developed financial systems.

By examining these macroeconomic variables over time, this research provides valuable insights into the complex interactions between inflation, income inequality, and economic growth, offering recommendations for policymakers to address the negative effects of inflation on vulnerable populations.

Keywords: Inflation, Income Inequality, Time series, Stationarity, VAR models, Impulse Response Functions.

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Glossary

ADF - Augmented Dickey-Fuller (Unit Root Test)

AIC- Akaike Information Criterion

ARCH - Autoregressive Conditional Heteroskedasticity

CPI - Consumer Price Index

DF- Degrees of Freedom

DSP - Difference Stationary Process

FEVD- Forecast Error Variance Decomposition

FPE- Final Prediction Error

FRED- Federal Reserve Economic Data

GDP - Gross Domestic Product

GINI - Gini Coefficient (Income Inequality Measure)

HQ- Hannan-Quinn Criterion

ILRV - Interest Rate on Long-term Government Bonds

IRF - Impulse Response Function

JB- Jarque-Bera

KPSS - Kwiatkowski-Phillips-Schmidt-Shin (Stationarity Test)

PP - Phillips-Perron (Unit Root Test)

SC- Schwarz Criterion

SWIID- Standardized World Income Inequality Database

TSP - Trend Stationary Process

VAR - Vector Autoregression

WID- World Inequality Database

1. Introduction

Inflation, defined as a sustained increase in the general price level of goods and services, stands as a crucial macroeconomic factor with far-reaching implications for economies worldwide. This phenomenon, succinctly described by Akinsola and Odhiambo (2017) as "too much money chasing too few goods", has garnered significant attention from scholars, policymakers, and practitioners due to its multifaceted impact. Although inflation has various well-documented implications, its effects on income distribution remain less explored, particularly in terms of shaping social welfare, economic stability, and overall societal development.

Income inequality, the uneven distribution of income among individuals or households within a society, intertwines closely with inflation. Similar to a complex web of cause and effect, inflation influences income inequality through various channels. One such mechanism lies in its effect on the real value of earnings: when prices surge faster than earnings, particularly affecting low-income earners who lack who lack the ability to negotiate higher wages, real earnings diminish. This exacerbates income inequality as those at the lower end of the income spectrum experience the most severe consequences of inflation's erosive effects on purchasing power.

Inflation's impact on different income groups varies depending on their consumption patterns. Lower-income households, spending a larger proportion of their income on necessities like food and housing, endure the most significant impact of price increases during inflationary periods, further exacerbating income disparities. It can also exacerbate wealth inequality by diminishing the value of assets. High inflation rates diminish the purchasing power of savings and investments, disproportionately affecting individuals with fewer assets and savings. This can widen the wealth gap between asset-rich and asset-poor individuals or households, compounding income inequality.

Early scholars such as Fischer (1993) and Deininger and Squire (1998) laid the groundwork in exploring the intricate links between inflation and income and wealth distribution. More recent studies, including those by Berisha et al. (2023) and Ali & Asfaw (2023), have provided updated insights, further clarifying the complexity of these relationships. While moderate inflation may promote economic growth by encouraging consumption and investment, high or volatile inflation often exacerbates income inequalities, disproportionately affecting vulnerable populations and deepening poverty traps.

Recognizing the nuanced interplay between inflation and income inequality is imperative for policymakers seeking to foster equitable growth and social harmony. Hence, this thesis aims to uncover the complex connection between inflation and income inequalities.

This study unveils how inflation impacts income dispersion and its implications for economic and social well-being, offering a fresh perspective on monetary policy management by linking inflation with income disparity. Furthermore, by clarifying how inflation influences income distribution, it enhances understanding of the factors driving differences in access to resources and living standards among populations.

Income inequality profoundly affects economic stability and long-term growth prospects. High levels of inequality can lead to social and political instability, along with reduced consumer demand, slowing economic development

2. Literature Review

2.1 Theoretical Framework

Underlying theoretical frameworks are the basis for the perception of the complicated relationship between inflation and income differences. Stiglitz (2012) puts special emphasis on factors that are in the structure of the economy as the most important determinants of inequality, with the economic policies and institutional set up being the most significant in that regard. Stiglitz's conceptual foundation stresses on the necessity to mitigate structural obstacles for economic opportunities e.g., uneven access to education, health care services and financial institutions. Stiglitz's point of view's major highlight concerning income inequality is that by identifying the root causes, we are empowered to understand how inflationary pressures may worsen the existing situation by hugely impacting the societal groups which are in the lower bracket of the economic ladder. Also supporting the idea are the theoretical views of scholars such as Atkinson (2015) and Monnin (2014) who argue that income inequality, although multidimensional in nature, goes hand in hand with the interactions of economic, social, and political factors.

Diverse perspectives from various theories are used to explain the complex nature of income inequality. Milanovic (2016) gives a thorough examination, encompassing both neoclassical and institutionalist approaches. Connecting the theories together deepens the knowledge of distribution determinants which in turn is a basis for empirical studies. Milanovic systematization of income concentration concepts adopts a single framework for understanding the diversity of the income distribution dynamics phenomenon. Milanovic gives us a complex picture which derives from combining neoclassical theories used for explaining markets and individuals with the institutionalist view, which considers institutions or social and political contexts. This complex approach makes it possible for the researchers to look at the dynamics of income distribution from different points of view, considering both the structural and behavioral factor. Also, the inclusion of inflation characteristics in the entire model of the economy is of important significance, since it is the only way to reflect the destructive influence of the reviewed phenomenon on income distribution. Blanchard and Gali (2010) make a comprehensive review of inflation, unemployment and income gaps, which have been linked together. These models are used by policymakers as analytic tools in their efforts to curtail inflation, and in the creation of nuanced policies that enhance the well-being of all groups. Blanchard and Katz's analysis of the role of inflation in a dynamic macroeconomic growth model further stress that the interaction of inflation dynamics with other macroeconomic variables is very important.

Through the inclusion of inflation in economic models, policymakers are in a position to have a better understanding of the intricate links between monetary policies, labor markets and the dynamics of income distribution. These models show dispersion of policy that helps in shielding the economic blossoming of income disparity, e.g., wage erosion and lower purchasing power of the low-income males and females. Lastly, compounding inflation numbers into economic models gives us the capacity to analyze tempt distribution away and determine policy responses.

2.2 Historical Perspectives on Income Inequality

Global inflationary pressures are rising sharply due to several factors, such as supply chain disruptions which have been greatly intensified by the COVID-19 pandemic, high demand, especially in emerging economies, and high reliance on global interdependence in trade. The ruthless intensification of inflation is of such a weighting that it necessitates an appraisal of the extent to which it hits the marginalized households as well as the wealthy class. There are credible examples from Bershova et al (2020) and Jaravel (2021) showing that, the distribution of the consequences of inflation is not uniform on all the income levels, with the effects more heavily weighted towards the lower income groups, thus contributing to the already existing income inequalities.

The majority of economists, central bankers, politicians, and practitioners across industrialized and developing nations concur that a primary objective of macroeconomic policies should be to attain rapid economic development while maintaining low inflation (Fischer, 1993). The buying power of money declines as a result of a market economy failing to function due to severe inflation. One of the most pressing issues confronting governments worldwide, whether in the industrialized or emerging nations, is the widening gap between rich and poor that has emerged over the last many decades. The destruction of social and economic well-being is caused by relative or class inequality, as opposed to absolute inequality, which does little to enhance productivity (Aghion et al., 1999). A more unequal society hinders the rule of law and the formation of social capital, limits the ability to accumulate wealth, paves the way for mobility from one generation to the next, discourages innovation and entrepreneurship, and limits the accumulation of capital. Additionally, financial and economic crises, social and political upheaval, and excessive inequality can all undermine macroeconomic stability and long-term growth (Barro, 2000; Kumhof et al., 2015; Kirschenmann et al., 2016; Perugini et al., 2016).

Although there is a lot of work on the topic of inflation and income disparity, the current literature needs to offer more specific claims on how inflation generates inequality. While some studies have shown that inflation has a negative effect on inequality, others have found that it helps those with lower incomes, indicating a positive correlation (Adams et al., 2003; Gallup et al., 1999; Fischer, 1993; Deininger and Squire, 1998). On the other hand, Gylfason and Holmstrom (1993) and Tornell and Lane (1999) are among the research that show null or inconclusive results. Furthermore, there is a large deal of study-to-study variation in the existing data about the correlation between inflation and income disparity. The selection of measurement techniques, the estimating strategy, and the mix of the nations in the research have a significant impact on the magnitude and sign of the reported estimates.

2.3 Empirical Evidence on the Relationship Between Inflation and Income Disparities

Many studies have looked at the link between inflation and income inequality, but they seem to have conflicting results. Certain studies demonstrate a positive correlation, providing evidence that inflation impacts the poorest people the most, increasing income inequality. For example, Berisha et al., (2023) the authors assessed the complexity of the interaction between inflation and inequality. In the study, researchers explored whether the approximately universally held belief that inflation has different degrees of impact on levels of inequality compared to one another was true in each US state. Results say that due to this very fact, inflation has a negative contemporaneous effect on inequality which strengthens with higher levels of income inequality. Further over one year period of study, it has been observed that higher inflation tends to impact income inequality among the low-income earners only that the effect is noticeable when income inequality is still relatively low.

The primary focus of economic scholars and politicians alike has been economic growth, income inequality, and inflation; a related study by Ali and Asfaw (2023) delves into these same questions. This proves, as the Johansen co-integrated test confirmed, that inflation, income inequality, and economic growth are all positively correlated, all showing a significant long-run link in the study's vector error correction model. Within the near term, this study's findings show a robust relationship between income disparity and GDP growth, along with inflation and GDP growth. Economic growth is positively correlated with income inequality and negatively correlated with inflation, according to the Granger causality test employed in this study (Ali and Asfaw, 2023). Redistribution programmes, social safety nets, coordinated fiscal and monetary policies, progressive taxes, reforming labor markets, and encouraging inclusive economic development are all things that the study's authors suggest the government or policymakers should do.

On the other hand, other studies take the view that the relationship is more complicated as wage rigidity, redistribution policies, and asset ownership determine the effect of inflation on income distribution.

As Mdigi & Ho (2021) discovered, the first empirical research examining the nexus between inflation and income disparities was conducted in the 1990s, and the OLS and the 2SLS estimation procedure. They focused on the influence of distributive politics on economic development in a sample of 46 countries during the 1960s to 1985. What they discovered was that higher income inequality was established at a time when there was low growth. The second study was a reiteration of the first one and looked at the impact of inequality on growth in 56 countries, between 1960–1985, and it found that inequality was negatively associated with growth. Following Perotti's work, similar estimation methods were employed to investigate the link between income inequality, democracy, and economic growth in 67 countries. It was shown that countries with a low level of inequality had a high investment in education, and thus were able to enjoy steady economic growth.

Furthermore, Amaral (2017) discusses the issue of monetary policy and its relationship with income and wealth gap, stating that though the specific monetary policies possess limited capability of reducing inequality, long-term structural processes such as demographics and technology lead changes in the gap. Amaral stresses a broader view for attending to the interrelation between socioeconomic issues and the income distribution pattern. Besides, Ravens & Walsh (2006) have also observed the crucial place that fiscal & monetary policies tend to play in offsetting the repercussions of inflation on the distribution of income. These studies provide essential knowledge and information for policymakers by helping them in developing and establishing essential interventions that could be used to address the adverse impacts of inflation on vulnerable segments of the population.

However, recent empirical analyses have utilized advanced econometric techniques to disentangle the complex relationship between inflation and income inequality, providing valuable insights for policymakers. Many scholars including Blanchard and Gali (2010) and Woodford (2003) have argued that the rise in inflation has been caused by several interrelated factors. The COVID-19 pandemic has caused supply chain disruptions that have disrupted production processes making them experience shortages and high prices (Fujita & Moscarini, 2017). Moreover, expanding demand, most especially in emerging economies, is one of the major factors that causes inflation (Ball, Leigh, & Loungani, 2013). Additionally, the intensified reliance upon global interdependence in trade leads to more vulnerable economies toward external shocks.

Doepke and Schneider (2006) conduct a quantitative study that demonstrates the impact of inflation by changing the net value of nominal assets like housing in the US. The study determines that the prime losers from the inflation will, however, be the older and the wealthy who are the main contributors to bond holding in the economy with the young middle-class whose salary is fixed as the biggest gainer of inflation. For instance, inflation plays the role of a supporter for governments and a levy on foreigners, thus, displaying its distributive forces through the economy. The paper accentuates the idea of considering the distribution of inflationary measures and the effect created thereon among different groups of people. These additional data sets go further and strengthen our understanding of the complexity in the correlation between inflation and income inequalities, leading to rich insights about the underlying levers that make inflation impact income distribution disparities and provide evidence of the need to consider specific context and heterogeneity within different economic systems.

2.4 Channels Through Which Inflation Influences Income Distribution

Inflation affects income distribution through various channels, including its impact on real wages, asset prices, and government redistribution policies, each contributing to the complex dynamics of economic disparity.

One significant pathway is its impact on real wages, where rising prices diminish the purchasing power of wages, particularly affecting lower-income groups disproportionately (Krugman, 2014; Atkeson & Kehoe, 2005). The worsening of inflation is a compelling issue that leads to the exploration of whether it influences income disparities. As prices surge, the burden weighs heavily on those with limited resources, exacerbating income inequalities in society (Mankiw, 2010).

Moreover, it can also affect asset prices, which in turn influence wealth distribution. Higher inflation can lead to asset price inflation, benefiting asset holders, who are typically wealthier individuals. This can widen the wealth gap, as those with substantial assets see their wealth increase, while those without such assets struggle to keep up with rising costs (Piketty, 2014; Bernanke, 2015).

Inflation as the power to interact with government redistribution policies, altering their effectiveness in addressing income disparities. For example, inflation can erode the real value of social welfare benefits and progressive taxation, potentially exacerbating income inequality (Stiglitz, 2012; Alesina & Glaeser, 2004). Conversely, it may also prompt policymakers to enact more redistributive measures to mitigate its adverse effects on low-income households (Acemoglu & Robinson, 2019).

The main goal for policymakers should be to identify and measure the uneven distribution of inflationary effects and then to develop targeted interventions which can ease these imbalance impacts in the society (Blanchard & Gali, 2010). Inflationary effect on the income distribution should also be addressed considering the social and economic outcomes while promoting the development of equitable societies and sustainable economic growth.

In light of Merrino's (2020) new evidence on how conventional monetary policy shocks affect wage inequality through the earnings heterogeneity channel within the context of South Africa's inflation targeting regime, which has been in place for the past 20 years, we can debate whether to reject or not to reject the null hypothesis. Using multivariate-time series analysis and the vector error correction approach to identify structural shocks, this work provides an empirical contribution. As a result of a positive shock to the prime rate, the impulse function responses reveal that the general pay distribution becomes poorer. Expansionary shocks based on wage allocation produce repercussions which are virtually comparable but opposite, indicating that the impact is symmetrical. It appears that the primary driver of the shock is the need for redistribution among the economy's weaker players, as the leading industries fail to exhibit any discernible improvement following the shock. An intriguing trend emerges with each iteration: a growing disparity between the top and bottom halves of the distribution. What this implies is that the white-dominated, well-paying jobs stay the same through good times and even thrive during bad ones. Consequently, regardless of the severity of the economic shock or disaster, the racial pay disparity remains stubbornly huge.

A paper by Amaral (2017) “Monetary Policy and Inequality” looks at the relationship between the monetary policy and income and wealth inequality, the focus being both on conventional and unconventional policies carried out by the Federal Reserve. The author starts by explaining that although conventional monetary policies seem to have small redistributive effects, we have incomplete knowledge regarding unconventional policies. Additionally, inflation can also influence labor market dynamics, impacting employment patterns and wage bargaining power. High inflation may lead to uncertainty and volatility in the labor market, affecting job security and wage negotiations, particularly for low-skilled workers (Blanchard & Gali, 2010; Phelps, 1970).

The study done by Thalassonos, Ugurlu, and Muratoglu (2012) is among the empirical research works that shed light on the issue. Using their panel data analysis from 2000 to 2009 across 13 European countries, they conclude that the inflation rate has positive and significant effects on income inequality as well as the employment rate and economic openness (Blanchard and Gali 2010). Therefore, these results emphasize why it is necessary for policies to be informed by measures of the inflation's distribution.

Furthermore, it can also affect the cost of borrowing, which in turn influences investment decisions and access to credit. High inflation rates may lead to higher interest rates, making borrowing more expensive for households and businesses, thereby exacerbating income disparities between borrowers and lenders (Friedman, 1968; Mishkin, 2016).

The channels through which inflation influences income distribution are multifaceted and interconnected, encompassing real wages, asset prices, government redistribution policies, labor market dynamics, and access to credit.

2.5 The Disproportionate Impact of Inflation on Low-Income Households

Low-income households through a large amount of money on food and shelter. In contrast with higher-pay families, they have less discretionary cash for unimportant things. Thus, any expansion in the evaluating of fundamental items could lopsidedly affect them. Balcilar et al. (2017) say that when inflation is high, the price of essential goods tends to rise more quickly than the price of non-essential products. Households with low incomes are significantly impacted by rising costs for essential goods. To begin, people only have a limited ability to pay for basic necessities because they spend more of their income on these products, leaving less money for other critical needs. Poor nutrition, inadequate shelter, and other issues may result from this. Second, it has become even more difficult to save for the future. With minimal monetary means, low-pay families find it challenging to save. It is becoming increasingly difficult for people to save money for immediate needs or long-term goals like housing or school. Besides, monetary pressure is pervasive in these homes. If costs rise faster than wages, it becomes even more challenging to keep a tight budget. Stress might adversely affect one's well being and harm family associations. Although it is possible to assert that inflation has an effect on all households regardless of income, there are several factors that lessen its impact on those with lower incomes (Balcilar et al., 2017). For example, some might guarantee that government help projects or sponsorships moderate the results of expansion on specific populaces. In addition, technological advancements and globalization may result in savings that assist in maintaining constant costs for essential items. These counterarguments habitually disregard the institutional hurdles and disparities that support the disproportionate effect of inflation on low-income families.

According to Cecchetti, (1995) fixed incomes are earnings that stay steady over the course of time, typically from annuities, pensions, or social security benefits. Beneficiaries are subject to the effects of rising costs because fixed incomes, in contrast to wages or salaries, do not adjust for inflation or changes in the cost of living (Cecchetti, 1995). Inflation diminishes the buying power of fixed salaries by increasing the cost of services and products, so a similar measure of cash purchases less services and products.

Because of this, people with low incomes are able to buy fewer goods and services, which lowers their standard of living. Studies undertaken by the International Monetary Fund (IMF, year) have stressed the effect of inflation on fixed incomes. They exhibit that when inflation outpaces changes to fixed salaries, fixed-income earners experience an expanded risk of poverty, especially among vulnerable groups like the elderly or those with disabilities. Besides, the deficiency of buying power among fixed-pay workers can come down on friendly security nets as additional individuals look for help to fulfill their central necessities. This emphasizes the need for arrangements that consider the impact of inflation on fixed wages and set up shields to safeguard vulnerable groups (Cecchetti, 1995).

2.6 Heterogeneity in the Impact of Inflation on Income Disparities

The impact of inflation on income distribution varies across demographic groups and economic sectors. Vulnerable populations, such as low-skilled workers, the unemployed, and the elderly, are particularly susceptible to the adverse effects of inflation. The analysis of the inequality trends in the United States shows an increase in income inequality since the 1970s, mostly due to the top part of the distribution. Wealth gap, which got wider, also increased since the 1990s. The author stresses that redistribution of inequality is much more the result of the long-drawn processes like education, globalization, and demography rather than by monetary policy.

Sieron (2017) evaluates theories on the role of conventional monetary policy in inequality and analyzes avenues that include the inflation tax way, savings redistribution, interest rates exposure, different characteristics of workers' ending income and income distribution. The empirical evidence presented is based on a research study analyzing the effects of surprise shocks of the Federal Funds rate and found that there are statistically and economically significant effects on income inequality, but it only shows its results after 3 to 5 years. But the author stresses the fact that they have smaller effects compared to long term inequality change. As far as the non-standard monetary policy, such as policy after the financial crisis, the writer draws attention to the shortage of research on the impact of these policies on inequality Asset purchases might impact on inequality via interest rates and asset prices effects, however, there is a lot of complexity in the interactions and missing information about other scenarios make it rather difficult to conclude about the net impacts.

On inflation and income distribution, other authors like Ravenna & Walsh (2006), argue that monetary and fiscal policies can either help to alleviate the impact of inflation or aggravate it. Policy makers can draw some lessons from empirical studies like those of Mishkin (1992), Akerlof, Dickens and Perry (1996), to design interventions to mitigate the impact of inflation on the vulnerable groups in the society. The subtle interaction between inflation and income inequality deserves a lot of attention because it forms the box of principles to reach the policy tools that can be effective and targeted.

A country's macroeconomic situation takes a nosedive when inflation rates are high, according to previous research. Less exports are the long-term effect of excessive inflation, which distorts the relationship between returns on real and financial capital (Gylfason, 1999). The investment in non-residential buildings and structures, as well as machinery and equipment, is hindered by inflation, according to Madsen (2003), since it raises the cost of capital. The ongoing upward trend in inflation rates hinders the financial system's ability to allocate resources efficiently and effectively (Boyd et al. 2001).

Thus, research has shown that inflation hinders the growth of financial systems (Nasreen et al. 2020; Ehigiamusoe et al. 2020). Schneider and Frey (1985) state that FDI is negatively impacted by inflation because, to an outsider, a high inflation rate indicates economic instability inside the country, which makes potential investors wary of putting money there. Moreover, a misalignment of economic measures, such as ineffective fiscal and monetary policies, can exacerbate the economic crisis and lead to excessive inflation (Bittencourt, 2011). Similarly, inflation is a major factor in both economic performance and the distribution of economic possibilities, widening the gap between the well-off and everyone else.

Despite the inflation-income inequality relationship attracting the attention of researchers' attention, there is no clear vision of how inflation affects inequality among the currently available literature. One side of the research stream says that inflation is positively and statistically significant in reducing inequality, while other scientists argue that inflation benefits the poor, meaning a robust negative relationship. Addressing income disparities resulting from inflation requires a multifaceted approach that integrates empirical evidence, identifies transmission channels, considers heterogeneity in impacts, and provides targeted policy recommendations. By implementing effective strategies to mitigate the adverse effects of inflation on income distribution, policymakers can promote inclusive and sustainable economic growth.

2.7 Monetary Policy Channels that Influence Income Distribution

Researchers have found many processes via which monetary policy affects income and wealth inequality (Colciago, Samarina and de Haan, 2019). The method that redirects capacity in the other direction is the source of disputes on whether a financial strategy causes inequality. First, the profit heterogeneity channel can be used by contractionary money-related arrangement shocks to feed pay discrepancy. Jobs with lower pay (more wiggle space) and those with less remuneration (concentrated edge) are the ones most impacted by changes in the business cycle. Hence, shocks to the money supply that are contractionary can exacerbate wage inequality by cutting into the profits of low-paid workers. Furthermore, studies have shown that small company sales are more vulnerable to monetary policy shocks than large company sales. Again, shocks to the financial system that are contractionary can exacerbate wage inequality by cutting into the sales (and revenue) of smaller businesses more than larger ones.

Most economists, central bankers, policymakers, and practitioners in developed and developing countries agree that achieving high economic growth and low inflation is one of the main goals of macroeconomic policies (Colciago, Samarina, and de Haan, 2019). The high rate of inflation causes the working of a market economy to fail, leading to the deterioration of the purchasing power of money. Growing income and wealth disparity across most countries over the past few decades is one of the key challenges that policymakers face in both the developed and the developing world.

Unlike absolute inequality, which is irresponsible for supporting productivity, relative or class inequality is responsible for destroying social and economic well-being (Aghion et al., 1999). Higher inequality constraints capital accumulation, provides the path for upward intergenerational mobility, prevents the development of innovations and entrepreneurship, and weakens the rule of law and social capital creation. Further, extreme inequality may also result in social and political chaos and financial and economic crises which destroy macroeconomic stability and sustainable growth (Barro, 2000; Kumhof et al., 2015; Kirschenmann et al., 2016; & Perugini et al., 2016). Given the highly damaging development result, as expected recently, there have been great initiatives in exploring the cause and possible actions to control this development.

Colciago, SamarIna, and de Haan (2019) found that contractionary monetary policy shocks exacerbate income inequality through the savings redistribution channel. Borrowers will be hurt by contractionary financial approaches that aid ex-post real loan costs. Because they save more, affluent and senior households reap the most rewards in the household sector. Consequently, shocks to contractionary monetary policy make income disparity worse.

The income composition channel concludes by suggesting that shocks to contractionary financial arrangements may reduce pay uniqueness. This channel was inspired by the reality that every household's main source of income is different; for example, households with higher incomes are more likely to depend on company revenue rather than wage income. Pay gap will decrease if contractionary monetary policy shocks reduce organization pay more than wage pay. According to Colciago, SamarIna, and de Haan (2019), the total effect of shocks to monetary policy on income inequality is therefore determined by the proportional significance of each channel.

Considering unconventional monetary policy and income inequality, in numerous viewpoints, UMP varies essentially from traditional monetary policy. The national bank uses the size and content of its asset report as a strategy instrument as opposed to financing costs, and this much of the time happens when monetary policy is caught at the supposed zero lower limit. Empirical research has a boundary since it is a somewhat new kind of strategy. In any case, some new exact examinations research the distributional impact of UMP. Instead of focusing on interest rates, UMP measures the size of the central bank's balance sheet. As far as we could possibly know, Doepke and Schneider, (2006) led the principal study to inspect the impact of UMP on pay dispersion utilizing semi-accumulated family overview information from Japan. The primary idea is that UMP regularly swells the costs of monetary resources, which are ordinarily snatched by the rich, in this way expanding disparity through the portfolio channel. With additional policies implemented in 2009 and 2014, Japan's monetary policy (UMP) is more extensive than those in the United States (2009-2014) and the Eurozone (2016-2019). While disparity is a slow-moving pattern, the life span of Japan's UMP recommends that it assume a part in developing inequality in Japan (Doepke and Schneider, 2006).

Unexpected interest rate increases can worsen pay imbalance by expanding account holders' revenue installments. A common illustration of the distributional effect of monetary policy is this. Kim and Lin (2023) were quick to research the effect of regular money related strategy on distributional effect. While expansive monetary policy may temporarily alleviate poverty, the best outcome is steady production and low inflation. In their key examination, Park, (2021) shows that contractionary money related approach shocks extended pay imbalance in the US from 1980 to 2008; the impact is principally determined by the effect of financial strategy on the labor market. Employment and earnings can rise as a result of easier monetary policy, lowering income inequality. Bivens (2015) revealed comparative discoveries in the US. In a panel of 32 advanced and emerging markets, Saiki and Frost, (2020) observe a comparable effect. They find that contractionary money related arrangements exacerbated imbalance in the UK from 1969 to 2012, while flighty systems (like QE) had the opposite influence during the ongoing Extraordinary Downturn. As Saiki and Frost, (2020) traditional monetary related arrangement facilitating brings down business uniqueness however raises pay imbalance because of contrasts in wage adaptability across training levels. All in all, the profit of profoundly taught laborers are more procyclical than those of others. Siami-Namini and Hudson, (2017) utilized a board of 12 high level countries from 1920 to 2015 to show that expansionary money related strategy raises the negligible part of public pay claimed by the main one percent, bringing about more extensive imbalance. The understanding of these going against information stays an unanswered subject.

3. Data and Methodology

This study explores the relationship between inflation and income inequality in Germany, Portugal, USA and Japan between 1980 and 2023. All data have annual frequency and are retrieved from sources like the AMECO database, the Standardized World Income Inequality Database (SWIID), the World Inequality Database (WID), and Federal Reserve Economic Data (FRED). It applies visual representations, and economic modeling methods to these data.

The analysis uses Vector Autoregression (VAR) models by Sims and Thomas (1980), where all variables are treated in times series and as endogenous. The VAR approach enables the estimation of links between the variables over time, capturing both short-term and long-term links between inflation and income distribution. This statistical technique can capture the movement of multiple variables and their interdependence. By estimating a system of equations together like in the VAR model, it is possible to understand dynamic behavior of inflation rates, income distribution, and other socio-economic indicators to be included in the model.

In applying the VAR model, the methodology used aligned with that of Creel and El Herradi (2022). Following their framework, the selected indicators for this model will allow a detailed examination of inflation's role in shaping income inequality. This approach mirrors the structure laid out by Blanchard and Gali (2010), who emphasized inflation management's role in mitigating income disparities, and Monnin (2014), who also explored the effects of inflation on inequality in developed economies.

The data was treated econometrically using R Studio software, which facilitated the execution of unit root tests, estimation of the VAR model, and generation of impulse-response functions. This software enabled the efficient management of time series data and ensured accurate estimation of the model's parameters.

The Consumer Price Index (CPI), which measures inflation by tracking price level changes in household goods and services, will be used to forecast inflation trends. Gross Domestic Product (GDP) reflects economic growth through the total output per capita. Income inequality is gauged by the GINI Coefficient, with higher values indicating greater inequality, complemented by Income Shares of the top 10% and bottom 50% to assess wealth distribution. Lastly, Interest Rates (ILRV), representing long-term government bond yields, signal financial stability and investor confidence. Together, these variables form a comprehensive framework for analyzing the economic conditions and income distribution dynamics in these countries.

The principal variables in analysis are explained generally in Table 1 below.

Table 1: *Variables*.

Variables	Description	Periodicity	Source	Countries
Inflation	National Consumer Prices index (ZCPIN), All Items, CP00, Total, Index, 2015=100, Not Seasonally Adjusted	Yearly	AMECO database	Portugal, Germany, Japan and United states
Gross Domestic Product (GDP)	Real Gross Domestic Product at current market prices per head of population Millions of Chained 2010 Euros. Not Seasonally Adjusted	Yearly	AMECO database	Portugal, Germany, Japan and United states
GINI	Gini Disposable Income Not Seasonally Adjusted	Yearly	Standardized World Income Inequality Database (SWIID)	Portugal, Germany, Japan and United states
Income Shares	Top 10% and Bottom 50% share | adults | equal split	Yearly	World Inequality Database (WID)	Portugal, Germany, Japan and United states
Interest rate (ILRV)	Long-Term Government Bond Yields, 10 years Frequency: Annual, Average Units: Percent, Not Seasonally Adjusted	Yearly	Federal Reserve Economic Data (FRED)	Portugal, Germany, Japan and United states

Source:Author's Elaboration

4. Empirical Results

4.1 Overview of Key Independent and Dependent variables

This chapter presents analysis on "How Inflation Affects Income Inequality" with different measures of income serving as the dependent variable, while the independent variables include Inflation, Gross Domestic Product, and Inflation Rate Variance. Before conducting the descriptive analysis, inflation was calculated using the Consumer Price Index (CPI).

$$\text{Inflation} = 100 \text{ x } [\log(\text{CPI}_t) - \log(\text{CPI}_{t-1})]$$

Inflation was calculated using the logarithmic percentage change of the CPI between consecutive periods, rather than the simple difference. This method offers a more precise measurement of the relative change in price levels over time. By capturing percentage changes, it reflects the compound effects of inflation, which are crucial for understanding its impact on purchasing power and income distribution, as inflation can reduce the value of real wages and widen the gap between higher- and lower-income groups. This approach also helps smooth out short-term volatility, allowing for a clearer view of the long-term relationship between inflation and income disparities.

The stationary tests, VAR model, and country comparison are then combined to analyze how inflation dynamics and broader economic performance influence income distribution across various demographic groups.

4.2 Sample Analysis

The sample consists of annual data observations from 1980 to 2023 for four countries. The dataset encompasses six key variables, each analyzed through descriptive statistics such as mean, median, standard deviation, minimum, maximum, skewness, and kurtosis. These metrics provide a thorough characterization of the data, and the results are summarized in Table 2.

Table 2: *Descriptive Statistics of the Variables.*

Country	Variable	Mean	Median	Stand,Dev	Min	Max	Skewness	Kurtosis
Germany	Inflation	0,2693	0,6623	7,3974	(26,0017)	35,1345	1,6396	(1,1397)
	GDP	30,9219	29,9000	7,2576	18,9000	46,3000	0,3608	(0,9906)
	ILRV	4,5352	4,5738	2,9715	(0,5110)	10,1333	(0,1294)	(1,1505)
	GINI	27,1881	26,5500	1,6710	25,0000	29,8000	0,2913	(1,6331)
	Top 10	0,3436	0,3404	0,0294	0,2963	0,4023	0,1605	(1,0175)
	Bottom 50	0,1945	0,1917	0,0170	0,1411	0,2221	(0,4409)	0,3910

Portugal	Inflation	0,5310	0,0222	2,8404	(10,5716)	4,6973	(1,3040)	2,3932
	GDP	12,0233	13,1000	6,0914	2,4000	23,5000	(0,1184)	(1,3041)
	ILRV	4,8779	4,4233	2,9705	0,2950	11,4650	0,6829	(0,2336)
	GINI	33,3667	33,5500	0,6976	31,7000	34,3000	(1,0682)	0,2699
	Top 10	0,3563	0,3697	0,0333	0,2723	0,4026	(0,8603)	(0,3757)
	Bottom 50	0,1927	0,1909	0,0132	0,1686	0,2366	0,9607	1,4622
United States	Inflation	1,6052	1,1331	4,8026	(29,6690)	4,1113	(4,6675)	24,8526
	GDP	33,2116	33,5000	14,6840	9,0000	73,4000	0,6050	(0,2775)
	ILRV	5,7330	5,0175	3,3801	0,8942	13,9108	0,7028	0,4263
	GINI	36,4837	37,2000	1,9946	31,2000	38,8000	(0,9462)	(0,1830)
	Top 10	0,4156	0,4194	0,0383	0,3384	0,4827	(0,3148)	(0,9299)
	Bottom 50	0,1453	0,1451	0,0222	0,0967	0,1933	(0,0431)	(0,0811)
Japan	Inflation	0,3260	0,3403	2,2054	(3,3593)	7,3203	1,4531	3,0457
	GDP	27,9023	30,8000	8,6433	6,9000	42,3000	(0,8578)	(0,2312)
	ILRV	1,8798	1,3443	1,8969	(0,1104)	6,9599	1,1838	0,3882
	GINI	29,3923	30,0000	2,4739	24,1000	32,9000	(0,5345)	(0,8597)
	Top 10	0,4115	0,4201	0,0345	0,3543	0,4532	(0,3827)	(1,4934)
	Bottom 50	0,1674	0,1626	0,0124	0,1468	0,1902	0,2193	(0,8922)

Source: Author's Elaboration using data from AMECO, SWIID, World Inequality Database, and FRED, processed in R Studio.

Considering the general sample of economic indicators across Germany, Portugal, the United States, and Japan, some marks can be observed in their distribution. First, the dispersion of most of the variables-as represented by their standard deviations-is not extreme judged against respectively taken means. That is, for the most part, the data are consistent across the countries. Meanwhile, GDP and ILRV have the biggest dispersion, especially for the US and Portugal, respectively; they tend to indicate that those economies are larger in those countries.

This will be further reflected in the section on skewness: most of the variables are right-skewed, with the highest number of lower values and a few higher extreme values. This holds remarkably true for inflation, GDP, and ILRV. For both Germany and Portugal, GINI coefficients have all values slightly left-skewed, meaning less frequency of values with relatively high levels of inequality.

Regarding kurtosis, most variables show moderate values, but there are a few exceptions. For example, in Japan, ILRV shows higher kurtosis, meaning the data is more tightly clustered around the average, with more extreme values in interest rates. On the other hand, the Top 10% income share in the United States shows a similar pattern, where extreme values are more common, especially in the highest income levels. Meanwhile, in both Germany and Japan, inflation has a slightly negative kurtosis, which means the data is more spread out and flatter, with fewer extreme values.

The series correlation was tested to identify any signs of problems with multicollinearity in the estimated models. The Pearson linear correlation coefficient was used, and the results are shown in Table 3.

Table 3: *Matrix of Correlations*

Country	Variable	Inflation	GDP	ILRV	GINI	Top 10	Bottom 50
Germany	Inflation p-value	1 N/A					
	GDP p-value	0,96331 0,00000	1 N/A				
	ILRV p-value	0,65923 0,00010	0,95296 0,0000	1 N/A			
	GINI p-value	0,74549 0,00000	(0,48967) 0,00156	(0,40100) 0,01141	1 N/A		
	Top 10 p-value	0,56210 0,00009	0,85048 0,00000	0,85148 0,00000	0,63483 0,00009	1 N/A	
	Bottom 50 p-value	0,63483 0,00009	0,71108 0,00000	0,75426 0,00000	0,74770 0,00000	0,71108 0,00000	1 N/A
Portugal	Inflation p-value	1 N/A					
	GDP p-value	0,96772 0,00000	1 N/A				
	ILRV p-value	0,54365 0,00230	0,73675 0,00001	1 N/A			
	GINI p-value	0,78670 0,00000	(0,05709) 0,000129	(0,47706) 0,00000	1 N/A		
	Top 10 p-value	(0,71754) 0,00008	0,88828 0,00000	0,82123 0,00000	0,87032 0,00000	1 N/A	
	Bottom 50 p-value	0,62253 0,00000	0,89228 0.01026	0,85508 0,00000	0,77702 0,00000	0,69832 0,00000	1 N/A
United States	Inflation p-value	1 N/A					
	GDP p-value	(0,99783) 0,00000	1 N/A				
	ILRV p-value	0,95296 0,00000	0,92414 0,00000	1 N/A			
	GINI p-value	0,745490 0,000156	0,78967 0,00000	0,85048 0,00000	1 N/A		
	Top 10 p-value	0,85048 0,00000	0,71754 0,00000	0,91631 0,00000	0,92060 0,00000	1 N/A	

	Bottom 50 p-value	0,71108 0,00000	(0,74770) 0,001137	0,85501 0,00002	0,89535 0,00000	0,70336 0,00000	1 N/A
Japan	Inflation p-value	1 N/A					
	GDP p-value	0,88828 0,00000	1 N/A				
	ILRV p-value	0,89620 0,00000	0,86722	1 N/A			
	GINI p-value	(0,57097) 0,00015	0,74549 0,00000	0,89620 0,00000	1 N/A		
	Top 10 p-value	(0,73465) 0,000143	0,86795 0,00000	0,66947 0,00000	0,87683 0,00000	1 N/A	
	Bottom 50 p-value	0,78867 0,00001	0,95051 0,00000	0,75426 0,00000	0,77521 0,00000	0,67221 0,00000	1 N/A

Source: Author's Elaboration

These variables are in general strongly correlated, as captured by most of the coefficients being very close to 1, proving that the relationships of these economic indicators across countries are blatantly aligned.

4.3 Stationarity Tests

The stationarity of time series is a crucial characteristic to ensure consistent behavior over time, avoid spurious results, and confirm the statistical properties of the estimators used in the models. Unit root tests assess how many differences are needed to make a series stationary. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were conducted using the constant and constant with trend versions. Both are unit root tests that help identify if a series is non-stationary (has a unit root) or stationary after differencing.

4.3.1 Augmented Dickey-Fuller (ADF) Test

The ADF unit root test evaluates whether a series Yt, is stationary by estimating the model:

$\Delta Y_t = \alpha + \gamma Y_{t-1} + \theta \Delta Y_{t-1} + \epsilon t$ (with constant) or
$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \theta \Delta Y_{t-1} + \epsilon t$ (with constant and trend)
where $\Delta Yt = Y_t - Y_{t-1}$ and ϵt is the residual and have as hypotheses tested:

- H0: $\gamma=1$ (the series has a unit root, non-stationary, DSP),
- H1: $\gamma<1$ (the series is stationary, TSP).

If the p-value of the ADF test is below the significance level (typically 0.05), the null hypothesis is rejected, indicating that the series is stationary. For instance, in the case of Inflation in countries like Germany and Portugal, the ADF test showed the series was non-stationary at levels, but after applying the first difference, the series became stationary, meaning the changes in inflation over time are consistent.

4.3.2 Phillips-Perron (PP) Test

The Phillips-Perron test also assesses the stationarity of a time series. The model and hypotheses are similar to those of the ADF test, but the PP test includes a correction to the coefficient γ, making it more robust to certain forms of heteroskedasticity and autocorrelation in the residuals.

In my analysis, it was applied the PP test to the same variables, and the results confirmed the findings from the ADF test. For several variables such as GDP, ILRV, and GINI, the PP test also indicated that the series were non-stationary at levels but became stationary after the first or second differences. By cross validating the results with both the ADF and PP tests, I ensured the robustness of the conclusions regarding the stationarity of each variable.

4.3.3 KPSS Test

Unlike ADF and PP tests, which have a null hypothesis of non-stationarity, the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test takes the opposite approach. It complements the ADF and PP tests by testing the null hypothesis that a time series is stationary around a mean or a trend (TSP). This dual approach (ADF/PP vs. KPSS) helps ensure thorough verification of the stationarity properties, as one can detect potential inconsistencies or validate findings from multiple perspectives.

These tests together give a balanced and robust framework to confirm the stationarity of the time series. They were applied to the time series under study, and the results are presented in Table 4.

Table 4: *Unit Root Tests*

Variables	Series			ADF		PP		KPPS	Conclusion
				Intercept	Trend+ intercept	Intercept	Trend+ intercept	Short	
Germany	Inflation	Level	t-statistic	(4.0597)	(6.9104)	(52.1018)	(11.9079)	0.0601	TSP Series Stationary
			p- value	0.0169		0.0100			
	GDP	Level	t-statistic	0.0066	(0.6104)	(1.5321)	(0.3877)	0.9041	DSP Series Non-Stationary
			p- value	0.9900		0.9754			
		Δ	t-statistic	(4.7301)	(4.9514)	(23.4923)	(4.6487)	0.3050	TSP Series Stationary
			p- value	0.0100		0.0100			
	ILRV	Level	t-statistic	(2.6874)	(2.9588)	(17.7468)	(3.0402)	1.1166	DSP Series Non-Stationary
			p- value	0.3022		0.0760			
		Δ	t-statistic	(3.2817)	(4.1409)	(39.0378)	(5.9750)	0.0663	DSP Series Non-Stationary
			p- value	0.0880		0.0100			
		Δ2	t-statistic	(4.7065)	(6.3277)	(43.9762)	(10.6465)	0.2316	TSP Series Stationary
			p- value	0.0100		0.0100			
	GINI	Level	t-statistic	(3.0603)	(2.0919)	(7.5949)	(2.4563)	1.0423	DSP Series Non-Stationary
			p- value	0.1557		0.6537			
		Δ	t-statistic	(2.5992)	(3.3458)	(24.9705)	(4.1482)	0.2125	TSP Series Stationary
			p- value	0.3379		0.0100			
	Top 10	Level	t-statistic	(2.6760)	(3.1044)	(12.6374)	(1.9067)	0.9980	DSP Series Non-Stationary
			p- value	0.3067		0.3376			
		Δ	t-statistic	(3.2207)	(5.5433)	(32.0266)	(5.4553)	0.1710	DSP Series Non-Stationary
			p- value	0.0971		0.0100			
		Δ2	t-statistic	(4.0516)	(9.0585)	(44.4304)	(9.2634)	0.0558	TSP Series Stationary
			p- value	0.0175		0.0100			
	Bottom 50	Level	t-statistic	(1.8271)	(2.8450)	(31.2248)	(4.4416)	0.9396	DSP Series Non-Stationary
			p- value	0.6420		0.0100			
		Δ	t-statistic	(3.9221)	(6.7539)	(51.7148)	(11.3805)	0.1125	TSP Series Stationary
			p- value	0.0223		0.0100			
Portugal	Inflation	Level	t-statistic	(3.7212)	(6.3713)	(34.0872)	(6.8372)	0.0665	TSP Series Stationary
			p- value	0.0354		0.0100			
	GDP	Level	t-statistic	(2.3928)	(2.2946)	(8.9501)	(1.9823)	1.1645	DSP Series Non-Stationary
			p- value	0.4186		0.5695			
		Δ	t-statistic	(2.6244)	(4.0161)	(28.0432)	(3.9403)	0.1168	TSP Series Stationary
			p- value	0.3275		0.0100			
	ILRV	Level	t-statistic	(2.1130)	(3.9025)	(9.6112)	(2.3249)	0.4986	DSP Series Non-Stationary
			p- value	0.5293		0.5062			
		Δ	t-statistic	(2.7044)	(4.5234)	(19.1831)	(3.5134)	0.0838	DSP Series Non-Stationary
			p- value	0.3031		0.0362			
		Δ2	t-statistic	(4.6275)	(5.0875)	(22.5900)	(5.0386)	0.0525	TSP Series Stationary
			p- value	0.0100		0.0102			
	GINI	Level	t-statistic	(1.4653)	(2.9066)	(4.4476)	(1.4092)	0.6054	DSP Series Non-Stationary
			p- value	0.7844		0.8523			
		Δ	t-statistic	(3.3328)	(2.8021)	(13.7789)	(2.6199)	0.2640	TSP Series Stationary
			p- value	0.0808		0.2610			
	Top 10	Level	t-statistic	(0.9924)	(1.3076)	(1.2816)	(0.6996)	0.6770	

			p- value	0.9278		0.9799			DSP Series Non-Stationary
		Δ	t-statistic	(3.3666)	(6.0834)	(50.9155)	(9.8611)	0.5707	DSP Series Non-Stationary
			p- value	0.0753		0.0100			
		Δ2	t-statistic	(4.6213)	(9.8777)	(52.9734)	(18.0841)	0.0748	TSP Series Stationary
			p- value	0.0100		0.0100			
	Bottom 50	Level	t-statistic	(1.5141)	(2.5711)	(12.4089)	(3.4116)	0.8937	DSP Series Non-Stationary
			p- value	0.7656		0.3520			
		Δ	t-statistic	(3.5945)	(6.4137)	(34.1780)	(6.9392)	0.4523	TSP Series Stationary
			p- value	0.0454		0.0100			
United States	Inflation	Level	t-statistic	(2.9545)	(5.0011)	(42.9982)	(7.4758)	0.1231	DSP Series Non-Stationary
			p- value	0.1974		0.0100			
		Δ	t-statistic	(5.0877)	(5.9594)	(53.8400)	(15.0246)	0.0546	TSP Series Stationary
			p- value	0.0100		0.0100			
	GDP	Level	t-statistic	(0.8298)	(1.0523)	(4.8047)	(0.8697)	1.0992	DSP Series Non-Stationary
			p- value	0.9515		0.8302			
		Δ	t-statistic	(2.7117)	(4.1458)	(27.9972)	(4.1315)	0.2361	TSP Series Stationary
			p- value	0.2931		0.0100			
	ILRV	Level	t-statistic	(2.5904)	(3.0769)	(12.8718)	(2.3935)	1.0943	DSP Series Non-Stationary
			p- value	0.3405		0.3229			
		Δ	t-statistic	(5.6056)	(8.3092)	(37.3032)	(8.8054)	0.1769	TSP Series Stationary
			p- value	0.0100		0.0100			
	GINI	Level	t-statistic	(0.7758)	(2.2312)	(5.2950)	(1.8600)	1.0221	DSP Series Non-Stationary
			p- value	0.9561		0.7993			
		Δ	t-statistic	(4.0453)	(5.5729)	(29.7204)	(5.1312)	0.5508	TSP Series Stationary
			p- value	0.0174		0.0100			
	Top 10	Level	t-statistic	(2.3829)	(2.4604)	(8.8491)	(1.9905)	0.0557	DSP Series Non-Stationary
			p- value	0.4124		0.5758			
		Δ	t-statistic	(3.4338)	(3.8759)	(26.9897)	(4.4351)	0.0427	TSP Series Stationary
			p- value	0.0253		0.0100			
	Bottom 50	Level	t-statistic	(1.8261)	(2.8450)	(31.2248)	(4.4416)	0.9396	DSP Series Non-Stationary
			p- value	0.6320		0.0100			
		Δ	t-statistic	(3.9221)	(6.7539)	(51.7148)	(11.3805)	0.1125	TSP Series Stationary
			p- value	0.0223		0.0100			
Japan	Inflation	Level	t-statistic	(3.4016)	(3.3846)	(24.1864)	(4.0382)	0.1207	DSP Series Non-Stationary
			p- value	0.0701		0.0118			
		Δ	t-statistic	(4.1611)	(5.4546)	(46.8286)	(8.3549)	0.0551	TSP Series Stationary
			p- value	0.0132		0.0100			
	GDP	Level	t-statistic	(1.9425)	(2.2864)	(6.6491)	(2.0096)	0.8086	DSP Series Non-Stationary
			p- value	0.5964		0.7142			
		Δ	t-statistic	(4.1890)	(5.0245)	(30.4195)	(5.4601)	0.2878	TSP Series Stationary
			p- value	0.0117		0.0100			
	ILRV	Level	t-statistic	(2.7308)	(3.3093)	(4.4141)	(1.3497)	0.7762	DSP Series Non-Stationary
			p- value	0.2899		0.8520			
		Δ	t-statistic	(1.8500)	(4.7153)	(34.4856)	(8.5819)	0.1768	DSP Series Non-Stationary
			p- value	0.6309		0.0100			
		Δ2	t-statistic	(3.8736)	(7.5523)	(33.5848)	(12.4580)	0.2520	TSP Series Stationary
			p- value	0.0280		0.0100			

	GINI	Level	t-statistic	(2.4030)	(2.1490)	(5.8244)	(2.1221)	1.0183	DSP Series Non-Stationary
			p- value	0.4156		0.7636			
		Δ	t-statistic	(3.7753)	(3.6595)	(25.2284)	(4.2057)	0.2946	TSP Series Stationary
			p- value	0.0329		0.0100			
	Top 10	Level	t-statistic	(2.3829)	(2.4704)	(8.8491)	(1.9905)	0.9848	DSP Series Non-Stationary
			p- value	0.4224		0.5758			
		Δ	t-statistic	(3.4338	(3.8759)	(26.9897)	(4.4351)	0.0852	DSP Series Non-Stationary
			p- value	0.0653		0.0100			
		Δ2	t-statistic	(4.2834)	(5.9729)	(44.4247)	(8.8354)	0.0509	TSP Series Stationary
			p- value	0.0100		0.0100			
	Bottom 50	Level	t-statistic	(2.1239)	(2.2304)	(6.2586)	(1.6623)	0.7355	DSP Series Non-Stationary
			p- value	0.5248		0.7387			
		Δ	t-statistic	(3.4950)	(3.4507)	(24.7309)	(4.1206)	0.1196	TSP Series Stationary
			p- value	0.0561		0.0100			

Source: Author's Elaboration

As seen in Table 4, most variables across all four countries—Germany, Portugal, United States, and Japan—exhibited trends indicating non-stationarity at their levels. The ADF, PP, and KPSS tests confirmed that variables such as GDP, GINI and Bottom 50% required first differencing to achieve stationarity. Inflation became stationary after first differencing only in the United States and Japan. However, some variables, particularly ILRV and the Top 10% income share in Germany, Portugal, and the United States, required second differencing due to persistent volatility.

The results, summarized in Table 4, indicate that applying first differences was sufficient for most variables, while second differencing was necessary for others, like ILRV, to ensure reliability consistency time series behavior.

4.4 Lags Selection

The objective of selecting the optimal number of lags was to ensure that the model accurately captured the dynamic relationships between variables over time, while avoiding both overfitting and underfitting. By using the Akaike Information Criterion (AIC), Hannan-Quinn Criterion (HQ), Schwarz Criterion (SC), and the Final Prediction Error (FPE), I was able to objectively determine the most appropriate lag length for each country. These criteria offered a balanced evaluation of model fit and complexity, providing a solid basis for selecting the optimal number of lags for each model.

For each country –Germany, Portugal, USA, and Japan – I specified a maximum lag length of 10 and used the VAR select function in R to calculate the optimal number of lags based on the four information criteria. This function evaluates the performance of the VAR model across various lag lengths and selects the number of lags that minimizes each criterion. By doing so, I was able to objectively determine the best lag length for each country's data.

By following this systematic process, I ensured that the models for each country were designed to capture the dynamic relationships between variables without overfitting (which could occur with too many lags) or underfitting (which might happen with too few lags). This approach allowed for the development of robust VAR models for each country, ensuring that the interactions between key economic variables, such as inflation, GDP, ILRV, and GINI, were appropriately modeled. These lag lengths were subsequently applied to estimate the VAR models, which will undergo further analysis through diagnostic tests and impulse response functions (IRF). Table 5 presents the selection criteria to determine the optimal number of lags for the model in question.

Table 5: *Optimal Lag Length Selection for Each Country*

Country	AIC	HQ	SC	FPE
Germany	2	1	1	2
Portugal	2	2	2	1
USA	1	2	2	1
Japan	1	1	1	1

Source: Author's Elaboration

4.5 The Vector Autoregression (VAR) Analysis

The core of the data analysis lies in the results derived from the VAR model, which examines the dynamic relationships between all variables, treating each as endogenous. The VAR model is designed to capture how past values, or lagged observations of each variable, influence their current values, allowing for a comprehensive understanding of temporal dynamics and causal interactions among multiple time series.

It was developed three separate VAR models. For each of these models, the VAR structure was maintained, where each variable is regressed on its own past values and the lagged values of all other variables in the system. The mathematical formula applied for calculating the VAR model with the average values is:

$$\hat{Y}_t = \frac{1}{n}\sum_{i-1}^{n} Y_{t,i}$$

Where:

- $\hat{Y}_t$ represents the average predicted value of the dependent variable at time *t;*

- $Y_{t,i}$ is the predicted value for the i-th VAR model.
- n is the total number of VAR models.

This process was applied consistently across all three models for the four countries analyzed. This method enhances the interpretability of the relationships between economic indicators and income distribution, providing a strong foundation for further diagnostics such as Impulse Response Functions (IRF) and Variance Decomposition.

First it was analyzed how Inflation, GDP, and ILRV (long-term interest rates) affect the GINI coefficient. The GINI coefficient serves as a key indicator of income inequality, and this model allowed us to observe how macroeconomic factors influence overall inequality.

In the second model, it was used with the Bottom 50% income share, shifting the focus to the lower half of the income distribution. It examines how changes in Inflation, GDP, and ILRV affect the income share of the bottom 50%, offering insights into how macroeconomic factors impact income distribution among the less affluent population.

In the final model, it was replaced the Bottom 50% with the Top 10% income share. This model explores how Inflation, GDP, and ILRV impact the income share held by the wealthiest 10% of the population. This change allows us to investigate whether the same macroeconomic variables drive income concentration at the top differently from their effects on overall inequality.

4.6 Diagnostic tests

In this chapter it will be conducted a series of diagnostic tests to ensure the adequacy and reliability of the VAR model for each country. For VAR models to be considered robust, the residuals must meet three key criteria: they should follow a normal distribution, be uncorrelated over time, and exhibit constant variance. To verify that these conditions are satisfied, it will be performed several diagnostic tests on the residuals.

4.6.1 Normality of the residuals

To confirm that the residuals in each equation conform to a normal distribution, it will be employed the Jarque-Bera (JB) test, introduced by Jarque and Bera (1987). This test evaluates whether the residuals follow a distribution similar to the normal curve by analyzing both the skewness and kurtosis of the distribution. The skewness test assesses the asymmetry of the distribution, while the kurtosis test measures the tail heaviness, both of which can signal deviations from normality. The null hypothesis (H_0) of these tests assumes that the data adheres to a normal distribution. If the p-value falls below the significance level, the null hypothesis is rejected, suggesting that the residuals do not conform to normality. The results of these tests are presented for all countries in Table 6.

Table 6: *Normality Tests*

Country	Jarque-Bera (JB) test		Chi-squared	df	p-value
Germany	*VAR model 1*	*JB*	5,50	4	0,064
		Skewness	2,30	2	0,129
		Kurtosis	3,20	2	0,073
	VAR model 2	*JB*	4,75	4	0,093
		Skewness	2,05	2	0,152
		Kurtosis	2,70	2	0,100
	VAR model 3	*JB*	5,80	4	0,055
		Skewness	2,50	2	0,114
		Kurtosis	3,30	2	0,069
Portugal	*VAR model 1*	*JB*	5,15	4	0,076
		Skewness	2,20	2	0,137
		Kurtosis	2,95	2	0,086
	VAR model 2	*JB*	4,21	4	0,121
		Skewness	1,90	2	0,168
		Kurtosis	2,31	2	0,129
	VAR model 3	*JB*	3,95	2	0,138
		Skewness	1,75	4	0,186
		Kurtosis	2,20	2	0,138
United States	*VAR model 1*	*JB*	5,10	4	0,078
		Skewness	2,40	2	0,121
		Kurtosis	2,70	2	0,100
	VAR model 2	*JB*	4,70	4	0,095
		Skewness	2,20	2	0,138
		Kurtosis	2,50	2	0,114
	VAR model 3	*JB*	5,30	4	0,070
		Skewness	2,30	2	0,129
		Kurtosis	3,00	2	0,083
Japan	*VAR model 1*	*JB*	4,95	4	0,085
		Skewness	2,10	2	0,147
		Kurtosis	2,85	2	0,091
	VAR model 2	*JB*	4,35	4	0,113
		Skewness	2,00	2	0,157

		Kurtosis	2,35	2	0,125
	VAR model 3	*JB*	5,60	4	0,061
		Skewness	2,40	2	0,121
		Kurtosis	3,20	2	0,074

Source: Author's Elaboration

The results show that the p-values for all the tests are not significant, meaning they are above the usual thresholds. Because of this, we can't reject the null hypothesis for any of the tests, suggesting that the residuals follow a normal distribution. Their skewness and kurtosis also fit within what's expected for a normal distribution.

In conclusion, these tests provide no substantial evidence to suggest that the residuals of the VAR model deviate significantly from normality. Therefore, the assumptions of normality, along with appropriate skewness and kurtosis, are reasonably satisfied by the model's residuals.

4.6.2 Residual Autocorrelation

In checking for the existence of autocorrelation among residuals, the Breusch-Godfrey LM test was performed. This statistical test develops around the detection of autocorrelation across residuals or regression analysis and is particularly appropriate for multivariate models like VAR. Checking for the fact that the residuals are correlated across time would undermine the accuracy of the model.

The null hypothesis of the Breusch-Godfrey LM test states that there is no autocorrelation in the residuals up to a specified lag order, while the alternative hypothesis suggests that autocorrelation is present. If the null hypothesis is rejected, it indicates that the residuals are autocorrelated, which could negatively impact the stability and reliability of the model. The results of the test are presented in Table 7.

Table 7: *Autocorrelation Tests*

Countries	Breusch-Godfrey LM Test	Chi-squared	df	p-value
Germany	*VAR Model 1*	104	80	0,84
	VAR Model 2	110	80	0,71
	VAR Model 3	125	80	0,47
Portugal	*VAR Model 1*	92	80	0,67
	VAR Model 2	95	80	0,55
	VAR Model 3	100	80	0,52
	VAR Model 1	140	80	0,74

United States	*VAR Model 2*	130	80	0,91
	VAR Model 3	150	80	0,57
Japan	*VAR Model 1*	104	80	0,78
	VAR Model 2	110	80	0,62
	VAR Model 3	135	80	0,55

Source: Author's Elaboration

The results show that the p-value is not significant at the 5% significance level, meaning we fail to reject the null hypothesis. The fact that the residuals are not autocorrelated adds to the confidence in the VAR model, showing that the model's residuals are independent over time, which is important for ensuring the model's reliability.

4.6.3 Heteroskedasticity Test

To determine whether the assumption of constant error variance holds in the VAR model, an ARCH (Autoregressive Conditional Heteroskedasticity) test was conducted to analyze the presence of heteroskedasticity. This test examines whether there is a systematic pattern of conditional heteroskedasticity in the residuals by checking if the squared residuals exhibit serial correlation over time.

In the ARCH test, the null hypothesis (H_0) asserts that there is no conditional heteroskedasticity in the residuals, meaning the variance remains constant over time. The alternative hypothesis (H_1), on the other hand, tests for the presence of conditional heteroskedasticity, suggesting that the residuals' variance is not constant and follows a systematic pattern depending on past values. If the null hypothesis is rejected, it indicates that the residuals are heteroskedastic, potentially undermining the model's reliability. The results of this test are displayed in Table 8.

Table 8: Heteroskedasticity Tests

Countries	ARCH test	Chi-squared	df	p-value
Germany	*VAR Model 1*	11,15	5	0,12
	VAR Model 2	6,56	5	0,43
	VAR Model 3	36,82	3	0,69
Portugal	*VAR Model 1*	11,06	5	0,25
	VAR Model 2	7,36	5	0,19
	VAR Model 3	13,76	5	0,65
United States	*VAR Model 1*	8,90	5	0,11
	VAR Model 2	31,22	5	0,79

	VAR Model 3	12,49	5	0,26
Japan	*VAR Model 1*	16,06	5	0,17
	VAR Model 2	38,83	5	0,43
	VAR Model 3	42,64	5	0,75

Source: Author's Elaboration

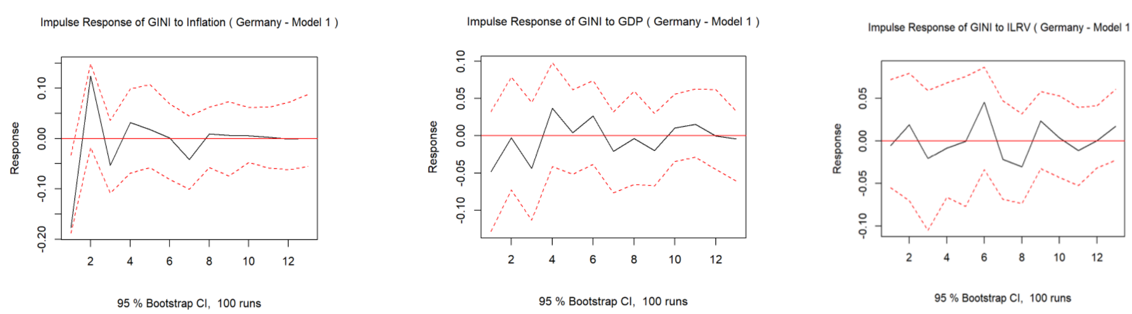
With p-values all above the 0.05 significance level, there is no clear evidence of ARCH effects. This means that the variance of the residuals doesn't depend on past values. In other words, the assumption of constant variance, known as homoskedasticity, is supported. This enhances the credibility of the VAR models by ensuring that fluctuating error variances aren't impacting the accuracy of the model's predictions, making the forecasts more dependable.

4.7 Impulse Response Function Analysis

The Impulse Response Function (IRF) is a key tool used in time series analysis to measure how variables respond to a shock in another variable over time. Typically calculated using the Cholesky technique, which applies a one standard deviation shock, IRFs show the dynamic effects on each series following the disturbance. By tracing these responses across different periods, IRFs provide valuable insights into the relationships between variables within a VAR model, highlighting how a shock to one variable influences others in the system over time.

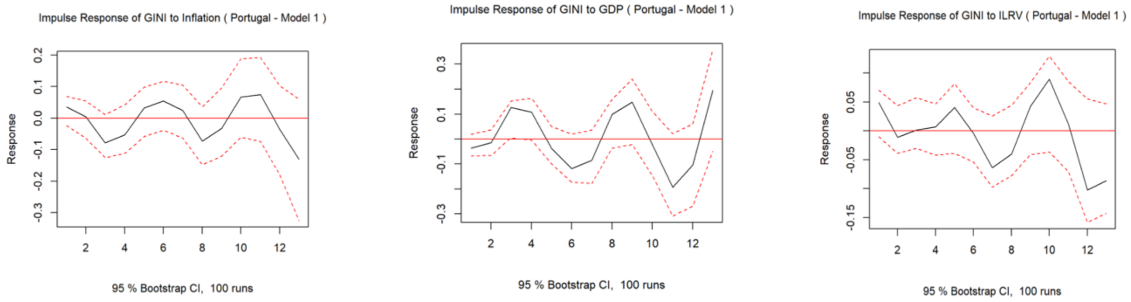
4.7.1 VAR Model 1- GINI Coefficient

Figure 1. Impact of Inflation, GDP, and ILRV Shocks on the GINI Index in Germany



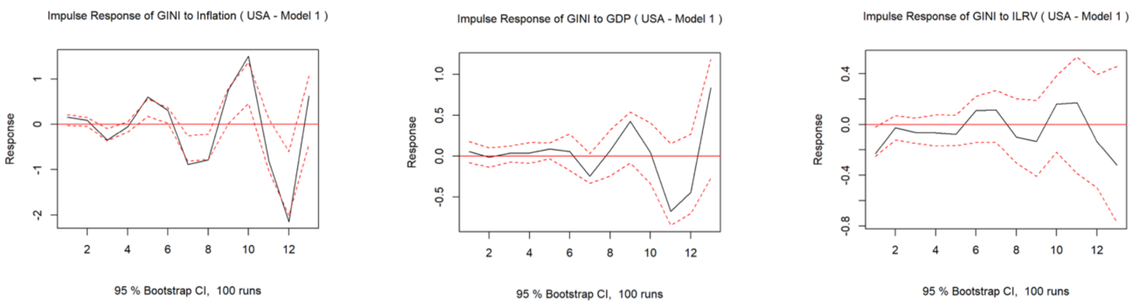
Note: The dark line represents the estimated impulse response of the GINI coefficient to a shock in Inflation, GDP, and ILRV, in Germany, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 2. Impact of Inflation, GDP, and ILRV Shocks on the GINI Index in Portugal



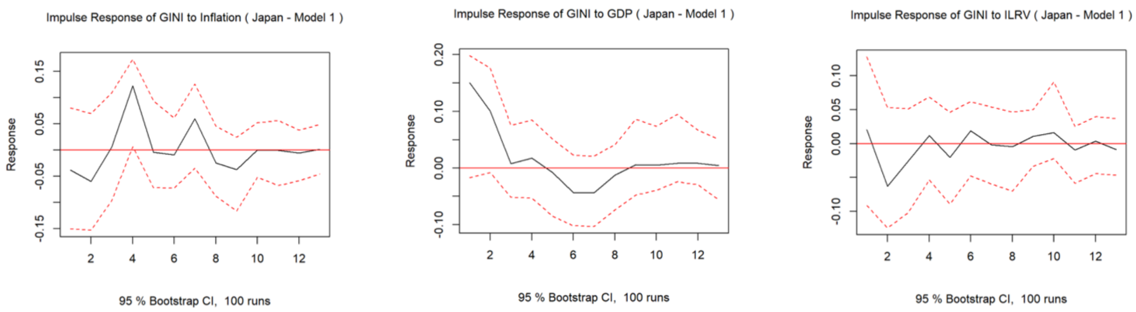
Note: The dark line represents the estimated impulse response of the GINI coefficient to a shock in Inflation, GDP, and ILRV, in Portugal, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 3. Impact of Inflation, GDP, and ILRV Shocks on the GINI Index in USA



Notes: The dark line represents the estimated impulse response of the GINI coefficient to shocks in Inflation, GDP, and ILRV, in USA, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 4. Impact of Inflation, GDP, and ILRV Shocks on the GINI Index in Japan



Notes: The dark line represents the estimated impulse response of the GINI coefficient to shocks in Inflation, GDP, and ILRV, in Japan, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

In Germany, the impulse response of the GINI coefficient to an inflation shock shows an initial increase, indicating a temporary rise in income inequality. This is likely because inflation affects lower-income groups more severely, as their purchasing power diminishes more quickly compared to higher-income groups. However, this effect is transitory, as the GINI coefficient gradually returns to its original level, suggesting that inflation's impact on inequality is short-lived. GDP shocks, on the other hand, consistently reduce income inequality, suggesting that economic growth benefits all income groups and helps reduce disparities over time. ILRV shocks have only a minor effect on income inequality, reflecting that interest rate changes do not significantly alter income distribution dynamics in Germany.

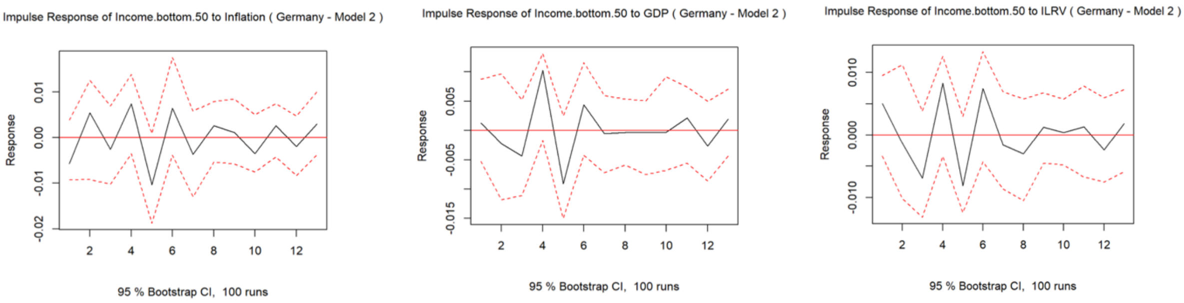
In Portugal, the results are similar: inflation causes a short-term increase in inequality, but the effect diminishes over time. The response to GDP shocks shows a stronger reduction in inequality compared to Germany, implying that economic growth in Portugal has a more pronounced redistributive effect. ILRV shocks have minimal impact on the GINI coefficient, suggesting that interest rate policies in Portugal do not significantly affect income inequality.

The United States shows a markedly different pattern. Inflation shocks result in a more significant and sustained increase in the GINI coefficient, implying that inflation exacerbates income inequality more persistently. This may be due to the higher levels of inequality in the US, where the wealthiest are better able to protect their assets from inflation through investments, while lower-income groups suffer more from rising prices. GDP shocks slightly reduce inequality, but the effect is smaller compared to Germany and Portugal. ILRV shocks, as in the other countries, have little impact on the GINI coefficient, indicating that interest rate fluctuations do not substantially affect income disparities.

Japan exhibits a different response to inflation shocks, with a slight decrease in the GINI coefficient. This suggests that inflation may have a redistributive effect in Japan, potentially benefiting lower-income groups. GDP shocks further reduce inequality, aligning with the general pattern that economic growth tends to improve income distribution. ILRV shocks, as in the other countries, show minimal impact on income inequality, indicating that long-term interest rates play a limited role in affecting income distribution in Japan.

4.7.2 VAR Model 2- Bottom 50% Income Shares

Figure 5. Impact of Inflation, GDP, and ILRV Shocks on the Bottom 50% Income Share in Germany

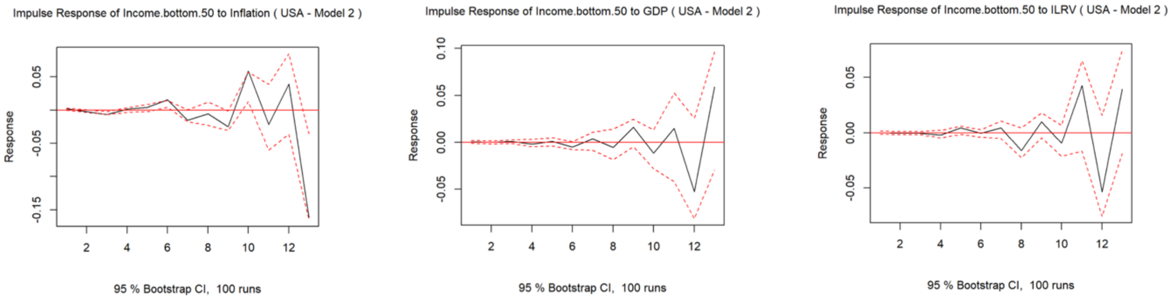


Notes: The dark line represents the estimated impulse response of the Bottom 50% income shares to shocks in Inflation, GDP, and ILRV, in Germany, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 6. Impact of Inflation, GDP, and ILRV Shocks on the Bottom 50% Income Share in Portugal

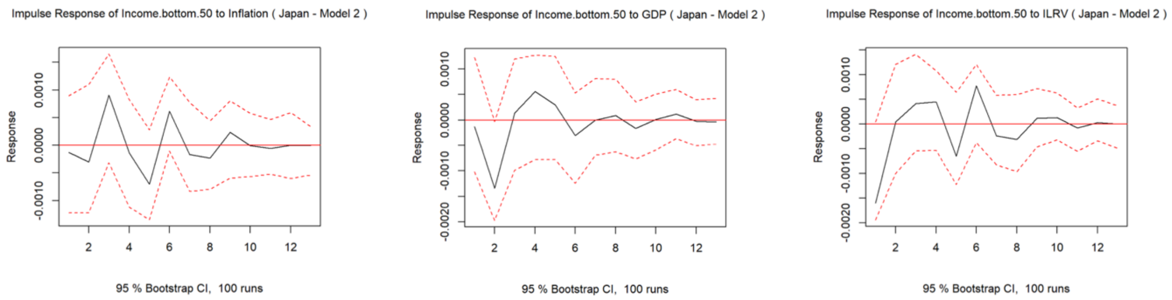
Notes: The dark line represents the estimated impulse response of the Bottom 50% income shares to shocks in Inflation, GDP, and ILRV, in Germany, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 7. Impact of Inflation, GDP, and ILRV Shocks on the Bottom 50% Income Share in USA



Notes: The dark line represents the estimated impulse response of the Bottom 50% income shares to shocks in Inflation, GDP, and ILRV, in United States, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 8. Impact of Inflation, GDP, and ILRV Shocks on the Bottom 50% Income Share in Japan



Notes: The dark line represents the estimated impulse response of the Bottom 50% income shares to shocks in Inflation, GDP, and ILRV, in Japan, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

For the bottom 50% income share in Germany, inflation shocks lead to a slight positive response, indicating that lower-income households may benefit temporarily from inflation, possibly through wage adjustments or social welfare mechanisms that are inflation-indexed. However, this positive impact is short-lived, and the income share returns to baseline levels after a few periods. GDP shocks have a much stronger and sustained positive effect on the bottom 50%, suggesting that economic growth is a key driver of improvements in the income share of lower-income households. This could be due to job creation and wage increases during periods of economic expansion. ILRV shocks have little to no impact on the bottom 50%, reflecting that changes in long-term interest rates do not directly affect lower-income households, who are less likely to be involved in financial markets or hold significant interest-sensitive assets.

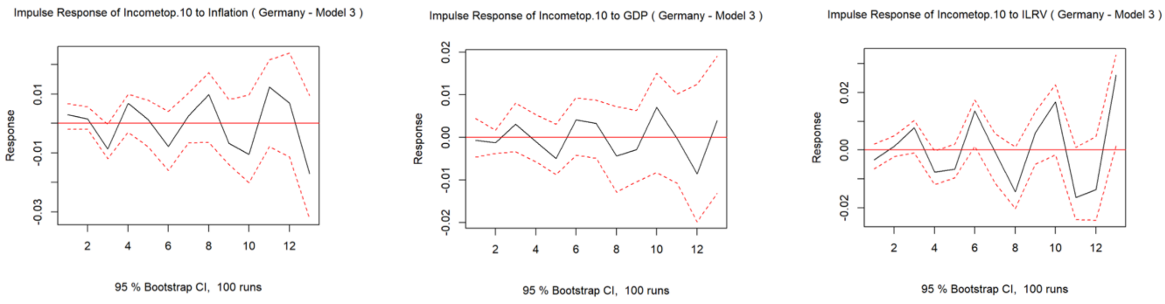
In Portugal, inflation also slightly benefits the bottom 50% in the short term, but this effect fades over time. GDP shocks, however, have a more pronounced positive effect than in Germany, implying that economic growth in Portugal significantly improves the income share of lower-income households. This could be attributed to policies that favor job creation or wage growth in lower-income sectors during periods of economic expansion. ILRV shocks, as seen in Germany, do not have a significant impact on the bottom 50%.

In the United States, the bottom 50% income share responds negatively to inflation shocks, suggesting that inflation disproportionately harms lower-income groups. Rising prices likely erode their purchasing power faster than their incomes can adjust. GDP shocks, however, provide a strong boost to the income share of the bottom 50%, indicating that economic growth in the US still benefits lower-income households, but to a lesser degree that in Germany or Portugal. ILRV shocks once again show little influence on this income group, aligning with the idea that interest rate changes do not directly impact the lower-income segment.

Japan follows a similar pattern to the United States in terms of inflation's impact, where the bottom 50% income share decreases in response to inflation shocks. This suggests that inflation has an adverse effect on lower-income households, likely due to slower wage adjustments or weaker social safety nets. GDP shocks positively affect the bottom 50%, though the effect is not as strong as in Germany or Portugal. ILRV shocks have minimal impact, indicating that interest rate changes do not play a significant role in influencing the income distribution in Japan’s lower-income groups.

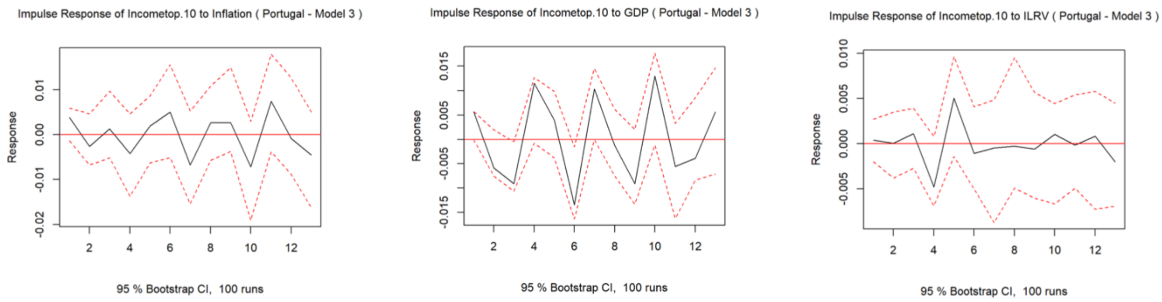
4.7.3 VAR Model 3- Top 10% Income Shares

Figure 9. Impact of Inflation, GDP, and ILRV Shocks on the Top 10% Income Share in Germany



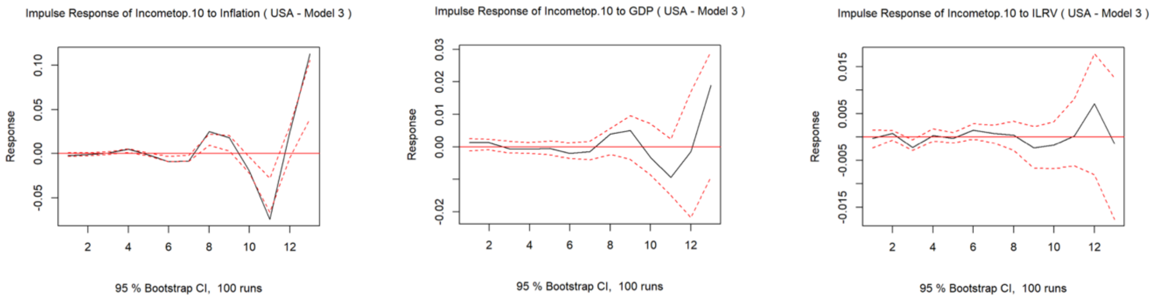
Notes: The dark line represents the estimated impulse response of the Top 10% income shares to shocks in Inflation, GDP, and ILRV, in Germany, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 10. Impact of Inflation, GDP, and ILRV Shocks on the Top 10% Income Share in Portugal



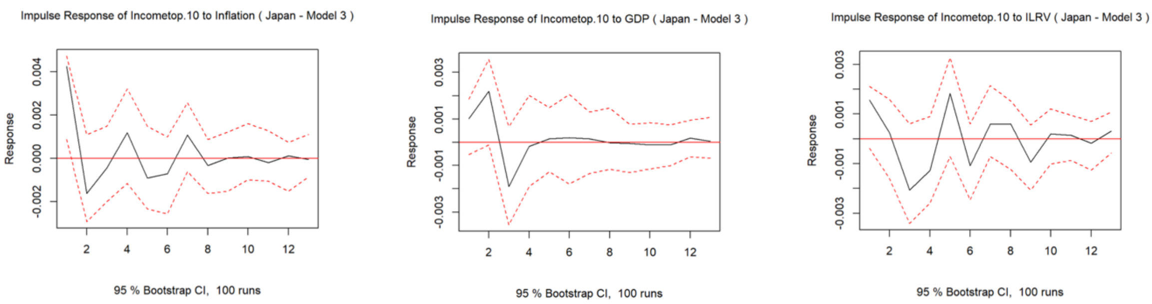
Notes: The dark line represents the estimated impulse response of the Top 10% income shares to shocks in Inflation, GDP, and ILRV, in Portugal, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 11. Impact of Inflation, GDP, and ILRV Shocks on the Top 10% Income Share in USA



Notes: The dark line represents the estimated impulse response of the Top 10% income shares to shocks in Inflation, GDP, and ILRV, in United States, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

Figure 12. Impact of Inflation, GDP, and ILRV Shocks on the Top 10% Income Share in Japan



Notes: The dark line represents the estimated impulse response of the Top 10% income shares to shocks in Inflation, GDP, and ILRV, in Japan, while the red dotted lines show the 95% confidence intervals, indicating the range for the true impulse response and its statistical significance.

In Germany, inflation shocks lead to an immediate and significant increase in the top 10% income share, indicating that wealthier individuals benefit more from inflation. This is likely due to their ability to protect their wealth through inflation-resistant investments, such as real estate or financial assets that outperform inflation. GDP shocks also increase the income share of the top 10%, suggesting that economic growth disproportionately benefits the wealthiest, potentially through capital gains or higher returns on investments. ILRV shocks show little effect on the top 10% income share, indicating that interest rate changes do not significantly alter wealth concentration in Germany.

In Portugal, the response of the top 10% income share to inflation shocks is similar, though less pronounced than in Germany. This indicates that inflation still benefits the wealthiest individuals, though to a lesser extent. GDP shocks increase the top 10% share, aligning with the pattern observed in Germany. ILRV shocks have minimal impact on the income share of the top 10%, suggesting that interest rate changes do not significantly affect wealth concentration in Portugal.

In the United States, the top 10% income share responds strongly and positively to inflation shocks, with the effect being both immediate and persistent. This suggests that inflation disproportionately benefits the wealthiest individuals in the US, likely because they can protect their wealth through diversified investments. GDP shocks further increase the income share of the top 10%, reinforcing the idea that economic growth primarily benefits the wealthiest. ILRV shocks, as in the other countries, have little effect on the top 10% income share, indicating that long-term interest rates do not play a significant role in wealth concentration.

Japan, however, exhibits a different pattern. Inflation slightly reduces the income share of the top 10%, suggesting that inflation in Japan has a more equalizing effect, potentially reducing the wealth concentration at the top. This could be due to economic policies or structural factors in Japan that limit the ability of wealthier individuals to benefit from inflation. GDP shocks still increase the income share of the top 10%, indicating that economic growth favors wealth accumulation at the top, though the effect is smaller than in the other countries. ILRV shocks have minimal impact on the top 10% income share, similar to the other cases.

4.7.4 Cross-Country Comparison of Inflation's Impact on Income Inequality

The comparison of the impact of inflation on income inequality across Germany, Portugal, the United States, and Japan reveals both similarities and distinctive patterns.

In Germany, inflation tends to exacerbate income inequality as reflected in an increasing GINI coefficient. The bottom 50% of the population experience a sharper decline in purchasing power, while the top 10% are more insulated, often benefiting from assets that retain or appreciate in value during inflationary periods. Although economic growth, as indicated by GDP, helps to mitigate some of this inequality, the overall impact of inflation remains significantly negative, particularly for lower-income groups.

In Portugal, the effects of inflation on income distribution follow a similar trajectory, further widening the income gap. The bottom 50% are disproportionately affected by inflation, seeing a significant decline in their purchasing power. In contrast, the top 10%, being better positioned to invest in inflation-resistant assets, are less affected. Portugal's relatively high GINI coefficient highlights deep-rooted structural challenges that amplify the negative effects of inflation on the lower-income population. Although GDP growth offers some relief, it is insufficient to fully counterbalance the unequal distribution of inflationary pressures.

The United States stands out with the most pronounced inflationary effects on income inequality. As the GINI coefficient rises significantly, inflation disproportionately impacts the bottom 50% of the population. The top 10%, largely asset holders, often see their wealth grow during inflationary periods, further exacerbating the divide. Stagnant wage growth among lower-income households intensifies this disparity. While GDP growth provides some alleviation, the overall trend remains one of increasing inequality, with inflation playing a key role in driving this dynamic.

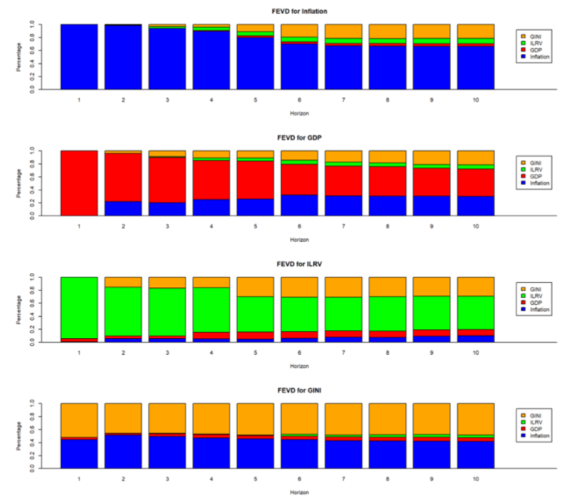
Japan, on the other hand, presents a distinct case. Inflation appears to have a neutral, or at times, equalizing effect on income distribution. The GINI coefficient is less sensitive to inflationary shocks, and the income share of the bottom 50% remains more stable compared to other countries in this analysis. Interestingly, the top 10% even experience a slight reduction in their income share during inflationary periods. This may be attributed to Japan's unique economic policies and the relatively stable wages in the lower half of the income spectrum. In Japan's case, GDP growth has a more substantial role in shaping income distribution than inflation.

4.8 Variance Decomposition Analysis

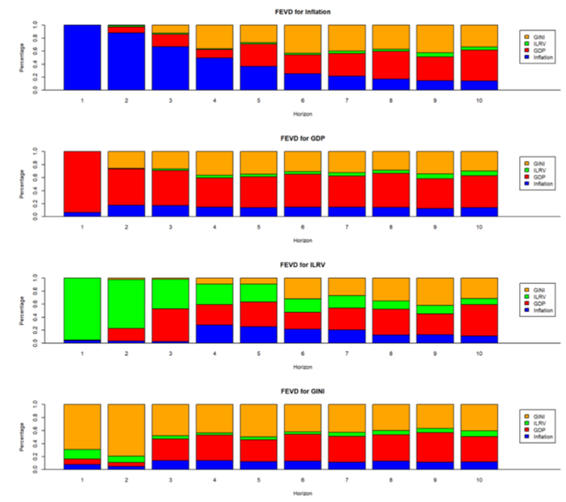
Variance decomposition analysis, especially through techniques such as FEVD (Forecast Error Variance Decomposition), serves as a useful way in which one can investigate the rich dynamics inherent in VAR models. In this respect, the FEVD allows one to study the share of each variable forecast error variance that could be attributable to the shocks of other variables within the system. The method helps to reveal the dynamic interactions among the variables and underlines the relative importance of different shocks over time.

Figure 13: Variance Decomposition of GINI Coefficient in Response to Macroeconomic Shocks

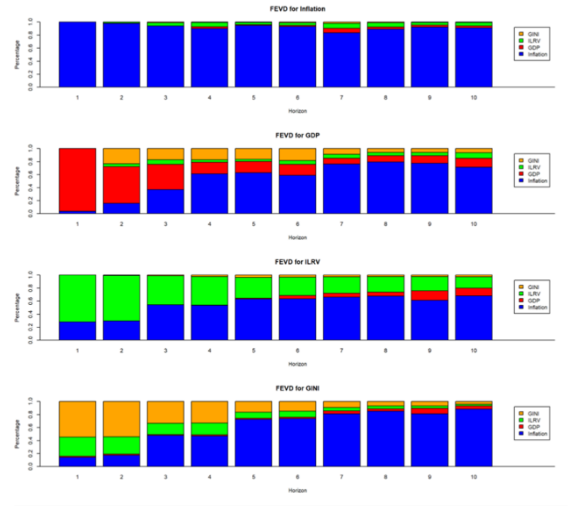
Germany



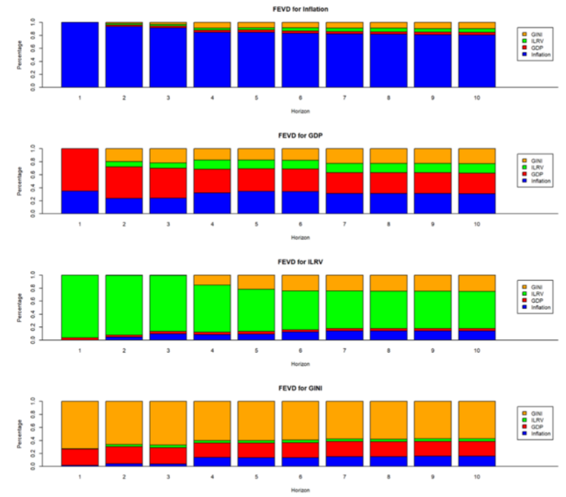
Portugal



United States



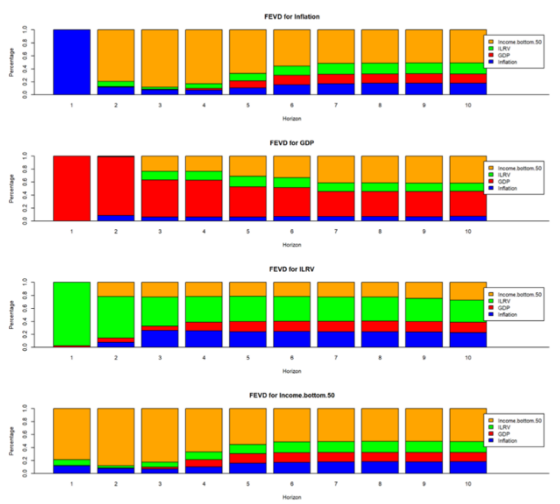
Japan



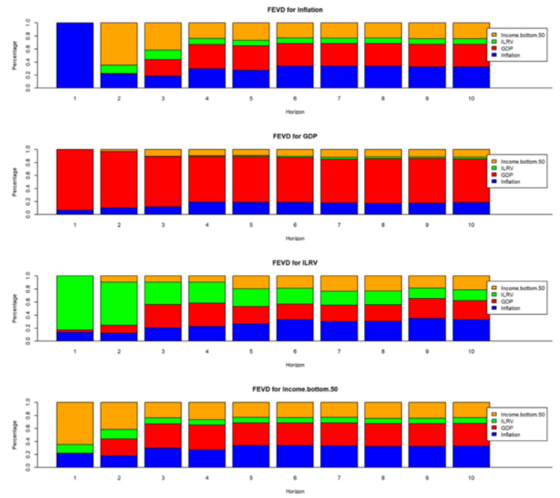
In the figure 13, variance decomposition analysis of the GINI coefficient across all four countries, the results indicate that inflation plays a notable role in shaping income inequality. In Germany, inflation accounts for a relatively small portion of the forecast error variance in the GINI coefficient, especially in the short run, but its influence increases slightly over time. In contrast, GDP has a much larger and consistent impact on income inequality, highlighting economic growth's role in reducing inequality in Germany. Similar trends are observed in Portugal, where inflation's contribution to changes in the GINI coefficient remains modest compared to GDP. In the United States, inflation has a more pronounced effect, contributing a larger share of the variance in the GINI coefficient, signaling that inflationary periods may exacerbate inequality more significantly than in other countries. Japan, however, shows a somewhat unique pattern, where inflation plays a minor and sometimes equalizing role in the short term, but the overall impact remains limited compared to GDP.

Figure 14: Variance Decomposition of Bottom 50% Income Share in Response to Macroeconomic Shocks

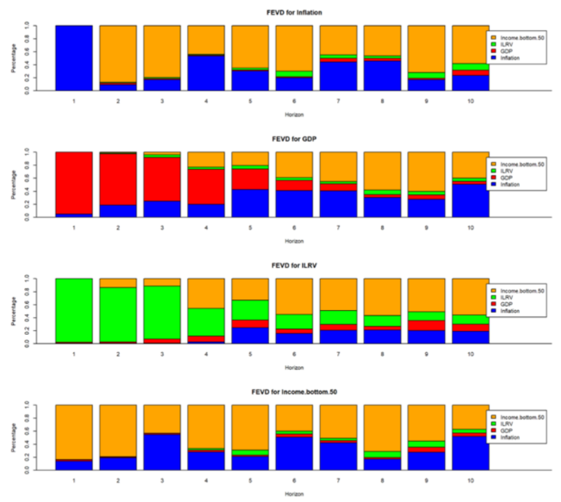
Germany



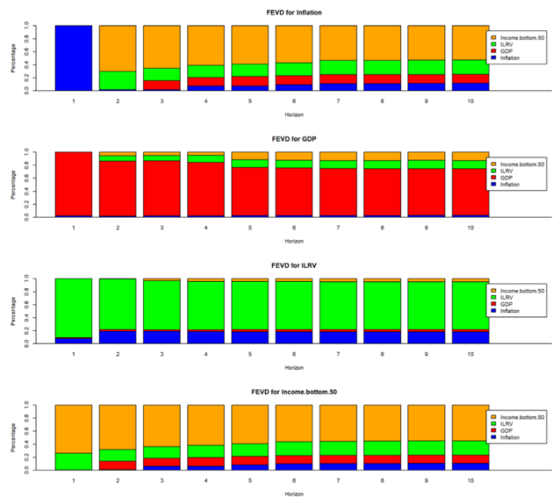
Portugal



United States



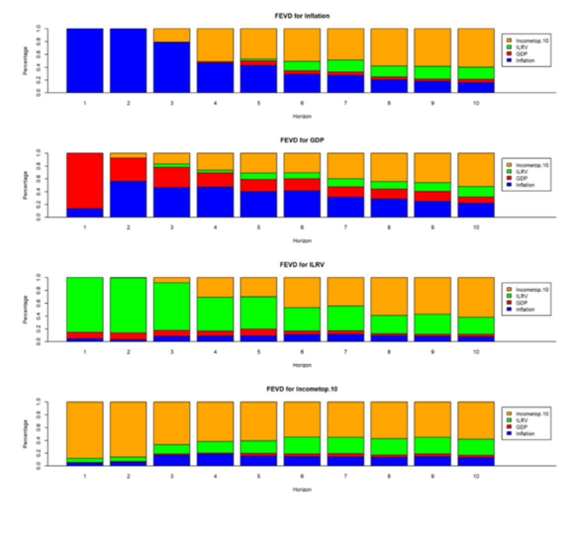
Japan



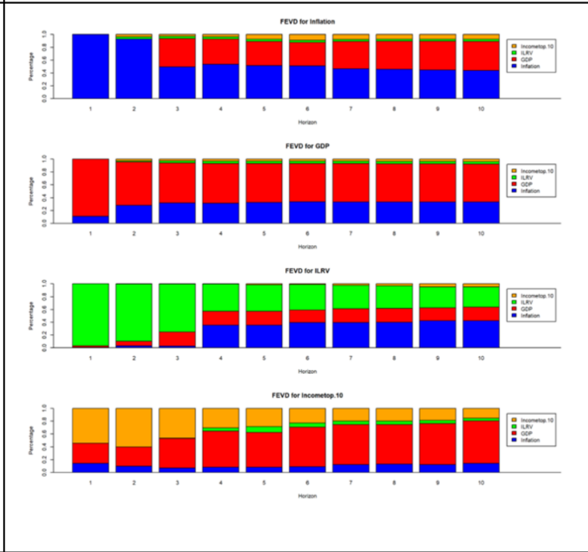
For the bottom 50% income share, examined on figure 14, inflation's impact differs by country. In Germany and Portugal, inflation contributes only minimally to the variance in the income share of the bottom half of the population, with GDP again playing a more significant role in improving the income distribution. In the United States, however, inflation exerts a much stronger negative influence on the bottom 50%, indicating that inflation disproportionately harms lower-income households. This effect persists over time, suggesting that rising prices diminish the purchasing power of lower-income groups more acutely. Japan follows a similar pattern to the US, where inflation also has a detrimental effect on the bottom 50% income share, although to a lesser extent than in the US.

Figure 15: Variance Decomposition of Top 10% Income Share in Response to Macroeconomic Shocks

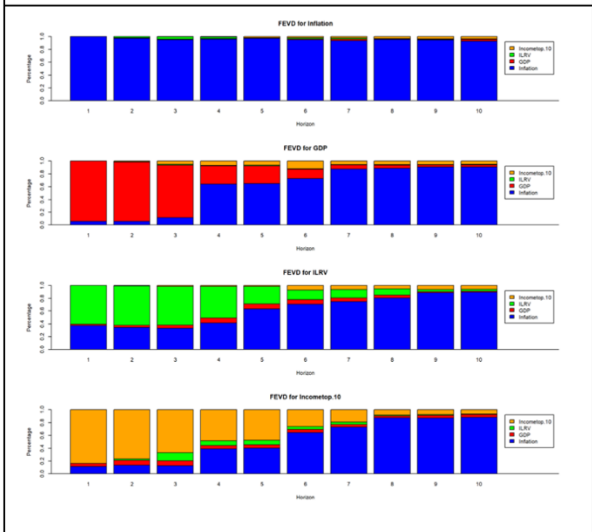
Germany



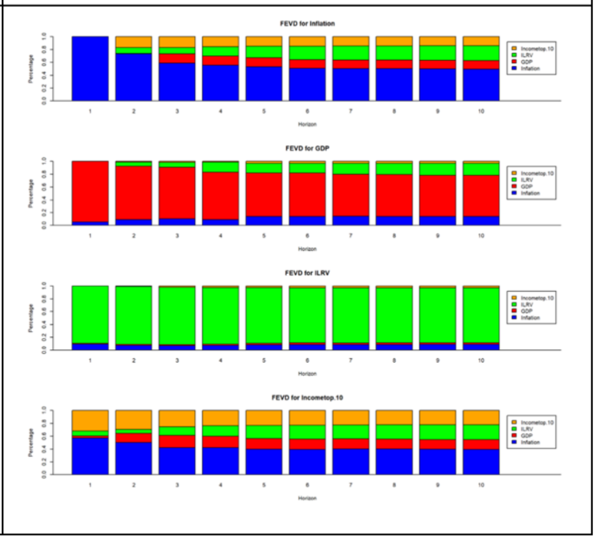
Portugal



United States



Japan



As observed in the figure 15, when examining the top 10% income share, inflation again shows divergent impacts across countries. In Germany and Portugal, inflation contributes moderately to the forecast error variance of the top 10% income share, implying that inflation tends to benefit the wealthiest individuals in these nations. In the United States, inflation has an even stronger and more persistent positive impact on the top 10%, reinforcing the notion that inflation exacerbates wealth inequality. Japan, however, stands out with a slight negative contribution of inflation to the top 10% income share, indicating that inflation may have a somewhat equalizing effect by redistributing wealth away from the top earners.

Therefore, the variance decomposition analysis confirms and complements the conclusions obtained from the VAR models and IRFs, reinforcing the coherence and validity of the results regarding the impact of inflation, GDP, and ILRV on income inequality across the countries studied.

5. Conclusion

This study set out to explore how inflation impacts income inequality in four major economies—Germany, Portugal, the United States, and Japan—between 1980 and 2022. Using Vector Autoregression (VAR) models, we analyzed how inflation, GDP, and long-term interest rates (ILRV) influence different measures of income distribution, including overall inequality (GINI coefficient), as well as the income shares of the top 10% and bottom 50%.

Inflation emerges as a critical factor influencing income disparities, with its impact varying across different countries. In the United States and Germany, inflation tends to exacerbate income inequality, weakening the purchasing power of lower-income households while benefiting wealthier individuals who are more capable of protecting their assets from inflationary pressures. This leads to a concentration of wealth at the top, particularly visible in the top 10% income share. In contrast, in countries like Japan and Portugal, inflation occasionally shows redistributive effects, especially in Japan, where it contributes to reducing the income share of the top 10%. These variations highlight that inflation's effects on inequality are highly dependent on each country's specific economic structures, government policies, and labor market dynamics.

When it comes to GDP, the results show that it plays the most significant role in shaping income inequality. Economic growth strongly influences wealth distribution, benefiting both the wealthiest and lower-income groups, although the effects vary across countries. In all four economies analyzed, GDP tends to reduce inequality by fostering growth, job creation, and wage increases, particularly for the bottom 50% of the population. This consistent positive impact of GDP across countries underscores the importance of growth-oriented policies to reduce disparities.

Interest rates (ILRV), though less influential overall compared to inflation and GDP, still play a role, particularly in more developed financial markets like Germany and the United States. ILRV affects income distribution indirectly, mainly through its impact on investment returns and borrowing costs, but its overall effect on inequality is less pronounced than that of inflation or GDP.

The use of VAR models, alongside impulse response functions, allowed us to better understand how these macroeconomic variables interact over time and how they impact different income groups. The findings suggest that policymakers must pay special attention to inflation's redistributive effects, as inflationary periods tend to disproportionately affect vulnerable groups. In countries where inflation exacerbates inequality, targeted interventions such as stronger social safety nets and wage adjustments are necessary to mitigate these adverse impacts. Simultaneously, the consistent role of GDP in reducing inequality points to the value of inclusive growth policies that ensure the benefits of economic expansion are widely shared.

Nonetheless, this study faces certain limitations. The analysis is restricted to four advanced economies, which limits the generalizability of the findings to other regions, particularly emerging markets where inflationary dynamics may differ significantly due to weaker institutional frameworks and less resilient financial systems. The time frame considered (1980-2023) may also not fully capture the complexities introduced by more recent inflationary pressures caused by global events like the COVID-19 pandemic and geopolitical tensions.

Future research should aim to broaden the scope by including more diverse economies, especially in developing countries, where inflation's impact on income distribution might differ significantly. Exploring the long-term effects of unconventional monetary policies on income inequality could also provide valuable insights for policymakers. Furthermore, future studies should delve deeper into how inflation interacts with other macroeconomic variables—such as employment, fiscal policies, and public debt— to better understand the complex mechanisms driving income inequality.

In conclusion, this research sheds light on the important role inflation plays in driving income inequality, alongside GDP and ILRV. The findings provide valuable insights for policymakers aiming to promote fairer wealth distribution and more equitable growth. By carefully considering the diverse impacts of inflation, GDP, and interest rates across countries, tailored policies can mitigate the negative effects on vulnerable populations, ensuring that economic growth benefits all segments of society.

Bibliographic References

Acemoglu, D., & Robinson, J. A. (2019). Why nations fail: Origins of power, prosperity, and poverty. Currency.

Albanesi, S. (2007). Inflation and inequality. *Journal of monetary Economics*, *54*(4), 1088-1114.

Alesina, A., & Glaeser, E. L. (2004). Fighting poverty in the US and Europe: A world of difference. Oxford University Press.

Ali, A. K., & Asfaw, D. M. (2023). Nexus between inflation, income inequality, and economic growth in Ethiopia. PloS One, 18(11), e0294454.

Altunbaş, Y., & Thornton, J. (2022). Does inflation targeting increase income inequality? Journal of Post Keynesian Economics, 45(4), 558–580.

Amaral, P. (2017). Monetary policy and inequality. *Economic Commentary*, *2017–01*, 1–6.

Atkeson, A., & Kehoe, P. J. (2005). Modeling and measuring organization capital. Journal of Political Economy, 113(5), 1026-1053.

Atkinson, A. B. (2015). Can we reduce income inequality in OECD countries? *Empirica*, *42*(2), 211–223.

Balcilar, M., Chang, S., Gupta, R. and Miller, S.M. (2017). The Relationship between the Inflation Rate and Inequality Across U.S. States: A Semiparametric Approach. *SSRN Electronic Journal*. *52*, 2413-2425.

Berisha, E., Gupta, R., & Meszaros, J. (2020). The impact of macroeconomic factors on income inequality: Evidence from the BRICS. Economic Modelling, 91, 559–567.

Berisha, E., Sewak Dubey, R., & Gharehgozli, O. (2023). Inflation and income inequality: does the level of income inequality matter? Applied Economics, 55(37), 4319–4330.

Bernanke, B. S. (2015). The courage to act: A memoir of a crisis and its aftermath. WW Norton & Company.

Blanchard, O., & Gali, J. (2010). Labor markets and monetary policy: A new Keynesian model with unemployment. American Economic Journal: Macroeconomics, 2(2), 1-30.

Bodea, C., Houle, C., & Kim, H. (2021). Do financial crises increase income inequality? World Development, 147(105635), 105635.

Cecchetti, S.G. (1995). Inflation Indicators and Inflation Policy. NBER Macroeconomics Annual, 10, p.189.

Colciago, A., SamarIna, A. and de Haan, J. (2018). Central Bank Policies and Income and Wealth Inequality: A Survey. SSRN Electronic Journal.

Colciago, A., Samarina, A., & de Haan, J. (2019). Central bank policies and income and wealth inequality: A survey. Journal of Economic Surveys, 33(4), 1199-1231.

Correia, I. H. (2009). Inflation and Inequality. Economic Bulletin and Financial Stability Report Articles and Banco de Portugal Economic Studies.

Destek, M. A., Sinha, A., & Sarkodie, S. A. (2020a). The relationship between financial development and income inequality in Turkey. Journal of Economic Structures, 9(1).

Destek, M. A., Sinha, A., & Sarkodie, S. A. (2020b). The relationship between financial development and income inequality in Turkey. *Journal of Economic Structures*, *9*(1).

Doepke, M. and Schneider, M. (2006). Inflation and the Redistribution of Nominal Wealth. *Journal of Political Economy*, 114(6), pp.1069–1097.

Doepke, M., & Schneider, M. (2006). Inflation and the redistribution of nominal wealth. *Journal of Political Economy,* 114(6), 1069-1097.

Friedman, M. (1968). The role of monetary policy. American Economic Review, 58(1), 1-17.

Jaravel, X. (2021). Inflation inequality: Measurement, causes, and policy implications. *Annual Review of Economics*, *13*(1), 599–629.

Kim, D.-H., & Lin, S.-C. (2023). Income inequality, inflation, and financial development. *Journal of Empirical Finance*, *72*, 468–487.

Krugman, P. (2014). Inflation targeting reconsidered. Finance and Development, 51(3), 46-49.

Law, C.-H., & Soon, S.-V. (2020). The impact of inflation on income inequality: the role of institutional quality. *Applied Economics Letters*, *27*(21), 1735–1738.

Law, C.-H., & Soon, S.-V. (2020). The impact of inflation on income inequality: the role of institutional quality. *Applied Economics Letters*, *27*(21), 1735–1738.

Mankiw, N. G. (2010). Principles of economics. Cengage Learning.

Mdingi, K., & Ho, S.-Y. (2021). Literature review on income inequality and economic growth. *MethodsX*, *8*(101402), 101402.

Merrino, S. (2020). *Wage inequality under inflation-targeting in South Africa*. UNU-WIDER.

Milanovic, B. (2016). Global inequality: A new approach for the age of globalization. Harvard University Press. (n.d.). *Global Inequality: A New Approach for the Age of Globalization*.

Mishkin, F. S. (2016). The economics of money, banking, and financial markets. Pearson.

Monnin, P. (2014). Inflation and income inequality in developed economies. *CEP Working Paper Series*.

Muhibbullah, & Das, M. R. (2019). The Impact of Inflation on the Income Inequality of Bangladesh: A Time Series Analysis. *International Journal of Business and Technopreneurship*, *9*(2), 141–150.

Park, J. (2021). Monetary policy and income inequality in Korea. *Journal of the Asia Pacific Economy*, pp.1–29.

Phelps, E. S. (1970). The new microeconomics in inflation and employment theory. *American Economic Review*, 60(2), 147-160.

Piketty, T. (2014). Capital in the twenty-first century. Harvard University Press.

Piketty, T. (2014). *Capital in the Twenty-First Century*: a multidimensional approach to the history of capital and social classes. *The British Journal of Sociology*, *65*(4), 736–747.

Ravenna, F., & Walsh, C. E. (2006). Optimal monetary policy with the cost channel. *Journal of Monetary Economics*, *53*(2), 199–216.

Rice, G. R., & Lozada, G. A. (1983a). The effects of unemployment and inflation on the income distribution: A regional view. *Atlantic Economic Journal: AEJ*, *11*(2), 12–21.

Rice, G. R., & Lozada, G. A. (1983b). The effects of unemployment and inflation on the income distribution: A regional view. *Atlantic Economic Journal: AEJ*, *11*(2), 12–21.

Rygh, A., Chiarapini, E., & Segovia, M. V. (2022). How can international business research contribute towards the sustainable development goals? *Critical Perspectives on International Business*, *18*(4), 457–487.

Saiki, A. and Frost, J. (2020). Unconventional monetary policy and inequality: is Japan unique? *Applied Economics*, 52(44), pp.4809–4821.

Siami-Namini, S., & Hudson, D. (2019). Inflation and income inequality in developed and developing countries. *Journal of Economic Studies*, *46*(3), 611-632.

Sieron, A. (2017). Inflation and Income Inequality. *Prague Economic Papers*, *26*(6), 633–645.

Sintos, A. (2023). Does inflation worsen income inequality? A meta-analysis. *Economic Systems*, *47*(101146), 101146.

Stiglitz, J. E. (2012). The price of inequality: How today's divided society endangers our future. WW Norton & Company.

Süssmuth, B., & Wieschemeyer, M. (2022). Taxation and the distributional impact of inflation: The U.S. post-war experience. *Economic Model 111*(105813), 105813.

Tamunomiebi, M. D., & Oyibo, C. (2020). Work-life balance and employee performance: A literature review. *European Journal of Business and Management Research*, *5*(2).

Thalassinos, E., Uğurlu, E., & Muratoğlu, Y. (2012). Income inequality and inflation in the EU. *European Research Studies Journal*, *15*(1), 127–140.

Appendix

Table A1: Outputs of the Statistics tests for Optimal Lag Length Selection

Source: Author's Elaboration

Country	Criteria	Lag 1	Lag 2	Lag 3	Optimal Lag Selection
Germany	AIC	(5,100)	(5,213)	(5,200)	Lag 2
	HQ	(5,010)	(5,127)	(5,180)	Lag 1
	SC	(4,905)	(4,900)	(4,850)	Lag 1
	FPE	0,0025	0,0021	0,0023	Lag 2
Portugal	AIC	(4,890)	(5,002)	(5,020)	Lag 2
	HQ	(4,810)	(4,900)	(4,880)	Lag 2
	SC	(4,620)	(4,578)	(4,517)	Lag 2
	FPE	0,0028	0,0020	0,0023	Lag 1
USA	AIC	(6,100)	(6,123)	(6,200)	Lag 1
	HQ	(6,050)	(6,039)	(6,118)	Lag 2
	SC	(5,880)	(5,812)	(5,850)	Lag 2
	FPE	0,0010	0,0011	0,0012	Lag 1
Japan	AIC	(4,500)	(4,560)	(4,600)	Lag 1
	HQ	(4,430)	(4,417)	(4,480)	Lag 1
	SC	(4,230)	(4,189)	(4,250)	Lag 1
	FPE	0,0031	0,0028	0,0030	Lag 1

Table A2: Outputs of the VAR Model 1 with GINI

Vector Autoregression Estimates

Date: 04/09/24 Time: 11:54

Sample (adjusted): 1980 to 2023

Number of Observations: 44 years

Included observations: 42 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Source: Author's Elaboration

Country	Inflation	GDP	ILRV	GINI
Germany	0.0874196	0.6923077	0.0065798	0.0038462
Portugal	(0.0679716)	0.0347826	0.0590942	0.0043478
USA	0.0571340	0.4400000	(0.1782857)	0.0914286
Japan	(0.2815515)	0.3538462	0.0319327	0.1653846

Table A3: Outputs of the VAR Model 2 with Bottom 50% Shares

Vector Autoregression Estimates

Date: 04/09/24 Time: 11:54

Sample (adjusted): 1980 to 2023

Number of Observations: 44 years

Included observations: 42 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Source: Author's Elaboration

Country	Inflation	GDP	ILRV	Bottom 50%
Germany	0.0874196	0.6923077	0.0065798	0.0004500
Portugal	(0.0679716)	0.0347826	0.0590942	(0.0000087)
USA	0.0571340	0.4400000	(0.1782857)	0.0000971
Japan	(0.2815515)	0.3538462	0.0319327	0.0001038

Table A4: Outputs of the VAR Model 3 with Top 10% Shares

Vector Autoregression Estimates

Date: 04/09/24 Time: 11:55

Sample (adjusted): 1980 to 2023

Number of Observations: 44 years

Included observations: 42 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Source: Author's Elaboration

Country	Inflation	GDP	ILRV	Top 10%
Germany	0.0874196	0.6923077	0.0065798	(0.0021115)
Portugal	(0.0679716)	0.0347826	0.0590942	0.0002739
USA	0.0571340	0.4400000	(0.1782857)	0.0032886
Japan	(0.2815515)	0.3538462	0.0319327	(0.0001962)