ASYMMETRIC EFFECTS OF INFLATION ON INCOME INEQUALITY: EVIDENCE FROM THRESHOLD MODELS IN TURKIYE

Nezir KÖSE[1],

[1] Istanbul Beykent University, Faculty of Economics and Administrative Sciences, Department of Economics, İstanbul, Türkiye, nezirkose@beykent.edu.tr, ORCID: 0000-0002-4127-357X

Ali Talih SÜT[2] (Corresponding Author)

[2] Istanbul Beykent University, Faculty of Economics and Administrative Sciences, Department of Economics, İstanbul, Türkiye, talihsut@beykent.edu.tr, ORCID: 0000-0001-8879-3196

ABSTRACT

The main objective of this study is to analyze the asymmetric effects of highly volatile inflation on income inequality in Türkiye between 1990 and 2023. Despite its high growth potential, Türkiye has a fragile economic structure and experienced a period of highly volatile inflation during the specified period. Such volatility may lead to imbalances in income distribution. Empirical studies specifically focusing on the asymmetric effects of inflation on income inequality in Türkiye remain limited. This study seeks to address this gap in the literature. Threshold regression and threshold Structural Vector Autoregression (SVAR) models are employed as suitable methodologies to investigate the relationship between inflation and income inequality. The Bai-Perron (1998) method is employed to determine threshold values, enabling inflation rates to be classified as either low or high, based on the period within the study's scope. The findings reveal a U-shaped relationship between inflation and income inequality, indicating that while low inflation reduces inequality, high and unstable inflation increases it. The study also examines the effects of human capital and economic growth by utilizing various additional variables. It provides general implications and recommendations based on the findings.

Keywords: inflation, income inequality, threshold SVAR, Threshold regression

JEL codes: C22, D63, E31

1. INTRODUCTION

Income groups may react differently to inflation from country to country or over different periods, creating uncertainty in the literature on the subject. Analyses using linear methodology point to three different findings. The first is the studies that find that inflation increases income inequality (e.g., Dollar and Kraay, 2001; Bulir and Gulde, 1995; Scully, 2002; Albanesi, 2007, Beck et al, 2007). These studies mostly state that the destruction of real income caused by inflation affects low-income groups in the country's economy the most. This is based on the assumptions that low-income groups are generally composed of fixed-wage earners and have relatively higher cash holdings relative to income than high-income groups. The second is the studies that find that inflation reduces income inequality (e.g., Blinder and Esaki, 1978; Mocan, 1999; Brandolini and Sestiro, 1994; Heer and Maussner, 2005; Sun, 2011; Maestri and Reoventini, 2012; Coibion et al., 2017). These studies generally draw attention to some special case advantages of the inflationary process for low-income groups. One of these advantages is that the high borrowing tendency in the inflationary process alleviates the debt burden in real terms. In other words, the income holder who borrows at fixed interest rates and in national currency will pay a lower amount

in real terms at maturity in the face of high inflation. Thus, income distribution will improve as there will be an income transfer to the lower income group, which tends to borrow more relative to its income during high inflation. On the other hand, since increased employment opportunities in the face of inflation will lead to an inflation-unemployment trade-off based on the Phillips curve analysis, the lower income group will be positively affected by inflation. It is inevitable that decision units borrowing at fixed market interest rates will be in an advantageous position in the inflationary process in short run. On the other hand, increased employment opportunities in the inflationary process will likely directly affect the low-income group. In addition, studies such as those by Buse (1982), Dobson and Dobson (2010) and Yue (2011) have found that inflation does not affect income distribution. Such linear findings have also shed light on the implications of nonlinear methods. Many studies involving nonlinear methods have emphasized that low inflation and high inflation have different effects on income inequality. However, as with the findings obtained with linear methods, there is no consensus in the literature on the relationship between inflation and income inequality in studies conducted with non-linear methodologies. While some studies have concluded that inflation affects income inequality in a U-shape (e.g., Bulir, 2001; Galli and van der Hoeven, 2001; Balcilar et al., 2018; Alpağut, 2024), some studies have found that the relationship between them is in the form of an inverted U (e.g., Akarsu and Gharehgozli, 2024; Monnin, 2014; Nantob, 2015).

Empirical findings on the impact of inflation on income inequality provide important guidance for policymakers. Although contractionary policies implemented in the fight against inflation are effective in achieving price stability, they can have adverse consequences, especially for low-income groups, and therefore can be considered as a 'bitter recipe'. The direction and severity of the impact of inflation on income inequality depend to a large extent on the overall structure of the economy and the characteristics of the human structure that constitutes income groups. In this context, the impact of inflation on inequality is thought to be closely related to factors such as the level of unemployment, the education level of the labor force, and economic growth. In this study, it is assumed that economic growth is the fundamental indicator of the overall economic structure; the GINI coefficient is the fundamental measure of income inequality; and the unemployment rate and mean years of schooling are the fundamental variables related to the human capital structure. On the other hand, in economies characterized by high inflation volatility, the perspective on these variables is subject to alteration in accordance with the implemented policies. In other words, it is thought that high or low inflation can have an impact on the process, and many studies support this idea. Consequently, it is hypothesized that the level of inflation exerts a significant influence on the relationship between inflation and inequality. In this context, it is observed that there is a gap in the literature in the Türkiye sample. There are many studies in the literature analyzing the effect of inflation on income inequality in Türkiye. These studies are mostly analyzed within the scope of a linear relationship. However, inflation is highly volatile in Türkiye between 1990 and 2023. This volatility is likely to lead to a differentiation in the effect of inflation on income inequality. In this context, this study aims to fill this gap in the literature. In addition to questioning the symmetric/asymmetric effect, this study also questions the effect of education level and unemployment on income inequality and the effect of economic growth on income inequality among the factors affecting human capital. On the other hand, the threshold value of inflation is important for income distribution in terms of determining which rate is considered low or high. In this context, the threshold value is considered to be a signal for policymakers to take action in directing social policies.

The layout of the paper is as follows. In section 2, the literature is briefly reviewed. Section 3 discusses the assumptions and data of the study. In section 4, we discuss the

empirical results from threshold regression and threshold SVAR models. The study ends with the conclusion section.

2. LITERATURE REVIEW

2.1. Previous Research

There is a significant empirical literature investigating the inflation-inequality link. Inflation is having a negative impact on low-income households as they hold a larger proportion of their assets in cash. Bulir and Gulde (1995) show that inflation distorts income distribution in the short run by conducting cross-country analyses. Romer and Romer (1998) show that higher unexpected inflation corresponds to a higher share of income for the poor and a lower Gini coefficient in the United States. In addition, Romer and Romer (1998) found that there is a negative correlation between the average income of the poor and inflation in cross-country analyses. The negative relationship is especially strong for industrialized countries. Easterly and Fischer (2001) determine that the poor are more likely than the rich to cite inflation as a top national concern. This suggests that low-income households perceive inflation as more costly. In the Göcen (2024) study, findings based on panel data analyses using data from 2012 to 2018 for 58 countries showed that inflation has a strong negative impact on income inequality. The results of this study indicate that increases in institutional quality and decreases in inflation are important to slow down income inequality.

Empirical studies show that inflation can reduce or increase income inequality. Dollar and Kraay (2001), Bulir and Gulde (1995), Scully (2002), Albanesi (2007) and Beck et al. (2007) reported a positive relationship between inequality and inflation, while studies by Blinder and Esaki (1978), Mocan (1999), Brandolini and Sestito (1994), Heer and Maussner (2005), Sun (2011), Maestri and Reoventini (2012) and Coibion et al. (2017) found that inflation reduces inequality more. What these studies have in common is that they focus on the linear effect of inflation on income inequality. Recent empirical studies focus on the fact that the relationship between inflation and inequality depends on the level of the inflation rate. For example, Bulir (2001) investigates the relationship between inflation and income distribution using a cross-sectional dataset of 75 developing and developed countries with the help of dummy variables, each representing a different inflation range. This study shows that lowering inflation significantly reduces income inequality in a hyperinflation environment, while moving from low inflation to very low inflation (defined as below 5%) leads to increased inequality. A similar conclusion was reached by Galli and van der Hoeven (2001), who used fixed effects panel regression for a sample of 15 OECD countries and the United States. Galli and van der Hoeven (2001) found that rising inflation in low-inflation countries reduces income inequality, whereas rising inflation in countries with a high initial inflation rate increases income inequality. The estimated inflation rate, which minimizes inequality, is around 6% in the USA and around 12% in the sample of OECD countries. In a study on OECD countries, Monnin (2014) examined income inequality with the basic variables of income, unemployment, and inflation, and control variables. For the asymmetric effect, the square of income and inflation variables is included in the model. An important point that distinguishes this study from the examples in the literature is that inflation and income variables are divided into components using the HP filter. Inflation trends, inflation cycles, and inflation deficits are examined in three components. In addition, the GDP variable is divided into its components by the same method. As a result, it has been determined that income inequality for OECD countries has an inverted U-shaped nonlinear structure. In the first regression of the study, the square of inflation was not included in the model. In the second regression, it was included in the model. In the first model, income inequality is largely determined by economic growth. In the second model results, income inequality was relatively close to both inflation and economic growth.

Nantob (2015) finds a relationship between high levels of inflation and high-income inequality. The effect of inflation on income inequality has a maximum level, after which income inequality begins to decrease, which implies a non-linear relationship. Balcilar et al. (2018) found a U-shaped relationship between inflation and income inequality in US states during the period 1967-2009 using a semiparametric IV estimation approach with a threshold ranging from 2% to 5.6%, depending on the specification. Siami-Namini and Hudson (2019) found that the nonlinear relationship has different models in developed (U-shaped) and developing (inverted U-shape) countries. Although it is not a two-way relationship in the short term, it is in question for both developed and developing countries in the long term. Zheng et al. (2020) suggest that there is a negative link between inflation and income inequality. Zheng et al. (2023) arrived at mixed results showing a negative, positive, and U-shaped effect of inflation on income inequality. Binder (2019) suggests that the relationship between inflation and inequality depends on the interaction between political regimes and central bank independence. The link between inflation and income inequality is becoming more negative as central bank independence increases in democratic European countries. Boel (2018) found that inequality decreases for low to moderate inflation rates, while the opposite is true when inflation rises from moderate to high levels. Aktaş and Dokuzoğlu (2022) investigated the relationship between inflation and income inequality in 40 developed and developing countries. In the study, the relationship was examined according to different threshold levels. As a result, it has been determined that it has a negative effect up to a certain threshold value and a positive effect after this threshold value. Glawe and Wagner (2024) investigate the nonlinear inflation-inequality relationship using data from 101 countries in the period 1985-2020 with the dynamic threshold panel data model. This study shows that inflation rates exceeding 6% are associated with higher income inequality, but below this threshold, the correlation remains insignificant. Akarsu and Gharehgozli (2024) investigated the nexus between inflation and inequality with a quadratic function in the European Union between the years 1990 and 2019. They have shown that the relationship between inequality and inflation follows a U-shape.

In studies on Türkiye, Destek et al. (2017), Keskin (2022), Bayraktar et al. (2019), Pata (2020), Ünal and Doğan (2021), Akbulut (2021), Naimoğlu (2023), and Gemicioğlu et al. (2024) concluded that increases in inflation have an increasing effect on income inequality. Gülmez and Altıntaş (2015), and Kanberoğlu and Arvas (2014) found that inflation reduces income inequality. The number of studies examining the effect of inflation on income inequality with nonlinear models is very limited for Türkiye. Alpağut (2024) study points out that in the relationship between inflation and income inequality for Türkiye, inflation first negatively affects income inequality, and after a certain point, the effect is positive. This situation shows that the relationship between inflation and income inequality is "U" shaped for Türkiye.

Studies are finding that inflation reduces income inequality, albeit limited, in the literature on Türkiye. Kanberoğlu and Arvas (2014) find that private sector loans and per capita income decrease income inequality along with inflation in the period between 1980 and 2012. Gülmez and Altıntaş (2015) analyzed the 1981-2011 period with trade openness and inflation and found that these two variables reduce income inequality. Destek et al. (2020), Pata (2020), Keskin (2022), and Naimoğlu (2023) examined income inequality centered on financial development and financial structure and used inflation as a control variable. Keskin (2022), for the period 1987-2019, shows that inflation and financial development have an increasing effect on income inequality. Pata (2020), on the other hand, argues that the relationship between financial development and income inequality in the 1987-2016 period is explained in an inverted U-form and also finds that the increase in the stock of fixed capital along with inflation increases income inequality in the long-run. On the other hand, Destek et al. (2020) show that inflation increases income inequality in the short term, but inflation has a reducing effect in the long term. Additionally, the study,

which has obtained findings indicating that the increase in public expenditures and real income reduces inequality, discusses the effect of financial development on income inequality in different dimensions. However, Naimoğlu's (2023) study for the period 1990-2021 shows that inflation increases income inequality both in the short term and in the long term, and unemployment increases in the same way. Along with these, Naimoglu (2023) provides evidence that there are effects of financial development that reduce income inequality. Analyzing the impact of inflation and FDI on income inequality for the period 1974-2015, Bayraktar et al. (2019) conclude that both variables increase income inequality. These findings show that FDI distorts income distribution by widening the income gap between skilled and unskilled labor and causing monopolization. These results emphasize the importance of price stability in ensuring income equality. Ünal and Doğan (2021), in their study for the period 2005-2018, draw attention to the fact that inflation prevents the gap between low- and high-income groups from closing, and thus inflation is a factor that distorts income distribution. Similarly, the studies of Akbulut (2021) and Gemicioglu et al. (2024) draw attention to the fact that inflation increases income inequality in a linear form.

2.2. Current Work

Empirical studies using Turkish data examine the effects of various macroeconomic variables such as income, trade, unemployment, interest rates, financial development, foreign investments, and inflation on inequality. Although these studies mostly cover linear relationships, nonlinear relationships have also been investigated, especially in the context of income and financial development. On the other hand, there is a limited number of studies on the nonlinear effect of inflation on income inequality in the Turkish sample. Alpağut (2024) points to an "inverted U" relationship between growth and income inequality and a "U" shaped relationship between inflation and income inequality. The effects of trade, unemployment, and gross fixed capital formation variables are also analyzed. This study, while considering the nonlinear inflation-income inequality relationship together with growth and unemployment factors, contributes to the literature in terms of considering the education factor. In addition, it is the first study to examine the asymmetric effect of inflation on income inequality in Türkiye via the threshold SVAR model. Findings from the threshold SVAR model provide new empirical evidence for policymakers. On the other hand, this study differs from Alpağut (2024) by finding the threshold value of inflation, providing a comparison with current targets.

Aktaş and Dokuzoğlu (2022) concluded that the level of inflation determines the direction of income inequality in developed and developing countries, including Türkiye, in order to examine the non-linear effects of income inequality. Akarsu and Gharehgozli (2024), on the other hand, confirmed the parabolic relationship between inflation and income inequality and focused on the effectiveness of tax policies in mitigating the negative effects of inflation on inequality. Although this study is similar to the panel data analyses by Aktaş and Dokuzoğlu (2022) and Akarsu and Gharehgozli (2024), it focuses directly on the dynamics of the Turkish economy. Although the datasets of both studies include Türkiye, the country differs from other developing and middle-income economies with respect to income distribution and inflation dynamics. In particular, Türkiye has distinguished itself from both developed and developing countries through the economic policies implemented in response to the inflationary pressures arising from the COVID-19 pandemic and the Russia-Ukraine war. Along with supply-side external constraints, it has faced inflationary pressures well above global inflation as a result of the exchange rate shock it experienced. This process necessitates evaluating Türkiye separately from similar economies.

This study, while considering the nonlinear inflation-income inequality relationship together with growth and unemployment factors, contributes to the literature in terms of

considering the education factor. In addition, it is the first study to examine the asymmetric effect of inflation on income inequality in Türkiye via the threshold SVAR model. Findings from the threshold SVAR model provide new empirical evidence for policymakers. On the other hand, this study differs from Alpağut (2024) by finding the threshold value of inflation, providing a comparison with current targets.

3. ASSUMPTIONS AND DATA COLLECTION

The study of Simon Kuznets (1955) argues that economic growth will primarily increase income inequality and that if the increase in economic growth is more than a threshold level, economic growth will begin to reduce income inequality. This claim is referred to in the literature as Kuznets' "inverted-U" hypothesis. The validity of the hypothesis is still debated today, and economic growth is used as one of the main variables in studies to determine the factors that cause income inequality. In addition, studies examining the effect of some macroeconomic variables as well as economic growth on income inequality have increased over time. The most prominent of these variables are human capital, unemployment and inflation. Human capital is one of the most important social factors influencing income inequality. Since the decrease in education and skill inequality among employees will lead to an increase in human capital, the income inequality of countries will decrease as human capital increases. Some studies point out that unemployment increases income inequality (Morsy, 2011). The increase in unemployment rates generally worsens the relative positions of the low-income group, increasing income inequality. Higher unemployment rates also contribute to income inequality. According to Stiglitz (2015), unemployment is the worst of market failures, the biggest source of inefficiency, and a major cause of income inequality.

In developing countries, the view that inflation increases income inequality is widespread. The most important argument for this view is that if nominal wages increase less than inflation, inflation will reduce workers' real income. Eliminating the negative impact of high inflation on low-income earners is achieved by reducing the long-term growth rate. High inflation prevents producers from perceiving price signals correctly, reducing investment appetite and preventing employment growth. Another reason why high inflation affects low-income groups more negatively is that the expenditures necessary to sustain daily life, especially food and transportation, have a higher share in the budget of low-income groups. For these reasons, high inflation increases income inequality. On the other hand, according to the Phillips curve, it is claimed that the relationship between inflation and unemployment rates is in the opposite direction. Therefore, policies that lead to some inflation increases in developed countries to reduce unemployment also have an indirect effect that results in a decrease in income inequality. For this reason, it is claimed that the increase in inflation, especially in developed countries where inflation is low, reduces income inequality. The most important reason for this claim is that labor incomes in developed countries are indexed to inflation. In addition, inflation has a positive effect on household welfare if income-earnings increases are higher than inflation increases in the long run.

In this study, it is assumed that the effect of inflation on income inequality in Türkiye is asymmetrical as a U-shape. During low inflation periods, the implementation of both expansionary monetary policies and some populist policies that significantly increase government expenditures by governments in Türkiye supports economic growth reduces the unemployment rate, increases real wages, and reduces income inequality. These policies lead to high inflation due to reasons such as excessive increases in public spending and devaluation as a result of expansionary monetary policies. This situation leads governments to fight high inflation. A tight monetary policy to combat high inflation reduces both economic growth and real wages. As a natural consequence of this, income

inequality increases during periods of high inflation. In other words, inflation reduces income inequality during periods of low inflation and increases it during periods of high inflation. The Gini coefficient was used as an indicator of income inequality. The Gini coefficient ranges from 0% to 100%. A value of 0% indicates perfect equality, meaning everyone's income is the same. A value of 100% indicates that one person receives all the income, i.e. perfect inequality. As the Gini index approaches 100%, income inequality increases. The Gini coefficient using household disposable income after tax and post-transfer was used for income inequality. The Gini coefficient data is obtained from the Standardized World Income Inequality Database. The annual percentage growth rate of gross domestic product (GDP) per capita in constant local currency was used as an indicator of economic growth. Economic growth data are taken from the World Bank Database. In the study, the mean years of schooling were used as the proxy variable of human capital. The average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level. Mean years of schooling were taken from the United Nations database. Unemployment refers to the share of the labor force that is without work but available for and seeking employment. The unemployment rate of the total labor force was taken from the World Bank database. Annual inflation based on the consumer price index is taken from the World Bank database. The sample period covers annual data from 1990 to 2023. The definitions of the variables are given below:

$gini$: Gini coefficient

mys: Mean years of schooling

gr: Economic growth

ur: Unemployment

inf: Inflation

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics

Some descriptive statistics of the variables within the scope of the study are given in Table 1. The Gini coefficient is between 39.7 and 42.7, with the lowest being in 2012 and the highest in 1994. The average for the Gini coefficient is 41.24, while the median is 41.40. The standard deviation for the Gini coefficient is close to zero at 0.98. In other words, the distribution of the Gini coefficients is quite homogeneous. According to the JB test, the Gini coefficient has a normal distribution. The average economic growth in Türkiye between 1990 and 2023 was 3.40, with a median of 4.68. The lowest value for economic growth was observed in 2001 at -6.92, and the highest growth rate was observed in 2021 at 10.43. The standard deviation for economic growth is 4.51. These results indicate that economic growth has an unstable structure over time. The JB test shows that economic growth has a normal distribution.

Table 1. Descriptive statistics

	Gini coefficient	Economic growth	Inflation	Mean years of schooling	Unemployment
Mean	41.24	3.40	36.44	6.44	9.81
Median	41.40	4.68	16.33	6.06	10.23
Maximum	42.70	10.43	105.22	8.81	14.03
Minimum	39.70	-6.92	6.25	4.46	6.50
Std. Dev.	0.98	4.51	32.30	1.49	1.95
Skewness	-0.14	-0.88	0.59	0.27	0.19
Kurtosis	1.67	3.07	1.78	1.64	2.60
Jarque-Bera	2.53	4.31	3.94	2.92	0.41
p-value	0.2823	0.1158	0.1397	0.2327	0.8136

Türkiye's average annual inflation between 1990 and 2023 is 36.44, while its median is 16.33. The significant difference between the mean and median is the extremely high values in inflation as a result of the financial crises experienced in Türkiye in some periods. The lowest annual inflation observed in Türkiye was 6.25% in 2009, and the highest inflation was 105.22% in 1994. The standard deviation for inflation is quite high at 32.30. This result indicates that annual inflation in Türkiye has shown great divergences over time, in other words, it is heterogeneous. The JB test shows that the distribution of inflation is a normal distribution. The mean years of schooling in Türkiye is constantly increasing over time. The mean for this indicator is 6.44 years, while the median is 6.06 years. The mean years of schooling, which was 4.46 years in 1990, increased to 8.81 in 2022. The claim that the distribution is normal according to the JB test in this variable could not be rejected at the 5% significance level. Unemployment rates in Türkiye range from 6.50% to 14.03%. The lowest unemployment rate was in 2000 and the highest in 2009. Türkiye's mean unemployment between 1990 and 2023 is 9.81, while its median is 10.23. According to the JB test, unemployment has a normal distribution.

4.2. Properties of Time Series Data

The time plots of the variables are given in Figure 1. While the Gini coefficient increased continuously from 1990 to 1994, it started to decrease from 1995 onwards and this trend continued until 2013. In 2014, an upward trend is observed again. This trend shows that the improvement in income inequality in Türkiye between 1995 and 2013 has been replaced by a worsening since 2014. The mean years of schooling are constantly increasing over time. The trend of these increases is linear. This situation shows that human capital in Türkiye has increased steadily between 1990 and 2023. Türkiye does not have a stable trend in economic growth over time. Although the general trend in economic growth is expansion, the economic contractions in 1994, 1999, 2001, and 2009 are especially noteworthy. These years correspond to Türkiye's financial/economic crisis periods.

Figure 1. Time plot of the variables

Although there have been decreases in some periods in Türkiye, the general trend in unemployment rates points to increases. The years with the highest unemployment rate are 2009, 2019, and 2020. These periods correspond to the global economic crisis and the COVID-19 pandemic. In other words, the global crisis in 2008 and the COVID pandemic reflected in the Turkish economy as recession and unemployment. The 1990s in Türkiye were a period of chronically high inflation of around 70%. Due to the financial crisis (devaluation) in 1994, inflation reached its highest level of 105.2 percent. Inflation, which was at the level of 54.4% during the 2001 financial crisis, tends to decrease after this year. In the inflation targeting regime, which started to be implemented implicitly in 2002 and explicitly since 2006, inflation has been at low levels, especially between 2004 and 2017. Inflation, which rose to 16.33% in 2018, remained at 15.18% and 12.28% in the following years in 2019 and 2020, respectively. With the impact of the COVID-19 pandemic, inflation increased to 19.59% in 2021. Due to the increases in energy prices and devaluation in 2022, inflation rose to 72.31% and remained high at 53.86% in 2023.

The unit root properties of the variables were examined using three alternative tests. These tests are Augmented Dickey-Fuller (ADF, 1981), Phillips-Perron (PP, 1988), and the breakpoint unit root test proposed by Vogelsang and Perron (1998). The results of the unit root tests are given in Table 2. The Gini coefficient is stationary at its level concerning the ADF and breakpoint unit root tests. According to the three alternative unit root tests, economic growth is stationary at its level, while the mean years of schooling, unemployment, and inflation are stationary at first order differences. In other words, the order of integration for the Gini coefficient and economic growth is zero, while for the other variables, it is one.

Table 2. Unit Root Test Results

Variable	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)		Breakpoint Unit Root Test (Vogelsang and Perron, WP)	
	t-Statistic	p-value	Adj. t-Stat	p-value	t-Statistic	p-value
$gini$	-3.8128	0.0069	-1.1320	0.6924	-6.1265	< 0.01
mys	-0.0541	0.9460	0.6689	0.9895	-2.7621	0.8049
Δmys	-3.1900	0.0303	-3.1465	0.0333	-5.1790	< 0.01
gr	-6.3392	0.0000	-6.4610	0.0000	-7.2050	< 0.01
ur	-2.2823	0.1830	-1.9561	0.3041	-4.7244	0.0226
inf	-1.3343	0.6029	-1.3388	0.6008	-3.3397	0.4805
Δinf	-6.6122	0.0000	-6.6247	0.0000	-7.4884	< 0.01

Only the constant is taken as an exogenous variable. Appropriate lag lengths for both ADF and WP tests were determined using the Akaike information criterion (AIC) with a maximum lag of 5. Appropriate Newey-West bandwidth for PP unit root tests is selected using Bartlett kernel. The break date is selected by using Dickey-Fuller min-t.

4.3. Testing Symmetry: Slope-based Test

The asymmetric specification according to the inflation for Gini coefficient is defined as follows:

$$gini_t = \alpha + \beta_1 inf_t \times D_t^{low} + \beta_2 inf_t \times D_t^{high} + \alpha_1 mys_t + \alpha_2 gr_t + \alpha_3 ur_t + \varepsilon_t \quad (1)$$

$$D_t^{high} = \begin{cases} 1 & if\ inf_t \geq \gamma \\ 0 & otherwise \end{cases} \text{ and } D_t^{low} = \begin{cases} 1 & if\ inf_t < \gamma \\ 0 & otherwise \end{cases} \quad (2)$$

where inflation is the threshold variable used to divide the sample into regimes, and γ is the unknown threshold parameter. This type of modeling strategy allows the effect of inflation on income inequality to differ depending on whether inflation is below or above an unknown γ level. Estimation methods for the threshold value can be broadly divided into two categories: global maximizers for breakpoints and sequentially determined breakpoints. In this study, both sequential application and global optimization procedures proposed by Bai and Perron (1998) were used to determine the threshold value for inflation. In both approaches, the threshold value for inflation was estimated as 11.14431.

Null hypothesis, which claims that the effect of inflation on the income inequality is symmetrical during periods of high and low inflation rates, can be tested using symmetry approach of Kilian and Vigfusson (2011) with the following equations:

$$inf_t = b_{10} + \sum_{i=1}^{p} b_{11,i} gini_{t-i} + \sum_{i=1}^{p} b_{12,i} inf_{t-i} + \varepsilon_{1t} \quad (3)$$

$$gini_t = b_{20} + \sum_{i=1}^{p} b_{22,i} gini_{t-i} + \sum_{i=0}^{p} b_{21,i} inf_{t-i} + \sum_{i=0}^{p} \beta_i (D_t^{high} \times inf_{t-i}) + \varepsilon_{2t} \quad (4)$$

Equation 3 is a standard linear VAR in inf_t and $gini_t$, but Equation 4 includes both inf_t and $D_t^{high} \times inf_{t-i}$ and, as such, in both high inflation and low inflation affect income inequality. The OLS residuals of the above model are uncorrelated. This means that the model can be estimated by standard regression methods (Kilian and Vigfusson, 2011).

The test of all symmetrical restrictions on the slopes involves the null hypothesis

$$H_0: \beta_0 = \beta_1 = \cdots = \beta_p = 0 \quad (5)$$

Equation 4 of the above model can be estimated by least squares and uses a Wald test to determine whether including $\left(D_t^{\text{high}} \times inf_{t-i}\right)_{i=0}^{p}$ improves the fit of the model. This modified slope-based test has an asymptotic χ^2_{p+1} distribution.

The ARDL(3,1,2) model was selected for equation-4 using AIC with a maximum lag of 4. For the null hypothesis, which claims that the effect of inflation on income inequality is symmetrical, the Chi-square statistic was found to be 10.546 and the p-value corresponding to this statistic was found to be 0.0145. The null hypothesis, which shows that slope-based symmetry is valid, can be rejected at the 5% significance level. This result shows that the effect of inflation on income inequality is asymmetric.

4.4. Threshold Regression Results

The discrete threshold regression model is defined in equation 1. The parameters of equation 1 were estimated by the OLS method. Discrete threshold regression results are given in Table 3. In this regression equation, the constant term, mean years of schooling, economic growth, and unemployment are non-threshold variables. In periods when inflation was lower than 11.14%, the inflation coefficient was negatively estimated as -0.08. This coefficient is statistically significant at the level of 1%. In periods of high inflation, when inflation is greater than 11.14%, the coefficient of inflation is positively estimated at 0.0184. The inflation coefficient was found to be statistically significant at the 1% significance level. These results indicate that inflation affects the Gini coefficient negatively during periods of low inflation and positively during periods of high inflation. In other words, increases in inflation in periods of low inflation reduce income inequality, while increases in inflation increase income inequality in periods of high inflation. These results show that the relationship between inflation and inequality in Türkiye is nonlinear in the form of a U-shape.

Table 3. Discrete threshold regression results

Variable	Coefficient	Std. Error	t-Statistic	p-value
$inf \leq 11.14431$ (13 observations)				
inf	-0.0800	0.0254	-3.1485	0.0040
$inf > 11.14431$ (20 observations)				
inf	0.0184	0.0019	9.5385	0.0000
Non-Threshold Variables				
Constant	40.8107	0.4787	85.2579	0.0000
mys	-0.1804	0.0610	-2.9576	0.0064
gr	0.0326	0.0146	2.2251	0.0346
ur	0.1155	0.0624	1.8518	0.0750
R-squared	0.8997	Durbin-Watson stat		1.1576
F-statistic	48.4547	Prob(F-statistic)		0.0000

Standard errors are adjusted HAC. The threshold variable is inflation. The threshold was determined with sequential breakpoint determination at 5% significant level using the Bai-Perron (1998) approach. The trimming percentage is taken as 15. Trimming is the percentage of observations of the threshold variables that are removed.

The coefficient of mean years of schooling, one of the non-threshold independent variables, was estimated as -0.1804. This coefficient is statistically significant at the level of 1%. As the average years of schooling increase, the Gini coefficient, that is, income inequality, decreases. Although the economic growth coefficient was found to be statistically significant at the level of 5%, it was positively estimated at 0.0326, contrary to expectations. This result indicates that a dynamic examination of the relationship between economic growth and income inequality will yield more robust results. In addition, the unemployment coefficient was positively estimated at 0.1155 in accordance with the expectations. This coefficient is statistically significant at the 10% level. As unemployment increases, the Gini coefficient, that is, income inequality, increases.

4.5. The Threshold SVAR Model

Although the threshold regression model provides useful information about the asymmetric effects of inflation on income inequality, it does not provide information about the dynamic relationships between variables. For this reason, the dynamic effects of inflation on income inequality in Türkiye have also been examined via threshold SVAR models. The most important reason for using the threshold SVAR model is that it allows instantaneous constraints based on both economic theory and the structure of the Turkish economy, thus allowing us to obtain more complex and more realistic results. A SVAR model can be shaped by economic theory, institutional knowledge, and other constraints (Köse and Ünal, 2021). A SVAR model structures economic assumptions to analyze instantaneous connections between determinants through structural factorization (Bernanke, 1986; Blanchard and Watson, 1986; Sims, 1986). In innovation terms or orthogonalization of reduced form residuals of a VAR model, recursive Cholesky decomposition or non-recursive structural factorization can be applied. Orthogonalization by Cholesky decomposition shows causal relationships between variables with a causal chain. This solution may make sense with a reasonable interpretation for recursive ordering (Kilian, 2013). In this study, the SVAR model was used. One of the most important reasons for this is that the immediate relationship between inflation and income inequality is defined as bidirectional. This instantaneous constraint from economic theory allows structural factorization, while Cholesky decomposition does not. The short-run SVAR(p) specification for the A-B model can be written as the following (equation-2):

$$\boldsymbol{A}\left(\boldsymbol{I_k} - \boldsymbol{A_1 L} - \boldsymbol{A_2 L^2} - \ldots\ldots\ldots \boldsymbol{A_p L^p}\right)\boldsymbol{y_t} = \boldsymbol{A e_t} = \boldsymbol{B u_t} \quad (1)$$

where $\boldsymbol{L}$ lag operator, the vector $\boldsymbol{e_t}$ is error terms of the standard VAR model with covariance matrix $\boldsymbol{\Sigma_e}$, the vector $\boldsymbol{u_t}$ is error terms of the structural VAR model with covariance matrix $\mathbf{I_k}$, k is the number of variables in the model, and $\boldsymbol{A}$ and $\boldsymbol{B}$ are restriction matrices. The order condition requires $\boldsymbol{2k^2} + \frac{\boldsymbol{k(k-1)}}{\boldsymbol{2}}$ restrictions for identification in the short-run A-B model.

The most exogenous variable is the mean year of schooling. While the shocks of the mean year of schooling are not instantaneously affected by the shocks of any of the variables, their shocks instantaneously affect the shocks in the Gini coefficient, economic growth, and unemployment rate. While economic growth shocks have an instantaneous effect on shocks of all variables except for the mean year of schooling, their own shocks are instantaneously affected by only shocks of the mean year of schooling. In addition, unemployment rate shocks affect only Gini coefficient shocks instantaneously and are themselves only affected by inflation shocks instantaneously. Moreover, the relationship

between inflation and the Gini coefficient is assumed to be bidirectional. Inflation shocks have an instantaneous effect on the Gini coefficient shocks and vice versa. Inflation shocks also instantaneously affect unemployment rate shocks. The Gini coefficient is the most endogenous variable. Thus, the shocks of the Gini coefficient are instantaneously affected by the shocks of the mean year of schooling, economic growth, unemployment rate, and inflation. In addition, the Gini coefficient shocks have an instantaneous effect on inflation shocks. The fact that the Gini coefficient affects inflation is related to economic populism. According to this approach, populist economic policies focus on economic growth and income distribution rather than avoiding the risks of inflation. Populist policies that emphasize redistribution and price control lead to inflationary pressures, while income inequality decreases and inflation increases. Under these restrictions, a structural VAR model with A and B matrices can be specified as below (equation-3):

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & 0 \\ 0 & a_{42} & 0 & 1 & 0 & a_{46} \\ 0 & a_{52} & 0 & 0 & 1 & a_{36} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} e_t^{mys} \\ e_t^{gr} \\ e_t^{ur} \\ e_t^{inf^{low}} \\ e_t^{inf^{high}} \\ e_t^{gini} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} \end{bmatrix} \begin{bmatrix} u_t^{mys} \\ u_t^{gr} \\ u_t^{ur} \\ u_t^{inf^{low}} \\ u_t^{inf^{high}} \\ u_t^{gini} \end{bmatrix} \quad (2)$$

The optimal lag length for the VAR model is determined to be 3 using AIC. The identification needs to be checked for the SVAR model. There are 6 variables in the SVAR model. While k defines the number of variables, to ensure exact identification, constraints are needed $2k^2 - \frac{1}{2}\,k(k+1) = 51$. However, there are 52 restrictions in SVAR model. Due to the fact that the SVAR model is over identified, the appropriateness of over identification was tested with the Likelihood Ratio (LR) statistic. The LR test statistic value is 0.2630, the p-value is 0.6081. This result shows that the null hypothesis, in which overidentification is valid, cannot be rejected at the 5% significance level. In other words, overidentification is valid.

4.6. Variance Decomposition of The Gini Coefficient

Table 4 indicates the results of forecast error variance decomposition using structural VAR factors for the Gini coefficient. The results were reported for 10 years.

Table 4. Variance decomposition for the Gini coefficient using structural VAR factors

Period	mys	gr	ur	$Low\ inf$	$High\ inf$	$Gini$
1	0.29	33.01	1.65	0.32	63.03	1.70
2	0.11	24.80	0.75	11.78	59.77	2.80
3	0.95	19.20	0.73	20.18	57.81	1.13
4	2.35	14.76	3.42	20.92	57.93	0.62
5	2.60	12.65	6.66	20.19	57.44	0.47
6	3.28	12.12	8.83	18.25	56.72	0.81
7	4.06	11.74	9.51	17.19	55.64	1.86
8	4.59	11.83	9.94	16.25	54.49	2.90
9	4.70	12.51	10.74	14.87	53.47	3.72
10	4.63	13.46	11.16	13.76	52.75	4.24
Mean	2.76	16.61	6.34	15.37	56.90	2.02

The highest shares in the Gini coefficient variance decomposition are inflation during periods of high inflation. The share of high inflation in the Gini coefficient variance decomposition is quite high with 63.03% in the first forecast period. These shares maintain their high shares with 59.77% and 57.81%, respectively, in the second and third forecast periods, and these shares continue to be important in the following forecast periods, with more than 50%. In periods of low inflation, the share of inflation in the variance decomposition of the Gini coefficient is quite low at 0.32% in the first forecast period, while these shares increase dramatically to 11.78% in the second forecast period and 20.92% in the third forecast period, respectively. Although these shares decreased in the following forecast periods, they maintained their importance with a level of 13.76% in the tenth forecast period. These results indicate that inflation has a significant contribution to the Gini coefficient in both the short and long run during periods of high inflation, while it has a limited effect in the medium term, if not in the short term, in periods of low inflation. In the variance decomposition of the Gini coefficient, the share of economic growth in the first forecast period was 33.01%, while this share decreased to 24.80% in the second forecast period. In the following forecast periods, these shares decrease, but maintained a limited effect of around 12%. These results show that economic growth has an effect on the Gini coefficient in the short run, while this effect decreases in the long run.

In the variance decomposition of the Gini coefficient, both mean years of schooling and unemployment have negligible shares in the short term. The share of mean years of schooling in the first forecast period is 0.29%, and the share in the second forecast period is 0.11%. Although these shares increased in the following periods, they remained at a very limited level with 4.63% in the tenth forecast period. These results indicate that the mean year of schooling does not have an effect on the Gini coefficient. In the variance decomposition of the Gini coefficient, the shares of unemployment are quite low with 1.65% in the first prediction period and 0.75% in the second prediction period, respectively. These shares increase in the following forecast periods and go up to 11.16% in the tenth

forecast period. These results indicate that unemployment is ineffective on the Gini coefficient in the short run, while its effect is quite limited in the long run.

4.7. Impulse-Response Function for The Gini Coefficient

Since both inflation and mean years of schooling are not stationary at the level, confidence intervals for impulse-response functions are calculated with the Monte Carlo simulation method. Figure 2 indicates the response of the Gini coefficient to the variables. The response of the Gini coefficient to structural one standard deviation positive innovations was estimated. Impulses are the mean years of schooling, economic growth, unemployment, low inflation, and high inflation. Although the response of the Gini coefficient to positive shocks in the mean years of schooling is positive, it is statistically insignificant in all forecast periods. These results show that the mean years of schooling do not have an effect on income inequality in Türkiye. The same trend applies to unemployment. The response of the Gini coefficient to positive shocks in unemployment is positive in the first three forecast periods and negative in the following periods, but they are statistically insignificant in all forecast periods. These results indicate that human capital and unemployment do not have a significant effect on income inequality in Türkiye. The responses of the Gini coefficient to positive shocks to economic growth are negative. This response was found to be statistically significant only in the first forecast period. This result shows that economic growth reduces income inequality in Türkiye, but this effect is short-term.

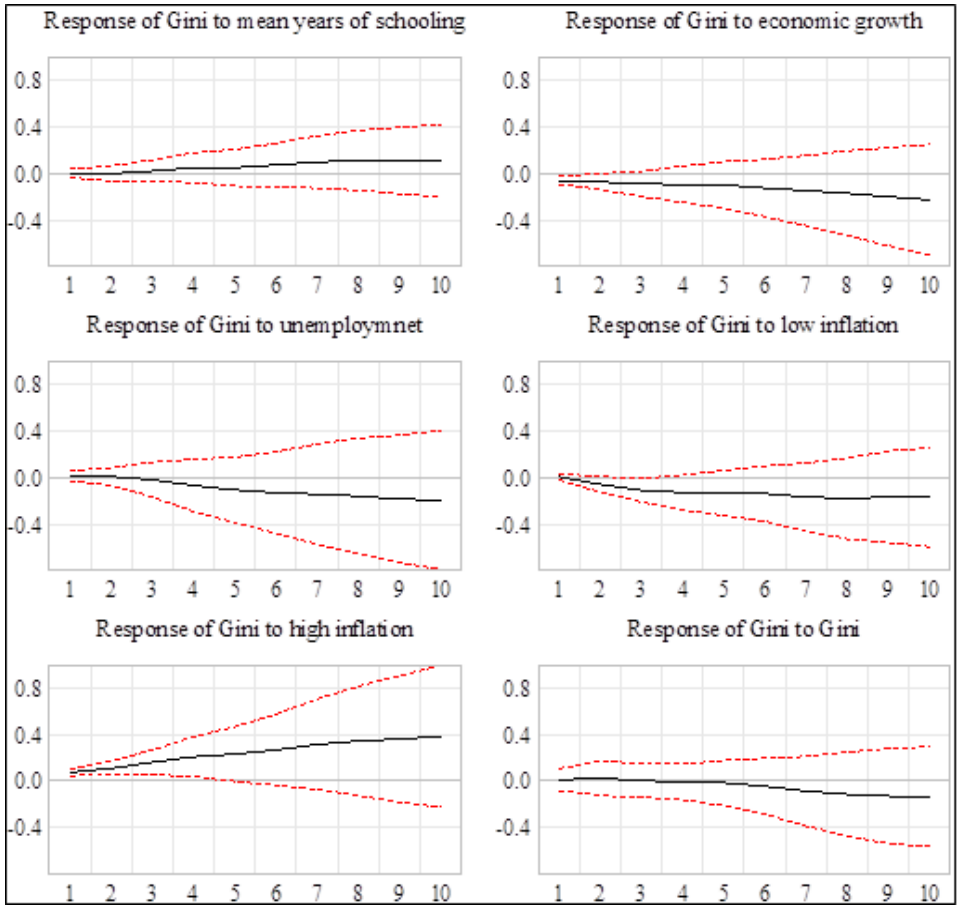


Figure 2. Response of Gini coefficient to structural VAR innovations (± 2 S.E.)

During periods of low inflation, the responses of the Gini coefficient to positive shocks in inflation are negative. This response was only statistically significant in the third

forecast period. These results indicate that increases in inflation during periods of low inflation reduce income inequality in Türkiye. However, while this effect is insignificant in the short term, it is significant in the long term at a limited level. In contrast, during periods of high inflation, the responses of Gini coefficient to positive shocks in inflation are positive. These responses were found to be statistically significant in the first four forecast periods. These results indicate that increases in inflation increase income inequality in Türkiye in both short- and long-term during periods of high inflation. In addition, the findings indicate that the effect of inflation on income inequality in Türkiye is asymmetrical in the form of a U-shape.

4.8. Robustness Checks

In this study, disposable (post-tax, post-transfer) income was used for inequality. The Gini index for income inequality can also be calculated using market (pre-tax, pre-transfer) income. In the study, econometric analyses were repeated using the Gini index based on market income. Thus, it is aimed to obtain more robust results by examining the effect of two different approaches used in the calculation of the Gini index on our results.

Both sequential application and global optimization procedures proposed by Bai and Perron (1998) were used to determine the inflation threshold value, and the threshold value for inflation was again estimated as 11.14431 in both approaches. The ARDL(3,1,1) model was selected for equation-4 using AIC with a maximum lag of 4. In the test of the null hypothesis, which expresses the claim that the effect of inflation on income inequality is symmetrical, the Chi-square statistic was found to be 9.5348 and the p-value was found to be 0.0085. This result shows that the null hypothesis can be rejected at the 1% significance level. In other words, the effect of inflation on market income inequality is asymmetrical.

The discrete threshold regression results are given in Table 5. In periods when inflation is below 11.14%, the inflation coefficient is estimated negatively as -0.0689, while in periods when inflation is greater than the threshold value, the inflation coefficient is estimated as positive as 0.0179. Inflation coefficients were found to be statistically significant at the 5% significance level. These results show that inflation negatively affects income inequality based on market income in periods of low inflation and positively affects it in periods of high inflation. These results indicate that increases in inflation have an effect that reduces income inequality in periods of low inflation, and increases in inflation have an effect that increases income inequality in periods of high inflation. In other words, the relationship between inflation and inequality in Türkiye has an asymmetrical structure with a U-shape.

Table 5. The results of discrete threshold regression

Variable	Coefficient	Std. Error	t-Statistic	p-value
$inf \leq 11.14431$ (13 observations)				
inf	-0.0689	0.0274	-2.5147	0.0182
$inf > 11.14431$ (20 observations)				
inf	0.0179	0.0020	8.9051	0.0000
Non-Threshold Variables				
Constant	41.2042	0.4735	87.0268	0.0000
mys	0.2957	0.0600	4.9295	0.0000
gr	0.0306	0.0115	2.6538	0.0132
ur	0.1422	0.0575	2.4739	0.0199
R-squared	0.8272	Durbin-Watson stat		1.0007
F-statistic	25.8598	Prob(F-statistic)		0.0000

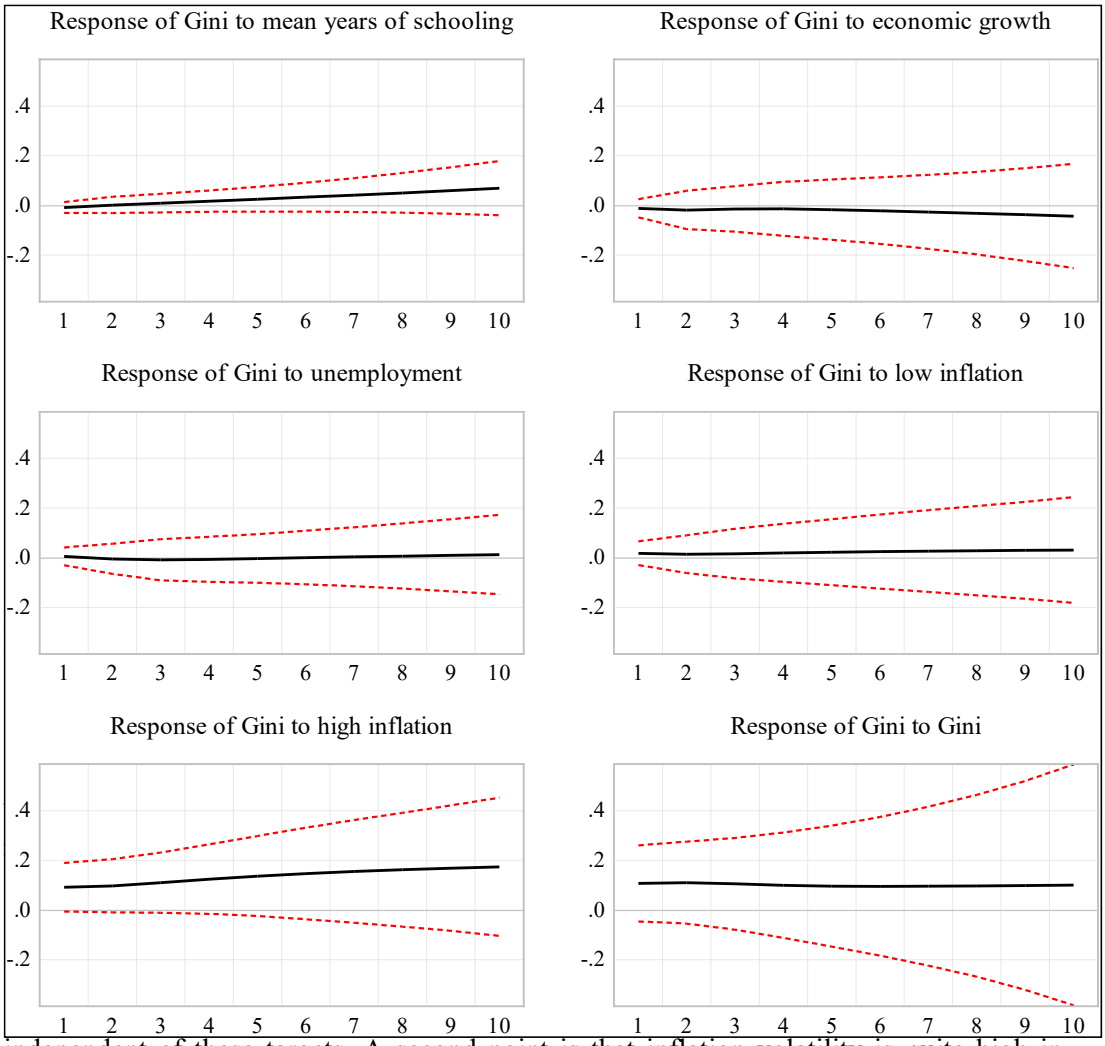
Standard errors are adjusted HAC. The threshold variable is inflation. The threshold was determined with sequential breakpoint determination at 5% significant level using the Bai-Perron (1998) approach. The trimming percentage is taken as 15. Trimming is the percentage of observations of the threshold variables that are removed.

The appropriate lag length for the VAR model is determined as 1 using AIC. Table 6 shows the results of variance decomposition obtained from the structural VAR model for the market income-based Gini coefficient over the 10-year forecast period. The variable that has the largest share in the variance decomposition of the Gini coefficient is inflation in periods of high inflation. While the share of this variable is 40.99% for the first forecast period, it increases in the following forecast periods and goes up to 60.18% in the tenth forecast period. On the other hand, in the variance decomposition of the Gini coefficient, the shares of inflation in periods of low inflation are negligible. While these shares were 1.55% in the first forecast period, they remain around 1% in the following periods and maintain their low share with 1.71% in the tenth forecast period. In addition to these, the shares of other variables in the variance decomposition of the Gini coefficient are also at a very low level. While the share of the mean year of schooling in the first forecast period is at a very low level with 0.37%, these shares increase in the following forecast periods and rise to 4.53% in the tenth forecast period. There is a similar trend for economic growth, with lower shares. These results indicate that the mean years of schooling and economic growth do not have a short-term effect on income inequality but have a limited effect in the long run. The shares for unemployment are quite low levels below 0.20% in all forecast periods. This result shows that unemployment does not have an effect on income inequality.

Table 6. Variance decomposition for the market income based-Gini coefficient using structural VAR factors

Period	mys	gr	ur	$Low\ inf$	$High\ inf$	$market\ income\ based-Gini$
1	0.37	0.70	0.14	1.55	40.99	56.24
2	0.18	1.19	0.12	1.21	41.88	55.41
3	0.24	1.08	0.19	1.17	45.07	52.26
4	0.47	0.99	0.19	1.24	48.95	48.17
5	0.86	0.99	0.15	1.34	52.49	44.16
6	1.38	1.08	0.12	1.45	55.32	40.66
7	2.01	1.25	0.10	1.54	57.38	37.72
8	2.75	1.48	0.10	1.61	58.80	35.26
9	3.59	1.76	0.12	1.67	59.69	33.17
10	4.53	2.07	0.15	1.71	60.18	31.36

The responses of market income-based Gini coefficient shocks to positive shocks in other variables are given in Figure 3. The Gini coefficient's response to positive inflation shocks during periods of high inflation is positive. While these responses were statistically significant only in the first forecast period, they were statistically insignificant in the following forecast periods. The responses of the Gini coefficient to positive shocks in all other variables were found to be statistically insignificant. These results indicate that increases in inflation during periods of high inflation increase income inequality in Türkiye.



independent of these targets. A second point is that inflation volatility is quite high in Türkiye. In this context, the results of the effect analyzed by distinguishing between high and low inflation have clear implications. According to the determined threshold, the effect of inflation on income inequality is asymmetric and U-shaped. This result is supported by both threshold SVAR and threshold regression results.

The economic stability created by low inflation has a reducing effect on income inequality. However, the negative effects of high inflation increase income inequality. Among the non-threshold variables, a one-unit positive shock in economic growth reduces income inequality, however, economic growth had a slightly negative impact on income inequality between 1990 and 2023. This result shows that stable and sustainable economic growth is important for reducing income inequality in Türkiye. In contrast, rapid but unstable economic growth can create inflationary pressures and lead to high inflation. High inflation affects lower-income groups more negatively, and income inequality can worsen. Therefore, the government should adopt a growth strategy to stimulate the economy and then focus on stabilizing economic growth.

This study examined the role of human capital structure in income inequality through the employment status and educational attainment of households and reached important findings. One of these findings is that although the education factor tends to increase continuously over time, its contribution to income inequality is not at the expected level.

This finding is an indication that the effect of the education factor on individual competencies is limited. Accordingly, to assess the potential benefits of effective education reforms, future research should focus on the effects of education on labor productivity and income inequality. Threshold regression results reveal that as the unemployment rate increases in Türkiye, income inequality also increases. On the other hand, empirical evidence from the threshold SVAR model suggests that the impact of unemployment on income inequality is quite limited in the long run. When job confidence is low and labor markets are extremely resilient, the impact of unemployment on income inequality is more likely to be significant. Moreover, the effect of unemployment on income inequality occurs when wage increases lag behind inflation and price increases outpace wage inflation, while income shifts from wage earners to profits. Such redistributive effects through inflation increase income inequality by hurting the poor comparatively more than the rich (Fischer and Modigliani, 1978; Laidler and Parkin, 1975). The limited impact of unemployment on income inequality in Türkiye indicates that labor markets are inflexible, and wage increases are determined depending on inflation.

The cost of reducing income inequality through populist policies is high inflation, and high inflation leads to more income inequality. This situation is called the "populist political spiral". In Türkiye, monetary and fiscal policies that improve the income status of low-income groups and thus reduce income inequality must not cause high inflation. Populist policies in Türkiye (expansionary monetary policy, high wage increases, increasing public expenditures, etc.) can reduce unemployment by creating a temporary vitality in the economy. Thus, it can reduce income inequality and, therefore, poverty. However, the inflationary effects of such a process should not be overlooked. Because the policies to be implemented to reduce high inflation (tight monetary policy, wage increases at a lower rate than inflation, limitation of public expenditures, etc.) will nullify the temporary gains in the economic vitality period. While monetary policy does not have a long-term effect on unemployment, it does have a lasting effect on increasing the volatility of average inflation and aggregate demand. Although inflationary monetary policy reduces unemployment in the short term, in the long run, high inflation and aggregate demand instability will adversely affect low-income earners and increase inequality in income distribution. To eliminate the distorting effects of inflation on income distribution in Türkiye, it is important to design social policies aimed at reducing poverty, as well as to fight inflation through a credible central bank that is independent of political influences, and to ensure permanent low inflation and price stability.

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- Conflict of interest: The Authors declares no competing interests.
- Data availability: All data and calculated data are based on publicly available databases. The full dataset is available on request from the author.
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