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THE RELATIONSHIP BETWEEN INCOME DISTRIBUTION, INFLATION AND ECONOMIC GROWTH: EXAMINING THE ASYMMETRIC RELATIONSHIP BASED ON THE KUZNETS HYPOTHESIS WITH FOURIER FUNCTIONS

Gelir Dağılımı, Enflasyon ve Ekonomik Büyüme İlişkisi: Kuznets Hipotezine Dayalı Asimetrik İlişkinin Fourier Fonksiyonlar ile İncelenmesi

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Keywords:
Income Distribution, Inflation, Economic Growth, Asymmetry, Fourier Functions.

JEL Codes:
B22, B23, C20, D63, O11.

Abstract

The relationship between inflation, economic growth, and income distribution in Türkiye is examined in this study. The F-ADL cointegration test was applied as the econometric method. The first result obtained is that economic growth has an increasing effect on income inequality. The second result is that inflation has a reducing effect on income inequality. The third result is that inflation and economic growth have an asymmetric relationship with income distribution. Economic growth initially has a positive effect on income inequality and then a negative effect beyond a certain threshold, indicating a "reverse U" shaped relationship. This result shows that the Kuznets hypothesis is valid in Türkiye. Regarding the relationship between inflation and income inequality, inflation initially has a negative effect, and then, after a certain threshold, the effect becomes positive, indicating a "U" shaped relationship. The findings are consistent with the literature. When relationships are linear, a single policy may be sufficient; however, in cases of asymmetric relationships, varied and multiple policies may be required. Thus, it is advisable to consider the asymmetry in the design of income distribution-regulating and welfare-enhancing economic policies.

Anahtar Kelimeler:
Gelir Dağılımı, Enflasyon, Ekonomik Büyüme, Asimetri, Fourier Fonksiyonlar.

JEL Kodları:
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Öz

Bu çalışmada Türkiye'de enflasyon, ekonomik büyüme ve gelir dağılımı ilişkisi incelenmiştir. Ekonometrik yöntem olarak F-ADL eş bütünleşme testi uygulanmıştır. Elde edilen ilk sonuç ekonomik büyümenin gelir eşitsizliğini artırıcı etkisi olduğudur. İkinci sonuç enflasyonun gelir eşitsizliğini azaltıcı etkisi olduğudur. Üçüncü sonuç ekonomik büyüme ve enflasyonun gelir dağılımı ile ilişkisinde asimetrik ilişkinin var olduğudur. Ekonomik büyüme gelir eşitsizliğini önce pozitif etkilemekte ve bir noktadan sonra negatif etkilemektedir. Bu durum "ters U" şeklinde bir ilişkiyi ifade etmektedir. Bu sonuç Kuznets hipotezinin Türkiye için geçerli olduğunu göstermektedir. Enflasyon ve gelir eşitsizliğini ilişkisinde ise enflasyon önce negatif etkilemekte bir noktadan sonra etki pozitif olarak gerçekleşmektedir. Bu durum enflasyon ve gelir eşitsizliği ilişkisinin "U" şeklinde olduğunu göstermektedir. Elde edilen sonuçlar literatürle uyumludur. İlişkiler doğrusal olduğunda zaman içerisinde tek bir politika yeterli olabilirken asimetrik ilişkilerde değişken ve çoklu politikalara ihtiyaç olabilmektedir. Bu sebeple gelir dağılımını düzenleyici ve refah artırıcı ekonomi politikalarının uygulamasında ilişkilerin asimetrik olabileceği gerçeği dikkate alınarak düzenlemelerin yapılması tavsiye edilir.

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1. Introduction

Inflation and income distribution are among the issues that are emphasized and studied in economic literature. In developing countries like Türkiye, high inflation can have negative effects on income distribution. A fair and balanced income distribution has an effect that increases social welfare. Increasing social welfare affects economic growth through different mechanisms. Some researchers argue that increasing income inequality negatively affects economic growth (Kravis, 1960; Hussain et al., 1994; Barro, 2000). However, some researchers such as Kuznets (1955) states that this negative effect can vary over time (Paukert, 1973; Papanek and Kyn, 1986; Campano and Salvatore, 1988; Ram, 1995; Dawson, 1997; Zang, 1998; Huang and Lin, 2007). The variable situation mentioned is due to asymmetry. Kuznets (1955) states that while income inequality increases in the early stages of economic growth, it decreases in later periods. Of course, this hypothesis has been applied by many researchers on different economies. Some researchers have also stated that this hypothesis may not be valid (Anand and Kanbur, 1993; Ogwang, 1995; Jacobsen and Giles, 1998; Gallup, 2012; Huang et al., 2012). The relationship between income distribution and economic growth, which is on the agenda of many researchers today, continues to be investigated.

An increase in inflation generally refers to an increase in the general price level. Increases in inflation levels change the purchasing power of individuals in different income groups. Inflation mostly negatively affects middle- and lower-income groups (Bach and Stephenson, 1974; Parkin and Laidler, 1975; Blinder and Esaki, 1978; Fischer and Modigliani, 1978; Cardoso et al., 1995; Easterly and Fischer, 2001; Romer and Romer, 1998). However, apart from the general acceptance, there are also studies indicating that inflation may not negatively affect income distribution (Doepke and Schneider, 2006; Adam and Zou, 2016; Herradi et al., 2023). There is no definitive consensus in the literature on the relationship between income distribution and inflation. However, a detailed examination of the relationship between inflation and income distribution can enable more effective formation of economic policies.

There are many studies on income distribution, inflation, and economic growth. Some of these studies focus on economic growth and income inequality, while others focus on inflation and income inequality. A much more limited number of studies have examined the effects of both inflation and economic growth on income inequality. This study aims to contribute to this limited literature.

The research has two contributions to the literature. First, as far as can be reached, the use of Fourier functions is quite new in the literature reviewed. The examination of the subject with the new econometric method will deepen the subject. The contribution of Fourier functions is that structural breaks can be captured softly. Considering the recent period, Türkiye has experienced important structural breaks such as natural disasters, pandemic outbreaks, and military uprisings. The traditional approach suggests adding a dummy variable to represent each structural break. It is quite difficult for the traditional approach to correctly reflect too many breaks to econometric models. Since Fourier functions are structures that can capture breaks without the need for sudden breaks and without knowing the starting date, there is no need for additional structural change studies in the model to be applied. Second, although the asymmetric effect of economic growth on income inequality has been studied in studies conducted on Türkiye, the asymmetric effect of inflation has not been studied. In this respect, the study fills the gap in the literature. Reconsidering

the effect of the high inflation that Türkiye has experienced in recent years on income distribution will contribute to the correct evaluation of the recent period.

In the planning of the study, firstly the theoretical information on the subject will be presented. Then the literature studies will be mentioned. In the following section, the methodology will be presented by introducing the data and hypotheses and the empirical results will be shared. In the conclusion section, there is a general evaluation.

2. Theoretical Backgrounds

2.1. Relationship between Inflation and Income Distribution

Periods of high inflation are processes that negatively affect the healthy functioning of the market, causing a decrease in purchasing power and changes in income distribution. Employers can easily add price changes to the price of their products for sale. Moreover, in addition to actual inflation, which depends on market characteristics, employers can also reflect expected inflation in their prices. In this sense, employers may have incomes equal to or perhaps above inflation (Bach and Stephenson, 1974:1). On the other hand, employee groups do not benefit from the reflection of expected inflation in wages. However, workers also receive income loss caused by inflation with a lag. This situation leads to significant income transfers between employers and employees.

Increases in the money supply are considered to be the direct cause of inflation. This phenomenon has been accepted in economic literature since the quantity theory of classical economics. An increase in the money supply at the rate of EG (Economic Growth) will not change the general equilibrium in the economy and will not lead to inflation. Countries increase their money supply more than necessary in certain periods for certain reasons. Since this situation will accelerate inflation, increases in money supply are considered a cause of INCI (Income Inequality). In addition to this situation, central banks set short-term interest rates to control monetary balances in the market and ensure price stability. Depending on the changes in the general economic situation (for example, the depreciation of the domestic currency due to the increase in the demand for foreign currency), it takes the interest rates out of the required range. This situation represents inflation created by central banks and has disruptive effects on income distribution. Richard Cantillon (1775) evaluated the effect of such increases in the money supply on INCI using a different approach. Once money is created, it is neither equally nor simultaneously distributed among individuals. This phenomenon, called the Cantillon Effect, is a concept that expresses that the new money created by the money supply goes to high-income groups and arrives very late to lower-income groups. This structure of the money supply indicates that the neutrality of money is disturbed. In this phenomenon, the excess money supply is expressed as new money. This new money falls primarily into the hands of one group. The effect channel is that this new money brings wealth to the group that acquires it before it causes inflation. This is the unjust enrichment of one group. On the other hand, the group that receives new money late receives new money after inflation has occurred. The second group will be impoverished as the purchasing power of the new money will decrease (Sieroń, 2017: 640). The Cantillon effect is an approach that expresses the deepening of the phenomenon that the money supply distorts the distribution of income through inflation.

Upon further examination of inflation and income distribution through macroeconomic variables, the phenomenon of unemployment becomes. This phenomenon, particularly emphasized by the Keynesian school, is referred to in the literature as the Phillips curve. As a result of rising inflation, wages increase. These wage increases are also a cost factor for employers (Shao and Silos, 2017: 127). Companies lay off some employees to control rising costs. This macroeconomic phenomenon causes the unemployment rate to increase in countries. This means that a certain group cannot earn an income. It is noteworthy that those who lose their jobs due to this type of unemployment are usually individuals who belong to the low-income group. (Blinder and Esaki, 1978: 604). In summary, inflation appears as a phenomenon that creates INCI by causing poor people to lose their jobs.

The increase in food prices is particularly important for low-income segments. Food makes up a larger share of the consumption basket of the poor. Since the share of food consumption of people in the high-income group is relatively small, it is not of great importance (Walsh and Yu, 2012: 6). With the increase in inflation, the purchasing power of the poor is mostly spent on food, leaving them unable to meet other necessities of life. Thus, inflation makes the poor poorer.

Another channel affecting inflation and INCI occurs in the asset market. Rising inflation due to the Pigou effect causes an increase in the nominal value of existing assets. This situation increases the nominal wealth of asset owners. However, there are different income groups in a country. Since lower-income groups that do not acquire assets do not have such assets, an increase in wealth cannot be expected (Muhibbullah and Das, 2019: 142). In addition, since lower income groups are the renters of assets and inflation increases the rental payments of these assets, lower income groups become poorer than before due to inflation.

Another channel is the imbalance between the borrower and the lender. Lenders transfer their resources to the borrower in exchange for a certain monetary benefit over a certain period of time. This monetary benefit includes expectations that arise when the act of lending takes place. However, if there is an increase in the rate of inflation, the increase in both actual and expected inflation causes the real return to the lender to decrease over time. This situation represents a transfer of resources from the lender to the borrower (Wolff, 2010; Mason and Jayadev, 2014; Kumhof et al., 2015).

When the relationship between inflation and INCI is assessed from a public finance perspective, several important issues emerge. The first is the relationship between inflation and the public budget. The real value of public claims declines due to the Olivera-Tanzi effect, especially in periods of high inflation. This phenomenon, which can cause a decrease in public revenues, also leads to budget deficits (Ruge-Murcia, 1999: 333). The occurrence of budget deficits can push policymakers toward contractionary fiscal policies. This means new taxes on individuals and firms. It is accepted that the increase in taxes has a distorting effect on income distribution and that low tax rates have a positive effect on income (Agranov and Palfrey, 2020: 1). The reason for this is that individuals in the high-income group have high wealth income and low wage income. On the contrary, low-income groups have high wage income and low wealth income (Taghizadeh-Hesary, 2020: 2605; Kim and Lin, 2023: 894). Since government revenue is generally collected from indirect taxes, the imposition of new taxes by the government will affect low-income people more. This situation highlights the possibility that changes in fiscal policy due to inflation may disrupt income equality. Larch (2012) provides evidence that INCI increases as a result of budget deficits.

2.2. Relationship between Economic Growth and Income Distribution

The impact of income distribution on growth has been a topic of interest to researchers for some time. It is based on the income-expenditure-production relationship predicted by the classical economic approach. A sufficient increase in income in the economy and the transformation of income into expenditure is a factor that triggers production. Income distribution refers to the fact that the income earned in the country is not distributed among the rich and the poor in certain percentages and according to the desired standards. Consequently, income is distributed to high-income groups, and production is not stimulated to the desired level. This transmission mechanism is generally based on the assumption that a deterioration in income distribution will negatively affect EG. Barro (2000: 6) makes a similar point, emphasizing in particular the low borrowing capacity of the segment negatively affected by income distribution. Barro states that the deterioration of the financial system has a negative impact on income distribution and emphasizes that this situation will affect EG. It is argued that a flow of income and wealth from the rich to the poor will increase the efficiency of production as the poor benefit from the financial system through inflation. Hussain et al. (1994: 1947) emphasized that deterioration in income distribution has significant effects, especially on households. The study also found that INCI increases, and rural-urban households lag behind in development. Kravis (1960: 416) discussed the impact of deterioration in income distribution on tax revenue. In the study, it was stated that the deterioration in income distribution affects not only individual income such as wages, interest, rents, but also all types of income. Such a deterioration in income is expected to have a negative impact on EG, as it will have a negative impact on tax revenues.

Kuznets (1955: 8) brought a new hypothesis to the idea that the deterioration of the commonly accepted income distribution will have a negative impact on EG. In his study of the USA, England, and Germany, the author examined the effect of EG on INCI. It is found that INCI increases in the initial stage of EG, and after economic development reaches a certain level, INCI decreases. The sudden decrease in INCI and increase in EG in the US and England after World War I was the main motivation for Kuznets' work (Gallup, 2012: 1). While the agricultural sector initially dominated the economy, income in this sector was low, but inequality was low. Over time, industrialization increases. However, although income in industry is high, inequality is also high. As economies transition from agriculture to industry, EG increases, but inequality also increases. However, with continued growth, population growth, and technological development, the income from savings by high-income earners will decrease, and the income from production and entrepreneurship will increase. Thus, INCI will decline (Kuznets, 1955: 10). Over time, studies have emerged that support Kuznets' ideas (Paukert, 1973; Papanek and Kyn, 1986; Campano and Salvatore, 1988; Ram, 1995; Dawson, 1997; Zang, 1998; Huang and Lin, 2007). However, some studies show that INCI is not in an inverted U-shape as described by Kuznets. (Anand and Kanbur, 1993; Ogwang,1995; Jacobsen and Giles, 1998; Gallup, 2012; Huang et al., 2012).

3. Literature Review

Fischer and Modigliani (1978) state that inflation has a negative effect on INCI. In particular, the authors state that lower-income groups suffer more than higher-income groups, and that inflation has shifted income from the wage group, which is the lower-income group, to the wealth group, which is the higher-income group. Cardoso et al. (1995) conclude that high inflation

in Brazil in the 1980s significantly eroded the incomes of low-income people. Easterly and Fischer (2001) concluded that inflation is positively related to poverty, based on some 32,000 household observations in 38 countries. There are also studies that find the opposite of the above. Bach and Stephenson (1974) assessed the issue in terms of debtor-creditor relations. The authors state that income shifts occur due to a decline in the real value of debt during periods of high inflation. The authors state that this income transfer occurs from the business world to wage earners. The authors state that during the high inflation period during World War II, 1.2 trillion dollars in the USA was transferred to the lower income group in this way. Parkin and Laidler (1975) study on the USA found that inflation was negatively related to INCI. As a result, authors stated that lower- and upper-income groups were affected more than income groups. It was stated that the group that was relatively unharmed was middle-income earners. Blinder and Esaki (1978) examined how inflation affected incomes between income groups. As a result of the analysis made in 5 different percentiles, income shifts due to inflation were observed from the upper-income group to the middle-income group. However, similar results are not valid for lower-income groups. In the study, no income transition from the middle-income group to the lower-income group was observed. These results differ considerably from previous results. Romer and Romer (1998), in the relationship between monetary policy and the welfare of the poor, state that steadily growing aggregate demand and low levels of inflation increase the welfare of the poor. The interesting result is that expansionary monetary policy temporarily reduces poverty in the short run. The authors explain that the effects are temporary because expansionary policies cannot permanently increase output in the long run and cannot exceed the natural rate. On the contrary, it has been found that when contractionary policies are implemented, inflation falls, and this increases poverty.

Although it is generally accepted that inflation damages low-income groups, Doepke and Schneider (2006) have suggested that in the US, individuals in the low-income group are better protected than those in the high-income group because low-income group holds government bonds. Herradi et al. (2023) examined the impact of inflation on high-income households in 14 developed countries. The results show that inflation negatively affects high-income groups in developed countries. Another study, which concludes that lower-income groups are protected from INCI, was conducted by Adam and Zou (2016). It is parallel to the study of Parkin and Laidler (1975) in its approach and conclusion. As a result, it is stated that middle-class young people in the euro area are largely unaffected by inflation. In the study on China, Xu et al. (2024) conclude that the effect of expansionary and contractionary monetary policy on income distribution is neutral.

Some of the studies that examine the asymmetric relationship between inflation and income inequality indicate that the relationship is in the form of a "U" (Aktas and Dokuzoglu, 2022; Monnin, 2014). Aktas and Dokuzoglu (2022) investigated the relationship between inflation and income inequality in 40 developed and developing countries. The study examined the relationship according to different threshold levels. As a result, it was determined that it had a negative effect up to a certain threshold value and a positive effect after this threshold value. Monnin (2014) examined income inequality with the basic variables of income, unemployment, and inflation and control variables in a study on OECD countries. The square of the income and inflation variables was included in the model for the asymmetric effect. An important point that distinguishes this study from the examples in the literature is that the inflation and income variables were separated into components using the HP filter. Inflation trend, inflation cycle and inflation gap were

examined in three components. In addition, the GDP variable was separated into its components with the same method. As a result, it was determined that income inequality for OECD countries has a nonlinear structure in the form of an inverted U. 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 obtained relatively close to each other by both inflation and economic growth.

Some studies indicate that the inflation-income inequality relationship is in the form of an inverted "U" (Balcilar, 2018; Uspri et al., 2023). Uspri et al. (2023) investigated the relationship between income inequality and inflation in Indonesia. In the study, the authors examined income inequality with inflation and growth variables. In addition, the authors used the square of inflation as an independent variable and investigated the asymmetric structure. The result obtained is that income inequality is in the form of an "inverted U". The effect of inflation on income inequality was determined as positive, while the effect of its square was determined as negative. Another important issue is that the effect of inflation on income inequality is higher than economic growth. Balcilar (2018) analyzed the US states with a semiparametric approach. As a result, a negative relationship was determined between the inflation rate and income inequality. The relationship was determined to be positive after a threshold value.

In the groundbreaking article published by Acemoglu and Robinson (2002), it is stated that the difference between the rich and the poor in countries is very large. It states that the possibility of people taking action and causing problems increases with the increasing course of inequality. It emphasizes that economic decision-makers tend to prevent inequality with monetary and fiscal policies during the period when inequality is at its highest. Thus, it states that the relationship is in the form of an “inverted U”. The meaning of the expression is that inequality first increases and then decreases with intervention.

There is evidence in the literature that economic growth and income inequality occur in an inverted U shape (Bulíř, 2001; Zhou and Li, 2011; Argun, 2017; Emek, 2019; Siami-Namini and Hudson, 2019). Siami-Namini and Hudson (2019) examined the relationship between income inequality and inflation in developed and developing countries. The econometric model and variables are parallel to the Monnin (2014) study. The difference is that separate regressions were created for the components of both inflation and economic growth variables. As a result, it was determined that income inequality had a nonlinear feature for both country groups. While the Kuznets hypothesis was not valid in developed countries, it was found to be valid in developing countries. Emek (2019) examined the macroeconomic factors affecting income inequality in 17 developing countries. As a result, the validity of the Kuznets hypothesis was confirmed. In addition, it was determined that inflation has a decreasing effect on income inequality, while unemployment has an increasing effect on income inequality. Argun (2017) conducted an analysis on 10 developing countries. As a result, it was determined that the Kuznets hypothesis was valid in these countries. In addition, it was stated in the study that inflation and trade volume also had a decreasing effect on income inequality. Zhou and Li (2011) conducted a semiparametric analysis of the relationship between inequality and development in 75 countries. As a result, it was determined that the Kuznets hypothesis was valid. In addition, it was stated in the study that trade and inflation increased inequality. Bulíř (2001) examined income inequality in the USA. In the study, the validity of the Augmented Kuznets Hypothesis was tested. In the regression model applied, economic growth and inflation variables expected to affect income inequality were used

together with control variables. For asymmetry effects, the square of the income variable was added to the model. As a result, it was determined that income inequality in the USA had a nonlinear structure in the form of an inverted U.

In the relationship between economic growth and income inequality, some studies have found a "U" shaped relationship (Monnin, 2014; Dincer, 2016; Akarsu, 2023; Herradi et al., 2023). Dincer (2016) investigated the relationship between inflation and income inequality in the USA. An econometric model was created in the study with the Kuznets approach. The square of the income and unemployment variables was used as explanatory variables. The result obtained is that income inequality is "U" shaped. The level value of the variables is positive, and their squares are negative. Another important result of the study is that the effect of economic growth on income inequality is higher than inflation and unemployment. Akarsu (2023) created an income inequality regression for the USA. The explanatory variables are economic growth, inflation and unemployment. The asymmetric effect was created with the square of economic growth. As a result, it was determined that income inequality has a U-shaped structure. Shahbaz et al. (2010) found that there is no asymmetric relationship between inflation and income inequality. Shahbaz et al. (2010) examined inflation, growth, and income inequality in Pakistan. In the study, the asymmetric relationship was investigated by including the squares of the economic growth and trade openness variables in the model. No asymmetric structure was found in the effect of inflation on income inequality. In the effect of trade openness, a relationship was found that first became positive and then negative.

It is seen that different results are obtained in the studies conducted for Türkiye. In the relationship between economic growth and income distribution, Takim et al. (2020), Ayla and Karis (2021), Durak and Akalin (2022) studies have determined that there is a positive relationship between economic growth and income inequality in Türkiye. These results show that economic growth is an important factor in reducing income inequality. However, Pece et al. (2016) and Yilmaz and Demirgil (2021) studies have determined a negative relationship between economic growth and income inequality. Some studies have addressed the situation with the Kuznets approach. Of these, Yeter and Demirgil (2024), Torusdag and Barut (2020), Akalin et al. (2018), Akinci and Akinci (2016) studies have concluded that the Kuznets hypothesis is valid for Türkiye. The common results of the studies are that increases in economic growth first positively affect income inequality, but after a threshold value, the effect becomes negative. Some studies have found findings that the Kuznets hypothesis is not valid in Türkiye. Gocen (2021), Abdioglu et al. (2019), Ak and Altıntas (2016) and Disbudak and Suslu (2009) found that increases in economic growth first negatively affected income inequality, and then the effect became positive. Another important issue is the effect of inflation on income inequality. In studies conducted on Türkiye, Naimoglu (2023), Ozbek and Ogul (2022), Pata (2020), Bayraktar et al. (2019), Destek et al. (2017) concluded that increases in inflation had an increasing effect on income inequality. Keskin (2022) and Kanberoglu and Arvas (2014) have found that inflation reduced income inequality. No studies investigating the relationship between inflation and income inequality within the framework of the Kuznets hypothesis were identified.

4. Empirical Analysis

4.1. Data and Hypothesis

The model to be used in the study was derived from the studies of Monnin (2014) and Siami-Namini and Hudson (2019). These are the studies that examine the asymmetric relationships between INCI, inflation and EG. These studies have adopted the same approach with examples from different countries. This study also examines the relationships in Türkiye with the same vision.

$$Gini_t = \beta_0 + \beta_1 Gdp_t + \beta_2 (Gdp)_t^2 + \beta_3 Inf_t + \beta_4 (Inf)_t^2 + \vartheta_T X_t + \mathrm{u}_t \quad (1)$$

The basic structure of the model to be used in the study is shown in equation (1). The basic model considers INCI as a dependent variable and EG and inflation as independent variables. Other variables were included in the model as control variables. The details of the variables used in the study are shown in Table 1. The study was conducted with the data of Türkiye for the period 1988-2022. The reason why the study is conducted in this period is because the Gini index data are available in this period from the WID database.

Table 1. Variables and Explanations

Variables	Explanations	Source
Gini	Gini Index	World Inequality Database (WID)
Gdp	Real GDP per capita (annual %) (current $)	World Bank, World Development Indicators Database (WDI)
Gdp^2	Square of GDP variable	
Inf	Consumer price index, CPI (annual %)	
Inf^2	Square of CPI variable	
Op	Trade openness (% of GDP)	
Un	Unemployment rate (% of total labor force)	
Inv	Gross fixed capital formation (% of GDP)	

The *Gini* coefficient is an index that generally measures INCI. The index in question takes a value between the numbers 0 and 1. As known from the Lorenz curve, when the index approaches 1, the inequality is high, and when it approaches 0, the INCI is decreasing. The *Gdp* variable represents EG, and the Gross Domestic Product per capita variable is used. A deflator has been used to make the data real. Gdp^2 is the square of the specified real GDP per capita variable. The *Inf* variable represents inflation. Percentage increases in the Consumer Price Index were used as inflation. The expression Inf^2 refers to the square of inflation. X denotes control variables. The control variables were defined as unemployment and trade openness and investment, following the original studies. Four different hypotheses are tested in this study.

H_{a1}: Economic growth has an impact on income inequality

H_{a2}: Inflation has an impact on income inequality.

H_{a3}: The relationship between economic growth and income inequality is asymmetrical.

The existence of the Kuznets inverted U-shape is determined according to the status of β_1 and β_2 coefficients specified in equation (1). If $\beta_1>0$ and $\beta_2<0$, the validity of the Kuznets hypothesis is confirmed. This result also indicates that there is an asymmetric relationship between INCI and EG (Siami-Namini and Hudson, 2019: 618).

H_{a4}: The relationship between inflation and income inequality is asymmetrical.

Depending on the status of β_2 and β_3 coefficients in equation (1), the existence of an asymmetric relationship between inflation and INCI is determined. It states that if $\beta_3<0$ and $\beta_4>0$, there is an asymmetric relationship between INCI and inflation (Shahbaz et al., 2010: 53).

Kuznets (1955) examined the relationship between INCI and growth. As a result, it is stated that INCI increases as a result of increasing EG and after a certain point, the relationship reverses. The literature refers to this asymmetric relationship as the inverted U-curve hypothesis. The positive effect of increasing EG on INCI in the early periods indicates the transition from an agricultural to an industrial society. Over time, EG transitions to a structure that reduces INCI due to the positive spillover effects of productivity growth in the industrial sector to both the agricultural, manufacturing, and service sectors (Amri, 2018: 10).

Table 2. Descriptive Statistics

	Gini	Inf	GDP	Un	Op	Inv
Mean	61.47	35.69	5.654	9.428	49.77	25.56
Median	61.23	15.75	6.273	9.290	48.79	26.19
Maximum	67.26	105.2	7.602	13.67	81.17	29.85
Minimum	57.68	6.250	3.062	6.260	30.47	17.95
St. Dev.	2.240	32.52	1.567	1.961	10.54	3.229

The maximum value of the *Gini* variable in the dataset, 67.26, belongs to 1988. The value, which was relatively high until the early 2000s, decreased from 2002 to 2015. In the following years, an increase can be observed. The lowest value, 57.68, belongs to 2007. The *Inf* variable expresses the percentage increase in consumer inflation. The value, which remained around 60% towards the 1990s, reached the highest value of the period with a maximum value of 105% in 1994. In the following periods, decreases in inflation are observed. In 2005, the annual increase reached 8%. The increasing value from year to year in the following periods is seen as 72% in 2022, which is the last year. The maximum value of EG is 7.60, the minimum value is 3.06 and the average value is 5.65. The *Un* variable represents the unemployment rate. Unemployment, which was around 8% in the 1990s, remained at values close to 10% in the 2000s and rose suddenly to 12.55 in 2009. Although it decreased in the following years, it reached its maximum value of 13.67 in 2019. Unemployment decreases in the following years. Trade Openness (*Op*) was seen at values close to 30% in the 1990s. There are relative increases from year to year. The highest value of 81.17% belongs to 2022. They show that Türkiye's trade volume is increasing steadily. The ratio of investment to national income (*Inv*), which was between 22-26% in the 1990s, reached its minimum value of 17.95% in 2001. The maximum value of 29.85% of the investment, which increased year by year in the following period, belongs to 2022, which is the last year.

4.2. Research Methodology

The Fourier ADL test is a cointegration test created using Fourier terms. This test is called F-ADL as used in the study of Banerjee et al. (2017). The working principle starts with the use of Fourier terms expressed in equation (2).

$$h(t) = \lambda_0 + \zeta_1 \sin\left(\frac{2\pi kt}{T}\right) + \zeta_1 \cos\left(\frac{2\pi kt}{T}\right) \quad (2)$$

In equation (2), the expression h represents the entirety of the deterministic terms. The Fourier terms to be used in the cointegration test are specified as sin and cos. In equation (2), k represents the optimum frequency value; t represents the trend; π represents the constant pi value; T represents the number of observations. The optimum frequency value is accepted as the value that minimizes the residual sum of squares (Yilanci et al., 2020: 21).

$$\Delta y_{1t} = \lambda_0 + \zeta_1 \sin\left(\frac{2\pi kt}{T}\right) + \zeta_1 \cos\left(\frac{2\pi kt}{T}\right) + \delta_1 y_{1,t-1} + \gamma'_2 y_{2,t-1} + \Phi' \Delta y_{2t} + \mu_t \quad (3)$$

The Fourier ADL test procedure is as specified in equation (3). γ, Φ and y_{2t} are explanatory variables and nx1 vectors of parameters. The frequency value expressed as k is used as an integer expression such that $1 \leq k \leq k_{max}$ and k_{max}=5. The procedure for using integers is based on the procedure envisaged in the study of Enders and Lee (2012). The null hypothesis is that there is no cointegration (H_0: $\delta_1 = 0$). The alternative hypothesis states that there is cointegration (H_1: $\delta_1 < 0$). This procedure is used in the use of the t-test. In the use of the F test, the null hypothesis is checked with a Wald test that the explanatory variables are equal to each other and to zero (H_0: $\delta_1 = \gamma = 0$). The obtained test statistic is compared with Table 1a for the model with constant, and with Table 1b for the models with constant and trend together. When the test statistic is greater than the table value, the alternative hypothesis is accepted to be valid (Banerjee et al., 2017: 117).

4.3. Findings

In this part of the study, firstly the results of a unit root test with a break for the variables and then the Fourier Unit Root test results will be given and compared. Then, the results of the F-ADL cointegration test, long-term coefficients, and short-term error correction model will be given respectively.

Table 3. Unit Root Test Results

Variables		Perron (1997) Unit Root test with breaks			
		Level		Δ	
		Constant	Constant & Trend	Constant	Constant & Trend
Gini	Stat.	-4.00	-3.51	-5.79***	-5.74***
	Break. Date	(2004)	(2003)	(2005)	(2005)
Inf	Stat.	-2.50	-2.65	-4.47**	-5.04***
	Break. Date	(1998)	(2021)	(2020)	(1994)
Inf^2	Stat.	11.94***	-5.90***	-7.61***	-9.47***
	Break. Date	(2021)	(2021)	(1994)	(1994)
Gdp	Stat.	-2.41	-1.67	-5.52***	-6.56***
	Break. Date	(2001)	(2002)	(2013)	(1998)
Gdp^2	Stat.	-2.15	-1.37	-5.97***	-6.69***
	Break. Date	(2021)	(2002)	(2013)	(2002)
Un	Stat.	-4.38*	-4.57	-4.96***	-4.93***
	Break. Date	(2000)	(2000)	(2009)	(2009)
Trd	Stat.	-1.56	-3.88	-5.26***	-5.66***
	Break. Date	(2017)	(2021)	(2015)	(1997)
Inv	Stat.	-4.16	-4.53	-6.81***	-6.64***
	Break. Date	(2010)	(1998)	(2009)	(1999)
Critical Values	1%	-4.94	-5.34	-4.94	-5.34
	5%	-4.44	-4.85	-4.44	-4.85
	10%	-4.19	-4.60	-4.19	-4.60

Note: ***, ** and * symbols refer to 1%, 5% and 10%.

Table 3 presents the unit root with structural break test result. The analysis was carried out in two structures: both constant and constant and trend. As a result of the test, it was determined that inf^2 and *Un* variables were I(0), stationary at the level; other variables were I(1), stationary in difference.

Table 4. Fourier Unit Root Test Results

Var.	co./ co+tr	k	Lag	SSR_{min}	Sin. t stat.	Cos. t stat.	F (Wald)	Linear/ Nonlinear	Fourier ADF Stat.	ADF Stat.	I(0)/ I(1)
Gini	co.	5	0	16.087	0.95	0.11	0.45	Linear	-	-2.04	I(1)
Gini	co+tr	1.6	6	15.177	-4.07[a]	-5.08[a]	10.75[a]	Nonlinear	-3.47	-	I(1)
Inf	co.	1	14	3837.8	10.97[a]	-9.32[a]	97.80[a]	Nonlinear	-9.67[a]	-	I(0)
Inf	co+tr	0.1	4	3613.4	-2.01[c]	1.54	9.37[b]	Nonlinear	-3.23	-	I(1)
Inf^2	co.	1	13	637462	-7.76[a]	6.81[a]	31.46[a]	Nonlinear	-5.29[a]	-	I(0)
Inf^2	co+tr	0.1	5	629325	-8.62[a]	-8.43[a]	24.28[a]	Nonlinear	-6.61[a]	-	I(0)
Gdp	co.	1	10	3.4341	-4.26[a]	3.11[b]	10.91[a]	Nonlinear	-4.60[a]	-	I(0)
Gdp	co+tr	0.9	10	394.92	-4.18[a]	1.20	12.06[a]	Nonlinear	-4.56[b]	-	I(0)
Gdp^2	co.	1	12	402.73	-4.94[a]	3.67[b]	24.76[a]	Nonlinear	-4.43[a]	-	I(0)
Gdp^2	co+tr	0.9	10	394.92	-3.70[a]	1.38	10.96[b]	Nonlinear	-4.88[a]	-	I(0)
Un	co.	2.4	9	32.600	5.39[a]	-1.20	15.04[a]	Nonlinear	-3.25[b]		I(0)
Un	co+tr	2.5	9	27.039	2.74[b]	-2.65[b]	13.88[a]	Nonlinear	-0.88	-	I(1)
Trd	co.	0.1	8	665.43	-2.99[a]	-3.13[a]	4.95	Linear	0.30	0.25	I(1)
Trd	co+tr	0.1	7	468.59	-3.25[a]	2.98[a]	13.58[a]	Nonlinear	-3.35	-	I(1)
Inv	co.	3.7	7	110.68	-3.28[a]	0.04	5.38	Linear	0.82	-1.89	I(1)
Inv	co+tr	3.5	0	90.303	3.13[a]	1.02	5.18	Linear	0.81	-3.02	I(1)

Note: The expressions a, b and c above the numbers indicate 1%, 5% and 10% statistical significance, respectively. In addition, co represents constant; co+tr represents constant and trend; k represents optimal frequency value; SSR represents minimum residual sum of squares.

In Table 4, the Fractional Frequency Fourier ADF test proposed by Bozoklu et al. (2020) was applied. Bozoklu et al. (2020) determined the frequency range as $0.1 \leq k \leq 5$. The frequency change value ($k_t - k_{t-1}$) is 0.1. Bozoklu et al. (2020) further developed the Fourier tests created before it. For example, the study of Enders and Lee (2012) used the frequency value as an integer, and the study of Omay (2015) accepted the maximum value of the frequency as 2 despite using fractional frequency. The test proposed by Bozoklu covers a wider frequency range than the previous tests.

The study of Enders and Lee (2012) was used for the maximum lag length ($p \leq T/2$) and the critical values used to test the validity of the F Wald test. Bozoklu et al. (2020: 10-11) Table A and Table B were used for the significance of the Fourier ADF statistics. In addition, Bozoklu et al. (2020: 6) state that at least one of the Fourier terms must be statistically significant for the validity of the test. For this reason, the t-statistic significances were given by adding the sin and cos columns to Table 4. Accordingly, it is seen that at least one of the trigonometric terms of the variables stated to have nonlinear properties in Table 4 is significant. This result is an important measure of the validity of the test.

Table 4 results show that *inf*, Inf^2, *Gdp*, Gdp^2, Un variables are I(0), stationary at the level. *Gini*, *Trd* and *Inv* variables are I(1), stationary at the difference. Unit root tests investigate whether variables can return to their mean. Since variables that are stationary at level return to their mean, it is accepted that the changes in the variable are temporary. In the opposite case, which is

differential stationarity, the changes experienced in the variables are evaluated as permanent. Accordingly, according to the structural break test results, only Inf^2 and *Un* variables are stationary in Türkiye. Thus, the effects on these variables are temporary. However, the Fourier test showed that *Inf*, Inf^2, *Gdp*, Gdp^2, *Un* variables are stationary. Thus, according to the Fourier test, these variables are temporary. These results show that Fourier tests make more sensitive measurements than traditional tests. According to the results obtained, when a policy is desired to be determined, it is not necessary to recommend a policy for variables whose changes are temporary, while it is necessary to recommend a policy for variables whose changes are permanent. Applying a policy to a variable whose changes are temporary may lead to unexpected results in economic terms. Therefore, it is vital for economic applications that the tests are accurate and up to date. In this example, where structural break and Fourier tests are applied, it is seen that Fourier tests provide more precise measurements when added to unit root tests.

Table 5. F-ADL Cointegration Test Results

		F test: 7.65* **	**Opt. Freq. V.**
Critical Values	1%	5.01	(2) AIC (1.33)
	5%	5.34"	

Note: *** symbol refers to 1%. The critical values were derived from the study by Banerjee et al. (2017).

Table 5 present F-ADL cointegration test result. If the F-test is greater than the specified critical values, it means that the null hypothesis that there is no cointegration is rejected. According to Table 5, since $F_{est}>f_{critic}$, the H_0 hypothesis has been rejected. It can be seen that there is a cointegration relationship between the variables.

Table 6. Long-run Coefficients of F-ADL Cointegration Test

Variables	**Coef.**	**St. E.**	**t. Stat**	**Prob.**
Gdp	4.039**	1.765	2.288	0.045
Gdp^2	-0.618***	0.149	-4.148	0.002
Inf	-0.136***	0.031	-4.356	0.001
Inf^2	0.0003*	0.000	2.085	0.063
Un	0.081	0.115	0.704	0.497
Op	-0.026*	0.012	-2.209	0.051
Inv	-0.028	0.019	-1.478	0.170

Note: ***, ** and * symbols refer to 1%, 5% and 10%.

Table 6 presents the long-run coefficients of cointegration. According to the table, other variables than *Un* and *Inv* are statistically significant. The variable that has the strongest effect on the dependent variable, *Gini*, is *Gdp*. The level value of the variable *Gdp* positively affects the dependent variable. Gdp^2 has a negative effect on the dependent variable. This indicates that the Kuznets hypothesis is valid. INCI first becomes positive, then reaches a certain level, and then becomes negative. This is the inverted U-shape described. Moreover, the fact that the *Gdp* variable has a positive coefficient and the *Gdp* variable has a negative coefficient and is statistically significant ($\beta_1>0$ and $\beta_2<0$) confirms the existence of an asymmetric relationship between growth and INCI. Another important result is related to the inflation variable. While the *Inf* variable had a negative impact on INCI, the Inf^2 variable had a positive impact on INCI. The structure of INCI predicts a U-shaped relationship, first negative and then positive. The fact that the *Inf* and Inf^2 variables have different coefficient signs and are statistically significant ($\beta_3<0$ and

$\beta_4>0$) confirms the asymmetry of the relationship. Among the control variables, only the *Op* variable is significant. It has a negative sign of the coefficient. This indicates that inequality in income distribution has decreased as a result of increasing trade volume. The leading frameworks addressing the relationship between trade and income inequality are the Heckscher-Ohlin and Stolper-Samuelson theorems. The Heckscher-Ohlin theorem assumes that countries export using the abundant factors of production available to them. Developing countries export unskilled labor-intensive goods and import skilled labor-intensive goods. Thus, with the increase in trade, export revenues shift more to the factor that produces unskilled goods. The Stolper-Samuelson theorem argues that the production factor used intensively to produce that product will benefit more from the increase in the price of a good. Thus, if the price of a labor-intensive good increases, the income from this price increase will again shift to the labor sector (Demir et al., 2012: 168; Lin and Fu, 2016: 129). The assumptions in both theories support each other and theoretically assume that trade can cause a decrease in income inequality. The negative relationship between trade and income inequality obtained for Türkiye is in line with theoretical expectations.

Table 7. Error Correction Model Results

Variables	Coef.	St. E.	t. Stat	Prob.
C	0.976***	0.096	10.16	0.000
@Trend	-0.113***	0.014	-7.632	0.000
ΔInf	-0.029	0.018	-1.594	0.141
ΔInf^2	-0.0002	0.0001	-1.507	0.162
ΔGdp	1.019	1.097	0.928	0.375
ΔGdp_{-1}	-0.763***	0.183	-4.155	0.002
ΔGdp^2	-0.298***	0.093	-3.206	0.009
ΔUn	-0.043	0.065	-0.659	0.524
ΔUn_{-1}	0.392***	0.069	5.623	0.000
ΔOp	0.010	0.016	0.659	0.524
@COS	-0.027***	0.002	-10.78	0.000
@SIN	-0.010***	0.001	-6.657	0.000
ECT	-1.473***	0.144	-10.20	0.000

Note: ***, ** and * symbols refer to 1%, 5% and 10%.

Table 7 presents the results of the error correction model created to detect short-term relationships. This is the error correction term, which is denoted by the abbreviation ECT. The fact that the sign of the coefficient is negative and statistically significant indicates the accuracy of the model. According to Table 7, the error correction term of -1.473 indicates that short-term errors fluctuate and reach long-term equilibrium. The terms Cos and Sin are significant. This indicates the validity of the Fourier model. When the coefficients are evaluated, statistically significant variables cannot be evaluated accurately because the variables exhibit a positive effect at one level and a negative effect at another level.

Table 8. Diagnostic Tests

Tests	Stat.	Prob.	Decision
Breusch-Pagan-Godfrey	14.80	0.73	No heteroscedasticity problem
Breusch-Godfrey	0.30	0.57	No autocorrelation problem.
Jarque-Bera	4.73	0.09	Have normal distribution properties
Ramsey RESET	0.96	0.33	Does not have excluded variables and no specification error
Cusum and $Cusum^2$	See Appendix-I for graphics.		No structural break

Table 8 presents the results of the diagnostic tests employed to assess the validity of the applied model. These results demonstrate that the model exhibits no autocorrelation or heteroscedasticity, is normally distributed, contains no excluded variables, and does not exhibit structural breaks.

The first finding obtained from the study is that economic growth has an increasing effect on income inequality. The finding is consistent with the results of the studies on Türkiye by Takim et al. (2020), Ayla and Karis (2021), Durak and Akalin (2022). The second finding is that the Kuznets hypothesis is valid. This finding is consistent with the results of Yeter and Demirgil (2024), Torusdag and Barut (2020), Akalin et al. (2018), Akinci and Akinci (2016). The third finding is that inflation has a reducing effect on income inequality. This finding is consistent with the results of Keskin (2022) and Kanberoglu and Arvas (2014). Since no study investigating the asymmetric relationships between inflation and income inequality could be identified, a comparison could not be made. The fourth finding is that trade volume reduces income inequality. This finding is consistent with the results of Kuscuoglu and Cicek (2021), Topuz and Dagdemir (2020), Disbudak and Suslu (2009).

5. Conclusion

The aim of this study is to determine the effects of asymmetric relations in economic growth and inflation on income distribution. Türkiye was selected for the study. The reason for choosing Türkiye is the high inflation. Within the scope of the issues explained in detail in the theoretical section, inflation is a fundamental factor affecting the general macroeconomic order and ultimately economic growth. In addition, as far as can be reached, an inflation-gini relationship created by inflation and the square of inflation has not been studied in Türkiye before. It is aimed to contribute to the literature in this respect. The data set created covers the period 1988-2022. The reason for the limitation in this date range is that the income inequality data was served in this date range. This issue is a limitation of the study.

The econometric model investigated in the study is derived from the studies of Bulíř (2001), Shahbaz et al. (2010), Dincer (2016), Siami-Namini and Hudson (2019), Monnin (2014), Uspri et al. (2023). These studies focused on the impact of asymmetry in inflation and economic growth on income inequality.

The study investigated the answers to 4 research questions. The first of these questions is the effect of economic growth on income inequality. According to the analysis results, economic growth increases income inequality. In addition, it has been determined that economic growth has a stronger effect than other factors affecting income inequality. When compared with the literature, it is consistent with the studies of Takim et al. (2020), Ayla and Karis (2021), Durak and Akalin (2022).

The second research question is the effect of inflation on income inequality. As a result of the study, it was determined that increases in inflation reduce income inequality. It is thought that the improving effect of inflation on income distribution is related to the recent period of low interest rates in Türkiye. It is known that low interest rates are an important opportunity for low-income groups to acquire wealth. As predicted by the studies of Wolff (2010), Mason and Jayadev (2014) and Kumhof et al. (2015), income transfers from lenders to borrowers may have occurred. For this reason, if such a relationship has occurred, the study of Barro (2000) that the changes in

the financial system improved their economic situation through inflation will be supported. The results are consistent with the studies of Keskin (2022) and Kanberoglu and Arvas (2014).

The third research question is the existence of an asymmetric relationship between economic growth and income inequality. The situation where economic growth positively affects income inequality, and the square of economic growth negatively affects income inequality supports Kuznet's inverted U-shaped hypothesis. The statistical significance of the coefficient signs of the applied cointegration test in the long run shows that economic growth affects income inequality in an inverted U-shaped structure for Türkiye. This situation also confirms the asymmetric relationship between economic growth and income inequality. The finding is consistent with the results of Yeter and Demirgil (2024), Torusdag and Barut (2020), Siami-Namini and Hudson (2019), Emek (2019), Akalin et al. (2018), Argun, (2017), Akinci and Akinci (2016), Zhou and Li (2011) and Bulíř (2001).

The fact that inflation negatively affects income inequality, and the square of inflation positively affects income inequality indicates that there is an asymmetric relationship between income inequality and inflation (Shahbaz et al., 2010: 53). The long-term coefficient signs of the applied cointegration test and the finding of statistical significance show that inflation affects income inequality in a U-shaped structure for Türkiye. This also confirms the asymmetric relationship between inflation and income inequality. When the empirical results of this study are compared with the following literature, it is seen that they are consistent with Aktaş and Dokuzoglu (2022) and Monnin (2014).

The results of the study contribute to the understanding of the complex relationships between income inequality, inflation, and economic growth. The analysis shows that there are significant relationships between income inequality, inflation, and economic growth. These results are consistent with the studies in the literature.

These findings highlight important issues to be considered in the formulation and implementation of economic policies. Inflation and economic growth should be taken into account in the implementation of policies aimed at reducing income inequality. We recommend that the strong relationship between economic growth and income inequality should be taken into account in the formulation and implementation of expansionary monetary and fiscal policies. The results of this study can guide future research and provide important guidance to policymakers.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement
I am a single author of this paper. My contribution is 100%.

Declaration of Researcher's Conflict of Interest
There is no potential conflicts of interest in this study.

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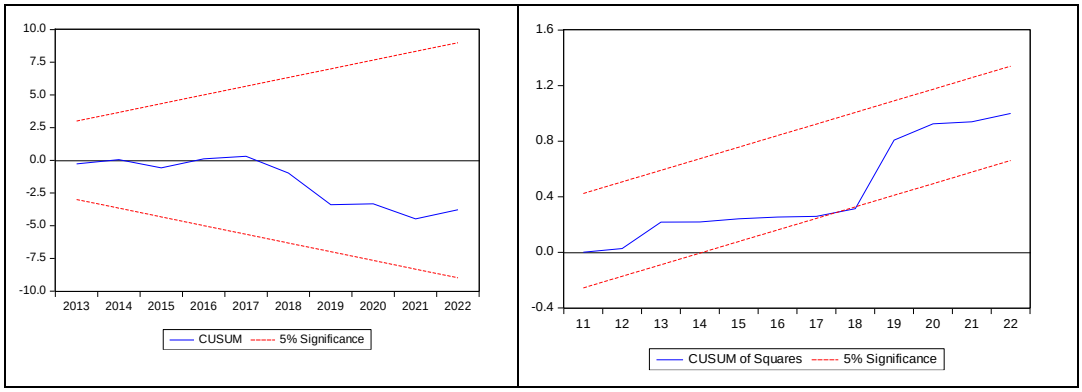
APPENDIX-I



Graph 1. CUSUM Tests Result