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# Does real interest rate reduce income inequality in India? Evidence from multivariate framework analysis.

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**Abstract**. This study empirically examines the impact of real interest rate on income inequality in India within a Kuznets Curve framework considering the role of economic growth, trade openness and technological innovation as the control variables. This study employs the ARDL bounds test for validating the long-run relationship over the annual data period 1995 to 2019. The results reveal the long-run relationship between the series in India. The findings suggest that the initial increase in interest rate significantly reduces income inequality. But, in a later stage, a threshold exists for such an increased interest rate to revert the prior beneficial impact. This finding further shows that Kuznets' inverted U-shaped hypothesis is not valid for the relationship between income inequality and real interest rate in India. It shows that the real interest rate impedes income distribution in the long run. These findings are also found to be robust using FMOLS and DOLS estimators. We find that economic growth significantly reduces income inequality, whereas trade openness promotes it. Surprisingly, technological innovation enhances income inequality, but this effect vanishes in the long-run. However, these findings suggest that policymakers in India should not ignore the impeding role of real interest rates while aiming at achieving effective income distribution between haves and have-nots in the long run.

**Keywords**. income inequality; interest rates, economic growth; India.

**JEL Codes.** D63; E49; O40; O53.

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## 1. Introduction

The increase in income inequality in recent years has drawn considerable attention from academic and policy experts on the relationship between economic growth and income inequality in both developed and developing countries. Economic growth and income inequality, being endogenous outcomes of the economic system, are subject to common influences, with respect to both structural changes and macroeconomic policies. Structural changes such as improvement in technology facilitate economic development, which is the underlying assumption of Kuznet's curve, and may result in economic inequality. However, macroeconomic policies, particularly fiscal policies are considered an important instrument for achieving goals in terms of equity and efficiency (Musgrave, 1959).

This paper focuses on the expenditure side of the budget and emphasizes the role of social spending in explaining the dynamics between growth and inequality[1]. Government spending in the social sector received an impetus with the emergence of endogenous growth theory (Lucas, 1988; Romer, 1994), which largely focused on enhancing human capital development. Such policies facilitate the process of innovation, research, knowledge creation, and information dissemination and reduce vulnerability to external shocks (Gebregziabher & Niño-zarazúa, 2014). Thus, the government expenditure in the social sector is found to have a positive impact on long-term economic growth and development (Benhabib & Spiegel, 1994). In addition, such policies play an important role in poverty and inequality reduction (Fiszbein et al., 2014). Indeed, the Millennium Development Goals that bring poverty reduction, equity, and risk management to the forefront of debates further drew the attention of policymakers and development agencies toward establishing a strong social welfare system, particularly for the poorest and most vulnerable section of the society (Baldacci et al., 2008).

Despite its relevance, few studies have attempted to explore the relationship between income inequality, economic growth, and government spending in the social sector[2]. Most of the empirical studies have analyzed either the impact of government spending in the social sector on economic growth (Antonia Afonso & Alegre, 2011; António Afonso & Furceri, 2010; Folster & Henrekson, 2001) or its role in poverty and income inequality reduction (Cubero & Vladkova, 2010; Foster, 2012; Ospina, 2010; Rudra, 2004). Further, these studies have not considered the role of gross income inequality in determining the impact of government spending on social spending and how such an impact influences the relationship between economic growth and net income inequality. While gross income inequality is pre-tax and government transfers' income inequality, net income inequality is post-tax and government transfers' income inequality.

Thus, our aim was to study the role of social spending in determining the relationship between economic growth and inequality. First, we analyzed the impact of gross income inequality and other political and economic factors on social spending. Second, we examined which categories of social spending (education, health, and social protection) are effective in reducing income inequality and the effects of these policies on economic growth.

The remainder of this paper is structured as follows: Section 2 provides a brief summary of our literature review, which deals with income inequality, economic growth, and government spending in the social sector. Section 3 describes the database and empirical methodology. Section 4 delineates the findings and results. Section 5 gives the discussion and policy implications. Section 6 provides the concluding remarks.

[1] In this study, social spending refers to government expenditure on education, health, and social protection.
[2] Arjona et al. (2003) examined the income distribution and social expenditure effects on economic growth.

## 2. Literature review

The literature identifies different routes through which interest rates can influence income inequality in any country. Firstly, the literature evidenced the unequal distribution of debt-to-income and debt-to-equity ratios for the households that belong to the different income distribution strata (Berisha et al., 2020; Martín-Legendre et al., 2020). Similarly, a study by Saez (2017) for the United States shows that the bottom 90% of households have had no savings for the last three decades. Therefore, it can be concluded that the top strata consisting of the few people in the income distribution typically have more savings than debt. In contrast, the lower strata (comprised of the majority population) of the income distribution have more debt than savings. Hence, an increase in interest rate creates a harmful effect on those who are in the lower-income strata, but it gives an advantage to the higher-income strata. In other words, increasing the benefits of interest rates will accrue to those who have more savings than debt compared to people with more debt than savings, thereby fueling income inequality.

Secondly, monetary policy contractions (increase in interest rate) probably create a loss of jobs for the lower-income households since they are the employees of the firms. The rise in interest rate affects the employees by reducing the fresh investment of firms in new employment generation projects, which, in turn, reduces the equilibrium rate of employment and, thereby, the unemployment level increases and falls in the income of the employees (Phelps, 1994). Similarly, investment at the firm level decreases due to the rising cost of capital (interest rate), which, in turn, leads to lower capital accumulation. Hence, the demand for labour reduces due to the given ratio of employment to capital, i.e., no new employment opportunity (Blanchard, 1999). In brief, the loss is happening for the labour class but not for the capital owners who are in the upper strata of income. Therefore, there is a possibility of the existence of a gap between the rich and poor in the economy. Hence, it is called the monetary policy impact due to earnings heterogeneity (Coibion et al., 2017).

Thirdly, a low-interest rate leads to increased income inequality, either due to boosting capital gains or asset prices shooting up (Auclert, 2019). This peculiar property of monetary policy is called the financial segmentation channel effect. The financial segmentation channel effect starts working when the monetary policy is expansionary in nature. Recently, an empirical analysis was conducted by Berisha et al. (2020), aiming to unveil the nexus between income inequality and other macroeconomic variables for the BRICS economies, in which they observed a positive impact of the real interest rate on income inequality. Similarly, Husain et al. (2020) explored the association between interest rates and income inequality in Indonesia. The results evolved from the dynamic ordinary least square (DOLS), and fully-modified OLS (FMOLS) show the income inequality exacerbation role of interest rate after attaining a threshold level.

From an empirical perspective, the study by Saiki & Frost (2014) shows the role of unconventional monetary policy (i.e. repairing the transmission mechanisms of monetary policy and financial markets stability) on inequality in Japan. The evidence shows the widening inequality role of unconventional monetary policy due to increased asset prices than the economic fundamentals, i.e., employment and wage during severe financial and economic stress. The upper strata of society are the holders of the asset, which, in turn, enhances their income over and above the lower strata. A similar conclusion has been reached by Bivens (2015) for the United States, Mumtaz & Theophilopoulou (2017) for the United Kingdom, O'Farrell & Rawdanowicz (2017) for advanced economies, and Furceri et al. (2018) for 32 emerging market and advanced countries while assessing the role of monetary policy on inequality.

Finally, economic growth creates either a positive or negative impact on income inequality. The popular Kuznets hypothesis states that in the early stage of economic progress, income inequality also rises with economic growth, whereas income inequality decreases at the later stages of economic growth due to the trickle-down effect (Kuznets, 1955). The Kuznets' inverted U-shaped hypothesis pertaining to the link between economic growth and income distribution has been confirmed in certain empirical studies, which include studies carried out by Ahluwalia (1976) for a sample of 60 countries, and Eusufzai (1997) for 54 countries. Similarly, the studies of Bahmani-Oskooee & Gelan (2008), Jha (1996), and Minami (1998) confirmed the hypothesis of the Kuznets curve. In contrast, certain studies also fail to establish the Kuznets Hypothesis while validating it either in time series or cross-country level (Anand & Kanbur, 1993; Angeles, 2010; Papanek & Kyn, 1986). Besides, it is observed that technology and innovation exhibit a significant role in determining inequality (Aghion et al., 2018). Similarly, the impact of globalization and trade openness on income inequality determination is undeniable (Jaumotte et al., 2013). Therefore, it is vital to control these factors while empirically modelling the income inequality function for India within a time series framework.

However, the literature survey reveals that there is theoretical construction related to the nexus between income inequality and interest rate in the literature. However, there is a need for empirical validation in the country-specific context for alleviating income inequality since interest rates play a pivotal role in determining income inequality through the accumulation of capital in the hands of a few. Besides this, we also found that there is no clear consensus among the studies assessing the impact of economic growth, technology, and trade on income inequality in India. Hence, it is worth conducting an empirical analysis of the impact of real interest rates on income inequality while considering economic growth, trade openness and technology as a control variable since India suffers from a skewed income distribution.

## 3. Model construction, data, and estimation strategy

This study specified the model to evaluate the nexus between income inequality, real interest rate, economic growth, trade openness and technology by following Berisha et al. (2020) and Husain et al. (2020).

$$INEQ_t = \gamma_0 + \gamma_1 RIR_t + \gamma_2 RIR_t^2 + \gamma_3 GDP_t + \gamma_4 OPEN_t + \gamma_5 TECH_{\ t} + \varepsilon_t \quad [1]$$

where, $\varepsilon_t$ is the error term, $INEQ$ is the income inequality, which is measured by the Gini coefficient index. The terms $i.e. RIR$ and $RIR^2$ stand for the real interest rate and its square term to capture the Kuznets' effect. Further, GDP denotes the gross domestic product (GDP), which is taken as a proxy for measuring real economic growth. The notations, i.e. $OPEN$ and $TECH,$ stand for trade openness (i.e. globalization) and technological change, respectively. Symbol $\gamma_0$ is the constant term, $\gamma_1, \gamma_2, \gamma_3, \gamma_4$ and $\gamma_5$ are also the coefficients of the explanatory variables.

An annual time series data from 1978-2019 has been collected for estimating the specified model. The period of inquiry was selected based on data availability for the Indian case. However, all the obtained data has been converted to the natural log for estimation to avoid the heterogeneity by following (Ansari et al., 2022; Pal et al., 2022; Shameem P et al., 2022; Villanthenkodath, Ansari, et al., 2022; Villanthenkodath, Mahalik, et al., 2022; Villanthenkodath & Mahalik, 2022; Villanthenkodath & Mohammed, 2022). The data obtained from different sources are reported in Table 1 with their detailed definitions.

Estimation of the specified model in equation 1 was conducted using the autoregressive distributed lag (ARDL) model of cointegration introduced by Pesaran et al. (2001) and Pesaran & Shin (1999). Many factors guide the choice of the ARDL bounds testing approach for the empirical analysis. First, it corrects the endogeneity of independent variables by selecting the appropriate lag while simulating the model.[3] Thus, the application of ARDL makes us deal with such an endogeneity issue in our modeling framework. Second, the model can be used even for a small sample size (i.e. 30-80 observations).

**Table1.** Definition of data and their sources.

| Variables | Definitions | Data source |
|---|---|---|
| **INEQ** | The data on post-tax/transfer income inequality called net Gini coefficient | SWIID |
| **RIR** | The real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. The terms and conditions attached to lending rates differ by country, however, limiting their comparability. We also take quadratic term. | WDI |
| **GDP** | GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. Data are in constant 2010 U.S. dollars. | WDI |
| **OPEN** | Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product. | WDI |
| **TECH** | Total patent applications (direct and PCT national phase entries) | WIPO |

**Note**: SWIID is the Standardized World Income Inequality Database (https://dataverse.harvard.edu/dataset), WID stands for World Inequality Database (https://wid.world/), WIPO is World Intellectual Property Organization (https://www3.wipo.int/ipstats) and WDI is the World Development Indicators (https://databank.worldbank.org/).

[3] The endogendiety problem arises in the literature when causality runs from income inequality to economic growth and vice-versa (Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Piketty and Saez, 2006). We are thankful to one of the reviewers for raising this issue at the revision stage.

Third, it is possible to use ARDL bound testing approach when the set of explanatory variables are either integrated of the order one i.e. I (1) or having integration of the mixed orders i.e. I (0) and I (1). Hence, there are no restrictions based on the nature of the data. Therefore, the ARDL model is superior to conventional cointegration techniques.

The long-run relationship among the variables is estimated by employing Equation 2, which is a corollary with the model specified in Equation 1.

$$\Delta LNINEQ_t = \lambda_0 + \sum_{i=1}^{p} \lambda_{1i} \Delta LNINEQ_{t-i} + \sum_{i=1}^{p} \lambda_{2i} \Delta LNRIR_{t-i} + \sum_{i=1}^{p} \lambda_{3i} \Delta LNRIR^2_{t-i} + \sum_{i=1}^{p} \lambda_{4i} \Delta LNGDP_{t-i} + \sum_{i=1}^{p} \lambda_{5i} \Delta LNOPEN_{t-i} + \sum_{i=1}^{p} \lambda_{6i} \Delta LNTECH_{t-i} + \varphi_7 LNINEQ_{t-1} + \varphi_8 LNRIR_{t-1} + \varphi_9 LNRIR^2_{t-1} + \varphi_{10} LNGDP_{t-1} + \varphi_{11} LNOPEN_{t-1} + \varphi_{12} LNTECH_{t-1} + \varepsilon_t \quad [2]$$

After obtaining and extracting the cointegration relation between the study variables and long-term coefficients, there is a need to estimate the short-run dynamics. Hence, the corresponding error correction model (ECM) equation has been estimated to obtain the short-run coefficients by using Equation 3.

$$\Delta LNINEQ_t = \lambda_0 + \sum_{i=1}^{p} \lambda_{1i} \Delta LNINEQ_{t-i} + \sum_{i=1}^{p} \lambda_{2i} \Delta LNRIR_{t-i} + \sum_{i=1}^{p} \lambda_{3i} \Delta LNRIR^2_{t-i} + \sum_{i=1}^{p} \lambda_{4i} \Delta LNGDP_{t-i} + + \sum_{i=1}^{p} \lambda_{5i} \Delta LNOPEN_{t-i} + \sum_{i=1}^{p} \lambda_{6i} \Delta LNTECH_{t-i} + \delta ECT_{t-1} + \varepsilon_t \quad [3]$$

In Equations 2 and 3, the first difference of the concerned variables is denoted by using Δ. The optimal lag length of variables is represented by employing $p$, while $\lambda_0$ stands for the constant term. The error correction term ($ECT_{t-1}$) shows the adjustment coefficient ($\delta$) where the correction of short-run disequilibrium can be judged in order to own the stable long-run relationship between the series. The second and first segments of equations represent the long-run relationship and short-run dynamics, respectively. Similarly, the null hypothesis stating no cointegration among the study variables can be expressed in the form of $H_0: \varphi_7 = \varphi_8 = \varphi_9 = \varphi_{10} = \varphi_{11} = \varphi_{12} = 0$. In contrast, the alternative hypothesis is also specified as $H_1: \varphi_7 \neq \varphi_8 \neq \varphi_9 \neq \varphi_{10} \neq \varphi_{11} \neq \varphi_{12} \neq 0$. The stated Hypothesis is tested using the joint F-statistics with the corresponding critical values suggested by Narayan (2005) for a sample size. The null hypothesis can be rejected when the computed F-statistic is above the upper limit of critical values, whereas the acceptance of the null hypothesis occurs when the F-statistic value is below the lower limit of critical values. However, the F- calculated value falls in between upper and lower bound critical values, and then there is no conclusive evidence of cointegration in the specified income inequality model.

Further, the overall long-run results of the employing ARDL model were cross-checked by using DOLS (Stock and Watson, 1993) and FMOLS (Pedroni, 2001) techniques. Although the interconnection between variables can be extracted by using various econometric approaches, the asymptotic coherence of the results can be available from FMOLS and DOLS techniques. Precisely, the FMOLS can handle the issue of serial /autocorrelation, endogeneity, and multicollinearity by undertaking a non-parametric approach. However, in DOLS, the same issue can be handled by using a parametric approach. Therefore, these techniques are superior to ARDL model.

## 4. Empirical results and discussion of findings

Figure 1 shows the trend of the variables over the sample period. It allows us to understand the long-run relationship between the series. The characteristics of the variables are also reported in Table 2. Towards this end, unit root tests for the variables are analyzed initially, and the same is reported in Table 3.

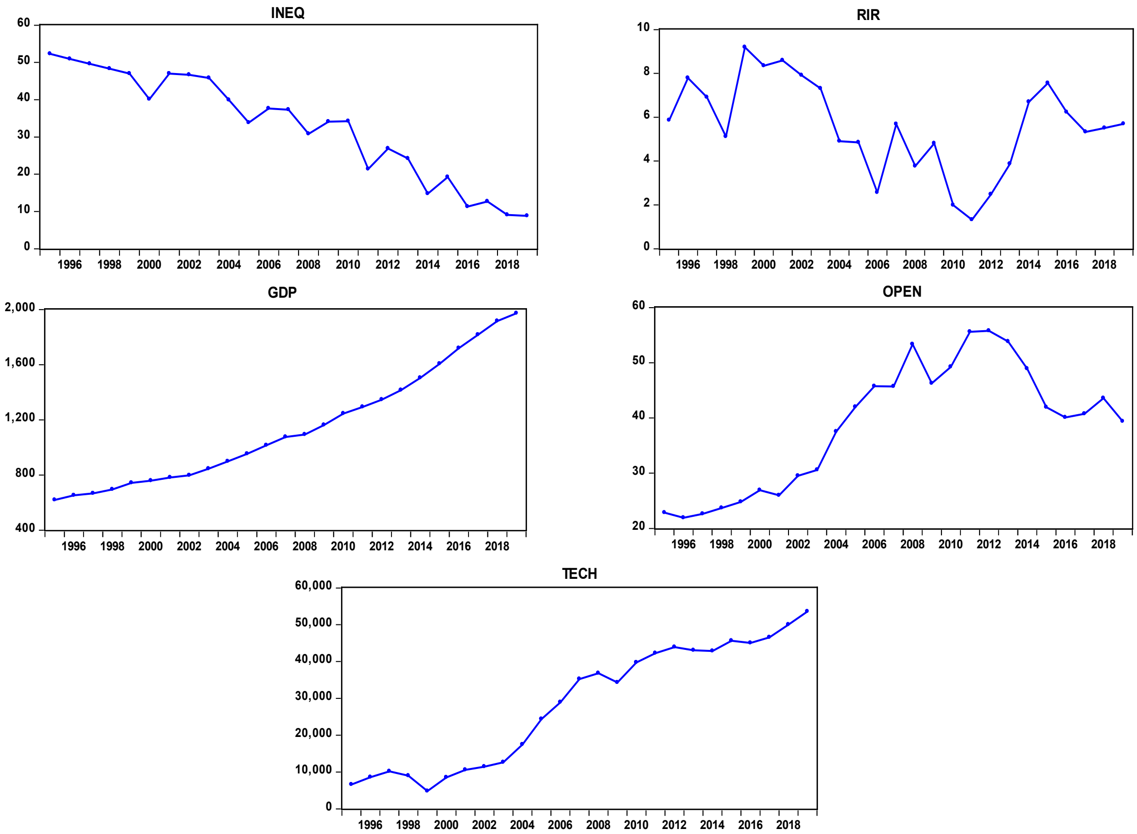


**Figure 1.** Trend plot of study variables.

**Table 2.** Descriptive statistics.

| Descriptive statistics | INEQ | RIR | GDP | OPEN | TECH |
|---|---|---|---|---|---|
| Mean | 32.955 | 5.612 | 1143.415 | 38.746 | 28489.440 |
| Median | 34.200 | 5.682 | 1075.994 | 40.743 | 34287.000 |
| Maximum | 52.277 | 9.191 | 1972.758 | 55.794 | 53627.000 |
| Minimum | 8.833 | 1.318 | 618.368 | 21.929 | 4826.000 |
| Std. Dev. | 14.293 | 2.124 | 422.105 | 11.378 | 16671.550 |
| Skewness | -0.359 | -0.30 | 0.555 | -0.124 | -0.119 |
| Kurtosis | 1.814 | 2.329 | 2.096 | 1.691 | 1.390 |
| Observations | 25 | 25 | 25 | 25 | 25 |

The outcomes of the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) test proposed by Dickey & Fuller (1979) and Phillips & Perron (1988) shown in Table 3 indicate that all the variables are stationary at the first difference. However, the conventional unit root tests are unable to capture the possible structural break in the series. Hence, this study employs the Zivot & Andrews (1992) structural break unit root test to check the integration order of the series amid a single structural break. This result is also in line with the conventional unit root with an exception for technology. Therefore, additional experiments can be conducted in the ARDL framework since the series consists of variables having a maximum of the first order of integration i.e. I(1).

For estimating the ARDL model, the selection of appropriate lag is necessary. Hence, this study chooses the Hannan-Quinn criterion (HQ) criteria for selecting the lag length as it produces more desirable outcomes in comparison to other criteria. The ARDL bound test result is presented in Table 4. Since the estimated value of F-statistics is higher than the upper bound critical value at a 1% level of statistical significance, there is evidence of the long-term association among the study variables. It means that the series moves to long-run equilibrium amid the presence of these variables.

**Table 3.** Unit root tests.

| | Dickey-fuller test | | PP test | | ZA | | | |
|---|---|---|---|---|---|---|---|---|
| | Level | Δ | Level | Δ | Level | Break | Δ | Break |
| ***LNINEQ*** | 3.291 | -8.983* | 1.159 | -8.983* | -0.261 | 2001 | -9.325* | 2002 |
| ***RIR*** | -2.145 | -5.456* | -2.232 | -5.449 | -2.748 | 2003 | -5.740 | 2014 |
| ***LNGDP*** | 1.123 | -3.992* | 1.520 | -3.972* | -0.818 | 2003 | -5.259* | 2002 |
| ***LNOPEN*** | -1.562 | -3.918* | -1.546 | -3.985* | -2.828 | 2001 | -5.348 | 2013 |
| ***LNTECH*** | -1.181 | -4.763* | -1.174 | -4.786* | -6.216* | 2010 | -7.813 | 2007 |

**Note.** * and *** : significant at 1% and 10% levels. Δ shows the first difference. LN stands for the natural log.

**Table 4.** ARDL cointegration test results.

| Bounds testing approach to cointegration | | | Diagnostic tests | | | |
|---|---|---|---|---|---|---|
| **Estimated model** | **Lag length** | **F-stat** | **$\chi^2$ Normal** | **$\chi^2$ Serial** | **$\chi^2$ ARCH** | **RESET** |
| *LNINEQ=f(RIR,RIR$^2$,LNGDP, LNOPEN, LNTECH)* | (3, 2, 2, 2, 1, 2) | 7.168* | 0.623 [0.732] | 0.384 [0.722] | 1.014 [0.327] | 0.085 [0.790] |

**Note**: * indicates the 1% level of statistical significance. The value inside [ . ] shows the probability value. n stands for the number of observation, while k is included explanatory variables in the model.

Further, the ARDL-based long-and short-run coefficients of the estimated model are presented in Table 5 (Panels I & II). The long-run results shown in Panel-I of Table 5 indicate that the real interest rate exhibits a downward trend in income inequality at the earlier stage. However, after attaining a threshold level, the increase in interest rate leads to an upward trend in income inequality. It means that there is evidence of the U-shaped relationship between income inequality and real interest rate in India. It shows an adverse impact of higher interest rates on income inequality in the long run.

The probable interpretation for rising income inequality due to the rise in real interest rate, in the long run, has many folds. First, the increase in interest rate benefits the households who belong to the higher income strata since they have higher savings than the debt service. Hence, they acquire higher returns on savings, thereby further increasing their income level. Second, the households with higher debt (bottom of income strata) will keep paying more interest payments to the banks, and eventually, their surplus over consumption (i.e. savings) could be reduced in the long run. It can create an income disparity between the rich and the poor. Third, monetary contraction (i.e. increasing interest rate) makes banking loans expensive for business firms. As a result, business firms reduce investment which also creates unemployment among lower-income households. Even if employment is created for lower income strata of the people, they are paid lower wages. It shows that increasing interest does not help much to poor people. It is a situation of income disparity between the rich and poor due to rising interest rates (Carruth et al., 1998; Phelps, 1994). These findings are in line with the study of Husain et al. (2020). However, an inverted U-shaped relationship between income inequality and real interest rate is found in the short run (Panel II).

The result also shows that economic growth significantly reduces income inequality in the long run. It indicates that income inequality reduces as economic growth improves. Alternatively, it is a sign of inclusive growth, creating employment opportunities for poor people. As a result, poor households can have a regular income not only to mitigate their basic requirements but also to increase their savings capacity. Eventually, the living standards of poor households tend to be higher with further increased economic growth. Our finding is not in line with (Adelman & Robinson, 1989; Bahmani-Oskooee & Gelan, 2008; Jha, 1996; Minami, 1998). However, the impact of economic growth on income inequality is not statistically significant in the short run. It shows that economic growth does not improve income distribution in the short run.

This may be because an expansion of economic activities creating employment opportunities takes some time. If people are not employed, then it becomes difficult to increase their living standards and income capacity.

Moreover, trade openness enhances income inequality both in the short and long runs. The possible cause for this could be that the country may be imposing import duties on the goods and services which are more highly demanded by poor people than the rich, which, in turn, causes the increase in price and widen the income gap. Besides, technological innovation increases income inequality in the long run, but it is not significant. Moreover, it becomes effective in reducing income inequality in the short run.

Table 5 (Panel II) also portrays a significant and negative speed of adjustment coefficient from short to long-run equilibrium. It means that about 80% of disequilibrium is corrected each year. The last segment in Panel III of Table 5 delineates the necessary post-estimation tests for checking the model adequacy. The included variables explain 68% of variations in inequality, the rest variations are captured in the error term. A significant F-statistics value indicates the overall goodness fit of the model. For the ARDL model validity and stability, the study used the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests proposed by Brown et al. (1975). Figure 2 shows the plots of CUSUM and CUSUMSQ, which fall within the significance of 5% level by confirming the estimation of the ARDL model is stable. Hence, the specified model and estimated parameters in this analysis are reliable and efficient.

**Table 5.** Estimated long- and short-run coefficients using the ARDL approach.

| **Panel-I: Long-run analysis** | | | | |
|---|---|---|---|---|
| **Dependent variable: *LNINEQ*** | | | | |
| **Regressors** | **Coefficient** | **SE** | **T-ratio** | **P- value** |
| ***RIR*** | -0.542** | 0.162 | -3.351 | 0.029 |
| ***$RIR^2$*** | 0.238** | 0.070 | 3.382 | 0.028 |
| ***LNGDP*** | -2.124* | 0.177 | -12.011 | 0.000 |
| ***LNOPEN*** | 0.746* | 0.125 | 5.968 | 0.004 |
| ***LNTECH*** | 0.155 | 0.131 | 1.180 | 0.304 |
| ***C*** | 14.161* | 0.387 | 36.552 | 0.000 |
| **Panel-II: Short-run analysis** | | | | |
| ***Δ RIR*** | 0.868*** | 0.401 | 2.163 | 0.097 |
| ***Δ $RIR^2$*** | -0.417** | 0.147 | -2.839 | 0.047 |
| ***Δ LNGDP*** | 0.415 | 2.504 | 0.166 | 0.876 |
| ***Δ LNOPEN*** | 1.604*** | 0.623 | 2.576 | 0.062 |
| ***Δ LNTECH*** | -0.576*** | 0.248 | -2.324 | 0.081 |
| ***CointEq(-1)**** | -0.801*** | 0.339 | -11.200 | 0.000 |
| **Panel-III**: Short-run diagnostic tests | | | | |
| ***R-squared*** | 0.96 | ***Adjusted R-squared*** | | 0.91 |
| ***SE of regression*** | 0.07 | ***SD of dependent variable*** | | 0.558 |
| ***Mean of dependent variable*** | 3.292 | ***F-statistic [prob.]*** | | 35.88 [0.001] |

**Note.** *, *, ***: 1%, 5%, 10% levels of statistical significance, respectively.

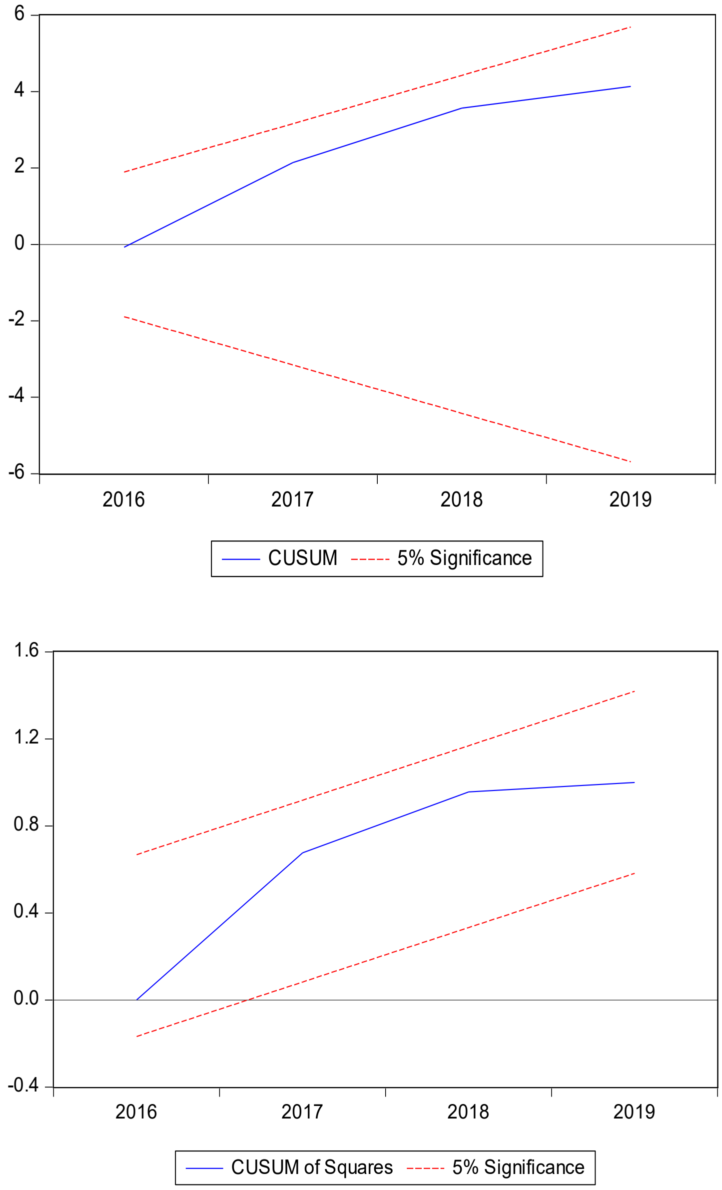


**Figure 2.** CUSUM and CUSUMSQ tests at 5% level of significance

Additionally, the robustness of the estimated overall long-run results of ARDL was validated by using FMOLS and DOLS techniques. The reported outcomes in Table 6 are also in harmony by exhibiting a significant U-shape relation of interest rate on income inequality. Besides, a significant negative (positive) impact of economic growth (trade openness and technological innovation) on income inequality has been further affirmed.

**Table 6.** DOLS and FMOLS results.

| **Panel-I: DOLS** | | | | |
|---|---|---|---|---|
| **Dependent variable: *LNINEQ*** | | | | |
| **Regressors** | **Coefficient** | **SE** | **T-ratio** | **P- value** |
| ***RIR*** | -0.823* | 0.236 | -3.492 | 0.010 |
| ***$RIR^2$*** | 0.353* | 0.094 | 3.755 | 0.007 |
| ***LNGDP*** | -2.502* | 0.161 | -15.550 | 0.000 |
| ***LNOPEN*** | 0.359*** | 0.190 | 1.890 | 0.101 |
| ***LNTECH*** | 0.534* | 0.146 | 3.651 | 0.008 |
| ***C*** | 14.604* | 0.351 | 41.572 | 0.000 |
| ***R-squared*** | 0.97 | ***Adjusted R-squared*** | | 0.93 |
| **Panel-II: FMOLS** | | | | |
| ***RIR*** | -0.139 | 0.189 | -0.734 | 0.472 |
| ***$RIR^2$*** | 0.083 | 0.076 | 1.087 | 0.291 |
| ***LNGDP*** | -2.102* | 0.158 | -13.325 | 0.000 |
| ***LNOPEN*** | 0.832* | 0.159 | 5.221 | 0.000 |
| ***LNTECH*** | 0.065 | 0.109 | 0.598 | 0.557 |
| ***C*** | 14.366* | 0.449 | 31.980 | 0.000 |
| ***R-squared*** | 0.93 | ***Adjusted R-squared*** | | 0.91 |

**Note**. *, *, ***: 1%, 5%, 10% levels of statistical significance, respectively.

## 5. Conclusion and policy implications

This study investigates the impact of real interest rates on income distribution in India by considering the influence of economic growth, trade openness and technology. Moreover, the Kuznets' Hypothesis is also analyzed using the square term of real interest rate in the income inequality function. For the empirical analysis, this study used the ARDL model for the data spanning from 1978 to 2019. The outcomes of the ARDL show that real interest rate fosters income inequality after reaching a threshold level, especially in the long run. Similarly, economic growth and trade openness also exacerbate income inequality in India, whereas technology is not effective in increasing it. The robustness of these findings is confirmed by using the DOLS and FMOLS techniques. We also observed a U-shaped connection between income quality and real interest rate. The outcome reveals that income inequality probably starts to spur if the real interest rate surpasses above 6.13% in India.

Based on the above findings, it can be argued that in case the monetary authority is increasing the interest rate, the households having more savings accrue the benefit, whereas households with more debt suffer a lot. It shows the consequence of such a move eventually creates income inequality in India. Therefore, the policymakers in India need to be cautious while forming monetary policy since there is a trade-off between macroeconomic stabilization and income distribution if the rate of interest goes beyond a threshold level.

We also find that economic growth reduces income inequality in India. It shows that rising economic growth reduces the income gap between rich and poor people in India. This is because the trickle-down growth effect equally benefits rich and poor people. Interestingly, the way the economic growth plan created in India is benefiting the labour force in the employment market. The poor people at the grass-root level of India also receive necessary benefits from the welfare scheme implementation.

Trade openness enhances income inequality both in the short and long runs. It suggests that policymakers in India need to provide attention to the price level of imported commodities. If oil is imported from oil-exporting countries with higher payments, then oil domestic oil suppliers will charge higher prices for the people who buy it. It may not be an issue for the rich people but it becomes expensive for the poor in India as it is a developing economy.

Finally, technological innovation enhances income inequality in the long run, but it is not effective. It implies that though technology usage by the business firms replaces the labour force in production activities in order to increase technical efficiency (i.e. output/technology), it does not become successful. This may be because producers integrate the labour force with technology in the production structure in order to minimize the cost of production, as labour is available at an affordable wage in India. As a result, employment level in the labour market is created, also improving income distribution rather than increasing income inequality.

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