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The Impact of Monetary Policy on Income Inequality in Advanced and Emerging Economies

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ABSTRACT

THE IMPACT OF MONETARY POLICY ON INCOME INEQUALITY IN ADVANCED AND EMERGING ECONOMIES

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This paper studies the effect of monetary policy on income inequality in eleven advanced and eleven emerging economies using quarterly data from 2005Q1 to 2021Q3 to estimate an Autoregressive Distributed Lag (ARDL) model for each country. The main purpose is to explore whether monetary policy affects income inequality differently in advanced and emerging economies. Depending on whether all the variables in a model are stationary at level, a stationary ARDL or long-run ARDL model is estimated. The top ten percent income share is used as the indicator of income inequality and the monetary policy rate is used as a proxy for the monetary policy conduct. Additionally, the inflation rate, unemployment rate, and the Total Share Price Index are included as the explanatory variables to capture the four theoretical transmission mechanism channels: portfolio composition, earnings heterogeneity, financial segmentation, and income composition channels. Each model also includes the interaction term between inflation and unemployment and squared values of each independent variable, which are used to identify the inequality-maximizing or minimizing values of the monetary policy rate, inflation, unemployment, and Total Share Price Index (in its logarithmic form). Partial derivation technique is employed to achieve this. The findings yield mixed results, with six of the eleven emerging economies and eight of the eleven advanced economies facing inequality-decreasing effect of a contractionary monetary policy. The results for each country were consistent with the theory, except for Germany and South Africa.

Keywords: Monetary Policy, Income Inequality, Advanced Economies, Emerging Economies

ÖZ

GELİŞMİŞ VE GELİŞMEKTE OLAN EKONOMİLERDE PARA POLİTİKASININ GELİR EŞİTSİZLİĞİNE ETKİSİ

YASMINAKHON KHASANOVA

Bu çalışma, her ülke için bir Otoregresif Dağıtılmış Gecikme (ARDL) modeli tahmin etmek için 2005Q1'den 2021Q3'e kadar olan üç aylık verileri kullanarak on bir gelişmiş ve on bir yükselen ekonomide para politikasının gelir eşitsizliği üzerindeki etkisini incelemektedir. Temel amaç, para politikasının gelişmiş ve gelişmekte olan ekonomilerde gelir eşitsizliğini farklı şekilde etkileyip etkilemediğini araştırmaktır. Bir modeldeki tüm değişkenlerin düzeyde durağan olup olmadığına bağlı olarak durağan bir ARDL veya uzun dönemli bir ARDL modeli tahmin edilir. Gelir eşitsizliğinin göstergesi olarak ilk yüzde onluk gelir payı, para politikası davranışının göstergesi olarak da para politikası faizi kullanılmaktadır. Ek olarak, dört teorik aktarım mekanizması kanalını (portföy bileşimi, kazanç heterojenliği, finansal bölümlendirme ve gelir bileşimi kanalları) yakalamak için açıklayıcı değişkenler olarak enflasyon oranı, işsizlik oranı ve Toplam Hisse Senedi Fiyat Endeksi dahil edilmiştir. Her model ayrıca enflasyon ve işsizlik arasındaki etkileşim terimini ve para politikası faiz oranı, enflasyon, işsizlik ve Toplam Hisse Senedi Fiyat Endeksi'nin (logaritmik biçim). Bunu başarmak için kısmi türetme tekniği kullanılır. Bulgular, on bir gelişmekte olan ekonomiden altısı ve on bir gelişmiş ekonomiden sekizinin daraltıcı bir para politikasının eşitsizliği azaltıcı etkisiyle karşı karşıya kaldığı karışık sonuçlar veriyor. Almanya ve Güney Afrika hariç her ülke için sonuçlar teori ile tutarlıydı.

Anahtar Kelimeler: Para Politikası, Gelir Eşitsizliği, Gelişmiş Ekonomiler, Gelişmekte Olan Ekonomiler

PREFACE

This study aims to fill in the gap in the relatively young empirical literature regarding the effect of monetary policy on income inequality. Using a separate time series analysis for each country, this study aims to explore whether monetary policy's effect on income inequality differs for advanced and emerging economies. In addition, this study aims to contribute to the existing empirical literature by identifying the theoretical transmission channels that are valid for each country. The secondary aim of this study is to identify inequality-maximizing or minimizing values of the explanatory variables (monetary policy rate, inflation, unemployment, and the Total Share Price Index) in the case of each country with the usage of the partial derivation technique.

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CHAPTER THREE

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LIST OF ABBREVIATIONS

ADF	:Augmented Dickey-Fuller
AIC	:Akaike Information Criterion
AR	:Autoregressive
ARDL	:Autoregressive Distributed Lag
BRICS	:Brazil, Russia, India, China, and South Africa
CEX	:Consumer Expenditure Survey
CMP	:Conventional Monetary Policy
CPI	:Consumer Price Index
CSC	:Capital-Skill Complementarity
DGP	:Data Generating Process
ECB	:European Central Bank
ECM	:Error Correction Model
EC	:Error Correction Term
FDI	:Foreign Direct Investment
FED	:Federal Reserve
FRED	:Federal Reserve Economic Data
GDP	:Gross Domestic Product
HAC	:Heteroskedasticity and Autocorrelation Consistent
HQC	:Hannan and Quinn Information Criterion
I (0), I (1), I (2)	:Integrated at Order Zero, One and Two, respectively
Iid	:independently identically distributed
IFS	:International Financial Statistics
IMF	:International Monetary Fund
ILO	:International Labor Organization
IRF	:Impulse Response Functions
LM	:Lagrange Multiplier
LS	:Lee-Strazicich
MLE	:Maximum Likelihood Estimator
OECD	:Organization for Economic Cooperation and Development
OLS	:Ordinary Least Squares

OVB	:Omitted Variable Bias
QE	:Quantitative Easing
RESET	:Regression Equation Specification Error Test
SAM	:Search and Matching
SIC	:Schwartz Information Criterion
SOEP	:Socio-Economic Panel
SVAR	:Structural Vector Autoregression
TB	:Trend Break
U.K	:United Kingdom
UMP	:Unconventional Monetary Policy
U.S	:United States
USSR	:Union of Soviet Socialist Republics
VAR	:Vector Autoregression
VARX	:Vector Autoregressive with Exogeneous Variable
VECR	:Vector Error Correction
WID	:World Inequality Database
ZA	:Zivot-Andrews

INTRODUCTION

Global inequality is a major issue that has attracted the attention of stakeholders such as policymakers, academic researchers, and civil society organizations. From an economic perspective, concerns regarding identifying the causes of and curbing economic inequality have been on the rise. Increasing globalization and famous works such as *"Capital in the 21st Century"* (Piketty and Goldhammer, 2014) have attracted worldwide attention to the topic of inequality. Moreover, the field of Economics requires a solid understanding of the relationship between inequality and financial development. Thus, the concept of inequality and the thorough identification of its determinants are crucial for the study of Economics (Roine et al., 2009).

Although central banks around the world have been disregarding the distributional effect of their policies, prioritizing other monetary policy targets, the relatively young empirical literature has identified the causal effect of monetary policy on economic inequality in general and income inequality in particular. Nevertheless, there are mixed findings for different countries. The theoretical literature on this topic has identified five theoretical transmission channels, through which monetary policy can affect wealth and income inequality. These channels go in opposite directions and thus suggest a controversy regarding the effect of an expansionary monetary policy on inequality. On the one hand, three of these channels, namely income composition, financial segmentation, and portfolio composition channels, show that an expansionary monetary policy exacerbates (increases) inequality. On the other hand, the other two channels, namely savings redistribution and earnings heterogeneity channels, show that an expansionary monetary policy reduces inequality. Considering the different directions of the theoretical channels and mixed findings of the empirical literature on this topic, additional research on different countries is required to resolve this controversy.

This study aims to explore whether the effect of monetary policy on income inequality is different for advanced and emerging economies. In addition, this study aims to contribute to the existing empirical literature by identifying the values of the explanatory variables at which inequality is minimized or maximized. Namely, an Autoregressive Distributed Lag (ARDL) model, along with the Bound Test, is employed to study the effect in each country, using the top 10 percent income share as the indicator of income inequality, monetary policy rate, inflation, unemployment, and the Total Share Price Index, along with the squared form of each variable and the interaction term between inflation and unemployment. To the author's knowledge, there are no studies that attempted to discover whether the effect of monetary policy on inequality is different in emerging and advanced economies. The most closely related work is the study conducted by Omar and Richter (2021), which analyzed the effect of monetary policy on income inequality using sample data for nine countries at different stages of development. However, Omar and Richter (2021) did not include variables other than the monetary policy rate, which could have better captured the theoretical transmission channels, and did not attempt to discover the values of the independent variables at which inequality is minimized or maximized.

This paper is structured as follows. Chapter 1 provides a literature review on economic inequality, its measurement, theories related to it, and empirical findings on the determinants of inequality in different countries. Moreover, chapter 1 describes the theoretical transmission channels through which monetary policy can affect inequality, along with the empirical findings on this topic. Chapter 2 describes the data and empirical methodology, including the specification of the data and its sources, data transformation, all the necessary steps for the ARDL-Bound Test methodology, and the partial derivation method to identify the values of regressors that minimize or maximize inequality. Chapter 3 provides empirical results from the analysis of each country. Finally, Conclusion and Policy Recommendations provides a conclusion, suggestions for policy makers, and possible limitations of the study.

CHAPTER ONE
LITERATURE REVIEW

This chapter provides a literature review, which includes the concept of economic inequality and its measurements (sections 1.1-1.2), a brief survey of theories of inequality (section 1.3), dynamics of inequality (section 1.4), the main determinants of inequality as identified by the empirical literature (section 1.5), the five theoretical channels through which the conduct of monetary policy can affect inequality (section 1.6 and its subsections), and a non-exhaustive survey of the empirical literature on this topic (section 1.7)

1.1. Economic Inequality

According to Sen (1992), ‘‘Equality in what is seen as the ‘base’ is invoked for a reasoned defense of the resulting inequalities in the far-flung 'peripheries.’’ This implies that supporting equality in one field can lead to justifying inequality in some other field (Napari, 2019). To illustrate, McKay (2002) defines inequality as the disparities in living standards across a population. Napari (2019) points out that such definitions are based on the outcome because they choose the outcome of a distribution as the evaluative space of inequality, irrespective of the actual distribution.

Economic inequality is defined as inequality in economic resources and opportunities, which leads to some individuals having a better quality of life than others. Economic inequality is a broad topic that can be narrowed to the analysis of disparities in wealth, income, consumption, and employment opportunities (Napari, 2019). There are different definitions of economic inequality, and this can be zeroed down to normative judgments regarding what economic arrangement improves social welfare (Sen & Foster, 1997). It has been noted by Sen (1992) that different variables such as income, wealth, consumption, and opportunities can be used to evaluate interpersonal inequalities. Napari (2019), in turn, notes that the plurality of variables that can be used to measure inequality makes it difficult to decide on a suitable perspective, and it is essential to select a particular focal point in analyzing inequality (Napari, 2019).

1.2. Measurements of Economic Inequality

Although it is intuitive to think that the analysis of inequality should focus on disparities in opportunities because they result in inequality in outcomes, outcome-based definitions are still worth studying (Napari, 2019). Attanasio and Pistaferri (2016), Lise and Seitz (2011), and Aguiar and Bills (2015) studied consumption, which is included in the outcome-based definitions of inequality.

It has been noted by Attanasio and Pistaferri (2016) that, in comparison to income and wealth, consumption complies with the economic notion of utility. Since welfare is measured via utility, consumption is a rational choice as a benchmark in evaluating economic inequality (Attanasio & Pistaferri, 2016).

However, other definitions of inequality are resource-based and select wealth and income variables as the focal points in studying inequality (Napari, 2019). Most researchers use income inequality in analyzing inequality, although it is not devoid of limitations. Namely, it has been identified as an inappropriate measure in detecting the true disparities in living standards (Slesnick, 2001). According to Attanasio and Pistaferri (2016), if at any given time the consumption distribution is narrower than that of income, or if consumption evolves more smoothly than income, a researcher analyzing inequality should make a clear distinction between income and consumption.

Following Napari (2019), who has selected income inequality in analyzing the effects of monetary policy on inequality in Ghana, this study uses income inequality in the analysis. Napari (2019) argues that high-income individuals tend to have high rates of saving and can increase their stock of wealth, so income inequality frequently leads to wealth inequality. Income and wealth inequality then result in consumption inequality (Napari, 2019).

1.3. Theories of Inequality

The theory of Kuznets (1955) is one of the most controversial theories of inequality. Kuznets attempted to describe the long-term changes in income distribution and explain what caused these changes. It was argued that inequality degrees vary with the stages of development: inequality is low at an early stage of development, it subsequently increases as the economy becomes more developed, and finally falls as the economy reaches a high level of development in terms of higher income and/or economic advancement. Kuznets' thesis was that as the economy is developing, the upper class with higher volumes of savings enjoys a lot of investment opportunities, so the upper class has a disproportionate benefit from the economic expansion. However, as the economy reaches an elevated level of development, inequality decreases due to the relative scarcity of labor and the entrenchment of the welfare state (Kuznets, 1995).

As mentioned before, the Kuznets hypothesis is controversial and has been disproven by substantial research, which showed rising inequality in developed countries. Studies by Deininger and Squire (1998), Bruno, Ravallion, and Squire (1996), and Ram (1997) have disproven Kuznets's ideas. Nevertheless, Barro (2000) showed that Kuznets's hypothesis is empirically sound given that other factors affecting income inequality are held constant.

It has been proposed by Piketty (2014) that inequality does not tend to decrease in the long run because capital returns always exceed economic growth in the long run, which leads to the disproportionately higher income of capital owners.

Milanovic (2016) shows that, from 1850 to 1980, inequality in the U.S and the U.K complies with Kuznets's hypothesis, but the figures after 1980 are consistent with Piketty's proposition.

Durlauf (1996) proposed that economic status is transmitted across generations, leading to persistent income inequality. More specifically, parents' choice of the neighborhood to live in affects their children's conditional probability distribution of income, and this enforces a strong neighborhood-wide feedback loop.

1.4. Dynamics of Inequality

It was discovered by Alvaredo et. al., (2018) that inequality varies worldwide: the Middle East has the highest and Europe has the lowest income inequalities. Pinkovskiy and Sala-i-Martin (2009) found that income inequality on a global scale decreased between 1970 and 2006. In line with that, Lakner and Milanovic (2016) found a marginal reduction in global income inequality from 72.2 in 1988 to 70.5 in 2008. Based on the benchmark years of 1988, 1993, 1998, 2003, and 2008, Lakner and Milanovic (2016) discovered that inequality in China and India has increased, while that of the Middle East and the Post-Soviet States has fallen.

As Russia transited from a state socialist system to a capitalist market economy, its economic inequality, namely wealth and income disparities, increased. Earlier studies analyzed inequality in Russia during the transition (Commander, Tolstopiatenko, and Yemtsov, 1997; Denisova, 2007; Flemming and Micklewright, 2000). Studies that followed the transition and focused on economic growth from 2000 to 2008 include Gorodnichenko, Peter and Stolyarov (2010) and Lukiyanova and Oshchepkov (2012). It was discovered that although inequality rose sharply during the transition in the 1990s, it fell during the period of economic growth.

Gorodnichenko, Peter and Stolyarov (2010) found that the economic growth (2000 to 2008), mainly due to the constant rise in oil prices, resulted in a disproportionate benefit for low-income households.

Neef (2020) analyzed the evolution of income inequality in Ryssia using the updated Distributional National Accounts series on the WID. The author describes the main developments of national income growth and income concentration for Russia from 1980 to 2019 and compares them to the developments in Eastern Europe. Three main findings were pointed out. Firstly, Russia's national income per adult has been growing exceptionally slowly since the late 2000s. Secondly, the transformations in the 1990s have resulted in Russia having a more polarized income distribution than Europe. Thirdly, although low-income earners have disproportionately benefitted from the economic growth in the last decade, the long-run analysis since 1989 still shows disproportionate income increases for the top 10% (Neef, 2020). It was stressed by Neef (2020) that "better data quality and transparency are highly needed to improve the precision of inequality estimates for the Russian Federation and to enable a more in-depth inequality analysis" (Neef, 2020).

Ukhova (2014) points out that the Russian government has started to make attempts to address high inequality, focusing on regional economic development and redistributive transfers to low-income and vulnerable regions and people. However, without addressing labor market challenges, realizing the redistributive potential of the tax system and public services, improving anti-discrimination legislation, and addressing the problems of corruption and an inequitable law enforcement system, the fight against inequality in contemporary Russia is unlikely to succeed (Ukhova, 2014). It is also stressed in Ukhova (2014) that, along with anti-corruption and anti-discrimination policies, fiscal policy must be used to decrease market income inequalities and as a source of additional revenue for social spending. According to the analysis of 2014, Russia's tax system had virtually no redistributive effect with its flat income tax of 13 percent. Moreover, it could also be argued that in its current state – with a 40 percent rate of tax evasion and extortionate illicit financial outflows (comparable only to China) – this system exacerbates the problem of income inequality instead of solving it (Ukhova, 2014).

Dorofeev (2021) showed that Russian income inequality is lower than the world average, but the structure of the Russian household income distribution stands out by an extreme concentration of national income in the hands of the top 1%. Using Rosstat's database, the author pointed out that the level of income inequality in Russia increased sharply after the collapse of the USSR and kept increasing until 2008, after which the level of income inequality began a steady decline (Dorofeev, 2021).

It was found by Vylkova (2021) that the level of income inequality in the Russian Federation is higher than in the European countries and lower than in the BRICS countries; the gap between the richest one percent and the middle class in Russia is the largest in the world, while there is no extreme poverty (Vylkova, 2021).

1.5. Determinants of Inequality

The causes and influences of economic inequality have attracted the attention of researchers. The findings vary with countries and region-specific features but on a broad scale, it has been found that economic growth, education, technology, level of globalization, unemployment, tax system, population size, and potentially monetary policy, whose effects on income inequality have been recently discovered, influence economic inequality.

Using the data from twenty-five high-income OECD countries, Tridico (2017) found that financialization, retrenchment of the welfare state, weakening of trade unions, and deepening of labor flexibility are the main causes of increasing inequality (Tridico, 2017). In the analysis of inequality in Turkey, Duman (2008) identified educational opportunities and access to schooling as factors affecting income inequality. In their analysis of the effect of Foreign Direct Investment (FDI) on income inequality in Turkey from 1970 to 2008, Ucal, Haug, and Bilgin (2016) found that FDI affects inequality both in the short run and in the long run, while Gross Domestic Product (GDP) growth, gross domestic capital formation, population growth, and literacy have negligible effects on inequality.

Cloninger (2016) used data from 53 relatively developed economies across various continents and found that 77% of the change in inequality is affected by the mean age of the population, percentage of GDP devoted to investment in capital goods, percentage of the population engaged in agriculture, economic growth, unemployment, and taxes as a percentage of GDP. Although the study has not been published, it leaves a gap of about 23 % of unexplained variation in inequality.

It was concluded by Bobkov, Vakhtina and Simonova (2016) that inequality in Russia is triggered by a rent-seeking behavior of major market players and a regressive tax system.

The study of wage inequality by Calvo, Lopez-Calva and Posadas (2015) concluded that the type of employment and returns to employment determine wage inequality.

Lisina and Van Kerm, (2022) examined the reasons for the observed changes in income inequality and poverty in Russia over the period 1994-to 2015 and found that changes in market returns, earnings, and pensions, are the main drivers of changes in income distribution. Falling inequality and poverty result from the decrease in the dispersion of earnings and an increase in pensions at the lower part of the income distribution (Lisina and Van Kerm, 2022).

1.6. Theoretical Transmission Mechanisms

Given the complex concept of money, theories of monetary policy are intricate. Monetary policy is succinctly defined by Wong and Chong (2014) as the regulation and manipulation of money to achieve some desired economic goals. Central banks are the key monetary authorities responsible for regulating and manipulating money in the economy. Monetary policy is almost universally considered to be one of the main instruments that can affect the economy. Various theories attempt to uncover the relationship between monetary policy and key macroeconomic variables such as inflation, employment, aggregate demand, or output. Goodhart (1989) points out that the key aim of monetary policy is to maintain price stability by decreasing the rate of growth to align with the potential rate of real economic growth. It is also noted by Yellen (1996) that although price stability is the most common aim of monetary policy, there are other complementary aims such as output stability or growth.

Studies like Heshmati and Kim (2013) emphasized the effects of fiscal policy on income inequality, but the empirical literature on the distributional effects of monetary policy is relatively young and has identified opposing magnitudes and directions. Galbraith (1998) points out that due to the key aim of monetary policy on maintaining price stability i.e., reducing inflation, the resulting high interest rates caused recessions, which in turn led to high unemployment rates and increased inequality. However, Bernanke (2015) argues that due to the ambiguous nature of the distributional effects of monetary policy, monetary authorities should not refrain from their key responsibility of maintaining price stability (Bernanke, 2015). Bernanke (2015) stresses that other policies are better equipped to promote equality. Amaral (2017) argues that there are channels through which monetary policy can influence inequality to the extent that household characteristics—like age, type of income, and portfolio composition—are correlated with income or wealth levels and interact with monetary policy changes (Amaral, 2017).

Coibion et. al (2017) described five theoretical transmission channels through which the conduct of monetary policy can affect inequality. These channels are elaborated in subsections 1.6.1 to 1.6.5.

1.6.1. Income Composition Channel

Households tend to have different primary sources of income, which can result in heterogeneous effects of monetary policy. Labor earnings are the most common sources of income for households at the bottom of the income distribution, whereas wealthier households tend to have a larger share of the business, financial, or transfer income. The conduct of monetary policy has heterogeneous effects on different households because it influences these sources of income differently. For instance, in the event of an expansionary monetary shock, business income, such as profits and interest income, tends to increase more than labor earnings due to the increase in asset prices. This can result in wealthier households disproportionately benefitting from economic expansion, and such a mechanism may lead to an increase in income and consumption inequality.

1.6.2. Financial Segmentation Channel

The financial segmentation channel is the second channel that may have inequality-increasing effects in the event of monetary expansion. The idea is that different households have different degrees of access to financial markets, and monetary policy tends to impact financial markets before impacting inflation and the real economy. Thus, following a monetary expansion, active participants in financial markets benefit more than those unconnected to financial markets. Similarly, households who are actively trading in financial markets can take precautions to prevent any negative effects monetary policy can have on them before those who are unconnected to financial markets. Since agents who are connected to financial markets tend to be at the top of the income distribution, an expansionary monetary policy can contribute to a rise in inequality and redistribution of wealth.

1.6.3. Portfolio Composition Channel

If low-income households tend to hold more currency than high-income households, who usually hold most of their wealth in other financial assets, inflation caused by an expansionary monetary policy will result in a transfer from low-income households to high-income households, leading to a rise in inequality. This mechanism is a form of a regressive consumption tax.

1.6.4. Savings Redistribution Channel

An expansionary policy can reduce income inequality through the savings redistribution channel. An unexpected increase in inflation associated with an expansionary monetary shock can benefit borrowers and hurt savers because it will lower the real value of debts, as pointed out by Doepke and Schneider (2006). Because high-income households tend to be savers while lower-income households tend to be borrowers, this mechanism leads to the disproportionate benefit of low-income households via decreased debt payments.

1.6.5. Earnings Heterogeneity Channel

The earnings heterogeneity channel works in the same direction as the savings redistribution channel. As has been mentioned before, some monetary authorities have full employment as a complementary goal. However, the effects of monetary policy on employment and earnings are different for low- and high-income households. For example, as has been shown by Heathcote, Perri, and Violante (2010), the earnings of richer individuals are usually affected by hourly wages. Lower-income groups are affected by hours worked and the unemployment rate. Thus, a policy rate cut that lowers unemployment in the short run tends to disproportionally benefit low-income households, thus, reducing income inequality.

1.7. Empirical Evidence on the Transmission Mechanism

This subsection provides a non-exhaustive survey of the relatively young empirical literature regarding the distributional impacts of monetary policy. The studies have yielded conflicting findings, differing in the direction and magnitude of the effects.

Considering a model of heterogeneous households in terms of their income, status, and wealth, Gornemann, Kuester, and Nakajima (2012) attempted to capture the earnings and income composition channels. It was found that inequality is worsened by a contractionary monetary policy shock. More specifically, a contractionary monetary policy hurts the unemployed the most because it tends to prolong their unemployment spell, as firms reduce labor demand.

In their study of the impact of monetary policy on income inequality in the United States, United Kingdom, Russia, Germany, France, Greece, China, South Africa, and Chile, Omar and Richter (2021) conducted a quantitative econometric analysis. To represent the conduct of monetary policy, the short-term interest rate in a quarterly form from the OECD database was utilized. For income share, the top 10 percent income share data from the WID website was used. Since the data on income was only available in the annual form, the cubic conversion method was performed to disaggregate the data into a quarterly series. For each country, a choice was made between two econometric models: ARDL and Error Correction Model (ECM), depending on whether the time series were cointegrated. The time series for the U.S, U.K, France, Russia, and South Africa were cointegrated, so the ECM was employed for these countries. On the other hand, the time series for the rest of the countries-Germany, China, Chile, and Greece- were not cointegrated, so the ARDL model was appropriate. It was found that monetary policy affects income distribution, not only in the short run but also in the long run. A contractionary monetary policy lowers inequality in the U.S, Germany, U.K, France, South Africa, China, and Russia. This result suggests that the dominant theoretical channels for these countries are the portfolio composition and income composition channel The results were different for Greece and Chile- a contractionary monetary policy increases inequality because the dominating channels in these countries are savings redistribution and earnings heterogeneity. (Omar and Richter, 2021).

Lenza and Slacalek (2018) studied the effects of quantitative easing on the income and wealth of individual euro area households, using a multi-country Vector Autoregressive

(VAR) model of the four largest euro area countries. The model included key variables affecting household income and wealth, such as the unemployment rate, wages, interest rates, house prices, and stock prices. The aggregate effects of quantitative easing were distributed across the individual households using a reduced-form simulation on microdata from the Household Finance and Consumption Survey, capturing the income composition, the portfolio composition, and the earnings heterogeneity channels of transmission. It was found that the earnings heterogeneity channel plays a key role: quantitative easing compresses the income distribution since many households with lower incomes become employed. In contrast, monetary policy has only negligible effects on wealth inequality. The authors conclude that while monetary policy is not the main cause of inequality in the long run (for which other factors, such as globalization or progressivity of the tax system are more important), also due to the likely temporary nature of its effects, Quantitative Easing (QE) substantially contributed to support vulnerable households (Lenza and Slacalek, 2018).

A study by Coibion et al. (2017) assessed the effects of monetary policy shocks on consumption and income inequality in the U.S. by using three different measures of inequality (the Gini index, the cross-sectional standard deviation, and the difference between the 90th and 10th percentiles) for data spanning 1980Q1 to 2008Q4. The Gini coefficient was constructed from U.S. quarterly household-level data based on the Consumer Expenditure Survey (CEX), and the authors estimated the Impulse Response Functions (IRFs) of Gini to be a one percentage point contractionary shock to the federal funds rate. It was observed that there was a rise in the inequality coefficient of 1.5 percentage points occurring about 18 months after the shock. The authors concluded that monetary policy has a statistically significant effect on income and labor earnings, with consumption and overall expenditure inequality being even more responsive to monetary policy shocks. These results support the continued development of models with heterogeneity across households which are suitable for monetary policy analysis (Coibion et al., 2017).

Mumtaz and Theophilopoulou (2016) assessed whether monetary policy shocks contributed to the increase in earnings, income, and consumption inequality in the U.K from 1969 to 2012. The authors used two common measures of inequality: the Gini coefficient of levels and the cross-sectional standard deviation of log levels which removes zero values thus reducing sensitivity to outliers. Using the Structural Vector Autoregressive Model (SVAR), to study whether monetary policy shocks played a significant role in determining the level of inequality in the pre and post 1993 period, the benchmark estimation of the form in equation 1.1 was used.

$$Z_t = c + \sum_{j=1}^{p} \beta_j Z_{t-j} + \upsilon_t \quad (1.1)$$

In equation 1.1, $(Z_t = E_t, Y_t)$, where E_t is the quarterly inequality measure of focus and Y_t is a matrix of quarterly GDP, CPI, short-term interest rates, and the effective exchange rate. Contractionary monetary policy was found to result in deterioration in earnings, consumption, and income inequality. It was estimated that, at the one-year horizon, a contractionary shock that raises the short-term rate by 100 basis points is associated with an increase in the income and wage Gini coefficients by 3–10%, which is in line with the findings by Coibion et al. (2017). The increase in the Gini coefficient observed between 1980Q1 and 1990Q1 amounted to 20%. (Mumtaz and Theophilopoulou, 2017).

Using a measure of unanticipated changes in policy rates for a panel of 32 advanced and emerging market countries over the period 1990-to 2013, Furceri, Loungani, and Zdzienicka (2018) assessed the effect of monetary policy shocks on income inequality. The authors estimated IRFs of the form in equation 1.2 directly from local projections of Jorda (2015).

$$Y_{i,t+k} - Y_{i,k} = \alpha_i^k + \upsilon_t^k + \beta^k MP_{i,t} + \pi^k X_{i,t} + \varepsilon_{i,t}^k \quad (1.2)$$

In equation 1.2, Y is the log of the income inequality measure, α_i is the country fixed effects, υ_t is the time fixed effects, MP is the monetary policy shock, and X is a control matrix that includes the lagged monetary policy shocks and lagged inequality measures. Expansionary monetary policy was found to reduce inequality, and more specifically, using unexpected changes in monetary policy rates that are orthogonal to innovations in economic activity, it was found that an unexpected decrease of 100 basis points in the policy rate reduces inequality by about 1¼ percent in the short term and by about 2¼ percent in the medium term. The effect is also economically significant, given the high persistence and limited variation in the Gini coefficient-the magnitude of the medium-term effect is approximately equivalent to a standard deviation of the change in the Gini coefficient (2.4 percent) in the sample. The effect, however, varies over time, depending on the type of shocks (contractionary versus expansionary monetary policy) and the state of the business cycle, and across countries depending on the initial level of inequality and share of labor income. The effect is larger for positive monetary policy shocks, especially during expansions. According to the cross-country comparison, the effect is larger in countries with higher labor share of income and smaller redistribution policies. Finally, while an unexpected increase in policy rates increases inequality, changes in policy rates driven by an increase in growth are associated with lower inequality. (Furceri, Loungani, and Zdzienicka , 2018).

A paper by Samarina and Nguyen (2019) investigates how expansionary monetary policy affects income inequality in 10 euro-area countries over the period 1999–2014. They estimated a panel Vector Autoregressive with Exogeneous Variable (VARX) model with an exogenous euro area monetary policy shock identified by a Proxy-SVAR framework. The analysis distinguished between two distributional channels – macroeconomic and financial – through which monetary easing may have opposite effects on income inequality. Monetary expansion stimulates output, job creation, and wage growth, benefiting low and middle-income households and reducing income inequality. At the same time, lower interest rates lead to higher asset prices and capital returns; this may increase income inequality by making rich households better off. The macroeconomic channel was captured by wages and employment, while the financial channel was by asset prices and returns. To examine these channels, the authors analyze PVARX IRFs of income inequality and channel variables to an expansionary monetary policy shock. As the data on income inequality are annual while all other variables are quarterly, mixed-frequency data techniques were applied. It was found that expansionary monetary policy in the euro area reduces income inequality, especially in the periphery countries. The macroeconomic channel leads to these equalizing effects: monetary easing reduces income inequality by raising wages and employment. However, there is some indication that the financial channel, through higher asset prices and returns due to monetary easing, may weaken the equalizing effect of expansionary monetary policy. Moreover, the results indicate that the impact of monetary policy on income inequality is mainly propagated through the general equilibrium effects on economic activity, labor earnings, and employment. Changes in asset prices affect only a small fraction of households at the upper end of the income distribution, which has a negligible impact on the whole income distribution. The financial channel is more likely to have wealth rather than income effects through changes in the value of assets and liabilities in households' balance sheets. (Samarina and Nguyen, 2019).

A paper by Davtyan (2016) analyzes the distributional effect of monetary policy in the U.S, using the data that covers the whole income distribution, including the top one percent. A cointegrating relation was found among real output, prices, the federal funds rate, and the Gini index of income inequality. Consequently, Vector Error Correction (VECR) model was used for the analysis of the relationship. To identify a monetary policy shock, the paper employs contemporaneous identification with ex-ante identified monetary policy shocks and log run identification. In particular, the VAR methodology is applied to identify monetary policy shock. The obtained results indicate that a contractionary monetary policy shock decreases the Gini index of income inequality up to 0.4 percentage points (Davtyan, 2016).

Villarreal (2014) estimated monetary policy shocks for the period 1995Q1 to 2012Q4 using Mexico Labor Force Survey data to empirically investigate the nature of the relationship between monetary policy and household income inequality in Mexico. First, the author estimated a reduced form VAR as in equation 1.3 and then inverted the coefficient matrix to compute the impulse response functions.

$$Y_{t+1} = \beta(L)Y_t + u_{t+1} \quad (1.3)$$

Yt' = $[\Delta y, inf, i, \Delta e]$ is a vector of GDP growth (Δy), inflation (inf), interest rate (i), and the exchange rate variations (Δe). $\beta(L)$ is a lag polynomial of order p, and ut is the covariance matrix of innovations. The response of household's income inequality, and its components, to monetary policy shocks, indicate that unanticipated increases in the nominal interest rate are correlated with a reduction of household income inequality in the short run and that the effect dissipates over a two-year horizon. Thus, contractionary monetary policy (if unanticipated) is correlated with a reduction in income inequality (Villareal, 2014).

A study by Kulp (2020) analyzes the effects of conventional (CMP) and unconventional monetary policy (UMP) on income inequality in post-reunification Germany. An ARDL model is estimated via Ordinary Least Squares (OLS), where the policy rate set by the Bundesbank and the main refinancing operations set by the European Central Bank (ECB) after its establishment in 1998 enter the regressions as the measure of CMP, while UMP is proxied with the yield of the 10-year German government bond. Income inequality is captured with an annual Gini coefficient based on the German Socio-Economic Panel (SOEP). After linearly interpolating the Gini coefficient to generate quarterly values, the regressions are run over the sample period from 1991Q1 to 2018Q1. The analysis finds that contractionary conventional monetary policy is inequality-increasing. Other things equal, a one-percentage-point increase in the policy rate set by the central bank leads to a rise in the Gini coefficient of 0.002% after one year. This suggests that CMP affects inequality through the savings redistribution channel. That is, a policy rate cut induces inflation which in turn reduces inequality due to the reduction of the value of debt payments of borrowers and cash deposits of savers. On the other hand, a one-percentage-point increase in the yield of the 10-year German government bond (contractionary UMP shock) is associated with a decrease in the Gini coefficient of 0.004% after four quarters. This indicates that a fall in the 10-year German government bond resulting from QE has an inequality-increasing impact, suggesting that in the case of Germany, QE mainly benefitted high-income individuals more likely to be active in financial markets through its positive effect on capital income and increased asset prices (Kulp, 2020).

A paper by Napari (2019) investigates the impact monetary policy has on income inequality in a financially underdeveloped developing country, Ghana, using the income Gini for the period 2002Q1 to 2013Q4 and the monetary policy rate for the same period. Also, inflation rate, foreign exchange rate, financial development index, and GDP growth are used to control their impact on inequality that may be ascribed to monetary policy. The analysis employs baseline and robustness check estimations, regarding the causality of monetary policy and income inequality. The baseline estimation employed a VECR model, and the robustness check estimation employed the IRFs by local projections methodology which is robust to misspecification. From the IRFs by local projections, which is the preferred model, it is concluded that contractionary monetary policy leads to an increase in income inequality in Ghana marginally. The findings appear to confirm Romer and Romer’s (1999) savings redistribution hypothesis (Napari, 2019).

Dolado, Motyovszki, and Pappa (2018) used a New Keynesian model with capital-skill complementarity (CSC) in the production function and asymmetric search and matching (SAM) frictions in the labor market between high and low-skilled workers. The main result is that an unexpected monetary easing increases earnings inequality by raising the relative income share of highly skilled workers. Disentangling the effects of different sources of heterogeneity, it was found that the interaction of CSC and SAM asymmetry is crucial in delivering this result. In effect, while the increase in labor demand induced by an unexpected cut in interest rates leads to larger wage increases for high-skilled workers with smaller matching frictions (SAM-asymmetry channel), the increase in capital demand amplifies this wage divergence due to these workers being more complementary to capital than substitutable unskilled ones are (CSC channel). These findings are not qualitatively specific to monetary policy shocks but turn out to be similar for any other type of shock which stimulates aggregate demand, although to a lesser degree. The reason is that an unexpected easing of monetary policy stimulates investment, while, say, an unexpected expansionary fiscal shock crowds it out. These results are robust to including wage rigidities (Dolado, Motyovszki, and Pappa, 2018)

An empirical study by Romer and Romer (1999), which is the oldest paper on this topic, explored the influence of monetary policy on poverty and inequality both over the business cycle in the U.S and over the long run in a large sample of countries, namely a sample of 76 countries from 1980 to 1990. It was found that there are important links between monetary policy and the well-being of the poor in both the short run and the long run, but the short-run and long-run relationships go in opposite directions. An expansionary monetary policy aimed at rapid output growth is associated with improved conditions for the poor in the short run, but a prudent monetary policy aimed at low inflation and steady output growth is associated with enhanced well-being of the poor in the long run (Romer and Romer, 1999). However, as argued by Kulp (2020), since the authors do not use the tools available to central banks as the measures of monetary policies but instead macroeconomic indicators that, according to Romer and Romer (1999), monetary policy affects most in the long run, namely average inflation, and aggregate demand variability. The interpretation of these findings requires caution because the results are based on correlation, which does not necessarily imply causation. Therefore, the possibility of an Omitted Variable Bias (OVB) is present in this case, since average inflation and aggregate demand volatility are not solely determined by monetary policy actions (Kulp, 2020).

Williamson (2005) investigated the effects of monetary policy on prices, output, consumption, and employment, considering a monetary model of heterogeneous households. This model aimed to show the heterogeneous effects of the conduct of monetary policy on households. The key assumption was that there is only one asset, fiat money, and the central bank intervenes by making money transfers to households. These transfers are received by some households, and not by others. A key feature of the model is that, in each period, exchange occurs between members of households who received the transfer and members of households who do not. The model showed that in the event of an expansionary monetary policy, monetary injection is disproportionately advantageous to some households. The other households do not receive the advantage but end up incurring the cost of inflation (Williamson, 2005).

Overall, it is evident that empirical literature, based on research on different countries, yields mixed results. Table 1.1 provides a simplified summary of empirical studies on the effect of monetary policy on inequality, as described in greater detail above. It is apparent that most of the studies have applied a VAR-VECM approach as well as the IRFs by local linear projections of Jorda (2005), and only the studies of Kulp (2020) and Omar and Richter (2021) have used the ARDL framework.

Table 1.1 Summary of Empirical Studies

Study	Country	Period	Method
Contractionary monetary policy leads to a reduction in inequality			
Villarreal (2014)	Mexico	1995Q1-2012Q4	Reduced form VAR, Impulse Responses by local projections of Jordà (2005)
Davtyan (2017)	U.S.	1983-2012	VECR
Dolado, Motyovszki, and Pappa (2021)	U.S.	1979M1-2016M6	New Keynesian SAM frictions
Omar and Richter, (2021)	U.S., U.K., Russia, Germany, France, China, and South Africa	Different for each country	ARDL and ECM
Contractionary monetary policy leads to an increase in inequality			
Lenza and Slacalek (2018)	France, Germany, Italy, and Spain	1999Q1-2016Q4	Bayesian multi-country VAR, local linear projection method of Jordà (2005)
Coibion et al. (2017)	United States	1980Q1-2008Q4	Various regression froms, local linear projection method of Jordà (2005)
Mumtaz and Theophilopoulou (2016)	United States	1969Q1-2012Q1	Structural VAR
Furceri, Loungani, and Zdzienicka (2018)	32 advanced and emerging market economies	1990-2013	Local linear projection method of Jordà (2005)
Samarina and Nguyen (2019)	10 euro-area countries	1999–2014	panel VARX, local linear projection method of Jordà (2005)
Kulp (2020)	Germany	1991Q1-2018Q1	ARDL
Napari (2019)	Ghana	2002Q1-2013Q4	VAR/VEC, Jorda (2005)'s impulse responses by local linear projections
Romer and Romer (1999)	70 countries	1969-94	Linear regressions
Omar and Richter (2021)	Greece and Chile	Different for each country	ARDL

CHAPTER TWO
DATA AND EMPIRICAL METHODOLOGY

This chapter specifies the countries, the variables, and the model to be used for each country (section 2.1), describes the data and its sources (section 2.2), the transformation of the data (section 2.3). Additionally, section 2.4 and its subsections explain the methodology of Unit Root tests to be employed, and Section 2.5 describes the ARDL-Bounds Test approach. Finally, section 2.6 explains the partial derivation technique used to identify the values of the independent variables that minimize or maximize inequality.

2.1. Countries, Variables, and General Model

This section specifies the countries, variables, and the general model to be used in the analysis. This study employs a time series analysis to explore the effect of monetary policy on income inequality in twenty-two different economies, using sample data from 2005Q1 to 2021Q3. The twenty-two countries to be studied have been separated into two groups consisting of eleven countries each, namely emerging and advanced economies. Economy groupings from IMF's Fiscal Monitor were used to identify the advanced and emerging economies (Fiscal Monitor, April 2021). Due to issues of data availability for some countries, especially for emerging economies, only eleven countries could be studied from each group. The emerging economies to be studied include Brazil, Chile, China, Colombia, Hungary, Indonesia, Mexico, Poland, Russia, South Africa, and Turkey. The advanced economies to be studied include Australia, Finland, France, Germany, Iceland, Japan, Norway, Spain, Switzerland, the United Kingdom, and the United States.

The top 10 percent income share is modeled as a function of lags of itself, the current and lagged values of monetary policy rate (key rate), inflation, unemployment rate, and the Total Share Price Index, along with the interaction term between inflation and unemployment, and the squared forms of each explanatory variable. The rate of unemployment, inflation and the Total Share Price Index are selected following authors like Coibion et al. (2017), Mumtaz and Theophilopoulou (2017), Kulp (2020), Villareal (2014), and Napari (2019), who included these variables to avoid the omitted variable bias, since they can affect income inequality, too. However, in this study, the main purpose of including the rate of unemployment, inflation and Total Share Price Index is to capture the portfolio composition channel through inflation, the financial segmentation and income composition channels through the Total Share Price Index, and the earnings heterogeneity channel through unemployment. The savings redistribution channel could not be explored by this study due to the unavailability of a suitable variable representing the real value of debt payments by the households for each country. The interaction term between inflation and unemployment is used to control the possible correlation between the two variables. The squared values of the independent variables, in turn, are used in the final stage of the analysis to identify the values at which the dependent variable is maximized or minimized. The functional form of the general model is specified in equation 2.1.

$$\mathrm{Top10} = \mathrm{f}\left(\mathrm{top10}_{\mathrm{t-i}}, \mathrm{keyrate}_{\mathrm{t-i}}, \mathrm{cpi}_{\mathrm{t-i}}, \mathrm{unemp}_{\mathrm{t-i}}, \mathrm{share}_{\mathrm{t-i}}, \mathrm{int}_{\mathrm{cpi}_{\mathrm{unemp}}}, \mathrm{keyrate}^2, \mathrm{cpi}^2, \mathrm{unemp}^2, \mathrm{share}^2\right) \quad (2.1)$$

where the top 10 percent income share and its lags are represented by top10 and $top10_{t-i}$, the current and lagged monetary policy rate by $keyrate_{t-i}$, the current and lagged percentage change in Consumer Price Index by cpi_{t-i}, the current and lagged unemployment rate by $unemp_{t-i}$, and the current and lagged Total Share Price Index by $share_{t-i}$. Additionally, $int_{cpi_{unemp}}$ represents the interaction term between inflation and unemployment, and $keyrate^2, cpi^2, unemp^2,\ and\ share^2$ represent the squared forms of each related variable.

2.2. Data and Data Sources

This section describes the data, its description, sources, and the frequency at which the data was derived for each country. This information is presented in Tables 2.1-2.7. The data sources used by this study include World Inequality Dataset (WID), International Financial Statistics (IFS) dataset by International Monetary Fund (IMF), Federal Reserve (FED) Bank of Atlanta, International Labor Organization (ILO), the website of Bundesbank, and Federal Reserve Economic Data (FRED). It is important to note that in the case of Indonesia, the monetary policy rate data did not have the values for the first two quarters of 2005, so the sampling period had to be reduced from the common 2005Q1-2021Q3 to 2005Q3-2021Q3.

Table 2.1 Data and Data Sources for Australia, Chile, Colombia, Hungary, Iceland, Mexico, Norway, Poland, Russia, South Africa, Switzerland, Turkey, and the US

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10 percent income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	Monetary Policy-Related Interest Rate, Percent per Annum	*keyrate*	IFS	Quarterly	2005Q1-2021Q3
Unemployment	Unemployment rate, percent	*unemp*	IFS	Quarterly	2005Q1-2021Q3
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	IFS	Quarterly	2005Q1-2021Q3
Total Share Price Index	Total Share Prices for all Shares: Index	*share*	FRED	Quarterly	2005Q1-2021Q3

Table 2.2 Data and Data Sources for Brazil

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10% income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	Monetary Policy-Related Interest Rate, Percent per Annum	*keyrate*	IFS	Quarterly	2005Q1-2021Q3
Unemployment	Unemployment rate, percent	*unemp*	ILO	Annual	2005-2021
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	IFS	Quarterly	2005Q1-2021Q3
Total Share Price Index	Total Share Prices for all Shares	*share*	FRED	Quarterly	2005Q1-2021Q3

Table 2.3 Data and Data Sources for China

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10% income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	7-day reposition rate	*keyrate*	Atlanta FED	Quarterly	2005Q1-2021Q3
Unemployment	Unemployment rate, percent	*unemp*	ILO	Annual	2005-2021
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	FRED	Quarterly	2005Q1-2021Q3
Total Share Price Index	Total Share Prices for all Shares	*share*	FRED	Quarterly	2005Q1-2021Q3

Table 2.4 Data and Data Sources for Finland, France, Germany, and Spain

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10% income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	Monetary policy rate of the European Central Bank	*keyrate*	Bundesbank	Monthly	2005M1-2021M12
Unemployment	Unemployment rate, percent	*unemp*	IFS	Quarterly	2005Q1-2021Q3
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	IFS	Quarterly	2005Q1-2021Q3
Total Share Price Index	Total Share Prices for all Shares	*share*	FRED	Quarterly	2005Q1-2021Q3

Table 2.5 Data and Data Sources for Indonesia

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10% income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	Monetary Policy-Related Interest Rate, Percent per Annum	*keyrate*	IFS	Quarterly	2005Q3-2021Q3
Unemployment	Unemployment rate, percent	*unemp*	ILO	Annual	2005-2021
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	IFS	Quarterly	2005Q3-2021Q3
Total Share Price Index	Total Share Prices for all Shares	*share*	FRED	Quarterly	2005Q3-2021Q3

Table 2.6 Data and Data Sources for Japan

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10% income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	Immediate Rates: Less than 24 Hours: Central Bank Rates for Japan	*keyrate*	FRED	Quarterly	2005Q1-2021Q3
Unemployment	Unemployment rate, percent	*unemp*	IFS	Quarterly	2005Q1-2021Q3
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	IFS	Quarterly	2005Q1-2021Q3
Total Share Price Index	Total Share Prices for all Shares	*share*	FRED	Quarterly	2005Q1-2021Q3

Table 2.7 Data and Data Sources for the United Kingdom

Variable	Description	Representation	Data Source	Frequency	Data Points
Top 10% income share	Pre-tax national income share held by the p90p100 group	*Top10*	WID	Annual	2005-2021
Monetary policy rate	Immediate Rates: Less than 24 Hours: Call Money/Interbank Rate	*keyrate*	FRED	Quarterly	2005Q1-2021Q3
Unemployment	Harmonized Unemployment rate, percent	*unemp*	FRED	Quarterly	2005Q1-2021Q3
Consumer Price Index (CPI)	Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent	*cpi*	IFS	Quarterly	2005Q1-2021Q3
Total Share Price Index	Total Share Prices for all Shares	*share*	FRED	Quarterly	2005Q1-2021Q3

2.3. Data Transformations

This section describes the data transformation that was required for the analysis. Subsections 2.3.1, 2.3.2, 2.3.3, and 2.3.4, and 2.3.5 explain the logarithmic transformation, frequency conversion, seasonal adjustment, interpolation for missing values, and the final model for each country after all the necessary data transformations have been applied, respectively.

2.3.1. Logarithmic Transformation

Logarithmic transformation was applied for the Total Share Price Index, while other variables remained at a level because they are expressed in percentages. The logarithmic transformation of variables is beneficial for three reasons. Firstly, logarithmic transformation allows the coefficients to be interpreted as the elasticity of the dependent variable concerning a particular independent variable. Secondly, logarithmic transformation compresses the scale at which the variable is measured, thus reducing the problems of outliers, heteroskedasticity, and autocorrelation. Thirdly, if the model is nonlinear, the logarithmic function makes it linear and easier to interpret. In other words, a multiplicative model on the original scale corresponds to an additive model on the log scale. In the case of this study, though, the main reason for the logarithmic transformation of the Total Share Price Index is to keep the variables at a similar scale.

2.3.2. Frequency Conversion

As has been shown in the previous section, the frequency of the top 10 percent income share is incompatible with that of the other variables. Therefore, the data for was converted from annual frequency to quarterly frequency, using linear (based on the last observation) conversion method in Eviews. Additionally, the unemployment data for Brazil, China and Indonesia are only available in the annual frequency for the designated period, so the same linear interpolation technique was used to convert the unemployment data for Brazil and China to a quarterly frequency. The linear interpolation method assigns each value in the low frequency series to the last high frequency observation associated with the low frequency period, then places all intermediate points on straight lines connecting these points (Eviews 9, User's Guide I). This technique was selected because it replicates the original trends in the time series without many changes. However, a deviation from the linear conversion technique had to be made in the case of Indonesia, since it yielded data that was integrated of second order, which the ARDL method does not tolerate. Therefore, a quadratic conversion method was employed to convert Indonesia's unemployment data from annual to quarterly frequency. Quadratic conversion method fits a local quadratic polynomial for each observation of the low frequency series, then use this polynomial to fill in all observations of the high frequency series associated with the period. The quadratic polynomial is formed by taking sets of three adjacent points from the source series and fitting a quadratic so that either the average or the sum of the high frequency points matches the low frequency data observed. For most points, one point before and one point after the period currently being interpolated are used to provide the three points. For end points, the two periods are both taken from the one side where data are available (Eviews 9, User's Guide I).

For Finland, France, Germany, and Spain, the quarterly monetary policy rate of ECB was not available, so it was converted from a monthly into a quarterly frequency by employing the Average Observations method in Eviews.

2.3.3. Seasonal Adjustment

Seasonality is a pattern of a time series, which repeats at certain intervals every year. Due to such seasonal fluctuations in the data, it is sometimes difficult to determine whether changes in data for a given period reflect important increases or decreases in the level of the data or are due to regular fluctuations. The seasonally adjusted data, providing more readily interpretable measures of changes occurring in each period, reflects real economic movements without the misleading seasonal changes (Atuk and Ural, 2002). The seasonal adjustment was applied to all the variables except for those for whom frequency conversion methods were applied, namely the top 10 percent income share for all countries, unemployment for Brazil, China, and Indonesia, and the ECB policy rate for Finland, France, Germany, and Spain. The seasonal adjustment was carried out through the multiplicative Census X 12 method in Eviews. The multiplicative method was preferred since it has shown to smoothen the effects of seasonality more than the additive method. However, the multiplicative method is not applicable for data with negative values, so an additive method was applied on the percentage change in CPI data for Australia, Chile, China, Finland, France, Germany, Hungary, Japan, Poland, Spain, Switzerland, and the United States, as well as on the monetary policy rate data for Norway and Switzerland.

2.3.4. Interpolation for Missing Values

Unemployment data for Colombia and South Africa had some missing values. For Colombia, the values for the third and fourth quarters of the year 2006 were missing, and the data for South Africa had missing values for 2005Q2, 2005Q4, 2006Q2, 2006Q4, 2007Q2, and 2007Q4. Linear interpolation method in Eviews was applied to fill in the missing values. According to the User's Guide I of Eviews 9, linear interpolation is a basic technique that linearly approximates the missing values according to the previous non-missing value and the next non-missing value. Equation 2.2 shows the calculation of the interpolated value.

$$IV_{Lin} = (1-\gamma)P_{j-1} + \gamma P_{j+1} \quad (2.2)$$

where P_{j-1} is the previous missing value, P_{j+1} is the next non-missing value, and γ is the relative position of the missing value divided by the total number of missing values in a row. For instance, in the case of unemployment data for Colombia, there are 2 missing values in a row. Thus, the first was interpolated as 1/3 of the distance between the previous value and the next, and the second value was interpolated as 2/3 of the distance (Eviews 9, User's Guide I).

2.3.5. Specification of the Final Models

After all the necessary data transformations that were described in subsections 2.3.1-2.3.4, the final model can be specified for each country. The final model to be used in the analysis of Australia, Chile, Hungary, Iceland, Japan, Mexico, Norway, Poland, Russia, Switzerland, Turkey, United Kingdom, and United States is specified by equation 2.3. Equation 2.4 specifies the final model to be used in the analysis of Brazil, China, and Indonesia. Equation 2.5 presents the final model to be used in the analysis of Finland, France, Germany, and Spain. Finally, equation 2.6 presents the final model to be used in the analysis of Colombia and South Africa, whose unemployment data had missing values.

$$\mathrm{TOP10} = \mathrm{f}(\mathrm{top10}_{\mathrm{t-i}}, \mathrm{keyrate}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{cpi}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{unemp}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{lshare}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{int}_{\mathrm{cpi}_{\mathrm{unemp}}}, {\mathrm{keyrate}_{\mathrm{sa}}}^2, {\mathrm{cpi}_{\mathrm{sa}}}^2, {\mathrm{unemp}_{\mathrm{sa}}}^2, {\mathrm{lshare}_{\mathrm{sa}}}^2) \quad (2.3)$$

$$\mathrm{TOP10} = \mathrm{f}(\mathrm{top10}_{\mathrm{t-i}}, \mathrm{keyrate}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{cpi}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{unemp}_{\mathrm{t-i}}, \mathrm{lshare}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{int}_{\mathrm{cpi}_{\mathrm{unemp}}}, {\mathrm{keyrate}_{\mathrm{sa}}}^2, {\mathrm{cpi}_{\mathrm{sa}}}^2, \mathrm{unemp}^2, {\mathrm{lshare}_{\mathrm{sa}}}^2) \quad (2.4)$$

$$TOP10 = f(\mathrm{top10}_{\mathrm{t-i}}, \mathrm{keyrate}_{\mathrm{t-i}}, \mathrm{cpi}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{unemp}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{lshare}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{int}_{\mathrm{cpi}_{\mathrm{unemp}}}, \mathrm{keyrate}^2, {\mathrm{cpi}_{\mathrm{sa}}}^2, {\mathrm{unemp}_{\mathrm{sa}}}^2, {\mathrm{lshare}_{\mathrm{sa}}}^2) \quad (2.5)$$

$$\mathrm{Top10} = \mathrm{f}(\mathrm{top10}_{\mathrm{t-i}}, \mathrm{keyrate}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{cpi}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{unemp}_{\mathrm{inter}_{\mathrm{sa}_{\mathrm{t-i}}}}, \mathrm{lshare}_{\mathrm{sa}_{\mathrm{t-i}}}, \mathrm{int}_{\mathrm{cpi}_{\mathrm{unemp}}}, {\mathrm{keyrate}_{\mathrm{sa}}}^2, {\mathrm{cpi}_{\mathrm{sa}}}^2, {\mathrm{unemp}_{\mathrm{inter}_{\mathrm{sa}}}}^2, {\mathrm{lshare}_{\mathrm{sa}}}^2) \quad (2.6)$$

Where the subscript $_{sa}$ expresses the seasonal adjustment, $unemp_{inter}$ stands for the unemployment rate on which interpolation was applied to fill in the missing values, $int_{cpi_{unemp}}$ stands for the interaction between the CPI percentage change and unemployment rate, and variables with the superscript ^{2} represent the squared values of the variables.

2.4. Unit Root Tests

This section describes the unit root tests that were employed by this study, namely the Augmented Dickey-Fuller (ADF), Zivot Andrews (ZA) and Lee-Strazicich (LS) tests. Subsections 2.4.1, 2.4.2, and 2.4.3 explain the concepts of the ADF, ZA and LS unit root tests, respectively.

2.4.1. ADF Test

The ADF test is used to identify the integration order of the variables without considering possible structural break(s) (Dickey & Fuller, 1979). Under the assumption that the series follows an AR(k) process, a parametric correction for higher-order correlation is constructed. Then, lagged difference terms of the dependent variable are added to the right-hand side of the test regression. The ADF with intercept (Equation 2.7) tests for the null hypothesis of a unit root against a mean-stationary alternative, while the ADF with intercept and a linear time trend (Equation 2.8) tests for the null hypothesis of a unit root against a trend-stationary alternative. The lagged first difference of the dependent variable, Δy_{t-i}, is used to control for the autocorrelation in the error terms (Waheed et al., 2007).

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^{k} \rho_i \Delta y_{t-i} + \varepsilon_t \tag{2.7}$$

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta t + \sum_{i=1}^{k} \rho_i \Delta y_{t-i} + \varepsilon_t \tag{2.8}$$

2.4.2. ZA Test

The test developed by Zivot and Andrews (1992) used to test for a unit root against the alternative of a one-time structural break, which is determined endogenously (from the data).Three models are utilized: (1) model A, which is based on a change in the intercept at one point; (2) model B, which is based on a change in the slope of the trend function, and (3) model C, which is a combination of one-time changes in the level and the slope of the trend function of the series. Equations 2.9-2.11 represent models A, B, and C respectively.

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta t + \varphi DU_t + \sum_{i=1}^{k} p_i \, \Delta y_{t-i} + \varepsilon_t \qquad (2.9)$$

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta t + \emptyset DT_t + \sum_{i=1}^{k} p_i \, \Delta y_{t-i} + \varepsilon_t \qquad (2.10)$$

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta t + \varphi DU_t + \emptyset DT_t + \sum_{i=1}^{k} p_i \, \Delta y_{t-i} + \varepsilon_t \qquad (2.11)$$

The dummy variables DU_t and DT_t stand for a mean shift occurring at each possible break-date (TB) and trend shift, respectively. To put it more formally,

$$DU_t = \begin{cases} 1 \ldots if \ t > TB \\ 0 \ldots \ otherwise \end{cases} and$$

$$DT_t = \begin{cases} t - TB \ldots if \ t > TB \\ 0 \ldots \ otherwise \end{cases} and$$

All three models have the null hypothesis that α_1=0, and this means that y_t has a unit root with a drift that excludes any structural break. On the other hand, the alternative hypothesis is that $\alpha_1 < 0$, implying that the variable is trend-stationary with a one-time break. Every point is considered a potential break-date (TB) and a regression is run for each point. Then, the date which minimizes the one-sided t-statistic for testing $\widehat{\alpha_1}(= \alpha - 1) = 1$ is chosen as the TB (Waheed et al., 2007).

2.4.3. LS Test

One of the weaknesses of endogenous break unit root tests, such as the ZA test, is that they do not consider a unit root with break. However, a unit root with break can lead to two problems. First, “spurious rejections” that tend to increase with the magnitude of the break can lead to false conclusions that a time series is stationary with break, or “trend-break stationary,” when it contains a unit root with break. Second, it is pointed out in Lee and Strazicich (2001) that most endogenous break unit root tests determine the break one period before the true break, and this issue is present under both the null and alternative hypotheses (Lee and Strazicich,2001). Lee and Strazicich (2013) found a solution to these problems by developing a unit root test that allows for one or two endogenously determined breaks. The test is formally known as the minimum Lagrange-Multiplier (LM) test. Both the one- and two-break tests do not have the issues of bias or spurious rejections under the null and alternative hypotheses. To illustrate the properties of LM test with one break, consider a data generating process (DGP) in equation 2.12.

$$y_t = \gamma' Z_t + X_t, \; X_t = \alpha X_{t-1} + \varepsilon_t \quad (2.12)$$

Z_t contains endogenous variables, and the null states that $\alpha = 1$. Lee and Strazicich (2013) examine Models A and C. Model A permits one break in intercept and is known as the “crash” model. Model C, in turn, permits a shift in intercept and change in trend slope. Equations 2.13 and 2.14 illustrate models A and C respectively.

$$Z_t = [1, t, D_t]', \text{ where } D_t = \begin{cases} 1 \ldots if \; t \geq TB + 1 \\ 0 \ldots \; otherwise \end{cases} and, \; \gamma' = (\gamma_1, \gamma_2, \gamma_3) \quad (2.13)$$

$$Z_t = [1, t, D_t, DT_t]', \text{ where } D_t = \begin{cases} t - TB \ldots if \; t \geq TB + 1 \\ 0 \ldots \; otherwise \end{cases} and \quad (2.14)$$

The test statistics are obtained according to the LM (score) principle, from equation 2.15.

$$\Delta y_t = \gamma' \Delta Z_t + \rho \tilde{S}_{t-1} + u_t \quad (2.15)$$

Where $\tilde{S}_t = y_t - \tilde{\theta}_x - Z_t \tilde{\gamma}, \; t = 2, .., T$; $\tilde{\gamma}$ are the coefficients in the regression of Δy_t on ΔZ_t;

$and \; \tilde{\theta}_x$ is the restricted Maximum Likelihood Estimator (MLE) of $\theta_x (= \theta + X_0)$, given by $y_1 - Z_1 \tilde{\gamma}$.

Meanwhile, ΔZ_t in Model A is $[1, \beta_t]'$ and $[1, \beta_t, D_t]'$ in Model C, where $\beta_t = \Delta D_t$ and $D_t = \Delta DT_t$. Hence, β_t and D_t refer to change in intercept and trend under the alternative, and to a one period jump and (permanent) change in drift under the null hypothesis, respectively.

The unit root null hypothesis states that $\rho = 0$, and the LM test statistic is given by $\tilde{\tau}$. In turn, the break, TB, is identified as the point which gives the minimum unit root test statistic, and this process is illustrated by equation 2.16.

$$Inf \; \tilde{\tau}(\tilde{\lambda}) = Inf \; \tilde{\tau}(\lambda), \text{ where } \lambda = \frac{TB}{T} \text{ and } \lambda \in [0,1] \quad (2.16)$$

Like the technique of the ADF test, the LS test corrects for the autocorrelation in the error terms by including $\Delta \tilde{S}_{t-i,} i = 1, \ldots, k$ (Lee & Strazicich, 2013).

Lee and Strazicich (2003) developed an LM unit root test for two structural breaks and considered the same DGP. However, in this case Z_t is a vector of exogenous variables, A(L)ε_t=B(L)u_t, A(L) and B(L) being finite order polynomials with u_t identically independently distributed (iid) with mean of zero and variance of σ^2. Models A (equation 2.17) and C (equation 2.18) permit two breaks in level and level and trend, respectively.

$Z_t = [1, t, D_{1t}, D_{2t}]'$ where D_{it}=$\begin{cases} 1 \ldots if\ t \geq TB_i + 1, i = 1,2 \\ 0 \ldots\ otherwise \end{cases}$ and (2.17)

$Z_t = [1, t, D_{1t}, D_{2t}, DT^*_{1t}, DT^*_{2t}\ ]'$ where $DT^*_{it} = \begin{cases} 1 \ldots if\ t \geq TB_i + 1, i = 1,2 \\ 0 \ldots\ otherwise \end{cases}$ and (2.18)

The test statistics are obtained according to the LM (score) principle, as in the case for the one-break test, and the unit root null hypothesis states that $\rho = 0$ (Lee and Strazicich, 2003).

2.5. The ARDL Model

This section briefly describes the concept of the ARDL model, its application to cointegration, and presents reasons for selecting it instead of the commonly used VAR model. Subsections 2.5.1, 2.5.2, and 2.5.3 specify the ARDL model, explain the concept of the cointegration technique within the ARDL framework, and present arguments for choosing the ARDL model instead of the traditional VAR, within the ARDL framework, respectively.

2.5.1. The ARDL Model Specification

In an ARDL model, the right-hand side variables can be lagged values of the dependent variable and current and lagged values of one or more explanatory variables (Enders, 2008). Equation 2.19 specifies the general ARDL $(p, q_1, q_{2,} q_k)$model, as described by Nkoro and Uko (2016).

$$\Phi(L, p)y_t = \sum_{i=1}^{k} \beta_i\ (L, q_i)x_{it} + \delta w_t + u_t \qquad (2.19)$$

Where $\Phi(L, p) = 1 - \Phi_1 L - \Phi_2 L^2 - \cdots - \Phi_p L^p$ and $\beta(L, q) = 1 - \beta_1 L - \beta_2 L^2 - \cdots - \beta_q L^q$.

L is a lag operator, with $L^0 y_t = X_t, L^1 y_t = y_{t-1}$, and w_t is a s x 1 vector of deterministic variables like the constant, time trend(s), dummy variable(s), or exogeneous variables with fixed lags. P= 0, 1, 2,…m, q=0,1,2,…,m, i=1,2,…,k. The maximum lag order, m, is specified by the researcher. Finally, t refers to the sample period, such that t=m+1, m+2…,n. The ARDL model can be conveniently estimated via the OLS method as long as the error term, u_t, is independently identically distributed with the mean of zero and constant variance of ϑ^2(Nkoro and Uko, 2016).

2.5.2. ARDL-Cointegration Technique

Bound Test was developed by Pesaran, Smith and Shin (2001) to test for cointegration or long-run relationship within the ARDL framework. Unlike other cointegration tests, Bounds Test can be applied to a combination of I (0) and I (1) variables, but will collapse if any of the variables are I (2) (Pesaran, Smith, and Shin, 2001). Therefore, even if unit root testing is not obligatory within the ARDL framework, its usage is still preferable to ensure that none of the variables are I (2). In the Bound Test, the bound F-statistic is computed and carried out on each of the variables as they stand as endogenous variable while others are assumed as exogenous variables (Nkoro and Uko, 2016). Equations 2.20 and 2.21 specify the test for cointegration within the ARDL $(p, q_1, q_{2,} q_k)$ framework, as it has been described by Nkoro and Uko (2016).

$$\Delta X_t = \delta_{0i} + \sum_{i=1}^{k} \alpha_i \Delta X_{t-1} + \sum_{i=1}^{k} \alpha_2 \Delta Y_{t-i} + \delta_1 X_{t-1} + \delta_2 Y_{t-1} + v_{1t} \quad (2.20)$$

$$\Delta \mathrm{Y_t} = \delta_{0i} + \sum_{i=1}^{k} \alpha_i \Delta \mathrm{Y_{t-1}} + \sum_{i=1}^{k} \alpha_2 \Delta \mathrm{X_{t-i}} + \delta_1 \mathrm{Y_{t-1}} + \delta_2 \mathrm{X_{t-1}} + \mathrm{v_{1t}} \quad (2.21)$$

The null hypothesis states that there is no long-run relationship and thus no cointegration, or specifically that $\delta_1 = \delta_2 = 0$ (Nkoro and Uko, 2016). This is tested via the F-statistic or Wald Test. There are two sets of critical values. The lower critical bound assumes that all the variables are I (0) and thus there is no cointegration, while the upper bound assumes that all the variables are I (1) and thus there is cointegration. The null is rejected when the computed F-statistic exceeds the upper bound critical value but cannot be rejected when the F-statistic is below the lower bound critical value. If the null hypothesis in the Bounds Test is rejected, the long-run ARDL model can be estimated as specified by equation 2.22, as it has been explained in Nkoro and Uko (2016).

$$\mathrm{Y_t} = \delta_0 + \sum_{i=1}^{k} \alpha_1 \mathrm{X_{1t}} + \sum_{i=1}^{k} \alpha_2 \mathrm{X_{2t}} + \sum_{i=1}^{k} \alpha_n \mathrm{X_{nt}} + \mathrm{v_{1t}} \quad (2.22)$$

Where $X_{1t}, X_{2t}, \ldots, X_{nt}$ are the long-run forcing variables. Nkoro and Uko (2016) also point out that the ECM associated with the ARDL (p, q_1, q_2, q_k) model can be derived by rewriting equation 2.19 in terms of the lagged levels and first differences. In other words, the following relations are substituted into equation 3.14:

$$y_t = \Delta y_t + y_{t-1}, y_{t-1} = y_t - \sum_{j=1}^{s-1} \Delta y_{i-j}, s = 1,2, \ldots, p$$

$$w_t = \Delta w_t + w_{t-1}, x_t = \Delta x_t + x_{t-1}, \text{ and } x_{1t-s} = yi_{t-1} - \sum_{j=1}^{s-1} \Delta x_{it-j}, s = 1,2, \ldots, q_i$$

Equation 2.23 shows the result of the substitutions, and equation 2.24 presents the equation for the Error Correction term (EC_t), which is defined as how much of the disequilibrium in the previous period is corrected within the current period. Positive EC_t reflects divergence or further departure from the equilibrium, while negative EC_t reflects convergence, or approach to the equilibrium. The EC_t lies between the values of 0 and 1, with 0 meaning no adjustment and thus no long run relationship, and 1 meaning full adjustment within one period. It is important to note in equation 2.23 that the quantitative importance of the Error Correction term is measured by $\Phi(1,\hat{p}) = 1 - \widehat{\Phi}_1 - \widehat{\Phi}_2 - \cdots \widehat{\Phi}_p$. The dynamics of the model's convergence to equilibrium in the short run is given by $\widehat{\Phi}_j$ and β_{ij} (Nkoro and Uko, 2016).

$$\Delta y_t = -\Phi(1,\hat{p})EC_{t-1} + \sum_{i=1}^{k}\beta_{i0}\Delta x_{it} + \delta\Delta w_t - \sum_{j=1}^{p-1}\Phi_i\Delta_{t-j} - \sum_{i=1}^{k}\sum_{j=1}^{\hat{q}-1}\beta_{ij}\Delta x_{i,1-j} + \mu_t \quad (2.23)$$

$$\mathrm{EC_t} = \varepsilon_t = y_t - \sum_{i=1}^{k}\widehat{\theta}_i x_{it} - \psi' w_t \quad (2.24)$$

2.5.3. ARDL versus VAR

Throughout the literature review discussed in chapter one, it can be concluded that most of the research papers conducted on the effect of monetary policy on income inequality have opted for the VAR model due to its many advantages. The VAR model is considered one of the most user friendly, flexible, and successful models in the analysis of time series (Zivot & Wang, 2006). Moreover, each variable in a VAR model is treated as endogenous without restrictions on the structural relationships. Due to the controversy that usually arises in theory, restrictions are generally placed by statistical tools, and this is one of the biggest advantages of VAR (Brooks, 2014). Moreover, the VAR model generalizes the univariate autoregressive model to the multivariate case, thus providing beneficial features such as estimating the dynamic interrelation between variables and being indifferent about the choice of the dependent variable.

However, the VAR model is not devoid of considerable weaknesses. Firstly, Lütkepohl, Krätzig, and Phillips (2004) note that since VAR is a "reduced form" model, it can be used as only a tool to assemble the data dynamics. Thus, it can be argued that VAR models lack a sold theoretical foundation. Additionally, there is a technical limitation as to how many variables can be included in a VAR model, otherwise the estimates can be inaccurate (Carnot et al., 2011). Moreover, Romer (2012) employed a VAR model in regressions of output and money, and notes that VAR might not be able to solve the problem of reverse causation. An example of such reverse causation that a VAR model might not solve is that the central bank can tailor its policy to predictions regarding the future dynamics of the economy (Kulp, 2020). Finally, a high number of lags in a VAR model can lead to overparametrization and, in turn, multicollinearity and loss of degrees of freedom (Carnot et al, 2011). Keeping all the disadvantages of VARs in mind, this study has selected an alternative time series technique, which is the ARDL model.

Nkoro and Uko (2016) have listed many advantages of the ARDL model, the most important of which is that all variables are assumed endogenous because each variable stands as a single equation (Nkoro and Uko, 2016). Additionally, the ARDL model differentiates between a dependent and independent variable(s) in the case of a single long run relationship (Pesaran, Smith, and Shin, 2001). Finally, a simple linear transformation can be used to deduce the ECM, which shows how equilibrium in the long run is achieved through short run adjustments (Nkoro and Uko, 2016). It is also important to note that, given the purpose of the study, the ARDL model tolerates more right-hand side variables than does a VAR model.

2.6. The Application of Partial Derivation

This section briefly explains the partial derivation methodology employed by this study. This technique is applied to identify the values of the explanatory variables that maximize or minimize the dependent variable (top ten percent income share) in the model for each country. For this purpose, the squared values of the explanatory variables as well as interaction term between inflation and unemployment are included in each model. Equation 2.25 specifies the simplified general model (with only the current values of the explanatory variables and without the subscripts) applied to the analysis of each country, and equations 2.26-2.29 show how inequality-maximizing or minimizing values of the monetary policy rate (keyrate), inflation (cpi), unemployment(unemp), and logarithm of Total Share Price Index (lshare) are derived, respectively. It is important to note that if the coefficient of the squared explanatory variable is negative, the variable in question maximizes the top ten percent income share, while the effect is minimizing if it is positive. Additionally, the mean values of unemployment and inflation are inserted into the interaction term in equations 2.27 and 2.28 and denoted as $\overline{unemp}$ and $\overline{cpi}$, respectively.

$$\text{Top10} = \beta_0 + \beta_1\text{Top10}_{t-i} + \beta_2\text{keyrate} + \beta_3\text{cpi} + \beta_4\text{unemp} + \beta_5\text{lshare} + \beta_6\text{cpi(unemp)} + \beta_7\text{keyrate}^2 + \beta_8\text{cpi}^2 + \beta_9\text{unemp}^2 + \beta_{10}\text{lshare}^2 \quad (2.25)$$

$$\frac{\partial \text{top10}}{\partial \text{keyrate}}: \beta_2 + 2(\beta_7)\text{keyrate} = 0, \text{keyrate} = \frac{\beta_2}{\pm 2(\beta_7)} \quad (2.26)$$

$$\frac{\partial \text{top10}}{\partial \text{cpi}}: \beta_3 + \beta_6\overline{\text{unemp}} + 2(\beta_8)\text{cpi} = 0, \text{cpi} = \frac{\beta_3 + \beta_6\overline{\text{unemp}}}{\pm 2(\beta_8)} \quad (2.27)$$

$$\frac{\partial \text{top10}}{\partial \text{unemp}}: \beta_4 + \beta_6\overline{\text{cpi}} + 2(\beta_9)\text{unemp} = 0, \text{unemp} = \frac{\beta_4 + \beta_6\overline{\text{cpi}}}{\pm 2(\beta_9)} \quad (2.28)$$

$$\frac{\partial \text{top10}}{\partial \text{lshare}}: \beta_5 + 2(\beta_{10})\text{lshare} = 0, \text{lshare} = \frac{\beta_5}{\pm 2(\beta_{10})} \quad (2.29)$$

CHAPTER THREE
EMPIRICAL RESULTS

This chapter provides empirical results of the methodology described in chapter 2. Sections 3.1 to 3.22 provide the results for each country, while section 3.23 summarizes and discusses the results for all countries. The analysis has been performed in a systematic manner for each country. Namely, the analysis starts with the description of the graphs for each variable, followed by unit root testing for each variable. If all the variables prove to be stationary at level, or I (0), a stationary ARDL model is run. In contrast, if there is a combination of I (0) and I (1) variables, Bound Testing is performed. If the Bound Test shows cointegration, a long-run ARDL model is estimated. It is important to note that each model is supported by Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors to make the results as accurate as possible. Additionally, the number of lags in each model was selected by the Akaike Information Criterion (AIC), which selects relatively higher number of lags than the other two common criteria- Schwartz Information Criterion (SIC) and Hannan and Quinn Information Criterion (HQC) (Napari, 2019). Since the ARDL model tolerates more parameters and thus more lags than the VAR model, the usage of AIC could help to better capture the transmission mechanism channels by including more lags than the SIC and HQC. In both cases, Wald Test is performed for the overall significance of the coefficients that have been shown to be individually insignificant (by the t-test in the model). The analysis is completed by the application of partial derivation to estimate the values of explanatory variables that maximize or minimize the dependent variable. If one or more of the models fail to capture the appropriate theoretical transmission mechanism channels and/or the inequality-minimizing or maximizing values of explanatory variables turn out to be ambiguous, the model will be tested for Omitted Variable Bias (OVB) with the help of the Ramsey Regression Equation Specification Error Test (RESET) test.

3.1. Results for Australia

This subsection presents the results of estimations for Australia. Figure 3.1 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price index, respectively. Australia's top ten percent income share reached its minimum in 2008Q4, at approximately 0.2977. In the following quarters, it mostly kept increasing until it reached its peak in 2017Q4 at approximately 0.3356, after which the value started to decrease and became relatively constant after 2018Q4 at approximately 0.3254. Australia's monetary policy rate rapidly decreased in 2009Q1 at around 3.3%, after which it increased again to about 3.8% in 2010Q4, and mostly kept decreasing until it became constant after 2020Q4 at 0.1%. Inflation in Australia was relatively constant around the mean but had its peak in 2008Q3 at 5.0%, after which it rapidly decreased in 2009Q3 to 1.3%, kept fluctuating during the following quarters until reaching its minimum in 2020Q2 at -0.3%. Australia's unemployment highly fluctuated despite a relatively small scale between 4 % and 7 %. It reached its minimum in 2008Q1 at 4.03%, after which it kept fluctuating and peaked at 7.02% in 2020Q3, and then fell steadily to 4.59 in 2021Q3. The logarithm of Total Share Price Index in Australia was increasing in the beginning of the sampling period to 4.79 in 2007Q4, rapidly declined to 4.14 in 2009Q1, after which it mostly kept increasing but declined again to 4.62 in 2020Q4 but increased to 4.90 in 2021Q3.

Figure 3.1 Graphs for Australia's Data

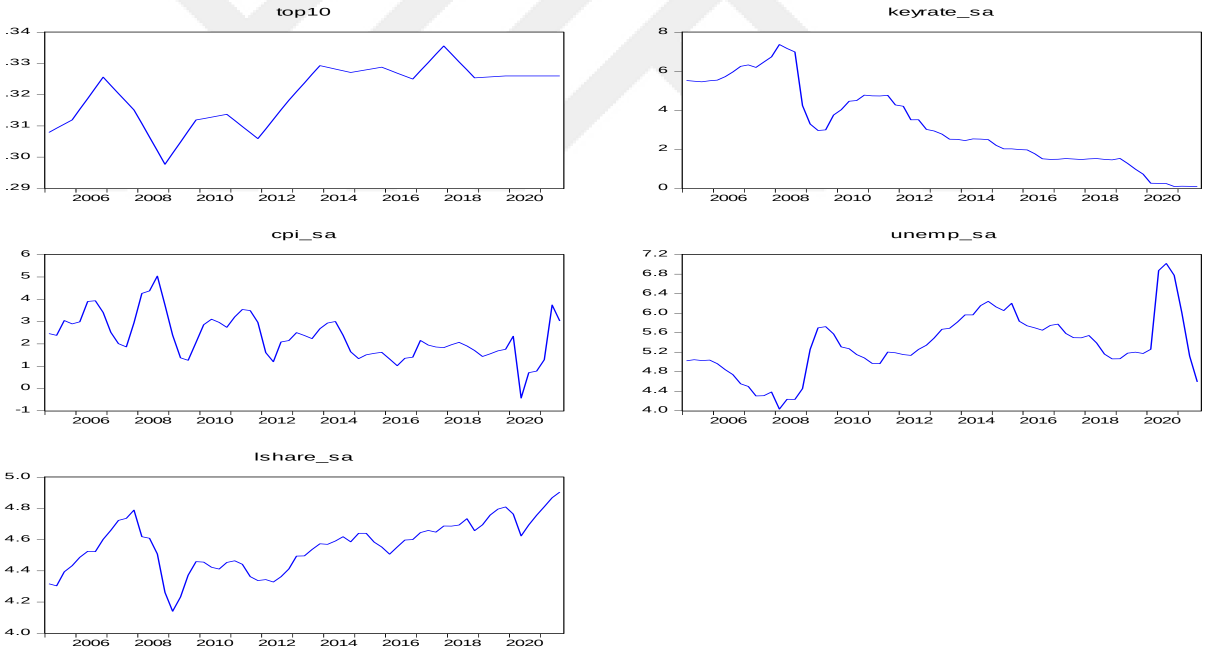

Table 3.1 Results from the ADF, ZA and LS Unit Root Tests for Australia

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.0471	-2.5653	-4.2662 2013Q1	-3.2864 2017Q3	-4.1060 2012Q1	-3.7119** 2017Q4	-4.3232*** 2009Q4, 2012Q1	-4.3084* 2012Q3	-7.4758*** 2007Q4, 2013Q2
Keyrate_sa	-0.7001	-4.1669***							
Cpi_sa	-2.2614	-4.1977***							
Lshare_sa	-1.2464	-2.4279	-6.5385*** 2008Q3	-4.5505** 2011Q3	-6.4617*** 2008Q3	-3.3089* 2008Q1	-3.4025*	-6.1128*** 2009Q3	-7.3600*** 2008Q2

							2007Q3 2008Q1		2010Q4
Unemp_sa	-1.9304	-2.4495	-4.8355* 2017Q2	-4.7966*** 2015Q2	-4.8968* 2013Q4	-2.8610 2008Q2	-2.8228 2008Q2 2013Q4	-5.1370*** 2008Q3	-6.5524** 2014Q3 2019Q4

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.1, all the variables have turned out to be stationary at level, or I (0), so a standard ARDL model is applicable, without the Bounds Test. Table 3.2 presents the results from the ARDL model estimation for Australia.

Table 3.2 ARDL Model for Australia

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.4951	0.1011	14.7834	0.0000
TOP10(-2)	-0.6614	0.1668	-3.9649	0.0003
TOP10(-3)	-0.2456	0.1664	-1.4761	0.1476
TOP10(-4)	0.2585	0.1014	2.5480	0.0147
KEYRATE_SA	-0.0009	0.0011	-0.8657	0.3917
KEYRATE_SA(-1)	-0.0029	0.0009	-3.1727	0.0029
KEYRATE_SA(-2)	0.0032	0.0007	4.7482	0.0000
CPI_SA	-0.0012	0.0034	-0.3403	0.7353
CPI_SA(-1)	0.0008	0.0003	3.3558	0.0017
LSHARE_SA	0.2710	0.0864	3.1368	0.0032
LSHARE_SA(-1)	-0.0152	0.0045	-3.3828	0.0016
LSHARE_SA(-2)	0.0137	0.0058	2.3700	0.0226
LSHARE_SA(-3)	0.0001	0.0053	0.0242	0.9808
LSHARE_SA(-4)	-0.0119	0.0037	-3.1943	0.0027
UNEMP_SA	-0.0020	0.0049	-0.4170	0.6788
UNEMP_SA(-1)	0.0022	0.0008	2.9344	0.0055
INT_CPI_UNEMP	3.92E-05	0.0005	0.0795	0.9370
KEYRATE_SA_SQ	2.91E-05	0.0001	0.2409	0.8108
CPI_SA_SQ	1.76E-05	0.0002	0.0829	0.9344
LSHARE_SA_SQ	-0.0283	0.0093	-3.0520	0.0040
UNEMP_SA_SQ	9.29E-06	0.0004	0.0243	0.9807
C	-0.5371	0.1890	-2.8423	0.0070
Adjusted R-squared	0.9848			
F-statistic	192.4430	Durbin-Watson stat		2.4745

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.2, the coefficients next to the keyrate_sa, cpi_sa, the third lag of lshare_sa, unemp_sa, int_cpi_unemp, and all the squared terms except for lshare_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged terms, the interaction term, and the squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.3 presents the results from the Wald Test for Australia's model.

Wald Test Coefficient Restrictions for Australia's model

Null hypothesis: keyrate_sa=cpi_sa=unemp_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.3 Wald Test Result for Australia

Test Statistic	Value	df	Probability
F-statistic	0.3447	(3, 41)	0.7931
Chi-square	1.0341	3	0.7930

According to Table 3.3, the p-value of the F-statistic, the null cannot be rejected, and the coefficients next to the keyrate_sa, cpi_sa and unemp_sa are not included in the interpretations. The coefficient next to the first lag of keyrate_sa is negative, while that next to the second lag is positive. To sum up, the collective effect is positive. Thus, a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to an increase in the top 10 percent income share by about 0.0003% within two quarters. The coefficient next to the first lag of cpi_sa is positive and significant, indicating the presence of the portfolio composition channel. Thus, a 1 % increase in inflation results in about 0.0008% increase in the top ten percent income share within one quarter. The financial segmentation and income composition channels have been captured, too since the coefficients next to lshare_sa and all its lags, except for the third one, are statistically significant with a collective effect of approximately 0.2576%. Thus, a 1 % increase in the logarithm of Total Share Price Index results in an approximately 0.2576% increase in the top ten percent income share within four quarters. Finally, the earnings heterogeneity channel has been captured since the coefficient next to the first lag of unemp_sa is positive and statistically significant, indicating that a 1 % increase in unemployment results in about 0.0022% increase in the top ten percent income share within one quarter.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.1 to 3.4 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.2 and 3.4, the mean values of unemployment and inflation, which are approximately 5.3403 and 2.3120, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0009+2(2.91E-05)\ keyrate\_sa=0 \qquad (3.1)$$

From equation 3.1, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 15.4639%.

$\frac{\partial top10}{\partial cpi_{sa}}$: =-0.0012+3.92E-05(5.3403) +2(1.76E-05)cpi_sa=0 (3.2)

From equation 3.2, the value of cpi_sa that minimizes the top 10 percent income share is approximately 28.1438%.

$\frac{\partial top10}{\partial lshare_{sa}}$: 0.2710-2(0.0283) lshare_sa =0 (3.3)

From equation 3.3, the value of lshare_sa that maximizes the top 10 percent income share is approximately 4.7880.

$\frac{\partial top10}{\partial unemp_{sa}}$: -0.0020+3.92E-05(2.3120) +2(9.29E-06)unemp_sa=0 (3.4)

From equation 3.4, the value of unemp_sa that minimizes the top 10 percent income share is approximately 102.7648%.

Since inequality-minimizing values of inflation and unemployment are ambiguous, i.e too large, it is necessary to test the model for OVB with the help of the Ramsey RESET test. Table 3.4 presents the results from the Ramsey RESET test for Australia's model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.4 Result from the Ramsey RESET Test for Australia's Model

	Value	df	Probability
t-statistic	0.017888	40	0.9858
F-statistic	0.000320	(1, 40)	0.9858

3.2. Results for Brazil

This subsection presents the results of estimations for Brazil. Figure 3.2 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price index, respectively. Brazil's top ten percent income share was quite stable despite being relatively high, but rapidly decreased after 2018Q4 and reached its minimum in 2019Q4, at approximately 0.5707. Afterwards, it increased to about 0.5831 in 2020Q4 and remained almost constant till 2021Q3. Brazil's monetary policy rate had a mostly declining trend except for when it reached its peak between 2015Q3 and 2016Q3 at around 14.3%, after which it declined and reached its minimum at about 2.0% in 2020Q3. Brazil's inflation experienced a rapid fall to about 3.0 % in 2007Q1, after which it had a mainly increasing trend till reaching its peak to about 10.3 % in 2016Q1. The inflation fell, though, to about 2.6 % in 2017Q3, slightly increased, and then fell again to reach its minimum of about 2.1 % in 2020Q2, while it finally had a rapid increase back to its peak of about 10.3 % in 2021Q3. Unemployment in Brazil had a decreasing trend at the beginning of the sampling period, increased rapidly from about 7.3% in 2008Q4 to about 8.5% in 2009Q4, after which it fell and reached its minimum of about 6.7 % in 2014Q4. Afterwards, it rose to 12.8 % in 2017Q4, declined to about 11.9 % in 2019Q4 and kept increasing to its peak of about 14.2 % in 2021Q3. The logarithm of Total Share Price Index in Brazil was increasing in the beginning of the sampling period to about 4.88 in 2008Q2, rapidly declined to 4.31 in 2008Q4, after which it increased to 4.94 in 2010Q4 kept declining to 4.47 in 2016Q1. Afterwards, it was mostly increasing and reached 5.37 in 2019Q4, declined to 5.15 in 2020Q2, and finally increased to 5.53 in the second and third quarters of 2021.

Figure 3.2 Graphs for Brazil's Data

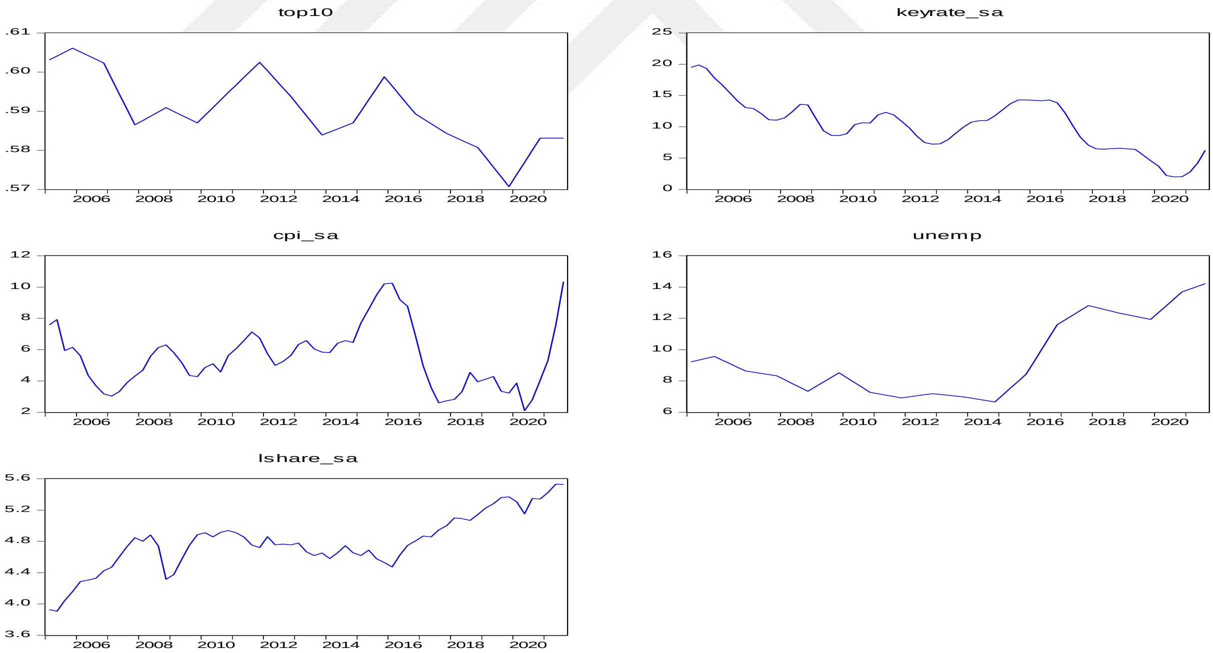

Table 3.5 Results from the ADF, ZA and LS Unit Root Tests for Brazil

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-2.2766	-3.4809*	-4.5907* 2018Q2	-4.3683* 2015Q2	-4.5813 2010Q1	-4.4850*** 2010Q3	-4.5697** 2010Q3 2016Q3	-4.6648** 2015Q4	-6.7593** 2010Q2 2018Q2

Keyrate_sa	-2.0167	-2.5146	-3.5370 2013Q2	-3.1450 2015Q4	-3.8367 2014Q4	-3.7216** 2017Q2	-4.0598** 2010Q2 2017Q2	-4.7786** 2014Q3	-6.2408** 2014Q2 2018Q2
Cpi_sa	-2.3720	-2.3507	-3.8007 2016Q4	-2.3636 2011Q1	-3.5214 2018Q4	-3.3769* 2016Q3	-4.5991*** 2016Q3 2018Q3	-3.9666 2016Q2	-6.7177** 2015Q2 2018Q3
Lshare_sa	-0.93369	-1.7497	-4.3369 2012Q2	-4.0179 2016Q2	-4.1557 2013Q2	-2.0147 2008Q4	-2.1787 2012Q1 2013Q1	-3.7449 2013Q4	-4.8791 2008Q1 2016Q4
Unemp	-0.2068	-1.6097	-4.0236 2010Q1	-4.2087* 2013Q2	-4.8550* 2015Q1	-2.5766 2015Q1	-2.6954 2015Q1 2016Q2	-4.5367** 2015Q3	-6.9616** 2013Q3 2016Q4

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.5, all the variables, except for the lshare_sa are stationary at level, or I (0), when one or two structural breaks are excluded. However, according to all three tests, lshare_sa shows a unit root. Since the ARDL model does not tolerate I(2) variables, the differenced variable, dlshare_sa was tested for the existence of a unit root to make sure that it is I(1). If the ADF with neither the intercept nor trend shows stationarity, the variable is confirmed to be I (1) and the testing procedure stops. Table 3.6 presents the result from the on dlshare_sa for Brazil.

Table 3.6 ADF Test Result on dlshare_sa for Brazil

First-difference variable	**ADF (none)**
dlshare_sa	-2.8206***

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.6, the null hypothesis of a unit root is rejected, so lshare_sa is confirmed to be I (1). Due to the combination of I (0) and I (1) variables, an ARDL: Bounds test approach is appropriate. Table 3.7 shows the results of the Bound Test for the data in Brazil.

Table 3.7 Bound Test Result for Brazil

Test Statistic	Value	k
F-statistic	4.8314	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.7, since the value of the F statistic exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.8 shows the ARDL Long Run Form of the model for Brazil.

Table 3.8 ARDL Long Run Form for Brazil

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.2379	0.0599	-3.9685	0.0003
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE_SA	-0.0037	0.0012	-3.4274	0.0014
LSHARE_SA	0.2764	0.0900	3.0697	0.0037
CPI_SA	-0.0036	0.0024	-1.4757	0.1475
UNEMP	-0.0103	0.0063	-1.6384	0.1088
INT_CPI_UNEMP	0.0004	0.0002	2.1222	0.0398
KEYRATE_SA_SQ	0.0003	0.0001	4.6563	0.0000
LSHARE_SA_SQ	-0.0278	0.0095	-2.9379	0.0053
UNEMP_SQ	0.0003	0.0003	1.0342	0.3069
CPI_SA_SQ	0.0001	0.0001	0.4254	0.6727
C	-0.0283	0.2048	-0.1381	0.8907

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.8, the coefficient of the cointegrating equation is negative and less than one, in addition to being statistically significant. The coefficients next to the cpi_sa, unemp_sa, unemp_sq, and cpi_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the unemp_sq, and cpi_sa_sq, although insignificant, are not included due to the risk of a multicollinearity problem. Table 3.9 presents the result from the Wald Test conducted on the data for Brazil.

Wald Test Coefficient restrictions for Brazil

Null hypothesis: cpi_sa=unemp=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.9 Wald Test Result for Brazil

Test Statistic	Value	df	Probability
F-statistic	2.1067	(2, 42)	0.1343
Chi-square	4.2134	2	0.1216

According to the probability value of the F-statistic in Table 3.9, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the cpi_sa and unemp are not included in the interpretations. The coefficient next to the keyrate_sa is negative and statistically significant, indicating that a contractionary monetary policy (a 1 % increase in the monetary policy rate) leads to a decrease in the top 10 percent income share by about 0.0037% in the long run. Additionally, this model has captured the financial segmentation and income composition channels, since a 1 % increase in the lshare_sa leads to an approximately 0.2764% increase in the top ten percent income share in the long run.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.5 to 3.8 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.7 and 3.8, the mean values of unemployment and inflation, which are approximately 9.3756% and 5.5266%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0037+2(0.0003)\ \text{keyrate\_sa}=0 \tag{3.5}$$

From equation 3.5, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 6.1667%.

$$\frac{\partial top10}{\partial lshare_{sa}}: 0.2764-2(0.0278)\ \text{lshare\_sa}=0 \tag{3.6}$$

From equation 3.6, the value of lshare_sa that maximizes the top 10 percent income share is approximately 4.9712.

$$\frac{\partial top10}{\partial cpi_{sa}}: -0.0036+0.0004(9.3756)+2(0.0001)\ \text{cpi\_sa}=0 \tag{3.7}$$

From equation 3.7, the value of cpi_sa that minimizes the top 10 percent income share is approximately -0.7512%.

$$\frac{\partial top10}{\partial unemp}: -0.0103+0.0004(5.5266)+2(0.0003)\text{unemp}=0 \tag{3.8}$$

From equation 3.8, the value of unemp that minimizes the top 10 percent income share is approximately 13.4823%.

3.3. Results for Chile

This subsection presents the results of estimations for Chile. Figure 3.3 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price index, respectively. Chile's top ten percent income share started from its lowest point (around 0.623), increased to about 0.635 in 2006Q4, declined to approximately 0.626 in 2009Q4, reached its peak of 0.663 in 2011Q4, fell to 0.627 in 2017Q4 and remained constant. Chile's monetary policy rate was increasing in the beginning until reaching its peak of 8.3% in 2008Q3 but declined to its trough of 0.5% in 2009Q3. Afterwards, it kept fluctuating between 5.3% and 1.5%. Inflation in

Chile reached its peak of 9.3% in 2008Q3, rapidly declined to its trough of -3.0% in 2009Q4, then increased to positive values and kept fluctuating until reaching 4.9% in 2021Q3. Chile's unemployment was highly fluctuating but had its trough of approximately 6.0% in 2013Q3, rapidly increased to about 13.0% in 2020Q3, and then declined to 8.8% in 2021Q3. The logarithm of Total Share Price Index in Chile started out from its minimum of approximately 3.90 in 2005Q1, fluctuated but with an increasing trend until reaching its peak of about 5.00 in 2018Q1, declined to about 4.60 in 2020Q2 and reached about 4.75 in 2021Q3.

Figure 3.3 Graphs for Chile's Data

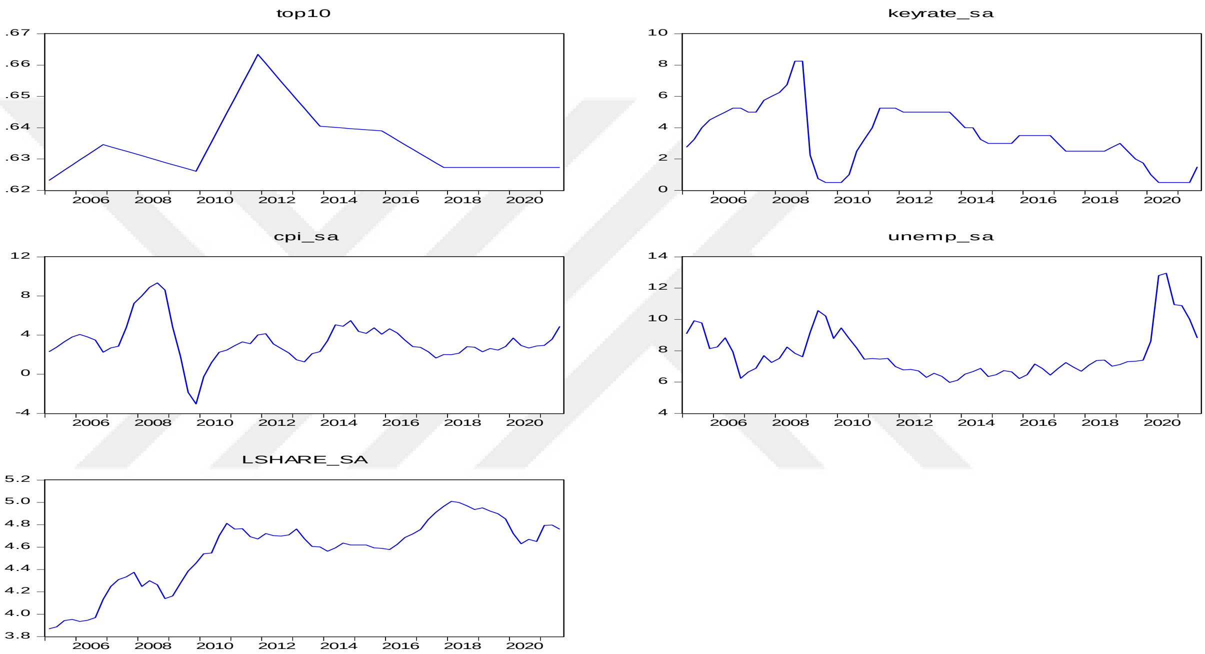

Table 3.10 Results from the ADF, ZA and LS Unit Root Tests for Chile

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.4236	-1.5658	-6.8446*** 2010Q1	-4.4520** 2011Q3	-6.9044*** 2010Q1	-3.2976* 2012Q1	-3.7854** 2012Q2 2013Q2	-5.4798*** 2012Q4	-6.9440** 2010Q3 2015Q1
Keyrate_sa	-1.9209	-3.1782*	-4.5806 2011Q1	-3.8797 2013Q2	-4.6729 2011Q1	-3.8481** 2008Q1	-3.8974** 2008Q1 2010Q3	-3.888220 2015Q1	-9.6199*** 2008Q3 2011Q4
Cpi_sa	-3.0441**								
Lshare_sa	-2.6781*	-2.7593	-3.4581 2009Q1	-3.1849 2010Q4	-3.2524 2009Q2	-3.3517* 2009Q2	-3.4164* 2009Q2 2009Q4	-4.4976** 2009Q2	-6.2911** 2013Q1 2017Q1
Unemp_sa	-2.5010	-2.4736	-3.5745 2019Q1	-3.7927 2017Q1	-3.7458 2016Q3	-3.4208* 2010Q2	-3.4889*	-4.3887**	-5.1807

2008Q2 2010Q2	2019Q3	2010Q2 2019Q3

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root test results in Table 3.10, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.11 shows the ARDL model for Chile.

Table 3.11 ARDL Model for Chile

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.3247	0.1869	7.0861	0.0000
TOP10(-2)	-0.3815	0.1578	-2.4183	0.0199
KEYRATE_SA	-0.0004	0.0006	-0.6957	0.4904
KEYRATE_SA(-1)	0.0004	0.0003	1.3633	0.1799
KEYRATE_SA(-2)	0.0007	0.0003	2.7400	0.0089
KEYRATE_SA(-3)	-0.0007	0.0004	-1.5741	0.1228
KEYRATE_SA(-4)	-0.0006	0.0004	-1.5678	0.1243
CPI_SA	0.0031	0.0013	2.3732	0.0222
CPI_SA(-1)	-7.10E-05	0.0003	-0.2511	0.8029
CPI_SA(-2)	0.0002	0.0003	0.6444	0.5227
CPI_SA(-3)	-1.79E-05	0.0001	-0.1250	0.9011
CPI_SA(-4)	-0.0004	0.0001	-2.4934	0.0166
LSHARE_SA	5.99E-05	0.0001	0.5728	0.5698
UNEMP_SA	0.0032	0.0015	2.2141	0.0322
INT_CPI_UNEMP	-0.0005	0.0002	-2.7481	0.0087
KEYRATE_SA_SQ	6.01E-05	5.14E-05	1.1695	0.2486
LSHARE_SA_SQ	-3.50E-07	4.95E-07	-0.7087	0.4823
UNEMP_SA_SQ	-0.0001	5.33E-05	-1.9192	0.0616
CPI_SA_SQ	4.30E-06	3.86E-05	0.1114	0.9118
C	0.0186	0.0210	0.8858	0.3807
Adjusted R-squared	0.9895			
F-statistic	308.2331	Durbin-Watson stat		1.9465

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.11, the coefficients next to the keyrate_sa and its first, third and fourth lags, the first three lags of cpi_sa, lshare_sa, and all the squared terms are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged terms, keyrate_sa_sq, and lshare_sa_sq, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.12 shows the Wald Test result for Chile.

Wald Test Coefficient Restrictions for Chile

Null hypothesis: keyrate_sa= lshare_sa=unemp_sa_sq=cpi_sa_sq =0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.12 Wald Test Result for Chile

Test Statistic	Value	df	Probability
F-statistic	2.8827	(4, 43)	0.0336
Chi-square	11.531	4	0.0212

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.12, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa and lshare_sa, are included in the interpretations. The collective effect of keyrate_sa and its second lag is positive and significant. Thus, a contractionary monetary policy (an increase in the monetary policy rate by 1%) is an increase in the top 10 percent income share by about 0.0003% within two quarters. All the transmission mechanisms appear to be present in this model, since the coefficients next to the lshare_sa, cpi_sa and its fourth lag, and unemp_sa are positive and statistically significant. The coefficient next to lshare_sa suggests that a 1 % increase in the logarithm of the Total Share Price Index leads to an approximately 0.0001% increase in the top ten percent income share in Chile in the same quarter. The collective impact of the coefficients next to cpi_sa and its fourth lag suggests that a 1% increase in inflation leads to an approximately 0.0027% increase in the top ten percent income share in Chile within four quarters. The coefficient next to unemp_sa suggests that a 1% increase in unemployment results in an approximately 0.0032% increase in Chile's top ten percent income share in the same quarter.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.9 to 3.12 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.11 and 3.12, the mean values of inflation and unemployment, which are approximately 3.3128 % and 7.7882 %, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0004+2(6.01\text{E-}05)\text{keyrate\_sa}=0 \quad (3.9)$$

From equation 3.9, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 3.3279%.

$$\frac{\partial top10}{\partial lshare_{sa}}: 5.99E-05-2(3.50\text{E}-07)\text{lshare}_{\text{sa}}=0 \quad (3.10)$$

From equation 3.10, the value of lshare_sa that maximizes the top 10 percent income share is approximately 8.5571%.

$\frac{\partial top10}{\partial unemp_{sa}}$: $0.0032 - 0.0005(3.3128)$-2(0.0001) unemp_sa=0 (3.11)

From equation 4.11, the value of unemp_sa that maximizes the top 10 percent income share is 7.7180%.

$\frac{\partial top10}{\partial cpi_{sa}}$: $0.0031 - 0.0005$(7.7882)+2(4.30E-06)cpi_sa=0 (3.12)

From equation 3.12, the value of cpi_sa that minimizes the top 10 percent income share is approximately 92.3372%.

Since inequality-minimizing value of inflation is ambiguous, i.e too large, it is necessary to test the model for the Omitted Variable Bias (OVB) with the help of the Ramsey RESET test. Table 3.13 presents the results from the Ramsey RESET test for Chile's model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.13 Result from the Ramsey RESET Test for Chile's Model

	Value	df	Probability
t-statistic	1.431823	42	0.1596
F-statistic	2.050116	(1, 42)	0.1596

3.4. Results for China

This subsection presents the results of estimations for China. Figure 3.4 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. China's top ten percent income share increased to 0.3256 in 2006Q4, rapidly declined to its minimum of 0.2977 in 2008Q4, had a mostly increasing trend until reaching its peak of 0.3356 in 2017Q4, declined to 0.3254 in 2018Q4 and remained constant. China's monetary policy rate was highly fluctuating throughout the sampling period, despite a relatively low scale of between approximately 0.01% in 2009Q2 and 0.045%in 2013Q4. Inflation in China peaked at about 8.1% in 2008Q1 rapidly declined to its minimum of -1.6% in 2009Q2, increased again to 6.5% in 2011Q3, and kept fluctuating until declining to 1.1% in 2021Q3. China's unemployment had a relatively small scale but had its rapid fall to about 4.28% in 2018Q4, increased to 5.0% in 2020Q4, and slightly declined to 4.86% in 2021Q3. The logarithm of Total Share Price index in China rapidly increased from 3.51

in 2005Q1 to its peak of 5.0 in 2007Q4, fell to 3.98 in 2008Q4 and kept varying until it reached 4.57 in 2021Q3.

Figure 3.4 Graphs for China's Data

Table 3.14 Results from the ADF, ZA and LS Unit Root Tests for China

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.0471	-2.5653	-4.2662 2013Q1	-3.2864 2017Q3	-4.1060 2012Q1	-3.7120** 2017Q4	-4.3232*** 2009Q4 2012Q1	-4.3084* 2012Q3	-7.4758*** 2007Q4 2013Q2
Keyrate_sa	-2.5553	-2.3896	-5.0393** 2010Q4	-3.9933 2013Q3	-4.9505* 2010Q4	-4.3318*** 2010Q4	-4.4735*** 2010Q4 2014Q3	-4.9657*** 2012Q2	-5.6360 2010Q2 2013Q2
Cpi_sa	-3.7973***	-4.9650***							
Lshare_sa	-4.7814***	-5.1188***							
Unemp	-3.1887**	-3.2430*							

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the results of the three unit root tests in Table 3.14, all the variables are I (0), or stationary at level. Thus, a regular ARDL model was run, without the Bounds test. Table 3.15 presents the ARDL model for China.

Table 3.15 ARDL Model for China

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.1191	0.1420	7.8817	0.0000
TOP10(-2)	-0.2721	0.2514	-1.0824	0.2865
TOP10(-3)	0.1691	0.2111	0.8012	0.4284
TOP10(-4)	-0.2428	0.1268	-1.9148	0.0637
KEYRATE_SA	0.0595	0.2897	0.2054	0.8385
KEYRATE_SA(-1)	-0.0590	0.0416	-1.4187	0.1648
KEYRATE_SA(-2)	0.0386	0.0570	0.6762	0.5033
KEYRATE_SA(-3)	-0.1192	0.0452	-2.6370	0.0124
LSHARE_SA	-0.0349	0.0193	-1.8052	0.0796
LSHARE_SA(-1)	-0.0065	0.0032	-2.0295	0.0501
LSHARE_SA(-2)	0.0079	0.0026	3.0662	0.0042
LSHARE_SA(-3)	0.0013	0.0033	0.3935	0.6963
LSHARE_SA(-4)	-0.0076	0.0030	-2.5270	0.0162
CPI_SA	0.0164	0.0089	1.8538	0.0722
CPI_SA(-1)	-2.41E-05	0.0003	-0.0736	0.9417
CPI_SA(-2)	0.0002	0.0002	0.7041	0.4860
CPI_SA(-3)	0.0006	0.0003	2.2489	0.0309
UNEMP	0.4101	0.0949	4.3211	0.0001
UNEMP(-1)	-0.0366	0.0113	-3.2333	0.0027
UNEMP(-2)	0.0110	0.0071	1.5552	0.1289
UNEMP(-3)	0.0084	0.0060	1.3990	0.1706
INT_CPI_UNEMP	-0.0038	0.0019	-2.0467	0.0483
KEYRATE_SA_SQ	0.3669	4.1840	0.0877	0.9306
LSHARE_SA_SQ	0.0042	0.0022	1.8732	0.0694
CPI_SA_SQ	-1.94E-05	7.14E-05	-0.2724	0.7869
UNEMP_SQ	-0.0424	0.0103	-4.1349	0.0002
C	-0.7468	0.2254	-3.3132	0.0022
@TREND	0.0002	4.39E-05	3.8357	0.0005
Adjusted R-squared	0.9838			
F-statistic	140.2296	Durbin-Watson stat		2.3513

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.15, the coefficients next to the keyrate_sa and its first two lags, cpi_sa and its first two lags, lshare_sa and its first and third lags, the second and third lags of unemp_sa, keyrate_sa_sq, lshare_sa_sq, and cpi_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged terms, keyrate_sa_sq, lshare_sa_sq, and cpi_sa_sq, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.16 presents the Wald Test results for China.

Wald Test Coefficient Restrictions for China

Null hypothesis: keyrate_sa= lshare_sa=cpi_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.16 Wald Test Result for China

Test Statistic	Value	df	Probability
F-statistic	4.1084	(3, 35)	0.0134
Chi-square	12.3251	3	0.0063

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.16, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, lshare_sa, and cpi_sa are included in the interpretations. The coefficients next to the keyrate_sa is positive, while the one next to its third lag is negative. When the coefficients are added up, the collective effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is a decrease in the top 10 percent income share by 0.0597% within 3 quarters. Two transmission mechanism channels have been captured by this model: portfolio composition and earnings heterogeneity channels. Firstly, the collective effect of cpi_sa and its third lag is positive and significant, where a 1% increase in inflation leads to an increase in the top ten percent income share by 0.0170% within three quarters, and this indicates the presence of the portfolio composition channel. Secondly, the collective effect of unemp and its first lag on top 10% is positive and significant, where a 1 % increase in unemployment results in a 0.3735% increase in the top ten percent income share within one quarter, and this shows the presence of the earnings heterogeneity channel.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.13 to 3.16 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.15 and 3.16, the mean values of unemployment and inflation, which are approximately 4.5582% and 2.5289 %, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: 0.0595+2(0.3669)\text{keyrate\_sa}=0 \qquad (3.13)$$

From equation 3.13, the value of keyrate_sa that minimizes the top 10 percent income share is approximately -0.0811%.

$$\frac{\partial top10}{\partial lshare_{sa}}: -0.0349 + 2(0.0042)\text{lshare}_{\text{sa}} = 0 \qquad (3.14)$$

From equation 3.14, the value of lshare_sa that minimizes the top 10 percent income share is approximately 4.1548%.

$\frac{\partial top10}{\partial cpi_{sa}}$: 0.0164 − 0.0038(4.5582)-2(1.94E-05) cpi_sa=0 (3.15)

From equation 3.15, the value of cpi_sa that maximizes the top 10 percent income share is -23.7412%.

$\frac{\partial top10}{\partial unemp}$: 0.4101 − 0.0038(2.5289)-2(0.0424)unemp =0 (3.16)

From equation 3.16, the value of unemp that maximizes the top 10 percent income share is approximately 4.7228%.

3.5. Results for Colombia

This subsection presents the results of estimations for Colombia. Figure 3.5 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Colombia's top ten percent income share peaked to 0.5694 in 2008Q4, gradually declined to its minimum of 0.5335 in 2015Q4, increased to 0.5469 in 2018Q4 and remained constant. Colombia's monetary policy rate peaked at 10.0% in 2008Q3 and kept fluctuating until declining to 1.8% in 2020Q3 and remained constant. Inflation in Colombia highly fluctuated at a scale of approximately 1.57% and 8.23%. It peaked twice: 7.7% in 2008Q3 and 8.2% in 2016Q3, and its lowest points were about 2.0% in 2010Q1, 2013Q1, 2013Q4 and finally 1.6% in 2021Q1. Colombia's unemployment rate had a relatively low fluctuation between 11.4% in 2005Q1 and 10.7% in 2021Q1, but rapidly increased to its peak of 18.6% in 2020Q2, after which it slightly declined to 13,4% in 2021Q3. The logarithm of Total Share Price index in Colombia started out from its minimum of 3.59 in 2005Q1, rapidly increased to 4.38 in 2006Q1, fluctuated to reach its highest values of approximately 4.98 between 2010Q4 and 2013Q1, and ended up reaching 4.62 in 2021Q3.

Figure 3.5 Graphs for Colombia’s Data

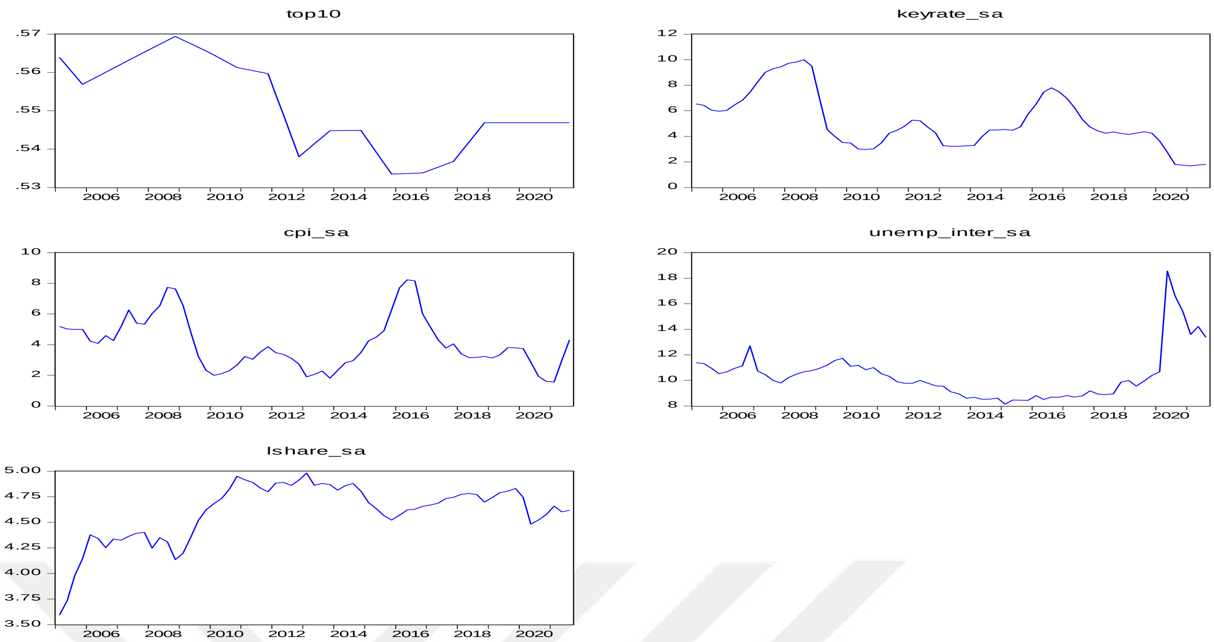

Table 3.17 Results from the ADF, ZA and LS Unit Root Tests for Colombia

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash,1 Break	Crash,2 Breaks	Break, 1 Break	Break,2 Breaks
Top10	-1.6209	-2.3673	-5.1176** 2012Q1	-3.7380 2016Q1	-4.9930* 2012Q1	-2.4100 2017Q1	-2.4805 2017Q1 2018Q3	-3.6949 2013Q4	-5.1655 2011Q3 2018Q2
Keyrate_sa	-1.9963	-3.5928**							
Cpi_sa	-3.4252**								
Lshare_sa	-2.7487*	-3.1100	-5.8130*** 2009Q2	-4.2891* 2012Q2	-5.4074** 2009Q3	-1.8517 2008Q1	-2.0033 2006Q3 2008Q1	-3.4808 2011Q4	-4.2363 2007Q4 2010Q4
Unemp_inter_sa	-2.2116	-2.2413	-3.8123 2018Q4	-4.5826** 2017Q4	-4.4779 2017Q2	-2.6736 2018Q3	-2.7624 2018Q3 2019Q3	-4.6131** 2019Q3	-7.7648*** 2013Q1 2019Q4

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root tests in Table 3.17, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Due to numerous insignificant coefficients, the maximum lag for dynamic regressors was selected as 5, instead of 4. Table 3.18 shows the ARDL model for Colombia.

Table 3.18 ARDL Model for Colombia

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.5474	0.0425	36.417	0.0000
TOP10(-2)	-0.6683	0.0385	-17.3580	0.0000
KEYRATE_SA	-0.0015	0.0010	-1.4786	0.1493
KEYRATE_SA(-1)	0.0019	0.0006	3.0082	0.0052
KEYRATE_SA(-2)	-0.0016	0.0006	-2.8419	0.0079
KEYRATE_SA(-3)	-0.0003	0.0008	-0.3459	0.7318
KEYRATE_SA(-4)	0.0017	0.0006	2.7761	0.0092
CPI_SA	5.26E-05	0.0011	0.0486	0.9616
CPI_SA(-1)	0.0004	0.0008	0.4324	0.6685
CPI_SA(-2)	-0.0012	0.0007	-1.6823	0.1026
CPI_SA(-3)	0.0011	0.0009	1.2000	0.2392
CPI_SA(-4)	-0.0004	0.0007	-0.6055	0.5493
CPI_SA(-5)	-0.0009	0.0004	-2.2241	0.0336
LSHARE_SA	0.0169	0.0578	0.2932	0.7713
LSHARE_SA(-1)	0.0010	0.0035	0.2747	0.7854
LSHARE_SA(-2)	-0.0048	0.0025	-1.9069	0.0658
LSHARE_SA(-3)	0.0029	0.0020	1.4543	0.1559
LSHARE_SA(-4)	0.0094	0.0037	2.5163	0.0173
LSHARE_SA(-5)	-0.0123	0.0049	-2.5369	0.0164
UNEMP_INTER_SA	0.0003	0.0008	0.3153	0.7546
UNEMP_INTER_SA(-1)	-8.76E-06	0.0002	-0.0579	0.9542
UNEMP_INTER_SA(-2)	-0.0001	0.0001	-0.8337	0.4108
UNEMP_INTER_SA(-3)	0.0002	0.0002	1.1143	0.2737
UNEMP_INTER_SA(-4)	0.0004	0.0002	2.3707	0.0242
UNEMP_INTER_SA(-5)	-0.0004	0.0002	-1.5721	0.1261
INT_CPI_UNEMP	3.36E-06	6.66E-05	0.0505	0.9600
KEYRATE_SA_SQ	7.08E-05	6.05E-05	1.1702	0.2508
LSHARE_SA_SQ	-0.0011	0.0066	-0.1668	0.8686
CPI_SA_SQ	2.60E-05	5.28E-05	0.4926	0.6258
UNEMP_SQ	-1.65E-06	2.12E-05	-0.0775	0.9387
C	0.0261	0.1501	0.1736	0.8633
Adjusted R-squared	0.9924			
F-statistic	273.0981	Durbin-Watson stat		2.2191

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.18, the coefficients next to the keyrate_sa and its third lag, cpi_sa and its first four lags, lshare_sa and its first three lags, unemp_inter_sa and its lags except for the fourth one, the interaction term, and all the squared terms are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged and squared terms and the interaction term, although individually insignificant, are not included test due to the risk of a multicollinearity problem. Table 3.19 shows the results from the Wald Test for Colombia.

Wald Test Coefficient Restrictions for Colombia

Null hypothesis: keyrate_sa=cpi_sa=lshare_sa=unemp_inter_sa =0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.19 Wald Test Result for Colombia

Test Statistic	Value	df	Probability
F-statistic	1.6228	(4, 31)	0.1934
Chi-square	6.4912	4	0.1653

According to the p-value of the F-statistic in Table 3.19, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, cpi_sa, unemp_inter_sa and lshare_sa, are not included in the interpretations. The collective effect of the first, second, and fourth lags of keyrate_sa is positive and statistically significant. Thus, a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to an increase in the top 10% income share by 0.0020% within four quarters. Additionally, the model has captured the earnings heterogeneity channel since the coefficient next to the fourth lag of unemp_inter_sa is positive and significant, indicating that a 1 % increase in unemployment leads to a 0.0004% increase in the top ten percent income share within four quarters.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.17 to 3.20 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.19 and 3.20, the mean values of unemployment and inflation, which are approximately 10.3782% and 4.0729%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0015+2(7.08\text{E-}05)\text{keyrate\_sa}=0 \quad (3.17)$$

From equation 3.17, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 10.5932%.

$$\frac{\partial top10}{\partial lshare_{sa}}: 0.0169-2(0.0011)\text{lshare}_{\text{sa}}=0 \quad (3.18)$$

From equation 3.18, the value of lshare_sa that maximizes the top 10 percent income share is approximately 7.6818%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 5.26E-05+3.36E-06(10.3782)+2(2.60\text{E-}05)\text{cpi\_sa}=0 \quad (3.19)$$

From equation 3.19, the value of cpi_sa that minimizes the top 10 percent income share is -1.6821%.

$$\frac{\partial top10}{\partial unemp_{inter_{sa}}}: 0.0003 + 3.36E - 06(4.0729)-2(1.65E-06)unemp\_inter\_sa=0 \tag{3.20}$$

From equation 3.20, the value of unemp_inter_sa that maximizes the top 10 percent income share is approximately 95.0560%.

3.6. Results for Finland

This subsection presents the results of estimations for Finland. Figure 3.6 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively Finland's top ten percent income share was highly fluctuating despite a relatively small scale. It rapidly declined to about 0.3213 in 2005Q4, increased to about 0.3406 in 2008Q4, declined to 0.3228 in 2009Q4, reached its minimum of about 0.3153 in 2013Q4, rose 0.3386 in 2017Q4, rapidly declined to 0.3312 in 2019Q4, and increased to its peak of 0.3451 in 2021Q3. The ECB monetary policy rate started out at 2.0% in 2005Q1, rose to its peak of 4.3% in 2008Q3, declined to 1.0% in 2009Q3, remained constant until 2011Q1, increased to 1.5% in 2011Q3, and fell in 2016Q2 to its minimum of 0.0% to remain constant the end of the sampling period. It is important to note that this description of the ECB policy rate series is applicable for the analysis of the data for France, Germany, and Spain, and thus will not be repeated for these countries. Inflation in Finland peaked at 4.5% in 2008Q3, rapidly dropped to its minimum of -1.0% in 2009Q4, increased to 3.8% in 2011Q3, declined to -0.4% 2015Q3, and gradually increased to reach 2.2% in 2021Q3. Finland's unemployment rate fell to its minimum of 6.30% in 2008Q1, rose to 9.08% in 2009Q4, fluctuated and reached its peak of about 9.6% in 2015Q3, fell again to about 6.60% in 2019Q3, increased to 8.32% in 2020Q3, and finally declined to 7.51% in 2021Q3. The logarithm of Total Share Price index in Finland increased from 4.33 in 2005Q1 to 4.96 in 2007Q4, declined to its minimum of 4.06 in 2009Q1 and followed a mostly increasing trend until it peaked to 5.03 in 2021Q3.

Figure 3.6 Graphs for Finland's Data

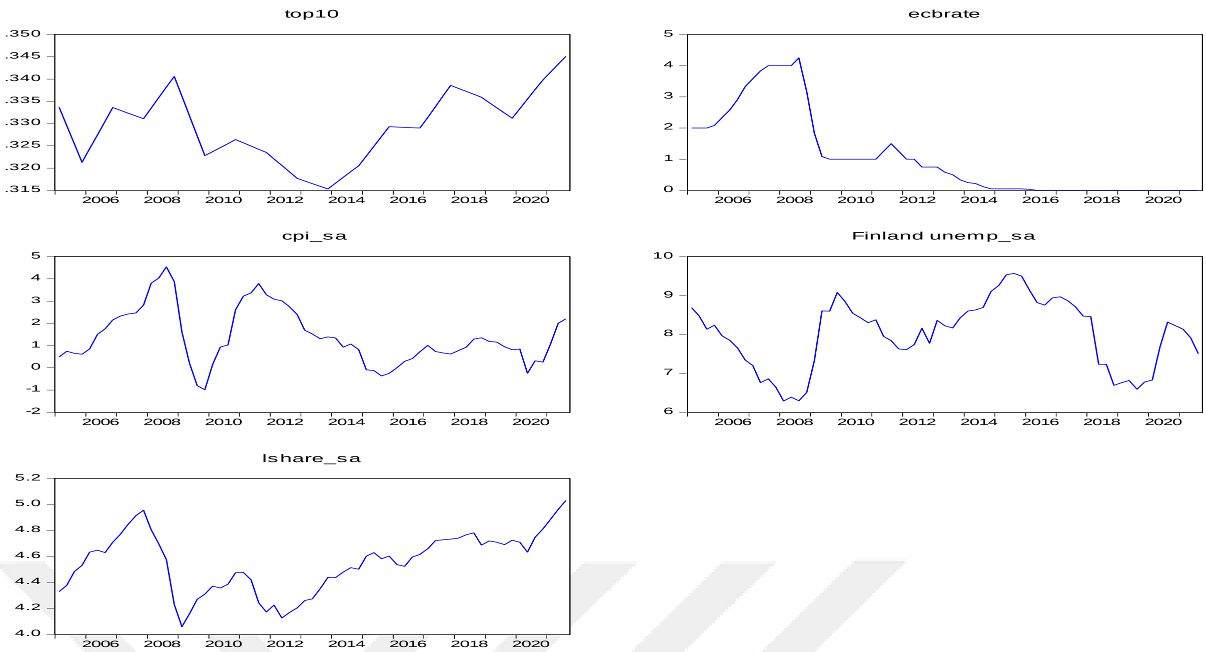

Table 3.20 Results from the ADF, ZA and LS Unit Root Tests for Finland

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-0.9786	-1.2983	-3.5752 2009Q1	-4.2926* 2013Q3	-4.5358 2012Q1	-2.5088 2009Q2	-2.6542 2009Q2 2015Q2	- 4.8097* * 2012Q2	-5.1279 2011Q3 2016Q1
Keyrate	-1.6762	-2.5246	-8.3744*** 2008Q3	-4.4077* 2014Q1	- 10.7503** * 2008Q4	-3.1079 2009Q1	-3.7315** 2008Q2 2009Q1	- 4.9064* ** 2010Q2	-8.3219*** 2008Q2 2011Q4
Cpi_sa	-2.6751*	-3.4016*	-4.6985* 2014Q4	-3.7389 2017Q4	-4.7076 2014Q4	-2.4566 2008Q4	-2.8074 2007Q4 2009Q4	- 5.3928* ** 2014Q3	-5.5583 2010Q1 2014Q1
Lshare_sa	-1.1405	-1.6952	-4.3914 2008Q3	-4.1516* 2011Q4		-3.0502 2008Q1	-3.1935 2008Q1 2008Q4	- 5.4193* ** 2009Q3	-6.1915** 2008Q2 2011Q1
Unemp_sa	-2.3071	-2.2415	-4.5831 2018Q2	-3.9658 2015Q4	-4.5280 2018Q2	-3.0186 2009Q2	-3.1357 2009Q2 2018Q1	-3.6917 2015Q2	-6.4425** 2008Q4 2017Q4

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the Augmented Dickey-Fuller (ADF), Zivot Andrews (ZA), and Lee Strazicich LM unit root test results in Table 3.20, all the variables are stationary at level, or I(0) at at least 5% level of significance. Therefore, a standard ARDL model is built. Table 3.21 shows the ARDL model for Finland.

Table 3.21 ARDL Model for Finland

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.1374	0.1152	9.8735	0.0000
TOP10(-2)	-0.3869	0.1583	-2.4435	0.0188
TOP10(-3)	0.1615	0.0889	1.8167	0.0764
KEYRATE	0.0025	0.0015	1.6614	0.1041
KEYRATE(-1)	0.0018	0.0014	1.3169	0.1950
KEYRATE(-2)	-0.0028	0.0012	-2.2734	0.0282
KEYRATE(-3)	0.0023	0.0010	2.3419	0.0240
KEYRATE(-4)	-0.0017	0.0005	-3.1219	0.0032
CPI_SA	0.0156	0.0045	3.4819	0.0012
LSHARE_SA	0.0927	0.0334	2.7735	0.0082
LSHARE_SA(-1)	0.0029	0.0035	0.8388	0.4063
LSHARE_SA(-2)	0.0051	0.0029	1.7668	0.0845
UNEMP_SA	0.0214	0.0047	4.5469	0.0000
UNEMP_SA(-1)	0.0012	0.0005	2.2603	0.0290
UNEMP_SA(-2)	-0.0019	0.0005	-3.7753	0.0005
INT_CPI_UNEMP	-0.0017	0.0005	-3.8341	0.0004
KEYRATE_SQ	-0.0008	0.0002	-3.3977	0.0015
CPI_SA_SQ	-0.0005	0.0003	-1.8235	0.0753
LSHARE_SA_SQ	-0.0101	0.0037	-2.7020	0.0099
UNEMP_SA_SQ	-0.0012	0.0003	-4.2099	0.0001
C	-0.3125	0.0972	-3.2151	0.0025
Adjusted R-squared	0.9820			
F-statistic	169.9814		Durbin-Watson stat	2.0285

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.21, the coefficients next to keyrate and its first lag, the first two lags of lshare_sa, and cpi_sa_sq are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.22 shows the result from the Wald Test for Finland.

Wald Test Coefficient Restrictions for Finland

Null hypothesis: keyrate=cpi_sa_sq=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.22 Wald Test Result for Finland

Test Statistic	Value	df	Probability
F-statistic	1.9992	(2, 42)	0.1481
Chi-square	3.9985	2	0.1354

According to the p-value of the F-statistic in Table 3.22, the null cannot be rejected, and the coefficient next to keyrate is not included in the interpretations. The coefficients next to the second, third and fourth lags of keyrate are significant and their summed-up effect is negative. Thus, a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10% income share by 0.0022% within four quarters. The positive and significant coefficient of cpi_sa shows the presence of the portfolio composition channel, indicating that a 1 % increase in inflation increases the top ten percent income share by 0.0156% within the same quarter. The positive and significant coefficient of lshare_sa shows the presence of the financial segmentation and income composition channels, indicating that a 1 % increase in the log of total share prices increases the top ten percent income share by 0.0927% within the same quarter. Finally, the summed-up effect of unemp_sa and its two lags is positive and significant, and this shows the presence of the earnings heterogeneity channel. More specifically, a 1 % increase in unemployment increases the top ten percent income share by 0.0206% within two quarters.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.21 to 3.24 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.22 and 3.24, the mean values of unemployment and inflation, which are approximately 7.9999% and 1.3925%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate}: 0.0025\text{-}2(0.0008)\ \text{keyrate}=0 \qquad (3.21)$$

From equation 3.21, the value of keyrate that maximizes the top 10 percent income share is approximately 1.5625%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0156 - 0.0017(7.9999) - 2(0.0005)\text{cpi}_{\text{sa}} = 0 \qquad (3.22)$$

From equation 3.22, the value of cpi_sa that maximizes the top 10 percent income share is approximately 2.0002%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: 0.0927 - 2(\ 0.0101)\text{lshare}_{\text{sa}} = 0 \qquad (3.23)$$

From equation 3.23, the value of lshare_sa that maximizes the top 10 percent income share is approximately 4.5891%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0214 - \ 0.0017(1.3925) - 2(0.0012)\text{unemp\_sa}=0 \qquad (3.24)$$

From equation 3.24, the value of unemp_sa that maximizes the top 10 percent income share is approximately 7.9303%.

3.7. Results for France

This subsection presents the results of estimations for France. Figure 3.7 shows the graphs of the top ten percent income share, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. France's top ten percent income share peaked at 0.3393 in 2007Q4, dropped 0.3218 in 2009Q4, fluctuated between 0.3317 in 2011Q40.3242 in 2019Q4 despite a relatively small scale, until it 0.3113 in 2021Q3. Inflation in France was fluctuating between approximately 3.29% in 2008Q2 and -0.42 % in 2009Q4, but it ended up at 1.70% in 2021Q3. France's unemployment rate experienced two troughs: 7.19% in 2008Q1 and 7.24% in 2020Q2. It peaked at about 10.50% in 2015Q2, after which it began to decline but increased again to 8.97% in 2020Q3, and slightly declined to about 8.0% in 2021Q3. The logarithm of Total Share Price index in France increased from 4.30 in 2005Q1 to 4.72 in 2007Q2, after which it decreased rapidly to about 4.0 in 2009Q1. It then had a generally increasing trend until it peaked at about 4.9 in 2021Q3.

Figure 3.7 Graphs for France's Data

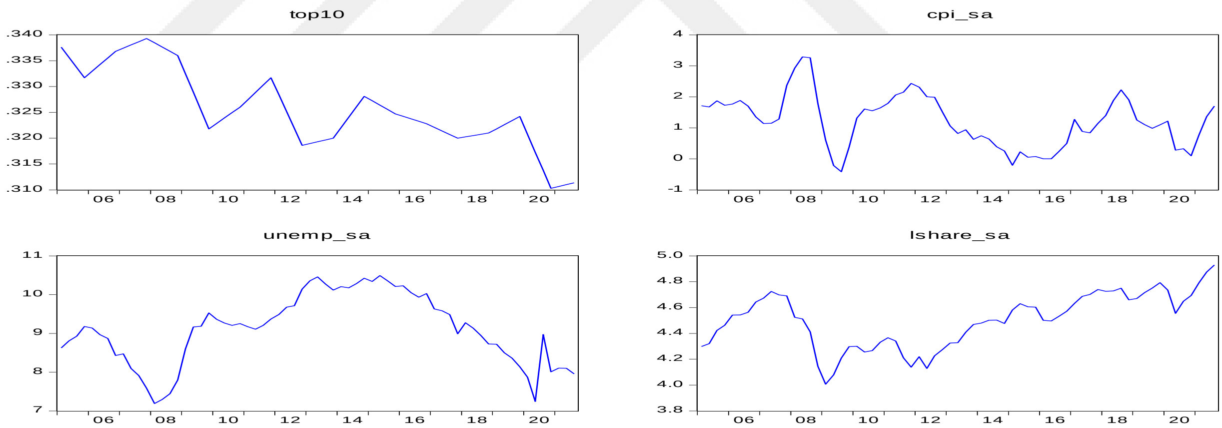

Table 3.23 Results from the ADF, ZA and LS Unit Root Tests for France

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-0.9675	-4.5471***							
Keyrate	-1.5710	-2.7772	-8.3744*** 2008Q4	-4.4077* 2014Q1	- 10.7503*** 2008Q4	-3.1079 2009Q1	-3.7315** 2008Q2 2009Q1	- 4.4729** 2010Q1	- 7.2484*** 2008Q2 2010Q4
Cpi_sa	-3.8934***								
Lshare_sa	-1.6103	-2.2642	-5.9009*** 2008Q3	-4.3893* 2009Q2	-5.4793** 2008Q3	-2.8879 2007Q4	-3.2557 2007Q4 2012Q1	- 4.5475** 2008Q2	-5.2568 2008Q2 2013Q4
Unemp_sa	-1.6814	-1.6011	-3.1419 2009Q1	-4.5437** 2015Q1	-4.3325 2014Q3	-1.8946 2019Q4	-1.9359 2009Q3 2017Q3	-4.0349 2013Q2	-4.8511 2010Q2 2015Q2

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root test results in Table 3.23, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.24 shows the ARDL model for France.

Table 3.24 ARDL Model for France

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.1406	0.1641	6.9516	0.0000
TOP10(-2)	-0.5019	0.1453	-3.4541	0.0014
KEYRATE	-0.0054	0.0028	-1.8996	0.0651
KEYRATE(-1)	0.0013	0.0014	0.9214	0.3627
KEYRATE(-2)	-0.0023	0.0013	-1.8051	0.0790
KEYRATE(-3)	0.0008	0.0013	0.6524	0.5181
KEYRATE(-4)	-0.0019	0.0009	-2.0272	0.0497
CPI_SA	0.0080	0.0038	2.1080	0.0417
CPI_SA(-1)	-0.0008	0.0007	-1.2441	0.2211
CPI_SA(-2)	0.0004	0.0005	0.8944	0.3767
CPI_SA(-3)	-0.0002	0.0005	-0.4533	0.6529
CPI_SA(-4)	0.0010	0.0005	1.8738	0.0687
LSHARE_SA	-0.0990	0.0579	-1.7107	0.0953
LSHARE_SA(-1)	0.0041	0.0027	1.5078	0.1399
LSHARE_SA(-2)	0.0055	0.0024	2.2507	0.0303
LSHARE_SA(-3)	-0.0047	0.0027	-1.7427	0.0895
LSHARE_SA(-4)	0.0057	0.0025	2.2976	0.0272
UNEMP_SA	0.0061	0.0054	1.1313	0.2650
INT_CPI_UNEMP	-0.0008	0.0004	-1.9665	0.0566
KEYRATE_SQ	0.0011	0.0005	2.2775	0.0285
CPI_SA_SQ	-0.0002	0.0004	-0.5413	0.5914
LSHARE_SA_SQ	0.0101	0.0063	1.6033	0.1172
UNEMP_SA_SQ	-0.0003	0.0003	-1.1330	0.2643
C	0.2984	0.1535	1.9448	0.0592
@TREND	-0.0003	0.0001	-3.0742	0.0039
Adjusted R-squared	0.9853			
F-statistic	170.7896		Durbin-Watson stat	2.1275

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.24, the coefficients next to keyrate and its first three lags, the four lags of cpi_sa, lshare_sa and its first and third lags, unemp_sa, the interaction term, and all the squared terms of the variables except for the keyrate_sq are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged and squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. The exception is cpi_sa_sq, which can be included in the F test because cpi_sa will not be included. Table 3.25 shows the results from the Wald Test for France.

Wald Test Coefficient Restrictions for France

Null hypothesis: keyrate =lshare_sa=unemp_sa=cpi_sa_sq=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.25 Wald Test Result for France

Test Statistic	Value	df	Probability
F-statistic	2.2364	(4, 38)	0.0832
Chi-square	8.9457	4	0.0625

According to the p-value of the F-statistic in Table 3.25, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the keyrate, lshare_sa, and unemp_sa, are not included in the interpretations. The coefficient next to the fourth lag of keyrate is negative and statistically significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10% income share by approximately 0.0019% within four quarters. Additionally, the model captures the portfolio composition channel since the coefficient next to cpi_sa is positive and significant. This means that a 1 % increase in cpi_sa leads to a 0.0080% increase in the top ten percent income share. The coefficients next to the second and fourth lags of lshare_sa are positive and significant, indicating the presence of the financial segmentation and income composition channels. More specifically, a 1% increase in the logarithm of Total Share Price Index leads to an approximately 0.0112% increase in the top ten percent income share within four quarters.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.25 to 3.28 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.26 and 3.28, the mean values of unemployment and inflation, which are approximately 9.1018% and 1.2195%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate}: -0.0054+2(0.0011)\text{keyrate} = 0 \qquad (3.25)$$

From equation 3.25, the value of keyrate that minimizes the top 10 percent income share is approximately 2.4545%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0080 - 0.0008(9.1018) - 2(0.0002)\text{cpi}_{\text{sa}} = 0 \qquad (3.26)$$

From equation 3.26, the value of cpi_sa that maximizes the top 10 percent income share is approximately 1.7964%.

$$\frac{\partial \mathrm{top10}}{\partial \mathrm{lshare}_{sa}}: -0.0990 + 2(0.0101)\mathrm{lshare}_{sa} = 0 \qquad (3.27)$$

From equation 3.27, the value of lshare_sa that minimizes the top 10 percent income share is approximately 4.9010%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0061 - 0.0008(1.2195) - 2(0.0003)\mathrm{unemp\_sa}=0 \qquad (3.28)$$

From equation 3.28, the value of unemp_sa that maximizes the top 10 percent income share is approximately 8.5407%.

3.8. Results for Germany

This subsection presents the results of estimations for Germany. Figure 3.8 shows the graphs of the top ten percent income share, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Germany's top ten percent income share increased from its minimum of 0.33 in 2005Q1 to 0.37 in 2007Q1, slightly fluctuated and rapidly increased to its peak of about 0.38 in 2015Q1, after which it gradually declined to 0.37 in 2021Q3. Inflation in Germany increased to 3.2% in 2008Q2, rapidly dropped to its minimum of -0.1% in 2009Q3, kept fluctuating and reached its minimum again in 2020Q4 and its peak o4.0% in 2021Q3. Germany's unemployment rate had a clear declining trend from its maximum of 11.4% in 2005Q2 to its minimum of 3.0% in 2019Q2, after which it slightly increased to 3.4% in 2021Q3. The logarithm of Total Share Price index in Germany from 3.96 in 2005Q1 4.51 in 2007Q4, rapidly declined to its trough of 3.81 in 2009Q1, after which it had a generally increasing trend and reached its maximum of 4.85 in 2021Q3.

Figure 3.8 Graphs for Germany's Data

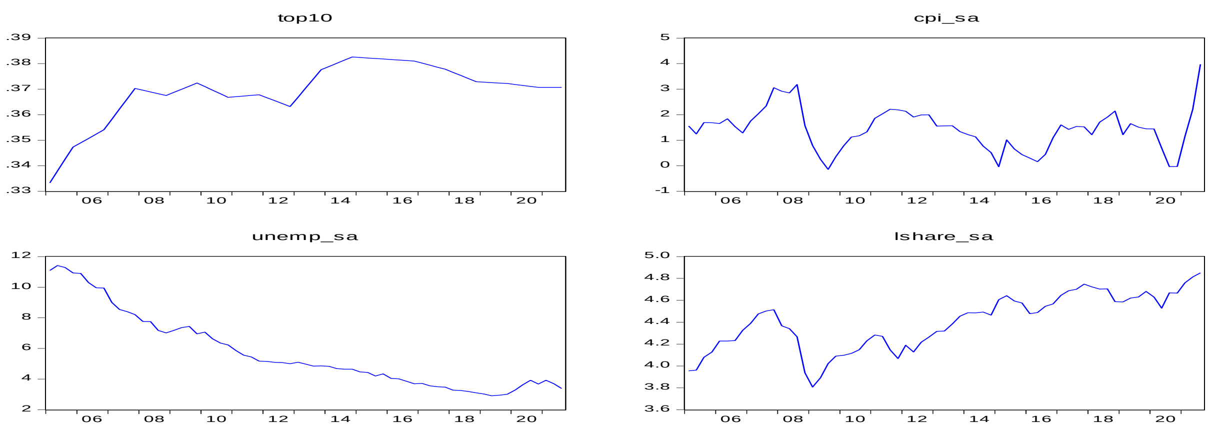

Table 3.26 Results from the ADF, ZA and LS Unit Root Tests for Germany

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash,1 Break	Crash,2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-3.5207***	-2.6299	-6.6315*** 2013Q1	-3.4408 2016Q1	-5.5203** 2013Q1	-2.1138 2007Q2	-1.7769 2008Q1 2008Q4	-6.2203*** 2014Q4	-4.3216 2009Q3 2014Q1
Keyrate	-1.5710	-2.7772	-8.3744*** 2008Q4	-4.4077* 2014Q1	-10.7503*** 2008Q4	-3.1079 2009Q1	-3.7315** 2008Q2 2009Q1	-4.4729** 2010Q1	-7.2484*** 2008Q2 2010Q4
Cpi_sa	-2.5559	-2.3714	-3.8091 2008Q4	-3.8356 2016Q3	-4.1867 2008Q4	-2.2915 2007Q3	-2.7157 2008Q4 2009Q3	-4.9707*** 2008Q2	-5.5944 2014Q2 2018Q4
Lshare_sa	-0.9514	-2.5925	-5.1286** 2008Q3	-4.0012 2009Q2	Near singular matrix error	-3.1897* 2007Q4	-3.3383* 2007Q4 2012Q1	-3.8092* 2008Q2	-5.4437 2008Q2 2013Q4
Unemp_sa	-3.5269**								

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the Augmented Dickey-Fuller (ADF), Zivot Andrews (ZA), and Lee Strazicich LM unit root test results in Table 3.26, all the variables are stationary at level, or I(0) at at least 5% level of significance. Therefore, a standard ARDL model is built. Table 3.27 presents results from the ARDL model for Germany.

Table 3.27 ARDL Model for Germany

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.1029	0.1642	6.7189	0.0000
TOP10(-2)	-0.2768	0.1715	-1.6141	0.1132
TOP10(-3)	-0.2348	0.0829	-2.8339	0.0068
KEYRATE	-0.0059	0.0016	-3.5812	0.0008
CPI_SA	-0.0001	0.0008	-0.1669	0.8681
CPI_SA(-1)	-0.0007	0.0003	-2.4148	0.0197
LSHARE_SA	-0.0636	0.0205	-3.1038	0.0032
LSHARE_SA(-1)	0.0025	0.0020	1.2687	0.2108
LSHARE_SA(-2)	0.0044	0.0013	3.3265	0.0017
UNEMP_SA	0.0008	0.0008	0.9488	0.3476
INT_CPI_UNEMP	-0.0002	0.0001	-1.3840	0.1729
KEYRATE_SQ	0.0011	0.0003	3.6497	0.0007
LSHARE_SA_SQ	0.0071	0.0024	2.9625	0.0048
UNEMP_SA_SQ	-0.0002	5.27E-05	-3.3110	0.0018
CPI_SA_SQ	0.0001	0.0001	0.9501	0.3469
C	0.2780	0.0690	4.0314	0.0002
@TREND	-0.0003	5.92E-05	-4.5001	0.0000
Adjusted R-squared	0.9896			
F-statistic	377.4474	Durbin-Watson stat		1.9810

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.27, the coefficients next to the cpi_sa, the first lag of lshare_sa, unemp_sa, int_cpi_unemp, and cpi_sa_sq are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the cpi_sa_sq and int_cpi_unemp, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.28 presents the results from the Wald Test for Germany.

Wald Test Coefficient Restrictions for Germany

Null hypothesis: cpi_sa= lshare_sa(-1)=unemp_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.28 Wald Test Result for Germany

Test Statistic	Value	df	Probability
F-statistic	0.7915	(3, 47)	0.5047
Chi-square	2.3746	3	0.4984

According to the p-value of the F-statistic in Table 3.28, the null cannot be rejected, and the coefficients next to the cpi_sa, lshare_sa(-1) and unemp_sa are not included in the interpretations. The coefficient next to the keyrate is negative and statistically significant, despite being small. Thus, a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10% income share by approximately 0.0059%. However, the transmission mechanism channels, such as the portfolio-composition, financial segmentation, income composition, and earnings heterogeneity channels cannot be identified. This is because the coefficient next to cpi_sa is negative and insignificant, the coefficient next to the lshare_sa is negative though significant, and that next to the unemp_sa is insignificant.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.29 to 3.32 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.31 and 3.32, the mean values of inflation and unemployment, which are approximately 1.4353% and 5.7228%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate}: -0.0059+2(0.0011)\text{ keyrate}=0 \quad (3.29)$$

From equation 3.29, the value of keyrate that minimizes the top 10 percent income share is approximately 2.6818%.

$$\frac{\partial top10}{\partial lshare_{sa}}: -0.0636+2(0.0071)\text{lshare}_{\text{sa}}=0 \quad (3.30)$$

From equation 3.30, the value of lshare_sa that minimizes the top 10 percent income share is approximately 4.4789.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0008 - 0.0002(1.4353) - 2(0.0002)unemp_{sa} = 0 \quad (3.31)$$

From equation 3.31, the value of unemp_sa that maximizes the top 10 percent income share is approximately 1.2824%.

$$\frac{\partial top10}{\partial cpi_{sa}}: -0.0001 - 0.0002(5.7228) + 2(0.0001)\text{cpi\_sa} = 0 \quad (3.32)$$

From equation 3.32, the value of cpi_sa that minimizes the top 10 percent income share is approximately 6.2228 %.

Since none of the theoretical transmission mechanism channels were captured by the model, it is necessary to test the model for OVB with the help of the Ramsey RESET test. Table 3.29 shows the results from the Ramsey RESET test for Germany's model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.29 Result from the Ramsey RESET Test for Germany's Model

	Value	df	Probability
t-statistic	0.455738	46	0.6507
F-statistic	0.207697	(1, 46)	0.6507

3.9. Results for Hungary

This subsection presents the results of estimations for Hungary. Figure 3.9 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Hungary's top ten percent income share increased from about 0.32 in 2005Q1 its peak of about 0.35 in 2007Q4, after which it declined to its minimum of about 0.3180 in 2012Q4 and followed a mostly increasing trend to reach about 0.34 in 2021Q3. The monetary policy rate in Hungary peaked at about 10% in 2008Q4, declined to about 5.2% in 2010Q2, increased to 7% in 2012Q2, kept declining to reach 0.9% in 2016Q2 and remained constant until 2020Q2, slightly declined again to its minimum of about 0.6% in 2020Q4 but increased to about 1.6% in 2021Q3. Hungary's inflation was fluctuating between its maximum of about 8.6% in 2007Q4 and minimum of about -0.9% in 2015Q1, after which it kept mostly increasing to about 5.0% in 2021Q3. The unemployment rate in Hungary increased from 6.8% in 2005Q1 to its peak of 11.0% in 2010Q2, after which it slightly fluctuated but declined to its minimum of about 3.3% in 2019Q3, increased to 4.5% in 2020Q2 but then declined to 3.8% in 2021Q3. The logarithm of Total Share Price Index in Hungary had a rapid fall from 4.85 in 2007Q4 to its trough of about 4.0 in 2009Q1, rapidly increased to about 4.70 in 2010Q1, slightly fluctuated but increased from about 4.43 in 2015Q1 to its peak of about 5.50 in 2021Q3.

Figure 3.9 Graphs for Hungary's Data

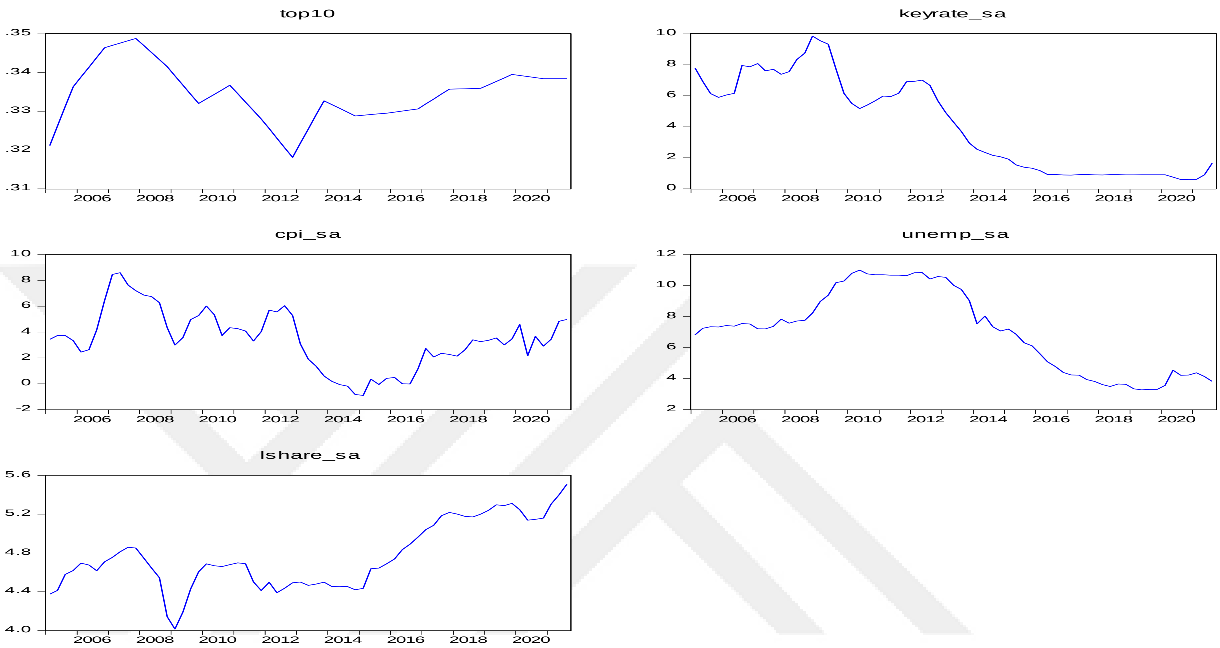

Table 3.30 Results from the ADF, ZA and LS Unit Root Tests for Hungary

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-2.1639	-1.8889	-4.3738 2011Q1	-5.5651*** 2012Q3	-5.7814*** 2012Q1	-2.8189 2013Q4	-3.0901 2008Q1 2013Q4	-3.2306 2013Q3	-5.5674 2007Q1 2013Q1
Keyrate_sa	-1.4915	-1.1719	-3.6724 2012Q4	-3.2877 2018Q1	-3.2621 2013Q3	-2.0295 2008Q3	-2.6317 2009Q4 2012Q4	- 5.5147*** 2013Q2	-6.7562** 2007Q4 2014Q2
Cpi_sa	-1.8480	-1.9638	-3.7267 2012Q4	-3.3944 2015Q4	-4.3816 2013Q1	-2.2505 2012Q4	-2.4309 2012Q4 2019Q4	- 5.7044*** 2013Q4	-5.8361* 2009Q2 2014Q2
Lshare_sa	-0.2226	-1.5335	-3.9289 2008Q1	-4.5996** 2013Q3	-4.8548* 2015Q2	-2.9199 2012Q1	-3.4739* 2008Q3 2011Q2	-4.5971** 2012Q1	-4.9774 2008Q1 2016Q1
Unemp_sa	-1.1578	-2.1989	-3.7308 2008Q4	-3.4543 2009Q3	-3.8948 2008Q4	-1.9415 2014Q3	-2.0303 2014Q1 2014Q3	-3.3663 2013Q1	-4.6942 2008Q3 2014Q3

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.30, all the variables except the unemp_sa are stationary at level, or I (0), when one or two structural breaks are excluded. On the other hand, unemp_sa is shown to be nonstationary at level by all three tests, so an ADF test with neither the intercept nor trend was performed on the differenced form to ensure that it is I (1) and not I (2). Table 3.31 shows the ADF test result on the differenced form of unemp_sa, dunemp_sa for Hungary data.

Table 3.31 ADF Test Result on dunemp_sa for Hungary

Differenced variable	ADF (none)
dunemp_sa	-2.2890**

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.31, he differenced form of the variable is stationary, so it is concluded to be I (1). Due to the combination of I (0) and I (1) variable(s) for the Hungary data, the Bounds test is appropriate. Table 3.32 shows the result from the Bounds Test applied for Hungary.

Table 3.32 Bound Test Result for Hungary

Test Statistic	Value	k
F-statistic	13.3418	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	3.03	4.06
5%	3.47	4.57
2.5%	3.89	5.07
1%	4.4	5.72

According to Table 3.32, since the value of the F statistic exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.33 shows the ARDL Long Run Form for Hungary.

Table 3.33 ARDL Long Run Form for Hungary

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.3684	0.0573	-6.4292	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE_SA	-0.0082	0.0015	-5.5862	0.0000
CPI_SA	0.0024	0.0012	2.0972	0.0419
LSHARE_SA	0.0589	0.0345	1.7095	0.0946
UNEMP_SA	0.0028	0.0018	1.5335	0.1325
INT_CPI_UNEMP	-0.0008	0.0001	-8.0562	0.0000
KEYRATE_SA_SQ	0.0009	0.0009	10.1007	0.0000
LSHARE_SA_SQ	-0.0033	0.0036	-0.9196	0.3629
CPI_SA_SQ	0.0004	0.0001	6.2791	0.0000
UNEMP_SA_SQ	0.0001	0.0001	0.9723	0.3363
C	0.1339	0.0851	1.5729	0.1231

@TREND	-0.0004	0.0009	-4.7499	0.0000

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.33, the coefficient of the cointegrating equation is negative, less than one and statistically significant. Additionally, the coefficients next to the lshare_sa, unemp_sa, lshare_sa_sq, unemp_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lshare_sa_sq and unemp_sa_sq, although insignificant, is not included due to the risk of a multicollinearity problem. Table 3.34 shows the results from the Wald Test performed on the data for Hungary.

Wald Test Coefficient restrictions for Hungary

Null hypothesis: lshare_sa= unemp_sa =0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.34 Wald Test Result for Hungary

Test Statistic	Value	df	Probability
F-statistic	4.5956	(2, 43)	0.0155
Chi-square	9.1912	2	0.0101

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.34, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the lshare_sa and unemp_sa are included in the interpretations. The coefficient next to the keyrate_sa is negative and statistically significant, so the effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is a decrease in the top 10 percent income share by 0.0082%. The financial segmentation and income composition channels have been captured by this model since a 1% increase in lshare_sa leads to a 0.0589% increase in the top ten percent income share. The portfolio composition channel is reflected through the positive and statistically significant of the coefficient next to the cpi_sa, which indicates that a 1% increase in inflation leads to a 0.0024% increase in the top ten percent income share. The positive and significant effect of unemp_sa (0.0028%) reflects the earnings heterogeneity channel.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.33 to 3.36 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.35 and 3.36, the mean values of unemployment and inflation, which are approximately 7.0904% and 3.4131%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0082+2(0.0009)\text{ keyrate\_sa}=0 \quad (3.33)$$

From equation 3.33, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 4.5556%.

$$\frac{\partial top10}{\partial lshare_{sa}}: 0.0589 - 2(0.0033)\text{lshare}_{\text{sa}} = 0 \quad (3.34)$$

From equation 3.34, the value of lshare_sa that maximizes the top 10 percent income share is approximately 8.9242.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0024 - 0.0008(7.0904) + 2(0.0004)cpi_{sa} = 0 \quad (3.35)$$

From equation 3.35, the value of cpi_sa that minimizes the top 10 percent income share is approximately 4.0904%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0028 - 0.0008(3.4131) + 2(0.0001)\text{unemp\_sa} = 0 \quad (3.36)$$

From equation 3.36, the value of unemp_sa that minimizes the top 10 percent income share is approximately -0.3476%.

Since inequality-minimizing value of unemployment is ambiguous, i.e it is negative, it is necessary to test the model for the OVB with the help of the Ramsey RESET test. Table 3.35 presents the results from the Ramsey RESET test for Hungary’s model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.35 Result from the Ramsey RESET Test for Hungary’s Model

	Value	df	Probability
t-statistic	0.262748	45	0.7939
F-statistic	0.069036	(1, 45)	0.7939

3.10. Results for Iceland

This subsection presents the results of estimations for Iceland. Figure 3.10 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Iceland’s top ten percent income share peaked at about 0.35 in 2007Q4, declined to its minimum of about 0.27 in 2010Q4, increased to about 0.30 in 2013Q4, slightly declined to about 0.29 in 2017Q4 and remained constant. The monetary policy rate in Iceland varied at a relatively large scale between about 0.7% and 18% throughout the sampling period. It peaked at about 18% in 2008Q4, declined to about 3.6% in 2011Q2, slightly fluctuated, declined to reach its minimum of about 0.7% in 2020Q4 and slightly increased to end up at approximately 1.2% in 2021Q3. Iceland's inflation had a relatively low variance except for when it peaked about 17% in 2008Q4, after which it declined to reach about 2% in 2011Q1, increased again to about 7% in 2012Q1, declined to its minimum of about 1 % in 2015Q1, and gradually rose to end up at about 4.2% in 2021Q3. The unemployment rate in Iceland had large fluctuations despite a relatively small scale. It had its minimum of about 2 % in 2007Q1, sharply increased to reach its peak of about 9% in 2010Q4, declined to about 3 % in 2018Q4, sharply increased again to about 8.5% in 2020Q4, and fell to end up at about 5% in 2021Q3. The logarithm of Total Share Price index in Iceland had a relatively large scale. It started out with an increasing trend to peak at about 6.45 in 2007Q4, sharply fell to its trough of about 3.60 in 2009Q2, after which it gradually increased to about 5.35 in 2021Q3.

Figure 3.10 Graphs for Iceland's Data

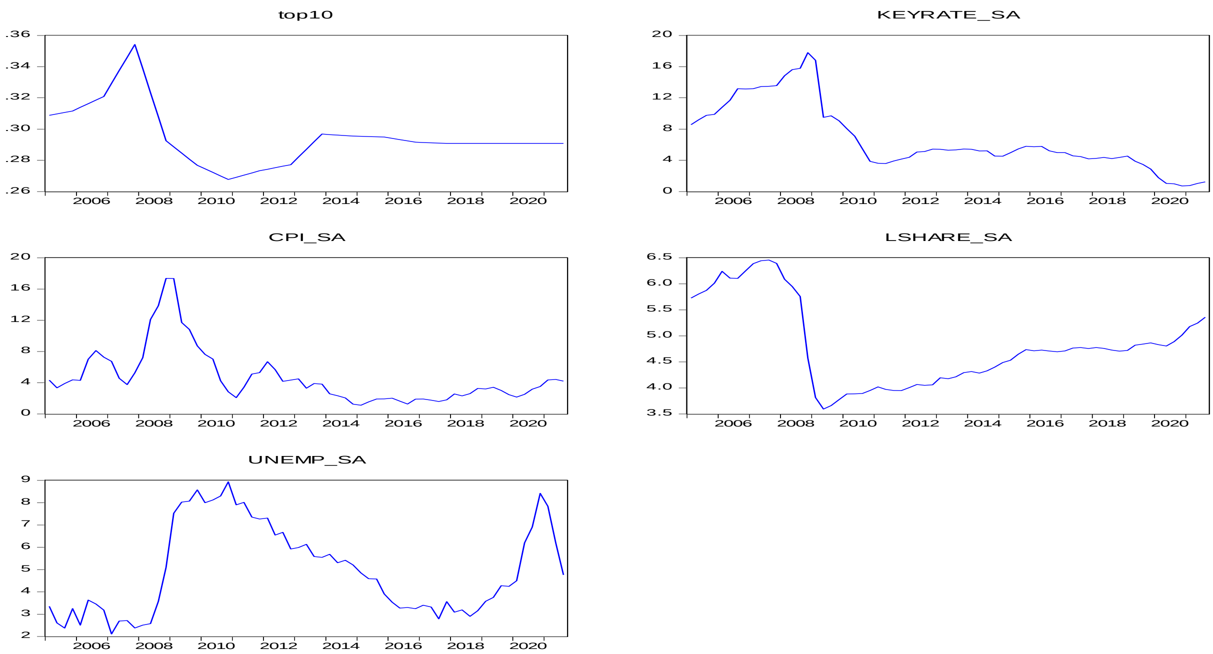

Table 3.36 Results from the ADF, ZA and LS Unit Root Tests for Iceland

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-2.7770*	-2.9101	-7.5982*** 2008Q1	-4.3538* 2010Q3	-4.8561* 2013Q1	-3.5571** 2008Q3	-4.7967*** 2008Q1 2008Q4	-4.5284** 2009Q1	-5.7625 2009Q1 2013Q4
Keyrate_sa	-1.0340	-2.7632	-6.2003*** 2009Q2	-3.6363 2011Q2	-7.3397*** 2009Q2	-3.7842** 2009Q2	-4.0790*** 2009Q2 2009Q4	-3.7278 2009Q4	-4.7002 2009Q4 2013Q2
Cpi_sa	-1.4493	-2.2555	-3.7414 2010Q2	-2.9555 2016Q2	-5.0908** 2010Q2	-2.5327 2009Q2	-2.8856 2009Q2 2009Q4	-4.9304*** 2009Q4	-6.3621** 2007Q3 2009Q4
Lshare_sa	-2.3613	-1.9166	-12.0656*** 2008Q4	-4.5535** 2009Q2	-13.0095*** 2008Q4	-3.1148 2008Q3	-3.2675 2008Q3 2009Q4	-4.6479** 2009Q4	-9.1025*** 2008Q2 2010Q3
Unemp_sa	-2.6006*	-2.5683	-4.1131 2008Q3	-3.3499 2009Q2	-4.0793 2008Q3	-2.5890 2010Q2	-2.6140 2007Q1 2010Q2	-3.4104 2011Q4	-4.4619 2009Q3 2018Q3

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the results from the three unit root tests in Table 3.36, all the variables, except unemp_sa, are stationary at level, or I (0). There is insufficient evidence that unemp_sa is I (0), since ADF test showed stationarity at only 10 % level of significance, Therefore, an ADF test with neither trend nor intercept was conducted on the first difference of the variable, dunemp_sa. Table 3.37 shows the ADF test result for dunemp_sa for Iceland data.

Table 3.37 ADF Test Result for dunemp_sa for Iceland

Differenced variable	ADF (none)
Dunemp_sa	-5.9237***

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.37, unemp_sa is concluded to be non-stationary at level, or I (1). Thus, the Bounds test approach is appropriate. Table 3.38 shows the result from the ARDL Bounds Test for Iceland.

Table 3.38 ARDL Bound Test Result for Iceland

Test Statistic	Value	k
F-statistic	27.4400	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	3.03	4.06
5%	3.47	4.57
2.5%	3.89	5.07

1%	4.4	5.72	

According to Table 3.38, since the value of the F statistic exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.39 shows the ARDL Long Run Form for Iceland.

Table 3.39 ARDL Long Run Form for Iceland

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.3869	0.0706	-5.4800	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE_SA	0.0099	0.0020	4.9348	0.0000
CPI_SA	-0.0086	0.0018	-4.7098	0.0000
LSHARE_SA	-0.2611	0.0755	-3.4562	0.0013
UNEMP_SA	0.0080	0.0029	2.7591	0.0088
INT_CPI_UNEMP	-0.0006	0.0002	-2.8962	0.0062
KEYRATE_SA_SQ	-0.0006	0.0002	-3.4332	0.0014
LSHARE_SA_SQ	0.0283	0.0077	3.6769	0.0007
CPI_SA_SQ	0.0011	0.0002	4.5835	0.0000
UNEMP_SA_SQ	-0.0004	0.0003	-1.5628	0.1262
C	0.8058	0.1835	4.3909	0.0001
@TREND	0.0010	0.0001	6.7607	0.0000

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.39, the coefficient of the cointegrating equation is negative, less than one and statistically significant. Additionally, all the long-run coefficients are significant at a 1 % level of significance. The only exception is unemp_sa_sq; however, the Wald Test cannot be applied since it is the only insignificant coefficient. The coefficient next to the keyrate_sa is positive and statistically significant, so the effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is an increase in the top 10 percent income share by approximately 0.0099%. Due to the negative coefficients of cpi_sa and lshare_sa, the portfolio composition, income composition, and financial segmentation channels are not present in Iceland. Nevertheless, the positive coefficient of unemp_sa reflects the earnings heterogeneity channel, indicating that a 1 % increase in unemployment leads to about 0.0080% increase in the top 10 percent income share.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.37 to 3.40 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.39 and 3.40, the mean values of unemployment and inflation, which are approximately 4.9655% and 4.6539%, respectively, were inserted into the interaction term.

$\frac{\partial top10}{\partial keyrate_{sa}}$: 0.0099-2(0.0006)keyrate_sa=0 (3.37)

From equation 3.37, the value of keyrate_sa that maximizes the top 10 percent income share is approximately 8.25%.

$\frac{\partial top10}{\partial lshare_{sa}}: -0.2611 + 2(0.0283)\mathrm{lshare}_{sa} = 0$ (3.38)

From equation 3.38, the value of lshare_sa that minimizes the top 10 percent income share is approximately 4.6131%.

$\frac{\partial top10}{\partial cpi_{sa}}: -0.0086 - 0.0006(4.9655) + 2(0.0011)cpi_{sa} = 0$ (3.39)

From equation 3.39, the value of cpi_sa that minimizes the top 10 percent income share is approximately 5.2633%.

$\frac{\partial top10}{\partial unemp_{sa}}$: $0.0080 - 0.0006(4.6539) - 2(0.0004)$unemp_sa =0 (3.40)

From equation 3.40, the value of unemp_sa that maximizes the top 10 percent income share is approximately 6.5096%.

3.11. Results for Indonesia

This subsection presents the results of estimations for Indonesia. Figures 3.11 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Indonesia's top ten percent income share started out at its minimum of about 0.42 but increased to reach its peak of approximately 0.48 in 2009Q4, fell to 0.43 in 2010Q4, slightly increased to about 0.45 in 2015Q4, fell back to its minimum in 2017Q4, rose sharply to 0.47 in 2017Q4 and remained constant. The monetary policy rate in Indonesia had a generally decreasing trend from its peak of about 13% in 2006Q1 to about 3.5% in 2021Q3. Indonesia's inflation had a relatively large scale. It increased sharply from about 8% in 2005Q3 to its peak of about 17.5% in 2005Q4, after which sharply declined to reach 6% in 2006Q4, rose again to about 7.8% in 2008Q3, declined to about 2.5% in 2009Q4, continued moderate fluctuations and finally reached its minimum of about 1.5% in 2021Q3. The unemployment rate in Indonesia started out at its peak of about 8% in 2005Q3, slightly fell to about 7.5% in 2007Q2, returned to its maximum within four quarters and from then on had a generally declining trend to reach its minimum of about 3.5% in 2019Q2, after which it slightly increased to end up at about 4.5% in 2021Q3. The logarithm of Total Share Price index in Indonesia started at its minimum of about

3.10, increased to about 4.0 in 2008Q1, sharply fell to about 3.30 in 2008Q4, after which it kept increasing to its peak of about 4.85 in 2019Q2, slightly fell to about 4.60 in 2020Q2, but increased back to its maximum in 2021Q3.

Figure 3.11 Graphs for Indonesia's Data

Table 3.40 Results from the ADF, ZA and LS Unit Root Tests for Indonesia

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-2.2576	-2.4551	-3.7969 2018Q1	-3.6325 2017Q3	-3.8790 2016Q1	-3.9717** 2010Q3	-4.2199*** 2010Q3 2018Q3	-4.1226* 2010Q3	-6.1448** 2010Q1 2018Q2
Keyrate_sa	-1.2881	-2.4062	-6.2190*** 2013Q3	-4.8027*** 2018Q3	-5.4023** 2013Q3	-5.6765*** 2013Q2	-5.6436*** 2013Q2 2019Q2	-6.2671*** 2013Q2	-6.4148* 2013Q2 2016Q2
Cpi_sa	-1.7438	-2.6446	-7.3220*** 2013Q3	-6.1084*** 2018Q4	-7.0247*** 2013Q2	-4.7788*** 2013Q2	-4.9082*** 2013Q2 2015Q3	-4.7744** 2013Q2	-8.2848*** 2008Q4 2013Q2
Lshare_sa	-1.8885	-1.7566	-4.8770* 2010Q3	-4.7724** 2013Q2	-5.0273* 2010Q3	-3.4293* 2010Q3	-3.8133** 2009Q1 2010Q3	-4.7258** 2014Q2	-5.4972 2008Q2 2011Q1
Unemp	-2.4467	0.0929	-2.9922 2008Q3	-4.4846** 2011Q4	-3.8765 2011Q3	-1.6585 2007Q2	-1.7734 2007Q2 2014Q2	-2.8449 2009Q1	-4.6213 2011Q2 2018Q2

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root test results in Table 3.40, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.41 presents the results from the ARDL model estimation for Indonesia.

Table 3.41 ARDL Model for Indonesia

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.1265	0.1075	10.4800	0.0000
TOP10(-2)	-0.0073	0.1651	-0.0444	0.9648
TOP10(-3)	0.1411	0.1110	1.2706	0.2112
TOP10(-4)	-0.2176	0.0944	-2.3035	0.0265
KEYRATE_SA	0.0222	0.0047	4.7205	0.0000
KEYRATE_SA(-1)	-0.0023	0.0020	-1.1486	0.2575
KEYRATE_SA(-2)	-0.0028	0.0013	-2.1263	0.0397
CPI_SA	-0.0024	0.0015	-1.6644	0.1039
CPI_SA(-1)	0.0021	0.0004	5.2888	0.0000
CPI_SA(-2)	0.0016	0.0004	4.4037	0.0001
CPI_SA(-3)	0.0010	0.0003	3.8145	0.0005
CPI_SA(-4)	0.0008	0.0002	3.5295	0.0011
LSHARE_SA	-0.0413	0.0230	-1.7942	0.0803
LSHARE_SA(-1)	0.0273	0.0072	3.8116	0.0005
UNEMP	0.0155	0.0047	3.3022	0.0020
INT_CPI_UNEMP	-0.0002	0.0002	-1.0566	0.2970
KEYRATE_SA_SQ	-0.0019	0.0004	-4.7221	0.0000
CPI_SA_SQ	0.0004	0.0001	2.8036	0.0078
LSHARE_SA_SQ	0.0054	0.0031	1.7731	0.0838
UNEMP_SQ	-0.0003	0.0004	-0.7710	0.4452
C	-0.1792	0.0575	-3.1163	0.0034
Adjusted R-squared	0.9754			
F-statistic	120.1169	Durbin-Watson stat		1.9290

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.41, the coefficients next to the first lag of keyrate_sa, cpi_sa, lshare_sa, the interaction term, lshare_sa_sq, and unemp_sq are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the first lag of keyrate_sa, interaction term, and lshare_sa_sq, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.42 presents the results from the Wald Test conducted for Indonesia data.

Wald Test Coefficient Restrictions for Indonesia

Null hypothesis: cpi_sa=lshare_sa=unemp_sq=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.42 Wald Test Result for Indonesia

Test Statistic	Value	df	Probability
F-statistic	2.4873	(3, 40)	0.0743
Chi-square	7.4620	3	0.0585

According to the p-value of the F-statistic in Table 3.42, the null cannot be rejected at a 5 % level of significance, and the coefficients next to cpi_sa, lshare_sa, and unemp_sq are not included in the interpretations. The collective effect of the coefficients next to keyrate_sa and its second lag is positive and statistically significant, despite being small. Thus, a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to an increase in the top 10% income share by approximately 0.0194 % within two quarters. The collective effect of the coefficients next to the four lags of cpi_sa is positive and significant (about 0.0055% within four quarters), and this indicates the presence of the portfolio composition channel. The coefficient next to the first lag of lshare_sa is positive and significant (about 0.0273%), and this indicates the presence of the financial segmentation and income composition channels. The effect of unemployment on the top ten percent income share in the same quarter is positive (about 0.0155%) and significant, and this means that the earnings heterogeneity channel is present, too.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.41 to 3.44 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.42 and 3.44, the mean values of unemployment and inflation, which are approximately 5.2216% and 5.6319%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: 0.0222-2(0.0019)\text{keyrate\_sa}=0 \quad (3.41)$$

From equation 3.41, the value of keyrate_sa that maximizes the top 10 percent income share is approximately 5.8421%.

$$\frac{\partial top10}{\partial cpi_{sa}}: -0.0024-0.0002(5.2216)+2(0.0004)cpi_{sa}=0 \quad (3.42)$$

From equation 3.42, the value of cpi_sa that minimizes the top 10 percent income share is approximately 4.3054%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: -0.0413+2(0.0054)\text{lshare}_{\text{sa}}=0 \quad (3.43)$$

From equation 3.43, the value of lshare_sa that minimizes the top 10 percent income share is approximately 3.8241%.

$$\frac{\partial top10}{\partial unemp}: 0.0155-0.0002(5.6319)-2(0.0003)unemp=0 \quad (3.44)$$

From equation 3.44, the value of unemp that maximizes the top 10 percent income share is approximately 23.9560%.

3.12. Results for Japan

This subsection presents the results of estimations for Japan. Figure 3.12 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Japan's top ten percent income share had a relatively small scale but experienced a sharp decline from its peak of about 0.4530 in 2007Q4 to about 0.4350 in 2009Q4, after which slightly rose to about 0.4430 and remained almost constant. The monetary policy rate in Japan had a very small scale but increased sharply from its minimum of about 0.10 in 2006Q2 to its maximum of about 0.80 in 2007Q4, after which it sharply declined to about 0.30 in 2008Q4 and remained almost constant. Japan's inflation varied between low negative and positive values but had some fluctuations. It increased from about 0% in 2007Q3 to about 2.2% in 2008Q3, after which it swiftly fell to its minimum of about -2.2% in 2009Q3, gradually increased to peak at about 3.7% in 2014Q2, declined to about -0.5% 2016Q3, slightly increased and ended up at about 0%. The unemployment rate in Japan had a relatively small scale but increased from about 4% in 2008Q1 to its maximum of about 5.3% in 2009Q3, kept declining to its minimum of about 2.20% in 2019Q4, and slightly increased to about 2.70% in 2021Q3. The logarithm of Total Share Price Index in Japan fell from about 4.70 in 2007Q2 to its minimum of about 3.90 in 2009Q1, slightly increased but then returned to its minimum in 2012Q1, after which it followed a generally increasing trend to end up at its maximum of about 4.85 in 2021Q3.

Figure 3.12 Graphs for Japan's Data

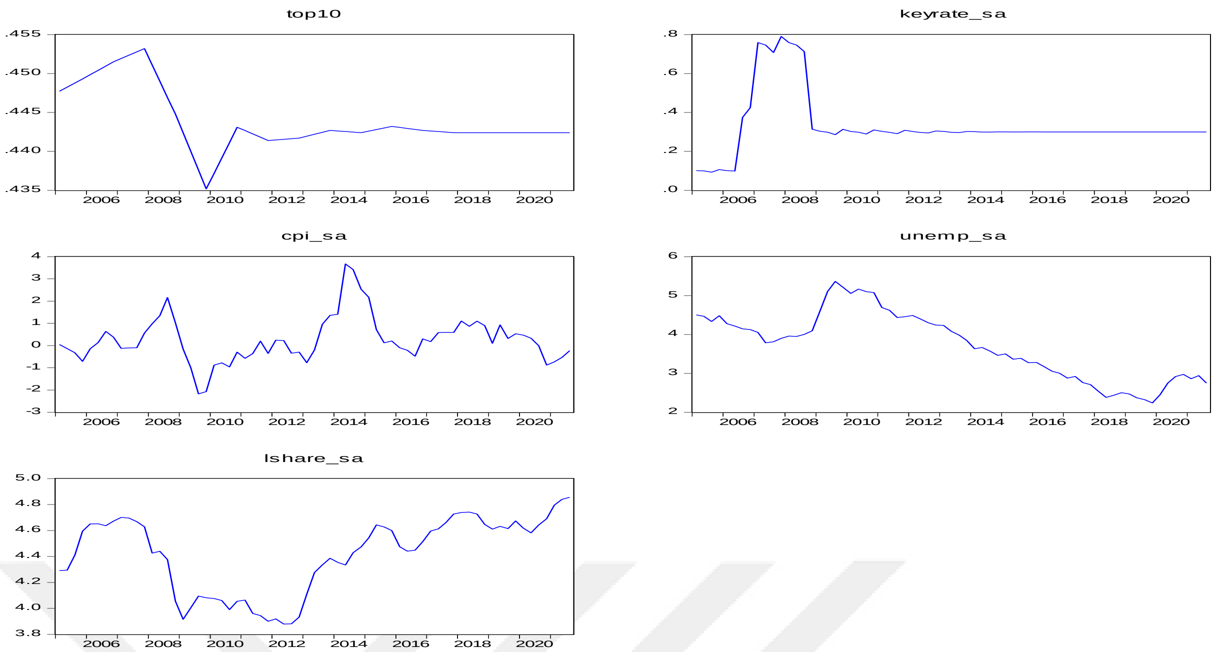

Table 3.43 Results from the ADF, ZA and LS Unit Root Tests for Japan

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-2.6293*	-2.4678	-6.8075*** 2008Q1	-5.1267*** 2009Q3	Near Singular Matrix Error	-4.2221*** 2008Q2	-4.5901*** 2008Q2 2010Q4	-5.7879*** 2008Q4	-10.6329*** 2008Q3 2011Q4
Keyrate_sa	-4.1594***	-5.5404***							
Cpi_sa	-2.4985	-2.6151	-4.5710 2013Q2	-2.9839 2015Q2	-4.5084 2013Q2	-4.8383*** 2013Q2	-5.0593*** 2011Q4 2013Q2	-5.3347*** 2011Q4	-6.6628** 2013Q1 2016Q1
Lshare_sa	-1.2423	-2.2197	-4.6418* 2008Q3	-4.5862** 2010Q1	-5.2935** 2013Q1	-2.8971 2008Q1	-3.0481 2008Q1 2012Q1	-3.2257 2008Q3	-4.8768 2007Q4 2013Q3
Unemp_sa	-0.6646	-2.2751	-4.2220 2009Q1	-4.0566 2009Q3	-4.9799* 2009Q1	-3.0133 2011Q1	-2.9779 2011Q1 2012Q3	-4.1478* 2012Q4	-5.2429 2010Q3 2017Q1

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.43, all the variables, except unemp_sa, are stationary at level, or I (0), according to the three unit root tests. There is insufficient evidence that unemp_sa is I (0), since the ZA and LM tests showed stationarity at only 10 % level of significance, Therefore, an ADF test with neither trend nor intercept was conducted on the first difference of the variable, dunemp_sa. Table 3.44 presents the ADF test result for dunemp_sa for Japan.

Table 3.44 ADF Test Result for dunemp_sa for Japan

Differenced variable	ADF (none)
Dunemp_sa	-2.6948***

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.44, unemp_sa is concluded to be non-stationary at level, or I (1). Thus, the Bounds test approach is appropriate. Table 3.45 shows the Bounds test result for Japan. According to Table 3.45, since the value of the F statistic exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.46 shows the ARDL Long Run Form for Japan.

Table 3.45 ARDL Bound Test Result for Japan

Test Statistic	Value	k
F-statistic	6.7540	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Table 3.46 ARDL Long Run Form for Japan

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.1637	0.0506	-3.2359	0.0024
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE_SA	-0.0410	0.0123	-3.3222	0.0019
CPI_SA	-0.0082	0.0024	-3.4160	0.0015
LSHARE_SA	0.0723	0.0403	1.7947	0.0803
UNEMP_SA	-0.0142	0.0055	-2.5759	0.0138
INT_CPI_UNEMP	0.0027	0.0007	3.9067	0.0004
KEYRATE_SA_SQ	0.0292	0.0176	1.6531	0.1061
CPI_SA_SQ	-0.0006	0.0002	-3.8725	0.0004
LSHARE_SA_SQ	-0.0072	0.0045	-1.6090	0.1155
UNEMP_SA_SQ	0.0025	0.0009	2.9717	0.0050
C	0.2915	0.0874	3.3371	0.0018

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.46, the coefficient of the cointegrating equation is negative, less than one and statistically significant. Additionally, the coefficients next to lshare_sa, keyrate_sa_sq and lshare_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficient next to the lshare_sa_sq, although insignificant, is not included due to the risk of a multicollinearity problem. Table 3.47 presents the results from the Wald Test performed on Japan data.

Wald Test Coefficient Restrictions for Japan

Null hypothesis: lshare_sa= keyrate_sa_sq =0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.47 Wald Test Result for Japan

Test Statistic	Value	df	Probability
F-statistic	3.5354	(2, 40)	0.0386
Chi-square	7.0708	2	0.0291

Note: The highlighted values are statistically significant at a 5 % level of significance.

According to the p-value of the F-statistic in Table 3.47, the null hypothesis is rejected at a 5 % level of significance, and the coefficient next to lshare_sa is included in the interpretations. The coefficient next to the keyrate_sa is negative and statistically significant, so the effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is a decrease in the top 10 percent income share by about 0.0410%. Additionally, the financial segmentation and income composition channels have been captured by this model since a 1% increase in lshare_sa leads to an approximately 0.0723% increase in the top ten percent income share.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.45 to 3.48 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.46 and 3.48, the mean values of unemployment and inflation, which are approximately 3.7184% and 0.2596%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0410+2(0.0292)\text{keyrate\_sa}=0 \tag{3.45}$$

From equation 3.45, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 0.7021%.

$$\frac{\partial top10}{\partial cpi_{sa}}: -0.0082+0.0027(3.7184)-2(0.0006)cpi_{sa}=0 \tag{3.46}$$

From equation 3.46, the value of cpi_sa that maximizes the top 10 percent income share is approximately 1.5331%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: 0.0723 - 2(0.0072)\text{lshare}_{\text{sa}} = 0 \tag{3.47}$$

From equation 3.47, the value of lshare_sa that maximizes the top 10 percent income share is approximately 5.0208%.

$$\frac{\partial top10}{\partial unemp_{sa}}: -0.0142 + 0.0027(0.2596) + 2(0.0025)unemp_{sa} = 0 \tag{3.48}$$

From equation 3.48, the value of unemp_sa that minimizes the top 10 percent income share is approximately 2.6998%.

3.13. Results for Mexico

This subsection presents the results of estimations for Mexico. Figure 3.13 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Mexico's top ten percent income share sharply increased from about 0.59 in 2007Q1 to its peak of about 0.65 in 2008Q4, fell to 0.625 in 2010Q4, fluctuated but returned to its peak in 2018Q4, fell to about 0.64 in 2020Q4 and remained constant. The monetary policy rate in Mexico started out from its peak of about 10% in 2005Q1, declined to about 7% in 2006Q4, then rose to about 8.2% in 2008Q3, declined to about 4.5% in 2009Q4, slightly fluctuated fell to its minimum of about 3% in 2014Q2, increased to about 8.2% in 2018Q4, fell to 4% in 2021Q1, and slightly increased to end up at 4.5% in 2021Q3. The inflation rate in Mexico had some fluctuations despite a relatively small scale. It increased sharply from about 3.7% in 2007Q4 to about 6.3% in 2009Q1, fell again to about 4% in 2009Q4, slightly increased but fell to its minimum of about 2.3% in 2015Q4, rose to its maximum of about 6.7% in 2017Q4, fell to about 2.7% in 2020Q2, then increased to end up at about 5.7% in 2021Q3. The unemployment in Mexico had small scale, too, but some fluctuations. It increased from its trough of about 3.20% in 2005Q4 to its peak of about 5.70% in 2009Q3, then followed a relatively smooth declining trend back to its minimum in 2018Q1, increased to about 4.75% in 2020Q2, after which it fell to end up at about 3.90% in 2021Q3. The logarithm of Total Share Price Index in Mexico started out from its minimum of about 3.40 in 2005Q1, increased to about 4.25 in 2007Q4, fell to about 3.80 in 2009Q1, after which increased back to 4.25 in 2009Q4, followed a generally increasing but slightly fluctuating trend and ended up at its peak of about 4.80 in 2021Q3.

Figure 3.13 Graphs for Mexico's Data

Table 3.48 Results from the ADF, ZA and LS Unit Root Tests for Mexico

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-3.9482***	-4.1631***							
Keyrate_sa	-2.0306	-1.9349	-4.6875* 2016Q1	-3.5870 2013Q2	-4.2995 2016Q3	-2.2848 2015Q4	-2.2935 2015Q4 2019Q4	-4.5193** 2016Q1	-5.3324 2013Q3 2017Q3
Cpi_sa	-3.3643**	-3.3032*							
Lshare_sa	-2.2904	-2.7725	-5.2627** 2009Q2	-4.8876*** 2014Q3	-4.8589* 2014Q4	-2.6752 2008Q1	-2.7220 2008Q1 2019Q2	-3.9033 2009Q4	-5.3591 2008Q1 2012Q4
Unemp_sa	-2.0105	-2.2610	-3.5551 2008Q3	-3.4067 2009Q3	-3.7437 2008Q4	-2.0827 2008Q4	-2.1331 2008Q4 2011Q1	-3.1134 2009Q2	-4.5043 2009Q2 2019Q4

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

Table 3.48 shows that unemp_sa is nonstationary at level, according to all three tests, while the other variables have been proven to be I(0), according to the ADF or the ZA and LM unit root tests that exclude 1 or 2 structural breaks. An ADF test with neither the intercept nor trend is performed on the differenced form of the unemp_sa, dunemp_sa to make sure that the variable is I(1), and not I(2). Table 3.49 shows the ADF test result for dunemp_sa for Mexico.

Table 3.49 ADF Test Result for dunemp_sa for Mexico

Differenced variable	ADF (none)
dunemp_sa	-2.8003***

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

Table 3.49 shows that unemp_sa is I(1) at a 1 percent level of significance. The combination of I(0) and I(1) variables allows for the Bounds Test approach in the ARDL framework. Table 3.50 shows the ARDL Bounds Test result for Mexico.

Table 3.50 ARDL Bound Test Result for Mexico

Test Statistic	Value	k
F-statistic	8.9779	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Since the value of the F statistic in Table 3.50 exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.51 shows the ARDL Long Run Form for Mexico.

Table 3.51 ARDL Long Run Form for Mexico

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.1241	0.0257	-4.8259	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE_SA	0.0089	0.0064	1.3878	0.1720
CPI_SA	0.0310	0.0189	1.6362	0.1088
LSHARE_SA	0.7671	0.2144	3.5786	0.0008
UNEMP_SA	0.0612	0.0453	1.3508	0.1835
UNEMP_SA_SQ	-0.0052	0.0046	-1.1392	0.2606
LSHARE_SA_SQ	-0.0859	0.0255	-3.3623	0.0016
KEYRATE_SA_SQ	-0.0006	0.0007	-0.8409	0.4048
INT_CPI_UNEMP	-0.0039	0.0029	-1.3551	0.1821
CPI_SA_SQ	-0.0011	0.0016	-0.7081	0.4825
C	-1.3024	0.4840	-2.6910	0.0100

Note: The highlighted values are statistically significant at a 5 % level of significance

Table 3.51 shows that the coefficient of the cointegrating equation is negative, less than one and statistically significant. Additionally, the coefficients next to keyrate_sa, cpi_sa, unemp_sa, unemp_sa_sq, keyrate_sa_sq, int_cpi_unemp, and cpi_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the interaction and squared terms, although insignificant, are not included due to the risk of a multicollinearity problem. Table 3.52 shows the Wald Test result for Mexico.

Wald Test Coefficient Restrictions for Mexico

Null hypothesis: keyrate_sa=cpi_sa=unemp_sa =0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.52 Wald Test Result for Mexico

Test Statistic	Value	df	Probability
F-statistic	4.1531	(3, 45)	0.0111
Chi-square	12.4593	3	0.0060

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.52, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, cpi_sa, and unemp_sa are included in the interpretations.

The coefficient next to the keyrate_sa is positive and statistically significant, despite being small. Thus, the effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is an increase in the top 10 percent income share by 0.0089%. All the transmission mechanisms appear to be present in this model, since the coefficients next to the lshare_sa, cpi_sa, and unemp_sa are positive and statistically significant. Firstly, a 1 % increase in the logarithm of Total Share Price Index leads to an approximately 0.7671% increase in the top ten percent income share. Secondly, a 1% increase in inflation leads to about 0.0310% increase in the top ten percent income share. Finally, a 1% increase in unemployment results in an approximately 0.0612% increase in the top ten percent income share.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.49 to 3.52 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.50 and 3.52, the mean values of unemployment and inflation, which are approximately 4.2381% and 4.1179%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: 0.0089 - 2(0.0006)\text{keyrate\_sa}=0 \quad (3.49)$$

From equation 3.49, the value of keyrate_sa that maximizes the top 10 percent income share is approximately 7.4167%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0310 - 0.0039(4.2381) - 2(0.0011)cpi_{sa} = 0 \quad (3.50)$$

From equation 3.50, the value of cpi_sa that maximizes the top 10 percent income share is approximately 6.5779%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: 0.7671 - 2(0.0859)\text{lshare}_{\text{sa}} = 0 \quad (3.51)$$

From equation 3.51, the value of lshare_sa that maximizes the top 10 percent income share is approximately 4.4651.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0612 - 0.0039(4.1179) - 2(0.0052)unemp_{sa}=0 \quad (3.52)$$

From equation 3.52, the value of unemp_sa that maximizes the top 10 percent income share is approximately 4.3404%.

3.14. Results for Norway

This subsection presents the results of estimations for Norway. Figure 3.14 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Norway's top ten percent income share peaked at about 0.343 in 2008Q4, sharply declined to about 0.31 in 2009Q4, increased in the following quarters, returned to 0.31 in 2015Q4, increased to 0.32 in 2018Q4, declined to its minimum of about 0.30 in 2020Q4 and finally slightly increased in 2021Q3. The monetary policy rate in Norway started out from about 1.8% in 2005Q1, increased to its peak of about 5.7% in 2008Q2, sharply declined to 1.2% in 2009Q, and kept slightly fluctuating to end up at its minimum of about 0%. The inflation rate in Norway underwent high fluctuations despite a relatively small scale between 0% and 5%. It sharply increased from its minimum of 0% in 2007Q2 to about 5% in 2008Q2, declined to about 2.3% in 2009Q1, returned close to its minimum value in 2012Q3, and kept fluctuating to end up at about 3.5% in 2021Q3. The unemployment in Norway had small scale, too, but relatively high fluctuations. It declined from about 4.6% in 2005Q3 to its minimum of about 2.4% in 2007Q4, maintained a generally increasing trend to reach its peak of about 5% in 2016Q1, declined to about 3.45% in 2019Q2, returned to its peak in 2020Q3, and declined to about 4% in 2021Q3. The logarithm of Total Share Price Index in Norway had a relatively large scale. It fell sharply from about 4.4 in 2008Q2 to about 3.7 in 2009Q1 and maintained a generally increasing trend to end up at its peak of about 5.2 in 2021Q3.

Figure 3.14 Graphs for Norway's Data

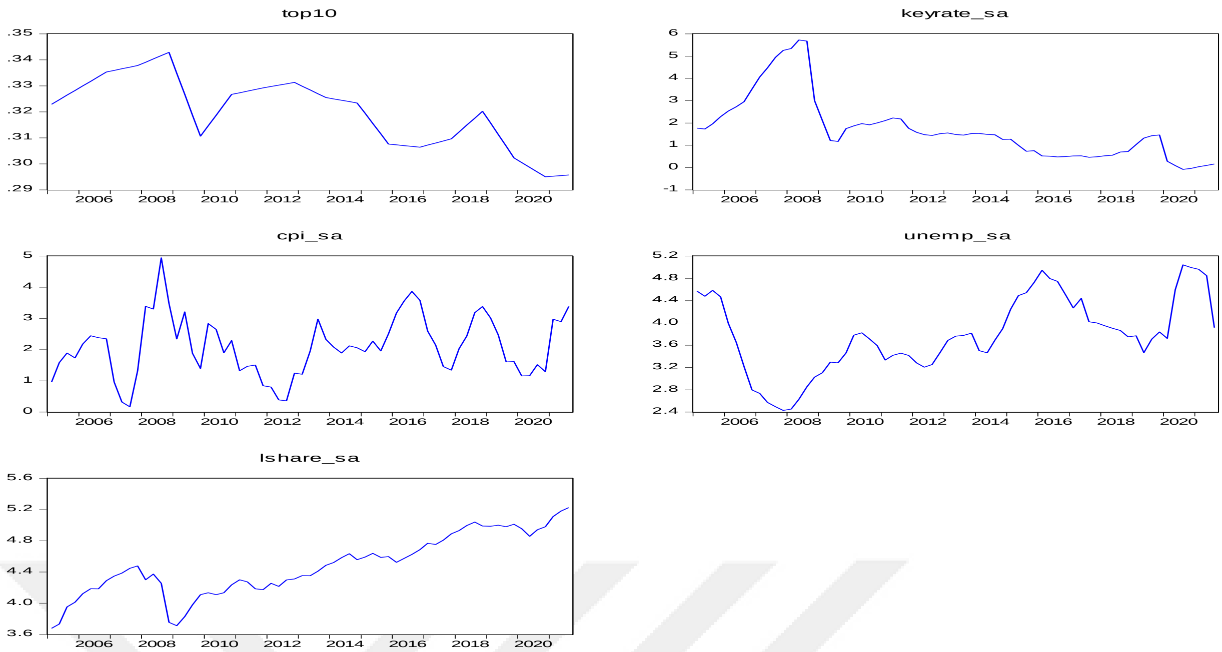

Table 3.53 Results from the ADF, ZA and LS Unit Root Tests for Norway

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-0.1652	-4.2246***							
Keyrate_sa	-1.8482	-3.8743**							
Cpi_sa	-2.8838*	-2.9376	-3.8063 2010Q3	-3.0960 2012Q3	-4.0616 2010Q3	-2.7462 2009Q2	-3.0705 2007Q3 2009Q2	-4.3699** 2010Q1	-8.2648*** 2010Q2 2016Q2
Lshare_sa	-1.3232	-3.0894	-7.1359*** 2008Q3	-4.6635** 2009Q3	-6.9816*** 2008Q3	-3.0483 2009Q2	-3.2469 2007Q1 2008Q1	-4.6833** 2009Q3	-6.8532*** 2008Q2 2010Q3
Unemp_sa	-2.2613	-3.2812*	-4.0515 2017Q3	-3.8828 2016Q4	-4.3807 2014Q3	-2.1884 2019Q1	-3.2590 2017Q3 2019Q1	-4.8138** 2015Q3	-6.4073** 2009Q2 2017Q1

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the Augmented Dickey-Fuller (ADF), Zivot Andrews (ZA), and Lee Strazicich LM unit root test results in Table 3.53, all the variables are stationary at level, or I(0) at at least 5% level of significance. Therefore, a standard ARDL model is built. Table 3.54 shows the results from the ARDL model for Norway.

Table 3.54 ARDL Model for Norway

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.2668	0.1545	8.1969	0.0000
TOP10(-2)	-0.3572	0.2184	-1.6356	0.1100
TOP10(-3)	-0.1564	0.1280	-1.2218	0.2291
KEYRATE_SA	-0.0050	0.0011	-4.6503	0.0000

KEYRATE_SA(-1)	0.0028	0.0007	3.8092	0.0005
KEYRATE_SA(-2)	0.0002	0.0012	0.1987	0.8435
KEYRATE_SA(-3)	-0.0024	0.0010	-2.5445	0.0150
CPI_SA	0.0009	0.0011	0.8080	0.4240
CPI_SA(-1)	-0.0006	0.0003	-2.1002	0.0422
CPI_SA(-2)	-0.0003	0.0004	-0.7602	0.4517
CPI_SA(-3)	0.0007	0.0005	1.4491	0.1553
CPI_SA(-4)	-0.0011	0.0003	-3.1547	0.0031
LSHARE_SA	0.0200	0.0205	0.9714	0.3373
UNEMP_SA	0.0006	0.0053	0.1199	0.9052
UNEMP_SA(-1)	-0.0020	0.0007	-2.8639	0.0067
UNEMP_SA(-2)	-0.0019	0.0010	-1.9008	0.0647
UNEMP_SA(-3)	0.0012	0.0007	1.7481	0.0883
INT_CPI_UNEMP	5.15E-05	0.0002	0.2097	0.8350
KEYRATE_SA_SQ	0.0004	0.0002	2.7119	0.0099
LSHARE_SA_SQ	-0.0024	0.0021	-1.1668	0.2504
CPI_SA_SQ	-5.75E-05	0.0001	-0.3973	0.6933
UNEMP_SA_SQ	-0.0002	0.0007	-0.3307	0.7426
C	0.0617	0.0363	1.6985	0.0974
@TREND	-0.0002	6.96E-05	-2.3779	0.0224
Adjusted R-squared	0.9933			
F-statistic	401.8671		Durbin-Watson stat	1.9861

Note: The highlighted values are statistically significant at a 5 % level of significance

Table 3.54 shows that the coefficients next to the second lag of keyrate_sa, cpi_sa and its second and third lags, lshare_sa, unemp_sa and its second and third lags, interaction term, and the squared terms except for keyrate_sa_sq, are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged, interaction and squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.55 shows the Wald Test result for Norway.

Wald Test Coefficient restrictions for Norway

Null hypothesis: cpi_sa=lshare_sa=unemp_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.55 Wald Test Result for Norway

Test Statistic	Value	df	Probability
F-statistic	3.6105	(3, 39)	0.0215
Chi-square	10.8317	3	0.0127

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.55, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the cpi_sa, lshare_sa, and unemp_sa are included in the interpretations. The coefficients next to the keyrate_sa and is first and third lags, when added up, have a negative effect. Thus, the collective effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is a decrease in the top 10 percent income share by about 0.0046% within three quarters. The negative coefficients of cpi_sa and its first and fourth lags indicate the absence of the portfolio composition channel. Meanwhile, the positive coefficient of lshare_sa shows the presence of the financial segmentation and income composition channels. To be exact, a 1 % increase in the logarithm of Total Share Price Index leads to about 0.0200% increase in the top 10 percent income share within the same quarter. Finally, the added-up effect of unemp_sa and its first lag is negative, indicating the absence of the earnings heterogeneity channel.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.53 to 3.56 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.55 and 3.56, the mean values of unemployment and inflation, which are approximately 3.7833% and 2.1046%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0050 + 2(0.0004)\text{keyrate\_sa}=0 \qquad (3.53)$$

From equation 3.53, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 6.25%.

$$\frac{\partial top10}{\partial lshare_{sa}}: 0.0200 - 2(0.0024)lshare_{sa} = 0 \qquad (3.54)$$

From equation 3.54, the value of lshare_sa that maximizes the top 10 percent income share is approximately 4.1667.

$$\frac{\partial \text{top10}}{\partial \text{cpi}_{\text{sa}}}: 0.0009 + 5.15\text{E} - 05(3.7833) - 2(5.75\text{E} - 05)\text{cpi}_{\text{sa}} = 0 \qquad (3.55)$$

From equation 3.55, the value of cpi_sa that maximizes the top 10 percent income share is approximately 6.1318%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0006 + 5.15E - 05(2.1046) - 2(0.0002)unemp_{sa}=0 \qquad (3.56)$$

From equation 3.56, the value of unemp_sa that maximizes the top 10 percent income share is approximately 1.7710%.

3.15. Results for Poland

This subsection presents the results of estimations for Poland. Figure 3.15 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Poland's top ten percent income share highly fluctuated at a relatively small scale. It increased from its minimum of about 0.3620 in 2005Q4 to its peak of about 0.3780 in 2008Q4, after which it fell to about 0.3640 in 2009Q4, and kept fluctuating to end up at 0.3770 in 2021Q3. The monetary policy rate in Poland had a generally decreasing trend, starting from its maximum of 6% in 2005Q1, returned to the maximum in 2008Q2, but then kept mainly decreasing to end up at about 0%. The inflation rate in Poland fluctuated between approximately -1% (2015Q1-2016Q2) and about 5% (2008Q3, 2020Q1, and 2021Q3). The unemployment in Poland had a generally declining trend but a relatively large scale. It started out at its peak of about 18.5% in 2005Q1, declined to about 6.7% in 2008Q4, slightly increased up to 10% in the following quarters, but went on to completely decline from 2015Q1 until it ended up at its minimum of about 3%. The logarithm of Total Share Price index in Poland started out from its trough of about 3.90, rapidly increased to about 4.77 in 2007Q3, sharply declined back to its trough in 2009Q1, after which it kept fluctuating but gradually increased to its peak of about 4.90 in 2021Q3.

Figure 3.15 Graphs for Poland's Data

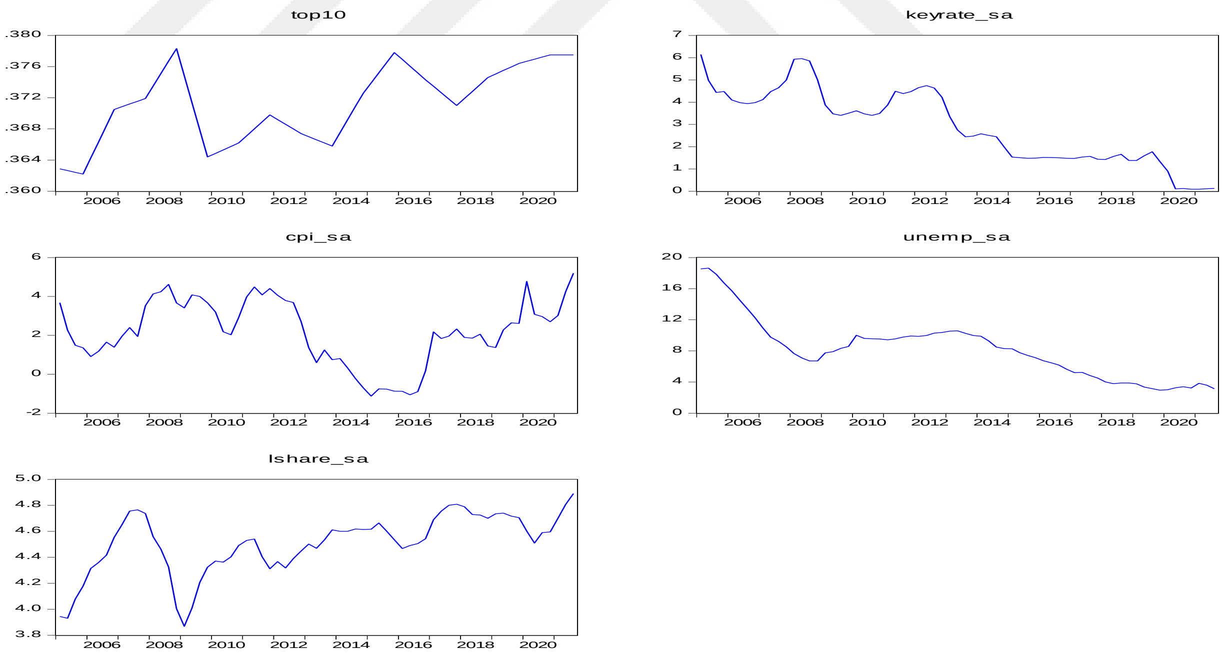

Table 3.56 Results from the ADF, ZA and LS Unit Root Tests for Poland

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.7756	-2.9448	-5.5240*** 2009Q1	-4.2355* 2012Q3	- 6.6923*** 2009Q1	-3.8689** 2009Q3	-4.9411*** 2009Q1 2009Q4	- 4.8639*** 2011Q1	-5.6209 2008Q4 2014Q3
Keyrate_sa	-0.4871	-3.8409**	-4.5775 2013Q1	Near Singular Matrix Error	-4.6684 2013Q1	- 4.4368** * 2007Q2	-4.3090*** 2007Q2 2018Q4	-4.6142** 2013Q1	-5.7652 2011Q2 2015Q3
Cpi_sa	-2.0403	-2.0280	-3.8592 2012Q4	-2.1292 2016Q1	-3.8641 2012Q4	-2.5229 2019Q4	-2.7797 2019Q1 2019Q4	-4.3789** 2013Q2	-5.3022 2011Q2 2014Q2
Lshare_sa	-1.9760	-4.1299***	-5.8518*** 2008Q3	-5.0112*** 2009Q4	Near Singular Matrix Error	-3.8196** 2008Q1	-3.8774** 2008Q1 2012Q1	- 6.7306*** 2008Q2	- 7.1110*** 2008Q2 2017Q4
Unemp_sa	-1.1249	-3.5269**	-5.9706*** 2011Q2	-5.1309*** 2012Q4	-5.5420** 2011Q2	-3.6847** 2009Q3	-4.1713*** 2009Q3 2010Q1	- 5.1517*** 2011Q1	-6.0772* 2011Q1 2016Q2

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the three test results in Table 3.56, all the variables are I (0), or stationary at level. Thus, a stationary ARDL model was run. The model with maximum lags of 4 suffered from insignificance of coefficients, so the maximum lags of dynamic regressors were set at 5. Table 3.57 shows the ARDL model results for Poland.

Table 3.57 ARDL Model for Poland

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	0.8834	0.1790	4.9364	0.0000
TOP10(-2)	-0.0050	0.1310	-0.0378	0.9700
TOP10(-3)	0.0703	0.1768	0.3978	0.6929
TOP10(-4)	-0.3368	0.1439	-2.3409	0.0243
KEYRATE_SA	-0.0005	0.0004	-1.2054	0.2351
KEYRATE_SA(-1)	-0.0004	0.0005	-0.7776	0.4414
KEYRATE_SA(-2)	-3.54E-05	0.0004	-0.0830	0.9343
KEYRATE_SA(-3)	0.0004	0.0005	0.8484	0.4013
KEYRATE_SA(-4)	-0.0014	0.0008	-1.7144	0.0942
KEYRATE_SA(-5)	0.0007	0.0004	1.854	0.0711
CPI_SA	0.0002	0.0005	0.5086	0.6138
LSHARE_SA	0.0093	0.0123	0.7572	0.4534
LSHARE_SA(-1)	0.0016	0.0021	0.7726	0.4443
LSHARE_SA(-2)	0.0030	0.0020	1.5086	0.1393
LSHARE_SA(-3)	-0.0034	0.0014	-2.3483	0.0239
UNEMP_SA	-0.0004	0.0002	-1.8422	0.0729
INT_CPI_UNEMP	-8.73E-05	4.55E-05	-1.9194	0.0621
KEYRATE_SA_SQ	0.0002	4.67E-05	4.6358	0.0000
UNEMP_SA_SQ	9.76E-06	1.03E-05	0.9496	0.3480
LSHARE_SA_SQ	-0.0015	0.0014	-1.0654	0.2931
CPI_SA_SQ	1.27E-06	4.48E-05	0.0284	0.9775
C	0.1310	0.0498	2.6300	0.0121

Adjusted R-squared	0.9818		
F-statistic	157.9248	Durbin-Watson stat	2.1663

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.57, the coefficients next to keyrate_sa and its lags, cpi_sa, lshare_sa and its first two lags, unemp_sa, the interaction term, and all the squared terms of the variables, except for the keyrate_sa_sq are individually statistically insignificant at a 5 % significance level (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the interaction, lagged and squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.58 shows the Wald test result for Poland.

Wald Test Coefficient Restrictions for Poland

Null hypothesis: keyrate_sa=cpi_sa=lshare_sa =unemp_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.58 Wald Test Result for Poland

Test Statistic	Value	df	Probability
F-statistic	3.8258	(4, 40)	0.0100
Chi-square	15.3031	4	0.0041

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.58, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, lshare_sa, cpi_sa, and unemp_sa are included in the interpretations. The coefficients next to the keyrate_sa is negative and statistically significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) decreases the top 10 percent income share by about 0.0005% in the same quarter. Three transmission mechanism channels have been captured by this model since the coefficient next to cpi_sa and the collective effect of those next to lshare_sa and its third lag are positive and significant. More specifically, the portfolio composition channel is shown by the positive coefficient of cpi_sa, which means that a 1 % increase in inflation leads to an approximately 0.0002% increase in the top ten percent income share in the same quarter. Additionally, the financial segmentation and income composition channels are reflected by the collective impact of lshare_sa and its third lag, which means that a 1 % increase in the logarithm of Total Share Price Index leads to about 0.0059% increase in the top ten percent income share within three quarters.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.57 to 3.60 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.58 and 3.60, the mean values of unemployment and inflation, which are approximately 8.2029% and 2.1709 %, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0005 + 2(0.0002)\text{keyrate\_sa}=0 \tag{3.57}$$

From equation 3.57, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 1.25%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0002 - 8.73E-05(8.2029) + 2(1.27E-06)cpi_{sa} = 0 \tag{3.58}$$

From equation 3.58, the value of cpi_sa that minimizes the top 10 percent income share is approximately 203.1942%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: 0.0093 - 2(0.0015)\text{lshare}_{\text{sa}} = 0 \tag{3.59}$$

From equation 3.59, the value of lshare_sa that maximizes the top 10 percent income share is approximately 3.10.

$$\frac{\partial top10}{\partial unemp_{sa}}: -0.0004 - 8.73E-05(2.1709) + 2(9.76E-06)unemp_{sa}=0 \tag{3.60}$$

From equation 3.60, the value of unemp_sa that minimizes the top 10 percent income share is approximately 30.2047%.

Since inequality-minimizing value of inflation and unemployment are ambiguous, i.e they are too large, it is necessary to test the model for the OVB with the help of the Ramsey RESET test. Table 3.59 presents the results from the Ramsey RESET test for Poland’s model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.59 Result from the Ramsey RESET Test for Poland’s Model

	Value	df	Probability
t-statistic	0.063393	37	0.9498
F-statistic	0.004019	(1, 37)	0.9498

3.16. Results for Russia

This subsection presents the results of estimations for Russia. Figure 3.16 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Russia's top ten percent income share peaked at about 0.52 in 2008Q4, rapidly declined to about 0.455 in 2010Q4, slightly fluctuated, reached its minimum of about 0.455 in 2014Q4, increased to about 0.465 in 2019Q3, and remained constant. The monetary policy rate in Russia had a relatively large scale with the highest values of about 17% in 2014Q4 and about 13% in 2008Q4, and the lowest values of about 4% in 2020Q4 and 5.5% in 2013Q4. The inflation in Russia fluctuated highly at a relatively large scale: about 15% in 2008Q1, 16.5% in 2015Q1, and 2.5% in 2018Q1 and 2020Q1, after which it increased to about 7% in 2021Q3. The unemployment in Russia rapidly increased from about 5.5% in 2008Q2 to about 8.7% in 2009Q2, declined to 5% in 2012Q4, slightly fluctuated afterwards, increased to about 6.5% in 2020Q3, but ended up at its minimum of about 4.5% in 2021Q3. The logarithm of Total Share Price index in Russia had a relatively large scale, starting from its minimum of 3.50 in 2005Q1, increased to about 4.75 in 2007Q4, rapidly declined to about 3.65 in 2008Q4, but then followed a generally increasing trend to reach its maximum of about 5.45 in 2021Q3.

Figure 3.16 Graphs for Russia's Data

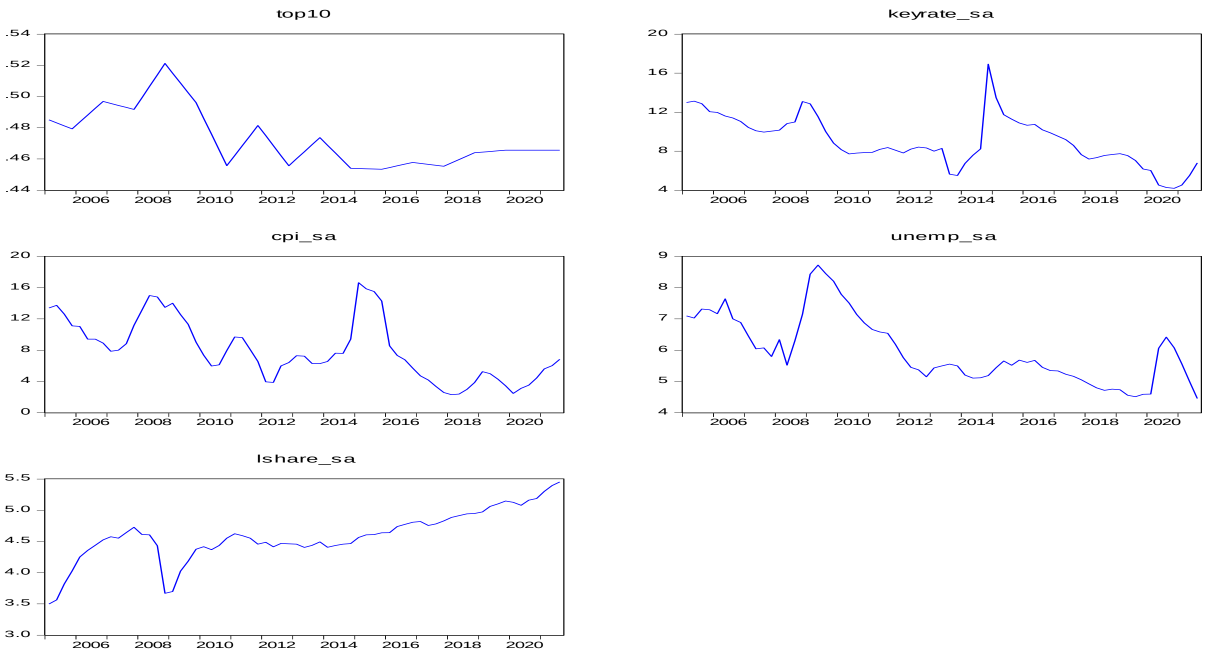

Table 3.60 Results from the ADF, ZA and LS Unit Root Tests for Russia

Variable	ADF	ZA	LS

	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.5644	-2.0067	-5.8991*** 2010Q1	-3.7606 2015Q2	-6.3269*** 2010Q1	-2.9061 2009Q3	-3.3789* 2009Q2 2010Q2	-4.3376** 2009Q3	-7.2767*** 2009Q3 2016Q4
Keyrate_sa	-1.7245	-2.2531	-4.7573* 2014Q3	-3.1087 2016Q2	-6.2817*** 2014Q4	-4.1483*** 2015Q4	-4.2665*** 2009Q4 2015Q4	-4.2398* 2014Q3	-6.2265* 2014Q2 2016Q2
cpi_sa	-2.0507	-2.9467	-3.5575 2014Q4	-2.8634 2015Q2	-3.6928 2014Q4	-3.2634* 2016Q2	-4.0359** 2014Q1 2016Q1	-3.4675 2015Q4	-5.1076 2014Q2 2017
Lshare_sa	-0.4354	-2.9204	-5.9233*** 2008Q3	-4.7833** 2015Q3	-4.8161 2014Q1	-3.2503* 2010Q1	-3.9235** 2009Q2 2010Q1	-5.3582*** 2008Q2	-7.6509*** 2008Q2 2016Q3
Unemp_sa	-1.1806	-2.6938	-4.8329* 2011Q4	-4.0946 2009Q2	-5.1553** 2011Q4	-4.4007*** 2010Q1	-4.4240*** 2010Q1 2011Q4	-4.2238** 2019Q4	-5.4897 2009Q4 2014Q2

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root test results in Table 3.60, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.61 shows the results from ARDL model for Russia.

Table 3.61 ARDL Model for Russia

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.0742	0.0945	11.3647	0.0000
TOP10(-2)	-0.4384	0.0808	-5.4223	0.0000
KEYRATE_SA	-0.0004	0.0021	-0.1835	0.8553
KEYRATE_SA(-1)	0.0001	0.0004	0.2715	0.7874
KEYRATE_SA(-2)	0.0003	0.0005	0.6087	0.5462
KEYRATE_SA(-3)	-0.0009	0.0003	-2.5853	0.0135
CPI_SA	-0.0016	0.0014	-1.1407	0.2608
CPI_SA(-1)	-0.0009	0.0005	-1.7408	0.0894
CPI_SA(-2)	0.0008	0.0004	1.9692	0.0559
LSHARE_SA	-0.0062	0.0247	-0.2524	0.8020
LSHARE_SA(-1)	0.0265	0.0052	5.0883	0.0000
UNEMP_SA	-0.0158	0.0077	-2.0515	0.0468
UNEMP_SA(-1)	0.0004	0.0011	0.3733	0.7109
UNEMP_SA(-2)	0.0007	0.0015	0.4388	0.6632
UNEMP_SA(-3)	-0.0004	0.0014	-0.2987	0.7667
UNEMP_SA(-4)	-0.0036	0.0010	-3.5872	0.0009
UNEMP_SA_SQ	0.0012	0.0007	1.6630	0.1041
LSHARE_SA_SQ	-5.01E-05	0.0028	-0.0180	0.9857
KEYRATE_SA_SQ	-4.75E-06	8.19E-05	-0.0579	0.9541
INT_CPI_UNEMP	0.0004	0.0002	1.7166	0.0938
CPI_SA_SQ	-8.06E-06	3.88E-05	-0.2076	0.8366
C	0.1725	0.0783	2.2023	0.0335
@TREND	-0.0006	0.0001	-5.3314	0.0000
Durbin-Watson stat	2.3832			
Adjusted R-squared	0.9822			
F-statistic	156.9376			

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.61, the coefficients next to the keyrate_sa and its first two lags, cpi_sa and its two lags, lshare_sa, the three lags of unemp_sa, and all the squared terms of the variables are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged and squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. The exception is the unemp_sa_sq, which can be included in the F test because unemp_sa will not be included. Table 3.62 shows the result from the Wald test for Russia.

Wald Test Coefficient Restrictions for Russia

Null hypothesis: keyrate_sa=cpi_sa=lshare_sa=unemp_sa_sq=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.62 Wald Test Result for Russia

Test Statistic	Value	df	Probability
F-statistic	2.2814	(4, 40)	0.0774
Chi-square	9.1255	4	0.0580

According to the p-value of the F-statistic in Table 3.62, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, cpi_sa, lshare_sa, and unemp_sa_sq are not included in the interpretations. The coefficient next to the third lag of keyrate_sa is negative and statistically significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10% income share by about 0.0009% within three quarters. Moreover, the coefficient next to the first lag of lshare_sa is positive and significant, which indicates the presence of income composition and financial segmentation channels. More specifically, a 1% increase in the logarithm of Total Share Price Index leads to about 0.0265% increase in the top ten percent income share within one quarter.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.61 to 3.64 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.62 and

3.64, the mean values of unemployment and inflation, which are approximately 5.9904% and 7.9902%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0004 - 2(4.75E-06)\text{keyrate\_sa}=0 \quad (3.61)$$

From equation 3.61, the value of keyrate_sa that maximizes the top 10 percent income share is approximately -42.1053%.

$$\frac{\partial top10}{\partial cpi_{sa}}: -0.0016 + 0.0004(5.9904) - 2(8.06E-06)cpi_{sa} = 0 \quad (3.62)$$

From equation 3.62, the value of cpi_sa that maximizes the top 10 percent income share is approximately 49.3896%.

$$\frac{\partial top10}{\partial lshare_{sa}}: -0.0062 - 2(5.01E-05)lshare_{sa} = 0 \quad (3.63)$$

From equation 3.63, the value of lshare_sa that maximizes the top 10 percent income share is approximately -61.8762.

$$\frac{\partial top10}{\partial unemp_{sa}}: -0.0158 + 0.0004(7.9902) + 2(0.0012)unemp_{sa}=0 \quad (3.64)$$

From equation 3.64, the value of unemp_sa that minimizes the top 10 percent income share is approximately 5.2516%.

Since inequality-maximizing values of monetary policy rate, inflation, and the logarithm of Total Share Price Index are ambiguous, i.e they are negative or too large, it is necessary to test the model for the OVB with the help of the Ramsey RESET test. Table 3.63 presents the results from the Ramsey RESET test for Russia's model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables is rejected, so the model is concluded to have an OVB.

Table 3.63 Result from the Ramsey RESET Test for Russia's Model

	Value	df	Probability
t-statistic	2.271112	39	0.0287
F-statistic	5.157949	(1, 39)	0.0287

3.17. Results for South Africa

This subsection presents the results of estimations for South Africa. Figure 3.17 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. South Africa's top ten percent income share started from its minimum of about 0.578 in 2005Q1, increased to 0.620 in 2007Q4, fell to about 0.590 in 2009Q4, increased to its peak of about 0.655 in 2012Q4, and remained constant. The monetary policy rate in South Africa peaked at about 12% in 2008Q2, declined to 7% in 2009Q3, kept slightly fluctuating between the values of 7% and 5%, fell after 2020Q1 and ended up at its minimum of about 3.5% in 2021Q3. The inflation in South Africa started out from its minimum of about 2%, increased to its maximum of about 11.5% in 2008Q3, declined to about 3.5% in 2010Q3, after which it kept fluctuating between 4% and 7%. The unemployment in South Africa highly fluctuated between 18-19% (2008Q4 and 2020Q2) and 29% (2005Q1, 2005Q4, and 2021Q3). The logarithm of Total Share Price index in South Africa had a relatively large scale, starting from its minimum of about 3.20 in 2005Q1, increased to about 4.10 in 2008Q2, declined to about 3.65 in 2009Q1, but then followed a generally increasing trend to reach its maximum of about 4.85 in 2021Q3.

Figure 3.17 Graphs for South Africa's Data

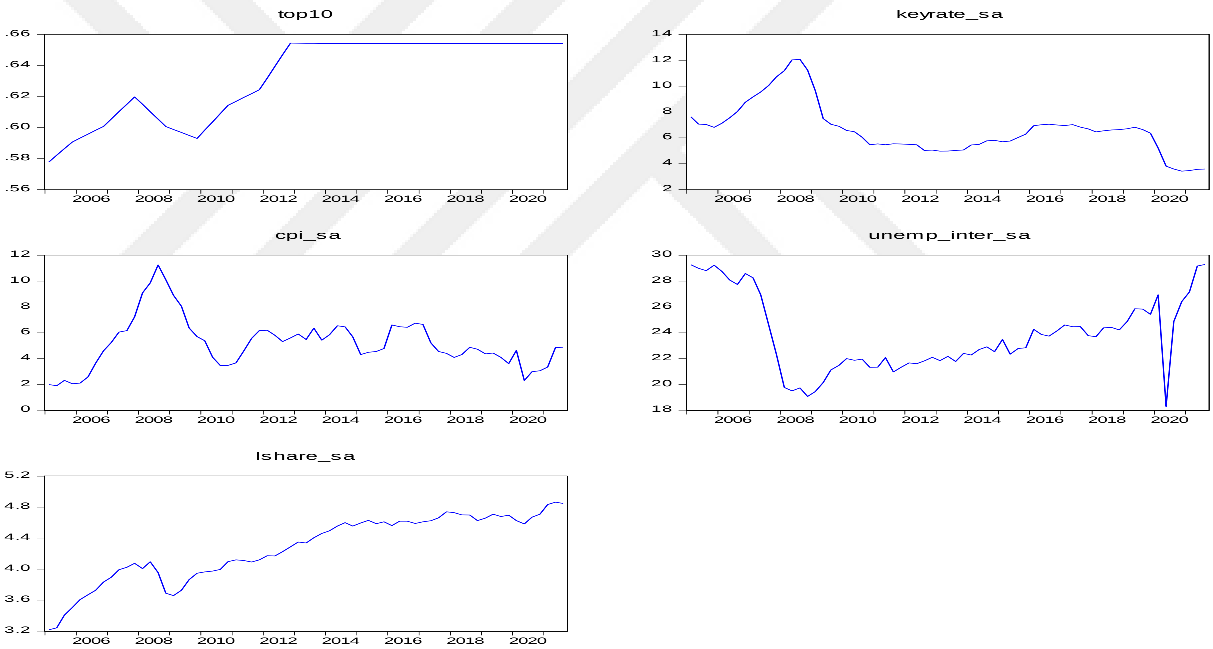

Table 3.64 Results from the ADF, ZA and LS Unit Root Tests for South Africa

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.4636	-1.9189	-4.7445* 2012Q1	-3.7619 2015Q3	-5.0102* 2012Q1	-2.9086 2010Q3	-3.2472 2010Q1 2010Q3	-4.0177 2015Q3	-7.7783*** 2008Q3 2012Q3
Keyrate_sa	-1.8539	-2.6795	-4.2693 2009Q1	-3.9989 2012Q3	-4.6735 2008Q4	- 4.0734** 2009Q1	-4.1488*** 2009Q1 2019Q4	-3.9115 2011Q1	-5.1624 2010Q3 2015Q2
Cpi_sa	-3.3232**								
Lshare_sa	-2.3768	-3.6691**							

Unemp_inter_sa	-2.2114	-2.6339	Near singular Matrix error	-4.5161** 2008Q3	Near singular Matrix error	-2.6046 2007Q4	-2.7277 2007Q4 2015Q4	-5.1163*** 2007Q3	-8.0630*** 2007Q4 2019Q4

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root test results in Table 3.64, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.65 shows the results from the ARDL model for South Africa.

Table 3.65 ARDL Model for South Africa

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.2649	0.1372	9.2222	0.0000
TOP10(-2)	-0.3604	0.1436	-2.5094	0.0160
KEYRATE_SA	-0.0017	0.0011	-1.6139	0.1140
KEYRATE_SA(-1)	0.0003	0.0009	0.3347	0.7395
KEYRATE_SA(-2)	0.0018	0.0010	1.7592	0.0858
KEYRATE_SA(-3)	-0.0028	0.0008	-3.4058	0.0015
LSHARE_SA	0.0126	0.0303	0.4161	0.6795
LSHARE_SA(-1)	-0.0061	0.0041	-1.4936	0.1428
CPI_SA	-0.0033	0.0024	-1.3691	0.1782
CPI_SA(-1)	-5.46E-05	0.0003	-0.1870	0.8526
CPI_SA(-2)	0.0004	0.0003	1.2272	0.2266
CPI_SA(-3)	0.0006	0.0004	1.3853	0.1733
CPI_SA(-4)	-0.0005	0.0003	-1.4658	0.1502
UNEMP_INTER_SA	0.0058	0.0020	2.9746	0.0048
INT_CPI_UNEMP	0.0001	8.22E-05	1.8056	0.0782
KEYRATE_SA_SQ	0.0001	6.03E-05	1.8050	0.0783
LSHARE_SA_SQ	-0.0017	0.0035	-0.4816	0.6326
CPI_SA_SQ	-4.05E-05	7.84E-05	-0.5161	0.6085
UNEMP_SQ	-0.0001	4.53E-05	-2.9857	0.0047
C	0.0070	0.0496	0.1412	0.8884
@TREND	0.0002	8.07E-05	1.9659	0.0559
Adjusted R-squared	0.9969			
F-statistic	982.1822	Durbin-Watson stat		1.8417

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.65, the coefficients next to keyrate_sa and its first two lags, cpi_sa and its four lags, lshare_sa and its first lag, the interaction term, and all the squared terms of the variables, except for the unemp_sq are individually statistically insignificant at a 5 % significance level (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged and squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.66 shows the results from the Wald test performed on the data for South Africa.

Wald Test Coefficient Restrictions for South Africa

Null hypothesis: keyrate_sa=cpi_sa=lshare_sa =0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.66 Wald Test Result for South Africa

Test Statistic	Value	df	Probability
F-statistic	1.9242	(3, 42)	0.1403
Chi-square	5.7724	3	0.1232

According to the p-value of the F-statistic in Table 3.66, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, cpi_sa, and lshare_sa are not included in the interpretations. The coefficient next to the third lag of keyrate_sa is negative and statistically significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10% income share by about 0.0028% within three quarters. In this model, only the earnings heterogeneity channel is captured since the coefficient next to the unemp_inter_sa is positive and statistically significant, indicating that a 1% increase in unemployment leads to about 0.0058% increase in the top ten percent income share in the same quarter.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.65 to 3.68 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.67 and 3.68, the mean values of unemployment and inflation, which are approximately 23.8204% and 5.1902%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0017 + 2(0.0001)\text{keyrate\_sa}=0 \quad (3.65)$$

From equation 3.65, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 8.5%.

$$\frac{\partial top10}{\partial lshare_{sa}}: 0.0126 - 2(0.0017)lshare_{sa} = 0 \quad (3.66)$$

From equation 3.66, the value of lshare_sa that maximizes the top 10 percent income share is approximately 3.7059.

$$\frac{\partial top10}{\partial cpi_{sa}}: -0.0033 + 0.0001(23.8204) - 2(4.05E-05)cpi_{sa} = 0 \quad (3.67)$$

From equation 3.67, the value of cpi_sa that maximizes the top 10 percent income share is approximately -11.3328%.

$$\frac{\partial top10}{\partial unemp_{inter_{sa}}}: -0.0058 + 0.0001(5.1902) - 2(0.0001)unemp_{inter_{sa}}=0 \quad (3.68)$$

From equation 3.68, the value of unemp_inter_sa that maximizes the top 10 percent income share is approximately -26.4049%.

The inequality-maximizing values of inflation and unemployment are ambiguous, i.e they are negative. Additionally, the portfolio composition, income composition, and financial segmentation channels were not captured in the model, although the coefficient of the monetary policy rate is negative. To shed light on these issues, it is necessary to test the model for the OVB with the help of the Ramsey RESET test. Table 3.67 presents the results from the Ramsey RESET test for Poland's model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.67 Result from the Ramsey RESET Test for South Africa's Model

	Value	df	Probability
t-statistic	0.965457	41	0.3400
F-statistic	0.932107	(1, 41)	0.3400

3.18. Results for Spain

This subsection presents the results of estimations for Spain. Figure 3.18 shows the graphs of the top ten percent income share, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Spain's top ten percent income share started out from a relatively low value of about 0.34, increased to its maximum of about 0.3590 in 2009Q4, fell to about 0.3400 in 2011Q4, increased to about 0.3530 in 2015Q4, and followed a declining trend to end up at its minimum of about 0.3340. The inflation in Spain highly fluctuated between around -1% (in 2009Q2, 2015Q1, and 2016Q2) and 5% (in 2008Q3), and ended up at about 3.5%. The unemployment in Spain started out from its trough of about 10%, gradually rose to its peak of about 26% in 2013Q2 and declined again to end up at 14.5%. The logarithm of Total Share Price index in Spain peaked at about 5.00 in 2007Q4, sharply declined to about 4.40 in 2009Q1, then fluctuated and reached its trough of about 4.20 in 2012Q2 and 2020Q2 and ended up at about 4.40.

Figure 3.18 Graphs for Spain’s Data

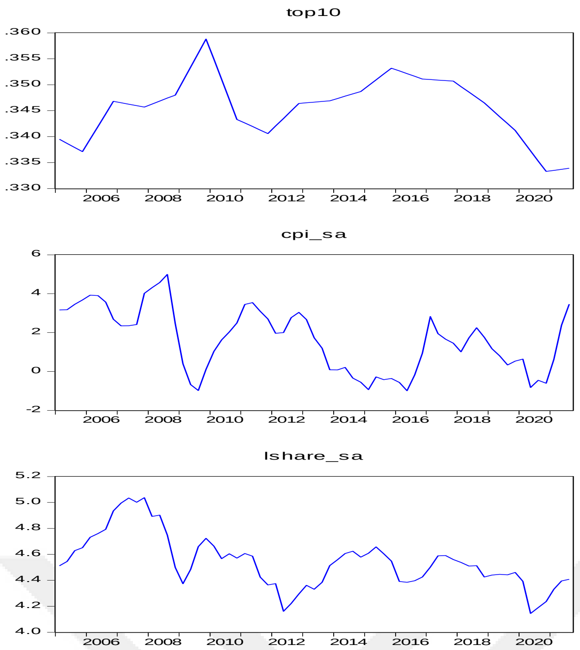

Table 3.68 Results from the ADF, ZA and LS Unit Root Tests for Spain

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-2.8228*	-2.8871	-4.0043 2019Q1	-4.3297* 2017Q3	-4.3350 2015Q1	-3.4809* 2006Q3	-3.5371* 2006Q3 2009Q3	-4.2609** 2019Q1	-5.2641 2010Q3 2016Q1
Keyrate	-1.5710	-2.7772	-8.3744*** 2008Q4	-4.4077* 2014Q1	-10.7503*** 2008Q4	-3.1079 2009Q1	-3.7315** 2008Q2 2009Q1	-4.4729** 2010Q1	-7.2484*** 2008Q2 2010Q4
Cpi_sa	-3.3139**								
Lshare_sa	-2.4042	-3.3832*	-4.4888 2008Q3	-3.9232 2012Q1	-4.6215 2013Q3	-3.1279 2012Q1	-3.3875* 2008Q1 2012Q1	-3.7965 2008Q2	-5.2077 2008Q1 2014Q1
Unemp_sa	-2.0255	-1.6290	-3.4581 2008Q1	-4.9078*** 2012Q3	-5.0362* 2011Q3	-2.3467 2008Q4	-2.5944 2008Q4 2014Q1	-3.3995 2013Q2	-5.0508 2010Q1 2014Q4

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.68, all the variables, except lshare_sa are stationary at level, or I (0), according to the three unit root tests. There is insufficient evidence that lshare_sa is I (0), since the ZA and LM tests showed stationarity at only 10 % level of significance, Therefore, an ADF test with neither trend nor intercept was conducted on the first difference of the variable, dlshare_sa. Table 3.69 shows the result from the ADF test on dlshare_sa for Spain.

Table 3.69 ADF Test Result on dlshare_sa for Spain

Differenced variable	ADF (none)
dlshare_sa	-5.8181 ***

Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

Table 3.69 shows that lshare_sa is concluded to be non-stationary at level, or I (1). Thus, the Bounds test approach is appropriate. Table 3.70 shows the Bounds Test result for Spain data.

Table 3.70 Bound Test Result for Spain

Test Statistic	Value	k
F-statistic	7.4163	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	3.03	4.06
5%	3.47	4.57
2.5%	3.89	5.07
1%	4.4	5.72

Since the value of the F statistic in Table 3.70 exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.71 shows ARDL Long Run Form for Spain.

Table 3.71 ARDL Long Run Form for Spain

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.3773	0.0735	-5.1310	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE	-0.0150	0.0049	-3.0718	0.0041
CPI_SA	0.0017	0.0017	0.9923	0.3277
LSHARE_SA	-0.0476	0.0593	-0.8024	0.4277
UNEMP_SA	0.0025	0.0008	2.9829	0.0052
INT_CPI_UNEMP	0.00002	0.00001	0.3634	0.7185
KEYRATE_SQ	0.0028	0.0009	3.2092	0.0028
CPI_SA_SQ	-0.0002	0.0002	-0.8801	0.3848
UNEMP_SA_SQ	-0.0001	0.0001	-2.9873	0.0051
LSHARE_SA_SQ	0.0056	0.0065	0.8674	0.3916
C	0.4477	0.1314	3.4070	0.0017
@TREND	-0.0005	0.0001	-3.8885	0.0004

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.71, the coefficients next to cpi_sa, lshare_sa, interaction term, cpi_sa_sq, and lshare_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the interaction and squared terms, although insignificant, are not included due to the risk of a multicollinearity problem. Table 3.72 shows the Wald Test results for Spain.

Wald Test Coefficient Restrictions for Spain

Null hypothesis: cpi_sa=lshare_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.72 Wald Test Result for Spain

Test Statistic	Value	df	Probability
F-statistic	3.7502	(2, 35)	0.0334
Chi-square	7.5003	2	0.0235

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic of Table 3.72, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to cpi_sa and lshare_sa are included in the interpretations. The coefficient next to the keyrate_sa is negative and statistically significant, so the effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is a decrease in the top 10 percent income share by about 0.0150%. The portfolio composition channel has been captured by this model since a 1% increase in cpi_sa leads to an approximately 0.0017% increase in the top ten percent income share. The coefficient next to lshare_sa is negative, so the model has not captured the financial segmentation and income composition channels. Finally, the earnings heterogeneity channel has been captured since the coefficient next to unemp_sa is positive and significant, indicating that a 1 % increase in unemployment leads to an increase in the top 10 percent income share by approximately 0.0025%.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.69 to 3.72 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.70 and 3.72, the mean values of unemployment and inflation, which are approximately 17.1281% and 1.6179%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate}: -0.0150 + 2(0.0028)keyrate = 0 \quad (3.69)$$

From equation 3.69, the value of keyrate that minimizes the top 10 percent income share is approximately 2.6786%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0017 + 0.000022(17.1281) - 2(0.0002)cpi_{sa} = 0 \quad (3.70)$$

From equation 3.70, the value of cpi_sa that maximizes the top 10 percent income share is approximately 5.1920%.

$$\frac{\partial top10}{\partial lshare_{sa}}: -0.0476 + 2(0.0056)lshare_{sa} = 0 \quad (3.71)$$

From equation 3.71, the value of lshare_sa that minimizes the top 10 percent income share is approximately 4.25%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0025 + 0.00002(1.6179) - 2(0.0001)unemp_{sa}=0 \quad (3.72)$$

From equation 3.72, the value of unemp_sa that maximizes the top 10 percent income share is approximately 12.6778%.

3.19. Results for Switzerland

This subsection presents the results of estimations for Switzerland. Figure 3.19 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Switzerland's top ten percent income share peaked at about 0.3490 in 2006Q4, sharply declined to its minimum of about 0.3120 in 2008Q4, increased to about 0.3390 in 2011Q, then gradually declined to end up at around 0.3250. The monetary policy rate in Switzerland had a relatively small scale. It was at its peak of about 3.3% from 2007Q4 to 2008Q3, rapidly declined to about 0.7% in 2009Q3, then gradually declined to its minimum of about -0.7% in 2021Q3. The inflation in Switzerland highly fluctuated at a relatively small scale. It increased from about 0.5% in 2007Q3 to around 3% in 2009Q3, then fell to its trough of about -1% in 2009Q3, kept fluctuating and ended up at around 1%. The unemployment in Switzerland had a relatively small scale with the highest values of around 3.80% in 2005Q1 and around 4.10% in 2009Q4. Its lowest values were around 2.50% in 2008Q3, 2.70% in 2011Q3, and 2.25% in 2019Q3, after which it ended up slightly increasing to around 2.85% in 2021Q3. The logarithm of Total Share Price index in Switzerland swiftly increased from around 4.20 in 2005Q1 to around 4.65 in 2007Q2, then sharply declined to its minimum of about 4.00 in 2009Q1. Afterwards, it gradually increased to its maximum of about 4.95 in 2021Q3.

Figure 3.19 Graphs for Switzerland's Data

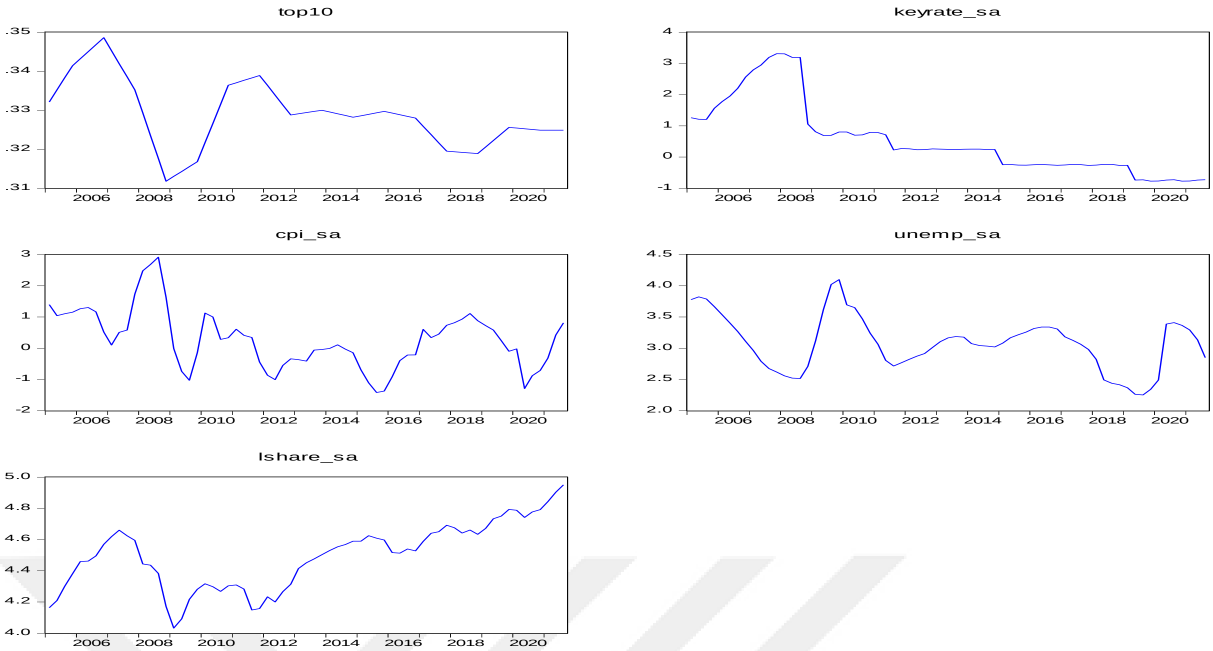

Table 3.73 Results from the ADF, ZA and LS Unit Root Tests for Switzerland

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash,2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-3.4382**	-3.9257**							
Keyrate_sa	-1.4259	-2.9445	-7.7191*** 2008Q4	-4.2058* 2011Q4	-13.8185*** 2008Q4	-3.3624* 2009Q1	-3.6078** 2009Q1 2011Q2	-5.9746*** 2010Q2	-11.311*** 2008Q2 2010Q2
Cpi_sa	-2.4217	-2.5213	-5.5128** 2017Q1	-4.8703*** 2013Q2	-5.4646** 2017Q1	-4.4812*** 2016Q1	-5.4886*** 2010Q2 2016Q4	-5.2597*** 2010Q1	-5.8195* 2010Q1 2016Q4
Lshare_sa	-0.3672	-2.0012	-5.6437*** 2008Q3	-4.4238* 2009Q2	-5.0166* 2008Q3	-2.9393 2009Q1	-3.3126* 2008Q1 2009Q1	-5.0960*** 2009Q4	-5.3399 2008Q2 2013Q2
Unemp_sa	-3.4512**	-4.1661***							

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to Table 3.73, the ADF test shows stationarity at level for the top10 and unemp_sa. Additionally, according to the ZA and LM unit root tests, after excluding the structural break(s), the other variables are I(0), too. Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.74 shows the results of the ARDL model for Switzerland.

Table 3.74 ARDL Model for Switzerland

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.4112	0.0813	17.3580	0.0000
TOP10(-2)	-0.4988	0.1095	-4.5563	0.0000
KEYRATE_SA	0.0012	0.0009	1.3916	0.1710
KEYRATE_SA(-1)	-0.0013	0.0006	-2.2243	0.0313
CPI_SA	-0.0027	0.0021	-1.2957	0.2018
CPI_SA(-1)	0.0012	0.0005	2.7230	0.0092
LSHARE_SA	-0.0283	0.0257	-1.1035	0.2758
LSHARE_SA(-1)	-0.0063	0.0047	-1.3550	0.1823
LSHARE_SA(-2)	0.0142	0.0030	4.7810	0.0000
LSHARE_SA(-3)	-0.0007	0.0057	-0.1300	0.8972
LSHARE_SA(-4)	-0.0077	0.0037	-2.0760	0.0438
UNEMP_SA	-0.0145	0.0089	-1.6229	0.1118
UNEMP_SA(-1)	0.0031	0.0009	3.6228	0.0008
INT_CPI_UNEMP	0.0004	0.0007	0.5857	0.5611
KEYRATE_SA_SQ	-3.18E-05	0.0003	-0.1176	0.9069
CPI_SA_SQ	-1.06E-05	0.0001	-0.0743	0.9411
LSHARE_SA_SQ	0.0031	0.0027	1.1206	0.2686
UNEMP_SA_SQ	0.0020	0.0015	1.3746	0.1762
C	0.1122	0.0521	2.1509	0.0370
Adjusted R-squared	0.9859			
F-statistic	242.3970		Durbin-Watson stat	2.2804

Note: The highlighted values are statistically significant at a 5 % level of significance.

According to Table 3.74, the coefficients next to keyrate_sa, cpi_sa, lshare_sa and its first and third lags, unemp_sa, interaction term, and all the squared terms of the variables are individually statistically insignificant (according to the t-test). This calls for the need for the Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged and squared terms, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.75 shows the result from Wald test on Switzerland data.

Wald Test Coefficient Restrictions for Switzerland

Null hypothesis: keyrate_sa=cpi_sa=lshare_sa=unemp_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.75 Wald Test Result for Switzerland

Test Statistic	Value	df	Probability
F-statistic	1.3360	(4, 44)	0.2717
Chi-square	5.3441	4	0.2538

According to the p-value of the F-statistic in Table 3.75, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, cpi_sa, lshare_sa, and unemp_sa are not included in the interpretations. The coefficient next to the first lag of keyrate_sa is negative and statistically significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10% income share by about 0.0013% within one quarter. The coefficient of the first lag of cpi_sa is positive and statistically significant, which indicates the presence of the portfolio composition channel, where a 1 % increase in inflation leads to about 0.0012% increase in the top 10% income share within one quarter. Additionally, the collective effect of the coefficients of the second and fourth lags of lshare_sa is positive and statistically significant, indicating the presence of income composition and financial segmentation channels, where a 1 % increase in the logarithm of Total Share Price Index leads to about 0.0065% increase in the top 10% income share within four quarters. Finally, the earnings heterogeneity channel was captured since the coefficient next to the first lag of unemp_sa is positive and significant, indicating that a 1 % increase in unemployment leads to about 0.0031% increase in the top ten percent income share within one quarter.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.73 to 3.76 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.74 and 3.76, the mean values of unemployment and inflation, which are approximately 3.0766% and 0.2785%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: 0.0012 - 2(3.18E - 05)keyrate_{sa}=0 \qquad (3.73)$$

From equation 3.73, the value of keyrate_sa that maximizes the top 10 percent income share is approximately 18.8679%.

$$\frac{\partial top10}{\partial cpi_{sa}}: - 0.0027 + 0.0004(3.0766) - 2(1.06E - 05)cpi_{sa} = 0 \qquad (3.74)$$

From equation 3.74, the value of cpi_sa that maximizes the top 10 percent income share is approximately -69.3094%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: -0.0283 + 2(0.0031)\text{lshare}_{\text{sa}} = 0 \qquad (3.75)$$

From equation 3.75, the value of lshare_sa that minimizes the top 10 percent income share is approximately 4.5645.

$$\frac{\partial top10}{\partial unemp_{sa}}: - 0.0145 + 0.0004(0.2785) + 2(0.0020)unemp_{sa}=0 \qquad (3.76)$$

From equation 3.76, the value of unemp_sa that minimizes the top 10 percent income share is approximately 3.5972%.

Since inequality-maximizing value of inflation is ambiguous, i.e it is negative, it is necessary to test the model for the OVB with the help of the Ramsey RESET test. Table 3.76 presents the results from the Ramsey RESET test for Switzerland's model. According to the probabilities of both the t- and F-statistics, the null hypothesis of no omitted variables cannot be rejected, so the model is concluded to have no OVB.

Table 3.76 Result from the Ramsey RESET Test for Switzerland's Model

	Value	df	Probability
t-statistic	0.039756	43	0.9685
F-statistic	0.001581	(1, 43)	0.9685

3.20. Results for Turkey

This subsection presents the results of estimations for Turkey. Figure 3.20 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. Turkey's top ten percent income share declined from around 0.52 in 2005Q1 to about 0.485 in 2007Q4, increased to 0.5130 in 2009Q4, reached its peak of about 0.5320 in 2018Q4, slightly fluctuated and ended up at 0.5200 in 2021Q3. The monetary policy rate in Turkey fluctuated at a relatively large scale. The highest points were around 18.5% in 2007Q1 and 22% in 2018Q4, while the lowest points were around 1.5% in 2011Q2, 3.5% in 2013Q3, and 6.6% in 2020Q3, after which it sharply increased to end up at around 17% in 2021Q3. The inflation in Turkey fluctuated between around 4.5% and 12.5% between 2005Q1 and 2018Q1, after which it sharply increased to its maximum of about 23% in 2018Q3, declined to around 10.5% in 2019Q4, and increased again ending up at about 19.5% in 2021Q3. The unemployment in Turkey remained at around 9% from 2005Q1 to 2008Q2, sharply increased to its peak of about 14% in 2009Q2, declined to reach its minimum of about 8.3% in 2012Q3, increased to 12% in 2017Q1, fell to 10% in 2018Q1, increased back to its peak in 2019Q3, and gradually fell to about 11.5% in 2021Q3. The logarithm of Total Share Price index in Turkey had a relatively large scale, starting from its minimum of about 3.45 in 2005Q1, after which it increased to around 4.20 in 2007Q4 and fell back to its minimum in 2009Q1. From then on, it followed a generally increasing trend to end up at its peak of about 5.20 in 2021Q3.

Figure 3.20 Graphs for Turkey's Data

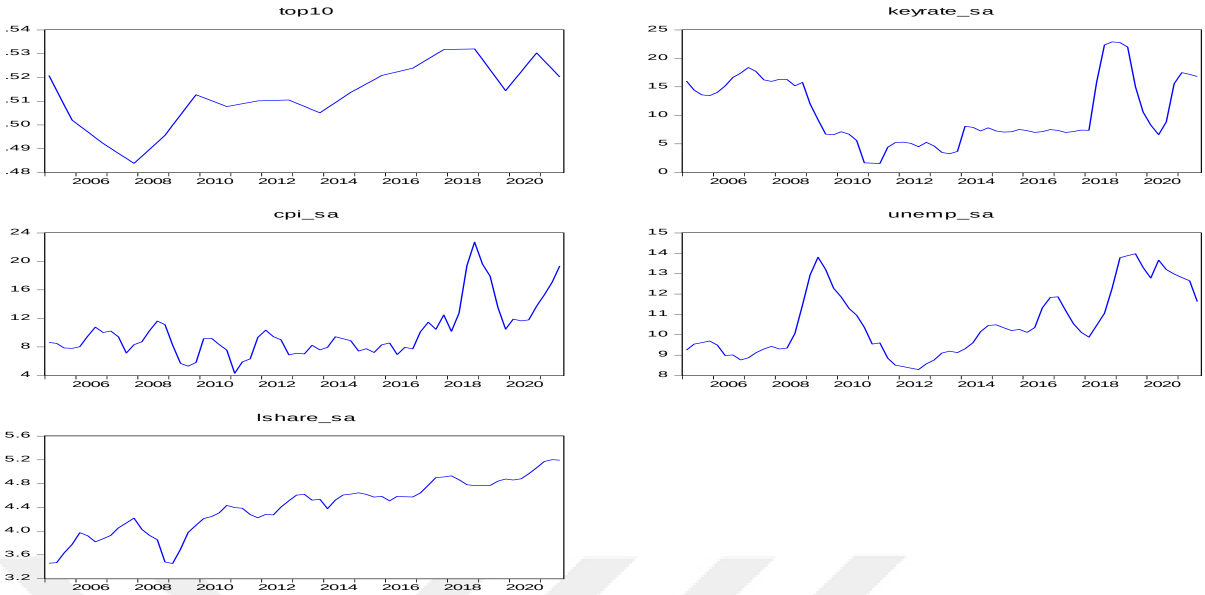

Table 3.77 Results from the ADF, ZA and LS Unit Root Tests for Turkey

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.8840	-3.1498	-4.5991* 2019Q1	-4.2652* 2018Q3	-4.4253 2017Q1	-2.4580 2009Q4	-2.7537 2009Q3 2019Q4	-4.3684** 2008Q3	-4.5014 2008Q3 2014Q3
Keyrate_sa	-1.7051	-2.5146	-5.0643** 2009Q1	-4.8943*** 2012Q1	-5.0287* 2009Q1	-2.1321 2019Q2	-2.2913 2008Q4 2019Q2	-4.4682** 2009Q1	-5.3236 2008Q4 2011Q2
Cpi_sa	-0.6766	-1.9574	-4.8716* 2018Q2	-3.1737 2015Q2	-4.8293* 2018Q2	-3.2607* 2018Q2	- 4.2163*** 2010Q4 2016Q4	-4.8413** 2016Q4	- 6.9209** 2016Q2 2019Q1
Lshare_sa	-0.8808	-3.4339*	-5.2798** 2010Q3	-4.7059** 2013Q1	-5.4694** 2010Q1	-4.3028*** 2013Q4	- 4.3805*** 2013Q4 2015Q4	-4.9237* 2014Q1	- 7.1088** * 2008Q2 2010Q3
Unemp_sa	-2.1964	-2.4620	-4.5852* 2011Q3	-3.4068 2012Q4	-4.6770 2010Q4	-3.6259** 2010Q1	-3.9677** 2009Q3 2010Q1	-3.6376 2012Q2	-4.8976 2010Q2 2019Q2

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the Augmented Dickey-Fuller (ADF), Zivot Andrews (ZA), and Lee Strazicich LM unit root test results in Table 3.77, all the variables are stationary at level, or I(0) at least 5% level of significance. Therefore, a standard ARDL model is built. Table 3.78 shows the results from the ARDL model for Turkey.

Table 3.78 ARDL Model for Turkey

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.3703	0.1098	12.4833	0.0000
TOP10(-2)	-0.2653	0.1849	-1.4349	0.1589
TOP10(-3)	-0.4815	0.2128	-2.2633	0.0290
TOP10(-4)	0.2855	0.1052	2.7132	0.0097
KEYRATE_SA	0.0003	0.0002	1.5896	0.1196
KEYRATE_SA(-1)	-0.0002	9.77E-05	-1.8314	0.0743
KEYRATE_SA(-2)	-0.0002	0.0002	-1.3387	0.1881
KEYRATE_SA(-3)	0.0003	0.0001	2.0786	0.0440
CPI_SA	0.0002	0.0005	0.3393	0.7361
LSHARE_SA	0.0047	0.0089	0.5259	0.6018
UNEMP_SA	0.0044	0.0010	4.4134	0.0001
UNEMP_SA(-1)	-0.0008	0.0008	-1.0230	0.3123
UNEMP_SA(-2)	0.0023	0.0009	2.6163	0.0124
UNEMP_SA(-3)	-0.0027	0.0008	-3.2015	0.0026
UNEMP_SA(-4)	0.0011	0.0005	2.3877	0.0216
INT_CPI_UNEMP	-6.25E-05	3.37E-05	-1.8547	0.0708
KEYRATE_SA_SQ	-1.61E-05	9.75E-06	-1.6519	0.1062
LSHARE_SA_SQ	-0.0010	0.0011	-0.9432	0.3511
CPI_SA_SQ	3.15E-05	9.32E-06	3.3757	0.0016
UNEMP_SA_SQ	-0.0002	5.07E-05	-3.3214	0.0019
C	0.0175	0.0222	0.7858	0.4365
@TREND	0.0001	5.01E-05	2.6752	0.0107
Adjusted R-squared	0.9925			
F-statistic	392.8153	Durbin-Watson stat		2.1650

Note: The highlighted values are statistically significant at a 5 % level of significance.

According to Table 3.78, the coefficients next to the keyrate_sa, the first and second lags of keyrate_sa, cpi_sa, lshare_sa, the first lag of unemp_sa, int_cpi_unemp, keyrate_sa_sq, and lshare_sa_sq are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged terms, the interaction term, the keyrate_sa_sq, and lshare_sa_sq, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.79 shows the results from the Wald Test conducted for Turkey.

Wald Test Coefficient Restrictions for Turkey

Null hypothesis: keyrate_sa= lshare_sa=cpi_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.79 Wald Test Result for Turkey

Test Statistic	Value	df	Probability
F-statistic	3.3195	(3, 41)	0.0290
Chi-square	9.9585	3	0.0189

Note: The highlighted values are statistically significant at a 5 % level of significance

According to the p-value of the F-statistic in Table 3.79, the null hypothesis is rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, lshare_sa, and cpi_sa are included in the interpretations. The coefficients next to the keyrate_sa and is third lag are positive and statistically significant, so the collective effect of a contractionary monetary policy (an increase in the monetary policy rate by 1%) is an increase in the top 10 percent income share by about 0.0006% within three quarters. All the transmission mechanisms appear to be present in this model, since the coefficients next to the lshare_sa, cpi_sa, and the collective impact of those next to unemp_sa, along with its second, third, and fourth lags, are positive and statistically significant. Firstly, a 1 % increase in the logarithm of Total Share Price Index leads to an approximately 0.0047% increase in the top ten percent income share in the same quarter. Secondly, a 1 % increase in inflation leads to an approximately 0.0002% increase in the top ten percent income share in the same quarter. Finally, a 1 % increase in unemployment leads to an approximately 0.0051% increase in the top ten percent income share within four quarters.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.77 to 3.80 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.78 and 3.80, the mean values of unemployment and inflation, which are approximately 10.6065% and 9.9722%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: 0.0003 - 2(1.61E-05)keyrate_{sa}=0 \qquad (3.77)$$

From equation 3.77, the value of keyrate_sa that maximizes the top 10 percent income share is approximately 9.3168%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0002 - 6.25E-05(10.6065) + 2(3.15E-05)cpi_{sa} = 0 \qquad (3.78)$$

From equation 3.78, the value of cpi_sa that minimizes the top 10 percent income share is approximately 7.3477%.

$$\frac{\partial \text{top10}}{\partial \text{lshare}_{\text{sa}}}: 0.0047 - 2(0.0010)\text{lshare}_{\text{sa}} = 0 \qquad (3.79)$$

From equation 3.79, the value of lshare_sa that maximizes the top 10 percent income share is approximately 2.35%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0044 - 6.25E-05(9.9722) - 2(0.0002)unemp_{sa}=0 \qquad (3.80)$$

From equation 3.80, the value of unemp_sa that maximizes the top 10 percent income share is approximately 9.4418%.

3.21. Results for the U.K

This subsection presents the results of estimations for the United Kingdom. Figure 3.21 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. U.K's top ten percent income share fluctuated between its peak of about 0.385 (in 2007Q4, 2009Q4, and 2013Q4) and trough of about 0.345 in 2010Q4, but finally settled at around 0.3560 after 2015Q4. The monetary policy rate in the U.K started out at around 5%, increased to its maximum of around 5.7% in 2007Q4, sharply declined to approximately 0.5% in 2009Q1, remained fairly constant in the following quarters, slightly increased to about 1% in 2018Q3, but ended up at its minimum of around 0% in 2021Q3. U.K's inflation fluctuated at a relatively small scale with the highest values of around 4.5% in 2008Q3 and 4.2% in 2011Q2 and the lowest values of about 1.5% in 2009Q3, 0.3% in 2015Q3, and 0.7% in 2020Q4. It ended up increasing to about 2.5% in 2021Q3. The unemployment in U.K sharply declined from about 2.5% in 2008Q15% in 2009Q2, started declining in 2012Q4, reached its minimum of about 2% in 2016Q4, rapidly increased from about 3% in 2020Q1 to its maximum of about 7% in 2020Q4, but declined to about 5% in 2021Q3. The logarithm of Total Share Price index in U.K started out from about 4.30, increased to around 4.60 in 2007Q2, rapidly declined to its minimum of about 4.10 in 2009Q1, increased to 4.40 in 2010Q1, and gradually increased to its peak of about 4.70 in 2021Q3.

Figure 3.21 Graphs for the U.K's Data

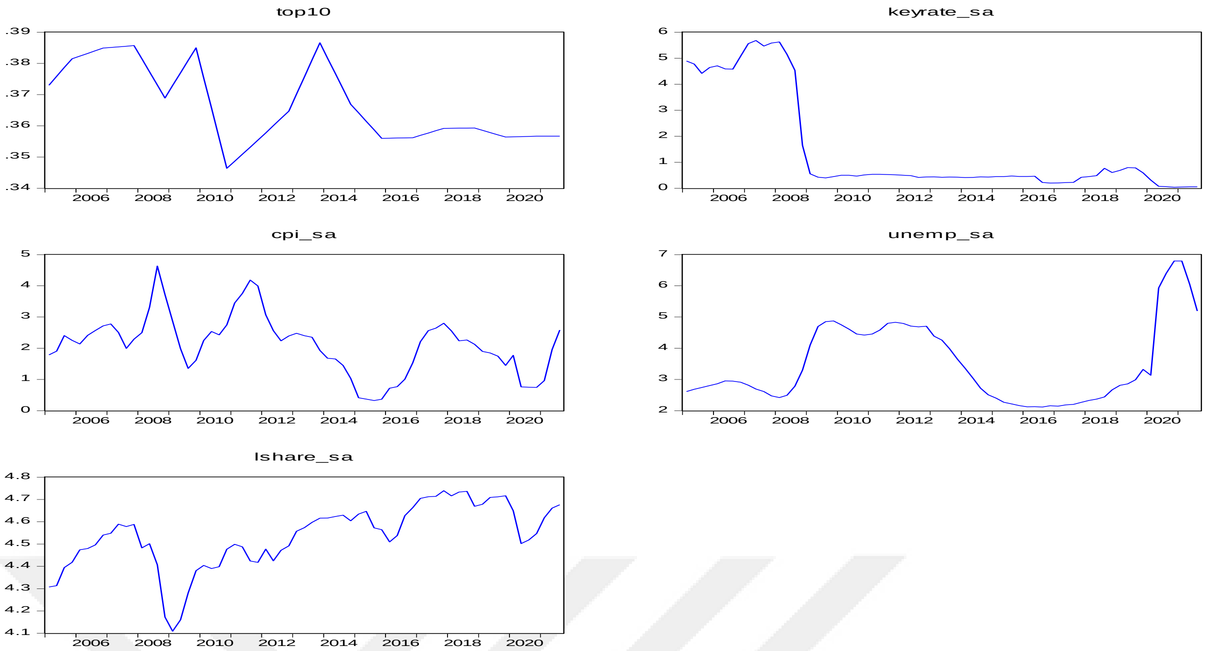

Table 3.80 Results from the ADF, ZA and LS Unit Root Tests for the U.K

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.4216	-4.1322***							
Keyrate_sa	-1.9270	-2.1460	-13.1808*** 2008Q4	-4.0832 2010Q2	-13.6626*** 2008Q4	-3.2885* 2008Q3	-3.4064* 2007Q2 2008Q3	-4.9151*** 2009Q1	-8.7845*** 2008Q2 2010Q3
Cpi_sa	-3.2571**								
Lshare_sa	-2.6004*	-3.4137*	-4.5635 2008Q3	-4.0483 2009Q1	-4.3218 2008Q3	-4.0834** 2007Q4	-4.2138*** 2007Q4 2018Q3	-3.8291 2009Q3	-4.8830 2008Q1 2010Q1
Unemp_sa	-1.1964	-1.7667	-3.4694 2008Q3	-3.0566 2009Q2	-3.9136 2008Q3	-1.4018 2008Q2	-1.5873 2010Q3 2014Q1	-3.0790 2013Q1	-5.4449 2010Q2 2015Q3

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

All the variables, except unemp_sa, are stationary at level, or I (0), according to the three unit root test results in Table 3.80. There is insufficient evidence that unemp_sa is I (0), since the ZA and LM tests showed stationarity at only 10 % level of significance, Therefore, an ADF test with neither trend nor intercept was conducted on the first difference of the variable, dunemp_sa. Table 3.81 shows the result from the ADF test on dunemp_sa for the U.K.

Table 3.81 ADF Test Result on dunemp_sa for the U.K

Differenced variable	ADF (none)
Dunemp_sa	-3.6005***

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

The unemp_sa is concluded to be non-stationary at level, or I (1), according to Table 3.81. Thus, the Bounds test approach is appropriate. Table 3.82 shows the result from the Bounds Test applied to U. K's data. Since the value of the F statistic in Table 3.82 exceeds the I1 Bound at a 5 % level of significance, the null hypothesis of no long-run relationships is rejected. Thus, a long-run model is estimated. Table 3.83 presents the results from the ARDL Long Run Form for the U.K.

Table 3.82 ARDL Bound Test Result for the U.K

Test Statistic	Value	k
F-statistic	6.1840	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Table 3.83 ARDL Long Run Form for the U.K

Cointegrating Equation Coefficient				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)	-0.3136	0.0681	-4.6055	0.0000
Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
KEYRATE_SA	0.0100	0.0024	4.1881	0.0001
CPI_SA	0.0039	0.0062	0.6312	0.5311
LSHARE_SA	0.3254	0.6322	0.5147	0.6093
UNEMP_SA	0.0239	0.0080	3.0094	0.0043
INT_CPI_UNEMP	-0.0001	0.0014	-0.0918	0.9272
KEYRATE_SA_SQ	-0.0008	0.0004	-1.8391	0.0725
CPI_SA_SQ	-0.0009	0.0006	-1.4709	0.1483
LSHARE_SA_SQ	-0.0289	0.0690	-0.4185	0.6776
UNEMP_SA_SQ	-0.0015	0.0008	-1.8200	0.0754
C	-0.6128	1.4437	-0.4245	0.6733

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.83, the coefficients next to the cpi_sa, lshare_sa, the interaction term and the squared terms are individually statistically insignificant at a 5 % level of significance (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the interaction term, cpi_sa_sq, and lshare_sa_sq, although insignificant, are not included due to the risk of a multicollinearity problem. Table 3.84 shows the result from the Wald Test applied to the data for U.K.

Wald Test Coefficient Restrictions for the U.K

Null hypothesis: cpi_sa=lshare_sa=keyrate_sa_sq=unemp_sa_sq=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant.

Table 3.84 Wald Test Result for the U.K

Test Statistic	Value	df	Probability
F-statistic	1.8762	(4, 45)	0.1311
Chi-square	7.5048	4	0.1115

According to the p-value of the F-statistic in Table 3.84, the null cannot be rejected, and the coefficients next to cpi_sa and lshare_sa, are not included in the interpretations. The coefficient next keyrate_sa is positive and statistically significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to an increase in the top 10% income share by about 0.0100%. The coefficient next to unemp_sa is positive and significant, which indicates the presence of the earnings heterogeneity channel. This means that a 1 % increase in unemployment leads to an approximately 0.0239% increase in the top ten percent income share.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.81 to 3.84 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.82 and 3.84, the mean values of unemployment and inflation, which are approximately 5.8071% and 2.1153%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: 0.0100 - 2(0.0008)keyrate_{sa}=0 \qquad (3.81)$$

From equation 3.81, the value of keyrate_sa that maximizes the top 10 percent income share is approximately 6.25%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0039 - 0.0001(5.8071) - 2(0.0009)cpi_{sa} = 0 \qquad (3.82)$$

From equation 3.82, the value of cpi_sa that maximizes the top 10 percent income share is approximately 1.8441%.

$$\frac{\partial \mathrm{top10}}{\partial \mathrm{lshare_{sa}}}: 0.3254 - 2(0.0289)\mathrm{lshare_{sa}} = 0 \qquad (3.83)$$

From equation 3.83, the value of lshare_sa that maximizes the top 10 percent income share is approximately 5.6298%.

$$\frac{\partial top10}{\partial unemp_{sa}}: 0.0239 - 0.0001(2.1153) - 2(0.0015)unemp_{sa}=0 \qquad (3.84)$$

From equation 3.84, the value of unemp_sa that maximizes the top 10 percent income share is approximately 7.8962%.

3.22. Results for the U.S.

This subsection presents the results of estimations for the U.S. Figures 3.22 shows the graphs of the top ten percent income share, monetary policy rate, inflation, unemployment, and logarithm of the Total Share Price Index, respectively. The top ten percent income share in the U.S had a relatively low scale. It started out from one of its lowest values, about 0.4270, but increased to 0.4430 in 2006Q4, declined to about 0.4240 in 2009Q4, increased to 0.4560 in 2012Q4, slightly fluctuated, but ended up at its peak of about 0.4570. The monetary policy rate in the U.S started out from 3%, increased to its peak of 7% in 2007Q1, sharply declined to its minimum of about 0% in 2008Q1 and stayed almost constant until 2015Q3, after which it kept increasing to reach about 3% in 2019Q2, but then fell back to end up at its minimum again. The inflation in the U.S highly fluctuated at a scale of around -1.5% (in 2009Q3) and 5.5% (in 2008Q3 and 2021Q3). Unemployment in the U.S remained at around 5% between 2005Q1 and 2008Q1, after which it increased to around 10% in 2009Q4, kept falling to reach its minimum of about 3.5% in 2019Q3, sharply increased to its maximum of about 12% in 2020Q2, but fell to about 5% in 2021Q3. The logarithm of Total Share Price index in the U.S had a relatively large scale. It started from about 4.20, increased to around 4.55 in 2007Q4, sharply declined to its trough of about 3.90 in 2009Q1, then gradually increased to end up at its peak of about 5.00.

Figure 3.22 Graphs for the U. S's Data

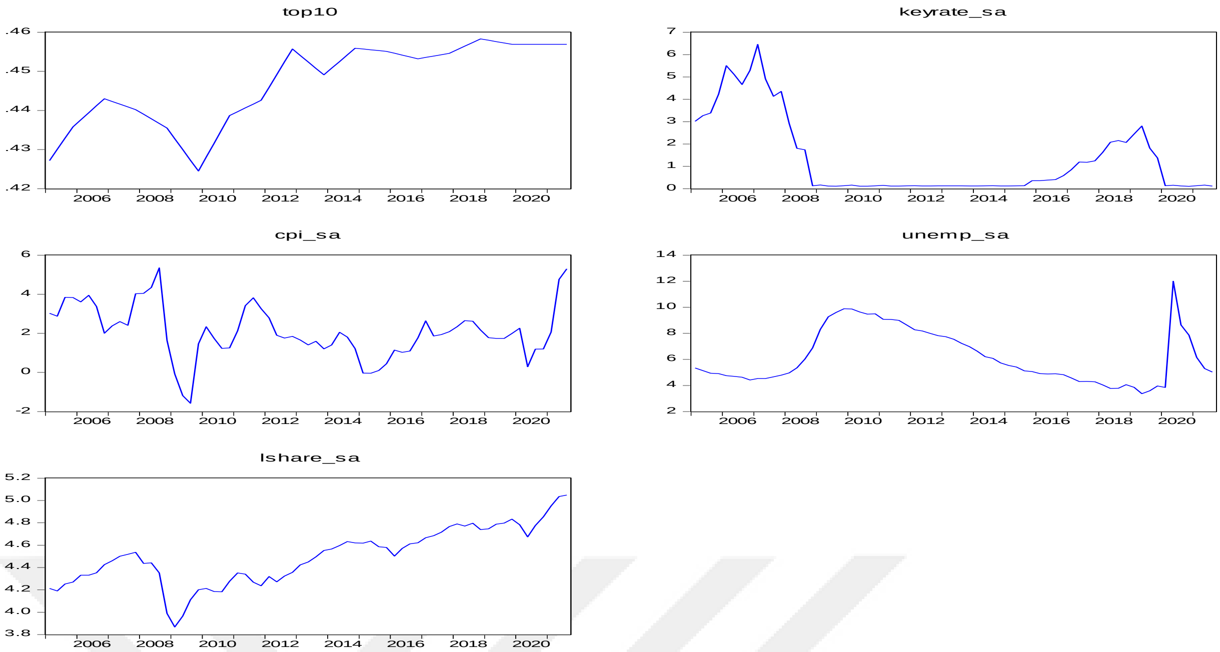

Table 3.85 Results from the ADF, ZA and LS Unit Root Tests for the U.S

Variable	ADF		ZA			LS			
	Intercept	Intercept and Trend	Intercept	Trend	Both	Crash, 1 Break	Crash, 2 Breaks	Break, 1 Break	Break, 2 Breaks
Top10	-1.0020	-3.2769*	-4.3840* 2012Q1	-3.8069 2015Q4	-4.1277 2010Q1	-4.8816*** 2010Q1	-5.1657*** 2010Q2 2011Q2	-4.6745** 2013Q4	-7.4203*** 2008Q3 2012Q1
Keyrate_sa	-2.9132**	-2.7641	-3.8342 2015Q4	-4.8896*** 2009Q1	-3.9514 2010Q1	-3.8184** 2019Q4	-3.9183** 2008Q1 2019Q4	-4.4232** 2016Q3	-5.9955* 2009Q3 2016Q3
Cpi_sa	-3.0526**	-2.7088	-4.0782 2008Q4	-3.6273 2016Q1	-3.2570 2008Q1	-3.0502 2012Q1	-3.1089 2007Q3 2008Q3	-5.9627*** 2008Q2	-6.0096* 2007Q3 2008Q2
Lshare_sa	-0.3425	-2.4754	-6.8375*** 2008Q3	-4.6301** 2009Q2	-6.6657*** 2008Q3	-3.6474** 2007Q4	-3.7616** 2007Q4 2008Q2	-5.2988*** 2008Q2	-6.2992** 2008Q2 2010Q4
Unemp_sa	-2.8679*	-2.8809	-3.3431 2014Q2	-3.3019 2009Q2	-3.7157 2008Q3	-3.3236* 2012Q2	-3.2748 2010Q2 2012Q2	-3.4364 2019Q4	-6.0976** 2009Q3 2019Q4

Note: Stationarity at 1%, 5% and 10% level of significance are represented by (***),(**) and (*) respectively

According to the ZA and LM unit root test results in Table 3.85, after excluding the structural break(s), the variables are I(0). Thus, the Bounds Test approach is not suitable and a stationary ARDL model will be run. Table 3.86 shows the results from the ARDL model for the U.S data.

Table 3.86 ARDL Model for the U.S

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TOP10(-1)	1.3490	0.1417	9.5196	0.0000
TOP10(-2)	-0.4802	0.1239	-3.8758	0.0003
KEYRATE_SA	-0.0003	0.0002	-0.9390	0.3526
KEYRATE_SA(-1)	0.0003	0.0002	1.1543	0.2543
KEYRATE_SA(-2)	-0.0003	0.0002	-1.6038	0.1156
KEYRATE_SA(-3)	0.0004	0.0002	2.7844	0.0078
KEYRATE_SA(-4)	-0.0007	0.0002	-3.2206	0.0023
CPI_SA	0.0002	0.0008	0.2166	0.8295
CPI_SA(-1)	0.0006	0.0003	2.0756	0.0436
LSHARE_SA	0.0290	0.0093	3.1269	0.0031
UNEMP_SA	-0.0002	0.0006	-0.2920	0.7716
INT_CPI_UNEMP	-1.01E-05	7.76E-05	-0.1307	0.8966
KEYRATE_SA_SQ	7.06E-06	2.87E-05	0.2455	0.8071
LSHARE_SA_SQ	-0.0028	0.0010	-2.8164	0.0071
CPI_SA_SQ	-9.54E-05	4.60E-05	-2.0723	0.0439
UNEMP_SA_SQ	1.65E-05	3.33E-05	0.4942	0.6235
C	-0.0143	0.0274	-0.5211	0.6048
Adjusted R-squared	0.9885			
F-statistic	333.6374	Durbin-Watson stat		2.1723

Note: The highlighted values are statistically significant at a 5 % level of significance

According to Table 3.86, the coefficients next to keyrate_sa and its first two lags, cpi_sa, unemp_sa, the interaction term, keyrate_sa_sq, and unemp_sa_sq are individually statistically insignificant (according to the t-test). This calls for the need for Wald Test to determine whether the coefficients can be included in interpretations. It is important to note that the coefficients next to the lagged and squared terms and the interaction term, although individually insignificant, are not included due to the risk of a multicollinearity problem. Table 3.87 shows the result from the Wald Test applied to the data for the U.S.

Wald Test Coefficient Restrictions for U.S

Null hypothesis: keyrate_sa=cpi_sa=unemp_sa=0

Alternative hypothesis: At least one variable is statistically different from zero and thus significant

Table 3.87 Wald Test Result for the U.S

Test Statistic	Value	df	Probability
F-statistic	0.3029	(3, 46)	0.8231
Chi-square	0.9087	3	0.8233

According to the p-value of the F-statistic in Table 3.87, the null cannot be rejected at a 5 % level of significance, and the coefficients next to the keyrate_sa, cpi_sa, and unemp_sa are not included in the interpretations. The collective effect of the third and fourth lags of keyrate_sa is negative and significant, so a contractionary monetary policy (an increase in the monetary policy rate by 1%) leads to a decrease in the top 10 percent income share by about 0.0003 % within four quarters. The coefficient next to lshare_sa is positive and significant, which indicates the presence of income composition and financial segmentation channels. To be exact, a 1 % increase in the logarithm of Total Share Price Index leads to about 0.0290% increase in the top 10 percent income share within the same quarter. Finally, the coefficient next to the first lag of cpi_sa is positive and significant, indicating the presence of the portfolio composition channel. Specifically, a 1% increase in inflation leads to about 0.0006% increase in the top 10 percent income share within one quarter.

Inequality-maximizing/minimizing values of the explanatory variables

Equations 3.85 to 3.88 show the partial derivation technique to find the values of independent variables which minimize or maximize inequality. In equations 3.86 and 3.88, the mean values of unemployment and inflation, which are approximately 6.2034% and 2.0859%, respectively, were inserted into the interaction term.

$$\frac{\partial top10}{\partial keyrate_{sa}}: -0.0003 + 2(7.06E-06)keyrate_{sa}=0 \tag{3.85}$$

From equation 3.85, the value of keyrate_sa that minimizes the top 10 percent income share is approximately 21.2465%.

$$\frac{\partial top10}{\partial cpi_{sa}}: 0.0002 - 1.01E-05(6.2034) - 2(9.54E-05)cpi_{sa} = 0 \tag{3.86}$$

From equation 3.86, the value of cpi_sa that maximizes the top 10 percent income share is approximately 0.7198%.

$$\frac{\partial \mathrm{top10}}{\partial \mathrm{lshare}_{\mathrm{sa}}}: 0.0290 - 2(0.0028)\mathrm{lshare}_{\mathrm{sa}} = 0 \tag{3.87}$$

From equation 3.87, the value of lshare_sa that maximizes the top 10 percent income share is approximately 5.1786%.

$$\frac{\partial top10}{\partial unemp_{sa}}: -0.0002 - 1.01E-05(2.0859) + 2(1.65E-05)unemp_{sa}=0 \tag{3.88}$$

From equation 3.88, the value of unemp_sa that minimizes the top 10 percent income share is approximately 6.6990%.

3.23. Discussion of the Results

This subsection summarizes and discusses the results presented in sections 3.1-3.22. Tables 3.88 and 3.89 summarize the results for each group of countries. Namely, they specify whether the effect of monetary policy on income inequality is positive or negative and list the transmission mechanism(s) that were captured for each country.

Table 3.88 Result Summary for Advanced Economies

Country	The Effect of a Contractionary Monetary Policy on Income Inequality	Transmission Mechanism(s)
Australia	Positive	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
Finland	Negative	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
France	Negative	Portfolio composition, income composition, and financial segmentation
Germany	Negative	None
Iceland	Positive	Earnings heterogeneity
Japan	Negative	Income composition and financial segmentation
Norway	Negative	Income composition and financial segmentation
Spain	Negative	Portfolio composition and earnings heterogeneity
Switzerland	Negative	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
U.K	Positive	Earnings heterogeneity
U.S	Negative	Portfolio composition, income composition, and financial segmentation

Table 3.89 Result Summary for Emerging Economies

Country	The Effect of a Contractionary Monetary Policy on Income Inequality	Transmission Mechanism(s)
Brazil	Negative	Financial segmentation and income composition
Chile	Positive	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
China	Negative	Portfolio composition and earnings heterogeneity
Colombia	Positive	Earnings heterogeneity
Hungary	Negative	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
Indonesia	Positive	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
Mexico	Positive	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity
Poland	Negative	Portfolio composition, income composition, and financial segmentation
Russia	Negative	Income composition and financial segmentation
South Africa	Negative	Earnings heterogeneity
Turkey	Positive	Portfolio composition, income composition, financial segmentation, and earnings heterogeneity

According to Tables 3.88 and 3.89, twelve countries experience negative effect of a contractionary monetary policy conduct on income inequality: Brazil, China, Finland, France, Germany, Hungary, Japan, Norway, Poland, Russia, South Africa, Spain, Switzerland, and the U.S. These findings are consistent with those of Villareal (2014)'s study of Mexico, Davtyan (2017) and Dolado, Motyazovski, and Papppa (2021)'s study of the U.S, and Omar and Richter (2021)'s study of the U.K, U.S, Russia, Germany, France, China, and South Africa. However, they contradict the findings of Lenza Slacalek (2018)'s study of France, Germany, Italy, and Spain, Coibion et al. (2017) and Mumtaz and Theophilopoulou (2016)'s study of the U.S, Furceri, Loungani, and Zdzienicka (2018)'s study of thirty two advanced and emerging market economies, Samarina and Nguyen (2019)'s study of ten euro-area countries, Kulp (2020)'s study of Germany, Napari (2019)'s study of Ghana. Romer and Romer (1999) 's study of seventy countries, and Omar and Richter (2021)'s study of Greece and Chile. Consistent with the theory, portfolio composition, income composition, and financial segmentation channels are present in ten of the aforementioned countries. In contrast, although the only channel that was captured in South Africa was the earnings heterogeneity channel, the effect of monetary policy was still negative. Moreover, the model for Germany failed to capture any of the four theoretical channels that this study attempted to explore. Further research could help resolve this controversy by using different variables in the models for Germany and South Africa. The rest of the eight countries are facing positive effect of a contractionary monetary policy conduct on income inequality: Australia, Chile, Colombia, Iceland, Indonesia, Mexico, Turkey, and U.K. Consistent with the theory, the earnings heterogeneity channel was captured in each of these countries. It is interesting to note that this study's findings are almost fully consistent with those of Omar and Richter (2021)'s, except for the case of the U.K, in which a contractionary monetary policy was found to be inequality-decreasing by the authors.

The difference between the effects of monetary policy on income inequality in emerging and advanced economies is not clear since the study has yielded mixed results: six of the eleven emerging economies and eight of the eleven advanced economies have experienced inequality-decreasing effect of a contractionary monetary policy. Further research could use different proxy variables for the dependent and/or independent variables to explore if there is a distinction.

Table 3.90 presents the values of the independent variables that maximize/minimize the top ten percent income share in each country. The values of inflation and/or unemployment were ambiguous in the models for countries like Australia, Chile, Hungary, Poland, Russia (whose values were all ambiguous except for the unemployment rate), South Africa, and Switzerland in a sense that they are either too small or too large. Ramsey RESET test was applied to test for OVB for each of these models in addition to the model for Germany, which failed to capture the relevant transmission mechanism channels. However, the OVB was not detected except for the case of Russia.

Table 3.90 Inequality-Maximizing/Minimizing Values of the Explanatory Variables for Each Country

Country	Monetary Policy Rate(%)	Inflation (%)	Unemployment (%)	Logarithm of Total Share Price Index
Australia	15.4639(-)	28.1438(-)*	102.7648(-)*	4.7880(+)
Brazil	6.1667(-)	-0.7512(-)	13.4823(-)	4.9712(+)
Chile	3.3279(-)	92.3372(-)*	7.7180(+)	8.5571
China	-0.0811(-)	-23.7412(-)	4.7228(+)	4.1548(-)
Colombia	10.5932(-)	-1.6821(-)	95.0560(+)	7.6818(+)
Finland	1.5625(+)	2.0002(+)	7.9303(+)	4.5891(+)
France	2.4545(-)	1.7964(+)	8.5407(+)	4.9010(-)
Germany	2.6818(-)	6.2228(-)	1.2824(+)	4.4789(-)
Hungary	4.5556(-)	4.0904(-)	-0.3476(-)*	8.9242(+)
Iceland	8.2500(+)	5.2633(+)	6.5096(+)	4.6131(-)
Indonesia	5.8421(+)	4.3054(-)	23.9560(+)	3.8241(-)
Japan	0.7021(-)	1.5331(+)	2.6998(-)	5.0208(+)
Mexico	7.4167(+)	6.5779(+)	4.3404(+)	4.4651(+)
Norway	6.2500(-)	6.1318(+)	1.7710(+)	4.1667(+)
Poland	1.2500(-)	203.1942(-)*	30.2047(-)*	3.1000(+)
Russia	-42.1053(+)*	49.3896(+)*	5.2516(-)	-61.8762(+)*
South Africa	8.5000(-)	-11.3328(+)*	-26.4049(+)*	3.7050(+)
Spain	2.6786(-)	5.1920(+)	12.6778(+)	4.2500(-)
Switzerland	18.8679(+)	-69.3094(+)*	3.5972(-)	4.5645(-)
Turkey	9.3168(+)	7.3477(-)	9.4418(+)	2.3500(+)
U.K	6.2500(+)	1.8441(+)	7.8962(+)	5.6298(+)
U.S	21.2465(-)	0.7198(+)	6.6990(-)	5.1786(+)

Note: Maximizing or minimizing effect of the value is denoted as + or – signs, respectively. An ambiguous result is marked as *.

CONCLUSION AND POLICY RECOMMENDATIONS

This chapter summarizes the results yielded by this study, offers policy implications for each country, provides suggestions for further research, and specifies possible limitations of the study.

Inequality is an exacerbating global issue, which has prompted policymakers, academic researchers, and civil society organizations to search for the various causes of it. Despite the economic growth after 2008 that has slowed inequality in many countries, it is still a major problem, especially in emerging economies. Although central banks around the world have been disregarding the distributional effect of their policies, prioritizing other monetary policy targets, the increasing inequality on a global scale has resulted in a heightened interest of researchers in ‘unconventional’ sources of economic inequality. One such possible source is the conduct of monetary policy, and a considerable number of studies have attempted to discover the link between monetary policy and inequality. However, most of these studies were conducted on either developed or developing economies, and insufficient attention has been given to emerging economies. Moreover, as per the author’s knowledge, no study has attempted to explore whether monetary policy affects inequality differently in developed and emerging economies.

This paper attempts to fill in the gap in the existing empirical literature by studying the effect of a monetary policy conduct on income inequality in eleven advanced and eleven emerging economies, using data from 2005Q1-2021Q3. The monetary policy rate was used as a measure of the conduct of monetary policy, and the top 10 percent income share was used as an indicator of income inequality in the analysis of each country. After the linear conversion of the top 10 ten percent income share (except for a quadratic conversion for Indonesia’s top ten percent income share) to generate quarterly values, an ARDL model (either stationary ARDL or cointegration-based ARDL) was estimated for each country’s data. The estimations have yielded mixed results, with six of the eleven emerging economies and eight of the eleven advanced economies having experienced inequality-decreasing effect of a contractionary monetary policy. The theoretical transmission mechanism channels captured in Brazil, China, Finland, France, Hungary, Japan, Norway, Poland, Russia, Spain, Switzerland, and the U.S, in which a contractionary (expansionary) monetary policy leads to a reduction (increase) in inequality, are consistent with the theory: portfolio composition, income composition, and financial segmentation channels. However, these channels were not captured in South Africa and Germany, and further research could help resolve this contradiction. Similarly consistent with the theory, earnings heterogeneity channel was present in countries that are facing inequality-increasing (decreasing) effect of a contractionary (expansionary) monetary policy: Australia, Chile, Colombia, Iceland, Indonesia, Mexico, Turkey, and the U.K. As for the independent variables that maximize/minimize the top ten percent income share in each country, the values of inflation and/or unemployment were ambiguous for countries like Australia, Chile, Hungary, Poland, Russia (whose values were all ambiguous except for the unemployment rate), South Africa, and Switzerland in the sense that they are either too small or too large. These results should be interpreted with caution, although the Ramsey RESET test did not detect the OVB except for the case of Russia.

The findings imply that strict inflation targeting that gives no monetary allowance (a strict contractionary monetary policy) will likely result in more inequality in Australia, Chile, Colombia, Iceland, Indonesia, Mexico, Turkey, and the U.K. In these countries, light inflation targeting is recommended since strict inflation targeting that is more aggressive to inflationary pressures will increase income inequality. The opposite can be suggested for policymakers in Brazil, China, Finland, France, Hungary, Japan, Norway, Poland, Russia, Spain, Switzerland, and the U.S.

Further studies could use different proxy variables to improve the analysis of the transmission mechanism channels in each country. Additionally, future research could opt for the employment of Impulse Response functions by Jorda (2005) within the VAR framework to better trace the transmission mechanism channels.

Interpretation and generalization of the results of this study should be done with caution due to the usage of various data transformations described in Chapter 3. Moreover, the top 10 percent income share, which is technically defined as “Pre-tax national income share held by the p90p100 group”, involves income before taxes have been paid out, while ideally, post-tax (disposable) income share would have provided better results. The availability of *disposable* income share data in quarterly form for each of the studied countries could help improve this analysis. Further studies could use a different inequality measure, which will ideally involve disposable income inequality since that might give a clearer picture and prevent the possible effects of data bias. Finally, due to the lack of a suitable variable that could directly capture the savings redistribution channel through the value of the real household debt, this channel could not be explored by this study.

From a strictly methodological point of view, the ARDL approach is not devoid of its weaknesses, despite its many advantages that have been explained in chapter 3. It is important to note that the usage of the ARDL model might have violated the assumption of strict exogeneity of the explanatory variables, which is necessary for OLS estimates to be unbiased and consistent (Kulp, 2020). This is because the ARDL model contains lagged dependent variable, and the models used in this study were not an exception. However, robust standard errors were used in the estimations for each country, namely HAC standard errors to make the results as accurate as possible.

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