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Empirical Insights on Inflation, Financial Development and Income Inequality in Central and Eastern European Countries

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Abstract

Given the recent debates on high inflation and widening income inequality in the post-pandemic period, this paper examines the empirical relationship between inflation, financial development, and income inequality in Central and Eastern European (CEE) countries in the period 2004-2022 using advanced panel data models to account for potential endogeneity, long-run and short-run patterns. The findings suggest that inflation has a positive impact on income inequality. Financial development exhibits a negative association with income inequality in the long-run and its interaction with inflation reduces income inequality. This suggests that a more developed financial system can help to reduce income inequality by facilitating access to credit and financial services for all segments of the population.

1. Introduction

The growing disparity in income and wealth globally (Ibrahim, 2024) has generated increasing concern among researchers and policymakers (Tosheva, 2018): The existence of a certain level of inequality is necessary to provide incentives in an efficient economic system, but too much inequality is seen as a threat to long-term growth and prosperity (Aghion et al., 1999): A higher degree of inequality hinders capital accumulation and upward transgenerational mobility, hinders innovation and entrepreneurship, and undermines the right to state and social capital (Nolan & Valenzuela, 2019):

Understanding the drivers of this inequality is critical to designing effective public policies (Chakroun, 2020; Cifuentes-Faura & Simionescu, 2024): In this

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context, inflation and financial development emerge as two key factors that can significantly influence income distribution. However, current theoretical models offer inconsistent predictions regarding the relationships between them.

The most efficacious method for monetary authorities to promote long-term economic growth and financial stability is through the maintenance of price stability (Ekinci et al., 2020): It is therefore crucial for policymakers to understand how income disparity may respond to changes in inflation in order to ascertain the appropriate level of consideration for distributional issues in the design of price stability programmes (Kim & Lin, 2023): While inflation can erode the purchasing power of the most vulnerable, exacerbating existing inequalities, financial development can act as a transmission channel for inequality through different mechanisms (Simionescu & Cifuentes-Faura, 2023): For example, increased access to credit may benefit mainly households with higher assets, widening wealth gaps (Kavya & Shijin, 2020): In addition, the development of sophisticated financial markets may generate investment opportunities that are beyond the reach of poorer households (Rajan & Zingles, 2003): However, financial development can also decrease inequality by promoting social mobility and facilitating access to financial services for the most disadvantaged (Kim & Lin, 2023):

The relationship between inflation and financial development, and its effects on inequality, is therefore complex and depends on several factors, such as the economic context, institutions and public policies implemented. In the case of Central and Eastern European countries (CEECs) there is practically no comprehensive analysis of this relationship. This study aims to address this gap by contributing to the literature in three significant ways. First, it offers a comprehensive analysis of the relationship between inflation, financial development, and income inequality in the CEECs, a region that remains underexplored despite its importance for economic convergence. Second, the study employs advanced econometric techniques, including cointegration tests adapted for cross-sectional dependence, to ensure robustness in a setting of unbalanced data. Finally, it incorporates a novel comparative approach, examining the differential effects of expected and unexpected inflation on income inequality, which is essential to understand how monetary policies impact different income groups.

Therefore, our objective in this paper is to analyze the intricate relationships between inflation, inequality, and financial development in Central and Eastern European countries, shedding light on how regional economic characteristics influence these dynamics. This region presents particular characteristics that make it a relevant case study for understanding these complex relationships. CEECs have similar levels of economic and social development, taking into account the evolution after many years of common historical characteristics (Khan et al., 2023): Many CEECs share a similar institutional framework, which helps to control for certain confounding factors. Despite significant progress, CEECs are still struggling to converge towards Western European income levels. This ongoing process could influence the relationship between inflation, inequality and financial development.

Some of these countries moved from centrally planned to market economies during the 1990s. This drastic change led to greater economic instability, including high inflation, due to price liberalization and the transition to looser monetary policies. Moreover, liberalization, privatization, and economic reforms were fundamental pillars of this process, and among its most notable consequences was the emergence of financial development as a crucial driver of economic growth and structural transformation (Cerovic et al., 2014; Fedajev et al. 2019): However, along with economic growth, the transition towards greater financial openness also led to changes in income distribution patterns, generating debates about the consequences of financial development on social equity (Cevik & Correa-Caro, 2020; Lazar & Litan, 2023):

CEECs faced high inflation during the pandemic and have implemented similar economic policies and reforms since 2004, given their EU membership. This provides a natural experiment to study the impact of different policy approaches on income inequality. Thus, their recent history of high inflation and rapid economic reforms offers valuable insights into how to manage these dynamic relationships.

The results suggest that inflation contributes to exacerbating income inequality, while the development of credit to the private sector has the potential to mitigate this effect in the long run.

This article is structured as follows. Section 2 presents the theoretical background, and Section 3 the literature review. The data and the methodology used in this study are shown in Sections 4 and 5, respectively. The results of the study and the robustness checks are presented in Sections 6 and 7. Finally, Section 8 presents the conclusions and offers policy recommendations to promote economic growth, strengthen financial institutions and reduce disparities in society.

2. The Influence of the Interaction of Inflation and Financial Development on Income Inequality

The interaction between inflation and financial development impacts income inequality in complex ways. Both inflation and financial development shape the distribution of wealth and income, but their interaction depends on several factors, including the structure of financial systems, economic institutions, and the specific effects of inflation on different socioeconomic groups. The mechanisms through which this interaction works are outlined below.

Inflation, defined as the sustained rise in the general price level of goods and services, affects income distribution in different ways, depending on the nature of inflation and the economic context. Inflation erodes the purchasing power of money, and individuals with fixed incomes or low wages often suffer the most because their income may not keep pace with rising prices. Low-income households generally spend a larger proportion of their income on basic goods, which means they bear a disproportionate share of inflation's burden (Piketty, 2014):

In contrast, wealthier individuals often have more assets that appreciate with inflation (e.g., real estate, stocks, or inflation-protected securities): As such, inflation

may disproportionately benefit the wealthy by increasing the value of their assets. Furthermore, wages for low-income workers tend to adjust more slowly in inflationary periods, exacerbating income inequality when inflation is high (Blanchflower & Oswald, 2016):

Additionally, inflation can result in a transfer of wealth from creditors to debtors. Lower-income individuals often carry higher levels of debt (e.g., consumer loans, mortgages): so inflation reduces the real value of their debt. However, wealthier individuals who are typically net creditors may experience a loss in real value of their assets, making them less likely to benefit from inflation (Romer, 2018):

On the other hand, financial development can have a dual effect on income inequality. In a well-developed financial system, poorer individuals and small businesses can access credit and invest in opportunities that would otherwise be unavailable. This can foster economic mobility by allowing the poor to invest in education, start businesses, or acquire assets (Beck et al., 2007):

However, in underdeveloped financial systems, access to credit is often limited, and low-income groups may be excluded from the benefits of financial markets. This exclusion can contribute to widening income inequality (Morduch, 1999): Additionally, financial development, particularly, in capital markets, often benefits wealthier individuals who have the financial knowledge and capital to invest in stocks, bonds, and other financial instruments. As a result, wealthier individuals are better positioned to benefit from economic growth driven by financial sector expansion, which can exacerbate wealth inequality (Stiglitz, 2012):

In many cases, the most significant benefits of financial development accrue to those who already hold substantial wealth, further concentrating capital in the hands of the rich and amplifying income inequality (Galor & Moav, 2004):

The interaction between inflation and financial development can have distinct effects on income inequality, which depends on how financial markets respond to inflationary pressures and how different income groups are integrated into the financial system.

In countries with well-developed financial systems, inflation may have a less detrimental effect on inequality (Kim & Lin, 2023): For example, households with access to financial products such as inflation-protected bonds, real estate, or diversified portfolios are better able to hedge against inflation, reducing the inequality gap (Mitchell, 2018): In such economies, the wealthier segments of society can protect their wealth from inflationary pressures, while the poorer groups remain exposed.

In economies with developed financial markets, inflation often leads to higher interest rates as central banks attempt to control inflation. For low-income households, this could mean higher borrowing costs, reducing access to credit for consumption or investment. In this scenario, the ability of the wealthy to access cheaper or more diverse sources of credit could exacerbate inequality, as lower-income individuals are priced out of borrowing (Kiyotaki & Moore, 1997):

A well-developed financial system can facilitate the use of financial tools that allow low-income individuals to protect their income and savings from inflation (e.g., savings accounts with high interest rates, inflation-linked bonds): In the absence of such financial development, inflation disproportionately harms those without access to these tools (Atkinson, 2015): Financial inclusion can thus mitigate the adverse effects of inflation on income inequality, though it requires active policy efforts to ensure that low-income groups can access financial services.

3. Literature Review

The relationship between inflation, financial development and income inequality is complex and multifaceted, as research shows. While inflation has been shown to have a positive relationship with poverty (Ali et al., 2022; Cahyani & Sitorus, 2024): it also plays an important role in income inequality, with some studies suggesting that inflation can lead to increased inequality (Kim & Lin, 2023; Adunts & Maialeh, 2024):

Empirical studies suggest that the relationship between inflation, financial development, and income inequality can vary across countries and contexts, but there are some general patterns. In countries with low levels of financial development, high inflation tends to exacerbate income inequality because the poor have fewer ways to hedge against rising prices. In countries with more developed financial systems, the effects of inflation on inequality can be less pronounced, especially if financial markets are accessible to a broad segment of the population. There is evidence that well-functioning financial systems can mitigate the negative effects of inflation by facilitating better access to credit, inflation-protected savings instruments, and financial education. Barro (2013) found that higher inflation is generally associated with greater income inequality, especially in developing countries where inflation tends to erode the purchasing power of the poor more than the rich. Aghion et al. (2006) suggested that inflation disproportionately hurts the poor, particularly in developing economies with high levels of informal labor, where wages do not adjust quickly. Beck et al. (2007) found that financial development tends to reduce income inequality in countries where there is broad access to financial services. However, the benefits of financial development often accrue disproportionately to the wealthy, unless measures are taken to promote financial inclusion. Claessens & Perotti (2007) demonstrated that while financial development can enhance economic growth, it may not necessarily reduce inequality unless specific policies promote access to credit and other financial resources for poorer segments of society. Mokhtarian (2018) analyzed how financial development interacts with inflation to affect income inequality, concluding that in countries with advanced financial markets, the negative effects of inflation on income inequality are less pronounced because financial development provides mechanisms to buffer against inflation.

High inflation can disrupt economic stability, eroding real incomes and savings, particularly for lower-income households, thus worsening income inequality

(Albanesi, 2007; Ali et al., 2022; Kim & Lin, 2023): Furthermore, inflation can lead to a redistribution of wealth from creditors to debtors, as the real value of debt decreases, potentially benefiting wealthier individuals and increasing inequality (Doepke & Schneider, 2023): This redistribution mechanism tends to favor wealthier individuals who are more likely to hold significant amounts of debt, thereby exacerbating income inequality (Simionescu, & Cifuentes-Faura, 2024):

There is, however, evidence suggesting that moderate levels of inflation might have a positive impact on income distribution by stimulating economic activity. For example, Alesina et al. (2021) argue that moderate inflation can increase aggregate demand and improve business profitability, leading to higher employment rates. This increase in employment particularly benefits lower-income groups, who are more likely to experience unemployment or underemployment during periods of low economic activity. Destek et al. (2020) estimate a positive impact of inflation on income inequality in the short run, while the opposite is true in the long run, in Turkey for the period 1990-2015.

The inverted U-shaped relationship found in some studies suggests that the impact of inflation on inequality may initially be negative but becomes positive beyond a certain threshold, as high inflation rates disproportionately harm those without inflation protection. Akarsu & Gharehgozli (2024) find that in middle-income countries, inflation initially reduces income inequality, but this effect reverses at higher inflation levels, demonstrating an inverted U-shaped relationship. In the case of South Africa, Ndou (2024) finds that inflation above 6% significantly increases income inequality, while inflation within the target range of 3-6% has a negligible impact.

Research on financial development's effects on income inequality also shows mixed results. In general, a well-developed financial sector can promote economic growth and reduce inequality by improving access to credit for low-income groups, as seen in emerging economies (Beck et al., 2007; Manta et al., 2023): However, De Haan & Sturm (2017) and Altunbaş & Thornton (2019) both observe that financial development's impact on inequality may follow an inverted U-shaped pattern, suggesting that the benefits of financial access may initially favor the wealthy until more inclusive financial policies are adopted.

A meta-analysis of 116 studies by Chletsos & Sintos (2023) indicates that the overall impact of financial development on income inequality is, on average, neutral. This means that, taking all studies together, there is no clear relationship between increased financial development and either an increase or a decrease in inequality. They find that the effects of financial development on income inequality depend on several factors, such as the depth, access and efficiency of financial institutions and markets.

Regional differences also shape the impact of financial development on inequality. Wang et al. (2024) analyze the effects of financial development on income inequality in 12 Asian countries classified into three groups based on their level of economic development: low, medium, and high. Using the Quantile-on-Quantile

approach, they conclude that the impact of financial development on income inequality varies according to the country's level of economic development. In underdeveloped countries and countries with high economic development (except South Korea): financial development tends to exacerbate income inequality, while in moderately developed countries, it promotes income equality.

4. Data

The database used in this study covers the period 2004-2022 and refers to Central and Eastern European countries that are located in the European Union: Czech Republic, Bulgaria, Hungary, Poland, Slovakia, Romania, Slovenia, Estonia, Lithuania and Latvia. The period is considered based on data availability, mostly for income inequality and financial indicators. The data are considered in natural logarithm and the names of the variables correspond to the indicators in natural logarithm. The selection of the period is conditioned by the data availability.

Income inequality is proxied by Gini index with data provided by World Bank and also by share of income held by the top 10% households before and after transfers and taxes given by World Top Incomes database (*gross_income* and *net_income*): Gini index is calculated based on market income.

Gini Coefficient presents both advantages and limitations. It does not reveal the specific identities of individuals at either end of the income spectrum within a population. The calculation of the Gini coefficient is unaffected by the overall economic size, measurement methodology, or national wealth. For instance, nations with vastly different levels of prosperity can exhibit identical coefficients if their income distributions are comparable. The Gini coefficient is not influenced by the total number of individuals within a population and it is sensitive to income redistribution from higher-income to lower-income individuals (Gastwirth, 2017): However, the reliability of Gini coefficient calculations can be influenced by sample size. Smaller economies or those with less economic heterogeneity often exhibit lower coefficients, while larger, more diverse economies tend to show higher values (Jankins, 2017): This can introduce bias in comparisons. The Gini coefficient is susceptible to errors in data collection, both systematic and random. Inaccurate data can significantly distort the coefficient's accuracy in reflecting income inequality. It is possible for countries with distinct income distribution patterns to have identical Gini coefficients if their overall income levels are similar. This limitation hinders the coefficient's ability to differentiate between varied inequality structures. The Gini coefficient does not account for changes in population demographics, which can substantially impact income inequality. For instance, a population with a growing young workforce, typically earning less than older workers, can experience significant income inequality shifts not fully captured by the coefficient (Sitthiyot, and Holasut, 2020):

Top 10% income share focuses on income concentration at the top, easy to understand and communicate, but it ignores inequality within the top 10%, provides a limited picture of overall inequality (Idrees and Ahmad, 2017):

Inflation (*inf*) is measured by consumer price index (2010 = 100): which shows modifications in the cost to the average consumer of getting a basket of products and services. The data are released by the World Development Indicators database.

The inflation volatility (*vol*) is computed by taking the estimated error in absolute value ($|\hat{e}_{it}|$) from the regression: $infl_{it} = \mu_i + v_t + e_{it}$. It is not necessary to use a semilogarithmic transformation for inflation since negative values and outliers for inflation are not present in the dataset.

Stock market and baking sector are important actors in the financial system and indicators related to them can capture the evolution of this financial system. Given the limited data availability for CEE countries, we considered as indicators domestic credit to private sector by banks (% of GDP) (*credit_banks*) and domestic credit to private sector (% of GDP) denoted by *credit*. For sensitivity analysis, Financial Development Index (*FD*) is considered instead of credit. The data are provided by the World Bank's Global Financial Development Database.

A vector of control variables is considered, which includes data series for indicators provided by the World Bank: GDP per capita (constant 2015 US$) denoted by *GDP* and its squared value to check any nonlinear relationship, unemployment rate (*unempl*) (% of total labor force) (modeled ILO estimate): trade openness (*trade*) (% of GDP) [(import+export)*100/GDP], urban population (*urban*) as percentage of total population, general government final consumption expenditure (constant 2015 US$) (*gov*): control of corruption (*corruption*) to measure quality of governance, educational attainment (*edu*): at least completed upper secondary, population 25+, total (%) (cumulative):

The control variables are considered with their values in the previous period to manage endogeneity. The Appendix reports descriptive statistics (Table A1) and matrix of correlation between explanatory variables (Table A2) in the models. To avoid multicollinearity, the estimations are designed as to avoid the presence of significantly correlated variables in the same models.

5. Empirical Methodology

5.1 Baseline Estimations

Statistic and dynamic panel data models are proposed to evaluate the impact of inflation on income inequality.

$$y_{it} = \alpha_i + \beta inf_{it} + \gamma' X_{it} + \delta_t + \varepsilon_{it} \quad (1)$$

$$y_{it} = \alpha_i + \rho y_{it-1} + \gamma' X_{it} + \delta_t + \varepsilon_{it} \quad (2)$$

α, δ account for country and time fixed effects to manage the bias generated by the lack of relevant variables in the model.

ε is the error terms that are considered being independently and identically distributed.

i is the index for country, *t* is the index for year, *X* is the vector of control variables.

The basic models were extended by adding variables related to financial development (*findev*) and their interactions with inflation rate:

$$y_{it} = \alpha_i + \beta_1 inf_{it} + \beta_2 inf_{it} \times findev_{it} + \beta_3 findev_{it} + \gamma' X_{it} + \delta_t + \varepsilon_{it} \quad (3)$$

$$y_{it} = \alpha_i + \rho y_{it-1} + \beta_1 inf_{it} + \beta_2 inf_{it} \times findev_{it} + \beta_3 findev_{it} + \gamma' X_{it} + \delta_t + \varepsilon_{it} \quad (4)$$

In this case, *y* stands for income inequality and that coefficient β_2 is the coefficient of interest that captures the effect of the interaction of financial development and inflation on inequality.

There are some issues that should be tackled in the econometric strategy. First, there are omitted variables related to policymakers' options and quality of institutions that connect income inequality, financial development and inflation. Second, the endogeneity is also important since there is autocorrelation determined by the use of dependent variable with a certain lag. Third, there is reverse causality from income inequality to financial development and from income inequality to inflation. The existence of income inequality affects economic performance. According to Albanesi (2007): poor people are the most affected by inflation, while more income inequality suppose pressure of rich people to promote high inflation. On the other hand, Claessens and Perotti (2007) showed that financial development diminishes incumbents' profits. Income inequality plays the role of maintaining the profits and stumbling the access to credit and affects the economic performance (Rajan and Zingales, 2003):

From technical point of view, presence of unit root in panel data is checked to choose the best type of model. If the data series are non-stationary (unit root is present) and integrated of the same order, fully modified ordinary least squares (FMOLS) regression to study the long-run relationship between income inequality, inflation and financial development. For robustness check and if cointegration is not supported, the endogeneity is managed by using panel autoregressive distributed lag model. In this case, two types of estimators are computed: mean group (MG) estimator and pooled mean group estimator (PMG): The PMG estimator assumes that countries eventually reach the same long-term equilibrium state, but allows for individual countries to have different paths to get there (short-run heterogeneity): This short-run variation could be due to factors like unique responses to policy changes, external shocks, or financial crises. In contrast, the MG estimator allows for heterogeneity in the short-run relationship between variables. This flexibility makes MG suitable for analyzing data from a large number of countries. However, for studies with a smaller sample size, MG can be sensitive to specific arrangements of the data (permutations) and outliers, as noted by Asteriou et al. (2021):

MG estimator focuses primarily on short-run dynamics, as it estimates individual-specific models. However, it can be extended to estimate long-run relationships through pooling the individual-specific estimates. On the other hand, PMG estimator explicitly models both short-run and long-run dynamics. It assumes a common long-run relationship but allows for heterogeneous short-run adjustments.

5.2 Calculation of Expected and Unexpected Inflation

Since it is necessary to understand the mechanisms for inflation to impact income inequality, we should decompose inflation in two major components: expected inflation (inf^{exp}) and unexpected inflation (inf^{unexp}): Previous study of Kim & Lin (2023) uses autoregressive moving average models to calculate expected and unexpected inflation, but we bring a novelty in literature by proposing the computation of the two components of the indicator using generalized regression neural networks (GRNNs): Unlike traditional neural networks that require multiple iterations through training data, GRNNs excel with just one pass. This makes them efficient for specific tasks. The hidden layer is populated with neurons, but the number of neurons directly corresponds to the number of training examples you have. Each neuron in the hidden layer acts as a representative of a specific training example. Its center is essentially located at the coordinates of that training data point. The output of a neuron in the hidden layer reflects the distance between the input vector you're feeding into the network and the corresponding training example the neuron represents. This distance calculation is often based on a multivariate Gaussian function, which helps determine the influence of each training example on the final prediction.

A GRNN is a radial basis function (RBF) network with only one fast pass learning. It includes a hidden layer and neurons from RBF. The number of neurons in hidden layer equals the number of training examples. The neuron's center is represented by the corresponding training example. The neuron's output is a measure of the distance between training example and input vector. The neuron is based on a multivariate Gaussian function, when x is the input vector, x_t is neuron's center and σ is the smoothing parameter:

$$G(x, x_t) = e^{-\frac{\|x-x_t\|^2}{2\sigma^2}} \tag{5}$$

The smoothing parameter shows the number of targets that are relevant for the weighted mean. When the weights are similar, the result has a value around the average of training targets and this happens when smoothing parameter is large. In case of a small value of this parameter, significant weights are assigned only to those training targets that are close to input vector.

Considering n training patterns that forms a training set given by the vector $\{x_1, x_2, \dots, x_n\}$ and n targets given by normally scalars $\{y_1, y_2, \dots, y_n\}$, two steps should be considered to compute the output knowing the input pattern x.

Step 1: the computation of weights that are a measure of closeness of x to training patterns

$$\omega_t = \frac{e^{-\frac{\|x-x_t\|^2}{2\sigma^2}}}{\sum_{j=1}^{n} e^{-\frac{\|x-x_j\|^2}{2\sigma^2}}} \tag{6}$$

Properties of weights: they decrease with distance to the training pattern; their sum is one and it represents the contribution of any training pattern to the final output.

Step 2: the calculation of GRNN output layer as a weighted mean of the training targets.

$$\hat{y} = \sum_{t=1}^{n} \omega_t y_t \tag{7}$$

The forecasts based on GRNNs represent expected inflation and the forecast errors measures the unexpected inflation. GRNN are applied in R using *tsfgrnn* package.

To generate multi-step ahead forecasts using GRNN, two primary approaches are utilized:

- Multiple Input Multiple Output (MIMO): This method involves training the model on target vectors containing successive values of the time series. The length of these vectors corresponds to the desired forecast horizon.
- Recursive: This strategy employs a sequential forecasting approach.

In practice, recursive strategy provides more accurate forecasts than MIMO strategy and it is used in this case to get the forecast errors.

6. Results

6.1 Main Results

Cross-sectional dependence test assumes the null hypothesis of cross-sectional independence. Cointegration test assumes no cointegration under null hypothesis. The panel unit root test works under the null assumption of no stationary.

The cross-sectional dependence is checked on data in level before selecting the best panel unit root test. In the case of cross-sectional dependence, the second-generation panel unit root tests should be applied. Table A3 in the appendix reports the results of test for checking the cross-sectional dependence, since it is essential in selecting the most suitable unit root test to check for stationarity. Excepting *urban* and *gross_income*, for all the other variables, the cross-sectional dependence hypothesis is supported at 1% significance level.

Given the cross-sectional dependence, the second-generation panel unit root test for unbalanced panel like CADF (Cross-Sectionally Augmented Dickey-Fuller)

is necessary to check for stationarity. The results (Table A4 in the appendix) suggest that all the data series are non-stationary in level, but stationary in the first difference at 5% significance level. Since all the data series are integrated of order 1, a potential cointegration is checked using Westerlund Cointegration test that provides reliable results under the cross-sectional dependence. First, we check cointegration for main variables and then we check it in each regression based on FMOLS approach for all the variables introduced in the regression model. If the cointegration is not supported for main variables, we will not proceed to the construction of the models based on FMOLS method. Table A5 suggests, in most cases, cointegration when the dependent variable are *Gini* and *gross_income*, but lack of cointegration when *net_income* is the dependent variable.

Since cointegration is supported in some cases, FMOLS estimators are computed in Table 1. Inflation has a significant and positive impact on Gini index and share of income held by the top 10% households before transfers and taxes. In average, one unit increase in inflation generates a growth of Gini index by 0.165 units up to 0.258 units, with a lower magnitude around 0.03 units for the income of the top 10% households before transfers and taxes. This result is in line with Ghossoub & Reed (2017) who noticed the pressure of inflation is felt in a disproportionate way by the poor people. Contrary to the results of Kim & Lin (2023): domestic credit to private sector and domestic credit to private sector by banks reduced Gini index and income held by the top 10% households before transfers and taxes. Easier access to credit allows businesses and individuals to invest, start companies, and buy homes. With access to credit, lower-income households can smooth out income fluctuations, invest in their future, and potentially break the cycle of poverty. General government final consumption expenditure reduced income inequality. Increased access to credit for businesses can lead to higher profits, potentially benefiting those at the top of the income distribution who own or manage these businesses. General government final consumption expenditure reduced income inequality. By providing a safety net, investing in human capital, and creating a more level playing field, governments can use public money to promote a more equitable society (Gnangoin et al., 2019): GDP and education had an indirect effect on income inequality. A growing economy creates more jobs and opportunities, potentially leading to rising wages for everyone, not just the top earners. This can lift lower-income individuals out of poverty and narrow the income gap. On the other hand, increased economic activity generates more tax revenue for the government. This revenue can then be used to fund social programs like welfare, unemployment benefits, and education, which directly redistribute wealth and reduce inequality. Education can help break the cycle of poverty by giving people the tools they need to get better jobs, earn more income, and improve their overall well-being (Lee & Lee, 2018):

The interaction between inflation and credit reduced Gini index, while this interaction enhanced *gross_income*. These findings suggest that financial development in interaction with inflation has the capacity to temperate the positive

impact of inflation on Gini index and turns into a negative one. This conclusion is supported by a strong argument that considers financial development as a buffer against shocks in the economy by reducing the information costs, tackling better the risks and decreasing the gap between investment and savings (Kim & Lin, 2023): On the other hand, financial development amplifies the positive impact of inflation on the income of the wealthiest 10% households before taxation, thereby exacerbating income inequality.

Trade and unemployment are only included in regressions with dependent variable gross income – but not in regressions with dependent variable Gini to avoid the multicollinearity, since the correlation matrix in the Appendix shows significant correlation between trade and GDP, credit_bank, credit, respectively and between unemployment and GDP, urban, gov, and inflation, respectively. The different number of observations for models is explained by the fact that some countries in the sample present missing values for some variables.

Table 1 Results of Estimations (FMOLS Estimator)

Variable	*Dependent variable: Gini*							*Dependent variable: gross_income*								
infl	0.165* (0.09)	0.178** (0.084)	0.178** (0.0.084)	0.257*** (0.044)	0.258*** (0.044)	-	-	0.032* (0.021)	0.033** (0.022)	0.033** (0.022)	0.143** (0.055)	0.143** (0.055)	0.0346** (0.023)	0.0346** (0.023)		
credit	-0.037 (0.022)	-0.04* (0.02)		-0.046* (0.02)		-0.008** (0.0032)	-	-0.025*** (0.005)	-0.022*** (0.006)		-0.04** (0.0066)		-0.033* (0.016)	-	-0.06* (0.040)	
credit_bank	-		-0.04* (0.071)		0.046* (0.063)	-	-0.008** (0.0032)	-		-0.022*** (0.064)		-0.004** (0.066)		-0.033* (0.016)		-0.06* (0.040)
gov	-	-0.014* (0.009)	-0.014* (0.009)			-0.060*** (0.019)	-0.060*** (0.019)	-	-0.010** (0.0036)	-0.010** (0.0036)					-0.038* (0.023)	-0.038* (0.023)
corruption	-					-		-			-0.036 (0.039)	-0.036 (0.039)				
edu	-			-0.620** (0.394	-0.620** (0.394)	-		-					-0.690** (0.287)	-0.690** (0.287)		
GDP	-	-	-	-	-	-0.359*** (0.050)	-0.359*** (0.050)	-	-	-	-	-	-	-0.258*** (0.057)	-	-0.258*** (0.057)
infl x credit		-0.051* (0.056)	-0.059* (0.051)	-0.048* (0.042)	-	-	-	-	0.01** (0.001)	0.014** (0.004)	0.013** (0.003)	-	-	-	-	-
vol		0.074 (0.012)								-0.213* (0.0102)						-0.034 (0.022)
unempl															0.042* (0.013)	-
trade															0.131* (0.086)	-
urban															-	0.039** (0.015)
constant	2.658 (0.445)	3.425** (0.743)	3.424** (0.743)	3.837 (0.138)	3.837 (0.138)	8.296*** (0.722)	8.295*** (0.721)	4.336 (0.021)	-0.878 (0.339)	-0.877 (0.339)	-1.757 (0.196)	-1.757 (0.195)	0.207 (0.558)	0.206 (0.558)	2.33 (0.831)	2.32 (0.831)
CD stat.	16.45***	9.556***	8.556***	10.330**	9.226***	5.833**	12.334***	11.424***	9.385***	15.894***	12.834***	8.934***	7.488***	14.366***	9.493***	13.662***
Adjusted R square	0.522	0.572	0.573	0.581	0.582	0.602	0.603	0.48	0.518	0.52	0.56	0.57	0.61	0.62	0.633	0.634
Westerlund (2007) cointegration test																
Stat. 1	0.73	5.47***	6.55***	3.91***	-3.03***	-1.63*	6.55 ***	3.90***	2.16 **	0.19	0.28	1.74 **	-3.78 ***	-2.86 ***	-3.42 ***	-2.13 **
Stat. 2	5.55***	5.47***	6.58***	3.96***	-3.06***	-2.16 **	4.46 ***	4.26***	4.14 ***	6.88 ***	3.41 ***	9.89 ***	-3.17***	-1.60 *	-2.88***	-3.12***
Stat. 3	5.56***	7.78***	4.46***	4.26 ***	-3.43 ***	-2.29**	3.82 ***	8.50 ***	5.55 ***	10.39 ***	2.43 ***	7.20 ***	-3.16 ***	-1.82**	-2.94 ***	-3.83***
Stat. 4	6.04***	7.40***	3.82***	8.57***	-1.63 *	6.55***	3.91***	7.88***	4.99 ***	8.51 ***	2.26 **	4.62 ***	-3.58***	-2.28 **	-2.97 ***	-2.61 ***
No. of observ.	352	922	732	666	490	556	556	352	732	886	696	520	490	666	746	936

6.2 Robustness Checks

The results in Table 2 based on MG estimator confirm the positive impact of inflation on income inequality and the negative effect of credit and government expenditure. In average, one unit increase in inflation generates a growth of Gini index by 0.178 units up to 0.258 units. The magnitude is lower in the case of the income held by top 10% households before and after the transfers and taxes, the increase being less than 0.1 for the indicator before taxation and around 0.1 for the indicator after taxation.

GDP is non-linearly correlated with income inequality which suggests that, in the long-run, more growth is harmful for income distribution. Control of corruption reduced income inequality. Corruption creates an environment where the wealthy and well-connected can exploit the system for personal gain. This undermines efforts to create a fair and equitable society, ultimately widening the gap between rich and poor. Unemployment and trade enhanced income held by the top 10% households before transfers and taxes, while urban population reduced it. High unemployment can disproportionately affect low-skilled workers. Businesses may struggle to find qualified workers for specialized positions, leading to higher wages and increased profits for those with the right skills (Cororaton, 2003): This can benefit the top 10% earners who tend to have higher levels of education and skills. Trade can lead to increased efficiency and productivity for businesses that can access cheaper resources or markets. This can lead to higher profits that could benefit shareholders and top earners in those companies. Cities tend to concentrate economic opportunities, education, and high-paying jobs. This can attract skilled workers and entrepreneurs, potentially increasing wages for those at the top.

The inconsistency across other regression specifications in Table 2 (i.e., 6 specifications for the Gini coefficient, but only 2 specifications for the gross income dependent variable, and 3 specifications for the net income dependent variable) are explained by the lack of valid models when additional variables were included (the parameters of these variables were not significant and the residuals were not stationary):

The approach based on PMG estimator allow us to analyse both long-run and short-run relationships between variables. Inflation had a long-run positive impact on Gini index, but this effect is not significant in the short-run. The impact becomes negative in the short-term in case of income held by the top 10% households. In average, in the long-run, one unit increase in inflation generates a growth of Gini index by less than 0.2 units, with a higher magnitude (higher than 0.5 units) for the top 10% households' income before and after transfers and taxes. In the long-run, the impact of inflation on the top 10% households' income becomes lower, with a decrease between 0.23 and 0.46 units before taxation and a decrease up to 0.1 units after taxation. The marginal effect of inflation on Gini index ranges from 0.011 to 0.014, being lower in the case of the income held by the top 10% households (from 0.003 up to 0.009 before taxes and transfers) and between 0.001 and 0.002 after taxes and transfers): The marginal effect of credit on Gini index is negative

ranging from -0.02 to -0.017. In the case of the income held by the top 10% households, the negative marginal effect is much lower (between -0.005 and -0.001 before taxes and transfers and between -0.003 and -0.01 after transfers and taxes):

Table 2 Results of Estimations (MG Estimator)

Variable	*Dependent variable: Gini*						*Dependent variable: gross_income*		*Dependent variable: net_income*		
infl	0.233** (0.096)	0.178** (0.048)	0.257** (0.044)	0.258** (0.044)	-	-	0.090* (0.054)	0.090* (0.054)	0.095*** (0.004)	-	0.124*** (0.007)
credit	-0.163*** (0.058)		-0.123** (0.061)	-0.123** (0.061)	-0.077** (0.036)	-	-0.133* (0.076)	-	0.059** (0.67)	-	-
credit_bank		-0.163*** (0.058)	-	-0.046 (0.063)	-	-0.077** (0.036)		-0.133* (0.076)	-	0.06* (0.-67)	-
gov		-0.049* (0.040)	-	-	-0.402*** (0.038)	-0.401*** (0.038)	-	-	-	-	-
corruption	-	-	-0.025** (0.297)	-0.024** (0.297)	-	-	-	-0.06*** (0.421)	-	-0.026** (0.-262)	-0.027** (0.-262)
edu	-	-	-	-	-	-	-	-	-	0.167*** (0.017)	0.168** (0.017)
GDP	-	-	-	-	-0.229** (0.102)	-0.228** (0.102)	-	-	-	-	-
GDP square					0.023* (0.01)	0.024* (0.01)			-		
unempl	-	-	-	-	-	-	-	-	-	0.027** (0.241)	0.027** (0.241)
trade	-	-	-	-	-	-	-	-	-	0.122* (0.06)	-
urban	-	-	-	-	-	-	-	-	-	-	-0.066*** (0.02)
infl x credit		-0.014** (0.047)	-0.015 (0.046)					0.058* (0.0338)	-	-	-
vol		-0.643 (0.559)							-	-0.599* (0.078)	-
constant	2.069 (8.153)	2.085 (8.164)	4.217*** (0.792)	4.216*** (0.792)	-3.178 (8.700)	-3.167 (8.703)	-0.458 (0.288)	-0.458 (0.288)	-2.19** (0.973)	-2.194** (0.970)	-1.096 (0.39)
CD stat.	3.223**	7.349***	8.884***	9.016***	10.045***	16.368***	6.023**	8.345***	10.322***	11.539***	11.644***
Root Mean Squared Error (sigma)	0.0279	0.0279	0.0318	0.0318	0.0278	0.0278	0.0334	0.0335	0.0111	0.0111	0.0209
No. of observations	366	922	718	696	732	746	366	710	366	1110	848

Source: own calculations in Stata. Standard errors are reported in brackets.

Notes: *,**,*** indicate significance at 1%, 5% and 10% level, respectively.

Only for that income after taxes and transfers the credit had a negative impact on both long and short-run. A particular attention should be assigned to the interaction between inflation and domestic credit to private sector. In the long-run, the impact of financial development on income inequality appears to be contingent on a country's inflation rate. In economies with low inflation, financial development may exacerbate income inequality. This could happen through mechanisms like unequal access to financial services, where wealthier individuals and businesses benefit more from credit and investment opportunities. On the other hand, in countries with high inflation, financial development might actually contribute to a

reduction in income inequality. This could be because a more developed financial system offers alternative stores of value besides cash, which loses purchasing power rapidly during high inflation. This could help protect the savings of lower-income households who are more reliant on cash.

The interaction term of inflation and financial development in Table 3 (PMG model) has a negative and significant coefficient for two dependent variables (Gini index and income held by top 10% households after taxes and transfers): and a positive and significant coefficient for the other dependent variable (income held by top 10% households before taxes and transfers):

First, let us explain the negative impact of interaction term of inflation and financial development on Gini index and income held by top 10% households after taxes and transfers. Volatile inflation can induce uncertainty, confusion, and employment instability, thereby exacerbating income inequality. Financial development, however, can serve as a countervailing force. By reducing information asymmetries, improving risk management capabilities, lowering the cost of external finance, and facilitating efficient capital allocation, financial development can mitigate the negative impact of inflationary shocks. Governments often implement progressive tax systems, where higher-income individuals pay a larger proportion of their income in taxes. As the income of the top 10% households increases because of inflation, they may be subject to higher tax rates, which will reduce their income and consequently alleviate income inequality. Second, the interaction term of inflation and financial development has a positive impact on income held by top 10% households before taxes and transfers. The inflation increases the income before taxation of the top 10% households and the financial development will increase it more which will enhance income inequality based on income held by top 10% households before taxes and transfers.

Surprisingly, contrary to the conclusion of Memon & Qureshi (2021): inflation volatility is negatively associated with income inequality and the top 10% income share. Higher-income individuals, particularly those with significant wealth, might be strongly affected by inflation, even more than low-income households. In this context, the assets of high-income individuals might reduce during inflationary periods more than the assets of low-income people, which reduces income inequality and top 10% income share.

The Common Correlated Effect PMG (CCEPMG) estimator was introduced in Ditzen (2018): based on the work of Chudik and Pesaran (2015) and Chudik et al. (2016): to address the issue of cross-sectional dependence in heterogeneous panel models. The results in Table 4 suggest just a long-run relationship between inflation, credit, interaction term and inflation volatility and income inequality based on Gini index and net income and a long-run connection between inflation, interaction between credit and inflation and gross income. These findings were also obtained using PMG estimators. The short-run connection is not supported in the short-run for all the variables. Only the connection between income held by the top 10% households before transfers and taxes and inflation volatility is supported in the

short-run. Higher inflation volatility reduced income held by the top 10% households before transfers and taxes, because in the short-term the assets of high-income individuals might reduce more than the assets of low-income people.

Table 3 Results of Estimations (PMG Estimators)

Variable	*Dependent variable: Gini*			*Dependent variable: gross_income*			*Dependent variable: net_income*		
Long-run									
infl	0.167* (0.092)	0.181* (0.090)	0.177* (0.091)	0.606** (0.115)	0.748*** (0.104)	0.698*** (0.106)	0.634* (0.454)	0.521*** (0.015)	0.598*** (0.021)
Credit	-0.054** (0.031)	-0.040** (0.022)	-0.069* (0.040)	-0.068*** (0.018)	-0.040* (0.022)	-0.035 (0.225)	-0.666** (0.310)	-0.228* (0.055)	-0.322*** (0.031)
gov	-	-0.528*** (0.097)	-	-	-0.412*** (0.103)	-		-0.013 (0.269)	-
infl x credit	-	-	-0.014** (0.006)	-	0.012*** (0.005)	0.017*** (0.006)	-	-0.001*** (0.0006)	-0.084* (0.049)
vol	-	-	-0.688*** (0.147)	-		0.048 (0.259)	-	-	-0.568*** (0.011)
unempl								0.033* (0.017)	
trade								0.116* (0.136)	
urban								-	0.057** (0.034)
Short-run									
Infl	-0.267 (0.378)	-0.355 (0.244)	-0.304 (0.274)	-0.230* (0.131)	-0.460*** (0.146)	-0.337** (0.104)	-0.036* (0.017)	-0.100*** (0.030)	-0.067** (0.032)
Credit	0.028* (0.087)	0.031* (0.074)	-0.068* (0.067)	0.045* (0.085)	0.311 (0.267)	-0.012 (0.070)	-0.063* (0.038)	-0.025* (0.024)	-0.055** (0.025)
gov	-	0.252 (0.155)	-	-	0.466*** (0.119)			0.239* (0.111)	-
infl x credit	-	-	0.003* (0.001)	-	-0.006*** (0.002)	-0.003* (0.002)	-	-0.0003*** (0.0002)	-0.001*** (0.0005)
vol	-	-	0.089 (0.139)	-	-	-0.270** (0.120)	-	-	-0.045** (0.047)
unempl								0.110 (0.003)	
trade								0.342 (0.336)	
urban									0.116 (0.104)
Constant	6.357 (0.578)	8.342*** (0.502)	2.776*** (0.807)	-2.380*** (0.561)	3.147*** (0.899)	-0.661*** (0.133)	2.334*** (0.433)	-0.403** (0.170)	0.347 (0.298)
Error correction term	-0.526* (0.092)	-0.551* (0.091)	-0.400 (0.094)	-0.602** (0.039)	-0.652* (0.081)	-0.453* (0.091)	-0.517** (0.028)	-0.382* (0.057)	-0.304* (0.092)
Residual	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Marginal effect of inflation- mean	0.014*	0.015*	0.011*	0.009	0.005	0.003	0.001	0.0012	0.002
Marginal effect of credit- mean	-0.02*	-0.02*	-0.017*	-0.005	-0.004	-0.001	-0.003	-0.002	-0.01
No. of observations	366	556	542	366	732	542	380	1126	732

Source: own calculations in Stata. Standard errors are reported in brackets. *,**,*** indicate significance at 1%, 5% and 10% level, respectively.

In average, in the long-run, one unit increase in inflation generates a growth of variation in Gini index by 0.351 units, but the magnitude is lower (around 0.25 units) for the top 10% households' income before and after transfers and taxes. One unit increase in credit in the long-run generates, in average, around 0.05 decrease in variation of Gini and gross_income and 0.15 decrease in net_income. The impact of the interaction between credit and inflation is even lower.

Table 4 Results of Estimations (Common Correlated Effect PMG (CCEPMG) Estimators)

Variable	*Dependent variable: ∆Gini*	*Dependent variable: ∆ gross_income*	*Dependent variable: ∆ net_income*
infl	0.351*** (0.024)	0.247*** (0.065)	0.251*** (0.017)
credit	-0.043*** (0.011)	-0.053 (0.102)	-0.150* (0.061)
infl x credit	0.012*** (0.001)	0.015** (0.008)	-0.033* (0.013)
vol	0.196*** (0.011)	0.216 (0.512)	-0.129*** (0.025)
∆ infl	-0.529 (0.440)	-0.465 (0.400)	-0.466 (0.310)
∆ credit	0.102 (0.091)	-0.210 (0.169)	-0.135 (0.112)
∆ infl x credit	0.065 (0.083)	-0.074 (0.056)	0.077 (0.195)
∆ vol	0.232 (0.289)	-0.619* (0.326)	-0.300 (0.267)
constant	-1.050 (2.044)	-2.178*** (2.203)	-1.906 (1.930)
No. of observations	1452	1452	1452

Source: own calculations in Stata. Standard errors are reported in brackets. *,**,*** indicate significance at 1%, 5% and 10% level, respectively.

The identification of inflation's impact on income inequality is complicated by the issue of simultaneity. This means that factors influencing inflation, such as supply shocks or loose monetary policy, may also directly affect income inequality. While including additional control variables can partially address this issue, it is crucial to ensure that the identified effect is truly due to inflation itself, not its underlying causes. To strengthen the identification of inflation's impact, this paper considered system GMM approach in a robustness check. A common approach is to use lagged levels of the endogenous variables as instruments. In system GMM, lagged differences of the endogenous variables are also used as instruments. This helps address potential issues with weak instruments. Any exogenous variables in the model can also be used as instruments for themselves. The choice of the number of lags for both levels and differences can significantly impact the results. This method can help isolate the causal effect of inflation, even when it is correlated with other factors. While dynamic regressions are often estimated using first differences, they can also be conducted with level variables, especially in panel data settings. The results in Table 5 are consistent with the previous ones based on PMG estimators. Inflation enhances the income inequality, while the credit reduces it.

Table 5 Results Based on System GMM Estimators

Variable	*Dependent variable: Gini*			*Dependent variable: gross_income*			*Dependent variable: net_income*		
Gini in the previous period	0.867*** (0.037)	0.797*** (0.061)	0.879*** (0.034)	-	-	-	-	-	-
gross_income in the previous period	-	-	-	0.753*** (0.046)	0.704*** (0.052)	0.721*** (0.053)	-	-	-
net_income in the previous period	-	-	-	-	-	-	0.831*** (0.023)	0.815*** (0.028)	0.810*** (0.025)
infl	0.070* (0.020)	0.082* (0.026)	0.121** (0.060)	0.149** (0.0.02)	0.704*** (0.052)	-0.737*** (0.036)	0.304*** (0.009)	0.188*** (0.016)	0.218* (0.120)
credit	-0.087*** (0.010)	-0.037** (0.011)	-0.061** (0.020)	-0.042** (0.017)	-0.044*** (0.01)	-0.057*** (0.018)	-0.194*** (0.005)	-0.191* (0.007)	-0.268*** (0.015)
gov	-	-0.427*** (0.022)	-	-	-0.678*** (0.186)	-	-	-0.075 (0.064)	-
infl x credit	-	-	-0.026** (0.010)	-	0.031*** (0.002)	0.033*** (0.005)	0.045** (0.021)	-0.015* (0.008)	-0.039*** (0.008)
vol	-	-	-0.143** (0.060)	-	-	0.032** (0.011)	-	-	-0.607* (0.354)
unempl	-	-	-	-	-	-	-	0.046* (0.012)	-
trade	-	-	-	-	-	-	-	0.195* (0.102)	-
urban	-	-	-	-	-	-	-	-	0.094** (0.043)
Constant	0.890 (0.130)	1.302** (0.645)	0.47** (0.060)	-0.029*** (0.156)	0.754** (0.300)	-0.063 (0.339)	-0.223*** (0.056)	0.163 (0.269)	0.274 (0.214)
No. of instruments	134	135	130	145	139	139	145	142	140
AR(1)	0.002	0.0023	0.004	0.03	0.045	0.038	0.011	0.015	0.021
AR(2)	0.226	0.279	0.225	0.483	0.498	0.5003	0.478	0.535	0.604
Sargan test statistics	34.56	38.29	40.38	55.29	46.39	18.95	20.05	33.53	10.57
No. of observations	546	736	904	546	722	722	722	1292	1102

Source: own calculations in Stata. Standard errors are reported in brackets. *,**,*** indicate significance at 1%, 5% and 10% level, respectively.

The key difference between the effects of expected and unexpected inflation on income/wealth inequality lies in their predictability. Economic agents can adjust their behavior in response to expected inflation. For instance, wage negotiations can incorporate expected inflation, and interest rates on loans can be adjusted accordingly (Menna & Tirelli, 2017): While expected inflation can still distort economic decisions and lead to some inefficiencies, its impact on income/wealth inequality is generally less pronounced compared to unexpected inflation (Cysne, 2004): While expected inflation can cause economic distortions, unexpected inflation is more likely to have a pronounced effect on income/wealth inequality because of its unanticipated nature and the subsequent reallocation of resources. Unexpected inflation can erode the value of fixed-income assets, benefiting debtors (often lower-income) at the expense of creditors (often higher-income): Wages might not keep pace with rising prices, especially for lower-income workers, exacerbating income

inequality. The value of real assets (like property, stocks) can increase faster than the general price level, benefiting asset holders (often wealthier individuals) (Mocan, 1999):

Given the way unexpected inflation is calculated (i.e., inflation forecast error): this variable is stationary and it is not appropriate to include such a variable in a cointegration-based estimator. Therefore, it is preferred the approach based on PMG estimator that allows for I(0) and I(1) series and not FMOLS approach.

Table 6 provides more insights on the mechanism behind the relationship between inflation, income inequality and financial development by considering expected and unexpected inflation. In the long-run, unexpected inflation increased income inequality measured through Gini index, but its interaction with domestic credit to private market reduced it. Unexpected inflation can widen income inequality in the long run because of erosion of saving and wage adjustment (Monnin, 2014): However, domestic credit to the private market can act as a countervailing force due to investment opportunities and asset price inflation. Moreover, unexpected inflation reduced income held by the top 10% households, but its interaction with credit had no impact on income.

In Table 6, unexpected inflation has a positive effect on inequality proxied with the Gini coefficient, but negative effect on inequality proxied with the income share of top 10% of households in the long-run. Gini coefficient captures overall income inequality. Unexpected inflation might disproportionately affect lower-income groups, leading to a widening income gap and an increase in the Gini coefficient. For instance, lower-income individuals might have a higher propensity to consume non-durable goods, which are often more sensitive to price increases. Income share of top 10% of households focuses on the upper tail of the income distribution. Unexpected inflation could redistribute income from the top 10% households to other income groups, potentially through mechanisms like wage adjustments lagging behind price increases, or increased taxation on capital gains.

Expected inflation contributed to more income inequality measured by Gini index, but reduced income held by the top 10% households before and after redistribution. Expected inflation interaction with domestic credit to private sector in the long-run reduced income inequality. Expected inflation can lead to increased asset prices and wage adjustments. Expected inflation can actually reduce the top 10% income share before redistribution because of erosion of fixed income and taxes on nominal income. Domestic credit to the private sector, as discussed earlier, can act as a buffer against inequality due to investment and job creation and due to spread of wealth creation.

Table 6 Results of Estimations (PMG Estimator) for Expected and Unexpected Inflation

Variable			
Long-run	***Dependent variable: Gini***	***Dependent variable: gross_income***	***Dependent variable: net_income***
inf^{exp}	0.215*** (0.012)	-0.005*** (0.003)	-0.0012*** (0.0004)
inf^{unexp}	0.007*** (0.002)	-0.072** (0.25)	-0.0075*** (0.002)
Credit	-0.014** (0.006)	-0.33* (0.058)	-0.093** (0.015)
inf^{exp} *x credit*	-0.001*** (0.0002)	-0.0002 (0.0001)	-0.0001* (0.00006)
inf^{unexp} *x credit*	-0.128** (0.04)	-0.018 (0.053)	0.008 (0.018)
Short-run			
inf^{exp}	-0.006 (0.049)	0.033 (0.059)	0.001 (0.0036)
inf^{unexp}	0.019 (0.034)	0.012 (0.711)	0.002 (0.0057)
Credit	-0.0011 (0.056)	0.03 (0.101)	-0.041** (0.020)
inf^{exp} *x credit*	0.0001*** (0.00006)	-0.001 (0.006)	-0.001 (0.001)
inf^{unexp} *x credit*	-0.002** (0.001)	-	-
Constant	1.348*** (0.228)	0.367*** (0.102)	0.435** (0.153)
Error correction term	-0.291*** (0.085)	-0.333*** (0.001)	0.266 (0.227)
Residual	I(0)	I(0)	I(0)
CD stat.	6.788***	8.967***	4.15**
No. of observations	936	936	936

Source: own calculations in Stata. Standard errors are reported in brackets.

Notes *,**,*** indicate significance at 1%, 5% and 10% level, respectively.

The previous theoretical indicates that the effect of unexpected inflation on income inequality should be much larger than the effect of expected inflation. However, the results reported in Table 5 indicate that the expected inflation has a much larger effect on inequality (measured with the Gini coefficient) than unexpected inflation. The effect of unexpected inflation on Gini index might reduce due to better insurance brought by the financial development. On the other hand, the wealthy can protect their assets from expected inflation by investing in assets that retain their value, while workers are more vulnerable to the eroding effects of rising prices.

Financial Development Index (FD) of Svirydzenka (2016) is considered in additional models instead of credit. The variable is weakly correlated with the explanatory variables in the models (coefficients of correlation under 0.16): In the long-run, the financial development reduced the income inequality, but in the short-run, there is no significant impact (Table 7):

Table 7 Results of Estimations (PMG Estimators) with FD as Explanatory Variable

Variable	*Dependent variable: Gini*			*Dependent variable: gross_income*			*Dependent variable: net_income*		
Long-run									
infl	0.187* (0.076)	0.149* (0.067)	-	0.548 (0.123)	0.655*** (0.116)	-	0.605* (0.547)	0.417*** (0.011)	-
FD	-0.421** (0.031)	-0.429** (0.022)	-0.069* (0.040)	-0.423*** (0.018)	-0.040* (0.022)	-0.035 (0.225)	-0.058** (0.310)	-0.067* (0.055)	-0.047*** (0.031)
gov	-	-0.555*** (0.038)	-	-	-0.544** (0.223)	-		-0.019 (0.211)	-
infl x credit	-	-	-0.010** (0.008)	-	0.015*** (0.002)	0.021*** (0.003)	-	-0.002*** (0.0003)	-0.091** (0.039)
vol	-	-	-0.766*** (0.111)	-		0.037 (0.338)	-	-	-0.433*** (0.017)
unempl								0.048* (0.011)	
trade								0.227* (0.147)	
urban								-	0.065** (0.028)
Short-run									
infl	-0.117 (0.155)	-0.319 (0.325)	-	-0.34* (0.129)	-0.477 *** (0.158)	-	-0.017* (0.003)	-0.147** (0.044)	-
FD	-0.033 (0.087)	0.031 (0.074)	-0.047 (0.067)	-0.009 (0.085)	-0.012 (0.267)	-0.016 (0.070)	-0.003 (0.038)	-0.002 (0.024)	-0.001 (0.025)
gov	-	0.286 (0.125)	-	-	0.533*** (0.114)			0.228* (0.145)	-
infl x credit	-	-	0.001* (0.0007)	-	-0.004*** (0.002)	-0.003* (0.001)	-	-0.0005*** (0.0001)	-0.002*** (0.0001)
vol	-	-	0.073 (0.345)	-	-	-0.337** (0.109)	-	-	-0.038** (0.026)
unempl								0.009 (0.01)	
trade								0.645 (0.318)	
urban									0.138 (0.139)
Constant	5.556 (0.334)	3.583 (0.337)	1.473 (0.486	3.334*** (0.117)	3.107*** (0.236)	0.442*** (0.148)	-2.384*** (0.664)	-0.338** (0.229)	0.229 (0.195)
Error correction term	-0.377* (0.006)	-0.491* (0.078)	-0.339 (0.067)	-0.783 ** (0.039)	-0.732* (0.076)	-0.385* (0.064)	-0.449 ** (0.034)	-0.866* (0.052)	-0.754* (0.0343
Residual	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
No. of observations	380	570	556	366	746	556	380	1126	746

Source: own calculations in Stata. Standard errors are reported in brackets.

Notes: *,**,*** indicate significance at 1%, 5% and 10% level, respectively.

7. Conclusions

The gap between rich and poor has been widening globally since the late 1980s, a trend that persisted even after the financial crisis and Great Recession, which some believe were fueled by the very inequality they preceded (Law & Soon, 2020): Consequently, policymakers are increasingly interested in how central bank actions, particularly regarding inflation, might affect income distribution.

Inflation impacts prices and asset returns, which in turn affect how people choose to invest their money and how much wealth they accumulate. It can also disrupt how the financial system allocates resources, leading to distortions in economic choices about saving and investing. Therefore, understanding the link between inflation and income inequality is becoming a higher priority.

However, the relationship between these two factors is complex and not fully understood, both in theory and based on real-world data. Rather than adding to the confusion with more statistical analyses, this paper takes a different approach. It investigates whether a country's level of financial development influences how inflation affects income inequality. This could help explain why existing studies on this topic have produced such mixed results.

This study, conducted on CEE countries during the period 2004-2022, led to several key conclusions. Inflation contributes to income inequality, but an increase in domestic credit to the private sector can mitigate this effect in the long run. Therefore, policy recommendations to address income inequality and inflation should focus on credit expansion. More credit allows SMEs to invest, expand, and hire more workers. This injects money into the middle and lower classes, reducing income inequality. Easier access to credit allows businesses to invest in new technologies and equipment, leading to increased productivity and potentially lower prices in the long term, tempering inflation. Promoting financial inclusion ensures that credit expansion benefits a wide spectrum of society, not just the wealthier segments. This can help lower-income groups better protect themselves against inflation and potentially reduce inequality. Developing policies that specifically target financial inclusion can provide greater protection for lower-income groups against the adverse effects of inflation. Strengthening regulatory frameworks to prevent excessive risk-taking by financial institutions can help maintain economic stability while promoting credit expansion. A robust regulatory environment ensures that credit expansion does not lead to financial instability, which could exacerbate income inequality.

However, this study presents few limitations. For example, potential channels for financial development to reduce the impact of inflation on income inequality are not considered. A relative low period is considered because of limited data availability. Only few control variables were considered in the models based on data availability for the analysed period. Therefore, future studies should take into account the proper channels for financial development to mitigate the harmful impact of inflation. Additionally, more control variables could be included, such as labor market and product reforms (Wiese et al., 2024) and financial crises (Bodea et al., 2021):

APPENDIX

Table A1 Descriptive Statistics

Variable (original data)	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
gini	176	31.50227	4.772731	23.2	41.3
GDP	190	13954.23	4567.933	4854.273	25349.76
unempl	190	8.003684	3.583955	2.02	19.48
credit_bank	176	49.15802	15.97748	0.1861522	101.3596
credit	176	49.18754	15.98279	0.1861699	101.388
trade	190	129.578	31.91375	58.47284	204.1215
urban	190	6210770	6444529	897427	2.35e+07
gov	190	2.20e+10	2.37e+10	3.43e+09	1.10e+11
corruption	154	.3931741	0.4428046	-0.3814435	1.580866
edu	124	80.19561	7.677778	62.9813	90.92707
infl	190	105.1895	16.33674	67.58026	151.9433
gross_income	190	0.3489937	0.0479228	0.2598	0.4526
net_income	190	0.5859842	0.0610476	0.4195	0.6872
FD	180	0.3475	0.0989942	0.12	0.57

Source: own calculations in Stata 15. Note: The means are calculated across both countries and years.

Table A2 Matrix of Correlation

	GDP	*unempl*	*credit_bank*	*credit*	*trade*	*urban*	*gov*	*corru-ption*	*edu*	*infl*
GDP	1									
unempl	-0.3296*	1								
credit_bank	0.1175	0.0994	1							
credit	0.1170	0.0991	1	1						
trade	0.6165*	-0.0615	0.2847*	0.2851*	1					
urban	-0.4752*	-0.1994*	-0.1949*	-0.1949*	-0.4982*	1				
gov	-0.0932	-0.3056*	-0.1814	-0.1816	-0.3084*	0.9106*	1			
corruption	0.4818*	-0.1360	0.1553	0.1543	0.0119	-0.3313*	-0.2247*	1		
edu	0.6719*	0.0641	0.2034	0.2033	0.5731*	-0.3780*	-0.1366	0.0131	1	
infl	0.4171*	-0.3866*	0.1071	0.1071	0.3649*	0.0104	0.1221	0.0555	0.2794	1

Notes: * means significant at 1% level. Source: own calculations in Stata 15.

Table A3 The Results of Pesaran (2015) CD Test

Variable	*CD-test stat.*	*p-value*
gini	4.18	<0.01
gdp	27.49	<0.01
unempl	21.11	<0.01
credit_bank	10.45	<0.01
credit	10.45	<0.01
trade	24.47	<0.01
urban	-0.05	0.959
gov	21.46	<0.01
corruption	10.76	<0.01
edu	13.49	<0.01
infl	28.78	<0.01
gross_income	-0.10	0.920
net_income	4.00	<0.01
FD	3.87	<0.01

Source: own calculations in Stata 15

Table A4 The Results of CADF Test

Variable	*Data series*	*one lag*		*two lags*		*Order of integration*
Gini	*in level*	-0.317	(0.376)	2.034	(0.979)	I(1)
	in the first difference	-3.012	(0.001)	-3.677	(<0.01)	
GDP	*in level*	0.661	(0.746)	0.559	(0.712)	I(1)
	in the first difference	-1.443	(0.075)	-1.358	(0.087)	
unempl	*in level*	0.828	(0.796)	-0.742	(0.229)	I(1)
	in the first difference	-3.347	(<0.01)	-2.536	(0.006)	
credit_bank	*in level*	1.069	(0.857)	1.836	(0.967)	I(1)
	in the first difference	-2.198	(0.014)	-4.335	(<0.01)	
credit	*in level*	0.823	(0.795)	1.842	(0.967)	I(1)
	in the first difference	-2.192	(0.014)	-4.085	(<0.01)	
trade	*in level*	0.998	(0.841)	1.863	(0.969)	I(1)
	in the first difference	-2.809	(0.009)	-1.341	(0.088)	
urban	*in level*	2.322	(0.990)	3.847	(0.999)	I(1)
	in the first difference	-2.461	(0.007)	-3.446	(<0.01)	
gov	*in level*	1.998	(0.977)	-1.175	(0.120)	I(1)
	in the first difference	-4.391	(<0.01)	-2.507	(0.006)	
corruption	*in level*	1.665	(0.936)	4.996	(0.999)	I(1)
	in the first difference	-2.189	(0.015)	-3.778	(<0.01)	
edu	*in level*	3.670	(0.999)	6.002	(0.999)	I(1)
	in the first difference	-2.907	(0.011)	-3.897	(<0.01)	
infl	*in level*	1.546	(0.939)	1.289	(0.901)	I(1)
	in the first difference	-3.269	(<0.01)	-3.690	(<0.01)	
gross_income	*in level*	-0.893	(0.186)	-0.008	(0.497)	I(1)
	in the first difference	-4.781	(<0.01)	-1.827	(0.034)	
net_income	*in level*	0.062	(0.525)	-0.063	(0.475)	I(1)
	in the first difference	-1.935	(0.027)	-2.291	(0.012)	
FD	*in level*	0.632	(0.736)	1.282	(0.900)	I(1)
	in the first difference	-4.113	(<0.01)	-4.567	(<0.01)	

Source: own calculations in Stata 15

Table A5 The Results Westerlund Cointegration Test

Variables (dependent variables: Gini, gross_income, net_income)	*Group and Panel Statistics*	*stat.*	*p-value*
infl, Gini, credit	G_t	0.73	0.255
	G_a	5.55	<0.01
	P_t	5.56	<0.01
	P_a	6.04	<0.01
infl, Gini, credit_bank	G_t	0.1066	0.4575
	G_a	-0.3860	0.3498
	P_t	-1.7095	0.0437
	P_a	0.1120	0.4554
infl, gross_income, credit	G_t	3.90	0.003
	G_a	4.26	<0.01
	P_t	8.50	<0.01
	P_a	7.88	<0.01
infl, gross_income, credit_bank	G_t	-2.5217	0.0058
	G_a	-0.3436	0.3656
	P_t	-1.9057	0.0283
	P_a	0.9653	0.1672
infl, net_income, credit	G_t	-1.9696	0.0244
	G_a	-0.4339	0.3322
	P_t	-1.4990	0.0669
	P_a	-0.9339	0.1752
infl, net_income, credit_bank	G_t	-1.9721	0.0243
	G_a	-0.4361	0.3314
	P_t	-1.5022	0.0665
	P_a	-0.9347	0.1750

Source: own calculations in Stata 15.

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