**SPECIALISED MASTER IN INTERNATIONAL AND DEVELOPMENT ECONOMICS**

# Monetary Policy and Income Inequality in Brazil
## Structural VAR Approach

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# Monetary Policy and Income Inequality in Brazil:

# Structural VAR Approach


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## Acronyms

| | |
|---|---|
| **BCB** | Banco Central do Brazil |
| **EMDCs** | Emerging and Developing Countries |
| **IRF** | Impulse Response Function |
| **MP** | Monetary Policy |
| **MPF** | Monetary Policy Framework |
| **SVAR** | Structural Vector Autoregressive |
| **VAR** | Vector Autoregressive |
| **VDFE** | Variance Decomposition Forcast Error |
| **UMP** | Unconventional Monetary Policy |

## Abstract

*The main objective of this study is to investigate the impact of monetary policy shock on income inequality in Brazil. To estimate the Structural Vector Autoregressive (SVAR) model, time series data is gathered from the first quarter of 1998 to the last quarter of 2021. Results from the SVAR model indicated that the impulse response of income inequality to a positive shock in monetary policy rate is positive and significant. The implication is that contractionary monetary policy propagates income inequality through earning heterogeneity and saving redistribution channels. A positive shock in private credit reduces income inequality both in the short run and long run. Moreover, the response of income inequality to a shock in inflation and unemployment rate is positive and significant. Lastly, the results of the variance decomposition factor revealed that 36.19 %, 17.8 %, and 4 % of the variation in income inequality came from private credit, real GDP growth, and unemployment rate respectively. Any policy that targets fair distribution of income in Brazil should enhance access to credit for many of the poor and decrease the rate of unemployment.*

***Key Words:*** Brazil, Income Inequality, Monetary Policy

# 1. Introduction: The State of Knowledge and Rationality of the Project

*"A nation will not survive morally or economically when, so few have so much and so many have so little'' said Bernie Sanders*

Inequality within most emerging and developed countries (EMDCs) has increased, a phenomenon that has received considerable attention (Dabla-Norris et al., 2015; Domanski et al., 2016). Rising wealth and income inequality is a global concern of researchers, practitioners, multilateral organizations, and policy-makers (Domanski et al., 2016; O'Farrell & Rawdanowicz, 2017; Arestis & Pérez-Moreno, 2022) since it is a moral issue and a political and macroeconomic objectives in a country. Since the middle of the 1980s, income inequality has increased. It is always important for capital owners to earn more income than ordinary people because capital owners gain more income through dividends, interest, rent, and profit (Piketty, 2014).

Statistically, the world's top 10% of the population control 52% of worldwide income and 76% of global wealth. Meanwhile, the world's poorest 50% of people own only 2% of the world's wealth and 8.5% of the total income (Lucas Chancel et al., 2022). The implication is that wealth disparities are more pronounced than income gaps globally. This means that poor people have a smaller share of world income and wealth. The gap in income and wealth inequality among the poor and the rich and so enormous that it has so many repercussions.

A number of studies ( See Piketty, 2014; Dabla-Norris et al., 2015; Bourguignon, 2018; Wolde et al., 2022) have been conducted in different countries to understand the causes and consequences of inequality in income. The rate of economic growth, improvement in human development index, absorption in labor, and advancement in technology and the energy sector are among the contributing factors to dynamics of inequality in income with in Emerging and Developing Countries (EMDCs here in after) (Shah Faisal, 2022; Dong et al., 2022; SeriN Oktay & Algan, 2022; Odhiambo, 2022; Wahiba & Dina, 2023). In fact, the relationship between economic disparity and national income is actually a controversial topic among scholars (Domanski et al., 2016) because it varies depending on the country stages of development, the methodology used, and the time horizon examined. For instance, the results of (Kuznet, 1955; SeriN Oktay & Algan, 2022;Wolde et al., 2022) showed that income disparity is positively correlated with

economic growth during the early phases of development. In contrast, income inequality narrows as development progresses.

In Latin America and the Caribbean in general and Brazil in particular, income inequality has also been a major concern for researchers and policymakers since at least the mid-20th century. Although the region has made significant progress on a number of social and economic fronts, many nations have struggled to reduce income disparity (Busso & Messina, 2020). In the majority of the countries in Latin America and the Caribbean, the early 2000s marked the start of an era of declining inequality (López-Calva & Lustig, 2010) due to positive external shocks accompanied by structural reforms in many countries, which brought macroeconomic stability (Busso & Messina, 2020) and a rise in public transfers to the poor and a decline in the wage gap received by the skilled and unskilled labors (López-Calva & Lustig, 2010). The most interesting aspect is that a decrease in the percentage of income going to the top one percent did not cause inequality to fall in Latin American nations. Rather, those at the bottom of the income distribution were climbing the income ladder (Busso & Messina, 2020).

The outbreak and the spread of covid 19 pandemic further exacerbated the prevailing trends of income inequality that will probably worsen the preexisting structural problems (Busso & Messina, 2020). Specifically, the year 2021 saw the Gini Index of Brazil rise to 0.544, the second-highest figure in the series. The highest figure in 2018 was 0.545 (IBGE, 2022). Due to this, Brazil is like Honduras, and Panama is the most unequal country in the region (Busso & Messina, 2020).

Empirical findings showed a rise in income disparity is connected to several effects. There is a negative correlation between income disparity and economic growth in low-income nations, according to certain research that has been done so far. Particularly, a high level of income disparity hinder the capability of the country to flourish economically, escape poverty, and intensifies macroeconomic instabilities ( Fawaz et al., 2014 ; Wahiba & Weriemmi, 2014; Dabla-Norris et al., 2015) and hinder the implementation of macroeconomic policies. Moreover, income inequality further reduces the fraction of economic growth going to poor people (Serin Oktay & Algan, 2022) and deteriorates their living standard. It may also be the source of social and political instabilities. Based on the finding of (Dabla-Norris et al., 2015), high degree of

income inequality can erodes citizens confidence in institutions, loss of trust and social cohesion, and as well as discourage people from looking forward for a better future.

Consequently, the aim of the government is to reduce the negative consequences of income inequality using macroeconomic policies. Keynesians argue that fiscal policy is more effective than monetary policy in enhancing economic activity by raising aggregate demand. As a result, over the past years, an emphasis has been placed on structural policies and the fiscal policy instruments of tax and government expenditure (Hohberger et al., 2020). Meanwhile, monetarists argue that monetary measures have stronger impact on price stability, creating employment opportunities, and maintaining fast and sustainable economic growth in a country (Friedman, 1968; Mishkin, 1995). Conventionally, the impact of monetary policy is explained only on the real side of the economy(Cecchetti, 1995;Saiki & Frost, 2014; Ampudia et al., 2018). There is a limited literature on how changing monetary policy affects income inequality through a variety of mechanisms. However, the potential impacts of monetary policy on redistribution have drawn more attention after the global financial crisis of 2008 (Saiki & Frost, 2014;Domanski et al., 2016;Hohberger et al., 2020).

Theories and empirical findings showed that interest rate, exchange rate, asset price, and credit are a hosts of general transmission channels through which monetary policy can impact on investment, aggregate demand and national income (Mishkin,1995; Mishkin, 2001; Mishkin, 2011; Ping, 2011;Samarina & Nguyen, 2019). Moreover, monetary policy has a distributional impact via income composition, financial segmentation, portfolio, savings redistribution and earnings heterogeneity channels (Coibion et al., 2017;Amaral, 2017) and will be delineated thoroughly in the forthcoming section of the paper. In fact, the impact of monetary policy is inconclusive on income inequality.

The use of various data, the country under consideration, the transmission mechanism, and the applied estimating techniques are all responsible for this. Despite the presence of significant income inequality in Brazil, there is limited evidence on the relationship between monetary policy and the Gini index as a measure of income inequality. So, investigating the distributional impact of monetary policy shocks on income inequality using Structural Vector Autoregressive (SVAR) is the main objective of this paper to contribute to the existing stock of knowledge. Specifically,

1) To study how income inequality in Brazil has evolved over the last decades.
2) To investigate how various channels of monetary policy transmission affect the income inequality measure in Brazil by applying SVAR.

To achieve the research objective, quarterly data on inflation rate, unemployment rate, real GDP growth rate, exchange rate, exchange rate, credit to the private sector, short-term interest rate, and measurements of income inequality (Gini coefficient) is garnered. For analyzing the collected data and examining the relationship between monetary policy and income inequality, the researcher deployed the SVAR model with the help of E-Views 10 statistical software. Moreover, the result of this project is expected to provide pertinent scientific evidence for policy makers in the formulation of appropriate macroeconomic policies to reduce income inequality in Brazil. Finally, it is expected that at least one article and one conference paper will be published.

This paper is organized into five parts. The introduction, rationality, and objective of the project portion are devoted to the first section. Both theoretical and empirical literature reviews on the link between monetary policy and income inequality are discussed in the second part. The methodology that includes data and methods, econometric model specification, and method of data analysis are discussed in part 3 of the paper. Part four presents empirical results and discussions based on research objectives and the results of precursor studies. Finally, conclusions and policy implications are considered in the fifth part.

# 2. Review of Related Literatures

## Introduction

This part presents both theoretical and empirical review of studies conducted related to monetary policy and income inequality. The purpose of the empirical literature review is to identify what has been done so far by previous scholars, how it has been done (methodological approaches) and the results and conclusions obtained. This can in turn have a paramount significance for identifying the gaps in knowledge and research.

## 2.1. Theoretical literature Review

### 2.1.1. Concept of Income Inequality

Income inequality is, by definition, the sum of the two factors of production which is inequality of income from labor and inequality of income from capital in all societies. The total income inequality increases in proportion to how unequally distributed each of these two factors is (Pikkety, 2014). In fact, loosely speaking, inequality can be used for different connotations. We may use the uneven distribution of income, wealth, consumption, or something else. Income for instance may vary between factors of production, across countries, regions, level of education, sex and in many other characteristics. Everyone in a country with complete income equality receives an equal part of the national income. This contrasts with perfect income inequality, in which so few people receive all the total income in the economy. But in no national economy does either of these extreme scenarios exist. It will happen between the two points of perfect equality and perfect income inequality.

It is usually a good thing when economic growth benefits the population equitably. Economic growth that is not distributed fairly is not healthier and must be judged based on equity. Studying the unequal distribution of income and wealth is fascinating for two main reasons (Ray, 1998). First, there are moral and philosophical justifications for being against inequality in general. There is no justification for treating individuals differently in terms of their access to lifetime economic resources. Second, inequality per se may not be the concern because lower rate of economic growth will be registered with higher degree of income inequality. The discussion

below about the four criteria which are helpful for inequality measurement are based on the (Ray, 1998).

1. **Anonymity (Names do not matter) Principle.**

Income permutation variations between individuals shouldn't affect the measurement of inequality. We don't want our measures of income inequality to depend on who is where or who is super rich/ super poor.

2. **Population Principle**

According to this principle of measuring income inequality, population size does not matter if the composition or the proportion of different income classes stay the same in percentage terms. The percentages of the population who earn various levels of income are all that counts.

3. **Relative Income Principle**

It is feasible to argue that just relative incomes should matter, and their absolute levels should not, like how population shares matter and absolute population values do not for measure of income inequality.

4. **The Dalton Principle**

Taking money from the rich person and giving it to the poor person reduces inequality in income. Conversely, the application of regressive transfer of income or a transfer of income from a relatively poor to a relatively rich person increases income inequality. It turns out that these four principles produce a ranking of income distribution from the relatively poor individuals to the rich individuals that is identical to that implied by the Lorenz curve discussed below.

### 2.1.2. Measures of Income Inequality

A well-known measure of income inequality which revealed how cumulative shares of income are earned by cumulative fractions of the population is the Lorenz curve. This curve provides a pictorial representation of the degree of inequality in a society showing the cumulative percentages of the population arranged in increasing order of income and the percentage of total income in a nation going to the population.

Practically, to construct the curve, first, we need to sort the individuals from the poorest to the richest based on their income level. Next, we plot the relative share of individuals in total income at each percentage of the population in the vertical axis and the cumulative percentages of the population arranged in ascending order of income are on the horizontal axis. Finally, the Lorenz curve is the term used for the drawn curve which has a convex shape. If everybody has the same level of income which is not the case in practice, there is no inequality, and the Lorenz curve is in the 45-degree line. However, the Lorenz curve becomes below the 45-degree line when there is inequality. The closer we are to the 45-degree line, the less inequality we have, and inequality tends to rise when we move away from the 45-degree line.

The Gini coefficient and the income quintile ratio are the other two most used indicators of income inequality. The value of Gini coefficient ranges from zero to one. There is no income inequality if its value is zero (total income equality) and there is perfect income inequality if the value of the coefficient is exactly one (Total income inequality) (Mumtaz & Theophilopoulou, 2017; O'Farrell & Rawdanowicz, 2017; Czeczeli, 2021). This paper focuses on the former to measure income inequality despite some caveats as mentioned by researchers.

## 2.2. Stylized Facts of Income Inequality

Dividing the income of the top ten percent to the bottom fifty percent of the population for the period 1820 to 2020 yields global income disparity. For the time mentioned, the top ten percent earned average income of more than double. Specifically, the average income of the bottom fifty percent is eighteen percent lower than the top ten percent of the people in 1820. The average income of the bottom fifty percent was forty one percent lower than the top ten percent of the population during 1910. In 1980, the average income of the world top ten percent was fifty three percent higher than the average income owned by the bottom fifty percent of the population. Further, in the year 2020, the income of the richest ten percent was thirty-eight times higher than the income of the bottom fifty percent of the population (WII, 2022). As a result, governments and other organizations are beginning to consider global income inequality as the most important issue due to its high average global level over various periods.

Countries in Latin America faced a higher degree of income disparity than other countries in the world. Statistically, Latin America had a 0.53 Gini coefficient in the middle of the 2000s, making it 18 percent more unequal than Sub-Saharan Africa, 36 percent more unequal than East Asia and the Pacific, and 65 percent more unequal than high-income countries (López-Calva and Lustig, 2010). Furthermore, Latin America is once again the continent with the highest level of inequality in 2021, with the wealthiest 10 percent of the population controlling 55 percent of the national revenue. However, just 36 percent of the regional income in Europe is controlled by the top 10 percent of earners. (López-Calva and Lustig, 2010).

The adult population's average national income in Brazil is €14,000. The richest ten percent makes over 30 times more than the lowest fifty percent ($2,800). The top ten percent of the population in Brazil receives 59 percent of the entire national income while the bottom half only receives ten percent making it the most unequal country in the globe. According to Lopez-Calva and Lustig (2010), inequality levels in Brazil are higher than those in the China where the top 10 percent receives 42 percent of the nation's income, and USA, where it is 45 percent. According to the results that are now available, the income shares of the top 10 percent have always been larger than those of 50 percent of the people. As a result, there has been persistently substantial income disparity in Brazil and confirmed by the figure shown below.

The figure below revealed the trend of income inequality of Brazil measured in the Gini coefficient. Generally, income inequality fluctuates over time for many reasons. It was significantly high during the first quarter of 1998 and has shown a slight and continuous decline since then despite the degree of inequality being large. This improvement in income distribution is because of the government's macroeconomic stabilization role by implementing a flexible exchange rate regime, a monetary policy framework that targets inflation, and various fiscal policy measures in the year 1999 (Ferreira de Mendonça & Martins Esteves, 2014).

Between 1999 to 2008, a considerable number of other factors such as increased trade openness (especially for labor intensive exporting sector), technological and financial development, a reduction in the unemployment rate, and measures against corruption lowers income inequality in Brazil. Furthermore, the adoption of social assistance programs based on the *Bolsa Família* condition cash transfer to improve the living standard of poor households and to improve access to basic services such as education, health and basic infrastructure played an additional role in

the slight reduction of inequality (OECD, 2010; Marcelo Côrtes Neri & Côrtes Neri, 2010 ; Ferreira de Mendonça & Martins Esteves, 2014). Moreover, due to the lagged impact of the Global Financial Crisis, in 2010, income inequality starts to rise and reaches its peak point and then tried to decline till 2020. But, after the year 2020, or covid crisis, income inequality starts to increase again.

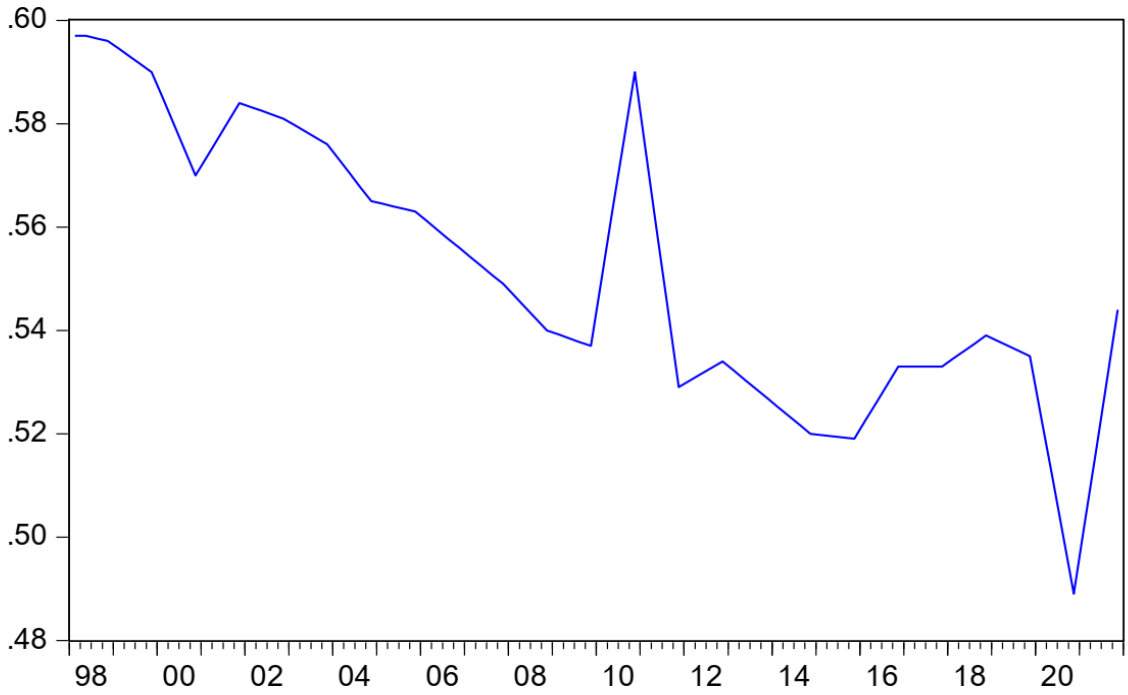



***Figure 2. 1:*** Evolution of Gini Index as a measures of income Inequality (1998Q1 to 2021Q4)

***Source*** own computation using WIID, 2023

As a closing for the stylized facts of income inequality, some of the driving forces of high-income inequality are globalization, technology, decrease in the rate of unemployment, social support program and economic growth. Some authors also considered fiscal macroeconomic policy as the driving force of income inequality. However, the authors Coibion et al. (2017) and Mumtaz & Theophilopoulou (2017) mentioned that unlike fiscal policy the contribution of monetary macroeconomic policy to income inequality is small.

## 2.3. The Monetary Transmission Mechanisms in Theory

The macroeconomic fluctuations in each country are the concern of policy makers and employ a wide range of macroeconomic policies. Monetary policy is one of the most important policies used to maintain a sustainable economic development via directly influencing price and exchange rate stability and full employment objectives. In many practical situations, the organization responsible for the conduct of monetary policy is the central bank (Mishkin, 2011) to control the flow of money and credit through open market operations, bank rates and others monetary instruments.

Aggregate demand management is the main target of fiscal policy while depends on inflation targeting, price stability and financial stability overall. The instruments of the macroeconomic policies can affect economic activities through the channels of spending, savings, investment, and labor supply (Indalmanie, 2016). For those who are in favor of monetary policy, the impact on economic growth is greater when monetary policy is used than fiscal policy. Meanwhile, Keynesians argued that posit that fiscal policy is better than monetary policy in the stimulation of growth. But, for many of the literature suggested that generalizing the impact of the two policies is impossible as it depends on the country under consideration and the channels of transmission.

More specifically, in an economy, monetary policy is one of the key macroeconomic policies where the growth, development and sustainability of economic activities rely on. For Milton Friedan and his followers, the only factor that determines the price level in the economy is money supply. They argued that inflation will occur when the growth rate of money supply faster than the rate of growth of national income. There will not be inflation if the increase in money supply is equal to the increases in output. The real variables such as price level, output, and employment are dominantly influenced by monetary policy through influencing key financial variables such as interest rates, exchange rate and monetary aggregates (Mishkin, 1996). However, except for price and nominal variables, money supply cannot affect the real variables in the long run. The concern about the impact of monetary policy on the economy has received enormous attention in macroeconomic theory and among central banks in the world because it has a significant impact on the well function of the economy. Thus, policy makers and politician care about the conduct of monetary policy (Mishkin, 2011).

Monetary Policy Transmission Mechanism is the channels used by the regulatory authority through which monetary policy affects the real economic activity (Taylor, 1995, Mishkin, 1996; Oyadeyi & Akinbobola, 2022; Farajnezhad, 2022). Interest rate, exchange rate, asset price and credit are the most important monetary policy transmission variables. Each central bank puts a different emphasis on each of the channels. Below in the first section is the discussion how each channel of monetary policy transmission affects the real side of the economic activities, and the second section is all about monetary transmission channels to impact on income inequality

### 2.3.1. Monetary Policy and Economic Activity

Below are the channels through which monetary policy affects the real side of the business cycle such as full employment, price stability, financial stability, and sustainable economic growth. The discussion is based on (Mishkin, 1995; Mishkin, 2004 and Mishkin, 2011) and the work of other authors.

### I. The Interest Rate Channel

Traditional Keynesian interest rate channel describes how monetary policy is transmitted to the real economy through the interest rate. Keynesians argue that expansionary monetary policy increases the availability of credit which decreases interest rates. This in turn encourages investment spending and private consumption, thereby the real GDP rises. Meanwhile, a decline in the quantity of money supply injected into the economy causes the rate of interest to increase which in turn rises the cost of capital, causing a decline in investment spending. Thereby, leading to a decrease in aggregate demand and output.

### II. The Exchange Rate Channel

According to this channel, the value of export, import, and net export is affected by the adoption of monetary policy. This channel has a strong linkage with the interest rate transmission channel of monetary policy. For instance, a deposit in domestic currency will be less attractive compared to a deposit denominated in foreign currency when the rate of domestic interest falls due to expansionary monetary policy. Consequently, there will be a depreciation of the domestic currency. The value of the domestic currency falls more than the foreign currency deposit and causes the export to rise as domestically produced goods and services become cheaper compared to foreign one. A rise in net export causes the national output to rise. Conversely, Contractionary

monetary policy causes the interest rate to increase which in turn increases the exchange rate (Appreciation), and a decline in net export and national level of output.

## III. The Asset Price Channel

As opposed to Keynesian economists, monetarists also consider the monetary effects of asset prices and wealth in addition to interest rates. The easiest way to understand this route of monetary policy transmission is through Tobin's theory. The theory aims to clarify how a change in monetary policy might impact an economy by changing the value of stocks or equities.

According to Tobin, q is the ratio between the market value of businesses and the cost of capital replacement. As a result, a greater value of q denotes that enterprises are worth more in the market than their capital replacement cost. To put it another way, new plant and equipment capital are not costly in comparison to a company's market worth.

The business entity can then issue financial assets and sell it for a high price compared to the cost of the facilities and machinery they are purchasing. Because companies can purchase numerous new investment goods with just a limited issuance of equities, investment spending will increase. Thus, the price of stocks tends to rise, q increases, investment, and output rise if there is an expansionary monetary policy. Meanwhile, contractionary monetary policy has the opposite effect that the price of stocks tends to decline, and q falls.

## IV. The Credit Channel

Under this channel, there are two most important sub-channels happen because of information problems in the credit market (Mishkin, 2011). These are the bank lending and the firm or household balance sheet channels. If monetary policy transmission through the bank lending channel goes right, it will have an impact on investment which has a huge multiplier effect on the growth of other sectors which will ultimately have an impact on economic growth (Mishkin, 2004). Expansionary monetary policy can increase bank deposits and bank reserves, further increasing the number of banks making loans. Increasing the number of bank loans will increase investment which in turn will increase the output (Miskin, 2004). In this channel, monetary policy has an important implication for small-sized firms than large-sized firms. Because small-

sized banks are more dependent on banks' loans while large-sized firms can generate funds not only from banks but also through stock and bond markets.

The second sub-channel of credit in which monetary policy affects the real business cycle is the bank balance sheet channel. Moral hazard and adverse selection problems in lending to business entities are severe when the net asset of the business firms is low. When the business firms have lower net value of assets, there is less collaterals for the loan and the higher will be the expected loss from adverse selection problem. In short, adverse selection problem rises associated with a decline in the net worth and this in turn leads to a decline in credit for investment. Firms with lower net assets may also commit moral hazard problems: having lower equity trigger for the firm to involved in unintended business activities and a riskier investment project which makes it less likelihood that lenders will be paid back.

The balance sheets of the firm will be affected using monetary policy in different ways. With expansionary monetary policy, the problems of adverse selection and moral hazard decreases. A rise in the quantity of money supply, increases equity prices and the net worth of firms to a rise in lending through collateral. All this process in turn has an impact on investment(increases) and total output (GDP increases). Conversely, a contractionary monetary policy reduces the price of the equities, stocks, and the net worth of the business firm. This in turn reduces lending, thereby investment and output because of the increase in adverse selection and moral hazard problems.

## 2.3. 2. Economic Inequality and Monetary Policy Channels

The discussion below about the different theoretical monetary policy channels related to economic disparity is based on the work of Nakajima, (2015); Coibion et al., (2017 and Amaral (2017). This part is the aim of our study, how income disparity is impacted by MP via varios mechanisms.

### I. The Income Composition Channel

According to this channel, a change in money supply by the regulatory body changes the income inequality between households who have different sources of income. This is because households in different income distributions (Low, middle, and high) reacts differently to a shock in monetary policy. For example, for low-income earners or households who mainly rely

on labour income, expansionary monetary policy has no significant impact on their wages. Whereas, for high-income earners or households whose source of income are business, financial and transfer income, the adoption of expansionary monetary policy has a tremendous impact and can increase the asset price and business profit. Thus, for this channel of monetary policy transmission, an increment in the quantity of money supply widens the disparity in the income received by the rich and the poor households. On the contrary, a tight monetary policy may decrease income inequality between households in a country.

## II. The Financial Segmentation Channel

For this channel, the income of the economic agents who are engaged in the financial market is higher than those who do not connected it. Thus, being connected and not connected in the financial market may contribute to income inequality to get worsen with expansionary monetary policy. Consequently, agents with a higher level of income that are involved in the financial market will reap a benefit from an increase in the money supply. This is because an expansionary monetary policy leads to higher asset prices that create the accumulation of wealth. Meanwhile, for those agents who don't have financial assets, an expansionary policy will not generate a significant benefit. Thereby, this aggravates income inequality.

## III. The Portfolio Channel

According to this channel of monetary policy transmission, an increment in the quantity of money supply increases income and consumption inequality between the rich and the poor households based on the portfolio holdings. Low-income families hold more liquid assets in their portfolio, change their consumption patterns and reduce the amount of consumption expenditure and welfare during inflationary period. Price hike hurts low-income households compared to higher-income households as they allocate most of their income to necessary goods and services, and income will be transferred the rich one. While high-income households hold less cash and more financial market assets in their portfolio. In closing, compared to rich households, the low-income household is subject to a disproportionately inflation tax during expansionary monetary policy shocks because they possess their portfolio in the form of cash.

### IV. The Savings Redistribution Channel

A considerable amount of literature indicates that higher-income earners save more while low-income individuals borrow more and hence are the net borrowers. A shock to monetary policy, such as expansionary, causes inflation that disadvantages savers while benefitting borrowers by reducing the value of assets and liabilities. Expansionary monetary policy is in favor of borrowers to pay low interest on debt while savers and lenders are adversely affected by receiving low returns on their deposit (Colciago et al., 2019). Thus, in this channel expansionary monetary policy decreases consumption and income inequality.

### V. The Earnings Heterogeneity Channel

This channel of monetary policy transmission to income inequality is related to the income composition channel discussed first. The primary source of income for most households is labor earnings. This channel reveals how the various labor income earning sources respond differently for low income and high-income households to a shock happening in monetary policy.

In a nutshell, the income composition channel, the financial segmentation channel, and the portfolio channel describe how economic inequality increases due to expansionary monetary policy. Whereas, the last two channels, the savings redistribution channel and the earnings heterogeneity channel show how economic inequality decreases due to expansionary monetary policy(Zungu & Greyling, 2022). Finally, different authors find different results as the final effects of monetary policy shocks on income inequality depend on the relative importance of each channel.

## 2.4. Empirical Literature Review

In this sub part of the project, we are reviewing the effect of monetary policy on income inequality.

### 2.4.1. Monetary Policy and Income inequality

Examining the distributional effects of monetary policy is a recent issue and many researchers have conducted a study to examine the effects of monetary policy shock on income inequality

using time series data, cross sectional data within country, and panel data. However, many of the studies conducted so far are concentrated in advanced economies such as the USA and the EU.

The earliest work was done by Romer and Romer (1998) and before this work, the role of monetary policy in explaining the rising economic inequality in the globe was ignored. In investigating the impact of MP on poverty and inequality both in the short run and the long run, the time series data from the USA and cross-sectional data from a group of 72 countries were collected and a univariate linear regression model was estimated. For the USA, the result showed that in the long run expansionary monetary policy improves the well-being of the poor and a reduction in income inequality in USA. While, in the cross-section case, the contractionary monetary policy reduces income inequality and the well-being of the poor. Finally, the study concluded that inflation is the most important channel in which monetary policy impacts inequality. Since then, the following studies have been conducted and reviewed below.

The first more rigorous investigation of the impact of monetary policy shocks on consumption and income inequality in the USA was undertaken by Coibion et al., (2017). They construct the measures of inequality from household-level data from 1980 to 2008. The result of the Impulse Response Function revealed that across households, the three different types of inequality measures increase with tight monetary policy shock. Further, they concluded that the income composition appeared to be the most important transmission channels in explaining the effects of monetary policy on income of the households.

Another study was conducted by Mumtaz and Theophilopoulou (2017) to empirically investigate the impact of monetary policy in the UK based on the household data collected from 1969 to 2012. The result of SVAR model is very similar to Coibion et al., (2017) where tight MP led to an increase consumption, wage, and income disparity. Moreover, the result suggests that tight MP has a larger negative effect on households with low income than individuals with high income.

O'Farrell & Rawdanowicz (2017) also examined the interaction between monetary policy and income inequality in advanced economies. MP easing has a priori ambiguous effects on net wealth and income inequality via debt interest payment, returns on assets, and asset prices of

financial channels than inflation and unemployment. The result revealed that monetary policy influences income and wealth inequality but, the magnitude is small. A house price increase, and a bond and stock price decrease generally reduce net wealth inequality. The study also showed that the effectiveness of monetary policy is impacted by a higher degree of income inequality.

Furceri et al., (2018) studied the effect of conventional MP (Short term interest rate) on income inequality for a panel of 32 EMDV countries over the period 1990–2013. The main finding of the study is that contractionary monetary policy via unpredicted increments in policy rate intensifies income inequality.

The impact of monetary policy on income inequality in the 10 Euro area nations from 1999 to 2014 was examined by SamarIna and Nguyen (2019). The author considered financial (Returns and asset price) and macroeconomic (Employment and wage) channels. The result showed that via macroeconomic channels the inequality in income has reduced in the euro area with the use of the expansionary monetary policy. However, the effect of monetary policy shock via financial channels has the opposite effect on income inequality.

Aye et al., (2020) used tax administrative data in South Africa to conduct a study on the relationship between wealth inequality and monetary policy. Results based on fixed and random-effects panel model estimates suggested that expansionary /Contractionary monetary policy increases/ Decreases wealth disparity. Further, wealth inequality increases with the decrease in inflation increasing asset prices (House and stock) and GDP per capita.

To analyse the effects of monetary policies on income inequality, Park (2021) estimated a block-exogeneity VAR representing Korean and US economies. The result revealed that expansionary or contractionary MP shock respectively decreases or increases income disparity after a year. Based on the results investigated, the study concluded that the earnings heterogeneity channel was found to be the most important channels via which MP affects income disparity in Korea,

Moreover, Czeczeli (2021) employed a panel ARDL on the 19 Euro area to see the impact of monetary policy on income inequality. The result of the study showed that the rise in the interest rates and unemployment rate amplify inequality. The study concluded that the effect of monetary policy on inequalities is modest, but not negligible.

Merrino(2022) studied the effects of standard monetary policy on wage inequality through earning heterogeneity channel in South Africa. The result of the Impulse response function indicated that the wage distribution gets worse for monetary policy shocks. Income inequality increases because of expansionary monetary policy, which raises wages for those at the top of the wage distribution while lowering them for those at the bottom. The opposite is true when monetary policy is contractionary.

To fight the severe impact of the Global Financial Crisis and the Great Recession, unconventional monetary policies are also employed by Central Banks (Czeczeli, 2021; Zungu and Greyling 2022). There is a growing body of literature that examine the effect of unconventional monetary policy on inequality during the Great Recession (Park, 2021). Saiki and Frost (2014) conducted a study on the effects of unconventional monetary policy on income inequality in Japan. Household survey data obtained from the Japanese Cabinet Office was used and Gini coefficients were calculated based on the income data. Results from vector autoregression revealed that unconventional monetary policy (Increase in asset price) increases inequality in income via the portfolio channel. In fact, an increase in asset price benefits individuals with high level of income than households who have low income and thereby widen income disparity. Again, in the USA and some European countries, Domanski et al. (2016) argue that through an increment in stock prices, unconventional monetary widened the disparity in wealth.

For instance, Zungu and Greyling (2022) examine the dynamic consequences of UMP on income disparity through income composition (Equity Index), portfolio (Housing price index), and earning heterogeneity (Captured by unemployment) channels in emerging countries. The result revealed that for all the transmission channels, income inequality rises with the adoption of UMP The study finally recognised the long-lasting impact of MP on income disparity, and central banks should consider the cost of this policy ahead of implementing it. This result is in line with the result of Evgenidis and Fasianos (2021) where the wealth disparity is widened by the house price effect and the portfolio rebalancing channel, outweighing the balancing impacts of the redistribution of savings and the inflation channel. The above discussions are summarized below in the table.

***Table 2. 1:*** Summary of Empirical Literatures

| **Studies** | **Country** | **Period** | **Method** | **MP Change (Channels)** | **Impact on inequality** |
|---|---|---|---|---|---|
| Romer and Romer (1998). | USA and other | | univariate linear regression | Expansionary/Contractionary , ..(Inflation) | Negative/Positive |
| (Saiki and Frost, 2014) | Japan | Q4 2008-2013Q4 | VAR | Expansionary UMP (Increase in asset price) | Positive |
| O'Farrell & Rawdanowicz (2017) | N/America and the EU | | Microsimulation | Expansionary (Financial channels) | Contrasting effect |
| Mumtaz and Theophilopoulou (2017) | UK | 1969 to 2012 | structural VAR | Contractionary | Positive |
| Coibion et al(2017) | USA | 1980 to 2008 | IRF based on the local projection and Romer and romer(1998) procedure | Contractionary (Income composition) | Positive |
| Furceri et al., (2018) | 32 EMDV countries | 1990–2013 | IRF through Local projection | Contractionary (Short term interest) | Positive |
| (SamarIna & Nguyen, 2019) | 10 EU countries | 1999–2014 | Panel VARX | Expansionary (Financial and macroeconomic channels) | Positive/Negative |
| Aye et al., (2020) | S/Africa | 2011 to 2017 | Fixed - and random-effects panel model | Expansionary/Contractionary (Asset price +/Inflation -) | Positive/Negative |

| | | | | | |
|---|---|---|---|---|---|
| Park (2021) | Korea | Survey | block-exogeneity VAR | Expansionary /contractionary (Earning heterogeneity) | Negative/Positive |
| (Czeczeli, 2021) | 19 EU countries | 2008-2018 | Panel ARDL | Contractionary (Rise Unemployment, rise in r) | Positive |
| (Zungu & Greyling, 2022) | Emerging Countries | 2000 to 2019 | Panel VAR | Expansionary UMP (Earning heterogeneity, income composition, portfolio | Positive |
| (Merrino, 2022) | S/Africa | Since 2000 | IRF from local projection | Expansionary/Contractionary (Income composition) | Positive/negative |

***Source:*** Own Compilation

## 2.4.2. Concluding Remarks, Lesson Learnt and Gaps Identified

The empirical literature discussed above investigated that a shock in MP has a modest influences on income disparity (Coibion et al., 2017; O'Farrell et al., 2017;Merrino, 2022)). In fact, the studies showed mixed results, some results are consistent, and some others are different or inconsistent with each other. The sign of the coefficient is sometimes negative, sometimes positive, and neutral depending on the characteristics of the country under investigation, the channels of monetary policy transmission, the time considered, the nature of data, and the estimation method used.

Regardless of the methodology, the transmission channels, the data used and the country under consideration, a positive shock in MP caused income disparity to upsurge (Saiki and Frost, 2014; O'Farrell & Rawdanowicz, 2017; SamarIna & Nguyen, 2019; Zungu & Greyling, 2022). On the other hand, (O'Farrell & Rawdanowicz, 2017, SamarIna & Nguyen, 2019) investigated that expansionary MP negatively affects the degree of inequality in income. Meanwhile, the disparity in income is positively related to the use of the contractionary monetary policy (Romer

and Romer, 1998; Mumtaz and Theophilopoulou, 2017; Coibion et al;2017; Furceri et al., 2018 ; Czeczeli, 2021).

We noticed that there are differences in the effect of MP on income inequality across countries or a group of countries based of income classification by World Bank. The following are the potential explanations for the variations in how monetary policy shocks affect income inequality in advanced and EMDV economies. When compared to the developed economies, the financial sector is underdeveloped, and the level of financial depth is low in many emerging and developing nations. There is a mismatch between the financial sector, the size of their economy, and the population. Due to the limited availability of financial services, the banking system is inefficient, which inhibits the growth of investment and overall demand.

Many EMDV nations have lesser credit as a percentage of GDP as compared to developed economies. Moreover, advanced economies have implemented a monetary policy framework that targets inflation, which is very important for the transmission of a shock in monetary policy to real economic activity and income inequality. Furthermore, between developed economies and EMDV countries, there are also significant differences in the level of credibility of the monetary policy that the central bank has enacted. Accordingly, depending on the characteristics of the countries and the transmission mechanism, the influence of monetary policy on income inequality in EMDV countries differs from those of the advanced economies.

In addition, we understood that most of the research conducted so far are concentrated in advanced economies and hence there is a limited empirical finding on the effect of MP through various channels in developing countries of Latin America and specifically, Brazil. Thus, this paper tried to contribute to the existing stock of knowledge by examining the distributional consequences of monetary policy in the case of Brazil. Moreover, this paper is intended to provide updated or timely information on the evolution and trends of income inequality in Brazil. Lastly, to increase the explanatory power of the model and reduce omitted variable bias, several macroeconomic variables are considered in the VAR model specification of this study.

# 3. Data and Methods

### Introduction

The grand objective of this paper is to investigate the distributional impact of monetary policy in Brazil from 1998 Q1 to 2021 Q4. To this end, in this chapter sources and types of data, and econometric model specification are vividly discussed. It also discusses important pre and post estimation econometrics diagnostic tests of using time series VAR or SVAR model.

## 3.1. Nature and Sources of Data

To achieve the research objectives, this paper deployed quarterly data series from the first quarter of 1998 to the last quarter of 2021 on real output, inflation rate, unemployment, monetary policy rate, private sector credit as percentage of credit, real exchange rate, and the Gini index as measure of income inequality in Brazil. The source of the data is mainly World Bank, the World Development Indicator, IBGS and Central Bank of Brazil. The rationale for selecting the above data sources is due to its reliability and the availability of data to quantify the impact of monetary policy on income inequality. While the main reason for interpolating data from yearly to quarterly is that to increase the number of observation and such data is suitable in estimating models that consider structural breaks.

**Income inequality (Gini coefficient):** The source of the yearly data is the World inequality indicator. However, this yearly data is interpolated to a quarterly data using linear interpolation technique in EViews 10. Since the first quarter of 1998 through the last quarter of 2021 are covered by the data we used for our analysis.

**Inflation Rate:** It is used to measure the the rate of inflation in the Brazil economy. A quarterly data is available and collected from the world Bank. From the first quarter of 1998 to the last quarter of 2021 are thus the period covered for the data used for the analysis.

**Rate of unemployment:** This is the rate of unemployment in Brazil and the source of the data is the World Bank. However, this yearly data is interpolated to a quarterly data using linear interpolation technique in EViews 10. As a result, like other variables included the data from the first quarter of 1998 to the last quarter of 2021 is considered for final analysis.

**Real GDP of growth rate**: The data in quarterly is collected from World bank and the data used for our analysis covers the period from the first quarter of 1998 to the last quarter of 2021.

**Real Foreign Exchange of Brazil (USD to BRL):** The source of the quarterly data is the Brazil Institute of Geography and Statistics (IBGS). It is expressed in US dollars to the domestic Brazilian Real (BRL). Therefore, the data employed for our analysis spans the first quarter of 1998 through the last quarter of 2021.

**Domestic Credit to private sector:** This is the percentage of credit as a share of GDP and the source of the yearly data is the World Bank. Linear interpolation technique in EViews 10 is employed to obtain the quarterly data and hence the data from 1998Q1 to the 2021Q4 is considered.

**Short-run Rate of Interest:** This is used as a monetary policy instrument and the source of the monthly data is the central bank of Brazil (BCB) and we interpolated to obtain the quarterly data for the final analysis. So, the data used for our analysis covers the period from the first quarter of 1998Q1 to 2021Q4.

## 3.2. Model Specification

Univariate time series is series is expressed in terms of its past values (The autoregressive component) and the current and the lagged value of the error terms. While Multivariate time series is a vector of time series data that is modeled at the same time, and it is applicable to explain the interactions among variables (Stock and Watson, 2001). Vector Autoregression (VAR) model pioneered by (Sims, 1980) is dynamic multivariate time series which is basically extension of the univariate autoregressive model and allows the variables to interact each other in the system without imposing a theoretical structure on the estimates. Compared to the univariate time series models, the VAR model provides superior forecasts or dynamic behavior of economic and financial time series (Stock and Watson, 2001).

This model can be used when investigating macroeconomic policy transmission mechanism. Thus, to evaluate the monetary transmission mechanism on income inequality, this paper employed a VAR model as a starting point. Consequently, the VAR model with p lag is specified in the following way.

$$y_t = \alpha + \beta_1 y_{t-1} + .. + \beta_p y_{t-p} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (1)$$

Where, the vector of the constant α represents a (7x1) matrix, βi is a (7x7) matrix of autoregressive coefficients, with lag value from 1 to p, $y_t$ is the (7x1) vector of endogenous variables. The endogenous variables (yt) considered in the model are the rate of inflation at time t ($inf_t$), unemployment rate at time t ($un_t$), real GDP at time t ($gdp_t$), foreign exchange rate at time t ($For_t$), private domestic credit at time t($cr_t$), rate of interest at time t ($r_t$), and gini coefficient index at time t ($gini_t$). Further, the error term $\varepsilon_t$ has a (7x1) vector and full fill the assumption of identically and independently distributed with mean zero and constant variance. Thus, a VAR model is a system in which each variable is regressed on a constant and p of its own lags as well as on p lags of the other variables.

However, VAR model is not without limitations. It does not allow for the identification of the existing relationships that exist among the variables and hence, the structural form of the model may not be identified. So, to remove the drawbacks of VAR; SVAR is used as an alternative framework which imposes restrictions on the range of economic relationships among the variables. Thus, this paper used the SVAR framework in modeling monetary transmission mechanism in Brazil in line with the underlying relationships among the variables.

Moreover, this paper deploys short-run restrictions on both A and B matrices which can help to analyze the impact of monetary policy rate shock on macroeconomic variables such as inflation, output, unemployment, and income inequality. Loosely speaking, this can be undertaken by taking a structural decomposition of the variance-covariance matrix of the residual as an identification strategy in the model. Then, the Impulse Response Function (IRF) would be estimated from a reduced form approach to know the reaction of the endogenous variables to a one standard deviation or shock from a system variable happening in different time periods. Forecast error of the variance decomposition is also estimated from SVAR approach to know the percentage of unexpected variation in each variable which is resulted from shocks of the other endogenous variables, due to monetary policy shock to all variables in the system.

## 3.3. Methods of Analysis

Both descriptive and econometric methods of analysis are used to analyze the data. In the econometrics analysis, the VAR developed by Simon (1980) as a reference point and the structural VAR are used to investigate the distributional consequences of monetary policy.

## 3.4. Diagnostic Tests

Before proceeding to the interpretations of estimates, the author has checked whether the classical linear regression model assumption satisfied or not. Various methods of detecting Autocorrelation (Residual AC LM test), Multicollinearity (VIF), Normality (Jarque Bera test) etc. are examined. Moreover, Augmented Ducky Filler tests are employed to check whether all the endogenous variables are stationary or not.

# 4. Results and Discussions

In this section of the study, the following main issues are addressed: The first section presents descriptive analysis of diagnostic tests such as unit root, autocorrelation, and stability tests. Econometric analysis and discussions from the quarterly data are presented in the last section. The data collected from the first quarter of 1998 to the last quarter of 2021 is analyzed using EViews statistical software. Specifically, the results of VAR model are used as a starting point and then SVAR model estimation results, impulse response, and variance decomposition results are thoroughly analyzed and discussed.

## 4.1. Results of Econometric Diagnostic Tests

### I. Optimal Lag Length Selection for the Model

In multivariate time series models such as VAR, including either too many or too few lags are problematic for the researchers. Too many lags lead to loss of the degree of freedom. Thus, it is mandatory to identify the optimal lag length ahead of estimating the VAR and the SVAR model. This is because the estimates of such models are highly sensitive to the number of lags considered. Thus, we deployed six various optimal lag length selection criteria. The result indicated that except for the loglikelihood, the remaining optimal lag length selection criteria suggest lag two in the model. The SVAR estimation starts from estimating the result of VAR and the coefficient estimates of the two models are presented in Annexes 1 and 2 section of the appendices.

***Table 4. 1*:** VAR Lag Order Selection Criteria

Endogenous variables: inf unemp RGDPgrowth forex cred r gini

Exogenous variables: C

Sample: 1998Q1 2021Q4

Included observations: 92

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 838.1170 | NA | 3.36e-17 | -18.06776 | -17.87589 | -17.99032 |
| 1 | 1807.946 | 1770.993 | 6.82e-26 | -38.08579 | -36.55079 | -37.46625 |
| **2** | **2036.789** | **383.0620*** | **1.39e-27*** | **-41.99540*** | **-39.11727*** | **-40.83377*** |
| 3 | 2077.045 | 61.25954 | 1.76e-27 | -41.80532 | -37.58407 | -40.10159 |
| 4 | 2116.988 | 54.70459 | 2.34e-27 | -41.60843 | -36.04405 | -39.36260 |

** Indicates lag order selected by the criterion*

*Where, LR is sequential modified LR test statistic (each test at 5% level), FPE is Final prediction error, AIC is Akaike information criterion, SC is the Schwarz information criterion, and HQ is the Hannan-Quinn information criterion.*

***Source:*** Own Computation Using EViews 10, 2023

## II. Test of Stationarity and Optimal Lag selection for Each Variable

To determine the stationarity of the variables considered in the VAR model specification, the unit root test is carried out using the Augmented-Dickey Fuller (ADF) test. Empirically, the null hypothesis that the variable is a unit root or non-stationary can be rejected if the absolute value of the ADF test statistics exceeds the test critical value at 5% level of significance. The results from table 4.2 below revealed that except for the rate of inflation and monetary policy rate, all variables are integrated of order one, they are stationary at first order difference.

***Table 4. 2:*** Unit Root Test Using Augmented-Dickey Fuller

| Variables | Lag selection criteria | Lag length | t-statistic of ADF test | Test Critical value at 5% | P-value of ADF test | Order of integration |
|---|---|---|---|---|---|---|
| Inflation rate | AIC | 2 | -3.875 | -2.892 | 0.0032 | I(0) |
| Unemployment rate | AIC | 2 | -3.211 | -2.892 | 0.02 | I(1) |
| Real GDP growth | AIC | 2 | -5.250 | -2.893 | 0.0000 | I(1) |
| Interest rate | AIC | 3 | -3.689 | -2.892 | 0.0057 | I(0) |
| Credit | AIC | 2 | -3.518 | -2.892 | 0.0095 | I(1) |
| Real Forex | AIC | 2 | -8.108 | -2.892 | 0.0000 | I(1) |
| Gini | AIC | 4 | -3.872 | -2.893 | 0.0033 | I(1) |

***Source:*** Own Computation Using EViews 10, 2023

## III. Test of Autocorrelation

In testing the no serial correlation assumption of the residuals, this study deployed the LM test. Since the probability value is greater than the 5 % level of significance, we concluded that there is no problem of serial correlation in the model**.**

***Table 4. 3:*** VAR Residual Correlation LM Tests

Sample: 1998Q1 2021Q4
Included observations: 94

| Null hypothesis: No serial correlation at lag h | | | | | | |
|---|---|---|---|---|---|---|
| Lag | LRE* stat | df | Prob. | Rao F-stat | Df | Prob. |
| 1 | 61.79387 | 49 | 0.1037 | 1.285796 | (49, 339.5) | 0.1054 |
| 2 | 60.81135 | 49 | 0.1200 | 1.263592 | (49, 339.5) | 0.1218 |

***Source:*** Own Computation Using EViews 10, 2023

## IV. Test of Stability

The roots of the characteristic polynomial of the coefficient matrix A are used to examine the stability of the VAR model. As the data set consists of quarterly observations, first a standard VAR system with two lags of each variable with a constant was estimated. Then, we conducted a test of stability and results from figure 4.1 below shows the model is correctly specified and quite stable because all inverse roots of the autoregressive polynomials are inside the unit circle. The result shows that there is no structural break or instability in the model for the sample period from the first quarter of 1998 to the last quarter of 2021 in Brazil.

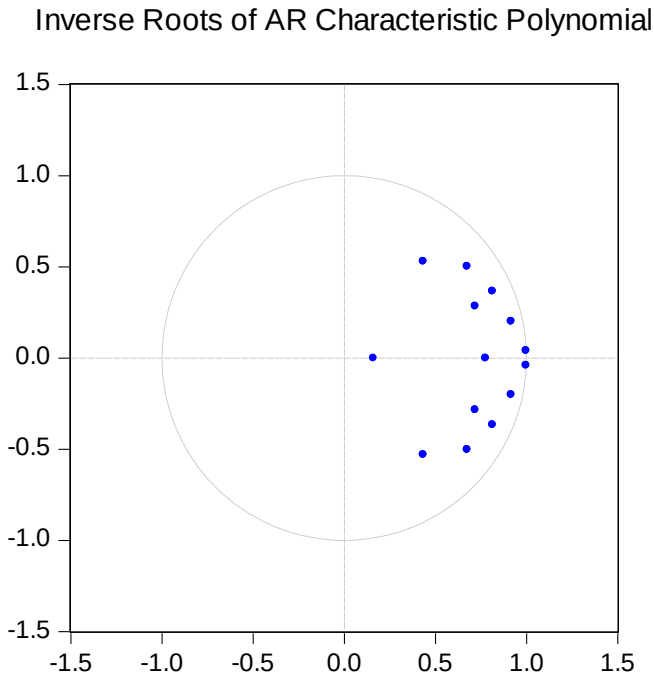



***Figure 4. 1:*** *Test of Stability Using AR Root*

***Source:*** Own Computation Using EViews 10, 2023

## 4.2. Structural VAR Model

The econometrics software package, EViews 10 was used to estimate the two multivariate regression models of VAR and SVAR. In the first step, the standard VAR specification was estimated, from which the results were used as starting values for the SVAR model. We do not interpret the estimates of the VAR specification due to some caveats of this model. It does not

impose restrictions on the wide range of economic relationships among the variables envisaged in the model. Thus, the VAR mode is used as a starting point only and the interpretation, conclusion, and policy implication of the monetary policy transmission mechanism to income inequality in Brazil is based on the estimate of impulse response and variance decomposition of the SVAR framework.

In macroeconomics, the structural VAR model is frequently used to evaluate policy choices. It sorts out the current relationships between the variables using economic theory (Sims, 1986). It distinguishes structural shocks from the VAR model, and it is superior to other simultaneous equation models for the analysis of multivariate time series (Stock and Watson, 2001). The requirement to impose residual restrictions on the short-run and long-run impulse response functions, or both so-called linear combination restrictions, is one of the fundamental concepts underlying SVAR estimation. Numerous SVAR models impose short-run restrictions.

For instance, Blanchard and Quah (1989), estimated the SVAR model based on the assumption of short-run restrictions of the feedback impact of endogenous variables contemporaneously. Thus, this paper deploys short-run restrictions on both A and B matrices which can help to analyze the impact of monetary policy rate shock on macroeconomic variables such as income inequality, inflation, output, and unemployment. Specifically, we have imposed diagonality on matrix A, except for some parameters in the bottom triangular or section of the matrix and diagonal on the B matrix. We did this by selecting a cross-factorization of the predefined matrix in EViews 10. Moreover, these SR restrictions are imposed by applying some mathematical relations. Loosely speaking, this can be undertaken by taking a structural decomposition of the variance-covariance matrix of the residual as an identification strategy in the model. Then, the impulse response functions and variance decomposition forecast of the error term are used to evaluate the variables of interest, in our case income inequality.

### 4.2.1. Results of Structural Impulse Response of Income Inequality

The result of impulse response function (IRF) from an extended version of the standard VAR model is elaborated in this section. The results of IRF for all the considered endogenous variables are presented in annex 4. The Central Bank of Brazil has used the short-run SELIC interest rate as its main important monetary policy tool. Thus, for this analysis, we are trying to look at the dynamic response of our target variable, income inequality to this unanticipated

policy shock and a shock in other macroeconomic variables. In figure 4.2 below, the solid bold blue lines depict the point estimates of the dynamic response functions, while dashed red lines represent a 95% confidence interval with a five percent level of error.

The impact of the shock or innovation to the SELIC rate of interest (Shock6) on income inequality was not immediate. After the second quarter, income inequality responded positively until the 8$^{th}$ period when the long-run equilibrium is maintained or an effect decay over time. Contractionary monetary policy through an increasing rate of interest increases income inequality for some period. This is because higher interest rates discourage investment and a decline in employment opportunities and a rise in unemployment. Thus, the gap between the income received by the rich and the poor gets wider. So, income inequality is a positive function of a shock in the short term SELIC rate of interest, and we anticipated that earnings heterogeneity and savings redistribution channel are the most important monetary policy transmission channels in Brazil.

In other words, a contractionary monetary policy can increase income inequality through earnings heterogeneity channel by reducing the level of income received by the lower income households. Further, income inequality is aggravated via saving redistribution channel by reducing the opportunity to get funds from the bank. Tight monetary policy is not in favor of borrowers who may be low-income households and they are obliged to pay high interest on debt while savers and lenders (Rich peoples) are positively affected by receiving high returns on their deposits. Despite the difference in the transmission channel this result is consistent with previous studies Furceri et al., (2018), SamarIna and Nguyen (2019), and Czeczeli (2021) who already investigated that contractionary monetary policy intensifies the inequality in income.

A one standard deviation shock or innovation to the rate of inflation (Shock1) initially has a significant positive impact on income inequality, especially until the 8$^{th}$ period. From the 6$^{th}$ period and onwards, the impact gradually declines until the 8$^{th}$ quarter when it touches its steady state or maintains the long-run equilibrium. However, the impact is negative in the 9$^{th}$ and 10$^{th}$ quarters. From this, we can understand that unexpected shocks in the rate of inflation have an impact both in the short run and long run. In emerging and developing countries like Brazil, most of the time the top 10 population owned factors of production and they are the producer entities where higher rate of inflation causes an increase in price of what they owned, profit, rent,

dividends and thereby the income level. While the income level of the poor remains unchanged. This widens the gap in income between the rich and the poor people. This result is consistent with the result investigated by Suratman et al., (2022) indicating that income inequality is a positive function of the rate of inflation in some of the Asian countries.

So, inflation is an important determining factors of income inequality in Brazil. A rise in the rate of inflation aggravates the income inequality problems through the portfolio channels of monetary transmission mechanism. This is because households with low level of income hold more liquid assets in their portfolio and a sudden price hike hurts them compared to higher-income households as they allocate most of their income to necessary goods and services, and income will be transferred to the rich one. In closing, compared to rich households, the low-income households are subject to a disproportionately inflation tax during monetary policy shocks (Nakajima, 2015; Coibion et al., 2017, Amaral, 2017).

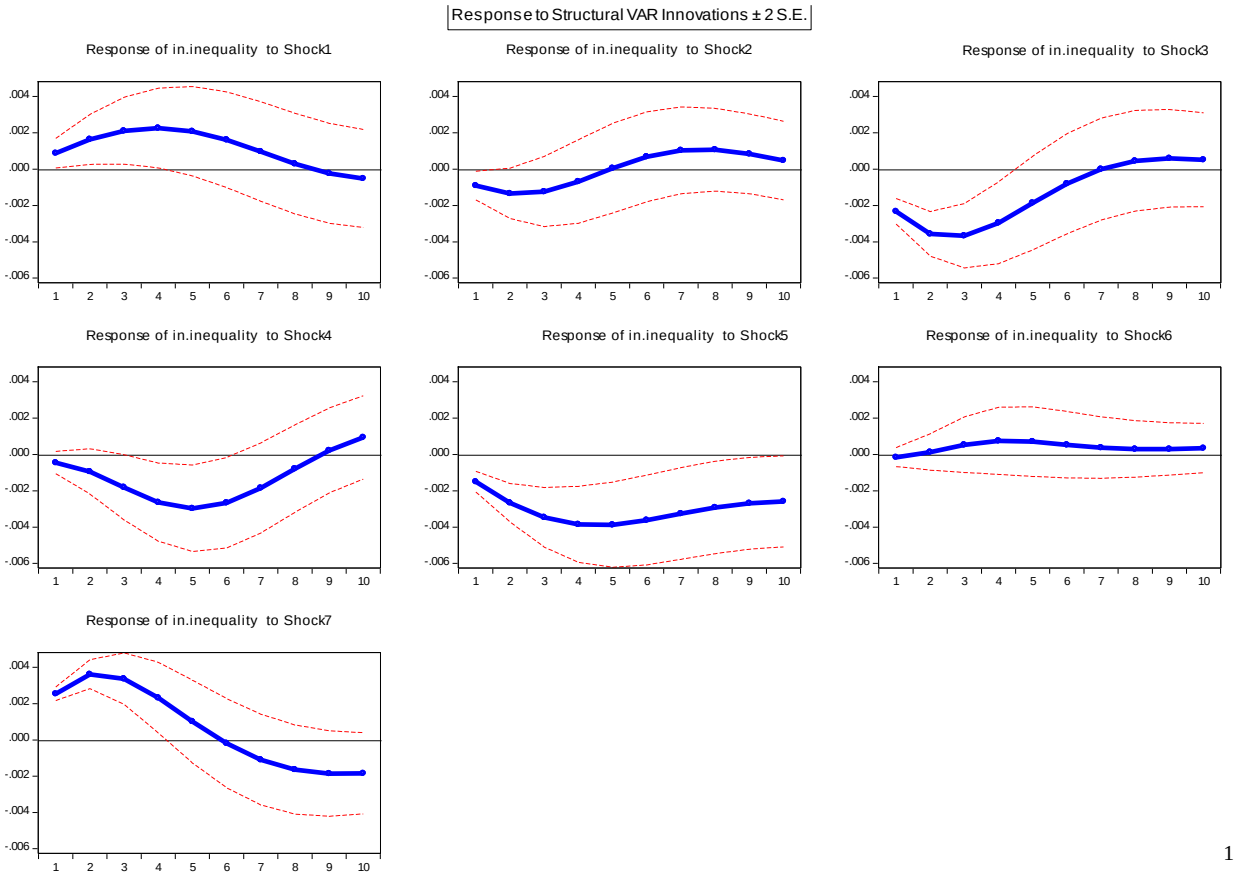
One of the studies conducted by Ferreira et al., (2006) showed the same result that a rising rate of inflation increases income inequality in Brazil by making the poor people to have the lowest share of income in the economy. Further, the result is also consistent with Nantob (2015) who investigated that higher rate of inflation intensified income inequality in developing countries. Therefore, the implication is that any policy maker intended to target the reduction of income inequality in Brazil should concede keep emphasis on inflation targeting monetary policy framework.

An innovation to the rate of unemployment (Shock2) initially decreases income inequality and the response of income inequality to the unanticipated shock in the rate of unemployment is negative until the $4^{th}$ period. However, in the long run, income inequality is positively impacted by unemployment rate shocks. Thus, after the $5^{th}$ quarter, income inequality significantly increased and howbeit a decreasing tendency after that. An increment in the rate of unemployment increases the gap in income received by the rich and the poor. The implication is that the earning heterogeneity and saving redistribution channel play a tremendous role in the long run that contractionary monetary policy increases income inequality. Thus, according to these channels of monetary policy transmission, decreasing the rate of unemployment by implementing expansionary monetary policy is one of options that should be targeted by policy makers to narrow income inequality.

The dynamic response of income inequality to the real GDP growth rate (Shock3) was negative until the 7th quarter. In the early stage of economic growth, a positive shock in real GDP growth reduces income inequality. This result is not in line with the empirical findings on the relationship between income inequality and economic growth by Kuznet (1955); SeriN Oktay & Algan (2022), Wolde et al., (2022). They suggested that in the early stages of development, inequality in income is positively related to growth of the economy and negatively related in the later stages of the development process. However, After the 7th quarter, our result is consistent with Piketty (2014) finding, income increases disproportionately that capital owners accumulate more wealth than people in the bottom of the distribution. Therefore, in the long run, more resources are owned by the richest 10 percent of the population which causes an increment in the income of the richest while the poorest could not increase. This makes the poor people poorer and the rich people richer, income inequality rises.

The response of income inequality to a positive shock in the exchange rate (Shock4) is negative. depreciation of domestic currency causes the income inequality to decline in Brazil for the time considered. However, this result is contradictory of the results investigated by Suratman et al., (2022). A one standard deviation innovation to the domestic credit to the private sector as a percentage of GDP (Shock5) has a significant impact on the reduction of income inequality for the whole periods in Brazil. From this, we can understand that unexpected shocks in the rate of credit have an impact both in the short run and long run.

An expansionary monetary policy creates more financing opportunities for potential borrowers, including many of the poor, at a reasonable rate of interest. This can increase the income of the poor, thereby the gap in the income of the poor and the rich people gets narrow or declines. Thus, the response of income inequality to a positive shock in credit is negative throughout the period and this result is consistent with the result investigated by Manthos Delis et al., (2023). The implication is that access to financial credit play a tremendous role for the reduction of income inequality in Brazil.




[1]

***Figure 4. 2:*** *Structural Impulse Response of Income Inequality in Brazil*

***Source:*** Own Computation Using EViews 10, 2023

## 4.2.2. Structural Impulse Response Results of Real Economic Variables to Interest Rate

As it is revealed below, the response of inflation to the unexpected shock in the Brazilian SELIC rate of interest is positive. The implication is that contractionary monetary policy increases the rate of inflation in the economy which is called a price puzzle in empirical literature (Stock & Watson, 2001; Luporini, 2008).. This might be since the inflexibility of prices in the Brazilian economy. Most empirical literature conducted so far investigated the same results and they

[1] Where shock1, shock2, shock3, shock4, shock5, shock6, and shock7 are unanticipated changes in the inflation rate, unemployment rate, real GDP growth rate, foreign exchange, credit, rate of interest, and Gini coefficient as a measure of income inequality respectively.

suggested that it may be because of the inability of the researchers to incorporate policy-making relevant variables (Stock and Watson, 2001). This may also be because the monetary policy is not tight enough and the prevailing long-lasting negative aggregate supply shock.

Moreover, there was a recession after the global financial crisis in many advanced economies, and according to the Philips curve relationship, this pronounced decline in real economic activities should have created severe deflation that did not happen, called Missing Deflation. Starting differently, the price puzzle is the disconnect between inflation and real economic activity (Aggregate demand) which is the flattening of the Philips curve. In closing, a rise in the rate of interest in turn increases the rate of inflation in the long run and hence, interest rate is the most important channel through which monetary policy affects inflation.

Unemployment's response to contractionary monetary policy is positive. A higher rate of monetary policy rate discourages the level of investment and thereby increases the rate of unemployment. There is no immediate response of the real GDP growth rate of Brazil to a sudden shock in monetary policy. But, in the long run, a positive shock in SELIC short-term interest impacted on the real GDP negatively.

Following an unexpected contractionary monetary policy, the domestic currency appreciates and hence, its response is positive. This is in line with the economic theory that a rise in the rate of interest rates causes the inflow of capital to the domestic economy which causes the domestic currency to appreciate. Finally, the response of private credit as a percentage of GDP seems to be negative but not immediate.

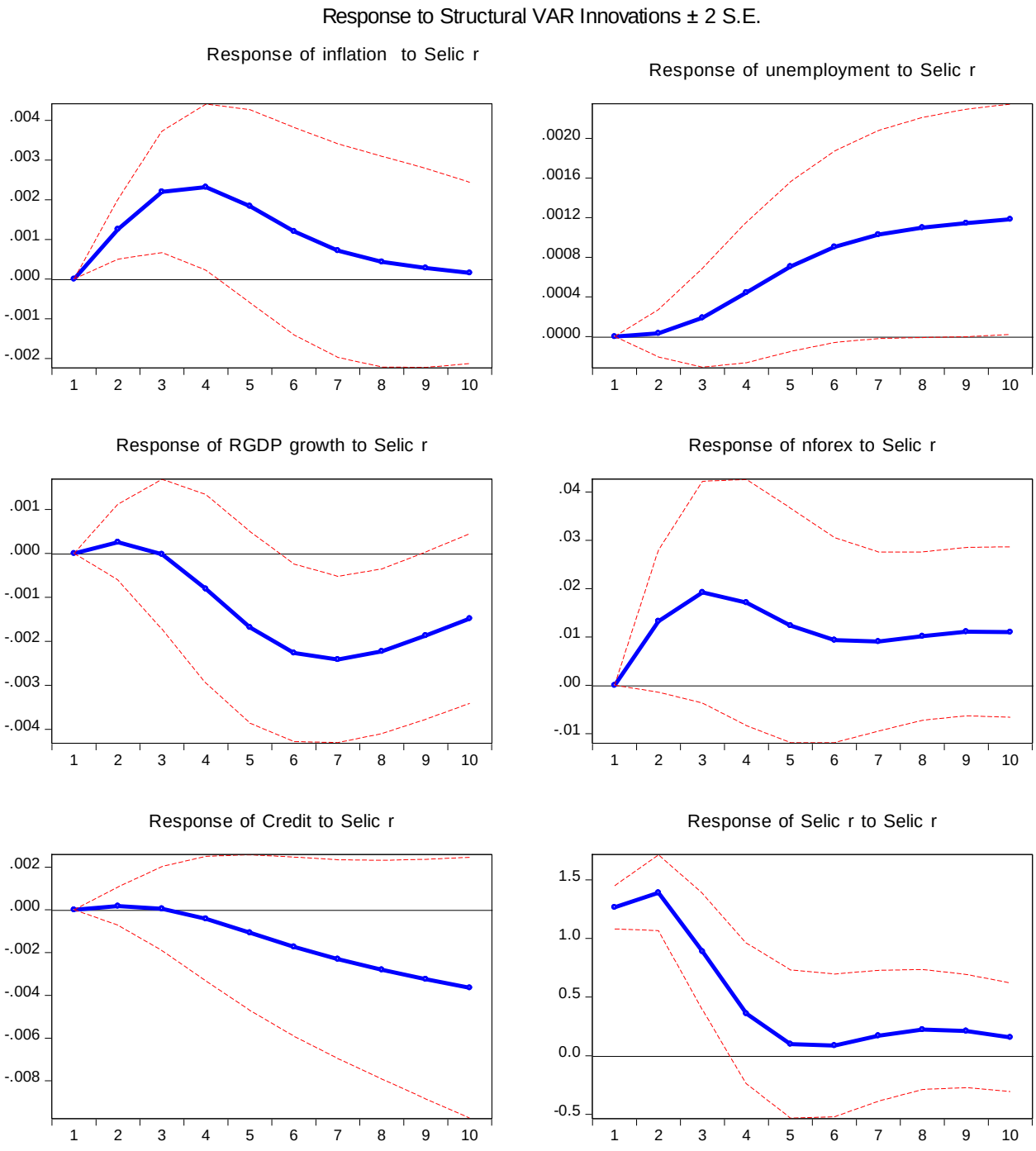



***Figure 4. 3:*** *Structural Impulse Response of Real Economic Variables to Interest Rate*

***Source:*** Own Computation Using EViews 10, 2023

Moreover, the response of the inflation rate to unexpected shock in the rate of unemployment is negative and continuously declines over periods (See Figure 4.4). This result is consistent with the Philips curve that revealed the tradeoff between inflation and unemployment. A one standard deviation shock in the real GDP growth impacted the rate of inflation negatively. This suggests that the Phillips curve does not reflect the positive correlation between the rate of inflation and real GDP growth or aggregate demand. However, this is not the case in Brazil for the time we considered, and it is because the monetary policy framework of Brazil is inflation targeting and price is inflexible.

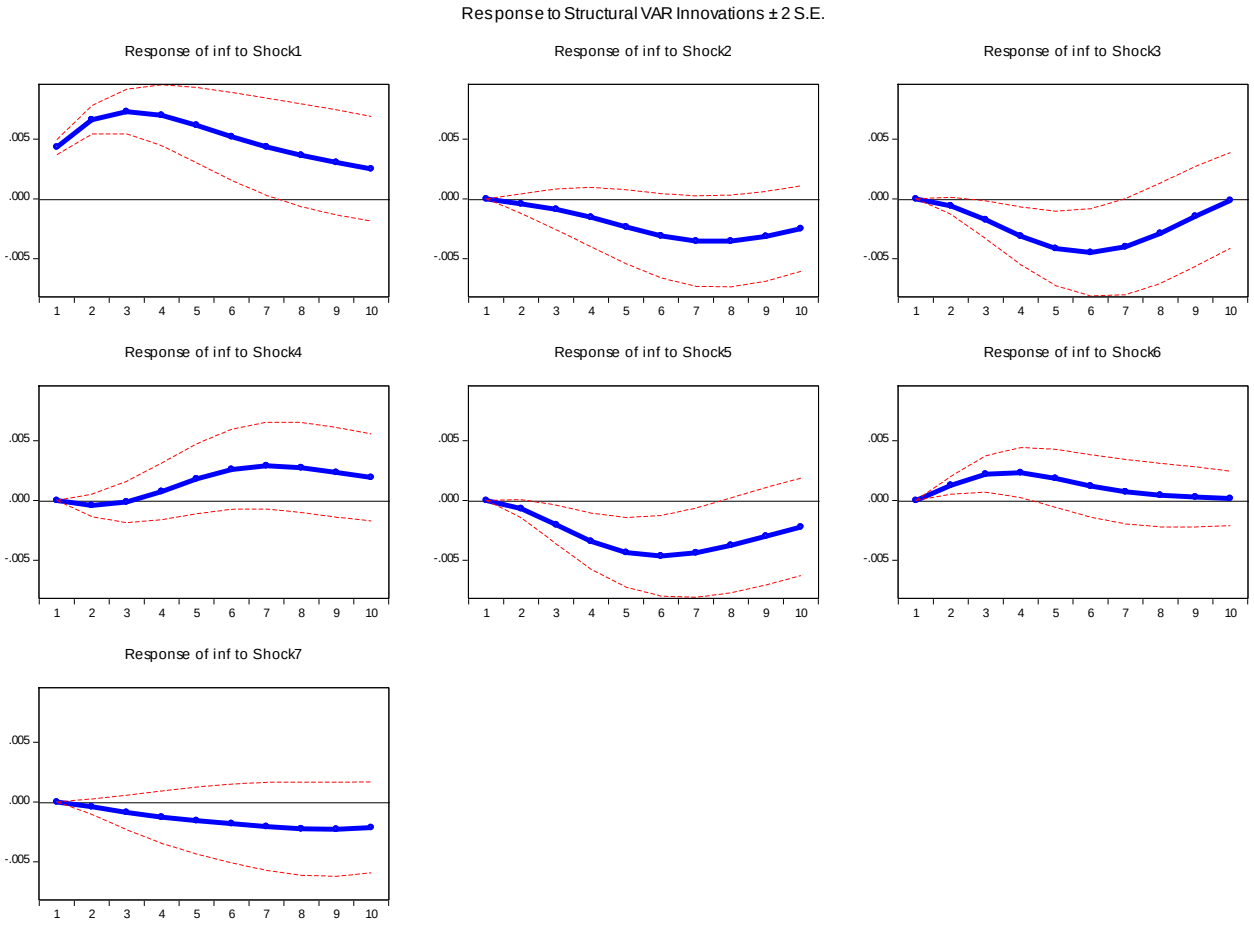



***Figure 4. 4*:** Structural Impulse Response of Inflation Rate in Brazil

***Source:*** Own Computation Using EViews 10, 2023

The response of the inflation rate to a sudden positive shock in exchange rate (Real Brazil to USD) was not immediate. However, after the second period it responded positively. The implication is that following the depreciation of the domestic currency the quantity of imported

goods and services decline and cause imported inflation in Brazil. Again, the response of inflation to a positive shock in credit and income inequality is negative. When credit availability to the private sector increases, investment is encouraged, and more output can be produced, aggregate supply increases. This may have a negative repercussion in the rate of inflation. Whereas, when income inequality rises, inflation declines. When the gaps between the incomes of the rich and poor increase, the government may adopt a policy that reduces the income inequality in the long run and thereby, a decrease in the quantity demanded of the rich people reduced inflation.

Regarding the response of the rate of unemployment (See figure 4.5), the positive innovation in the rate of inflation, real GDP growth, and credit reduces unemployment which is in line with economic theories.

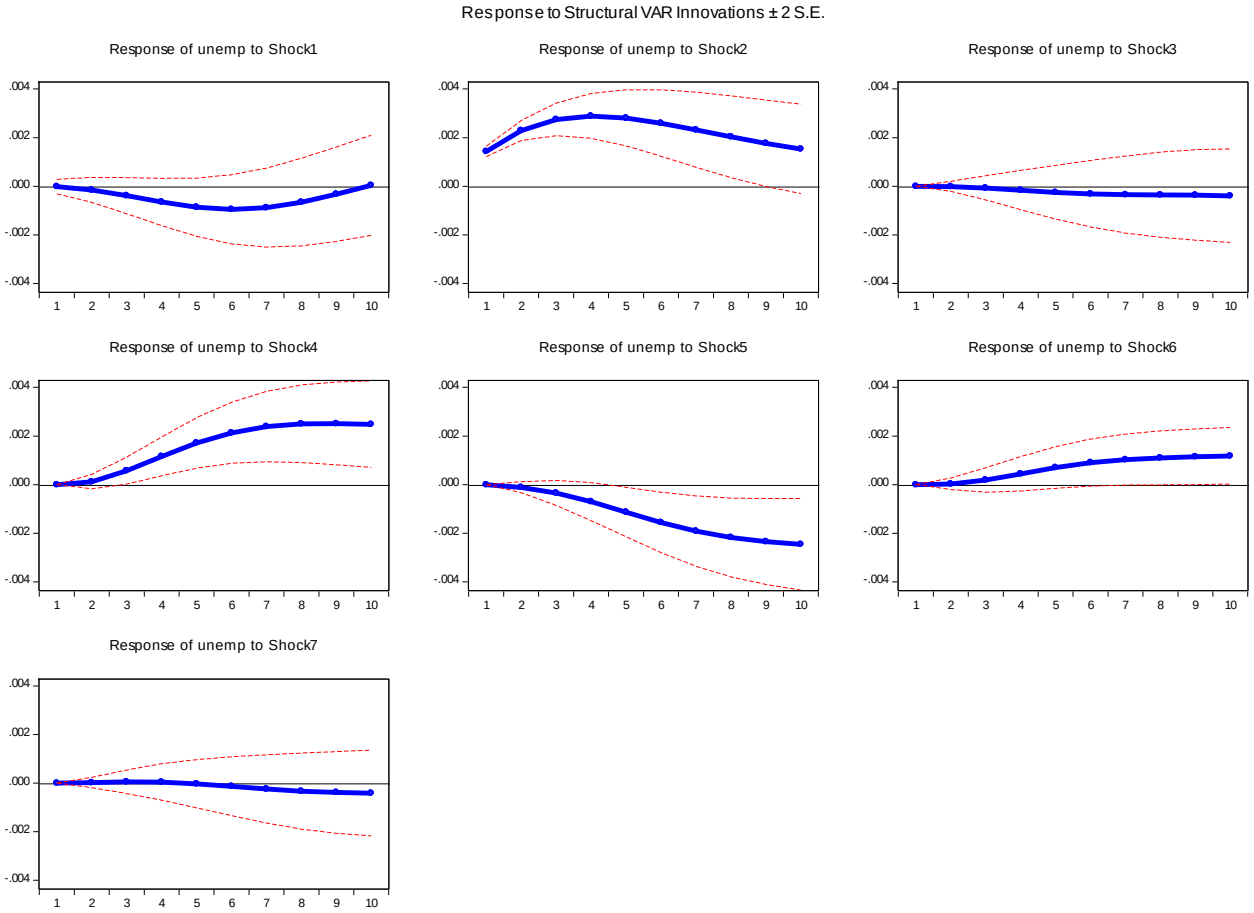



***Figure 4. 5:*** Structural Impulse Response of Unemployment Rate in Brazil

***Source:*** Own Computation Using EViews 10, 2023

The impact of a positive shock in the rate of inflation (Shock1) on the real GDP growth is positive in the short run suggesting the modern version of the Philips curve (Okun's law) relationship holds true. But, after the second quarter, the response became negative and intended to retain the steady-state level. The response of real GDP growth (See Annex 4) to the rate of unemployment (Shock2) is negative. The implication is that an unexpected positive shock in the rate of unemployment reduces the real output as there will be misallocation of resources in the economy. What we investigated is in line with economic theory, Okun law. The real GDP growth rate is unresponsive to foreign exchange (Shock 4) until the 6$^{th}$ quarter. But, then after, depreciation of domestic currency reduces output growth in Brazil. The dynamic response of real GDP growth is positive to a positive shock in domestic credit to private sector as a percentage of GDP (Shock 5) and income inequality (Shock 7), while it is negative for SELIC rate of interest increment (Shock6).

Coming to credit (See Annex 4), its response is negative throughout the period to a positive shock in the rate of inflation (Shock1). This is since a positive shock in inflation increases aggregate demand. So, the central bank of Brazil may adopt contractionary monetary policy via reducing the level of credit. Credit is unresponsive to a positive shock in the rate of unemployment rate (Shock2) in the short run. But, after the 7$^{th}$ quarter, the shock impacted positively. The shock in the rate of unemployment causes the central bank to implement a counter cyclical monetary policy to increase the availability of credit to many of the young unemployed individuals. Thus, the response of credit to unemployment is positive in the long run.

The response of credit to the positive shock in the real GDP growth is positive until the 8$^{th}$ quarter and retains its steady state level, and then tries to decline. Meaning the central bank may adopt procyclical monetary policy to expand the economic activity in a robust manner. Whereas the response of credit as a percentage of real GDP is positive to an unexpected increment in foreign exchange throughout the entire period. Lastly, a sudden increase in income inequality impacted positively on the percentage of credit. The government or any other concerned bodies may implement credit expansion to many of rural poor population as a solution for income inequality reduction.

Until the 3rd quarter, the Brazilian SELIC rate of interest is negative (Figure 4.6. below) to a positive shock in the rate of inflation (Shock1).

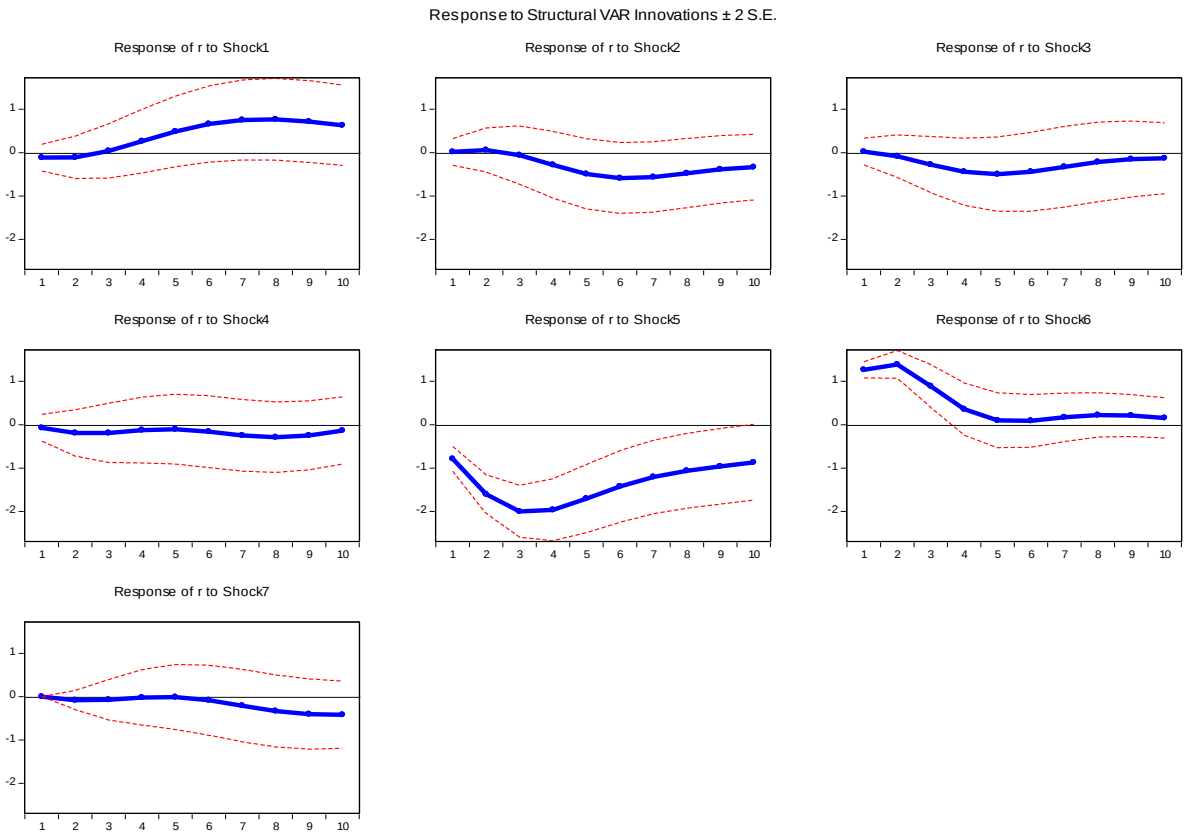



***Figure 4. 6:*** Structural Impulse Response Function of Interest Rate in Brazil

***Source:*** Own Computation Using EViews 10, 2023

But, in the long run the response is positive. Meaning an increment in the rate of inflation induced the central bank to employ contractionary monetary policy via increasing the rate of interest to discourage the aggregate demand. Up to the 3rd quarter, the Brazilian SELIC rate of interest is unresponsive to a positive shock in the rate of unemployment (Shock2). But, in the long run the response is negative. Meaning, an increment in the rate of unemployment induced the central bank to employ expansionary monetary policy via reducing the rate of interest. Finally, a positive shock in income inequality (Shock7) impacted the rate of interest negatively in the long run. To reduce an increment in the income inequality, the central bank may reduce the rate of interest and expand business activities. This in turn creates job opportunities for unemployed adults and those unable to earn money.

### 4.2.3. Results of Structural Variance Decomposition Forecast Error

Variance Decomposition Forecast Error (VDFE) is the percentage of the unanticipated change or the variance of the forecast error in individual variable that is resulted from shocks in the variable itself and the other variables in the model. The estimated results of the structural VDFE for all endogenous variables considered in the model are reported in annex 3 of the appendix section.

Results of the VDFE revealed that in Brazil, the main sources of fluctuation in income inequality are from income inequality itself, real GDP growth, credit, inflation, and unemployment. In the first period, 40.65% of the variation in the income inequality is explained by the shock in income inequality and the remaining percentage change is explained by the shocks of the other variables. Specifically, in the short run, 33.75%, 14.14 % of the variation in income inequality is explained by the shocks in real GDP and private credit as a percentage of GDP respectively. But, in the long run, a significant variation of income inequality is explained by credit.

Thus, the contribution of income inequality, to explain itself decreases to 17.91% in the $8^{th}$ quarter from 40. 65 % in the first period. In the $8^{th}$ period, 36.19% of the fluctuation in income inequality came from private credit as percentage of GDP. The change in income inequality in Brazil explains income inequality by 18.92%, credit shocks explain by 38.8%, real RGDP shock by 17.8%, and inflation shock by 8.4 % in the $10^{th}$ period. This result is consistent with the result of structural impulse response that implies that the variation in income inequality is better explained by private credit. To sum up, credit, output, and inflation have significant effect on the impulse response result. As a result, we can conclude that the effect of credit, output, and inflation rate on income inequality increases as time goes on.

Results from annex 3, show in the first quarter of 1998, 100% of the fluctuation in the rate of inflation is explained by the variation in inflation itself. However, it continuously declines to 58% and 46.18% in period five and ten respectively. Thus, in the long run, the shock in the real GDP growth and credit plays a very important role in explaining the variation of the rate of inflation. Statistically, for instance, the contribution of credit and output were zero in the first period and increased to 17.43 % and 12.88 % respectively in the $10^{th}$ period.

***Table 4. 4:*** Variance Decomposition of income inequality Using Structural VAR Factors

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.004324 | 4.912602 | 5.120591 | 33.75538 | 1.270529 | 14.14423 | 0.144128 | 40.65254 |
| 2 | 0.008075 | 6.385434 | 4.801998 | 33.40622 | 2.004109 | 17.19937 | 0.075068 | 36.12780 |
| 3 | 0.011497 | 7.873290 | 4.104227 | 31.40597 | 4.339508 | 21.14352 | 0.326932 | 30.80655 |
| 4 | 0.014568 | 9.144147 | 3.220284 | 28.26135 | 7.905183 | 25.31736 | 0.622459 | 25.52922 |
| 5 | 0.017349 | 9.894524 | 2.614834 | 24.91547 | 11.42136 | 29.06161 | 0.789928 | 21.30228 |
| 6 | 0.019774 | 10.00765 | 2.532151 | 22.21903 | 13.58633 | 32.07656 | 0.837971 | 18.74031 |
| 7 | 0.021701 | 9.646412 | 2.825385 | 20.44905 | 14.06553 | 34.38716 | 0.836150 | 17.79032 |
| 8 | 0.023063 | 9.128919 | 3.157780 | 19.35828 | 13.51894 | 36.09596 | 0.826450 | 17.91367 |
| 9 | 0.023935 | 8.701681 | 3.294827 | 18.55185 | 12.87200 | 37.30504 | 0.823314 | 18.45129 |
| 10 | 0.024466 | 8.401332 | 3.229396 | 17.79533 | 12.62002 | 38.19064 | 0.833480 | 18.92980 |

***Source:*** Own Computation Using EViews 10, 2023

*Where shock1, shock2, shock3, shock4, shock5, shock6, and shock7 are unanticipated changes in the inflation rate, unemployment rate, real GDP growth rate, foreign exchange, credit, rate of interest, and Gini coefficient as a measure of income inequality respectively.*

Nearly 100 % of the variation in unemployment rate is explained by itself in the first quarter of the year 1998 in Brazil and continuously declines to 43.28%. However, the contribution of shocks in foreign exchange and credit in explaining a shock in the rate of unemployment gradually rises. For instance, both variables do not explain the variation in unemployment in the short term, while in the long run, or in the $10^{th}$ period, 27.57 and 19.85% are explained by shocks in the foreign exchange and credit respectively. Finally, the results of the variance decomposition forecast error for real GDP growth, foreign exchange, credit, interest rate are reported in annex 3 of the appendix.

## 5. Conclusion and Policy Implications

Inequality within most emerging and developing countries has increased, a phenomenon that has received considerable attention from researchers and policymakers. In Latin America and the Caribbean in general and Brazil in particular, income inequality has also been a cross cutting issue since at least the mid-20th century. Specifically, the years 2021 and 2018 saw the Gini Index of Brazil to 0.544, and 0.545 respectively (IBGE, 2022) making Brazil one of the most unequal countries in the region and the world.

A considerable number of studies undertaken so far suggested that macroeconomic policies affect income inequality in addition to other factors. The study of the distributional effects of monetary policy, however, is a relatively new topic, and we recognized that most of the research done thus far is focused on the advanced economies of the USA and the EU region. As a result, there is a limited and inconclusive empirical finding on the inequality effect of monetary policy through various channels in Latin America and specifically, in Brazil. Inconsistent conclusions may be caused using various data types, the country under consideration, the transmission mechanism, and the used estimation techniques. So, the main aim of this research is to add to the limited and contentious body of literature by employing the structural VAR approach to examine how monetary policy shocks affect income inequality in Brazil. To achieve this objective, a time series of data ranging from 1998Q1 to 2021Q4 is collected and managed accordingly. Before estimating and interpreting the results of the SVAR model, appropriate econometric diagnostic tests have been undertaken.

Results from the SVAR model revealed that contractionary monetary policy through an increasing rate of interest increases income inequality for some period. The implication is that the earning heterogeneity and saving redistribution channel play a tremendous role in the long run in that contractionary monetary policy intensifies income inequality in Brazil. Unanticipated innovation in the rate of inflation has an impact on income inequality. A rising rate of inflation increases income inequality in Brazil by making poor people have the lowest share of income in the economy. The response of income inequality to a shock in unemployment is positive in the long run, which increases the gap in income received by the rich and the poor individuals. The response of income inequality to a positive shock in the exchange rate is negative. Moreover, the dynamic response of income inequality to the real GDP growth rate was negative in the short run

and positive in the long run. A positive shock in private credit as a percentage of GDP has a negative and significant impact on income inequality in the long run.

Lastly, the results of the variance decomposition factor error revealed that in Brazil, the main sources of fluctuation in income inequality are income inequality itself, real GDP growth, credit, inflation, and unemployment. The following recommendations are made based on the study's findings to keep Brazil's income distribution fair.

- Policymakers intending to target the reduction of income inequality in Brazil should concede and keep the emphasis on inflation targeting monetary policy framework.
- Decreasing the rate of unemployment by implementing expansionary monetary policy is one of the options that should be targeted by policymakers to narrow income inequality.
- The monetary policy authority should enhance access to financial credit to reduce income inequality in Brazil.

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# List of Appendices

**Annex 1: VAR Estimation Results**

Sample (adjusted): 1998Q3 2021Q4

Included observations: 94 after adjustments

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

| | Inf | Unemp | RGDPgr | Forex | cred | r | Gini |
|---|---|---|---|---|---|---|---|
| inf(-1) | 1.622589 | -0.040842 | -0.100274 | 1.424365 | -0.139843 | -30.48204 | 0.094129 |
| | (0.07071) | (0.02339) | (0.08375) | (1.40282) | (0.08660) | (24.4758) | (0.06530) |
| | [ 22.9485] | [-1.74595] | [-1.19730] | [ 1.01536] | [-1.61482] | [-1.24539] | [ 1.44157] |
| inf(-2) | -0.797427 | 0.012895 | 0.036116 | -0.975883 | 0.119051 | 13.90693 | -0.061153 |
| | (0.06781) | (0.02243) | (0.08032) | (1.34534) | (0.08305) | (23.4730) | (0.06262) |
| | [-11.7600] | [ 0.57481] | [ 0.44966] | [-0.72538] | [ 1.43345] | [ 0.59246] | [-0.97656] |
| unemp(-1) | -0.363458 | 1.588030 | -0.153089 | -8.867950 | 0.215055 | -0.960507 | -0.015687 |
| | (0.26393) | (0.08732) | (0.31262) | (5.23639) | (0.32326) | (91.3624) | (0.24373) |
| | [-1.37711] | [ 18.1867] | [-0.48970] | [-1.69352] | [ 0.66527] | [-0.01051] | [-0.06436] |
| unemp(-2) | 0.209587 | -0.665094 | -0.013172 | 11.20948 | -0.221571 | -64.20799 | 0.145563 |
| | (0.26346) | (0.08716) | (0.31207) | (5.22715) | (0.32269) | (91.2011) | (0.24330) |
| | [ 0.79551] | [-7.63036] | [-0.04221] | [ 2.14447] | [-0.68664] | [-0.70403] | [ 0.59828] |
| RGDPgr(-1) | -0.195530 | 0.006040 | 1.510948 | -1.724048 | 0.137630 | -21.52355 | -0.052054 |
| | (0.08009) | (0.02650) | (0.09486) | (1.58891) | (0.09809) | (27.7227) | (0.07396) |
| | [-2.44152] | [ 0.22796] | [ 15.9283] | [-1.08505] | [ 1.40313] | [-0.77639] | [-0.70384] |
| RGDPgr(-2) | 0.134125 | -0.012617 | -0.693675 | 1.828742 | -0.096178 | 28.95004 | 0.065622 |
| | (0.07462) | (0.02469) | (0.08838) | (1.48043) | (0.09139) | (25.8300) | (0.06891) |
| | [ 1.79750] | [-0.51111] | [-7.84851] | [ 1.23528] | [-1.05237] | [ 1.12079] | [ 0.95231] |
| forex(-1) | -0.004605 | 0.001752 | 0.000188 | 1.036824 | 0.003857 | 0.790053 | -0.002456 |
| | (0.00550) | (0.00182) | (0.00652) | (0.10916) | (0.00674) | (1.90466) | (0.00508) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | [-0.83700] | [ 0.96261] | [ 0.02885] | [ 9.49780] | [ 0.57230] | [ 0.41480] | [-0.48335] |
| forex(-2) | 0.013403 | 0.002908 | 0.001687 | -0.163300 | -0.005003 | 1.235964 | -0.004544 |
| | (0.00578) | (0.00191) | (0.00685) | (0.11474) | (0.00708) | (2.00189) | (0.00534) |
| | [ 2.31761] | [ 1.51966] | [ 0.24635] | [-1.42325] | [-0.70636] | [ 0.61740] | [-0.85086] |
| cred(-1) | -0.032972 | -0.014425 | 0.069400 | -0.611752 | 1.768516 | -157.4484 | -0.061281 |
| | (0.09065) | (0.02999) | (0.10737) | (1.79843) | (0.11102) | (31.3782) | (0.08371) |
| | [-0.36375] | [-0.48099] | [ 0.64637] | [-0.34016] | [ 15.9294] | [-5.01777] | [-0.73207] |
| cred(-2) | 0.018395 | 0.015019 | -0.081771 | 0.934614 | -0.763021 | 151.6077 | 0.042913 |
| | (0.08697) | (0.02877) | (0.10302) | (1.72554) | (0.10652) | (30.1065) | (0.08032) |
| | [ 0.21151] | [ 0.52197] | [-0.79376] | [ 0.54164] | [-7.16299] | [ 5.03571] | [ 0.53429] |
| r(-1) | 0.000974 | 2.76E-05 | 0.000205 | 0.009937 | 0.000163 | 1.095169 | 0.000276 |
| | (0.00029) | (9.5E-05) | (0.00034) | (0.00568) | (0.00035) | (0.09910) | (0.00026) |
| | [ 3.40258] | [ 0.29104] | [ 0.60478] | [ 1.74963] | [ 0.46520] | [ 11.0516] | [ 1.04276] |
| r(-2) | -0.000805 | 9.96E-05 | -0.000447 | -0.006351 | -0.000348 | -0.440201 | -0.000157 |
| | (0.00025) | (8.4E-05) | (0.00030) | (0.00502) | (0.00031) | (0.08755) | (0.00023) |
| | [-3.18276] | [ 1.19051] | [-1.49111] | [-1.26577] | [-1.12250] | [-5.02824] | [-0.67098] |
| gini(-1) | -0.155879 | 0.009313 | 0.030606 | -4.513568 | 0.217014 | -31.23852 | 1.421917 |
| | (0.12591) | (0.04166) | (0.14914) | (2.49813) | (0.15422) | (43.5864) | (0.11628) |
| | [-1.23800] | [ 0.22355] | [ 0.20521] | [-1.80678] | [ 1.40720] | [-0.71670] | [ 12.2286] |
| gini(-2) | 0.156978 | -0.000394 | 0.082737 | 4.071762 | -0.107699 | 83.65622 | -0.668485 |
| | (0.12081) | (0.03997) | (0.14309) | (2.39683) | (0.14796) | (41.8188) | (0.11156) |
| | [ 1.29942] | [-0.00986] | [ 0.57820] | [ 1.69881] | [-0.72788] | [ 2.00044] | [-5.99200] |
| C | 0.023979 | -0.001511 | -0.030679 | -0.088472 | -0.057270 | -15.57806 | 0.133990 |
| | (0.03296) | (0.01091) | (0.03904) | (0.65401) | (0.04037) | (11.4109) | (0.03044) |
| | [ 0.72742] | [-0.13851] | [-0.78574] | [-0.13528] | [-1.41849] | [-1.36519] | [ 4.40155] |
| R-squared | 0.968784 | 0.994990 | 0.964353 | 0.953211 | 0.998971 | 0.963503 | 0.978538 |
| Adj. R-squared | 0.963252 | 0.994102 | 0.958036 | 0.944920 | 0.998789 | 0.957035 | 0.974735 |
| Sum sq. resids | 0.001477 | 0.000162 | 0.002073 | 0.581490 | 0.002216 | 177.0163 | 0.001260 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.E. equation | 0.004324 | 0.001431 | 0.005122 | 0.085794 | 0.005296 | 1.496901 | 0.003993 |
| F-statistic | 175.1257 | 1120.653 | 152.6568 | 114.9602 | 5478.323 | 148.9695 | 257.2809 |
| Log likelihood | 386.4814 | 490.4560 | 370.5666 | 105.6362 | 367.4204 | -163.1287 | 393.9635 |
| Akaike AIC | -7.903860 | -10.11609 | -7.565247 | -1.928429 | -7.498306 | 3.789973 | -8.063054 |
| Schwarz SC | -7.498015 | -9.710240 | -7.159402 | -1.522585 | -7.092461 | 4.195818 | -7.657209 |
| Mean dependent | 0.061030 | 0.100781 | 0.021240 | 0.942477 | 0.480465 | 13.49397 | 0.549814 |
| S.D. dependent | 0.022558 | 0.018629 | 0.025004 | 0.365561 | 0.152175 | 7.221671 | 0.025123 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 1.77E-27 |
| Determinant resid covariance | 5.24E-28 |
| Log likelihood | 2018.686 |
| Akaike information criterion | -40.71672 |
| Schwarz criterion | -37.87581 |
| Number of coefficients | 105 |

**Annex 2:** Structural VAR Estimation Results

Sample (adjusted): 1998Q3 2021Q4
Included observations: 94 after adjustments
Estimation method: Maximum likelihood via Newton-Raphson (analytic derivatives)
Convergence achieved after 40 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

A =

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| C(1) | 1 | 0 | 0 | 0 | 0 | 0 |
| C(2) | C(7) | 1 | 0 | 0 | 0 | 0 |
| C(3) | C(8) | C(12) | 1 | 0 | 0 | 0 |
| C(4) | C(9) | C(13) | C(16) | 1 | 0 | 0 |
| C(5) | C(10) | C(14) | C(17) | C(19) | 1 | 0 |
| C(6) | C(11) | C(15) | C(18) | C(20) | C(21) | 1 |

B =

| | | | | | | |
|---|---|---|---|---|---|---|
| C(22) | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | C(23) | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | C(24) | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | C(25) | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | C(26) | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | C(27) | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | C(28) |

| | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | 0.003684 | 0.034122 | 0.107968 | 0.9140 |
| C(2) | -0.186942 | 0.120633 | -1.549675 | 0.1212 |
| C(3) | -2.788576 | 2.018162 | -1.381740 | 0.1671 |
| C(4) | 0.328132 | 0.121943 | 2.690857 | 0.0071 |
| C(5) | 76.90585 | 32.03077 | 2.400999 | 0.0164 |
| C(6) | -0.195320 | 0.066423 | -2.940528 | 0.0033 |
| C(7) | 0.046674 | 0.364624 | 0.128005 | 0.8981 |
| C(8) | -10.48420 | 6.024132 | -1.740366 | 0.0818 |
| C(9) | 0.141443 | 0.366115 | 0.386335 | 0.6992 |
| C(10) | 1.002420 | 92.73795 | 0.010809 | 0.9914 |
| C(11) | 0.639233 | 0.186675 | 3.424307 | 0.0006 |
| C(12) | 1.138729 | 1.703915 | 0.668302 | 0.5039 |
| C(13) | -0.103070 | 0.102168 | -1.008832 | 0.3131 |
| C(14) | -20.13117 | 25.99841 | -0.774323 | 0.4387 |
| C(15) | 0.431523 | 0.052500 | 8.219538 | 0.0000 |
| C(16) | -0.014714 | 0.006170 | -2.384859 | 0.0171 |
| C(17) | -1.464995 | 1.608141 | -0.910987 | 0.3623 |
| C(18) | 0.000790 | 0.003251 | 0.243075 | 0.8079 |
| C(19) | 157.7370 | 26.10547 | 6.042298 | 0.0000 |
| C(20) | 0.319423 | 0.061918 | 5.158810 | 0.0000 |
| C(21) | 0.000120 | 0.000208 | 0.577291 | 0.5637 |
| C(22) | 0.004324 | 0.000315 | 13.71131 | 0.0000 |
| C(23) | 0.001431 | 0.000104 | 13.71131 | 0.0000 |
| C(24) | 0.005057 | 0.000369 | 13.71131 | 0.0000 |
| C(25) | 0.083546 | 0.006093 | 13.71131 | 0.0000 |
| C(26) | 0.004998 | 0.000364 | 13.71131 | 0.0000 |
| C(27) | 1.264899 | 0.092252 | 13.71131 | 0.0000 |
| C(28) | 0.002546 | 0.000186 | 13.71131 | 0.0000 |

| | |
|---|---|
| Log likelihood | 1961.490 |

Estimated A matrix:

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.003684 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -0.186942 | 0.046674 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -2.788576 | -10.48420 | 1.138729 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.328132 | 0.141443 | -0.103070 | -0.014714 | 1.000000 | 0.000000 | 0.000000 |
| 76.90585 | 1.002420 | -20.13117 | -1.464995 | 157.7370 | 1.000000 | 0.000000 |
| -0.195320 | 0.639233 | 0.431523 | 0.000790 | 0.319423 | 0.000120 | 1.000000 |

Estimated B matrix:

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.004324 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.000000 | 0.001431 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.005057 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.083546 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.004998 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 1.264899 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.002546 |

Estimated S matrix:

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.004324 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -1.59E-05 | 0.001431 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000809 | -6.68E-05 | 0.005057 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.010970 | 0.015074 | -0.005759 | 0.083546 | 0.000000 | 0.000000 | 0.000000 |
| -0.001172 | 1.26E-05 | 0.000437 | 0.001229 | 0.004998 | 0.000000 | 0.000000 |
| -0.115338 | 0.017321 | 0.024517 | -0.071513 | -0.788305 | 1.264899 | 0.000000 |
| 0.000885 | -0.000904 | -0.002320 | -0.000450 | -0.001502 | -0.000152 | 0.002546 |

Estimated F matrix:

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.032932 | 0.000233 | -0.010210 | 0.034876 | -0.000288 | 0.008642 | 0.001161 |
| -0.033040 | 0.046939 | 0.008089 | 0.035335 | 0.052574 | 0.004456 | 0.027686 |
| 0.024510 | -0.013327 | 0.015395 | -0.002999 | -0.061888 | 0.002870 | -0.014665 |
| -0.475526 | 0.444974 | 0.202855 | 0.621940 | 1.348226 | -0.078204 | 0.479222 |
| -0.075834 | -0.176354 | 0.058059 | -0.337060 | 0.303197 | -0.128113 | 0.022755 |
| 5.425494 | -0.373354 | -3.042570 | 5.506183 | -18.59988 | 6.939033 | -1.954270 |
| 0.013706 | 0.020682 | -0.017220 | 0.031395 | -0.051680 | 0.018158 | 0.008015 |

## Annex 3: Variance Decomposition Using Structural VAR Factors

**Variance Decomposition of inflation rate:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.004324 | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.008075 | 95.51041 | 0.269213 | 0.535924 | 0.276698 | 0.748222 | 2.417972 | 0.241560 |
| 3 | 0.011497 | 87.47517 | 0.723754 | 2.593400 | 0.151163 | 3.503297 | 4.854462 | 0.698751 |
| 4 | 0.014568 | 77.44817 | 1.563898 | 6.172886 | 0.357531 | 7.704034 | 5.555482 | 1.198000 |
| 5 | 0.017349 | 67.20605 | 2.939204 | 10.08230 | 1.332765 | 11.74164 | 5.039582 | 1.658469 |
| 6 | 0.019774 | 58.66946 | 4.723995 | 12.92119 | 2.747581 | 14.57210 | 4.250647 | 2.115029 |
| 7 | 0.021701 | 52.73230 | 6.583701 | 14.14832 | 4.059246 | 16.19149 | 3.639132 | 2.645803 |
| 8 | 0.023063 | 49.17485 | 8.180643 | 14.09311 | 5.000170 | 17.01040 | 3.257985 | 3.282832 |
| 9 | 0.023935 | 47.27182 | 9.313094 | 13.45988 | 5.589279 | 17.36322 | 3.038694 | 3.964010 |
| 10 | 0.024466 | 46.28919 | 9.961129 | 12.88477 | 5.960109 | 17.43986 | 2.912258 | 4.552685 |

**Variance Decomposition of unemployment rate:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.001431 | 0.012400 | 99.98760 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.002710 | 0.334212 | 99.27958 | 0.000625 | 0.204394 | 0.158292 | 0.015244 | 0.007658 |
| 3 | 0.003939 | 1.124415 | 95.55617 | 0.030018 | 2.198182 | 0.827698 | 0.239143 | 0.024374 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 0.005132 | 2.275346 | 87.92449 | 0.115790 | 6.421454 | 2.351600 | 0.889155 | 0.022169 |
| 5 | 0.006305 | 3.385267 | 78.07833 | 0.234660 | 11.66023 | 4.782796 | 1.842585 | 0.016135 |
| 6 | 0.007436 | 4.065467 | 68.30386 | 0.346362 | 16.60634 | 7.826248 | 2.809747 | 0.041966 |
| 7 | 0.008486 | 4.186001 | 59.90280 | 0.429859 | 20.65107 | 11.08899 | 3.629576 | 0.111707 |
| 8 | 0.009433 | 3.868483 | 53.12993 | 0.487725 | 23.72712 | 14.27754 | 4.297700 | 0.211503 |
| 9 | 0.010276 | 3.361725 | 47.71752 | 0.535094 | 25.97553 | 17.22712 | 4.864732 | 0.318280 |
| 10 | 0.011038 | 2.915271 | 43.28213 | 0.590789 | 27.57626 | 19.85677 | 5.366733 | 0.412047 |

**Variance Decomposition of RGDP growth:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.005122 | 2.495485 | 0.016993 | 97.48752 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.009208 | 1.376055 | 0.141830 | 98.36934 | 0.006214 | 0.022857 | 0.076543 | 0.007162 |
| 3 | 0.012073 | 0.814581 | 0.599650 | 98.24033 | 0.058406 | 0.069797 | 0.044798 | 0.172438 |
| 4 | 0.013756 | 0.747734 | 1.851716 | 95.73970 | 0.122468 | 0.242488 | 0.378923 | 0.916972 |
| 5 | 0.014785 | 0.986422 | 4.148947 | 89.71856 | 0.108087 | 0.805037 | 1.622913 | 2.610034 |
| 6 | 0.015667 | 1.222345 | 6.797514 | 81.09466 | 0.360551 | 2.067184 | 3.530606 | 4.927143 |
| 7 | 0.016619 | 1.277427 | 8.514623 | 72.08485 | 1.917668 | 4.030632 | 5.250141 | 6.924664 |
| 8 | 0.017648 | 1.198926 | 8.748418 | 64.01967 | 5.552459 | 6.293473 | 6.249968 | 7.937085 |
| 9 | 0.018689 | 1.091014 | 8.043062 | 57.21488 | 10.73642 | 8.340413 | 6.574106 | 8.000105 |
| 10 | 0.019651 | 1.011542 | 7.278815 | 51.80171 | 15.98777 | 9.851109 | 6.514170 | 7.554881 |

**Variance Decomposition of foreign exchange:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.085794 | 1.634945 | 3.087129 | 0.450558 | 94.82737 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.124497 | 1.683234 | 1.810026 | 0.330019 | 94.08215 | 0.109096 | 1.133368 | 0.852106 |
| 3 | 0.149258 | 1.969100 | 1.311758 | 0.259769 | 91.10394 | 0.528292 | 2.451817 | 2.375325 |
| 4 | 0.166327 | 2.592364 | 1.086587 | 0.241665 | 88.29411 | 1.132085 | 3.036125 | 3.617063 |
| 5 | 0.179017 | 3.566811 | 0.969968 | 0.296232 | 86.26316 | 1.679361 | 3.098983 | 4.125490 |
| 6 | 0.189321 | 4.741082 | 0.903489 | 0.456203 | 84.74144 | 2.084379 | 3.015015 | 4.058387 |
| 7 | 0.198230 | 5.860825 | 0.874903 | 0.707975 | 83.43112 | 2.397250 | 2.958973 | 3.768948 |
| 8 | 0.206087 | 6.713836 | 0.899821 | 0.985435 | 82.24477 | 2.687247 | 2.981714 | 3.487180 |
| 9 | 0.212975 | 7.211728 | 1.012097 | 1.213944 | 81.23585 | 2.979016 | 3.063188 | 3.284180 |
| 10 | 0.218967 | 7.377576 | 1.251090 | 1.349104 | 80.47393 | 3.243572 | 3.150939 | 3.153787 |

**Variance Decomposition of credit:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.005296 | 4.895532 | 0.000564 | 0.679274 | 5.387281 | 89.03735 | 0.000000 | 0.000000 |
| 2 | 0.010528 | 6.236754 | 0.031209 | 0.979796 | 6.503451 | 85.94621 | 0.027131 | 0.275449 |
| 3 | 0.015843 | 7.395392 | 0.044005 | 1.267845 | 6.788267 | 83.46998 | 0.013257 | 1.021251 |
| 4 | 0.021135 | 8.209361 | 0.037517 | 1.534012 | 6.431361 | 81.51454 | 0.045567 | 2.227640 |
| 5 | 0.026431 | 8.644223 | 0.027105 | 1.787466 | 5.598373 | 80.00038 | 0.192026 | 3.750430 |
| 6 | 0.031775 | 8.781356 | 0.020203 | 2.040522 | 4.530160 | 78.84501 | 0.428301 | 5.354449 |
| 7 | 0.037190 | 8.748865 | 0.019428 | 2.293739 | 3.486691 | 77.93471 | 0.697615 | 6.818956 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 8 | 0.042682 | 8.665406 | 0.032969 | 2.532562 | 2.655382 | 77.14559 | 0.961476 | 8.006611 |
| 9 | 0.048243 | 8.618100 | 0.072916 | 2.735649 | 2.107444 | 76.38883 | 1.205279 | 8.871781 |
| 10 | 0.053847 | 8.660544 | 0.145821 | 2.886963 | 1.818282 | 75.62898 | 1.425862 | 9.433545 |

**Variance Decomposition of SELIC interest:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.496901 | 0.593691 | 0.013390 | 0.026826 | 0.228233 | 27.73334 | 71.40452 | 0.000000 |
| 2 | 2.609344 | 0.373103 | 0.052444 | 0.109520 | 0.615429 | 46.88001 | 51.87658 | 0.092915 |
| 3 | 3.422783 | 0.228618 | 0.058822 | 0.716822 | 0.675254 | 61.34080 | 36.88034 | 0.099340 |
| 4 | 4.008599 | 0.597187 | 0.547506 | 1.741810 | 0.593100 | 68.75120 | 27.69453 | 0.074674 |
| 5 | 4.442536 | 1.695159 | 1.675277 | 2.681735 | 0.538913 | 70.74872 | 22.59890 | 0.061295 |
| 6 | 4.772876 | 3.374179 | 2.967181 | 3.185070 | 0.582618 | 70.19475 | 19.61257 | 0.083639 |
| 7 | 5.036214 | 5.256491 | 3.916017 | 3.283450 | 0.767425 | 68.80033 | 17.72893 | 0.247353 |
| 8 | 5.253341 | 6.960168 | 4.415783 | 3.188283 | 1.010677 | 67.33120 | 16.47391 | 0.619981 |
| 9 | 5.428935 | 8.268749 | 4.642166 | 3.062150 | 1.154641 | 66.16724 | 15.57524 | 1.129819 |
| 10 | 5.565065 | 9.145185 | 4.782897 | 2.969529 | 1.157893 | 65.40017 | 14.90125 | 1.643079 |

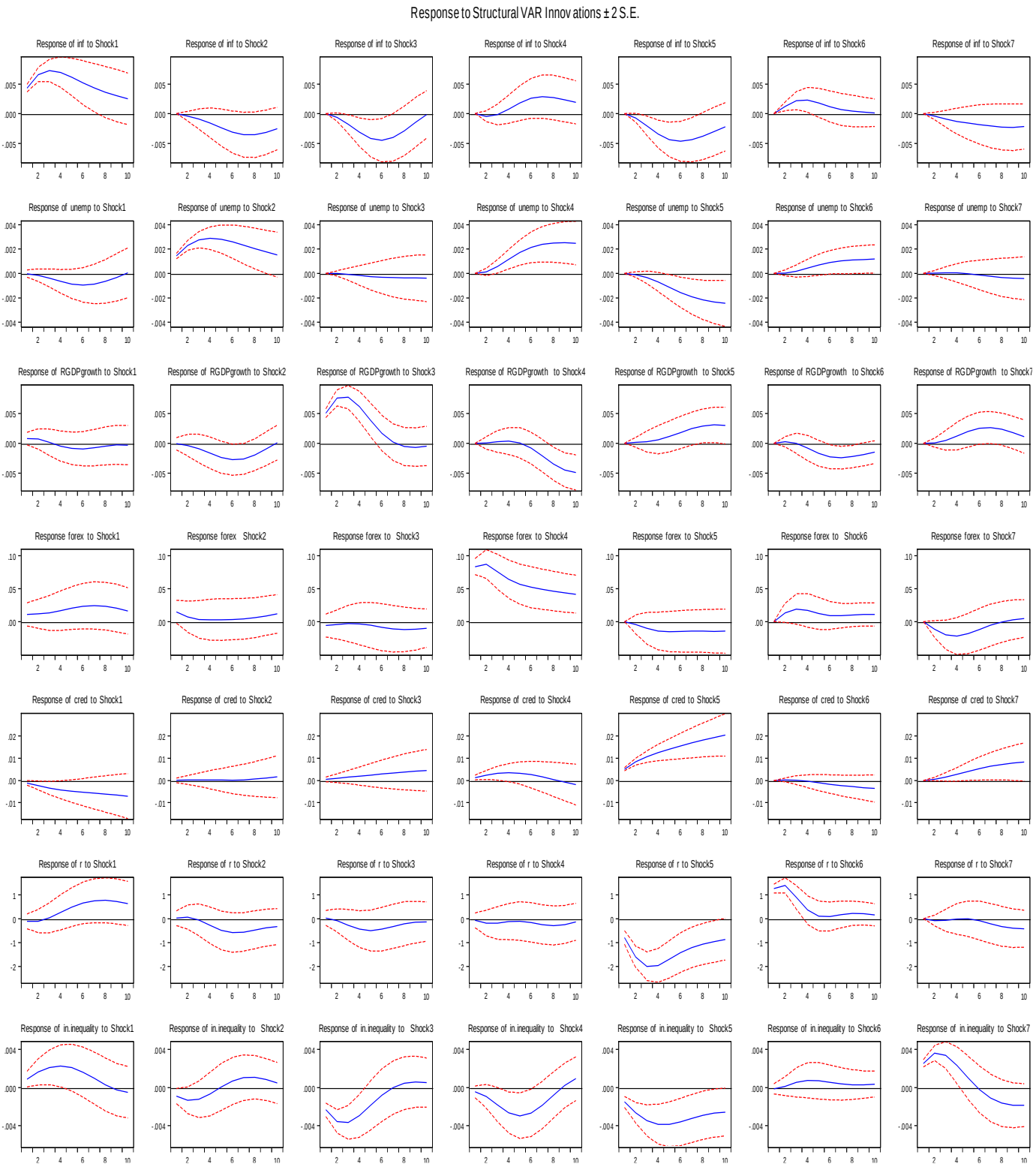
**Variance Decomposition of gini:**

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.003993 | 4.912602 | 5.120591 | 33.75538 | 1.270529 | 14.14423 | 0.144128 | 40.65254 |
| 2 | 0.007364 | 6.385434 | 4.801998 | 33.40622 | 2.004109 | 17.19937 | 0.075068 | 36.12780 |
| 3 | 0.010030 | 7.873290 | 4.104227 | 31.40597 | 4.339508 | 21.14352 | 0.326932 | 30.80655 |
| 4 | 0.011944 | 9.144147 | 3.220284 | 28.26135 | 7.905183 | 25.31736 | 0.622459 | 25.52922 |
| 5 | 0.013259 | 9.894524 | 2.614834 | 24.91547 | 11.42136 | 29.06161 | 0.789928 | 21.30228 |
| 6 | 0.014143 | 10.00765 | 2.532151 | 22.21903 | 13.58633 | 32.07656 | 0.837971 | 18.74031 |
| 7 | 0.014742 | 9.646412 | 2.825385 | 20.44905 | 14.06553 | 34.38716 | 0.836150 | 17.79032 |
| 8 | 0.015187 | 9.128919 | 3.157780 | 19.35828 | 13.51894 | 36.09596 | 0.826450 | 17.91367 |
| 9 | 0.015576 | 8.701681 | 3.294827 | 18.55185 | 12.87200 | 37.30504 | 0.823314 | 18.45129 |
| 10 | 0.015951 | 8.401332 | 3.229396 | 17.79533 | 12.62002 | 38.19064 | 0.833480 | 18.92980 |

Factorization: Structural

***Source:*** Own Computation Using EViews 10, 2023

**Annex 4:** Structural Impulse Response Functions of All Variables




***Source:*** Own Computation Using EViews 10, 2023